

1

Introduction

2

Thruster Unit

3

Well-Box

4

Hydraulic Steering System

5

Lubrication Oil System

6

Instruction Manual Control System

7

Commissioning & Test

8

Maintenance

9

10

LIPS THRUSTERS DRUNEN B.V.

MANUAL

for

FS 2500 - 450 / 1510 BO

STEERABLE THRUSTERS

T07300/01

**LIPS THRUSTERS DRUNEN B.V.
LIPSSTRAAT 52
P.O.BOX 6
5150 BB DRUNEN
THE NETHERLANDS**

LIPS THRUSTERS DRUNEN B.V.**MANUAL STEERABLE THRUSTER FS 2510 / 1510 MN**

<u>CHAPTER</u>	<u>TOPIC</u>
<u>1</u>	<u>Introduction</u>
1.1	General and Technical Data
<u>2</u>	<u>Thruster Unit</u>
2.1	Floating Shaft
2.2	Brake System
2.3	Upper Gearbox
2.4	Stem Section
2.4.1	Steering Unit
2.4.1.1	Hydraulic Steering Motor
2.4.1.2	Planetary Reduction Gearing
2.4.1.3	Azimuth Feedback Unit
2.5	Intermediate Shaft
2.6	Shank Assembly
2.7	Lower Gearbox
2.7.1	Propeller Shaft Seal
2.8	Propeller Assembly
2.8.1	Propeller
2.9	Cathodic Protection
<u>3</u>	<u>Well-box</u>
3.1	Adjustible Thrust Blocks



LIPS THRUSTERS DRUNEN B.V.

MANUAL STEERABLE THRUSTER FS 2510 / 1510 MN

<u>CHARTER</u>	<u>TOPIC</u>
<u>4</u>	<u>Hydraulic Steering System</u>
<u>5</u>	<u>Lubrication Oil System</u>
<u>6</u>	<u>Control System</u>
<u>7</u>	<u>Commissioning and Testing</u>
<u>8</u>	<u>Maintenance</u>
8.1	Non-Operation Period
8.2	Tools
8.3	Ordering Spare Parts
8.4	List of Representatives
<u>9</u>	<u>Instructions and Information Sheets</u>
<u>10</u>	<u>Appendix</u>
	Hydraulic System Components
	Lubrication System Components

List of Figures and Instructions

Chapter	Ident.nr	Parts list	Title	Rev
1	3004323		Arrangement FS 2500 - 450/1510 B0	0
1	3004330		Block diagram thruster control 2500 range	0
1.1			Classification data	0
1.1			Main technical data	0
1.1	3000514		Lips Thrusters paint specification	5
2.1	2017120	T073010061	Floating shaft	1
2.2	2017114	T073010062	Brake assembly	1
2.2	1054637	T073010064	Brake system	2
2.2	1009908		Disc brake caliper	0
2.3	2016915	T073000041	Upper gearbox complete	5
2.3	2017123	T073010042	Flange assembly	2
2.3	2007337		Mounting instructions taper fit (steel-steel)	0
2.3	2051935		Mounting of flange	2
2.3	2006192		Taper fit: blank form	0
2.3	3004611	T073010044	Assembly switch	0
2.4	3016917	T073010021	Stem section	1
2.4.1	2013110	T073010023	Steering unit	3
2.4.1.1	2013108		Hydraulic motor SAI M2 series	3
2.4.1.1	2016665		Hydraulic motor components	0
2.4.1.2	2013109		Planetary reduction gear	2
2.4.1.2	3001656		Mounting ring	0
2.4.1.3	2014339	T073010024	Azimuth feedback unit	4

Chapter	Ident.nr	Parts list	Title	Rev
2.4.1.3	3002491		Azimuth feedback unit	1
2.4.1.3	2010530	T073010035	Transmitter foundation	4
2.5	3004049	T073010022	Intermediate shaft	0
2.6	1017991	T073010014	Shank assembly	5
2.7	2013539	T073000011	Lower gearbox F2500	8
2.7	2001357	T073010016	Fin	2
2.7.1	W007090364	W007090364	Thruster seal assembly	C
2.8	1017990	T073010013	Propeller assembly	4
2.8	2006192		Keyless propeller mounting	
2.8	2006192		Taper fit: blank form	
2.8			Keyless propeller fit: calculation sheet	
2.8	1016061	T073010018	Propeller mounting	6
2.8.1	W009953103	W009953205	F.P. Propeller	0
2.9	2016967	T073010017	Anode plan type 2500	1
3	3002698	T073010080	Well-box	0
3	2017106		Well-box	3
3.1	3003802	T073010083	Adjustable thrust blocks	0
3.1	3003801		Installation of can with adjustable thrust blocks	1
4	TN 24.006E		General operating and maintenance instructions	
4	3000092 sh.2		Table of lubricants	
4	3004137		Flushing of hydraulic systems	
4	3004327	T073010070	Hydraulic diagram	0
4	3004329		Hydraulic power pack steering system	0

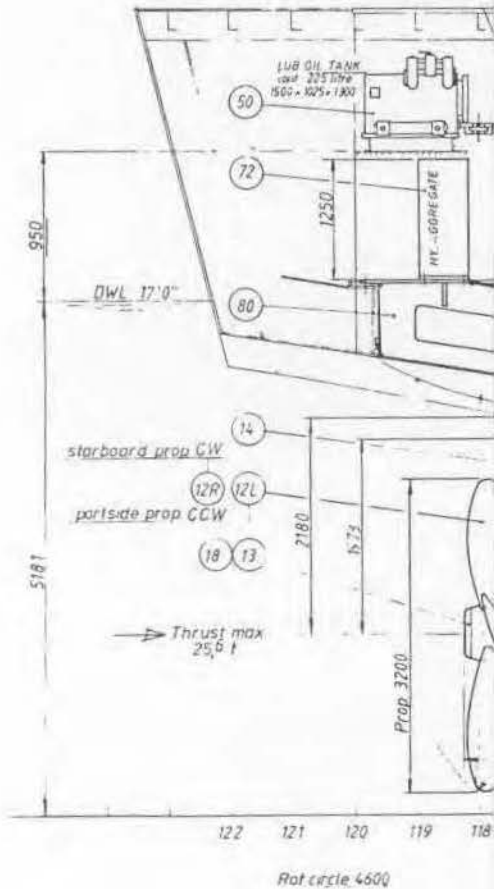
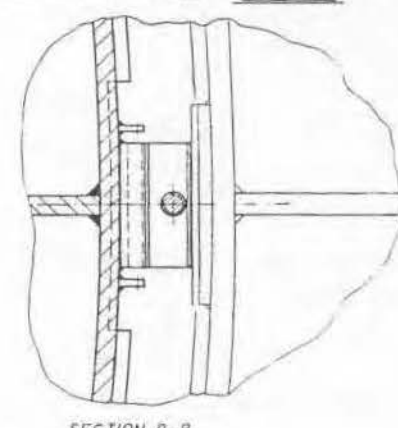
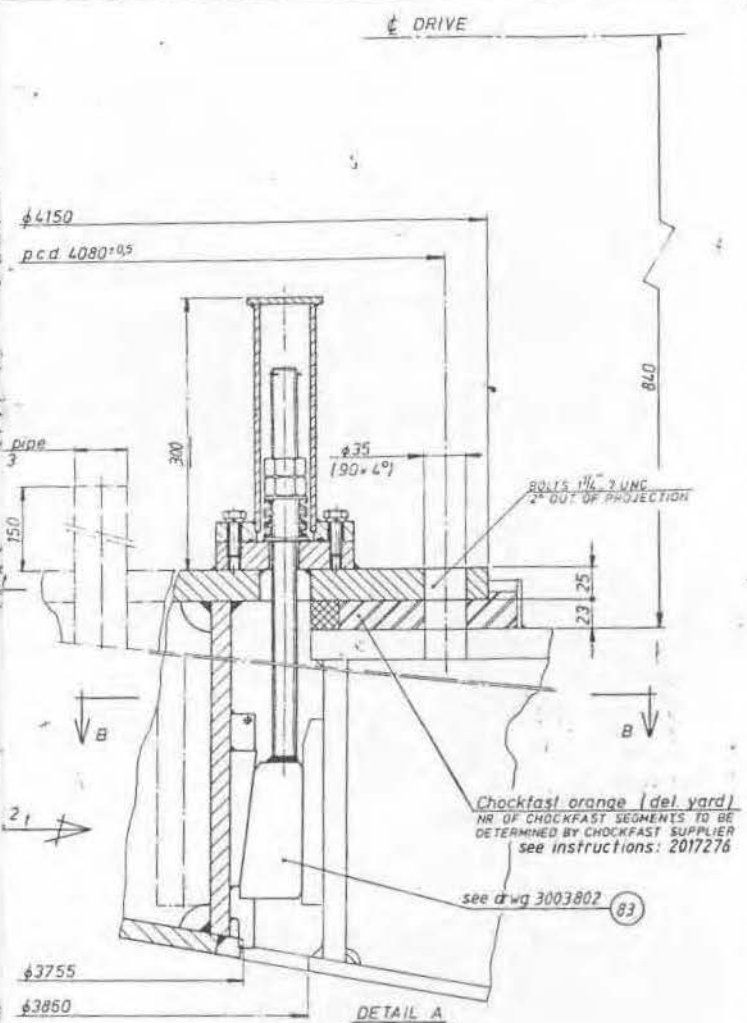
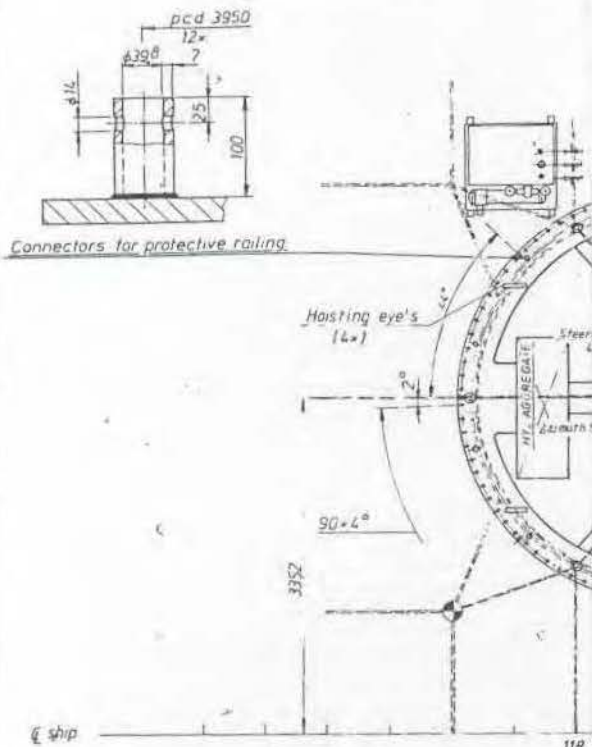
Chapter	Ident.nr	Parts list	Title	Rev
5	3000092 sh.2		Table of lubricants	
5	3004325		Lubrication system	0
5	3004355	T073010051	Tank-filter-cooler unit	0
5	2017090	T073010052	Pump unit	1
5	2017171	T073010057	Lube oil and hydraulic conn. on well-box	2
5	2016763	T073010053	Upper gearbox lube oil parts	1
5	2016765	T073010058	Three-way valve assembly	1
6.3.8	W000810409		Lay-out MCS panel	
6.3.8	W000810410		Lay-out bridge panel port	
6.3.8	W000810411		Lay-out bridge panel stbd	
6.3.8	W000810412		Lay-out bridge panel control transfer	
6.3.8	W000810413		Lay-out MCS panel control transfer	
6.3.8	W000810407		Cable and connection diagram	
6.3.8	W000810408		Electric diagram	
6.3.8	W000810406		Control cabinet	
6.3.9	W000808426		CAT (Coordinating Azimuth Thruster control module)	C
6.3.9	W000808226		CAT (Coordinating Azimuth Thruster control module)	-
6.3.9	W000808578		LU	A
6.3.9	W000808702		PPM	B
6.3.9	W000808848		ST	A
6.3.9	W000808646		ISV	B
6.3.9	W000806455		RIM	E
6.3.9	W000807760		RIM	-

Chapter	Ident.nr	Parts list	Title	Rev
6.3.9	W000808827		WB	A
7			General survey of activities to be carried out during commissioning and testing	
8			Maintenance	
8			Sampling instruction "AGOR NOAA"	
8.1			Non-operation period	
8.2	2050610	T072990096	Pumpset for (dis)mounting taper & cylind. fits	3
9	2050443		Torque manual	E
9	2005099		Information on "Loctite" products	
9	2007926		Assembly instructions lube and hydraulic piping	2
9	2010625		Mounting, maintenance and lubrication instructions for curved tooth couplings	
9			Instructions for mounting and storing hydraulic motors	
9			Trouble shooting hydraulic motor failure	
9	3004163		Hydraulic steering motor: Motor strip-down procedure	
9			"Brevini Nederland" instructions	
9	T003004075		Method of seal replacement "Waukesha" propeller shaft seal	
9	2017276		Work procedure for watertight pouring of thruster foundation	

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 1

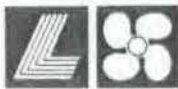
INTRODUCTION



Drill after pre-assembly, see instruction 3003801
 BLOCK DIAGRAM: 3004330 - Lub oil block-scheme 3004355
 TOTAL WEIGHT 27 900 kg (incl. can & oil)
 Auxiliaries 1200 kg appr

Job. nr. T07300.01

LIPS THRUSTERS BV		Arrangement 2500-450/1510 B0		A0	
3004323		3004323		3004323	



LIPS THRUSTERS DRUNEN B.V.

INTRODUCTION

General

The AGOR NOAA is equipped with two fixed pitch steerable stern thrusters, type FS2500-450/1510 BO.
For arrangement see drawing 3004323.

Both independently operating thrusters are single or dual controlled.

Note: starboard thruster is not identical to port-side thruster (different direction of rotation).

Each thruster is built up from a number of sub-assemblies accommodated in a fabricated steel structure (well-box). The vessel is fitted with a vertical well, running from the vessel's bottom to its interior, to receive the well-box. The well-box top cover plate is bolted on to the well top chord. On the lower side the created forces are transmitted through adjustable thrust blocks.

The upper side of the recess in the well-box which accommodates the thruster stem section is closed by the steering gearbox. The lower gearbox with propeller is connected to the steering pipe which projects from the vessel's bottom.

Auxiliaries, such as hydraulic units for steering and cooler, are arranged close to the thruster.

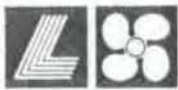
The thruster

The power of the horizontal prime mover is transmitted through a floating shaft to the input shaft of the upper gearbox. Between prime mover and thruster an electro-pneumatic controlled holding disc brake is provided. The secondary shaft of the upper gearbox is connected to the primary shaft of the lower gearbox through a vertical intermediate shaft.

Both gearboxes are fitted with spiral bevel gearsets, made of special high quality forged steel, case hardened and fine machined after hardening to Class 6 - DIN 3965 - (H.P.G. process) or better.

The crown wheels as well as the pinions are independently supported on both sides by anti-friction type bearings in order to minimize deflections and to assure optimal teeth contact under all load conditions.

The propeller shaft is fitted with a 4-bladed cunial mono-block propeller.
The propeller shaft seal is a triple lip seal, running at a liner with ceramic coating.



LIPS THRUSTERS DRUNEN B.V.

The propeller gearbox is bolted to the steering pipe, which is carried on roller bearings inside the support pipe, so that it may be rotated around its vertical axis through the steering gearbox connected to its top.

The steering gear is driven by geared hydraulic motors. A triple lip seal with ceramic coated liner is provided between the rotating steering pipe and the stationary support pipe.

Auxiliary systems

Lubrication

The lower gearbox, including the space inside the steering pipe, is fully flooded with lube oil and provided with a circulation system, consisting of electrically driven pump, twin filters, header tank, controls and alarms.

The lube oil pump takes suction from the lowest part of the lower gearbox via suction pipe and rotary seal at the top of the steering gearbox; return of oil via the inside of the steering pipe.

The same suction line may be used to drain the lube oil from the thruster in case of an oil change in case of an oil change with the vessel afloat.

Due to the prescribed mounting height of the header tank a positive pressure difference against the surrounding sea water is maintained on the thruster's dynamic seals.

The unit is fully flooded under all conditions, thus preventing any possible condensation.

Note: Failure of the lube oil circulation pump does not affect the proper lubrication of the gears.

The steering gearbox and the space between steering and support pipes is completely filled with lubrication oil and connected to the header tank to maintain a positive pressure difference over the triple lip sea against the surrounding sea water.

Note: The complete thruster unit is kept fully filled with lube oil to prevent corrosion by condensation.

The upper gearbox is fitted with a forged lubrication system, consisting of a tandem pump unit, with circulation pump (common with lower gearbox) and level pump, twin filters, coolers, valves, controls and alarms (common with lower gearbox).

The level pump maintains the operational oil level in order to minimize churning losses, however, when the thruster is idle the upper gearbox is automatically flooded with lubrication oil to prevent condensation.

Note: In the event of level pump failure the thruster may be operated at reduced power.



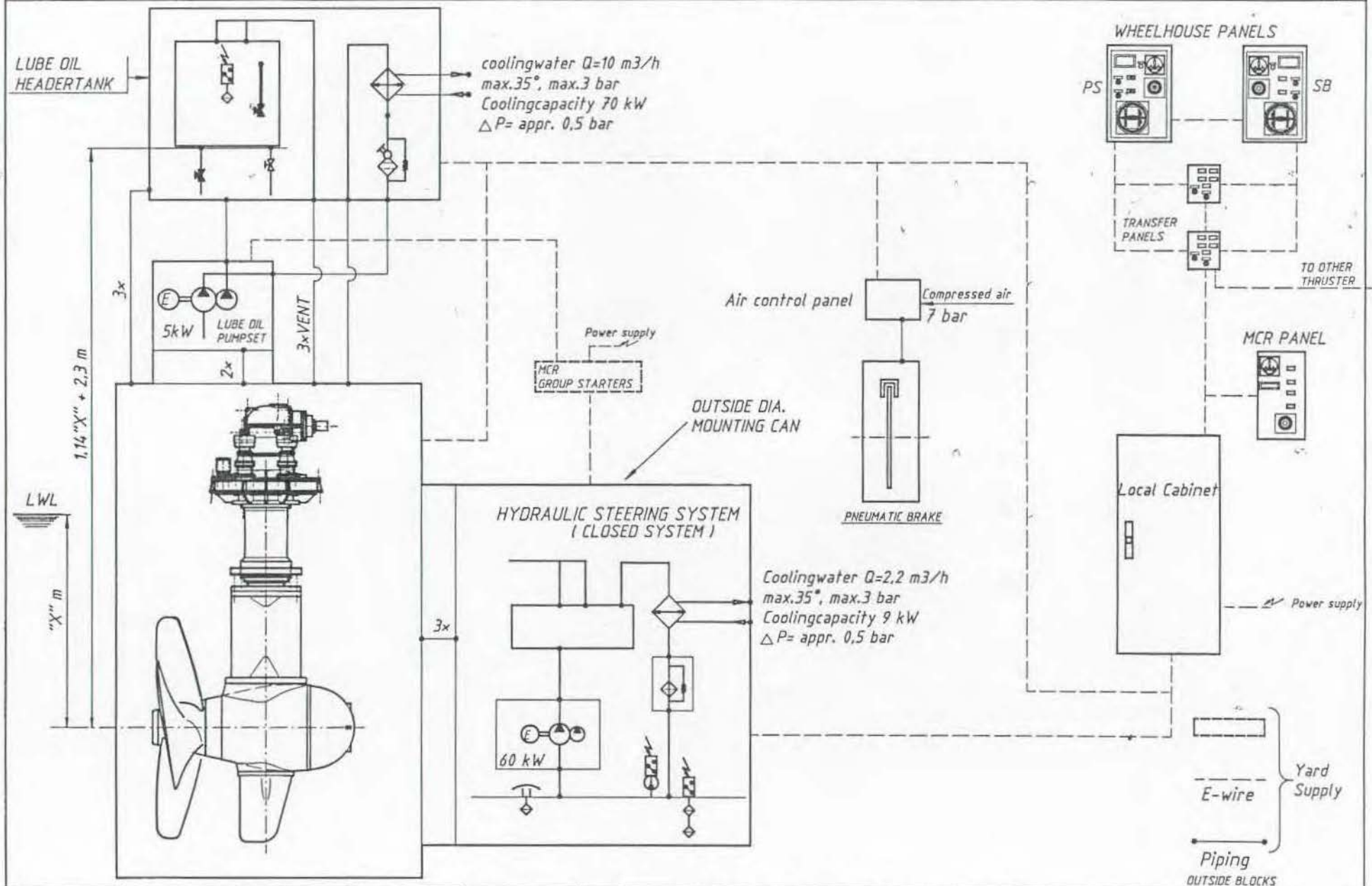
LIPS THRUSTERS DRUNEN B.V.

Hydraulic steering

The oil for steering is supplied by a electrically driven hydraulic pump.

The oil flow to the steering motors is controlled between zero and maximum for both directions of rotation.

The hydraulic powerpack includes all necessary elements for proper functioning of the system, such as safety valves, control valves, tank, cooler with thermostatic three-way valve, pressure sensors and alarms and discharge filters.



LIPS THRUSTERS DRUNEN B.V.

CHAPTER 1.1

GENERAL AND TECHNICAL DATA



LIPS

Lips Thrusters Drunen BV

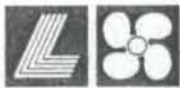
P.O. Box 6
 5150 BB Drunen
 The Netherlands
 tel: +31 4163 88115
 fax: +31 4163 76549

Classification Data Sheet

Date of issue	1994.10.24	PLEASE QUOTE THE ORDER NR. ON ALL DOCUMENTS
Order nr.	T07300/01	

Class Bureau	ABS
Class notation	+ A1, + AMS, + ACCU, Ice Class C0, E
	USCG (cf. Code of Federal Regulations, Title 46, Subchapter U and NVIC 1-69 with encl. (1) and NVIC 6-84 "Guide for the automation of Main and Auxiliary Machinery" resp. "Supplementary Guidance on Automated Main and Auxiliary Machinery").
Operation area	Unrestricted

Owner	Name	U.S. Navy
	Address	
	Country	U.S.A.
Vessel	Type	Oceanographic Research Vessel
	Main dimensions	80 x 15.8 x 8 mtr approx.
	New / existing	New
	Name	Class Designation: AGOR NOAA
Shipyard	Name	Halter Marine Inc.
	Address	Moss Point, MS
	Country	USA
	Hull nr.	1417
Thruster	Service type	Main propulsion, DP
	Number of units	2
	Designation	steerable, can-mounted stern thrusters
	Type	FS 2500-450 / 1510 BO
	Propeller dia	3200 mm
	Units per vessel	2
Prime mover	Manufacturer	G.E.
	Type	DC electric
	Max. Cont. Rating	3000 HP (2206 kW) / 900 rpm
	Ice Class Rating	same
	D.P. Rating	same
	Contract Rating	
internal copies:		file: T7301.CDS ID-nr: LTDAC



LIPS THRUSTERS DRUNEN B.V.

MAIN TECHNICAL DATA

Thruster type	: FS 2500-450/1510 BO
Input power	: 2206 kW
Input speed	: 900 rpm.
Maximum input torque	: 25600 Nm.
Reduction ratio (total)	: 5,077
Project drawing	: 3004323
Block diagram	: 3004330
Direction of rotation of input shaft (looking at thruster input shaft)	: SB: CW, PS: CCW
Calculated life time gears	: infinite
Propeller speed	: 177 rpm.
Propeller diameter	: 3200 mm. (4-blade FPP).
Propeller manufactured and finished to	: ISO 484/1-1981 (E) Class I
Propeller material	: Cunial.
Steering speed	: 2 rpm.
Electrical power (yard supply)	
- Auxiliaries	: 480 V - 60 Hz
- Control instruments	: 120 V - 60 Hz
- Emergency supply	: 24 V - DC
Auxiliaries pump power consumption	
- Lube oil system	: 5 kW.
- Hydr. steering system	: 60 kW.
Cooling water requirements (temp. max. 38 ⁰ C, press. 3 bar)	
- Lube oil system	: appr. 10 m ³ /h
- Hydr. steering system	: appr. 2,2 m ³ /h
Weight units	
- Thruster unit (incl. well-box & oil)	: appr. 27900 kg.
- Auxiliaries	: appr. 1200 kg.
Cathodic protection	: zinc anodes, 5 years protection
Painting	: 3000514
Prime mover (supplied by others)	: E-motor
Power	: 2206 kW
Speed	: 900 rpm.

id.nbr. 3000514
d.d. 1990.03.20
index 5 (92.08.27)

LIPS THRUSTERS PAINTSPECIFICATION

All components with exception of stainless steel, bronze/brass, rubber/synthetic and fit- and sliding-surfaces;

Pre-treatment (in case no primer-paint is applied):

Casting: Blasting according SA 2.5, ISO 8501-1
Steel (not pre-machined): Blasting according SA 2.5, ISO 8501-1
Steel (pre-machined): De-greasing

Blasting only after (if necessary) removal of oil/grease etc..

Painting:

	<u>Colour</u>	<u>Dry film-thickness</u>
<u>All components (primer)</u>		
- one layer AKZO REDOX EP3210 universal primer (1034997)	cream	50 microns
<u>Dry parts (including systems)</u>		
- above described primer (in case not yet applied)		
- one layer AKZO RUC 2300 coating SV (3000517)	white RAL9003	50 microns
- one layer AKZO RUC 2300 coating SV (3000517)	l.grey RAL7035	50 microns
- one layer AKZO RUC 2325 coating (3000516)	grey RAL7040	40 microns
<u>Wet parts</u>		
- above described primer (in case not yet applied)		
- one layer AKZO REDOX 3314 coat. HB (3000197)	l.grey MVD103	125 microns
- one layer AKZO REDOX 3314 coat. HB (3000197)	d.grey MVD110	125 microns

General:

- In case the correct primer is applied, the material can, after cleaning, degreasing and drying, be treated without further pre-treatment as described above.
- In case of damages or deterioration the concerning spot has to be pre-treated (blasting/de-greasing) again and re-painted.
- Damages (f.e. caused by welding or transport), which can be recovered immediately, may be repaired.
- All materials have to be protected as far as possible before assembly, welding etc. by the first coating (primer).
- Surface preparations, equipment and applications to be strictly in accordance with paint manufacturers specifications (part of this specification; id. nbrs.: 1034997, 3000197, 3000516, 3000517).
- Tiecoat and antifoulingssystem (same as on hull) to be applied on wet parts by building yard.



LIPS

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LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2

THRUSTER UNIT

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.1

FLOATING SHAFT

LIPS THRUSTERS DRUNEN B.V.

2.1 HORIZONTAL FLOATING SHAFT

The power of the prime mover (horizontal E-motor) is transmitted to the upper gearbox input shaft by means of a floating shaft.

The floating shaft arrangement consists of two curved tooth couplings and a rigid shaft.

As the design of the crowned teeth of the hubs which engage with the internal teeth of the flanged sleeves forms a joint, the entire coupling is double-jointed and therefore flexible, and so the couplings can compensate for angular and parallel offset misalignment of shafts which are not accurately aligned and permits axial movement of shafts.

The floating shaft includes a brake disc; diameter 915 mm.

Gear teeth require lubrication. The couplings are therefore provided with grease. Seals are fitted into the end rings to prevent leakage of grease and ingress of dirt.













For mounting, maintenance and lubrication instructions see chapter 9, ident nr 2010625.

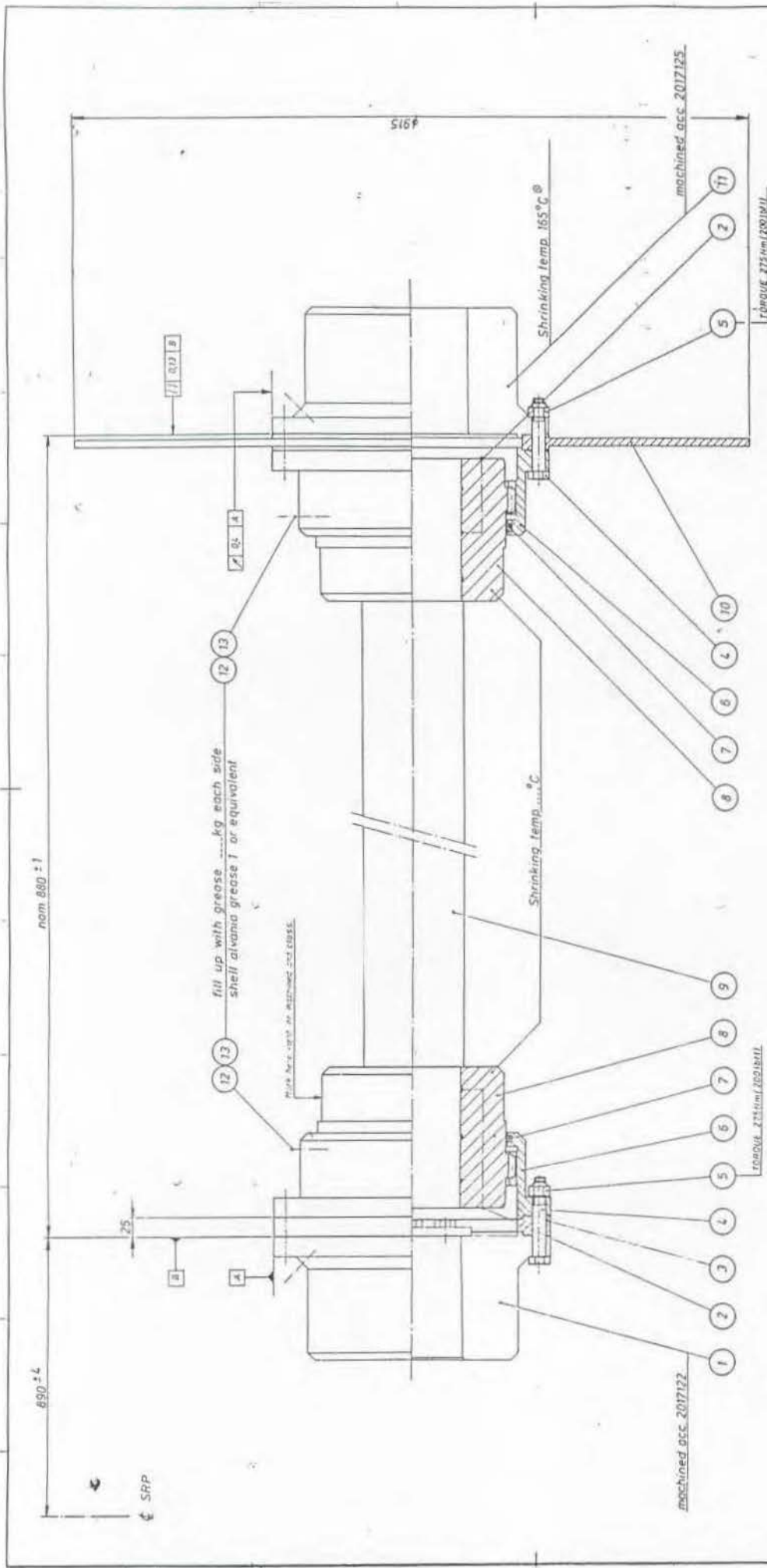
Floating shaft : **Bogenzahn-Kupplungen**

Curved Tooth Couplings

accouplements a denture bombée · acoplamientos de engranajes con dientes arqueados

Schmierstofftabelle · Table of lubricants · Tableau de lubrifiants · Table de lubrificantes

LIPS THRUSTERS	ISO-Viskositätsklasse	ISO viscosity class	ISO-Classe de viscosité	Clase de viscosidad ISO
 Agip				Fettschmierung (- 10° C bis + 90° C) Grease lubrication (- 10° C + 90° C) Lubrification à la graisse (- 10° C à + 90° C) Lubrificación con grasa (- 10° C hasta + 90° C)
				Aralub FDP 00
				BP Engergrease HT 0
				IMPERVIA MMO
				Chevron Dura-Lith Grease EP 0
				PEN-O-LED EP GREASE FIBRAX 370, FIBRAX EP 370
				MARSON EPL 1 MARSON EPL 2
				GRAFLOSCON C SG 0 STRUCTOVIS BHD MF
				Mobilplex 46 Mobilplex 47
				CALITHIA EP T1 ALVANIA EP 1
				Multifak EP2
				TACKE -Longlife Grease für 25.000 Betriebsstunden bzw. 5 Jahre (- 10° C bis + 120° C) for 25.000 operation hours or 5 years, resp. (- 10° C up to + 120° C)



For mounting instructions pos 1 see 2017123
 For coupling alignment instructions see 2010625

LBGK 160		SRP 1510		1.2.3		460 kg	
				20171210 1			
FLOATING SHAFT ASSEMBLY							

MIT ABW-NACH DIN 50028 3°C DURCHF. EMP. PLUS 0,05% GEWOLLE
 METADINAMIF 110,5 DIN 50033 31°C LOS-VERFAHREN
 HINRICHTEN: C.F. DIN 50034 31°C BP 4 11-455 SOCIETY

TITLE : FLOATING INTERMEDIATE SHAFT
TYPE : E=880 L=822
LIST : T073010061

PAGE : 1
DRAWING : 2017120
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	FLANGE	T002017122	1,0
11	FLANGE	T002017125	1,0
210	FLOATING INTERMEDIATE SHAFT	T002017120	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

E N D O F L I S T

1. Montage

1. Mounting

**1.1 Prüfen und
Reinigen**

**1.1 Testing and
cleaning**

1.1.1 Die Konservierung der Kupplungsteile wird, wenn nicht gesondert vereinbart, für normale Transportbedingungen vorgenommen. Der Korrosionsschutz gilt für ca. 6 Monate unter der Voraussetzung, daß die Teile sachgemäß gelagert werden (u. a. trocken und keine saure Atmosphäre). Vor Montagebeginn ist die Kupplung auf Vollständigkeit zu prüfen.

Alle Dichtflächen und Teile sorgfältig mit Benzin oder Nitro-Verdünnung (kein Petroleum) von Konservierungsmitteln säubern und entfetten.

1.1.1 The coupling components shall be protected for normal transport conditions, unless otherwise agreed upon.

The corrosion protection shall remain effective for about 6 months provided that the components are properly stored (i. e. in a dry non-acidic atmosphere).

Before commencement of assembly check that the coupling components are complete.

All sealing surfaces and parts must be thoroughly cleaned and degreased with benzine, nitro-diluent (no petroleum) to remove the conservation agents.

1.2 Montage

1.2 Mounting

1.2.1 Je nach Kupplungstyp Nabe mit aufgesetztem Gehäuse und O-Ringabdichtung bzw. Flansche mittels Schrauben oder Vorrichtung aufziehen. Aufziehen der Kupplungsteile durch Schläge ist nicht gestattet.

1.2.1 Depending on type of coupling, draw on the hub with mounted housing covers and O-ring seals resp. flange and spindle housing with screws or draw-on device. The coupling components must not be forced on by blows.

1.3 Wellen-/Naben-Verbindung

1.3 Connection of shafts and hubs

Aus der Vielzahl der Wellenverbindungen sind hier die gebräuchlichsten Arten aufgeführt.

1.3.1 Paßfederverbindung

Es wird empfohlen, Bohrung, Welle, Nut und Feder auf Maßhaltigkeit zu prüfen. Nabe mit aufgesetztem Gehäuse und O-Ring aufziehen.

Paßfedern in die Wellen einlegen. Zum leichteren Aufziehen kann die Kupplungsnabe leicht erwärmt (ca. 80° C) werden. Dabei ist die O-Ringdichtung vor Erwärmung zu schützen.

1.3.2 Einfache Schrumpfverbindung

Die erwärmte Kupplungsnabe mit hinterlegtem Gehäuse und O-Ringdichtung aufziehen. O-Ringdichtung gegen Erwärmen schützen. Paßflächen dürfen nicht mit Molykote oder ähnlichem eingeschmiert werden.

1.3.3 Zum Warmaufziehen Naben bzw. Flansche vorzugsweise im Elektro-Ofen oder mittels Gasringbrenner auf die erforderliche Schrumpftemperatur gleichmäßig und sachgerecht erwärmen. Vor dem Aufziehen die Aufweitung der Bohrung durch Kontrollmessung prüfen.

1.3.4 Ein relativ einfaches Hilfsmittel zur Temperaturüberwachung ist die sogenannte „Temperaturkreide“.

1.3.5 Abziehen der Naben nach dem Bratt- bzw. Öldruckverfahren. (SKF-Verfahren)

1.3.6 Vor dem Abziehen der Kupplungsnaben sind die Gehäuse von den Naben zurückzuschieben.

1.3.7 Druckölgerät mit den Nabenanschlußstellen verbinden und Öl in den Verband pressen, bis es an den Enden austritt.

1.3.8 Nunmehr Abziehvorrichtung ansetzen und Nabe unter Druck abziehen.

1.3.9 Beim Lösen muß der Druck etwas höher sein als die Flächenpressung im Verband. Im Mittel sind ca. 150 N/mm² ausreichend.

The standard types of shaft connection are listed here out of the many possible types of connection.

1.3.1 Fitting-key connection

It is advisable to check the dimensional accuracy of bore, shaft, groove and key.

Fit housing cover and O-ring seals, and insert fitting keys into the shafts. To facilitate drawing on the coupling hood can be slightly heated (up to about 80° C). In doing this protect the O-ring seal from heating.

1.3.2 Simple shrink-on connection

The heated coupling hubs with fitted housing cover and O-ring seals are drawn on. O-ring seals must be protected against heating. Fitting surfaces must not be greased with Molykote or similar.

1.3.3 For the hot drawing-on of hubs resp. flanges or spindle housings in an electric kiln or by means of a gas-ring burner, the components must be heated up to the required shrinking temperature uniformly and carefully.

Before drawing-on check the bore expansion by measurement.

1.3.4 A relatively simple aid for temperature monitoring is the so-called "temperature chalk".

1.3.5 Drawing off of hubs using the Bratt or oil-pressure method (SKF method)

1.3.6 Before drawing off of the coupling hubs, the housings must be pushed back from the hubs.

1.3.7 Connect up pressure-oil unit to hub connection points and force oil into the joint until it comes out at the ends.

1.3.8 Now apply the draw-off device and draw off the hub under pressure.

1.3.9 For dismounting the pressure must be slightly higher than the contact pressure in the joint. On average 150 N/mm² are sufficient.

1.4 Ausrichten
1.4 Alignment

1.4.1 Nach dem Aufziehen der Kupplungsteile sind die zu verbindenden Maschinen mit einer Toleranz von $\pm 0,5$ mm auf den Abstand „E“ auszurichten.
1.4.2 Die Angaben des Maschinenlieferanten sind hierbei grundsätzlich zu beachten.

1.4.1 After the drawing-on of the coupling components the machines to be connected must be aligned to a tolerance of ± 0.5 mm (with the exception of holder-ring couplings) at distance E.
1.4.2 The machine supplier's indications must be observed.

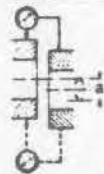
1.5 Ausrichtgenauigkeit
1.5 Precision of alignment

Die Genauigkeit des Ausrichtens wird aus dem Drehzahlbereich hergeleitet. (Siehe Tabelle 1-2)

The precision of alignment is a function of the speed range. (Table 1-2)

Maß E Dimensions mm		Ausrichtwerte, max. zul. Höhenversatz a in mm Alignment values, max. admissible vertical displacement a in mm								
		Betriebsdrehzahl in min ⁻¹ / Operating speed in min ⁻¹								
		bis/to 250	über over 250	bis to 630	über over 630	bis to 1600	über over 1600	bis to 4000	über over 4000	bis to 10000
über/over	bis/to									
	200	0,25	0,2		0,16		0,1		0,063	
200	500	0,5	0,35		0,25		0,17		0,112	
500	1000	1,0	0,75		0,53		0,38		0,25	
1000	1500	2,0	1,25		0,85		0,63		0,4	
1500	2000	2,5	1,7		1,2		0,9		0,6	
2000	2500	3,2	2,24		1,6		1,12		0,75	
2500	3000	4,0	2,8		1,9		1,32		0,85	
3000	3500	4,5	3,2		2,24		1,9		1,12	
3500	4000	5,3	3,75		2,65		1,9		1,25	

Tabelle 1 / Table 1



Höhenversatz
Vertical displacement



Klaffung
Gap

Maß E Dimensions mm		Ausrichtwerte, max. zul. Klaffung b - c in mm Alignment values, max. admissible gap b - c in mm								
		Betriebsdrehzahl in min ⁻¹ / Operating speed in min ⁻¹								
		bis/to 250	über over 250	bis to 630	über over 630	bis to 1600	über over 1600	bis to 4000	über over 4000	bis to 10000
bis/to	4000	0,25	0,2		0,16		0,1		0,063	

Tabelle 2 / Table 2

1.5.1 Zum genauen Ausrichten ist eine Meßuhr erforderlich. (Abb. 1)
1.5.2 Das Fluchten der Naben bzw. Flansche ist an mehreren Stellen durch Vergleichsmessung zu prüfen.
1.5.3 Bei Kupplungen mit größeren Abständen erfolgt das Ausrichten mittels optischer Geräte, Theodolit, oder anderen entsprechenden Vorrichtungen. (Abb. 2)

1.5.1 For precise alignment a dial gauge is necessary. (Fig. 1)
1.5.2 Alignment of hubs resp. flanges must be checked at several points by comparative measurements.
1.5.3 In the case of couplings with larger distances alignment is by means of optical instruments, theodolite, or other similar instruments. (Fig. 2).

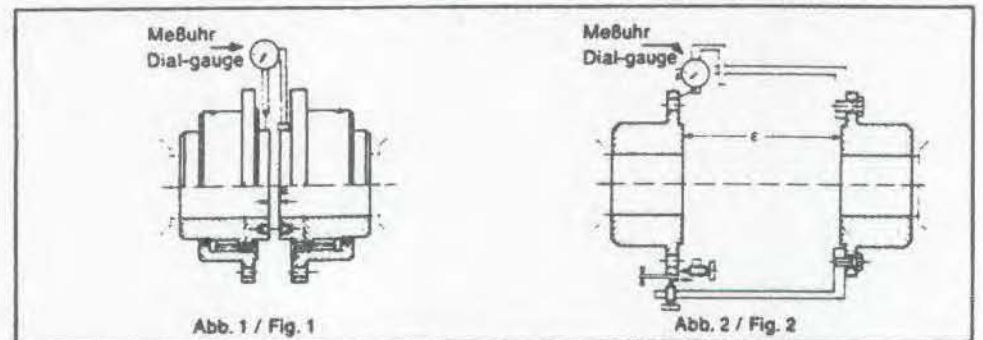
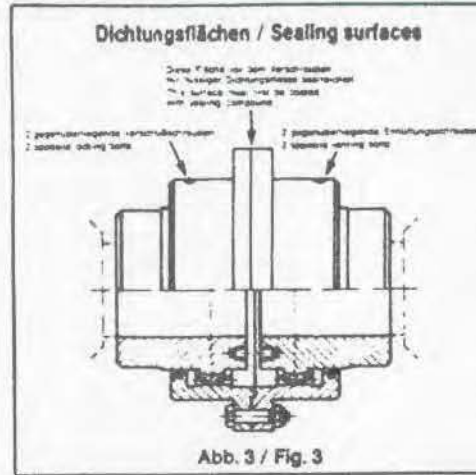


Abb. 1 / Fig. 1

Abb. 2 / Fig. 2

1.6 Abdichten
1.6 Sealing



Erf. Anzieh-Drehmomente M_A in Nm für Schrauben Required tightening torque M_A in Nm for bolts	
Abmessung Dimensions	Paßschrauben Fitting screws Mat. 6.8
M 6	10
M 8	25
M 10	49
M 12	86
M 14	135
M 16	210
M 18	290
M 20	410
M 22	550
M 24	710
M 27	1050
M 33	1900

Tabelle 3 / Table 3

- 1.6.1 Die O-Ringdichtung vor dem Verschrauben in die vorgesehenen Rillen einlegen.
- 1.6.2 Bei Sonderausführung mit Deckel die O-Ringdichtung von außen in die Rille des Gehäuses eindrücken und den Deckel mittels der Sechskantschrauben fest anziehen. (Abb. 5)
- 1.6.3 Nach erfolgtem Ausrichten Dichtflächen der Gehäuseflansche mit der mitgelieferten Dichtungsmasse bestreichen und durch Paßschrauben verbinden. (Abb. 3)
- 1.6.4 Das Kupplungsgehäuse muß axial verschiebbar sein.

- 1.6.1 The O-ring seals must be inserted into the grooves before bolts are tightened.
- 1.6.2 For special design with cover the O-ring-sealing has to be pressed in the groove of the housing and the cover has to be tightened by means of the hexagon head cap screws. (figure 5)
- 1.6.3 On completion of alignment coat the sealing surfaces of the housing flanges with the sealing compound supplied, and connect with fitting screws. (Fig. 3)
- 1.6.4 The coupling housing must be displaceable axially.

2. Schmierung
2. Lubrication
2.1 Fettschmierung
2.1 Grease lubrication

- 2.1.1 Das Einfüllen der angegebenen Fettmenge (Tab. 4) ist zweckmäßigerweise mit einer Fettpresse vorzunehmen. Vor dem Zusammenbau Verzahnung mit Fett bestreichen.
- 2.1.2 Fett nur bei geöffneter Entlüftungsschraube einfüllen.
- 2.1.3 Das Verschließen der Einfüllöffnungen erfolgt mittels Verschlusschrauben und Dichtring.

- 2.1.1 The required quantity of grease should be applied with a grease-gun (Table 4). Before assembly coat the toothing with grease.
- 2.1.2 Fill with grease only when venting screws are open.
- 2.1.3 The filler holes are closed by plugs and sealing rings.

Fettmenge / Grease quantity

Ges. Fettmenge Grease quant. in kg	Größe Dimension Type	32	38	48	60	70	80	90	100	110	125	140	160	180	200	225
		Lbk LBLk ohne Zw.-St. LBGk	0,03	0,04	0,06	0,10	0,15	0,22	0,29	0,44	0,55	0,79	0,9	1,23	1,9	2,4

Tabelle 4 / Table 4

Schmierstofftabelle / Table of Lubricants

Fettschmierung / Grease lubrication (-10°C bis +90°C)

AGIP	AGIP GR SLL AGIP GR MU/EP 1	FINA	MARSON EPL 1 MARSON EPL 2
Aral	Aralub FDP 00	Klüber Lubrication	GRAFLOSCON C SG 0 STRUCTOVIS BHD MF
BP	BP Engergrease HT 0	Mobil	Mobilplex 46 Mobilplex 47
Castrol	IMPERVIA MMO	Shell	Shell Alvania EP Fett 1
Chevron	Chevron Dura-Lith Grease EP 0	Texaco	Multifak EP0
ESSO	PEN-O-LED EP GREASE FIBRAX 370, FIBRAX EP 370		

3. Wartung während des Betriebes
3. Maintenance during operation

Für Dauerbetrieb ist ständige Überwachung empfehlenswert. Außerdem Kupplungen alle 8000 Betriebsstunden auf axiale Verschiebbarkeit überprüfen, reinigen und evtl. Maschinen nachrichten; dazu nach Entfernen der Flansch-Schrauben die vorgesehenen Abdruck-Gewindebohrungen zum Lösen der Verbindung benutzen.

3.1 Insbesondere sind folgende Kontrollen bei demontierter Kupplung zu empfehlen:

1. Verzahnung
2. O-Ringdichtung
3. evtl. Beschädigung der Dichtflächen

3.2 Um Beschädigungen der Dichtflächen zu vermeiden, keine Schraubenzieher oder ähnliche Werkzeuge zum Trennen der Kupplungsteile verwenden.

Wiederzusammenbau der Kupplungen erfolgt sinngemäß nach Absatz 1.

3.3 Fettfüllung alle 8000 Betriebsstunden oder spätestens nach 2 Jahren erneuern. Bei größeren Wartungsintervallen, z. B. 16000 Betriebsstunden oder max. 2 Jahre, sind vorzugsweise synth. Fette einzusetzen.

3.4 Es ist zu beachten, daß es sich bei den Kupplungen um Rotationsteile handelt.

Zur völligen Unfallverhütung ist Abdeckung erforderlich.

Die Zugänglichkeit zwecks Kontrolle des Schmierstoffes darf durch die Abdeckung nicht beeinträchtigt werden.

(Gesetz über techn. Arbeitsmittel vom 24. Juni 1968)

For continuous operation, continuous monitoring is advisable. Otherwise couplings must be checked for axial shift every 8000 operating hours, clean and adjust machine if necessary. For this after removing the flange and cover bolts use the threaded press-off holes to slacken the joint.

3.1 When the coupling is dismantled the following checks are particularly important:

1. Toothing
2. O-ring seal
3. Any damage to sealing surfaces

3.2 In order to avoid damaging the sealing surfaces, no screwdriver or similar tool must be used to separate the coupling halves.

The couplings are reassembled according to paragraph 1.

3.3 In the case of grease couplings the grease filling must be renewed at the end of 8000 operating hours or at the latest after 2 years. For longer intervals between servicing, e. g. 16000 operating hours or max. 2 years, it is best to use synthetic greases.

3.4 Remember that couplings are rotating components.

For complete protection against accidents they must be covered.

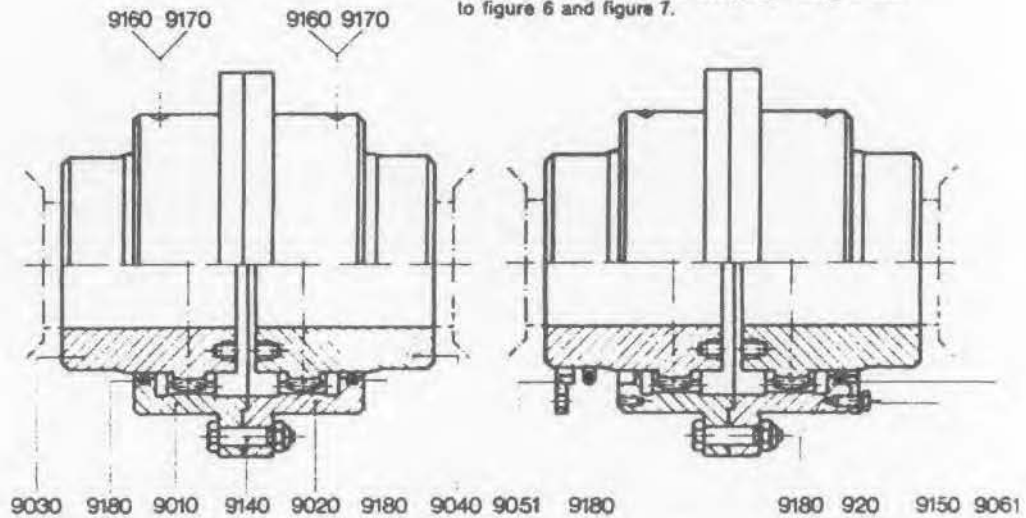
Access for inspection of the lubricant must not be hindered by the covering.

(Gesetz über techn. Arbeitsmittel 24 June 1968, law on technical plant).

Normale Ausführung
Standard Design

Sonderausführung mit Deckel
Ist auch bei den Kupplungsausführungen nach Abb. 6 und Abb. 7 möglich.

Special Design with cover
Is also possible for the coupling designs acc. to figure 6 and figure 7.

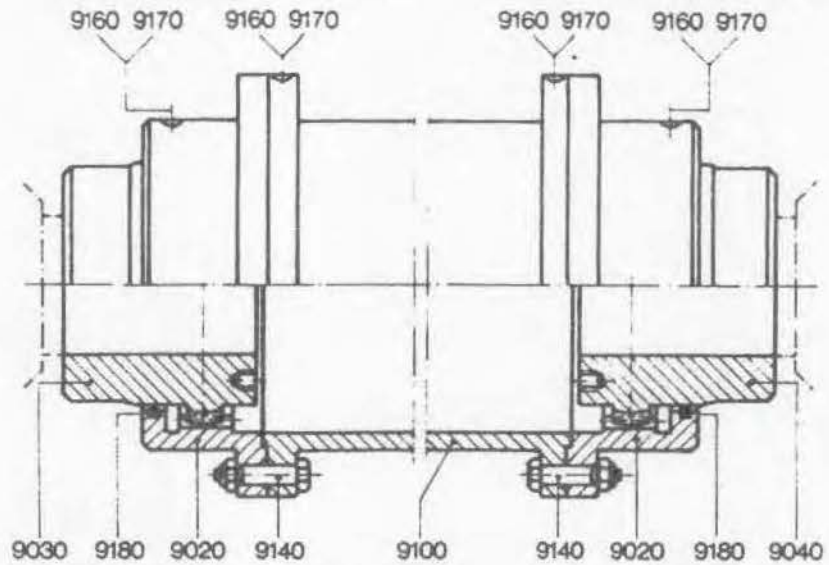


Stückliste Bogenzahn-Kupplung®, Typ LBk
Abb. 4 / Abb. 5

Teil-Nr.	Benennung
9010	Gehäuse „A“
9020	Gehäuse „B“
9030	Nabe „A“
9040	Nabe „B“
9140	Paßschraube
9160	Verschlußschraube
9170	Dichtring
9180	O - Ring
9051/61	O-Ring-Deckel
9150	6 Kl.-Kopfschraube
9200	Federring

Parts list for Bogenzahn-Kupplung® curved-tooth couplings, type LBk - Fig. 4 / Fig. 5

Part No.	Designation
9010	Housing A
9020	Housing B
9030	Hub A
9040	Hub B
9140	Fitting screw
9160	Locking screw
9170	Sealing ring
9180	O-ring seal
9051/61	O-ring-cover
9150	hexagon head cap screw
9200	spring washer

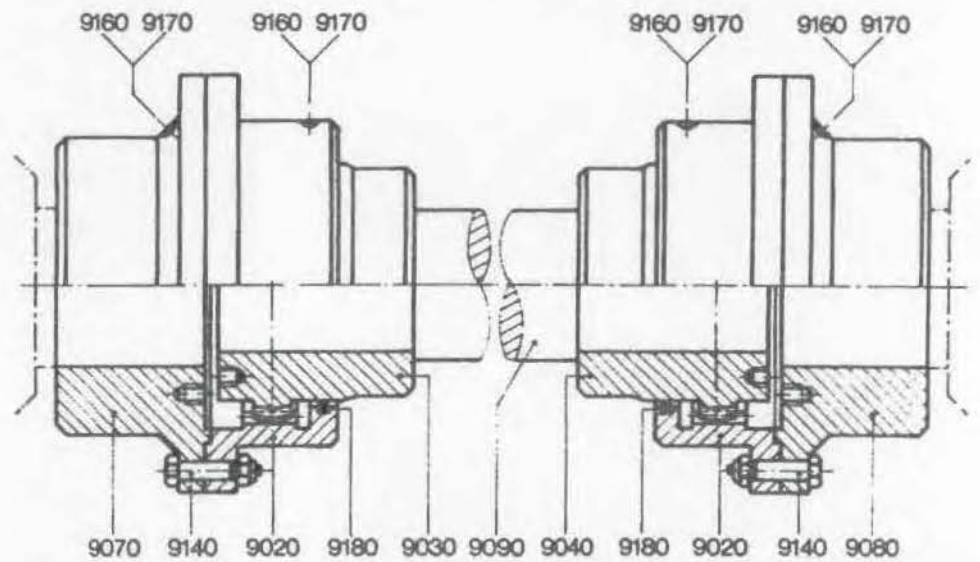


Stückliste Bogenzahn-Kupplung®, Typ LBLk
Abb. 6

Teil-Nr.	Benennung
9020	Gehäuse „B“
9030	Nabe „A“
9040	Nabe „B“
9100	Zwischenstück
9140	Paßschraube
9160	Verschlussschraube
9170	Dichtring
9180	O - Ring

Parts list for Bogenzahn-Kupplung® curved-tooth couplings, type LBLk - Fig. 6

Part No.	Designation
9020	Housing B
9030	Hub A
9040	Hub B
9100	Adapter
9140	Fitting screw
9160	Locking screw
9170	Sealing ring
9180	O-ring seal



Stückliste Bogenzahn-Kupplung®, Typ LBGk
Abb. 7

Teil-Nr.	Benennung
9020	Gehäuse „B“
9030	Nabe „A“
9040	Nabe „B“
9070	Flansch „A“
9080	Flansch „B“
9090	Zwischenwelle
9140	Paßschraube
9160	Verschlussschraube
9170	Dichtring
9180	O - Ring

Parts list for Bogenzahn-Kupplung® curved-tooth couplings, type LBGk - Fig. 7

Part No.	Designation
9020	Housing B
9030	Hub A
9040	Hub B
9070	Flange A
9080	Flange B
9090	Intermediate shaft
9140	Fitting screw
9160	Locking screw
9170	Sealing ring
9180	O-ring seal

Grouting

On concrete foundations, a minimum of one inch should be allowed for grouting.

A rich, non-shrink grout should be used. High-grade grout mixtures are available commercially. If the grout is to be prepared at the site, a cement-sand ratio of 1:2 is recommended. Just enough water should be used to give a stiff mixture. The clean, but rough surface of the foundation should be wet and the grout rammed or puddled under the base.

Alignment Procedure

Flexibly Coupled Drives

Level all mounting base supports before setting the base position. Before grouting the base, the alignment should be checked as follows:

1. Remove all coupling bolts and slide the shells back so that the hub faces are exposed.
2. Check the coupling hub spacing in accordance with the outline dimensions with the units in the mechanical center of their end play.
3. Start with the coupling next to the largest unit (usually the motor) or near the middle of multiple units. Check the radial alignment by using a straightedge across the two hubs at vertical and horizontal. Or by clamping a dial indicator to one hub and indicating the other on its outside diameter. Be sure that the dial-indicator supports do not bend or sag, since this will give inaccurate readings. The maximum variation should not exceed .002 inches (0.05 mm).
4. Insert feeler gage or use dial indicator at hub faces. Measure the gap between hub faces at 0, 90, 180 & 270° and record. Rotate both shafts together 90°. Repeat the gap readings. Continue rotation in 90° increments until five sets of readings are taken. The fifth set of readings is a check on the first set of readings to assure that data is reliable. The readings should not vary by more than .002 inches (0.05 mm) between the four readings taken at each coupling position.
5. Correct the horizontal alignment by shifting frames on the base and the vertical alignment by shimming between the machines and the base.
6. Repeat Steps # 2, 3 and 4 on each coupling, working away from the motor or center unit.

7. Recheck the couplings on long sets after completing the above checks, because shimming when checking subsequent units may affect those already checked. After the set has been aligned within the specified limits, the coupling shells may be bolted together.

The motor feet may be doweled to the base if desired.

Thrust Loads

Machines are expected to have no continuous external thrust (axial) loads. If thrust loads are expected, the maximum permissible continuous load, in the horizontal configuration, is tabulated in Table 3 by frame diameter.

For applications requiring greater horizontal thrust loads or vertical mounting thrust loads, consult GE Motors through a local GE Sales Office.

TABLE 3		
THRUST CAPACITY		
HORIZONTAL MOUNTING		
FRAME SIZE	LB.*	N*
6000	1200	5340
6100	1400	6230
6200	1400	6230
6700	1700	7560
6800	1700	7560
6900	2000	8900

*Based on an adjusted L_{10} Life of 10,000 hours.

OPERATION

WARNING: High voltage electric shock can cause serious or fatal injury. Disconnect power before touching any internal part. High voltage may be present even when the machine is not rotating. If used with a rectified power supply, disconnect all AC line connections to power supply. With other power supplies, disconnect all DC line and field connections. Also disconnect power from auxiliary devices. Failure to observe these precautions may result in damage to the equipment, injury to personnel, or both.

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.2

BRAKE SYSTEM



LIPS THRUSTERS DRUNEN B.V.

2.2 BRAKE ASSEMBLY

A pneumatic disc type holding brake is fitted at the input flange of the upper gearbox.

The brake assembly comprises:

- a brake disc fitted between the floating shaft flanges; diam. 915 mm (see drawing 3004095).
- two calipers, mounted on brackets (see drawing 2017114).
- an electric/pneumatic control panel for (remote) control of the brake (see drawing 1054637).

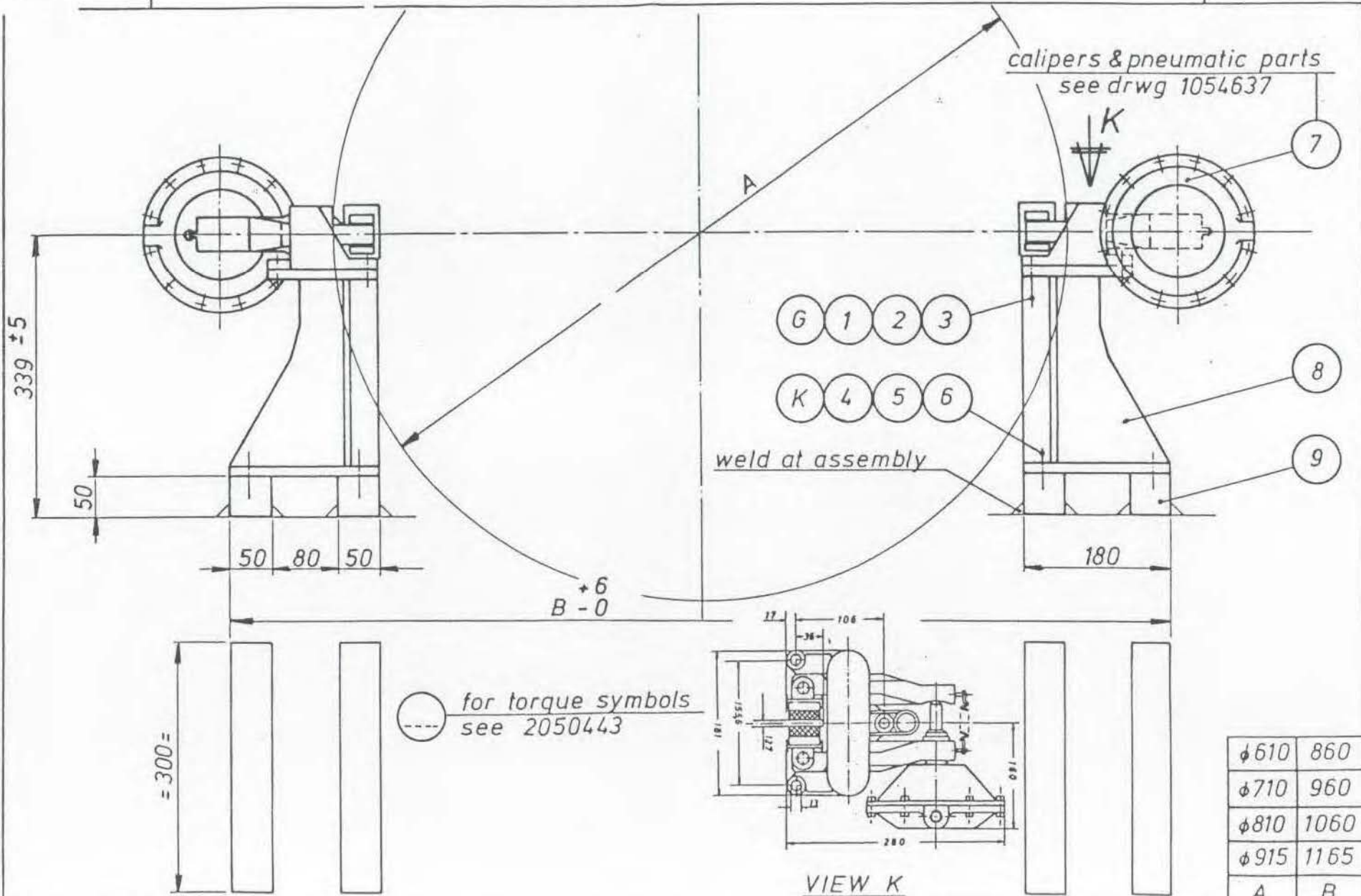
Maintenance is limited to periodically observing the thickness of the brake pads. See 1009908: "Disc Brake Caliper".

For brake operation see chapter 6: "Control System".

The brake control valve is provided with a manual override.

BRAKE CPL.

2017114⁰



$\phi 610$	860
$\phi 710$	960
$\phi 810$	1060
$\phi 915$	1165
A	B

08193/89

TITLE : ASSEMBLY BRAKE
TYPE :
LIST : T073010062

PAGE : 1
DRAWING : 2017114
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	HEXAGON SCREW	M713000482	6,0
2	SINGLE COIL SPRING WASHER	M716100033	6,0
3	HEXAGON NUT	M714040033	6,0
4	STUD. SCREW LENGTH 1,25 D	M711050435	6,0
5	SINGLE COIL SPRING WASHER	M716100039	6,0
6	HEXAGON NUT	M714040039	6,0
7	SEE ORDER PARTS LIST	T002999985	1,0
8	SUPPORT	T002013964	2,0
9	STRIP	T002007879	4,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

END OF LIST

TITLE : BRAKE SHOE
TYPE :
LIST : T073010064

PAGE : 1
DRAWING : 1054637
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	BRACE CALIPER	T001009908	2,0
2	VALVE	T001089875	1,0
3	VALVE	T001054902	1,0
4	PRESSURE SWITCH	T001026467	1,0
5	HOSE	T001007538	2,0
6	DEADENING, SOUND	T001054903	2,0
7	PLUG	T001054993	1,0
8	REDUCING NIPPLE	T001016560	2,0
9	STRAIGHT MALE STUD COUPLING	M710712120	2,0
10	STRAIGHT MALE STUD COUPLING	W006350210	3,0
11	STRAIGHT PIPE NIPPLE	M710100020	1,0
12	STRAIGHT MALE STUD COUPLING	W006350210	1,0
13	ADJ.BARREL-T FITTING W.PROGRESSIVE	W006430060	1,0
14	T-FITTING WITH PROGRESSIVE RING	M710801120	1,0
15	STRAIGHT FITTING W.PROGRESSIVE RING	M710722120	2,0
16	RECTIFIER	T001054994	1,0
17	PACKING	T001054995	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

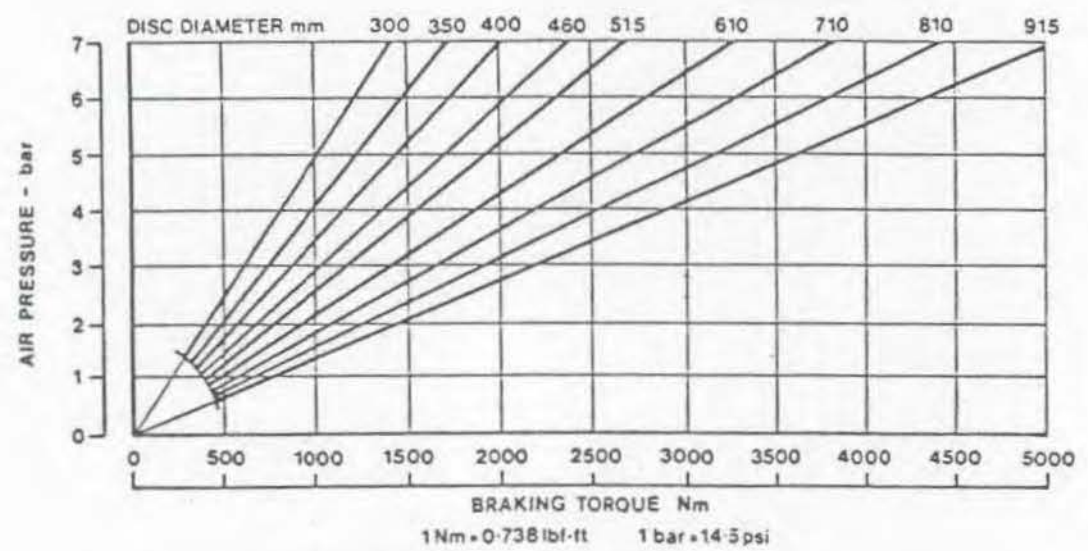
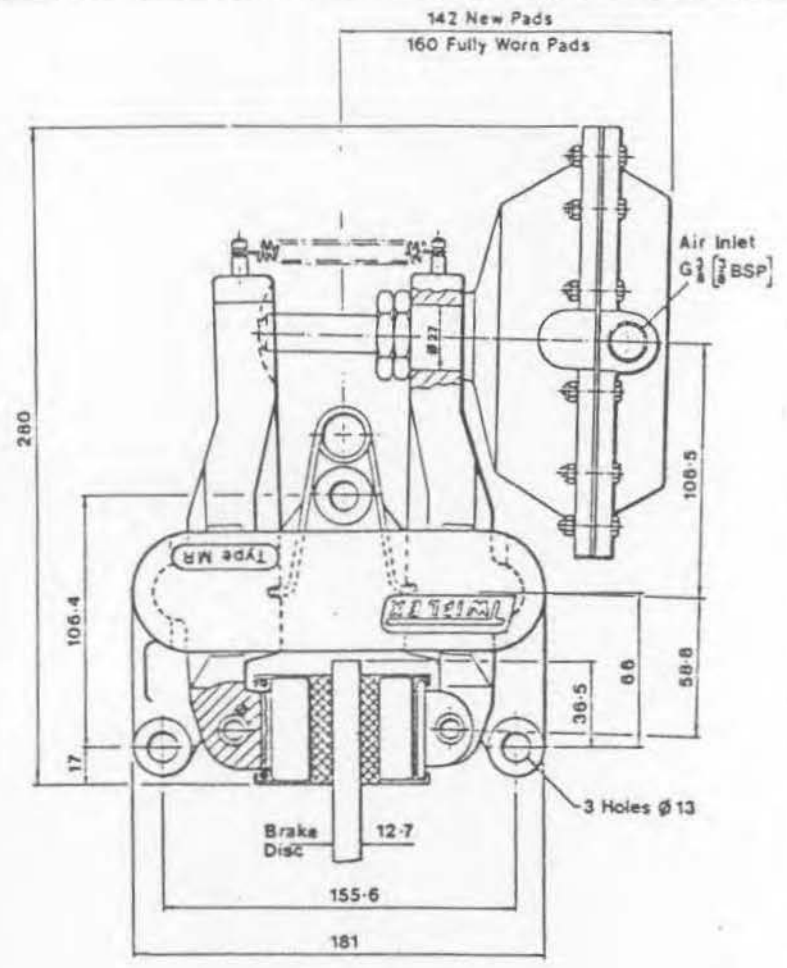
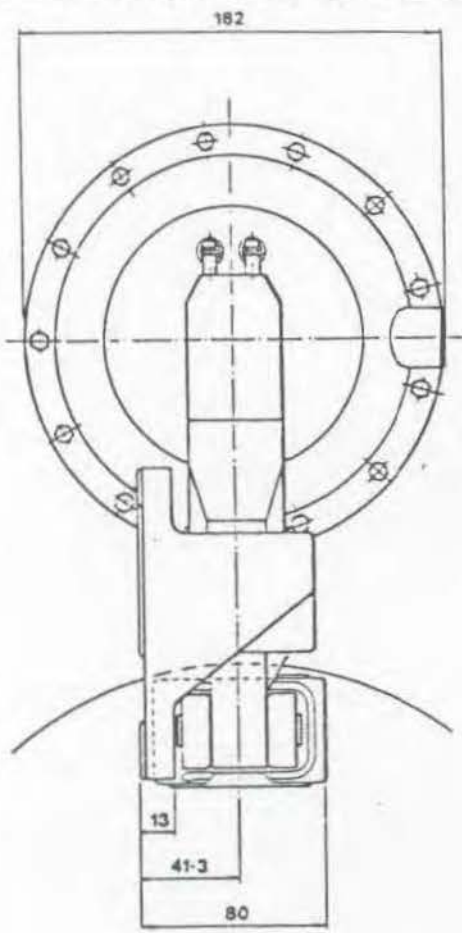
E N D O F L I S T



DISC BRAKE CALIPER
TYPES: MRB 5 and MRB 5 (1")
AIR APPLIED - SPRING RELEASED

DB 3020

Issue 1 Date: March 83



Caliper - constructed from SG iron to BS 2789
 Thruster - constructed from aluminium alloy to BS 1490
 Finish - hammer blue paint
 Weight (caliper and thruster) - 10.4 kg
 Volume displacement of thruster at full stroke is 426 ml
 Total pad area - 58 cm²

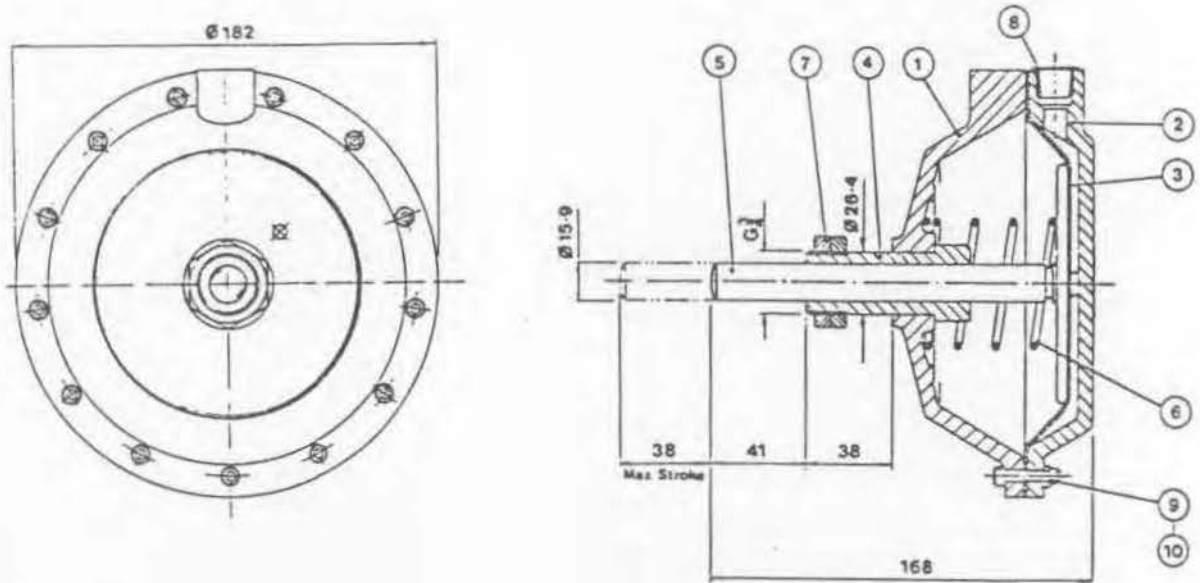
SPECIAL EXECUTIONS: LEFT HANDED VERSION T001060503
 WITH EQUALIZING LINK W008996941 (VERT. MOUNTING SH.5)

DISC BRAKE CALIPER
 TYPES: MRB 5 and MRB 5 (1")
 AIR APPLIED—SPRING RELEASED

DB 3020

Issue 1

Date: March 83



Thruster Type—B

Parts List

ITEM	COMPONENT	PART NO	QTY.	
1	FRONT CAP	724828	1	
2	REAR CAP	724822	1	
T003000640	3	DIAPHRAGM	720827	1
	4	MOUNTING BARREL	7941129	1
	5	PISTON ROD ASSEMBLY	720803 *	1
T003002884	6	COMPRESSION SPRING	255060	1
	7	LOCKNUT 3/4 BSP	515051	2
	8	REDCAP 3/8 BSP	830033	1
	9	M5 x 25 SKT HD CAP SCREW	540331	13
	10	M5 NYLOC NUT	510195	13

* In type MRB5 (1) pneumatic disc brake a shorter Piston Rod Assembly Part No. 720831 is used.

General Description

This is a low/medium torque pneumatically operated brake caliper using dry and filtered air (20 microns) at pressures up to 7 bar (100 PSI). Pneumatic brakes require a control valve which can be operated either manually or by a spool valve operated by a pneumatic or electric signal.

The caliper should be mounted horizontally in 3 and 9 o'clock disc positions to prevent bias due to weight of actuator. The caliper can be mounted, if necessary, on a pedestal mounting bracket, which is available from Twiflex (see Data Sheet DB 3016).

The thruster should be mounted on the caliper using the two lock-nuts (item 7) provided, and tightened to 60 Nm (44 lb-ft) torque.

If it becomes necessary to replace the diaphragm (item 3), remove the thirteen M5 fixing screws and the rear cap (item 2). Remove the worn diaphragm. Clean-up surfaces in contact with the diaphragm and re-assemble with new diaphragm in position.

Recommended Spares:—

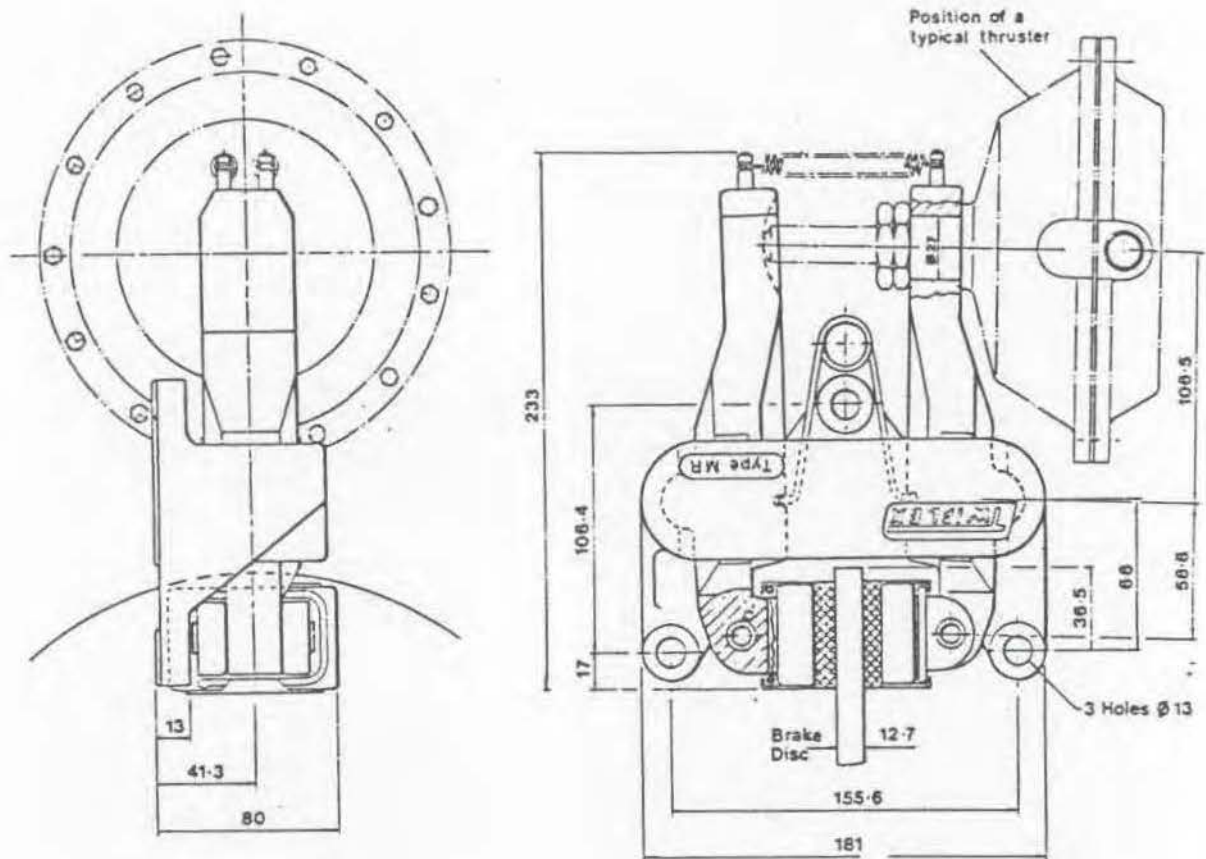
Diaphragm (item 3)
 Pad assembly 2 off (item 5 Data Sheet DB 3017)
 Standard Pad Assembly part number 074123

DISC BRAKE CALIPER TYPE: MR

DB 3017

Issue 4

Date: Dec 1989

**General Description**

The MR caliper accepts a number of interchangeable actuators – mechanical, electrical, hydraulic and pneumatic (shown above is a brake caliper operated by a typical pneumatic actuator). The MR caliper can be mounted with a standard Twiflex brake disc 12.7mm thick. Up to two calipers may be used with discs 250mm diameter. The number of brake calipers can be increased depending on disc size and torque required. MR brake calipers can be mounted at any angle around the periphery of the disc, but ideally they should be mounted horizontally. The minimum diameter for standard Twiflex disc is 250mm.

The MR brake caliper is normally supplied with the arms handed as shown. Shoe Arm assemblies (item 6 and 7) can be reversed and easily changed by removing the two sets of springs (item 2 and 3) and replacing them afterwards.

MR calipers are available to suit 25mm wide Twiflex discs. See Data Sheet DB 3022.

Pad Replacement in Air Applied Calipers

To replace the pads, secure the installation to ensure safety. Ease out the pad springs (item 4) and remove worn pads (item 5). Clean the disc and fit new pads. Replace pad springs.

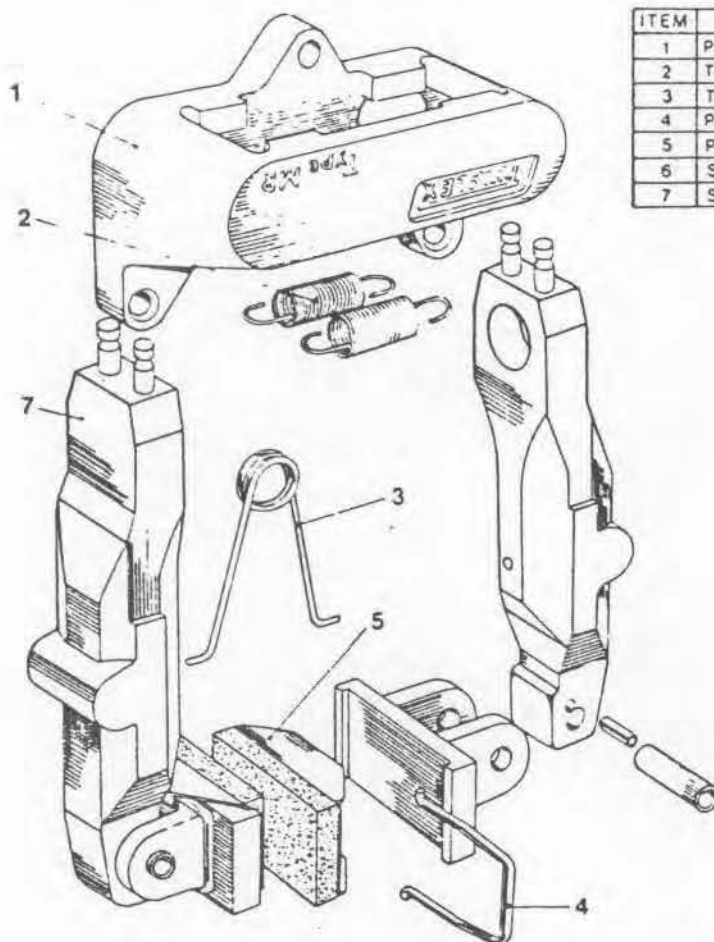
For pad replacement in any other type of brake caliper refer to the relevant Data Sheet (see list).

DISC BRAKE CALIPER TYPE: MR

DB 3017

Issue 4

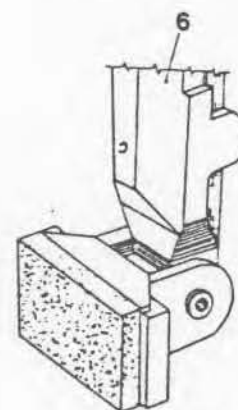
Date: Dec 1989



ITEM	COMPONENT	PART NO	QTY
1	PIVOT BASE	8030010	1
2	TENSION SPRING T003002885	2400035	2
3	TORSION SPRING T003002886	2500020	1
4	PAD SPRING T003002887	7900024	2
5	PAD ASS'Y T003000582	0780123	2
6	SHOE ARM ASS'Y (THRUSTER SIDE)	6600112	1
7	SHOE ARM ASS'Y (OPPOSITE SIDE)	6600113	1

Total pad area 58 cm²

Weight (caliper only) 6.2 kg



Material: — SG Iron—BS. 2789

Finish: — Hammer blue paint

**Exploded View of Caliper
MR Caliper Assembly — Part No. 6780413**

Total pad area = 58cm²

Pad dimensions (new) = 63.5 × 46 × 12.7mm (thick).

Pad wear allowance = 8mm.

Brake/Thruster	Description	Data Sheet	Braking Force
MRE	Pneumatically applied	DB3012	764N
MRG	Pneumatically applied	DB3012	1900N
MRA	Pneumatically applied	DB3019	7140N
MRBS	Pneumatically applied	DB3020	11400N
MRD	Pneumatically applied	DB3021	3700N
MRK	Spring applied, pneumatically released	DB4058	6400N
MRL	Spring applied, hydraulically released	DB4059	6400N
MRH	Mechanically applied, lever operated	DB1005	8000N
MRW	Mechanically applied, hand operated	DB1006	2600N

Braking Force is defined as the Tangential Force acting at the Effective Disc Radius.

Braking Torque (Nm) = Braking Force (N) × Effective Disc Radius (m)

where Effective Disc Radius (m) = Actual Disc Radius (m) — 0.03.

TITLE : DELIVERY
TYPE : ASSEMBLY NR.T001089799
LIST : T073010063

PAGE : 1
DRAWING : 1054637
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	SEAMLESS PRECISION TUBE	M301035203	2000,0 MM
2	SEAMLESS PRECISION TUBE	M301035203	2000,0 MM
3	SEAMLESS PRECISION TUBE	M301035203	2000,0 MM
4	STRAIGHT MALE STUD COUPLING	M710712120	1,0
5	STRAIGHT MALE STUD COUPLING	W006350210	1,0
6	STRAIGHT PIPE NIPPLE	M710100020	1,0
7	ADJ.BARREL-T FITTING W.PROGRESSIVE	W006430060	1,0
8	T-FITTING WITH PROGRESSIVE RING	M710801120	1,0
9	STRAIGHT FITTING W.PROGRESSIVE RING	M710722120	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.3

UPPER GEARBOX



LIPS THRUSTERS DRUNEN B.V.

2.3 UPPER GEARBOX

The upper gearbox is a single-stage angle drive in a split, distortion-free housing.

The primary shaft (horizontal input shaft) is driven by the floating shaft, which transmits the power from the prime mover.

The secondary shaft (vertical output shaft) is connected to the input shaft of the lower gearbox through a vertical drive shaft (intermediate shaft).

The gearbox is fitted with a spiral bevel gear unit, made of special high quality forged steel, case hardened and subsequently fine-machined to class 6 -DIN 3965- (H.P.G. process) or better.

The crown wheel as well as the pinion are independently supported on both sides by anti-friction type bearings in order to minimize deflections and to assure optimal teeth contact under all load conditions.

The load-carrying anti-friction bearings are calculated for an extended service-life.

The pinion is shrunk connected to the primary shaft.

The crown wheel is bolted to the forged on flange of the secondary shaft.

Lubrication

The upper gearbox is fitted with a forged lubrication system, consisting of a dual pumping unit with circulation pump and level pump, twin filters with "clogged filter" sensor, tube type cooler suitable for seawater, valves, controls and alarms.

This system is connected to the header tank.

The level pump maintains the operational oil level in order to minimize churning losses, however, when level pump is at floor level idle the gearbox is automatically flooded with lubrication oil to prevent condensation.

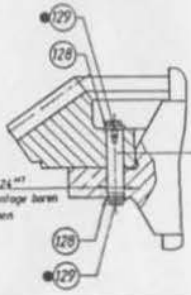
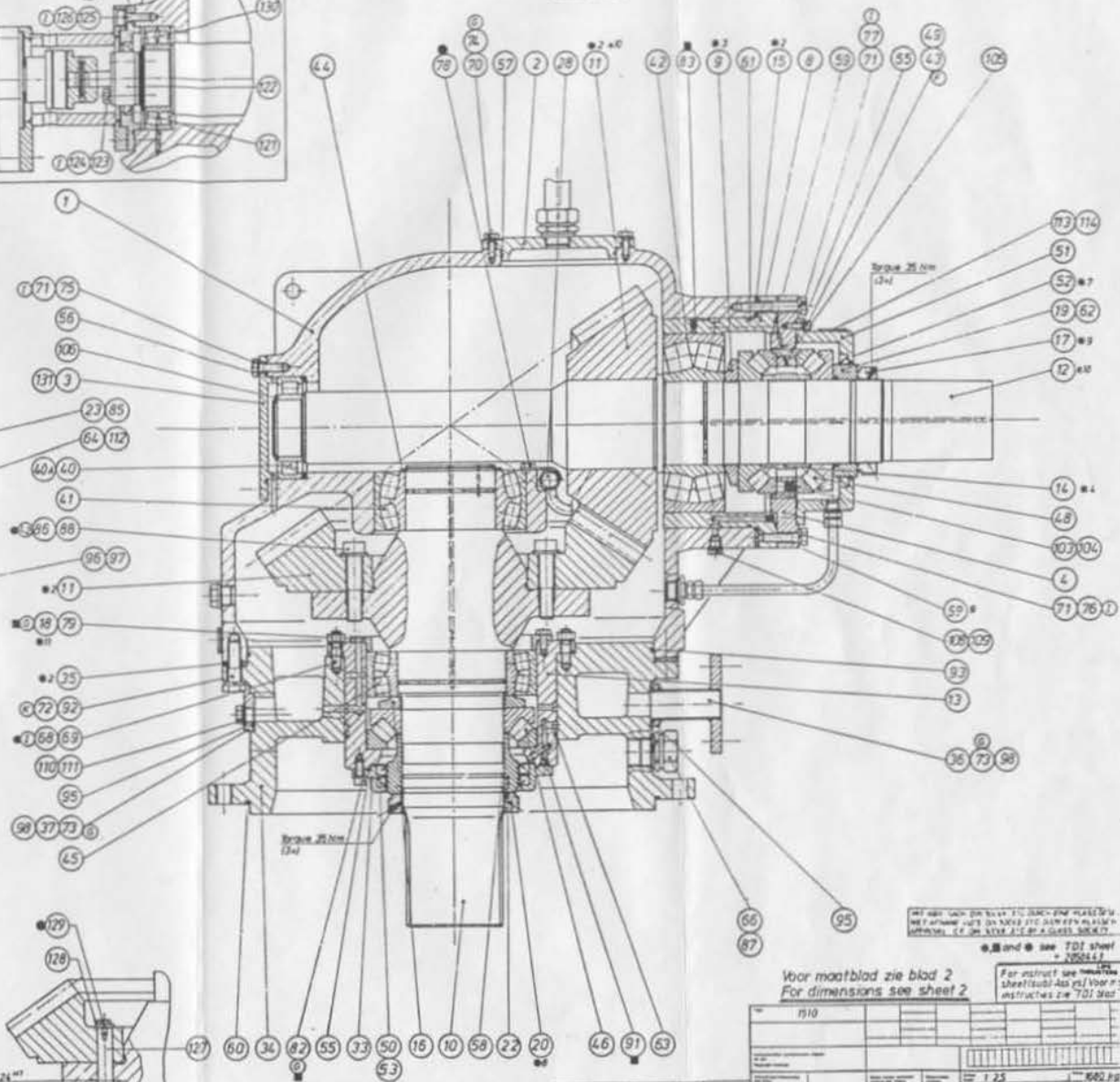
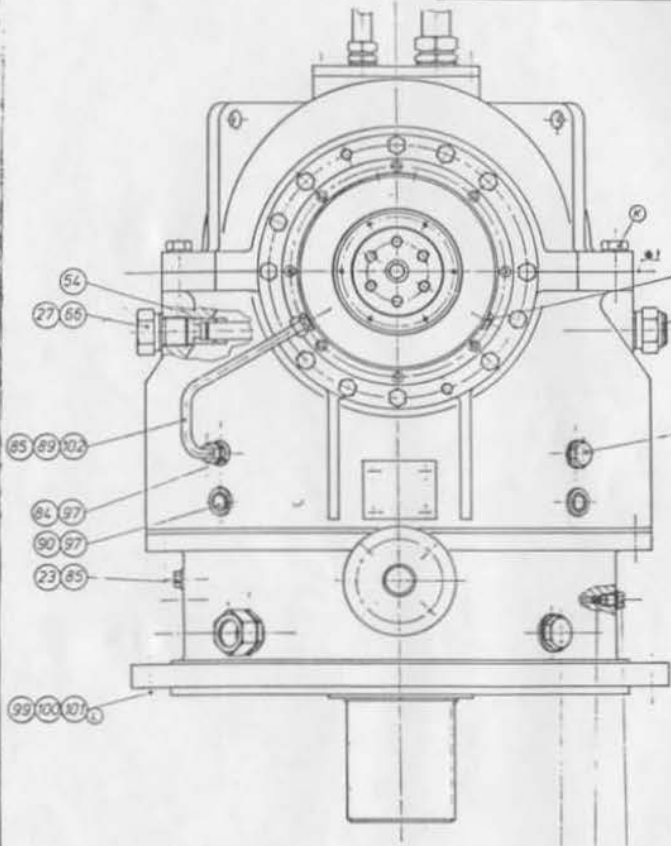
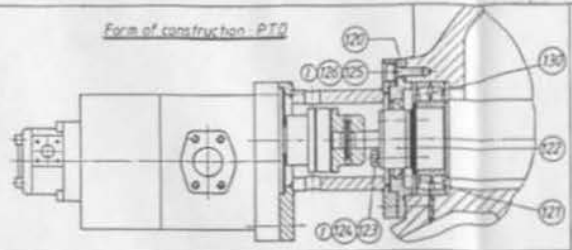
Note: In case of level pump failure the thruster may be operated at reduced power.

The dual (level and circulation) pump is electrically driven.

For lubrication oil diagram and additional information see section 5.

Form of construction - PT0

STANDARD



Get. 924¹¹
By montage boren
2 rumen

Met alle teken en tekeningen...
Het is niet toegestaan deze tekeningen te kopiëren of te verspreiden...
© 1980...
*Zie ook zie TDI sheet 100111

Voor maatblad zie blad 2
For dimensions see sheet 2

For instruct see...
Instructies zie TDI sheet 100111

n10		1.25		602 Pg	
BOVENWATERKUS KPL N10					
UPPER GEAR BOX CPL N10					
701	69103				

TITLE : UPPER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016915
 LIST : T073000041

PAGE : 1
 DRAWING : 2016915
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	GEARBOX,UPPER	T002017012	1,0
2	COVER	T001010556	1,0
3	COVER	T002017014	1,0
4	BEARING COVER	T002017034	1,0
8	BEARING HOUSING	T002017015	1,0
9	RING	T002015040	1,0
10	SHAFT	T002017011	1,0
11	SET, GEAR, UGB	T002014333	1,0
12	SHAFT	T002017009	1,0
13	BEARING HOUSING	T002017036	1,0
14	DISTANCE BUSH	T002017043	1,0
15	DISTANCE RING	T002017041	1,0
16	DISTANCE RING	T002017032	1,0
17	LOCKING NUT	T001089103	1,0
18	LOCKING WASHER	T002017038	1,0
19	RACE, BALL	T002017044	1,0
20	LOCKING NUT	T003003000	1,0
22	DISTANCE BUSH	T002017042	1,0
23	HEXAGON HEAD SCREW PLUG	M710380239	7,0
27	DIMINISHING	T002010546	2,0
28	LINE, OIL	T001010592	1,0
33	HOLDER	T002017035	1,0
34	LANTERN PIECE	T002017006	1,0
35	RING	T002010301	1,0
36	ADAPTER	T002010302	1,0
37	COVER	T002010303	1,0
40	BEARING,CYLINDRICAL ROLLER	W006220024	1,0
40A	DISTANCE RING	T003002542	1,0
41	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210926	1,0
42	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210027	1,0
43	HEX. SOCKET HEAD CAP SCREW	M712040280	8,0
44	RETAINING RING FOR SHAFT	T003000520	1,0
45	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210012	1,0
46	SPHERICAL ROLLER THRUST BEARING	W006260025	1,0
48	SPHERICAL ROLLER THRUST BEARING	W006260038	2,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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TITLE : UPPER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016915
 LIST : T073000041

PAGE : 2
 DRAWING : 2016915
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
49	SINGLE COIL SQUARE SECTION SPRING W	M716101031	8,0
50	SUPPORTING RING	T001016078	1,0
51	HOUSING, ROTARYSEAL, FOR	T002017033	1,0
52	OIL SEAL	W007065174	1,0
53	OIL SEAL	T001032733	2,0
54	O-RING	W007000860	2,0
55	O-RING	W007000963	2,0
56	O-RING	W007000829	1,0
57	O-RING	W007001048	1,0
58	O-RING	W007000730	1,0
59	CORD RING WITH VULCANIZED JOINT	W007000667	2,0
60	CORD RING WITH VULCANIZED JOINT	W007000298	1,0
61	O-RING	W007000517	1,0
62	O-RING	W007001069	1,0
63	O-RING	W007000580	1,0
64	HEXAGON HEAD SCREW PLUG	N710380254	1,0
66	COPPER SEALING RING	M731000340	5,0
68	STUD. SCREW LENGTH 1,25 D	M711050381	8,0
69	HEXAGON NUT	M714040036	8,0
70	SINGLE COIL SPRING WASHER	M716100033	6,0
71	SINGLE COIL SPRING WASHER	M716100036	18,0
72	SINGLE COIL SPRING WASHER	M716100039	20,0
73	HEXAGON SCREW	M713000478	4,0
74	HEXAGON SCREW	M713000480	6,0
75	HEXAGON SCREW	M713000530	6,0
76	HEXAGON BOLT	M713005536	4,0
77	HEXAGON BOLT	M713005539	8,0
78	HEXAGON SCREW	M713000474	2,0
79	HEXAGON SCREW	M713000476	8,0
81	RESTRICTOR	T001011115	2,0
82	HEX. SOCKET HEAD CAP SCREW	M712040330	6,0
83	RESTRICTOR	T001011116	3,0
84	REDUCING SOCKET NIPPLE	M710190241	1,0
85	COPPER SEALING RING	M731000261	9,0
86	HEX. SOCKET HEAD CAP SCREW	W007281070	12,0

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TITLE : UPPER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016915
 LIST : T073000041

PAGE : 3
 DRAWING : 2016915
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
87	STRAIGHT MALE STUD COUPLING	W006350221	2,0
88	PLAIN WASHER	W007375031	12,0
89	STRAIGHT MALE STUD COUPLING	W006350215	2,0
90	GLASS,SIGHT	T001020196	3,0
91	HEXAGON SOCKET PIPE PLUG	W006575100	2,0
92	HEXAGON BOLT	W007110163	20,0
93	CORD RING WITH VULCANIZED JOINT	W007000297	1,0
94	HEXAGON HEAD SCREW PLUG	M710380256	2,0
95	O-RING	W007000378	2,0
96	HEXAGON HEAD SCREW PLUG	M710380248	2,0
97	COPPER SEALING RING	M731000302	5,0
98	SINGLE COIL SPRING WASHER	M716100033	4,0
99	SINGLE COIL SPRING WASHER	M716100041	20,0
100	HEXAGON NUT	M714040041	20,0
101	STUD. SCREW LENGTH 1,25 D	M711050486	20,0
102	SEAMLESS PRECISION TUBE	M301035233	500,0 MM
103	PLUG	T002017101	6,0
104	SPRING	T002004954	6,0
105	PIN	T002017102	1,0
106	RETAINING RING FOR SHAFT	M718700392	1,0
108	HEXAGON HEAD SCREW PLUG	M710380038	3,0
109	COPPER SEALING RING	M731000251	1,0
110	HEXAGON HEAD SCREW PLUG	M710380243	3,0
111	COPPER SEALING RING	M731000290	1,0
112	COPPER SEALING RING	M731000323	1,0
113	TYPE SHIELD	T002017130	1,0
114	STRAIGHT GROOVED PIN	W007580262	4,0
127	DOWEL	T003002541	3,0
128	PLAIN WASHER	W007375051	6,0
129	HEXAGON SCREW	M713000424	6,0

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END OF LIST

TITLE : UPPER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016975
 LIST : T073010043

PAGE : 1
 DRAWING : 2016915
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	GEARBOX, UPPER	T002017012	1,0
2	COVER	T001010556	1,0
3	COVER	T002017014	1,0
4	BEARING COVER	T002017034	1,0
8	BEARING HOUSING	T002017015	1,0
9	RING	T002015040	1,0
10	SHAFT	T002017011	1,0
11	SET, GEAR, UGB	T002016969	1,0
12	SHAFT	T002017009	1,0
13	BEARING HOUSING	T002017036	1,0
14	DISTANCE BUSH	T002017043	1,0
15	DISTANCE RING	T002017041	1,0
16	DISTANCE RING	T002017032	1,0
17	LOCKING NUT	T001089103	1,0
18	LOCKING WASHER	T002017038	1,0
19	RACE, BALL	T002017044	1,0
20	LOCKING NUT	T003003000	1,0
22	DISTANCE BUSH	T002017042	1,0
23	HEXAGON HEAD SCREW PLUG	M710380239	7,0
27	DIMINISHING	T002010546	2,0
28	LINE, OIL	T001010592	1,0
33	HOLDER	T002017035	1,0
34	LANTERN PIECE	T002017006	1,0
35	RING	T002010301	1,0
36	ADAPTER	T002010302	1,0
37	COVER	T002010303	1,0
40	BEARING, CYLINDRICAL ROLLER	W006220024	1,0
40A	DISTANCE RING	T003002542	1,0
41	SPHERICAL ROLLER BEARING, DOUBLE ROW	W006210926	1,0
42	SPHERICAL ROLLER BEARING, DOUBLE ROW	W006210027	1,0
43	HEX. SOCKET HEAD CAP SCREW	M712040280	8,0
44	RETAINING RING FOR SHAFT	T003000520	1,0
45	SPHERICAL ROLLER BEARING, DOUBLE ROW	W006210012	1,0
46	SPHERICAL ROLLER THRUST BEARING	W006260025	1,0
48	SPHERICAL ROLLER THRUST BEARING	W006260038	2,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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TITLE : UPPER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016975
 LIST : T073010043

PAGE : 2
 DRAWING : 2016915
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
49	SINGLE COIL SQUARE SECTION SPRING W	M716101031	8,0
50	SUPPORTING RING	T001016078	1,0
51	HOUSING, ROTARYSEAL, FOR	T002017033	1,0
52	OIL SEAL	W007065174	1,0
53	OIL SEAL	T001032733	2,0
54	O-RING	W007000860	2,0
55	O-RING	W007000963	2,0
56	O-RING	W007000829	1,0
57	O-RING	W007001048	1,0
58	O-RING	W007000730	1,0
59	CORD RING WITH VULCANIZED JOINT	W007000667	2,0
60	CORD RING WITH VULCANIZED JOINT	W007000298	1,0
61	O-RING	W007000517	1,0
62	O-RING	W007001069	1,0
63	O-RING	W007000580	1,0
64	HEXAGON HEAD SCREW PLUG	M710380254	1,0
66	COPPER SEALING RING	M731000340	5,0
68	STUD. SCREW LENGTH 1,25 D	M711050381	8,0
69	HEXAGON NUT	M714040036	8,0
70	SINGLE COIL SPRING WASHER	M716100033	6,0
71	SINGLE COIL SPRING WASHER	M716100036	18,0
72	SINGLE COIL SPRING WASHER	M716100039	20,0
73	HEXAGON SCREW	M713000478	4,0
74	HEXAGON SCREW	M713000480	6,0
75	HEXAGON SCREW	M713000530	6,0
76	HEXAGON BOLT	M713005536	4,0
77	HEXAGON BOLT	M713005539	8,0
78	HEXAGON SCREW	M713000474	2,0
79	HEXAGON SCREW	M713000476	8,0
81	RESTRICTOR	T001011115	2,0
82	HEX. SOCKET HEAD CAP SCREW	M712040330	6,0
83	RESTRICTOR	T001011116	3,0
84	REDUCING SOCKET NIPPLE	M710190241	1,0
85	COPPER SEALING RING	M731000261	9,0
86	HEX. SOCKET HEAD CAP SCREW	W007281070	12,0

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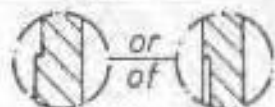
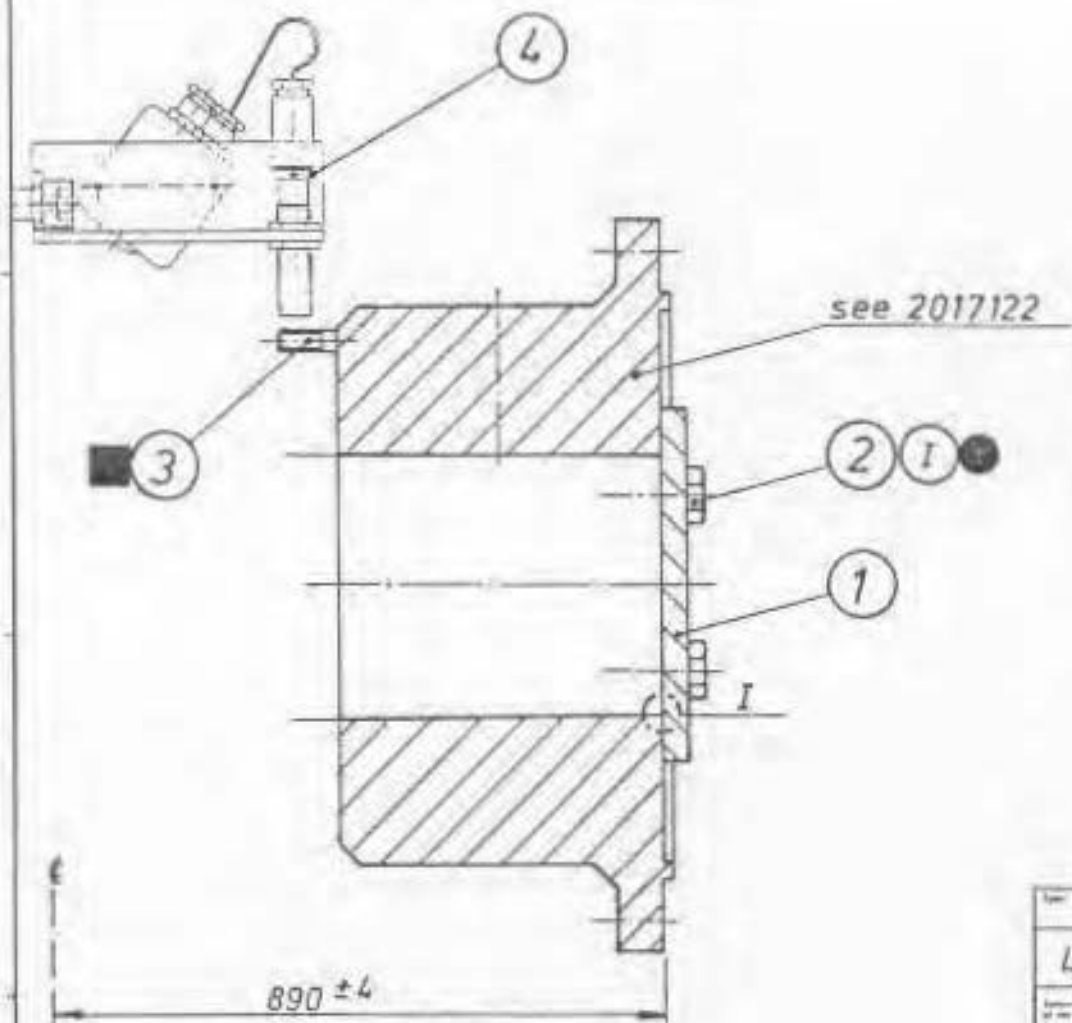
TITLE : UPPER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016975
 LIST : T073010043

PAGE : 3
 DRAWING : 2016915
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
87	STRAIGHT MALE STUD COUPLING	W006350221	2,0
88	PLAIN WASHER	W007375031	12,0
89	STRAIGHT MALE STUD COUPLING	W006350215	2,0
90	GLASS,SIGHT	T001020196	3,0
91	HEXAGON SOCKET PIPE PLUG	W006575100	2,0
92	HEXAGON BOLT	W007110163	20,0
93	CORD RING WITH VULCANIZED JOINT	W007000297	1,0
94	HEXAGON HEAD SCREW PLUG	M710380256	2,0
95	O-RING	W007000378	2,0
96	HEXAGON HEAD SCREW PLUG	M710380248	2,0
97	COPPER SEALING RING	M731000302	5,0
98	SINGLE COIL SPRING WASHER	M716100033	4,0
99	SINGLE COIL SPRING WASHER	M716100041	20,0
100	HEXAGON NUT	M714040041	20,0
101	STUD. SCREW LENGTH 1,25 D	M711050486	20,0
102	SEAMLESS PRECISION TUBE	M301035233	500,0 MM
103	PLUG	T002017101	6,0
104	SPRING	T002004954	6,0
105	PIN	T002017102	1,0
106	RETAINING RING FOR SHAFT	M718700392	1,0
108	HEXAGON HEAD SCREW PLUG	M710380038	1,0
109	COPPER SEALING RING	M731000251	1,0
110	HEXAGON HEAD SCREW PLUG	M710380243	1,0
111	COPPER SEALING RING	M731000290	1,0
112	COPPER SEALING RING	M731000323	1,0
113	TYPE SHIELD	T002017131	1,0
114	STRAIGHT GROOVED PIN	W007580262	4,0
127	DOWEL	T003002541	3,0
128	PLAIN WASHER	W007375051	6,0
129	HEXAGON SCREW	M713000424	6,0

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E N D O F L I S T



DETAIL I

*machined at assembly at distance measured
pasmaken by montage*

PUSH-UP DISTANCE $10^{+0,5}$ mm
OPSCHUIFWEG $10^{+0,5}$ mm

INJECTION PRESSURE 1860 ± 90 bar
DRUK TIJDENS MONTAGE 1860 ± 90 bar
FOR MOUNTING INSTRUCTIONS SEE 2007337
VOOR MONTAGE VOORSCHRIFTEN ZIE 2007337
FOR SYMBOLS AND TORQUE SEE 2050443
VOOR SYMBOLEN EN AANHAALMOMENTEN
ZIE 2050443

START POINT LOAD 35 bar
AANYANG - BELASTING 35 bar
MOUNTING OF FLANGE 2051935
FLENS MONTAGE 2051935

Type		/1510									
LBGk 160											
Drawing code		2017123									
Scale		1:2,5									
Title		FLANGE ASSEMBLY									
Date		2017123									
Author		J. B. B. B.									
Checked		J. B. B. B.									
Approved		J. B. B. B.									

TITLE : ASSEMBLY OF FLANGE + SPEED PICK-UP
TYPE : ASSEMBLY NR.T002017123
LIST : T073010042

PAGE : 1
DRAWING : 2017123
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	PLATE,ADJUSTING	T002017124	1,0
2	HEXAGON SCREW	M713000532	6,0
3	STUD. SCREW LENGTH 1,25 D	M711050280	8,0
4	SEE ORDER PARTS LIST	T002999985	1,0

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E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

MOUNTING INSTRUCTIONS TAPER FIT (STEEL-STEEL) IDNR.2007137E

(For propeller shaft / propeller hub connection see description ID.nr. 2006192, keyless propeller mounting.

- 1) Clean the shaft end thoroughly and check that the right hub will be mounted on the right shaft end (in reference to classification numbers which belong to the corresponding shaft numbers).
Check roughness, pay special attention to sharp edges (ends and oil grooves), smoothen if necessary.
- 2) Prepare shaft end with engineer's blue.
- 3) Mount the hub and push it with handforce or by its weight on the shaft end. Next dismount the hub.
Take care to preserve the obtained print.
On the shaft and on the hub it should clearly show if the taper is bearing correctly.
If the installation is under classification survey, a classification surveyor should attend to these actions.
- 4) Clean the shaft end and hub thoroughly and mount the necessary tool equipment. Use the correct type of oil for the hydraulic pump: OMALA 100 or equivalent.
A classification surveyor should attend the actual pressing-on procedure when this is applicable.
- 5) Now push the hub on the shaft and initialize a pre-load force (with only the hydraulic nut) of 10% of the total push-up force; see instructions on the drawing.
If this pre-load force is unknown, our construction department should be counselled.
The pre-load force, divided by the effective area of the hydraulic nut, gives the pre-load pressure.
- 6) After the hub is mounted with pre-load, a dial gauge has to be fitted on a fixed place with regard to the hub.
Place the sensor of the dial gauge on the hub and adjust it to zero.
Note the distance to the fixed point.
Now press the hub on the shaft according to the push-up length (see instruction or drawing) by means of the hydraulic nut.
The maximum pressure on the hydraulic nut will be about 10 times the pre-load pressure.
The hub should be kept under pressure during pushing on the shaft, accomplishing that it will move on an oil film.
This pressure should be noted on the drawing, if not please consult our engineering department.

1/2

Drunen, 1992

LIPS THRUSTERS DRUNEN B.V.

When the push-up length is reached, the hub should be depressurized, but the hydraulic nut should be kept under pressure for some time to prevent sliding back of the hub.

Alternatively to 4, 5 and 6, the hub may be fitted to the shaft, heated up to a suitable temperature T_2 , calculated as:

$$T_2 = T_1 + \frac{pu \cdot 10^{-5}}{a \cdot K \cdot d} + \text{appr. } 30^\circ \text{ C.}$$

T_1 = shaft temperature ($^\circ \text{C.}$)

pu = push-up length (mm)

K = taper ratio

d = mean cone diameter (mm)

a = 1,1 to 1,5; depending on material of the Hub

Auxiliaries to ascertain an exact push-up length have to be provided for, f.i. by machining the retaining cover on the final dimension beforehand or fitting a temporary cover over the hub (at the small end), using a precisely machined distance piece. Both hub and shaft to be cleaned with solvent. Hub to be heated-up slowly and especially evenly, preferably by induction.

- 7) If the flange is supplied with retainer plate, the difference between shaft end flange should be measured and the retainer adapted to this measure.
The push-up length must be stamped to the retainer plate.

DISMOUNTING INSTRUCTIONS:

Set up a buffer for the hub as follows:

Depressurize the hydraulic nut and loosen a little more than the push-up length.

Alternatively, put a suitable spacer between the shaft's end face and the retainer plate, using longer bolts, same property class, and re-tighten them.

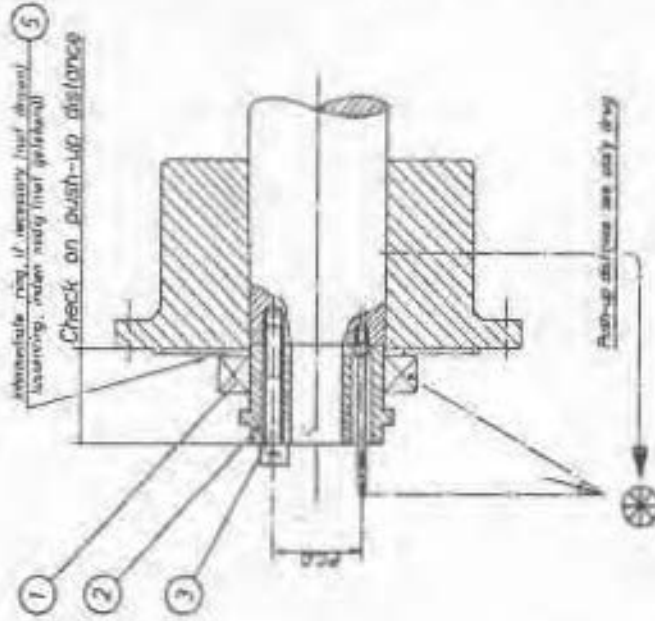
If required, as indicated by previous experience or a flange / hub diameter ratio of appr. 2, it is advised to heat up the flange outer diameter quickly to $50^\circ - 60^\circ \text{ C.}$

Area near taper must remain cold.

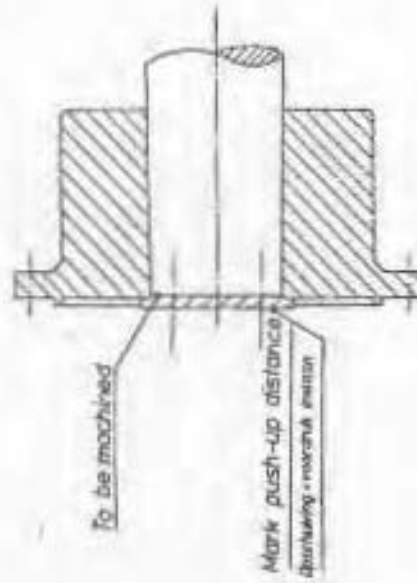
Then the hub is put under hydraulic pressure, after which it should come off the shaft with a loud bang as it hits the buffer. The buffer is essential for personnel safety, as well as to prevent damage to components.

NOTE: If the dismounting is an intermediate phase of the assembly of a complete gearbox, this dismounting must take place within one (1) week's time after mounting of the flange.

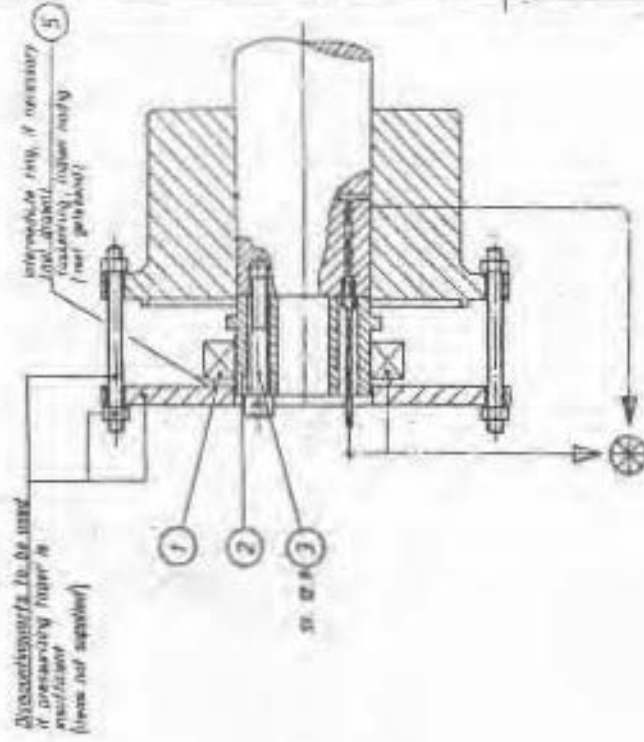
Mounting of flange



Adjusting of locipitate



Dismounting of flange



☞ To be connected with hy-pressure handpumpset (Dir. 2050810)

Mounting instructions see 205237
 See B. 205237 / Controlvalve 2050909 model

POSITION	AND	NO.	DESCRIPTION
205235	#120	70	3+3/8
205233	#125,5	80	3+1/2
205232	#140	80	3+1/2
205234	#140	80	3+1/2
205236	#140	80	3+1/2
205238	SHAFT	P.C.D.	80X1,5

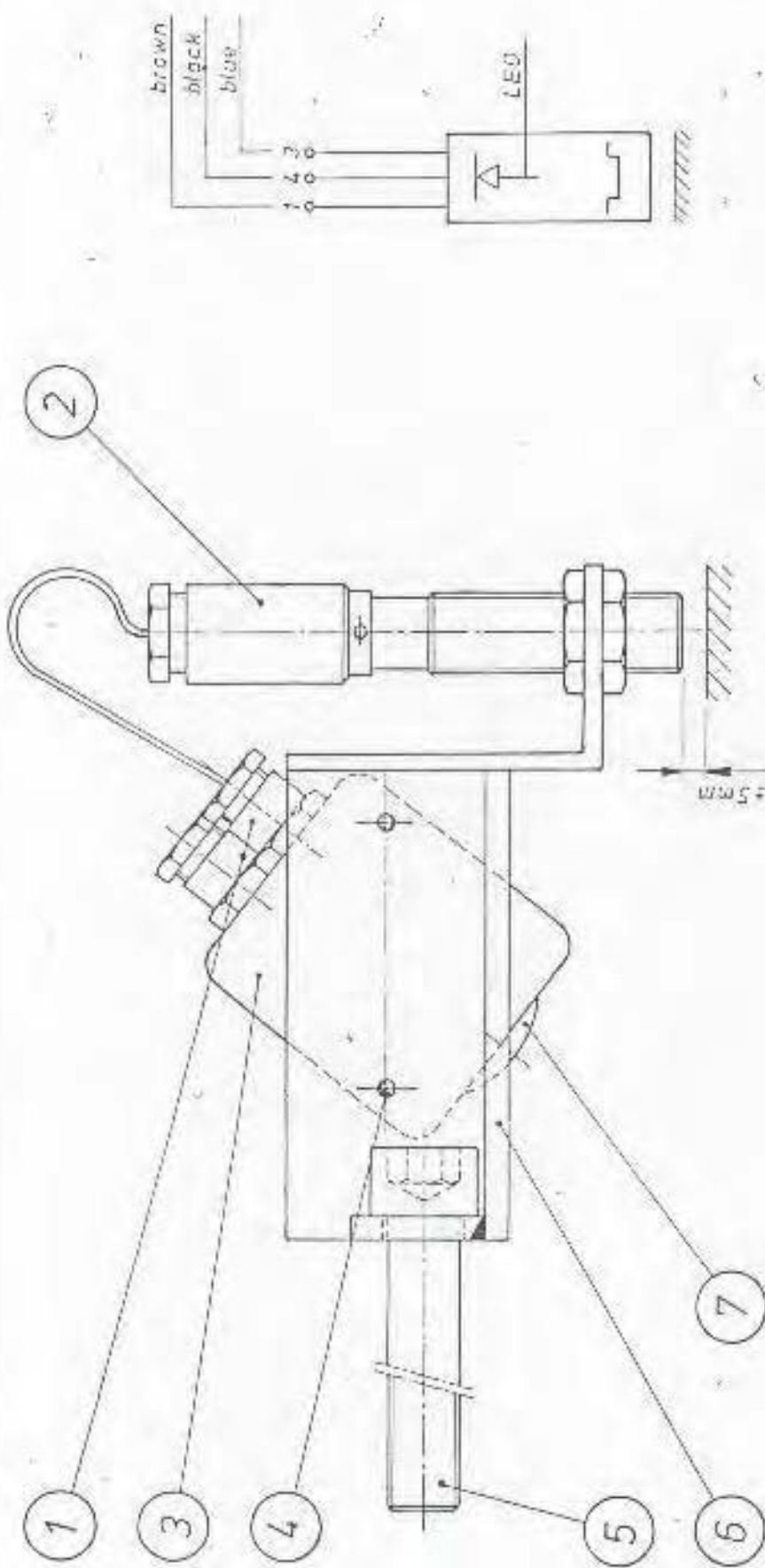
2051935

MOUNTING OF FLANGE

DATE	BY	CHECKED	APPROVED



LIPS THRUSTERS		Konische verbinding / Taper fit	
Datum: Date	_____	LTD order nr.	_____
Order naam: Order name	_____	Type Thruster:	_____
Volgnr: Sequence nr.	_____	Bouwnr.: Building nr.	_____
Keur: Class	_____	Schroefnr.: Propeller nr.	_____
Instructie: Instruction	2006192 / 2007337 brons staal	Op-pers tek.: Mounting drw.	_____
Soort verbinding: Which connection	_____		
<div style="border: 1px solid black; display: inline-block; padding: 2px;">eventueel vooraf invullen</div> <div style="border: 1px solid black; display: inline-block; padding: 2px;">alleen ter plekke invullen</div>			
Temp. naaf en as: Temp. hub & shaft	_____ °C	gebruikte persmoer: hy-nut used	_____
bijbeh. opschuifweg: corresp. push-up	_____ mm	bijbeh. voordruk: corresp. pre-load	_____ bar
hor. / vert.	1e montage	2e montage	3e montage
voordruk [bar] preload			
afstand tot huis [mm] distance to housing			
verschil met vorige difference w. previous			
opschuifweg [mm] push up			
moer druk [bar] nut press.			
naaf druk [bar] hub press.			
afstand tot as [mm] distance to shaft			
	LTD	Class	
Naam			
Paraaf			



Pos.	Bestimmungszeichen	Bestimmung	Menge	Größe	Messung
1					
2					
3					
4					
5					
6					
7					

Lieferprogramm 9306186 (fermo)	Zeichnung 1502	Ausführung 1
Materialgruppe 1.2	Zeichnung 1502	Ausführung 1
Artikelnummer 300666113	Zeichnung 1502	Ausführung 1

Sub ass y proximity switch 300666113	Zeichnung 1502	Ausführung 1
---	-------------------	-----------------

TITLE : ASSEMBLY SWITCH
TYPE : ASSEMBLY NR.T003004611
LIST : T073010044

PAGE : 1
DRAWING : 3004611
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	CABLE GLAND	W006541062	2,0
2	SWITCH	W006830227	1,0
3	TERMINAL BOX	T001023366	1,0
4	SLOTTED CHEESE HEAD SCREW	M712030376	2,0
5	HEX. SOCKET HEAD CAP SCREW	M712045390	1,0
6	SUPPORT	T003004610	1,0
7	BLIND PLUG	W008997038	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

END OF LIST

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.4

STEM SECTION

LIPS THRUSTERS DRUNEN B.V.

2.4 STEM SECTION

The main parts of the stemsection are:

- the steering gearbox
- the support pipe
- the steering pipe
- the vertical intermediate shaft

The main functions of the stemsection are:

- providing the azimuth capability
- penetrating the hull
- connecting the upper gearbox with the propeller gearbox
- transmitting torque to the propeller shaft

The upper flange of the support pipe is bolted to the steering gearbox; connection to the propeller gearbox is achieved through the shank (chapter 2.6).

On the cover of the steering gearbox four steering units are mounted, see paragraph 2.4.1. The pinion of each steering unit is connected to the spur gear wheel, providing the azimuth function.

The support pipe is the means by which the hull is penetrated and contains the bearings on which the steering pipe is carried.

The latter is projecting from the support pipe and has a flange to which the shank is bolted.

A sealing arrangement is provided for between the support pipe and the steering pipe consisting of three seal rings running on a ceramic coated liner.

Against the inner wall of the steering pipe the oil suction tube is fitted running from the bottom of the propeller gearbox to a sealing arrangement at the top of the steering pipe.

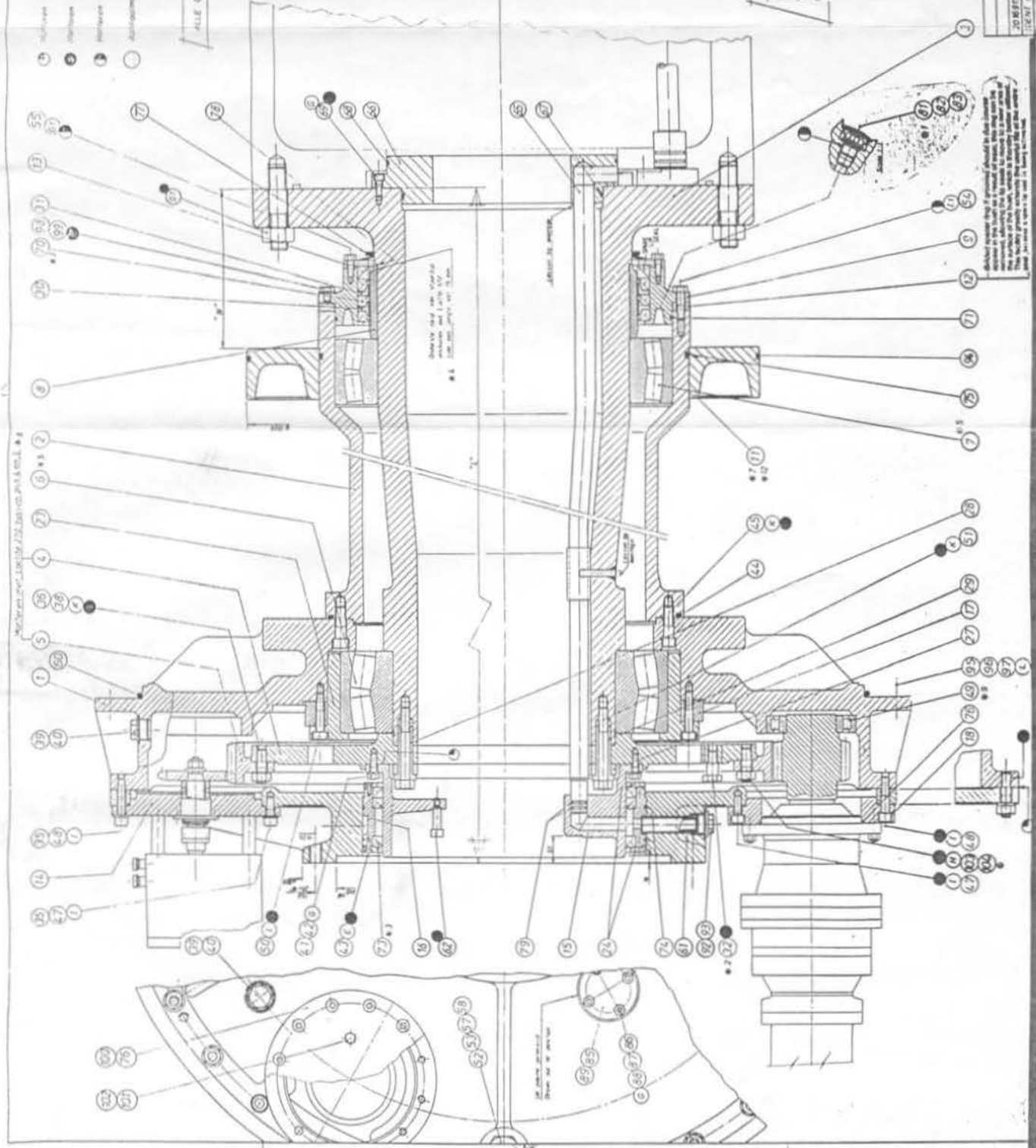
The vertical intermediate shaft is fitted with a shrunk connected sleeve with splines at each end. It transmits the power from the upper gearbox output shaft to the propeller gearbox input shaft.

- 1 Schrauben mit Loch 1/4
- 2 Schrauben mit Loch 2/16 242
- 3 Schrauben mit Loch 1/8 270
- 4 Aufhängemittel wiegen nicht 2033413

ALLE ÖPNUNGEN AUFZULEGEN

ANMERKUNG:
 Die in dieser Zeichnung angegebenen Maße sind die Nennmaße. Die tatsächlichen Maße können durch Fertigungstoleranzen abweichen. Die Fertigungstoleranzen sind in der Zeichnung angegeben.
 Die Maße sind in Millimetern angegeben. Die Maße sind in Zehntel Millimetern abgerundet.

EINZELNE ANORDNUNG		EINZELNE ANORDNUNG	
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40
41	42	43	44
45	46	47	48
49	50	51	52
53	54	55	56
57	58	59	60
61	62	63	64
65	66	67	68
69	70	71	72
73	74	75	76
77	78	79	80
81	82	83	84
85	86	87	88
89	90	91	92
93	94	95	96
97	98	99	100



TITLE : STEMSECTION
 TYPE : ASSEMBLY NR.T002016917
 LIST : T073010021

PAGE : 1
 DRAWING : 2016917
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
2	PIPE,SUPPORT	T002052298	1,0
3	PIPE,STEERING	T002017061	1,0
4	GEAR WHEEL HUB	T002006705	1,0
5	GEAR WHEEL	T002005774	1,0
6	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210914	1,0
7	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210924	1,0
8	LINER	T002006711	1,0
9	HOLDER	T002006738	1,0
01A	COVER	T002017067	1,0
01B	GEARBOX,STEERING	T002016708	1,0
01C	HEXAGON SOCKET HEAD SHOULDER SCREW	W007350034	6,0
01D	HEXAGON NUT	M714040036	6,0
11	GLAND	T002016710	1,0
12	DISTANCE RING	T002006717	1,0
13	RETAINING RING	T002006719	1,0
14	SEE ORDER PARTS LIST	T002999985	1,0
15	LINER	T002017109	1,0
16	HOLDER	T002016713	1,0
17	DISTANCE RING	T002016714	1,0
18	COVER	T002006737	4,0
23	BEARING BUSH	T002016712	1,0
24	RETAINING RING	T002006710	2,0
27	ADJUSTING RING	W004775022	24,0
28	BUSH,CENTRING	T002005869	23,0
29	BUSH,CENTRING	T002005868	1,0
30	SUPPORTING RING	T002006893	1,0
31	SUPPORTING RING	T002006788	1,0
32	INDICATOR	T002007059	1,0
35	SINGLE COIL SPRING WASHER	M716100036	20,0
36	HEXAGON NUT	M714040039	44,0
38	STUD. SCREW LENGTH 1,25 D	M711050432	44,0
39	HEXAGON HEAD SCREW PLUG	M710380256	4,0
40	COPPER SEALING RING	M731000340	4,0
41	HEXAGON SCREW	M713000480	12,0
42	SINGLE COIL SPRING WASHER	M716100033	12,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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TITLE : STEMSECTION
 TYPE : ASSEMBLY NR.T002016917
 LIST : T073010021

PAGE : 2
 DRAWING : 2016917
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
43	HEX. SOCKET HEAD CAP SCREW	W007281082	48,0
44	CORD RING WITH VULCANIZED JOINT	W007000300	1,0
45	HEX. SOCKET HEAD CAP SCREW	M712045438	32,0
47	HEX. SOCKET HEAD CAP SCREW	M712040382	40,0
48	HEX. SOCKET HEAD CAP SCREW	M712045387	10,0
49	BEARING,CYLINDRICAL ROLLER	W006220023	4,0
50	HEX. SOCKET HEAD CAP SCREW	M712045388	24,0
51	HEXAGON BOLT	M713005593	24,0
52	HEXAGON SCREW	T002007705	4,0
53	SEALING RING	T002009394	4,0
54	HEXAGON BOLT	W007110142	16,0
55	HEXAGON SCREW	M713001480	24,0
56	STUD. SCREW LENGTH 1,25 D	M711050435	25,0
57	O-RING	W007035628	4,0
58	O-RING	W007000809	4,0
60	CORD RING WITH VULCANIZED JOINT	W007001427	1,0
61	SEAMLESS PRECISION TUBE	M301035304	110,0 MM
62	HEXAGON SOCKET HEAD SHOULDER SCREW	W007350049	2,0
63	SINGLE COIL SPRING WASHER	M716100039	25,0
64	HEXAGON NUT	M714040039	25,0
65	LINE,OIL	T002017103	1,0
66	RING,CENTRING	T002017063	1,0
67	O-RING	W007000641	1,0
68	O-RING	W007000712	1,0
69	HEX. SOCKET HEAD CAP SCREW	M712040330	7,0
70	OIL SEAL	W007065164	4,0
71	CORD RING WITH VULCANIZED JOINT	W007000297	1,0
73	OIL SEAL	W007065163	3,0
74	CORD RING WITH VULCANIZED JOINT	W007001429	2,0
75	CORD RING WITH VULCANIZED JOINT	W007000300	1,0
76	SEAMLESS O-RING SEAL	W007031005	4,0
77	V-RING	M730030046	1,0
78	CORD RING WITH VULCANIZED JOINT	W007058006	1,0
79	O-RING	W007000577	2,0
81	HEXAGON HEAD SCREW PLUG	W006564111	1,0

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TITLE : STEMSECTION
 TYPE : ASSEMBLY NR.T002016917
 LIST : T073010021

PAGE : 3
 DRAWING : 2016917
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
82	DUBO RETAINING RING	M716601033	1,0
83	RED CAP	W004630023	1,0
84	COVER	T003001793	1,0
84B	O-RING	M730000140	1,0
84C	GLASS,SIGHT	T003001792	1,0
85	COVER	T002007058	1,0
86	STUD. SCREW LENGTH 1,25 D	W007265027	2,0
86B	HEX. SOCKET HEAD CAP SCREW	W007281053	2,0
87	SINGLE COIL SPRING WASHER	M716100031	2,0
88	HEXAGON NUT	M714040031	2,0
89	O-RING	W007000809	1,0
92	HEXAGON HEAD SCREW PLUG	M710380254	2,0
93	COPPER SEALING RING	M731000323	2,0
94	SEAMLESS O-RING SEAL	W007031006	1,0
95	STUD. SCREW LENGTH 1,25 D	M711050486	48,0
96	SINGLE COIL SPRING WASHER	M716100041	48,0
97	HEXAGON NUT	M714040041	48,0
98	HEXAGON SCREW	W007100410	4,0
99	PLAIN WASHER	M716000436	4,0
103	STUD. SCREW LENGTH 1,25 D	W007265037	4,0
104	HEXAGON NUT	W007210054	4,0
105	LIQUID LOCKING ADHESIVE	T002005545	1,0

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E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.4.1

STEERING UNIT



LIPS THRUSTERS DRUNEN B.V.

2.4.1 STEERING UNIT

The steering unit includes:

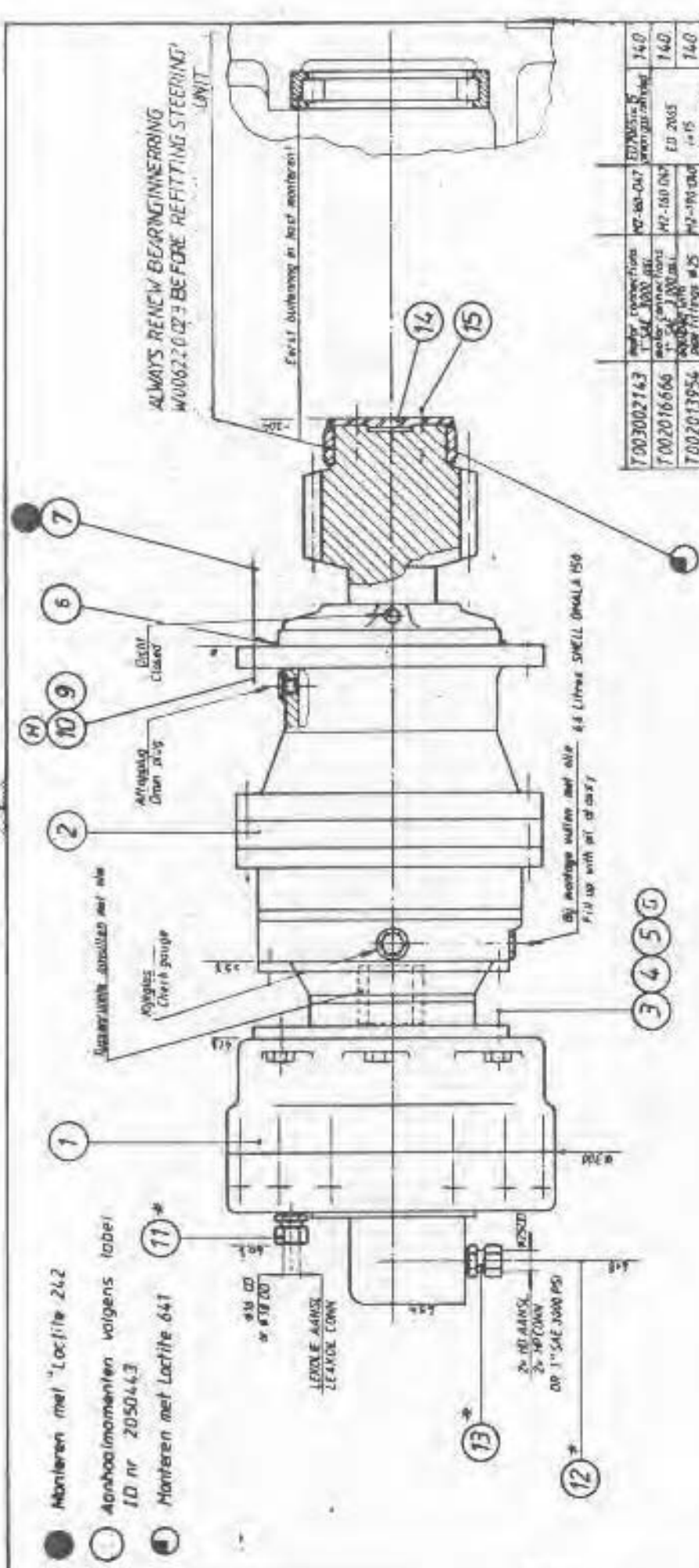
- 2.4.1.1 Hydraulic steering motor
- 2.4.1.2 Planetary reduction gearbox
- 2.4.1.3 Azimuth feedback unit

The thruster steering pipe with connected gearbox and propeller is rotated by hydraulic power through four steering motor assemblies fitted on the steering gearbox.

For lubrication of the reduction gear the same oil may be used as applied in the lubrication oil system of the thrusters. For oil types a specification sheet is included in paragraph 5.

The feedback unit is necessary to return "achieved steering position" to the indicators in the control stations, as well as feedback information to the steering control system.

- Monteren met "Loctite 242
- Aansluitmomenten volgens tabel ID nr 2050443
- Monteren met Loctite 641



ALWAYS RENEW BEARING INNERING
W00622.023 BEFORE REFITTING STEERING
UNIT

First burthing in last membrane!

68 Litres shell (shell 150)
Fill up with oil (dash)

7003002163	motor connections 1" SAE 1000 PSI	72-68-047	EDWARDS weight-saving	14.0
7002016666	motor connections 1" SAE 1000 PSI	72-100-007	ED 2005	14.0
7002013954	motor fittings #25	72-100-000	ED 2005	14.0
7002013110	motor fittings #25	72-100-000	ED 2005	14.0

ID NRS	REMARKS	POS. 1	POS. 2	MASS (kg)
	3. 100714 P. 100714			
	2. 201540 P. 201540			
	1. 100714 P. 100714			

ALLE OPENINGEN AFPLUGGEN MET PLASTIC DOPPEN

All pipe connections suitable for pipe acc. DIN 2391/C

* SEE PARTS LIST/DE STAALIJST

LIPS THRUSTRERS DRIVEN B.V.
CERTIFIED DOCUMENT
Date:

For info and requirements
see Lips Thrustrers/DI Sheet

MIT ACH NACH DIN 2004 31C DURCH DIE KLASSE BEZIELT
MET AFNAME VAN DIN 2004 31C DOOR DEEN KLASSEBEZIELT
APPROVAL OF DIN 2004 31C BY A CLASS SOCIETY

STEERING UNIT
BESTURING AANBOUW

LIPS THRUSTRERS A.	2013110
--------------------	---------

TITLE : STEERING MOTOR ASSY
TYPE : ASSEMBLY NR.T002016666
LIST : T073010023

PAGE : 1
DRAWING : 2013110
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	HYDRAULIC MOTOR	T002016665	1,0
2	REDUCTION BOX	T002013109	1,0
3	HEXAGON BOLT	M713005484	5,0
4	HEXAGON NUT	M714040033	5,0
5	SINGLE COIL SPRING WASHER	M716100033	5,0
6	O-RING	W007001021	1,0
7	STUD. SCREW LENGTH 1,25 D	W007265037	12,0
9	SINGLE COIL SPRING WASHER	M716100034	12,0
10	HEXAGON NUT	W007210054	12,0
11	STRAIGHT MALE STUD COUPLING	W006350147	1,0
12	PART NOT APPLICABLE	T002999998	1,0
13	PART NOT APPLICABLE	T002999998	1,0
14	HEX.SOCKET COUNTERSUNK HEAD CAP SCR	M712060172	2,0
15	RING, MOUNTING	T003001656	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.4.1.1

HYDRAULIC STEERING MOTOR

SAI s.p.a.

Technology



SAI GROUP SELECTION GUIDE PRODUCTS APPLICATIONS DRAWINGS WHERE WE ARE RESERVED CONTACTS



SAI Motori Idraulici S.p.A.
Indirizzo : Via Olanda 51 - 41100 MODENA Italy
Telefono : + 39 059 420111 / Fax : + 39 059 451260

MODEL M2-190 - 4 per cluster
- for model replaced this model.

SAI s.p.a. Via Olanda 51, 41100 MO Italy Tel. +39.059.420111 Fax +39.059.451260

where we are

STUE -

US!

3905 W 9TH ST
TRAMER, PA 19061

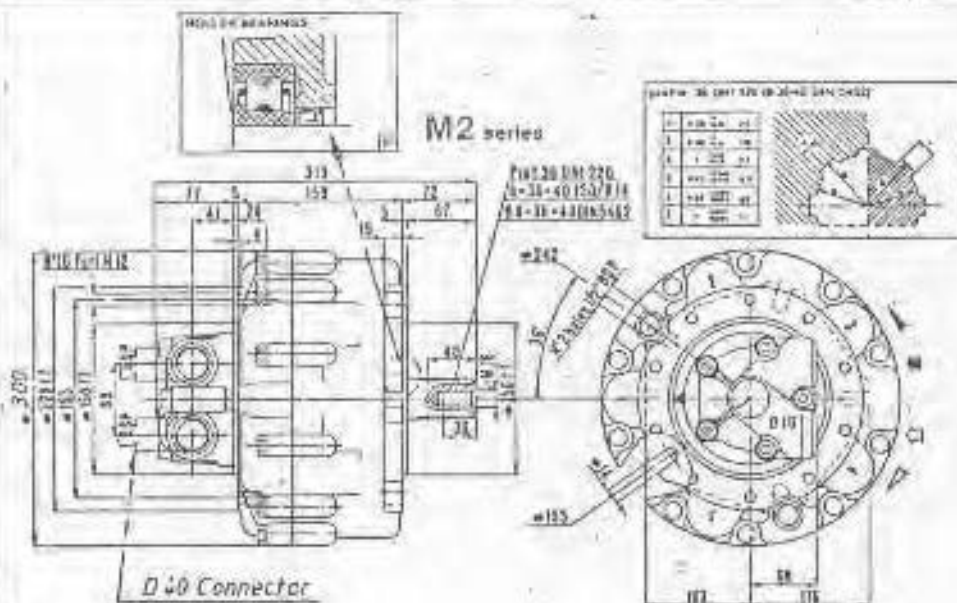
AT: 610-497-0190

FAX: 610-497-0194

EMAIL: info@saihyd.com

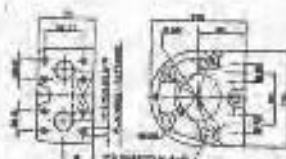
WEB: www.saihyd.com

3705 W 9TH ST
TRAMER, PA 19601



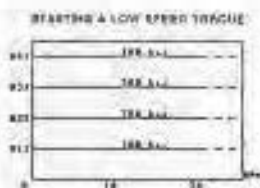
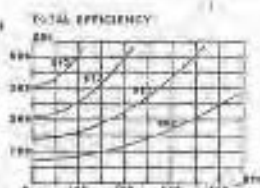
NOMINAL CONTINUOUS PRESSURE: 210 bar (3000 psi)
PEAK PRESSURE (1% per minute): 420 bar (6000 psi)

NOMINAL DISPLACEMENT		135	160	190
Displacement	cm ³ /rev	135	160	192
Bore	∅ mm	35	36	38
Stroke	mm	28	34	40
Specific torque	kgm/bar	0.22	0.26	0.31
Cont. torque	kgm	46	55	60
Peak power	HP	48	56	69
	KW	38	42	44
Peak speed	rpm	900	900	800



D47 Connector

MOTOR PERFORMANCE



The graphs above refer to the 300 cc motor.

TOTAL EFFICIENCY is higher for larger displacements at the same (90 + 2%) and lower for small displacements (90 - 2%).

TOTAL LEAKAGE includes leakage by gaps and internal leakage. The values given are indicative of the motor when working with oil of viscosity 40-50 cSt, temperature 50°C and with discharge 0.05. The proportion of internal leakage is typically 50% of the total.

STARTING TORQUE and low speed torque efficiency varies across the series as per table (efficiency). The values given are average values obtained in a closed loop with 8-10 bar back pressure. Torque fluctuation is ± 2% below 10 rpm.

IDLE PRESSURE is the required pressure difference required to turn the motor at the indicated speeds.

BOOST PRESSURE is the no-load pressure difference required when the motor is suddenly driven at the indicated speeds.

SPIN STABILITY: above 20 rpm the motor runs without speed fluctuations. Below 20 rpm speed fluctuation increases up to 25%. Below 5-8 rpm controllability of the oil and electricity for the cylinders etc. may cause larger fluctuations.

FOR DETAILS ON ALLOWABLE BACK PRESSURES, ON FREEWHEELING, CAVITATION AND MOTOR LEAKS see introduction.

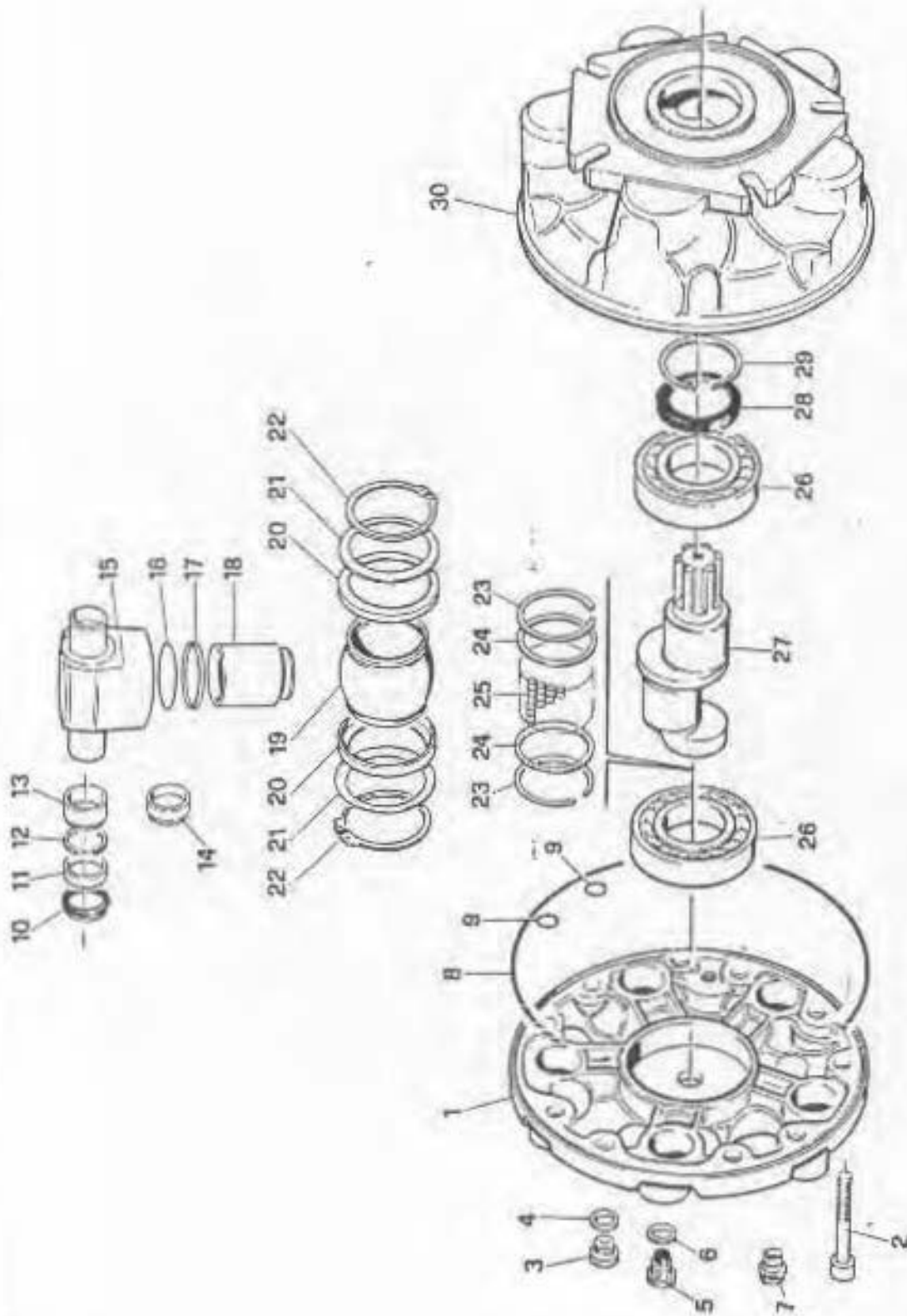
SAI 2013108

Approx. mass: M2 series: 45 kg
Case oil quantity: M2 series: 2.5 lit
Moment of inertia: 0.0048 kgm²

3000533	M2-135-88x36x40(DIN5462)-H-N-A/B-D47
2013910 R	M2-190-88x36x40(DIN5462)-H-N-A/B-D47 *
2016665	M2-160-88x36x40(DIN5462)-H-N-A/B-D47
2013910	M2-190-88x36x40(DIN5462)-H-N-A/B-D40
2013108	M2-160-88x36x40(DIN5462)-H-N-A/B-D40
2016378	M2-135-88x36x40(DIN5462)-H-N-A/B-D40
IDENT NR	TYPE / DESCRIPTION

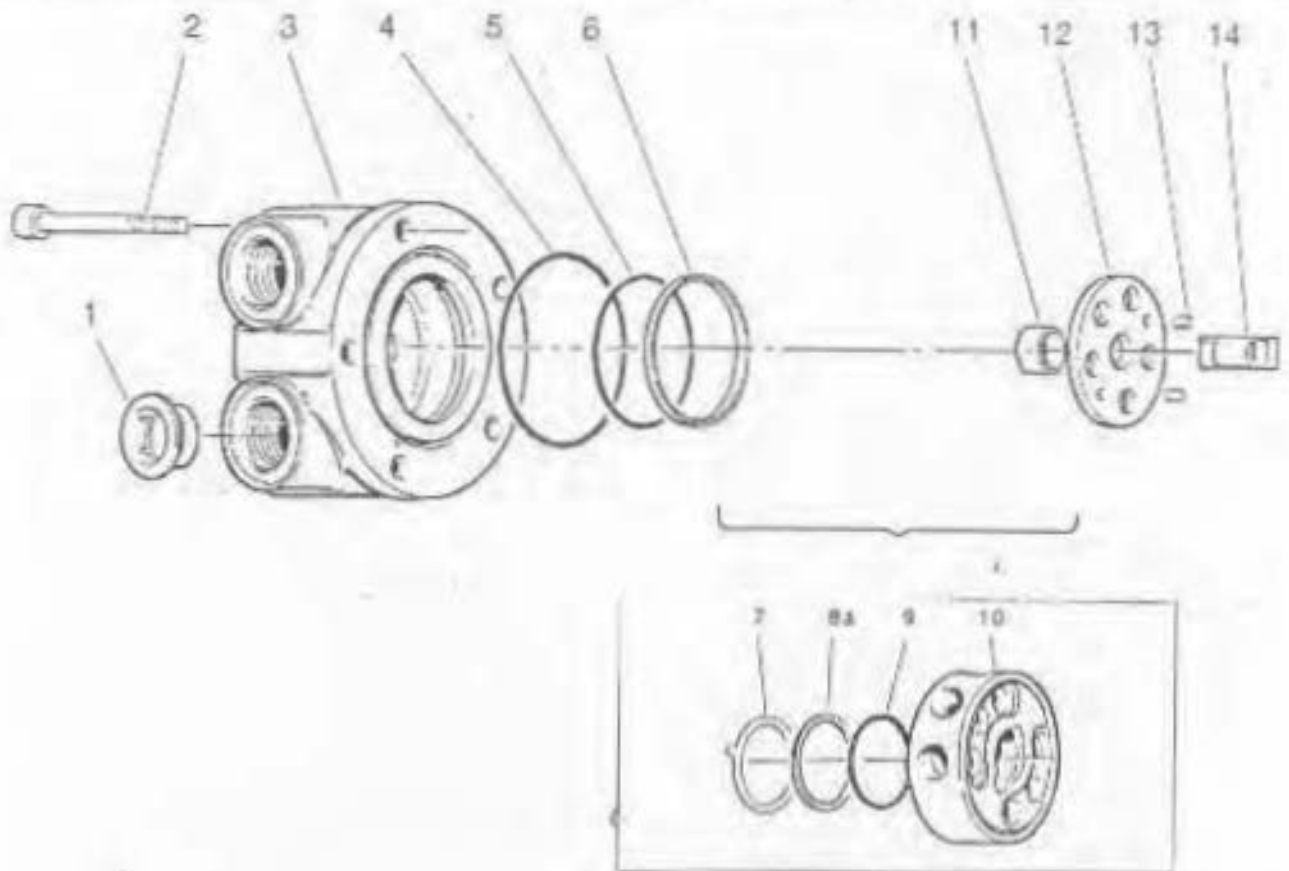
With Classification certificate acc. DIN 50049 Level 3.1C

Ident nr: 2016665



Ident nr: 2016665

M2 SERIES SPARE PARTS			
	DESCRIPTION	QUANT	CODE
1	motor cover	1	0 128 100 302
2	bolt 8.8 M12x45	10	0 010 025 244
3	drain plug 1/2"	1	0 010 023 047
4	washer	1	0 010 018 022
5	magnet plug 1/2"	1	0 010 023 059
6	washer	1	0 010 018 022
7	plastic plug 1/2"	1	0 010 023 015
8	cover/body o-ring	1	0 010 012 277
9	bolt hole o-ring	10	0 010 012 261
10	trunnion seal+o-ring	10	0 010 312 201
11	bushing	10	0 012 107 212
12	c.clip	10	0 010 001 103
13	normal bushing	10	0 112 109 212
14	short bushing	10	0 112 108 212
15	cylinder	5	0 142 102 205
16	cylinder o-ring	5	0 010 012 214
17	cylinder seal	5	0 010 038 002
18	piston	5	0 142 100 206
19	spher. supp. ring	1	0 128 100 210
20	retaining ring	2	0 128 102 311
21	retainer spring	2	0 128 101 220
22	external c.clip	2	0 010 001 059
23	internal c.clip	2	0 010 001 069
24	spacer ring	2	0 010 018 042
25	rollers	145	0 010 020 026
26	shaft bearing	2	0 010 007 015
27	male shaft uni	1	0 127 100 204
28	shaft seal babsl.	1	0 010 002 032
29	c.clip	1	0 010 001 061
30	motor body	1	0 128 100 601



DISTRIBUTOR		
1	plastic plug	0 010 023 011
2	bolt no 5 12.9 M12x80	0 010 025 343
3	distributor cover	0 140 047 003
4	o-ring seal	0 010 012 043
5	o-ring seal	0 010 012 040
6	plastic seal	0 010 038 054
7	steel anti-extrusion ring	0 140 000 013
8a	plastic seal ring	0 010 038 063
9	o-ring seal	0 010 012 256
10	rotary distributor	0 140 000 007
11	bush	0 140 000 012
12	bronze bearing disc	0 140 000 250
13	location pins	0 010 020 048
14	distributor drive pin	0 1120103 109

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.4.1.2

PLANETARY REDUCTION GEARING



DISTINTA BASE COMPONENTI

DENOMINAZIONE: OUTPUT SUPPORT

GRUPPO: DK 9 - EM 1065

VERSIONE: SPLINE - MR VERSION

DISTINTA N°

00/1100 C

FOG N°

GRUPPO

G.010-00/035.2

P	CODICE	DENOMINAZIONE	N°	NOTE
1	352/066.1/4200	SUPPORT	1	
2	354/174.2/4000	SEAL HOLDER	1	
3	311/137.3/0600	SHAFT	1	
4				
5				
6				[2013109]
7	335/200.2/1300	SHAFT	1	
8	412/341.0/0000	O-RING 2-251	1	
9				
10				
11	471/016.0/0000	NUT KM 15 M75x2-6H	1	
12	372/113.4/6400	RING	1	
13				
14				
15	422/141.0/0000	BEARING 33215 DIN 720	1	
16	422/139.0/0000	BEARING 30215 DIN 720	1	
17				
18	411/335.0/0000	SEAL BA31 85x110x12 DIN 3760	1	
19				
20	438/430.0/0100	PIN Ø12x60 UNI 6875-71	4	
21				
22	451/124.0/0100	OIL LEVEL PLUG TLA 2 3/8" GAS	1	MINITOR
23				
24	461/078.0/0000	BOLT M8 x25 UNI 5931-67-80	6	
25				
26				
27	468/012.0/0000	RING A8,4 UNI 1751	6	
28				
29	451/022.0/0000	PLUG 1/8" DIN 908	1	
30				
31				

brevini s.p.a.

REGGIO EMILIA - ITALIA MOD. T.B. 98

MODIFICA

DATA

FIRMA

SOSTITUISCE IL

SOSTITUITO DA

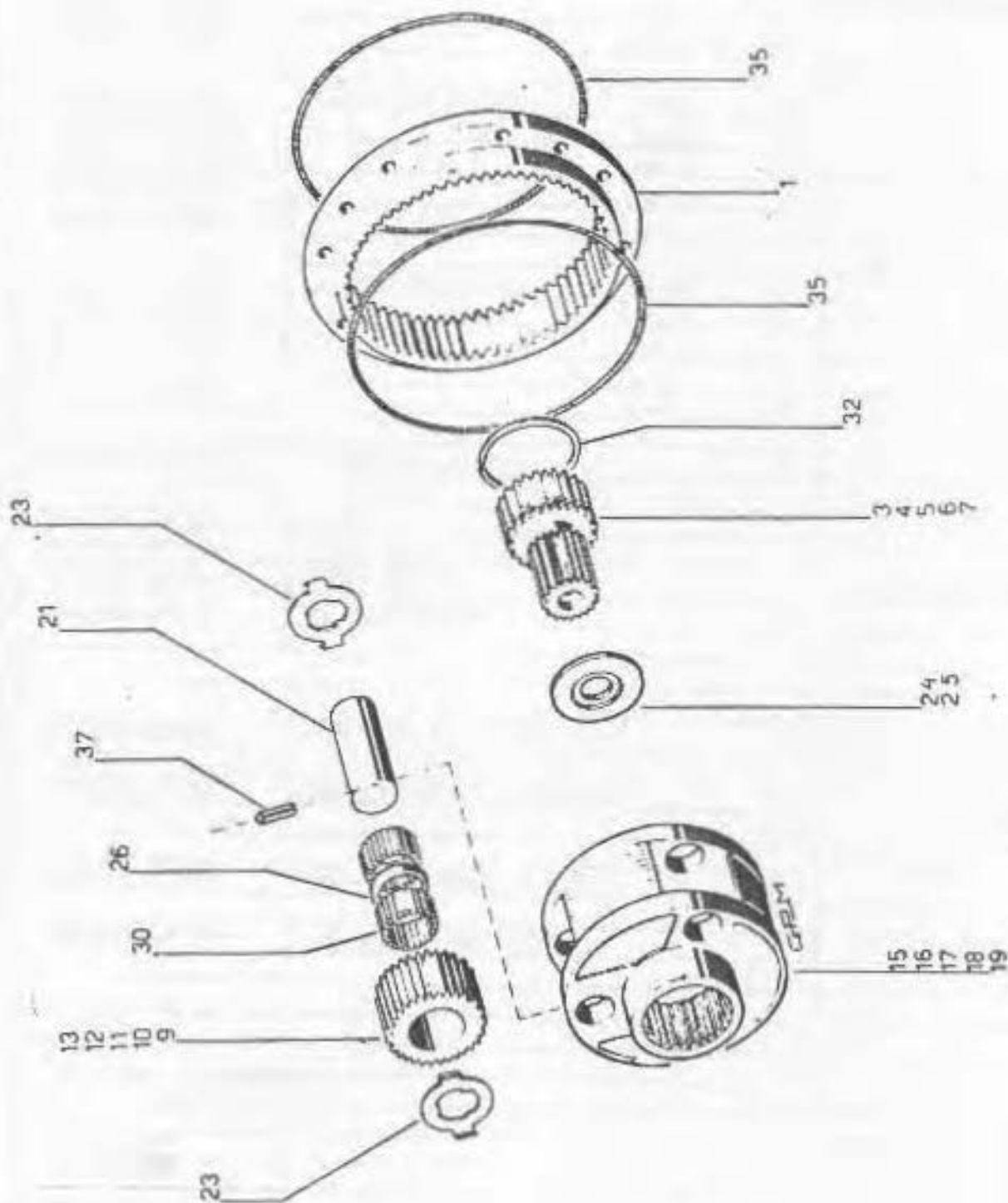


DENOM. RIDUZIONE EPICICLOIDALE
GRUPPO DK9 SERIE 80
VERS. GIUNTO CENTRALE

DISTINTA N° 6123
00-4108 B
GRUPPO N°
G.016 H-00 1011 1

MUD

2013109

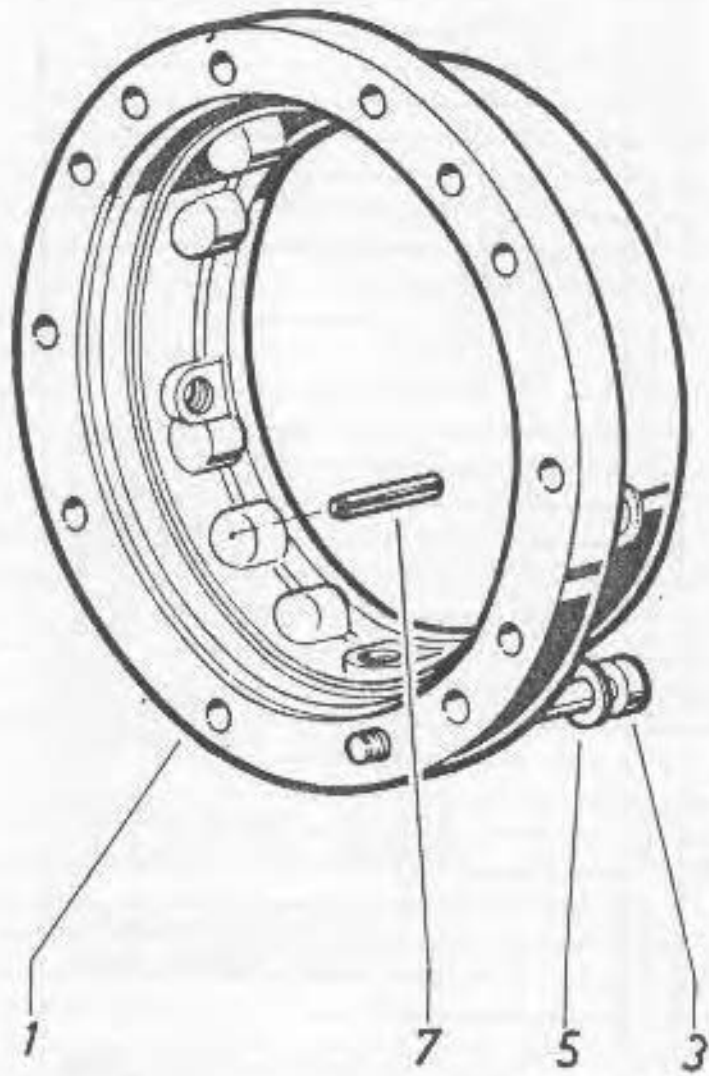




DENOM. : FLANGIATURA INTERMEDIA
GRUPPO - ED 2065 / ET 3250
VERS. : STANDARD

DISTINTA N° *bid 5* MOD.
00/3008
GRUPPO N°

2078709



BREVINI S.p.A.
REGGIO EMILIA - ITALIA

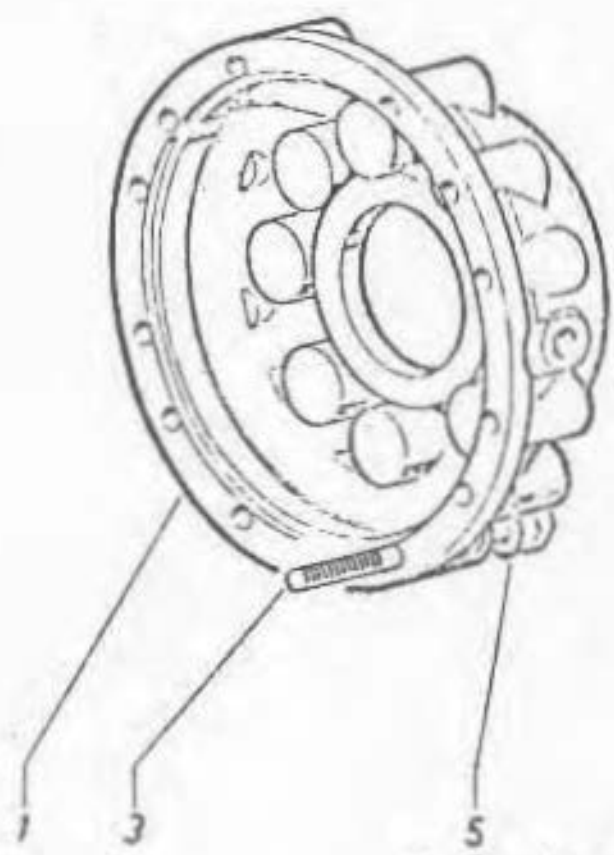


DENOM. FLANGIATURA UNIVERSALE
GRUPPO ED 2065
VERS. "33" IN ALL. "66" IN GHISA

DIST. N° ⁰¹¹⁰
00/3103/33-66
GRUPPO

MOD.

2013109



(- 6 - solo spec. 33)

RIEVERE S.p.A.
REGGIO EMILIA - ITALIA



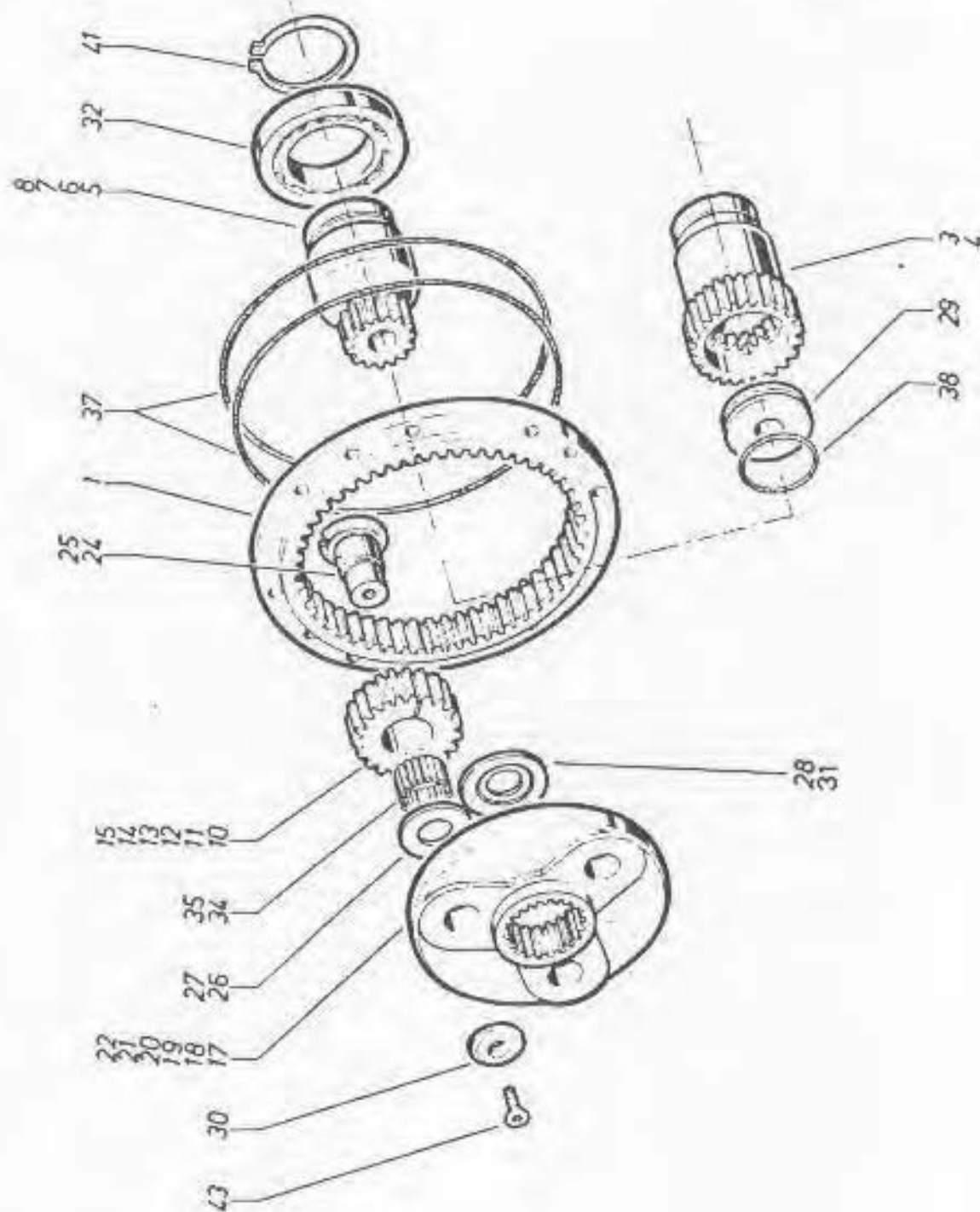
DENOM. : RIDUZIONE EPICICLOIDALE
GRUPPO : E.MI.14/S
SERIE 80
VERS. : UNIVERSALE

DISTINTA N° bld 60
00/4043

MOD

GRUPPO N°
G. 0145.00/022.1

2073109



brevini s.p.a.
REGGIO EMILIA - ITALIA



DENOM. SUPPORTO

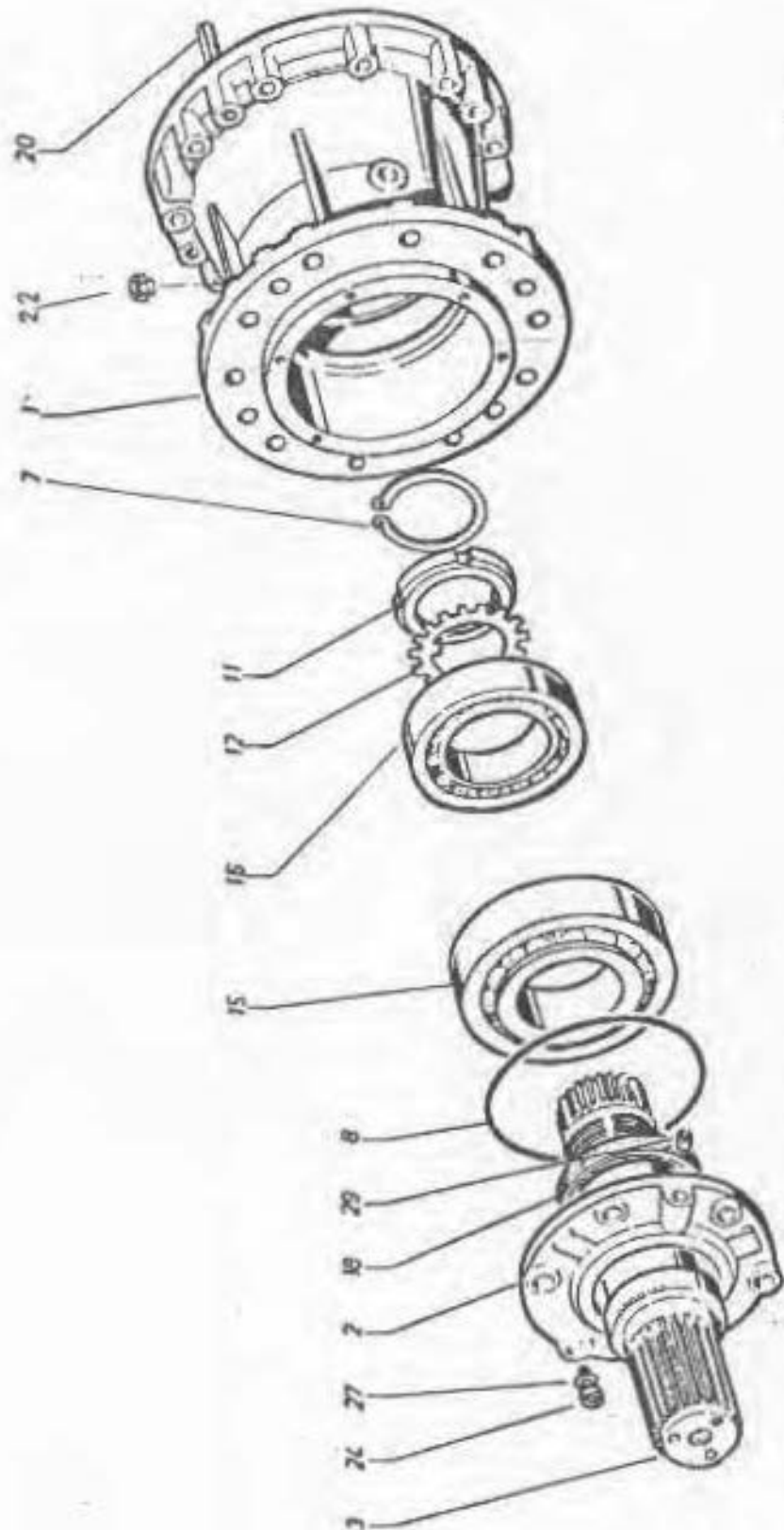
GRUPPO DK 9

VERS. MASCHIO RINF. MR

DIST. N° 61211
00/1100 - C

GRUPPO
G.010-00/035-2

sostituisce 00/1100 B



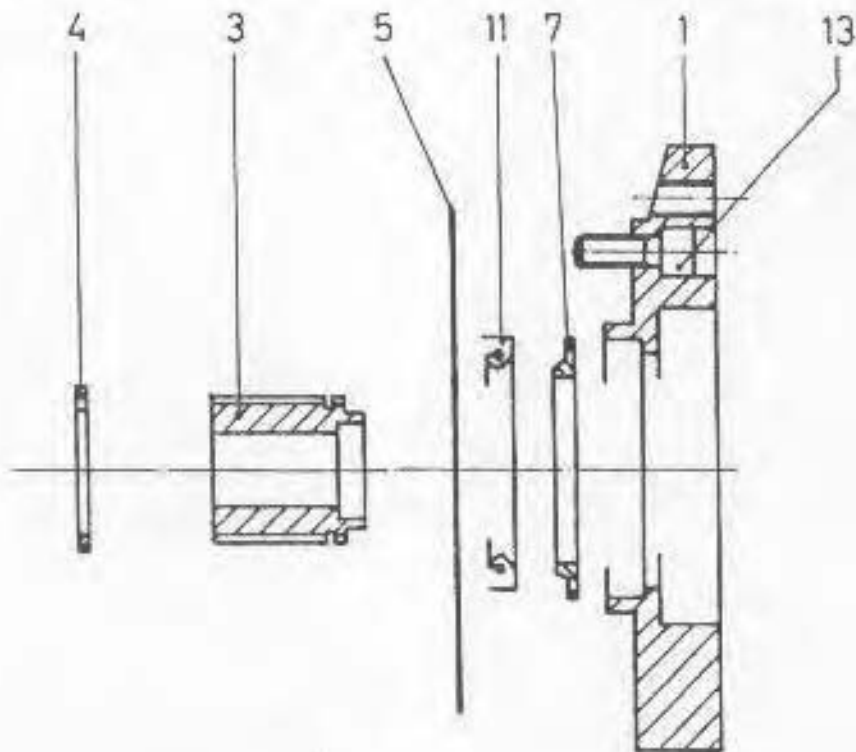
2813709

BREVINI s.p.a.

REGGIO EMILIA - ITALIA

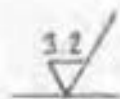
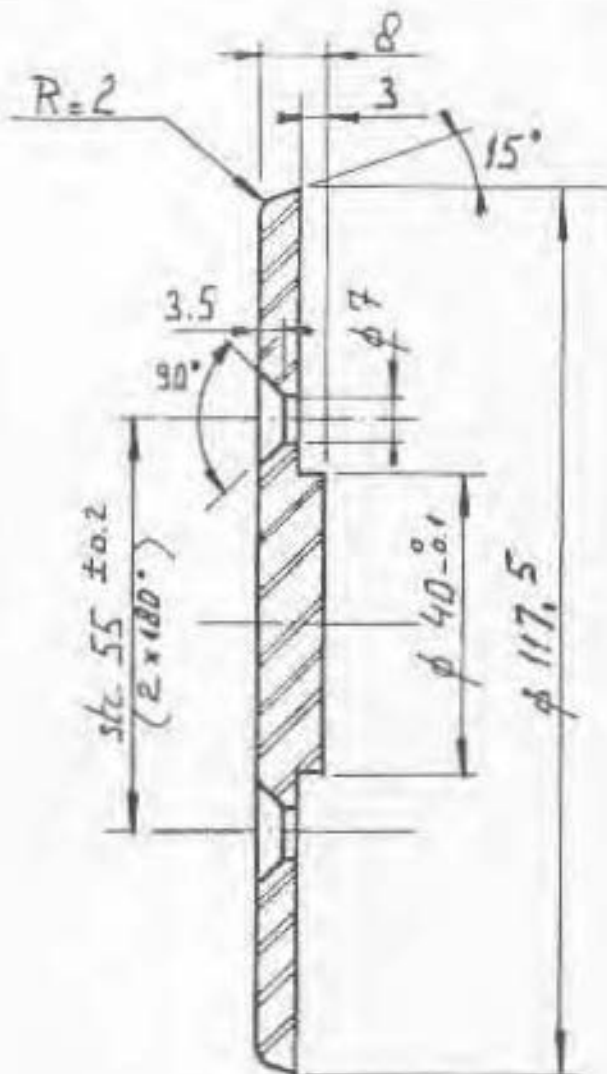
NAME : ADAPTORS
 GROUP : SAI MS 350 - 500
 VERS. :

NO: *bl 12*
 611.137T.1112
 "A"



X = 90

	CODE	DESCR.	NO
1	301/137.2/4000	FLANGE	1
2			
3	305/111.3/0100	COUPLING	1
4			
5	366/022.4/9000	PACKING	1
6			
7	364/024.4/6300	BACK UP RING	1
8			
9			
10			
11	<i>411/279.0/000</i>	SEAL BA 60x85x8	1
12			
13	462/137.0/0000	BOLT M12x30 UNI 5737-65	6

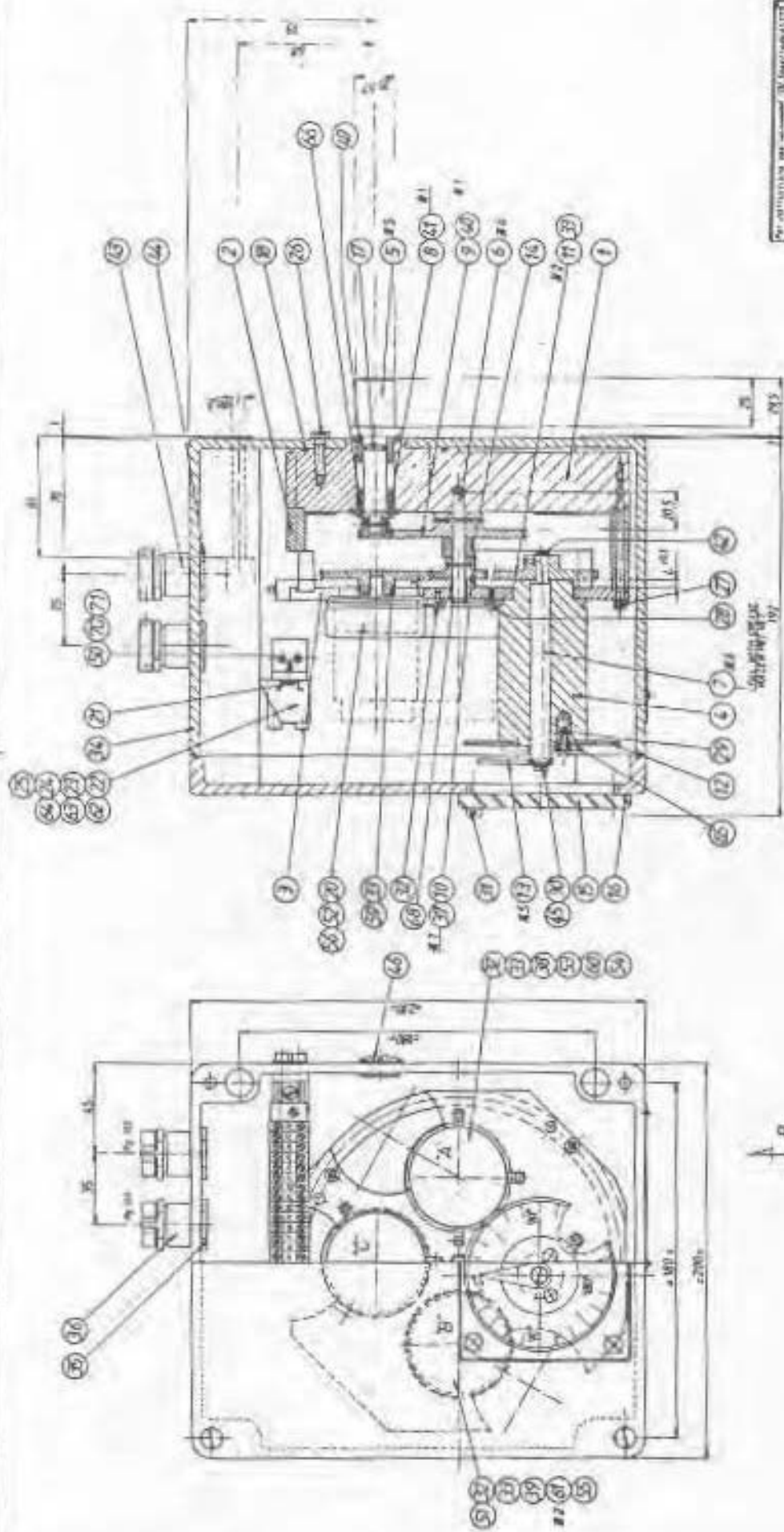


AUNDA KOLAH- PITA		POD- KLASER PISA KLASER	OVERSHAFING DESCRIPTION	PAG Nylon	MATERIAL	METRIK DIMENSIONS	KODENOMER OF WOODKLASER (EDGE-KLASER OF WOODKLASER)	OPERATION REMARKS									
WOOD METRIK DIMENSIE OPERASIE TOLERANSIE GELT OVERSCHAFING WERK FOR DIMENSIONS WITHOUT SPECIFIED TOLERANCE, THE TABLE BELOW IS APPLICABLE																	
		WETTING SILICONE POLYURETHAN	WETTING DIMENSION	SOON KLEIN	0	2	8	30	100	250	500	1000	2000	4000	8000	10000	18000
			FOR EN MET OP TO AND INCLUDING	FOR EN MET OP TO AND INCLUDING	3	6	30	120	375	600	900	1400	2000	3000	4500	6000	8000
			TOLERANSIE (TOLERANCE)	IN VERBODEN BEREIKEN FOR MACHING OPERASIE	+0.1	+0.1	+0.2	+0.3	+0.4	+0.5	+0.8	+1.0	+1.2	+1.5	+1.8	+2.0	+2.5
			BIJ OVERDE BEREIKEN FOR MACHING OPERASIE	BIJ OVERDE BEREIKEN FOR ALL OTHER OPERASIE	—	+0.5	+1	+1.5	+2	+3	+4	+5	+8	+10	+12	+15	+18
LIPS THRUSTERS					TITLE (NAME) Montage ring NU lager Mountingring												
		AMERIKANSE PROJECTE AMERICAN PROJECTION	OPDRACHTGEPUNTE BENEDICIE PUNTES TRADE CLASS IN THE CENTRAL PROJECTION CENTRAL AVERAGE CLASS IN THE	<input checked="" type="checkbox"/> 1:1 <input checked="" type="checkbox"/> 2:1 <input type="checkbox"/> 3:1	METRIK IN MILLIMETER DIMENSIONS IN MILLIMETER	SOON (SCALE)	1:1	DATE									
						TEKEN (DRAW)	rd. Kam	920220									
		DEZE TEKENING IS GEGROEVEN IN LIPS THRUSTERS BIJ EN MET 20000 20000 LIPS THRUSTERS DEP EGROEVEN DE MET 20000 20000 20000 20000 WERK DIMENSIE WERK DEPULCT OF VAN DEZER TER BEZAK WERK WERK WERK DIMENSIE WERK DEPULCT OF VAN DEZER TER BEZAK WERK WERK WERK DIMENSIE WERK DEPULCT OF VAN DEZER TER BEZAK WERK WERK WITHOUT THE WRITTEN PERMISSION OF THE OWNER MAY BE REPRODUCED OR USED FOR THIRD PARTIES OR BE OVER TO THIRD PARTIES FOR REUSE.					GECONTROLEERD (CHECKED)			APRIL 1992 (DATE)							
		LIPS THRUSTERS DRIVEN BY					GEMEN (APPROVED)			ly.							
		REPLAAS (REPLACE)	ORDER NO.	PART NO. - (DRAWING) NO. T00				TEKINGKLEINER (DRAWING) NO.									
				PART NO. - (DRAWING) NO. T00				3001656									
								FORMAAT (SIZE) A4									

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.4.1.3

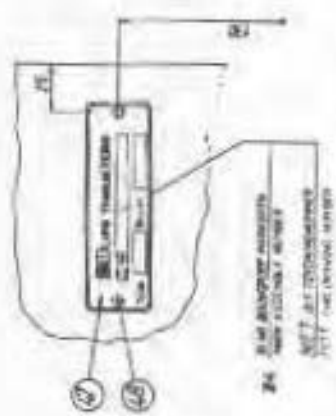
AZIMUTH FEEDBACK UNIT



FOR INFORMATION SEE DRAWING NO. 100-100-100-100

LEFT HAND THREADS
EXCEPT WHERE SHOWN OTHERWISE

REV	DATE	BY	CHKD
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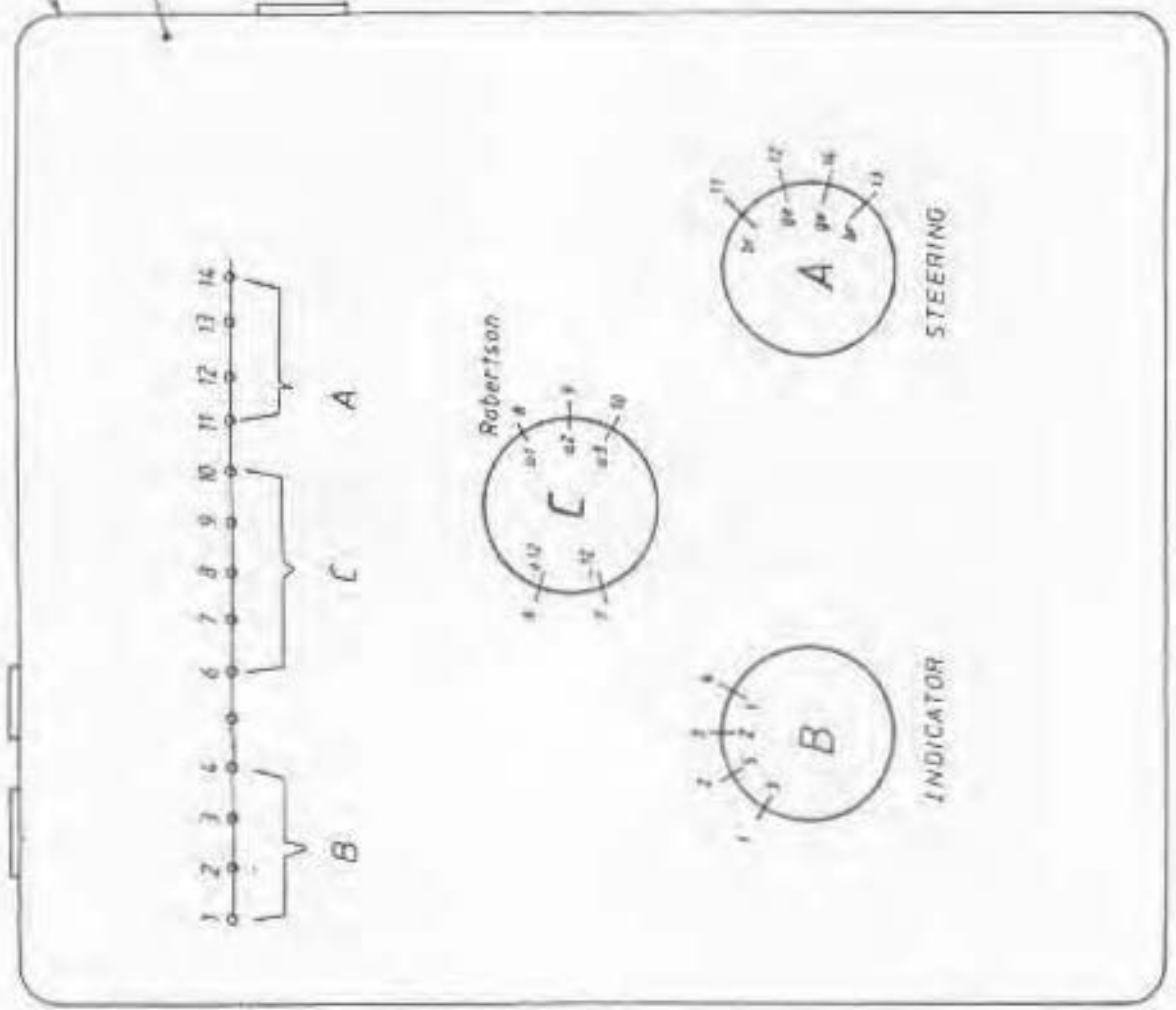
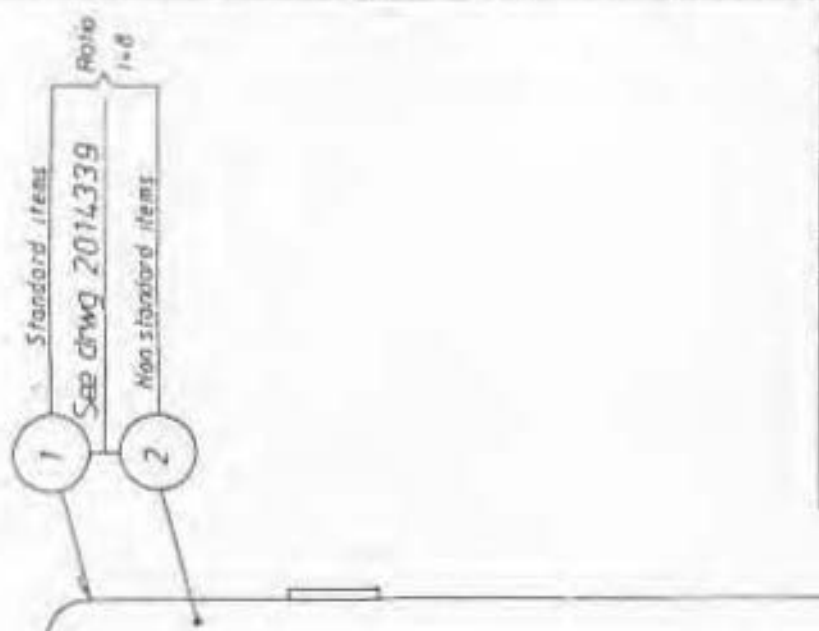
VIEW P

ALL DIMENSIONS ARE IN MILLIMETERS
UNLESS OTHERWISE SPECIFIED

201 413 99

ROBERTSON VALVE

COLOUR CODE	
RED	
BROWN	
YELLOW	
BLACK	
GREEN	
Wire size 0.5mm	
A = Potmeter type: PW 62.0-D Mfg: Fernhewig Mod: 9.1.103	
B = Potmeter type: SFCPS0A-657 2.5k Ω SAKAE T003002807	
C = DC Synchr Robertson sys. RTVS PW620-120 Mod: 9.1.103 for 300032	



Azimuth feedback unit 3 x POTMETER	
LIPS	A3
THRUSTERS BV	3002491

TITLE : AZIMUTH FEEDBACK UNIT
 TYPE : ASSEMBLY NR.T003002491
 LIST : T073010024

PAGE : 1
 DRAWING : 2014339
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
0	POWDER	T002006354	1,0
1	PLATE,BASE	T002010151	1,0
2	RING	T003002120	1,0
3	PLATE,BASE	T003002118	1,0
4	BUSH	T002014174	1,0
5	SHAFT	T002014175	1,0
6	SHAFT	T002010145	1,0
7	SHAFT	T002010144	1,0
8	GEAR WHEEL	T002010651	1,0
9	GEAR WHEEL	T002010652	1,0
10	GEAR WHEEL	T002010142	1,0
11	GEAR WHEEL	T002006116	1,0
12	DIAL	T002014176	1,0
13	POINTER	T001001833	1,0
14	BUSH	T002010140	1,0
15	GLASS,SIGHT	T002010148	1,0
16	PACKING	T002010146	1,0
17	X-SEALING RING	W007032004	1,0
18	O-RING	W007001412	1,0
20V	POTENTIOMETER	T003000632	1,0
21	SLOTTED CHEESE HEAD SCREW	M712030372	2,0
22	RAIL	T001032500	180,0 MM
23	CLIP	T002013019	28,0
24	WASHER,SQUARE	T002013020	1,0
25	END PLATE	T001032499	2,0
26	HEXAGON SCREW	M713001326	4,0
27	HEX. SOCKET HEAD CAP SCREW	M712045136	4,0
28	CLIP,BINDING	T001036516	2,0
29	SCREW	W007355085	3,0
30	SLOTTED CHEESE HEAD SCREW	M712030372	1,0
31	SLOTTED CHEESE HEAD SCREW	M712031424	4,0
32	CLIP,BINDING	T001036516	3,0
33	HEX.SOCKET SET SCREW W.CUP POINT	M712084066	8,0
34	TRANSMITTER BOX	T002010154	1,0
35	NUT	T001044147	4,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
 - THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
 ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
 DRAWING ARE FOR ILLUSTRATION ONLY

TITLE : AZIMUTH FEEDBACK UNIT
 TYPE : ASSEMBLY NR.T003002491
 LIST : T073010024

PAGE : 2
 DRAWING : 2014339
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
36	CABLE GLAND	T001033878	4,0
37	HEAVY TYPE CYL. SPRING DOWEL	M718500124	1,0
38	POTENTIOMETER	W006912289	1,0
39	POTENTIOMETER	T003002807	1,0
40	HEAVY TYPE CYL. SPRING DOWEL	M718500128	1,0
41	HEAVY TYPE CYL. SPRING DOWEL	M718500124	1,0
42	RETAINING RING FOR SHAFT	M718700160	1,0
43	CABLE GLAND	T001033878	3,0
44	NUT	T001044147	3,0
45	PLAIN WASHER	M716000023	1,0
46	BLIND PLUG	W008997038	4,0
47	TYPE SHIELD	T003000513	1,0
48	STRAIGHT GROOVED PIN	W007580262	4,0
49	BUSHING, COLLAR	T001071968	2,0
50	BRACKET	T003002119	2,0
51	PART NOT APPLICABLE	T002999998	1,0
52	PART NOT APPLICABLE	T002999998	1,0
53	PART NOT APPLICABLE	T002999998	1,0
54	PART NOT APPLICABLE	T002999998	1,0
55	PART NOT APPLICABLE	T002999998	1,0
56	PART NOT APPLICABLE	T002999998	1,0
59V	GEAR WHEEL	T002006116	1,0
60	GEAR WHEEL	T002006116	1,0
61	GEAR WHEEL	T002006116	1,0
62	MARKING, NUMBER	T002013255	1,0
63	MARKING, NUMBER	T002013256	1,0
64	MARKING, NUMBER	T002013257	1,0
65	CLAMPING RING	T002014177	1,0
66	PLAIN WASHER	W001960005	1,0
68	BEARING, SLIDE	T002010156	1,0
70	HEX. SOCKET HEAD CAP SCREW	M712040072	4,0
71	DUBO RETAINING RING	M716601023	4,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
 - THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
 ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
 DRAWING ARE FOR ILLUSTRATION ONLY

END OF LIST

TITLE : TRANSMITTER FOUNDATION
TYPE : ASSEMBLY NR.T002013982
LIST : T073010035

PAGE : 1
DRAWING : 2010530
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	GEAR WHEEL	T002005870	1,0
2	BUSH	T002010204	1,0
3	SHAFT	T002010203	1,0
4	COVER	T002013981	1,0
5	CLAMPING RING	T002010214	1,0
6	PIN, SPACER	T002010215	4,0
7	FLEXIBLE COUPLING	T002010561	1,0
10	PLAIN WASHER	W007375037	1,0
11	SELF LOCKING HEX.NUT WITH NYLON INS	M714050036	1,0
12	HEAVY TYPE CYL. SPRING DOWEL	M718500376	1,0
13	SEAMLESS O-RING SEAL	W007031005	1,0
14	SEALING. RING	T001001109	1,0
15	HEXAGON SCREW	M713000374	6,0
16	V-RING	M730030020	1,0
18	HEAVY TYPE CYL. SPRING DOWEL	M718500232	2,0
19	HEX. SOCKET HEAD CAP SCREW	M712045180	4,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.5

INTERMEDIATE SHAFT

LIPS THRUSTERS DRUNEN B.V.**2.5 INTERMEDIATE SHAFT**

The intermediate shaft is mounted between the upper gearbox shaft and the lower gearbox. It takes care of the power transmission from the upper gearbox to the lower gearbox.

On the top side connected to the vertical shaft of the upper gearbox and on the lower side connected to the vertical input shaft lower gearbox.

WITABEACN 217, 2009 310 GRACH EINE GLASS GESKILS
 METAFORME 205 S INN 200BY 110 DOOR EN GLASSUBMAM
 APICAL CP OM 205S 310 GRACH EINE GLASS SOCIETY

Krimpen

Als Temp 20°C
 Max Temp mit 230°C
 Jobtemperature 0,7 bis 0,8 mm

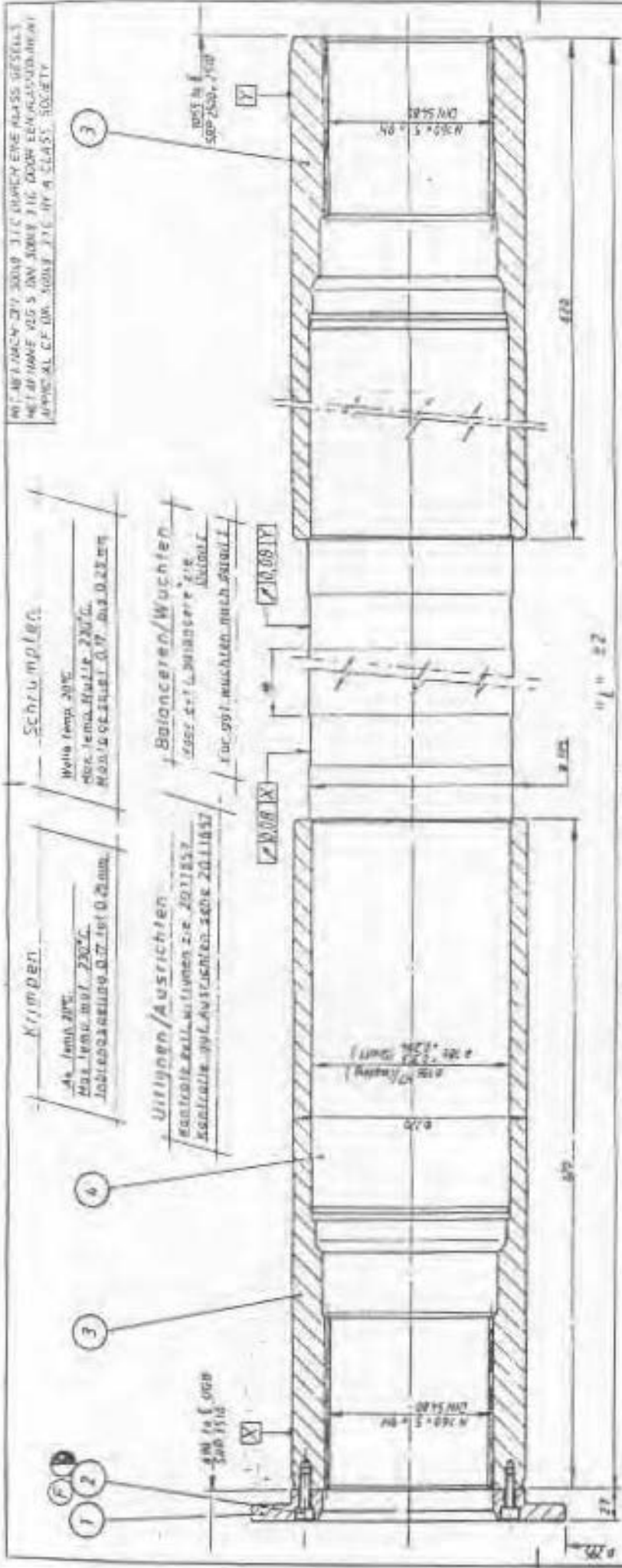
Schrumpfen
 Welle Temp 20°C
 Max Temp mit 230°C
 Max Job Temp 0,7 bis 0,8 mm

Uitlijnen/Ausrichten

Kontrolle ballwrijvingen zie 2011857
 Controle op Ausrichten zie 2011857

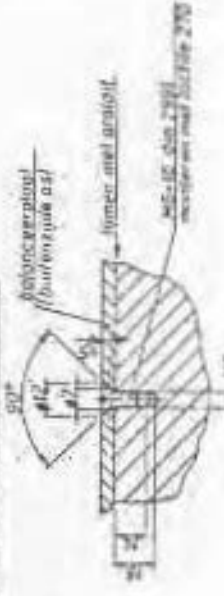
Balanceren/Wuchten

zie 2011857 zie 2011857
 Ein opt. wuchten nach stat. I



* Photo Balanceren/plan van de #215
 Balanceren/plan van de #215
 Balanceren/plan van de #215
 Balanceren/plan van de #215
 Balanceren/plan van de #215
 Balanceren/plan van de #215

BEVESTIGING BALANCEREN KAT



DETAIL I

2605	T003004050	2500/1510	4350	508
"L"	ASSEMBLY NO	Type	PAL	Gewicht
Intermediate shaft Assy Zwischenwelle Kpl DRUNEN BV 3010410419				

TITLE : INTERMEDIATE SHAFT
TYPE : ASSEMBLY NR.T003004050
LIST : T073010022

PAGE : 1
DRAWING : 3004049
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	LOCKING WASHER	T002017113	1,0
2	HEX. SOCKET HEAD CAP SCREW	M712040280	8,0
3	SLEEVE	T002013169	2,0
4	INTERMEDIATE SHAFT	T003004048	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.6

SHANK ASSEMBLY



LIPS THRUSTERS DRUNEN B.V.

2.6 SHANK ASSEMBLY

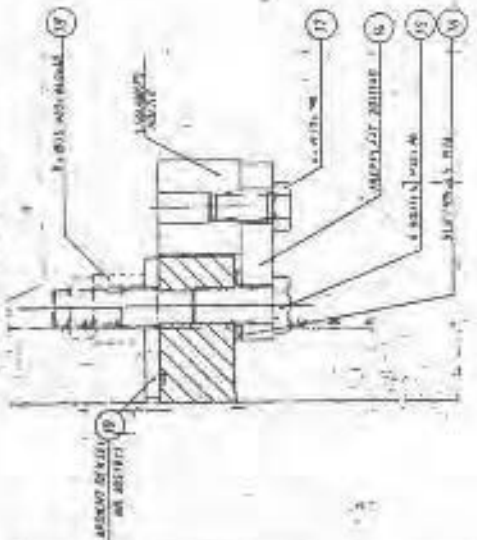
The shank connects the steering pipe with the propeller gearbox.

It is a GGG 40 cast construction in which the connection is made between the propeller gearbox input shaft and the vertical intermediate shaft.

The space is filled with oil which is circulated through the propeller gearbox.

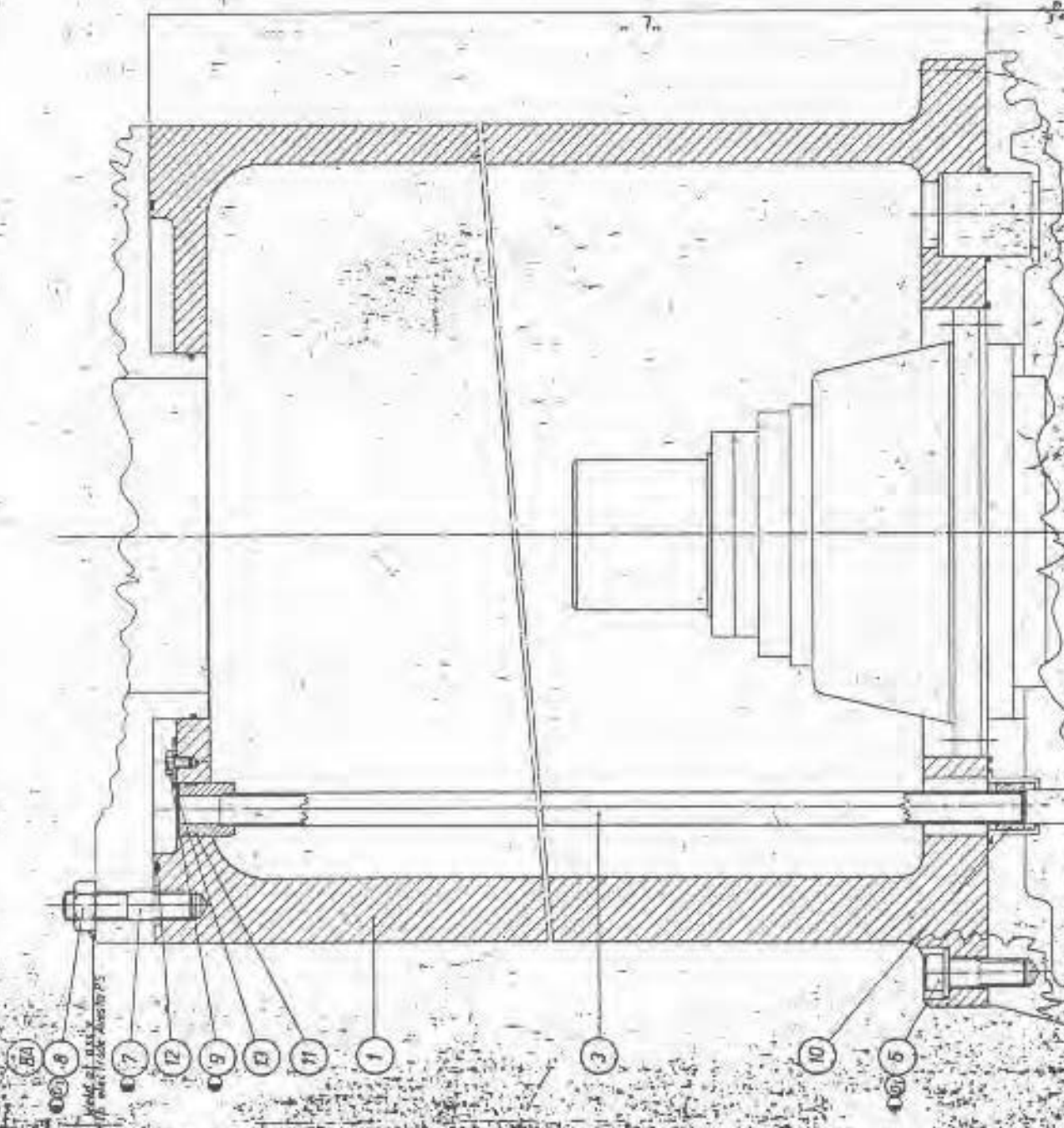
ATTN:	DATE: 08/11/03	BY: [Signature]	FOR: [Signature]
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4	08/11/03	08/11/03	08/11/03
5	08/11/03	08/11/03	08/11/03
6	08/11/03	08/11/03	08/11/03
7	08/11/03	08/11/03	08/11/03
8	08/11/03	08/11/03	08/11/03
9	08/11/03	08/11/03	08/11/03
10	08/11/03	08/11/03	08/11/03
11	08/11/03	08/11/03	08/11/03
12	08/11/03	08/11/03	08/11/03
13	08/11/03	08/11/03	08/11/03
14	08/11/03	08/11/03	08/11/03
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18	08/11/03	08/11/03	08/11/03
19	08/11/03	08/11/03	08/11/03
20	08/11/03	08/11/03	08/11/03
21	08/11/03	08/11/03	08/11/03
22	08/11/03	08/11/03	08/11/03
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48	08/11/03	08/11/03	08/11/03
49	08/11/03	08/11/03	08/11/03
50	08/11/03	08/11/03	08/11/03

PROHIBIT TRANSPORT WITH 5.0 BEAS FOR TRANSPORT ONLY



REV. 2000-04-3

FOR INFO AND REQUIREMENTS SEE LIST OF SUPPLIERS (2000000)



QTY	DESCRIPTION	UNIT	DATE	BY
1	5.0 BEAS	BEAS	08/11/03	[Signature]
1	IMPERMEABLE BARRIER	BAR	08/11/03	[Signature]
1	AIR BEARING	BEAS	08/11/03	[Signature]
1	4 BEAS/5 BEAS	BEAS	08/11/03	[Signature]
1	5.0 BEAS	BEAS	08/11/03	[Signature]

REV	DATE	DESCRIPTION	BY	CHKD
1	08/11/03	ISSUE FOR TRANSPORT ONLY	[Signature]	[Signature]
2	08/11/03	REVISED	[Signature]	[Signature]
3	08/11/03	REVISED	[Signature]	[Signature]
4	08/11/03	REVISED	[Signature]	[Signature]
5	08/11/03	REVISED	[Signature]	[Signature]
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7	08/11/03	REVISED	[Signature]	[Signature]
8	08/11/03	REVISED	[Signature]	[Signature]
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50	08/11/03	REVISED	[Signature]	[Signature]

SHANK ASSY TYPE 8500

Boeing
 Lockheed Martin
 1077851

TITLE : SHANK ASSEMBLY
TYPE : ASSEMBLY NR.T002013593
LIST : T073010014

PAGE : 1
DRAWING : 1017991
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	SHANK	T002013411	1,0
3	TUBE,OIL	T001017919	1,0
6	BOLT, SHOULDER	T001016091	22,0
7	STUD. SCREW LENGTH 1,25 D	W007265034	30,0
8	HEXAGON NUT	W007210132	30,0
8A	LOCKING WIRE	W007550008	3,1 MT
9	HEXAGON SCREW	M713000526	1,0
10	O-RING	W007035628	1,0
11	O-RING	W007001297	2,0
12	O-RING	W007001386	1,0
13	DISC	T001017975	1,0
14N	CONNECTING PLATE	T002011140	2,0
15N	HEXAGON SCREW	M713000738	4,0
16N	PLAIN WASHER	M716000050	20,0
17N	HEXAGON SCREW	M713000636	4,0
18	BUSH	T002015668	4,0
19	COVER	T002051911	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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DRAWING ARE FOR ILLUSTRATION ONLY

E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.7

LOWER GEARBOX



LIPS THRUSTERS DRUNEN B.V.

2.7 LOWER GEARBOX

The lower gearbox is a high capacity, single-stage angle drive in a streamlined casing.

The pinion shaft - pointing vertical upwards - is driven by the intermediate shaft, which transmits the power from the upper gearbox.

The bevel gears are designed with cyclo-palloid teeth, case-hardened and subsequently carbide-milled according to the HPG process.

Pinion and pinion shaft are one-piece (undivided).

The crown gear is bolted to the forged on flange of the propeller shaft.

The load-carrying anti-friction bearings are calculated for an extended service life.

The appliance of a sub-assembled pinion shaft bearing arrangement, improves the adjustability and facilitates mounting.

To avoid deflection due to the radial component of the tooth load, the pinion is supported in spherical roller bearings at both sides.

Axial forces due to the axial component of the tooth load, just as additional forces from the intermediate shaft, are absorbed by two self-aligning thrust bearings.

The propeller shaft is generously designed to ensure the absence of deflection under load and is supported in two spherical roller bearings. The thrust loads are absorbed by two self-aligning thrust bearings.

The "propeller side" bearing takes care of the endwise displacement due to temperature influences.

Dispose of oil is avoided by the propeller shaft seal. See chapter 2.7.1 for additional information.

The propeller is keyless taper fitted on the propeller shaft.

For detailed propeller information see: chapter 2.8.1.

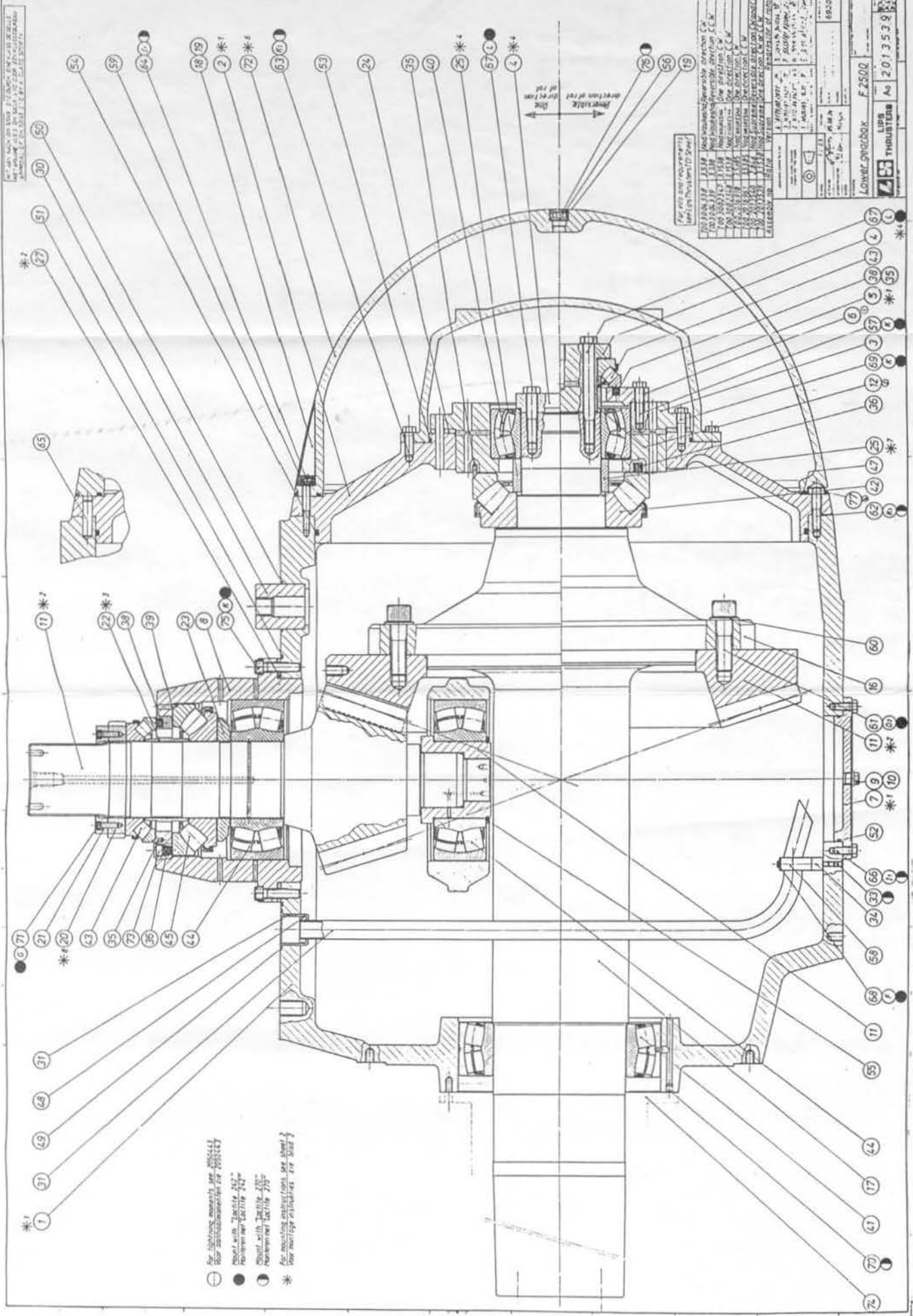
For propeller assembly see: chapter 2.8.

Lubrication of the motive parts

See chapter 5 for a description and diagram of the lubrication oil system.

As the gearbox is constantly fully filled with oil, all motive parts are running submerged in oil.

The oil from the header tank passes through the steering column to the lower gearbox and is returned by a restricted oil suction line which reaches down to the bottom of the gearbox where it picks up the oil. In this way a low circulation is realized which makes the oil is continuously refreshed.



FOR ALL INFORMATION SEE SHEET 2500-1
 LOWER GRATEBOX F.2500
 MANUFACTURED BY THE WESTINGHOUSE ELECTRIC CORPORATION

FOR ALL INFORMATION SEE SHEET 2500-1
 LOWER GRATEBOX F.2500
 MANUFACTURED BY THE WESTINGHOUSE ELECTRIC CORPORATION

10013000 1318	10013000 1319	10013000 1320	10013000 1321	10013000 1322	10013000 1323	10013000 1324	10013000 1325	10013000 1326	10013000 1327	10013000 1328	10013000 1329	10013000 1330	10013000 1331	10013000 1332	10013000 1333	10013000 1334	10013000 1335	10013000 1336	10013000 1337	10013000 1338	10013000 1339	10013000 1340	10013000 1341	10013000 1342	10013000 1343	10013000 1344	10013000 1345	10013000 1346	10013000 1347	10013000 1348	10013000 1349	10013000 1350	10013000 1351	10013000 1352	10013000 1353	10013000 1354	10013000 1355	10013000 1356	10013000 1357	10013000 1358	10013000 1359	10013000 1360	10013000 1361	10013000 1362	10013000 1363	10013000 1364	10013000 1365	10013000 1366	10013000 1367	10013000 1368	10013000 1369	10013000 1370	10013000 1371	10013000 1372	10013000 1373	10013000 1374	10013000 1375	10013000 1376	10013000 1377	10013000 1378	10013000 1379	10013000 1380	10013000 1381	10013000 1382	10013000 1383	10013000 1384	10013000 1385	10013000 1386	10013000 1387	10013000 1388	10013000 1389	10013000 1390	10013000 1391	10013000 1392	10013000 1393	10013000 1394	10013000 1395	10013000 1396	10013000 1397	10013000 1398	10013000 1399	10013000 1400
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LOWER GRATEBOX F.2500
 LIPS THURSTON No. 2,013,539
 8900

For Abbreviations see sheet 2500-1
 For Dimensions see sheet 2500-1
 For Material see sheet 2500-1
 For Assembly Instructions see sheet 2500-1
 For Maintenance Instructions see sheet 2500-1

TITLE : LOWER GEARBOX ASSEMBLY
TYPE : ASSEMBLY NR.T002016918
LIST : T073000011

PAGE : 1
DRAWING : 2013539
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	POD	T003002416	1,0
2	BEARING COVER	T003002419	1,0
3	BEARING HOUSING	T001011266	1,0
4	PLATE,CLAMPING	T002013576	1,0
5	COVER	T002013415	1,0
6	BEARING COVER	T002013577	1,0
7	COVER	T002051645	1,0
8	BEARING HOUSING	T001011270	1,0
9	METAL AND RUBBER SEAL RING (BONDED)	W006580044	1,0
10	HEXAGON HEAD SCREW PLUG	W006552115	1,0
11	GEAR SET FOR POD	T002016951	1,0
12	BUSH	T002014638	1,0
17	SHAFT,PROPELLER,COMPLETE	T001011264	1,0
18	PART NOT APPLICABLE	T002999998	1,0
19	PART NOT APPLICABLE	T002999998	1,0
20	HEXAGON CASTLE NUT	T002051359	1,0
21	RING,BLOCKING	T002012557	1,0
22	BUSH	T002012552	1,0
23	DISTANCE RING	T002013583	1,0
24	RING IN TWO PIECES	T001011300	1,0
25	DISTANCE RING	T002013486	1,0
27	RING	T001011187	1,0
30	DOWEL	T001016068	1,0
31	LINE,OIL	T001016098	1,0
33	HEX.SOCKET SET SCREW W.CUP POINT	M712085276	2,0
34	SHIM	T001017976	1,0
35	PIN	T001017984	3,0
36	SPRING	T002004954	12,0
38	SPRING	T001003859	12,0
39	PIN	T002012950	1,0
40	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210918	1,0
41	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210908	1,0
42	SPHERICAL ROLLER THRUST BEARING	W006260041	1,0
43	SPHERICAL ROLLER THRUST BEARING	W006260025	2,0
44	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210906	2,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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TITLE : LOWER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016918
 LIST : T073000011

PAGE : 2
 DRAWING : 2013539
 ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
45	SPHERICAL ROLLER THRUST BEARING	W006260024	1,0
47	CORD RING WITH VULCANIZED JOINT	W007001397	1,0
48	O-RING	W007001384	1,0
49	O-RING	W007000433	1,0
50	O-RING	W007001218	1,0
51	SEAMLESS O-RING SEAL	W007000028	1,0
52	SEAMLESS O-RING SEAL	W007031011	1,0
53	O-RING	W007030700	1,0
54	CORD RING WITH VULCANIZED JOINT	W007001385	1,0
55	RETAINING RING FOR SHAFT	M718700442	1,0
56	METAL AND RUBBER SEAL RING (BONDED)	M735000230	1,0
57	HEXAGON BOLT	M713005588	12,0
58	PIPE CLAMP	T002006886	1,0
59	PLAIN WASHER	M716000439	12,0
60	PLAIN WASHER	W007375034	20,0
61	HEX. SOCKET HEAD CAP SCREW	M712045592	20,0
62	HEXAGON BOLT	W007110144	30,0
63	HEXAGON SCREW	W007100387	12,0
64	HEX. SOCKET HEAD CAP SCREW	W007281104	12,0
65	HARDENED CYL. PIN	W007580265	6,0
66	HEXAGON SCREW	W007100386	8,0
67	HEXAGON BOLT	M713005647	8,0
68	HEXAGON BOLT	W007110155	2,0
69	HEXAGON BOLT	M713005587	12,0
70	HEX.SOCKET SET SCREW W.CUP POINT	M712085374	4,0
71	HEX. SOCKET HEAD CAP SCREW	M712040332	4,0
72	COVER, FAIRING	T002000166	1,0
73	HEXAGON SOCKET SCREW PLUG	W006564104	4,0
74	PROPELLER SHAFT SEALING	T002016973	1,0
75	HEX. SOCKET HEAD CAP SCREW	M712045438	16,0
76	HEXAGON HEAD SCREW PLUG	W006564110	1,0
77	LOCKING WIRE	W007550008	3,8 MT

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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END OF LIST

TITLE : LOWER GEARBOX ASSEMBLY
TYPE : ASSEMBLY NR.T002016961
LIST : T073010019

PAGE : 1
DRAWING : 2013539
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	POD	T003002416	1,0
2	BEARING COVER	T003002419	1,0
3	BEARING HOUSING	T001011266	1,0
4	PLATE,CLAMPING	T002013576	1,0
5	COVER	T002013415	1,0
6	BEARING COVER	T002013577	1,0
7	COVER	T002051645	1,0
8	BEARING HOUSING	T001011270	1,0
9	METAL AND RUBBER SEAL RING (BONDED	W006580044	1,0
10	HEXAGON HEAD SCREW PLUG	W006552115	1,0
11	GEAR SET FOR POD	T002016956	1,0
12	BUSH	T002014638	1,0
17	SHAFT,PROPELLER, COMPLETE	T001011264	1,0
18	PART NOT APPLICABLE	T002999998	1,0
19	PART NOT APPLICABLE	T002999998	10,0
20	HEXAGON CASTLE NUT	T002051359	1,0
21	RING,BLOCKING	T002012557	1,0
22	BUSH	T002012552	1,0
23	DISTANCE RING	T002013583	1,0
24	RING IN TWO PIECES	T001011300	1,0
25	DISTANCE RING	T002013486	1,0
27	RING	T001011187	1,0
30	DOWEL	T001016068	1,0
31	LINE,OIL	T001016098	1,0
33	HEX.SOCKET SET SCREW W.CUP POINT	M712085276	2,0
34	SHIM	T001017976	1,0
35	PIN	T001017984	3,0
36	SPRING	T002004954	12,0
38	SPRING	T001003859	12,0
39	PIN	T002012950	1,0
40	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210918	1,0
41	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210908	1,0
42	SPHERICAL ROLLER THRUST BEARING	W006260041	1,0
43	SPHERICAL ROLLER THRUST BEARING	W006260025	2,0
44	SPHERICAL ROLLER BEARING,DOUBLE ROW	W006210906	2,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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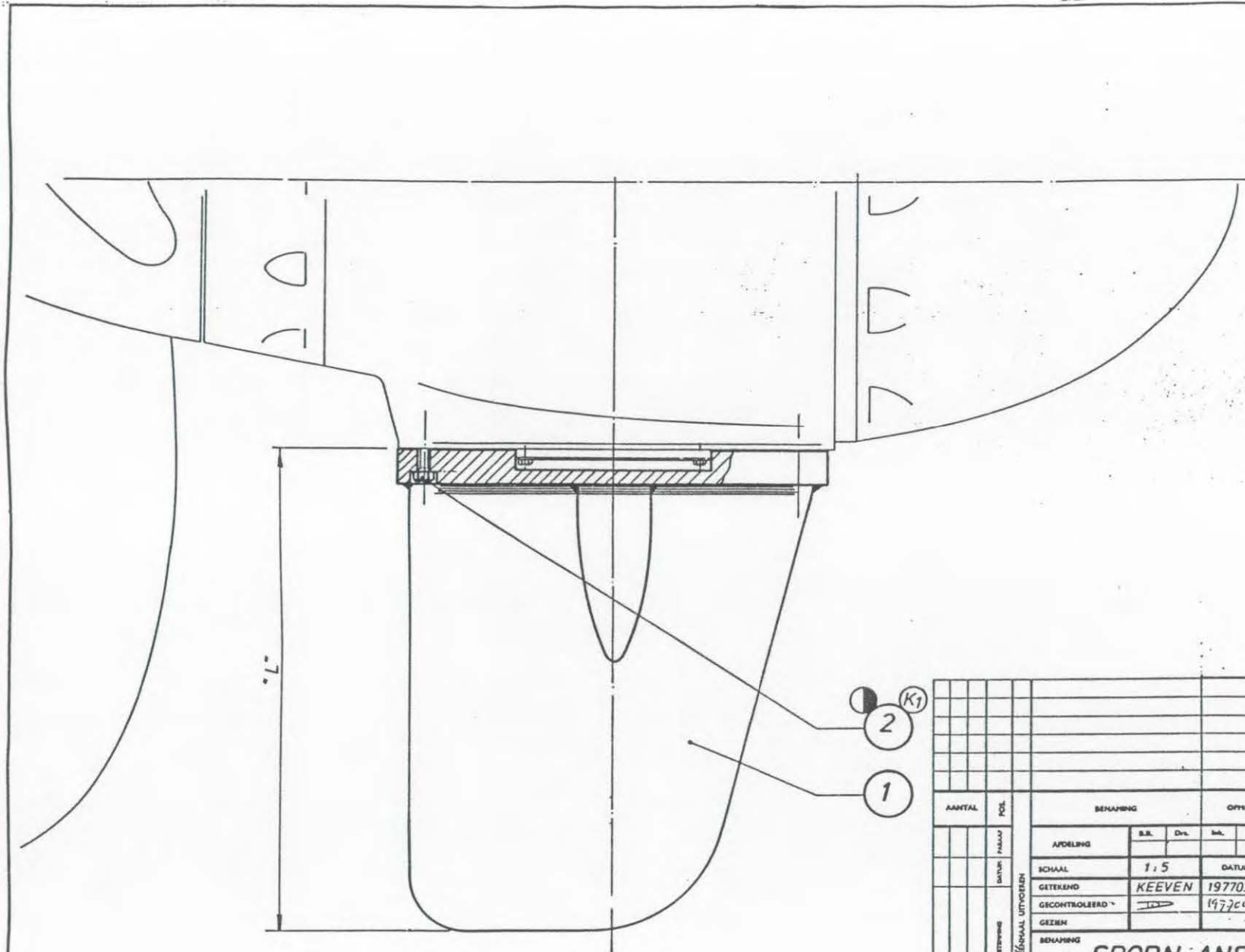
TITLE : LOWER GEARBOX ASSEMBLY
 TYPE : ASSEMBLY NR.T002016961
 LIST : T073010019

PAGE : 2
 DRAWING : 2013539
 ORDERNO.: T07300/01

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47	CORD RING WITH VULCANIZED JOINT	W007001397	1,0
48	O-RING	W007001384	1,0
49	O-RING	W007000433	1,0
50	O-RING	W007001218	1,0
51	SEAMLESS O-RING SEAL	W007000028	1,0
52	SEAMLESS O-RING SEAL	W007031011	1,0
53	O-RING	W007030700	1,0
54	CORD RING WITH VULCANIZED JOINT	W007001385	1,0
55	RETAINING RING FOR SHAFT	M718700442	1,0
56	METAL AND RUBBER SEAL RING (BONDED	M735000230	1,0
57	HEXAGON BOLT	M713005588	12,0
58	PIPE CLAMP	T002006886	1,0
59	PLAIN WASHER	M716000439	12,0
60	PLAIN WASHER	W007375034	20,0
61	HEX. SOCKET HEAD CAP SCREW	M712045592	20,0
62	HEXAGON BOLT	W007110144	30,0
63	HEXAGON SCREW	W007100387	12,0
64	HEX. SOCKET HEAD CAP SCREW	W007281104	12,0
65	HARDENED CYL. PIN	W007580265	6,0
66	HEXAGON SCREW	W007100386	8,0
67	HEXAGON BOLT	M713005647	8,0
68	HEXAGON BOLT	W007110155	2,0
69	HEXAGON BOLT	M713005587	12,0
70	HEX.SOCKET SET SCREW W.CUP POINT	M712085374	4,0
71	HEX. SOCKET HEAD CAP SCREW	M712040332	4,0
72	COVER,FAIRING	T002000166	1,0
73	HEXAGON SOCKET SCREW PLUG	W006564104	4,0
74	PROPELLER SHAFT SEALING	T002016973	1,0
75	HEX. SOCKET HEAD CAP SCREW	M712045438	16,0
76	HEXAGON HEAD SCREW PLUG	W006564110	1,0
77	LOCKING WIRE	W007550008	3,8 MT

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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E N D O F L I S T



WIJZIGINGEN/OPMERKINGEN			
LETTER	AARD DER WIJZIGING	DATUM	PARAAF
1	0197/88	1108	Ke.
2	10067/84	24.09.80	FF

2003004197	745
2016919	1012
2001357	890
ID. NR.	Length "L"



AANTAL	POE	BEHANDLING		OPMERKINGEN				MATERIAAL		WORM	LEV.	ONDERDEEL NR.
		AFDELING		B.R.	Dr.	Int.	K.C.	Mag.	Pluc.			
		SCHAAL	1:5	DATUM		max. toelatingen maatverwijking voor toelating zonder toelating verwijking zie DIN 7182		Kl. nr.				
		GETEKEND	KEEVEN	19770315				Kl. nr.				
		GECONTROLEERD		19770605				Kl. nr.				
		GEZINN				toelatingen voorbe- houden volgens de wet						overzicht reservé
BEHANDLING SPORN ANBAU Types 2500-1510-1502-1000 Skea Ass'y CP+FP												
										FORMAAT	Ident nr.	
										A2	2001357 (02)	

TITLE : FIN
TYPE : ASSEMBLY NR.T002016919
LIST : T073010016

PAGE : 1
DRAWING : 2001357
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	FIN	T002016865	1,0
2	HEXAGON SCREW	W007100413	20,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.7.1

PROPELLER SHAFT SEAL



LIPS THRUSTERS DRUNEN B.V.

2.7.1 PROPELLER SHAFT SEAL

The lower gearbox is equipped with a "Waukesha-Lips" propeller shaft seal; type M2M 330.

Main features are: (see drawing W007090364)

- Cast iron seal ring casing.
- Liner with coated wearing surface.

In case of seal failure, the static gauge pressure inside the gearbox will prevent water ingress.

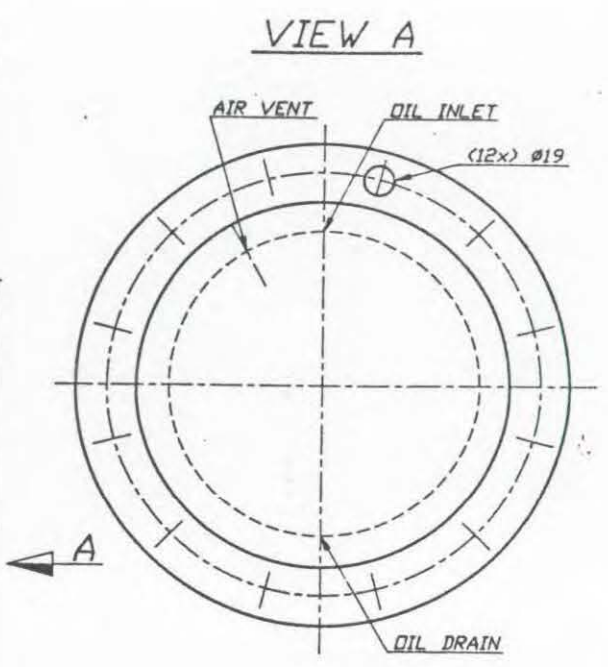
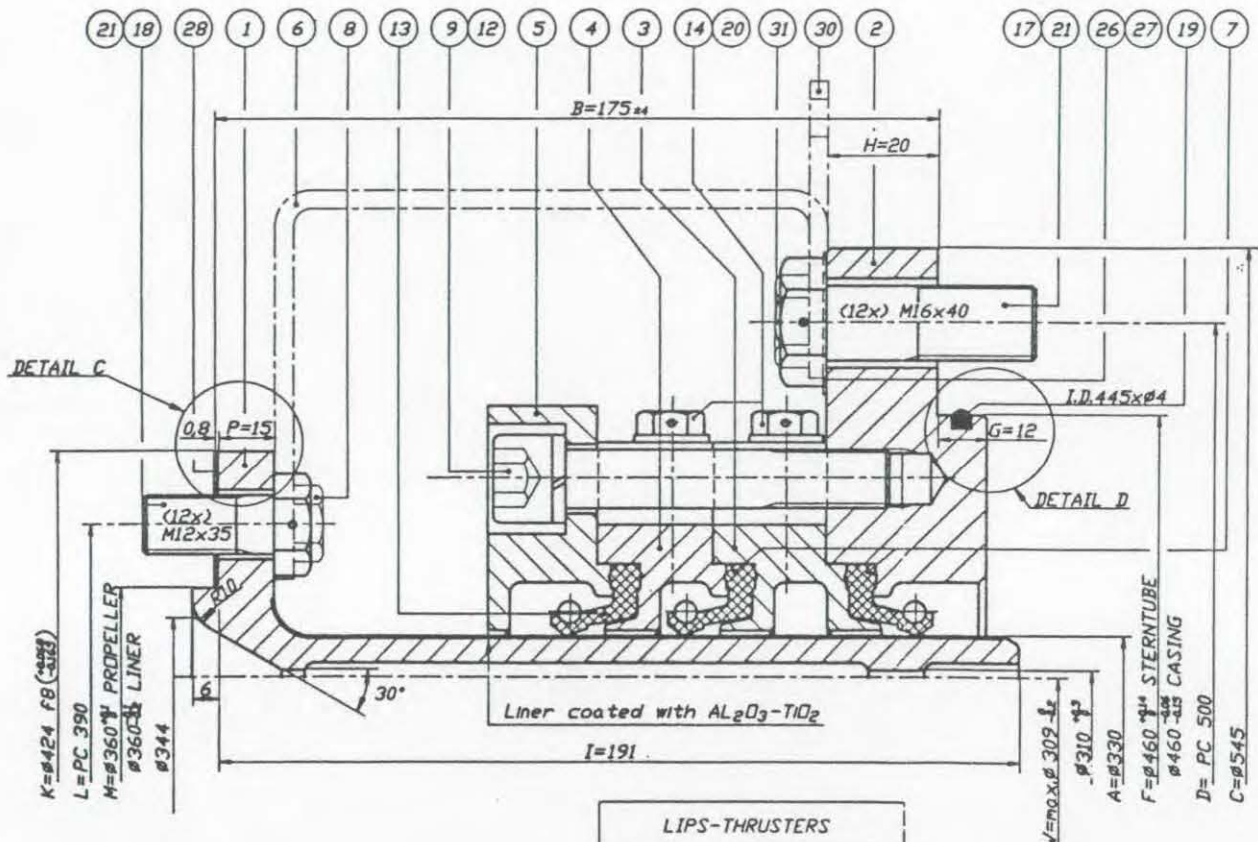
The seals can be inspected in place and renewed without removal of the propeller. This method of replacement is achieved by bonding.

For an illustrated description of aforementioned method, which requires special equipment, see instr.sheet T003004075, chapter 9.

MIR:HK:H:MED

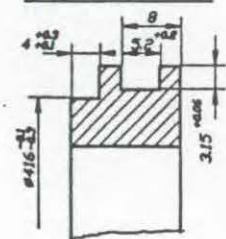
FORM 15/1971

W007090364

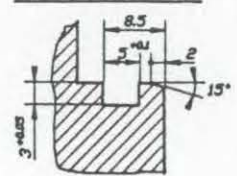


MASS APPROX. 168 kg

DETAIL C



DETAIL D



LIPS-THRUSTERS	
ORDER NR.	THRUSTER NR.
W04214/15	PX 0438
W04441/42	T07194/95
W04602/05	T07208/12
W04705/06	T07221/22
W04828/35	T07264/71
W04836/37	T07262/63

REPLACES PREVIOUS ISSUE

22 DEC 1993

- NOTE FOR SHIPYARD**
1. CASING PARTS TREAT AGAINST CORROSION
 2. CLAMPS (6) TO BE TAKEN AWAY AFTER INSTALLATION

D 221293 Max. shaft dia. C 051193 Paper size 04 B 04392 Bolt Length 04 A 180930 Extra plugs 04	DIMENSIONS IN MILLIMETERS FINISH (1/16") MACHING ALLOWANCE UNLESS OTHERWISE SPECIFIED (ISO 2768)	John Crane Marine-Lips Drunen - The Netherlands																												
	<table border="1"> <thead> <tr> <th>DIMENSION</th> <th>TOLERANCE</th> </tr> </thead> <tbody> <tr> <td>ABOVE</td> <td>UP TO AND</td> </tr> <tr> <td>0</td> <td>0</td> <td>H8</td> </tr> <tr> <td>6</td> <td>30</td> <td>H8</td> </tr> <tr> <td>30</td> <td>120</td> <td>H8</td> </tr> <tr> <td>120</td> <td>210</td> <td>H8</td> </tr> <tr> <td>210</td> <td>1000</td> <td>H8</td> </tr> <tr> <td>1000</td> <td>2000</td> <td>H8</td> </tr> <tr> <td>2000</td> <td>4000</td> <td>H8</td> </tr> <tr> <td>4000</td> <td>8000</td> <td>H8</td> </tr> </tbody> </table>	DIMENSION	TOLERANCE	ABOVE	UP TO AND	0	0	H8	6	30	H8	30	120	H8	120	210	H8	210	1000	H8	1000	2000	H8	2000	4000	H8	4000	8000	H8	TITLE THRUSTER SEAL ASSEMBLY
DIMENSION	TOLERANCE																													
ABOVE	UP TO AND																													
0	0	H8																												
6	30	H8																												
30	120	H8																												
120	210	H8																												
210	1000	H8																												
1000	2000	H8																												
2000	4000	H8																												
4000	8000	H8																												
THIS DRAWING REMAINS THE PROPERTY OF JOHN CRANE MARINE-LIPS. IT IS TO BE KEPT IN THE POSSESSION OF THE OWNER AND NOT BE REPRODUCED OR USED FOR OTHER PARTS OR BE GIVEN TO OTHER PARTS FOR PERISH.	SCALE 1:1	DRAWN R. HEINEN	DATE 09.03.89																											
CHECKED 	APPROVED 	DATE 5.11.93	TYPE 330 MK2-M																											
W007090364	C A3																													

PARTS LIST

AFT SEAL ASSEMBLY

TYPE : 330 MK2M
DRAWING NR. : W007090364 A3
REVISION : D

IT	NAME	MATERIAL	NR/ UNIT	SPARE/ UNIT	DIMENSIONS/REMARKS
1	Liner	Chrome steel	1		
2	Casing flange	GG 30	1		
3	Intermediate ring	GG 30	1		
4	Support ring	GG 30	1		
5	Cover (in 2/2)	GG 30	1		
6	Clamp	St.8.8/SS 41	4		
7	Seal ring	Viton	2		with spring
8	Hex. head bolt	St.8.8/SS 41	4		M8 x 16
9	Socket head screw	X 5 CrNi 18 10/SUS 304	12		M12 x 90
10					
11					
12	Spring washer	X 5 CrNi 18 10/SUS 304	12		for M12
13	Seal ring	Viton	1		with coated spring
14	Plug	X 5 CrNi 18 10/SUS 304	6		BSP 1/8"
15					
16					
17	Hex. head bolt	X 5 CrNi 18 10/SUS 304	12		M16 x 40
18	Hex. head bolt	X 5 CrNi 18 10/SUS 304	12		M12 x 35
19	O-ring	Nitrile rubber	1	1	I.D. 297 x 12
20	Washer	Copper	6		
21	Locking wire	X 5 CrNi 18 10/SUS 304	1	1	Dia.1 6m
22	Sheet packing	Non-asbestos	1		
23					
24					
25					
26	Name plate	Aluminium	1		
27	Drive nail	Ni-plated, harded steel	2		
28	Sheet packing	Non-asbestos	1		
29					
30	Transport plate	St.8.8/SS 41	1		
31	Hex. head bolt	St.8.8/SS 41	5		M16 x 25

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.8

PROPELLER ASSEMBLY



LIPS THRUSTERS DRUNEN B.V.

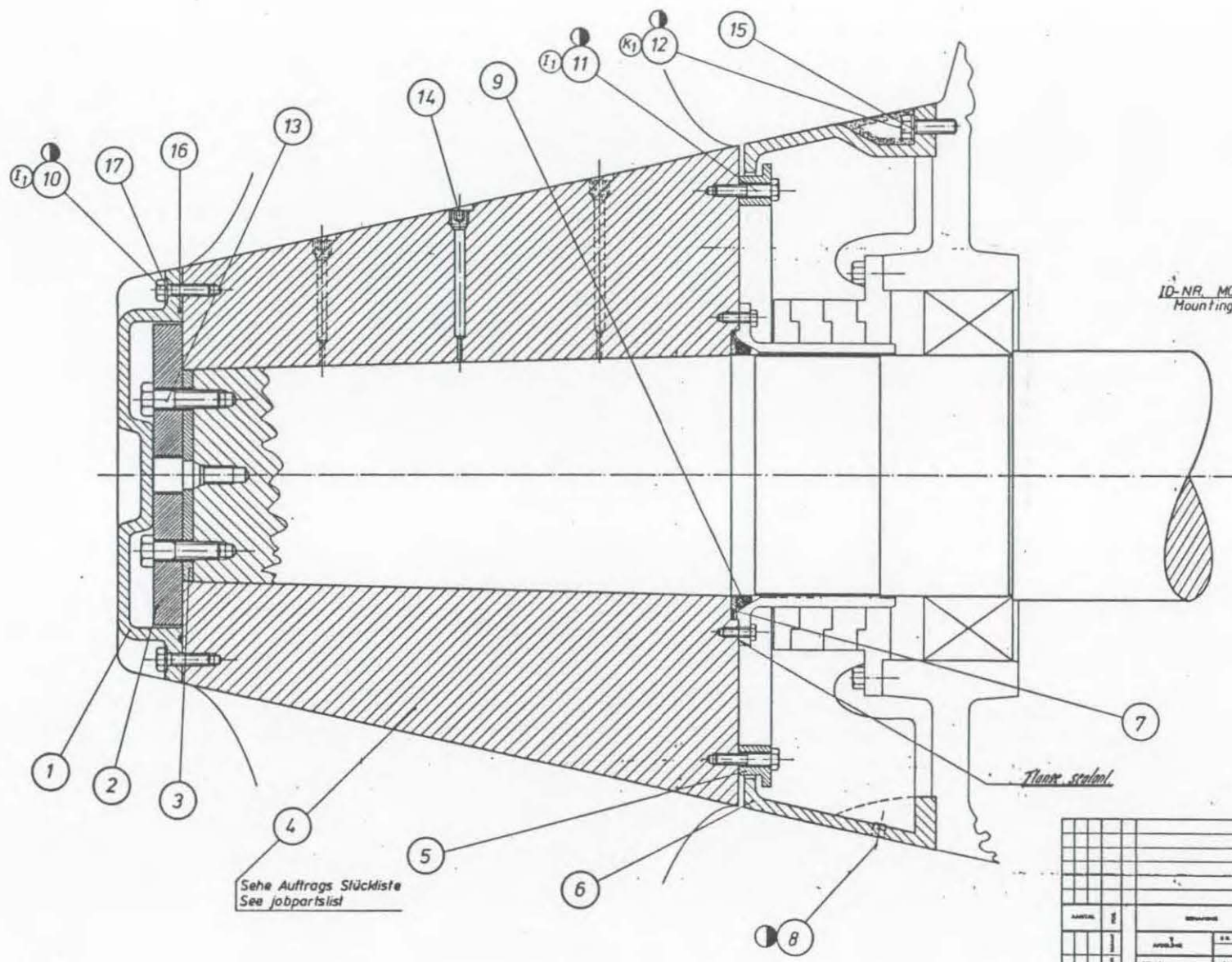
2.8 PROPELLER ASSEMBLY

The propeller is keyless taper fitted on the propeller shaft. See drawing 1017990 for propeller assembly. Procedure 2006192 must be followed to be certain propeller and propeller shaft are properly fit together. Before starting the mounting procedure, make sure that all required special attachments are on hand. See drawing 1016061.

Successive mounting actions:

- Check the propeller shaft seal for correct mounting and make sure that the liner seal (o-ring) is placed in position.
- Perform mounting procedure 2006192.
- Fasten propeller shaft liner to the propeller hub.
- Mount the split fairing.

WÄNDIGEN/OPPERINGEN			
LETTER	AARD DER WÄDIGING	DA/TUM	PARAAT
1	398/75	750721	T.P.
2	N 416/85	09 20	J
3	N 187/86	08/77	S.C.B.



ID-NR. MONTAGEZEIGNING 1016061
 Mounting propeller see drwg. 1016061

Sehe Auftrags Stückliste
 See jobpartlist

AARD	BESCHRIJVING	OPPERINGEN		MATERIAAL	HOOG	L.OM.	INHOUDSNO.
		NO.	A.M.				
1	1:25						
2	JE KLAD 19750626						
3	1:10						
4	1:10						

PROPELLER ASS-Y
 PROPELLERANBAU Type range 2500

LIPS THRUSTERS

A1 1017990

TITLE : PROPELLER ASSEMBLY
TYPE : ASSEMBLY NR.T001017990
LIST : T073010013

PAGE : 1
DRAWING : 1017990
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	CAP	T001011294	1,0
2	DISC	T001016043	1,0
3	GLAND	T001016055	1,0
4	SEE ORDER PARTS LIST	T002999985	1,0
5	PACKING, LABYRINTH	T001016069	1,0
6	COVER, FAIRING, IN TWO PIECES	T001016094	1,0
7	PART NOT APPLICABLE	T002999998	1,0
8	HEX. SOCKET SET SCREW W. CUP POINT	M712085374	2,0
9	CORD RING WITH VULCANIZED JOINT	W007000575	1,0
10	HEXAGON SCREW	W007100391	8,0
11	HEXAGON BOLT	W007110143	12,0
12	HEXAGON SCREW	W007100387	12,0
13	HEXAGON BOLT	M713005638	8,0
14	PART ON OTHER PARTS LIST	T002999990	3,0
15	PLAIN WASHER	W007375026	12,0
16	O-RING	W007000909	1,0
17	PLAIN WASHER	M716000436	8,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

E N D O F L I S T

KEYLESS PROPELLER MOUNTING

The bluefit of propeller and hub is to be checked in the presence of the Surveyor prior to the fitting. A fitting protocol is made on 2006192 p.3

1. Two fit tests are required and it is strongly recommended that these be carried out in a workshop.
2. Ensure that the propeller and propellershaft have the same temperature when they are fitted.
3. Reference marks should be made on the shaft and propeller boss to ensure an approx. equal relative position for each mounting. Mark the spot for measuring distance "Y" as well.
4. The shaft taper and propeller hub should be spotless clean and lightly oiled with similar hy-oil as used in the high pressure pumps.
5. Place the propeller carefully onto the shaft and mount the high pressure push-up equipment as indicated on the propeller mounting drawing: 1016061.
6. With the hydraulic nut and a high pressure pump, the propeller is pushed up with a pre-load, which is also the startpoint load.
Minimum startpoint load: 100 kN, valid for horizontal mounting.
[corresponding pressure: 67 bar].
Should vertical (downward) mounting be carried out, the preload pressure should be reduced with the weight of the propeller divided by the annular area of the hydraulic nut.
7. The two outer HP connections (A1 & A2) on the boss are connected to the high pressure pump(s) while the centre one (B) is used to vent the boss.
8. Mount a dial gauge as indicated on the drawing to monitor the push-up distance. Adjust the dial gauges to zero.
(Only the hydraulic nut is pressurized with the preload).
9. The push-up distance depends on the temperature and should be taken from the drawing
The start point distance between hub and gearbox face is measured with a micrometer.
(Only the hydraulic nut is pressurized with the preload).
10. Pressurize the boss until oil escapes bubble-free from the central or single HP connection on the boss. Then plug or tighten. Now further pressurize the boss until oil escapes between hub and shaft.

11. After the equipment has been fitted pressurize the hydraulic nut to push up the propeller with the correct distance while the boss is kept under (increasing) pressure. Tolerance on the push up distance: +/- 0.08 mm.
12. When the push-up distance is reached, release the pressure in the boss while the hy-nut remains under pressure for approximately 15 minutes. The distance "Y" may be measured (between hub and gearbox) to check the dial gauge reading.
13. To remove the propeller, release pressure from the hydraulic nut and retract the push-up unit for slightly more than the push-up distance. Pressurize the boss and the propeller will come off at once.
14. Alternatively, pressurise the boss again, leaving the nut in position. The propeller will slip off gradually, compressing the hydraulic nut.
15. Now the propeller should be fitted for the second time. Again the preload condition should be applied, whereafter the gauge is set again to zero.
16. The starting point distance should be equal to that for the first fitting. The difference may vary by 0,1 mm (+ or -). (difference caused by setting of the surfaces). Then push up as before.

If necessary, repeat until the difference in push-up length with the previous fitting is within a.m. limits.
17. When the propeller is definitely fitted the surveyor will record the details and certify the propeller fitting.
18. Dimension "X" should be measured with an accuracy of 0.01 mm. The distance ring or retainer plate must be ground to this thickness. It is advised to stamp this value and the thruster's building number into this ring or plate.
19. Fit the ring and box up the propeller, completely with cap and fastening materials.
20. The HP connection(s) in the boss should be closed with the destined plugs.
21. For future dismounting/remounting, note markings as per item 3 for relative position. The push-up distance will be determined by the machined retainer plate or distance ring only, i.e. irrespective of temperature and without the use of dial gauge, micrometer.



LIPS THRUSTERS		Konische verbinding / Taper fit	
Datum: Date _____	LTD order nr. _____		
Order naam: Order name _____	Type Thruster: _____		
Volgnr: Sequence nr. _____	Bouwnr.: Building nr. _____		
Keur: Class _____	Schroefnr.: Propeller nr. _____		
Instructie: Instruction	2006192 / 2007337 brons staal	Op-pers tek.: Mounting drw.	_____
Soort verbinding: Which connection _____			
<div style="border: 1px solid black; display: inline-block; padding: 2px;">eventueel vooraf invullen</div> <div style="border: 1px solid black; display: inline-block; padding: 2px;">alleen ter plekke invullen</div>			
Temp. naaf en as: Temp. hub & shaft _____ °C	gebruikte persmoer: hy-nut used _____		
bijbeh. opschuifweg: corresp. push-up _____ mm	bijbeh. voordruk: corresp. pre-load _____ bar		
hor. / vert.	1e montage	2e montage	3e montage
voordruk [bar] preload			
afstand tot huis [mm] distance to housing			
verschil met vorige difference w. previous			
opschuifweg [mm] push up			
moer druk [bar] nut press.			
naaf druk [bar] hub press.			
afstand tot as [mm] distance to shaft			
	LTD	Class	
Naam			
Paraaf			



KEYLESS PROPELLER FIT

job identification:
refer to drawing 1016061

T07300/01 AGOR NOAA

= DIMENSIONS =

hub dia front.....	815	mm
hub dia middle.....	666.500	mm
hub dia rear.....	518	mm
shaft dia, front.....	300	mm
shaft central bore.....	0	mm
bearing length.....	655	mm
taper ratio.....	25	

= MATERIALS =

Young's modulus hub.....	121	kN/mm2
ditto shaft.....	206	kN/mm2
Poisson ratio hub.....	0.330	
ditto shaft.....	0.300	
yield point hub.....	245	N/mm2
ditto shaft.....	500	N/mm2
linear exp. coeff. hub.....	1.6000E-05	
ditto shaft.....	1.1800E-05	

= LOADS =

power.....	2206	kW
input speed.....	900	rpm
gear ratio.....	5.0769	
torsionals.....	25	%
total thrust.....	251	kN
propeller part.....	1	

= FITTING =

service friction coeff.....	0.130	
assist. prop. mass.....	0	kg
hydr. nut.....SKF HMV	45	A
press. area nut.....	152	cm2
dry/oil mounting 0/1.....	1	

= REQUIRED PERFORMANCE =

torque safety value.....	2.800	at max. temp.
stress safety value.....	1.400	at min. temp.
max. temperature.....	35	Centigrade
min. temperature.....	0	Centigrade

RESULTS

Temperature	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00
min. pull-up	6.07	5.91	5.76	5.61	5.46	5.31	5.16	5.01
max. pull-up	10.23	10.08	9.93	9.78	9.63	9.48	9.33	9.18

design pull-up	9.60	9.45	9.30	9.15	9.00	8.85	8.70	8.55
pull-up tolerance = +/- .5								

contact press	70.96	69.90	68.85	67.79	66.73	65.67	64.61	63.56
stress safety	1.42	1.44	1.46	1.48	1.51	1.53	1.56	1.58
contact press	69.93	68.77	67.61	66.45	65.30	64.14	62.98	61.83
torque safety	4.53	4.48	4.43	4.38	4.33	4.27	4.22	4.16
Safety values implicate pull-up tolerance.								
minimum start point load.....	100	kN						
corresponding pressure.....	67	bar						

final nut press. at 20 C appr 1001 bar, injection press. appr 960 +/- 45 bar

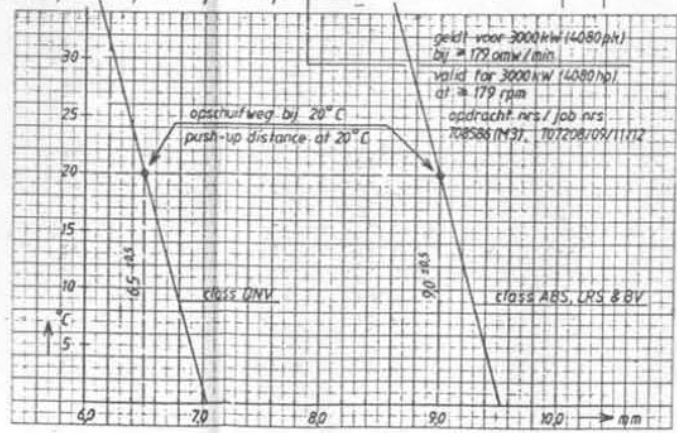
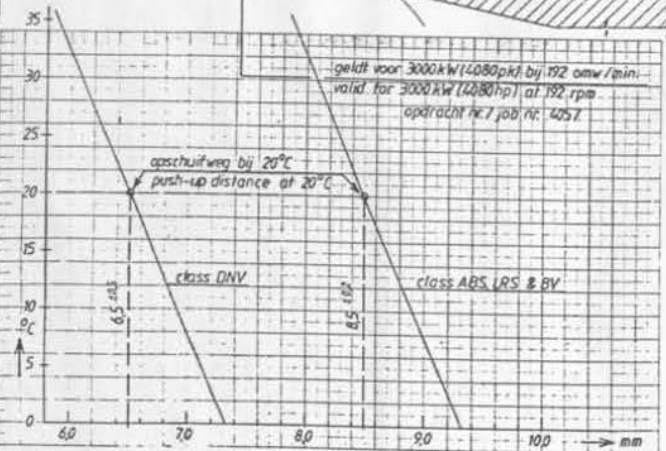
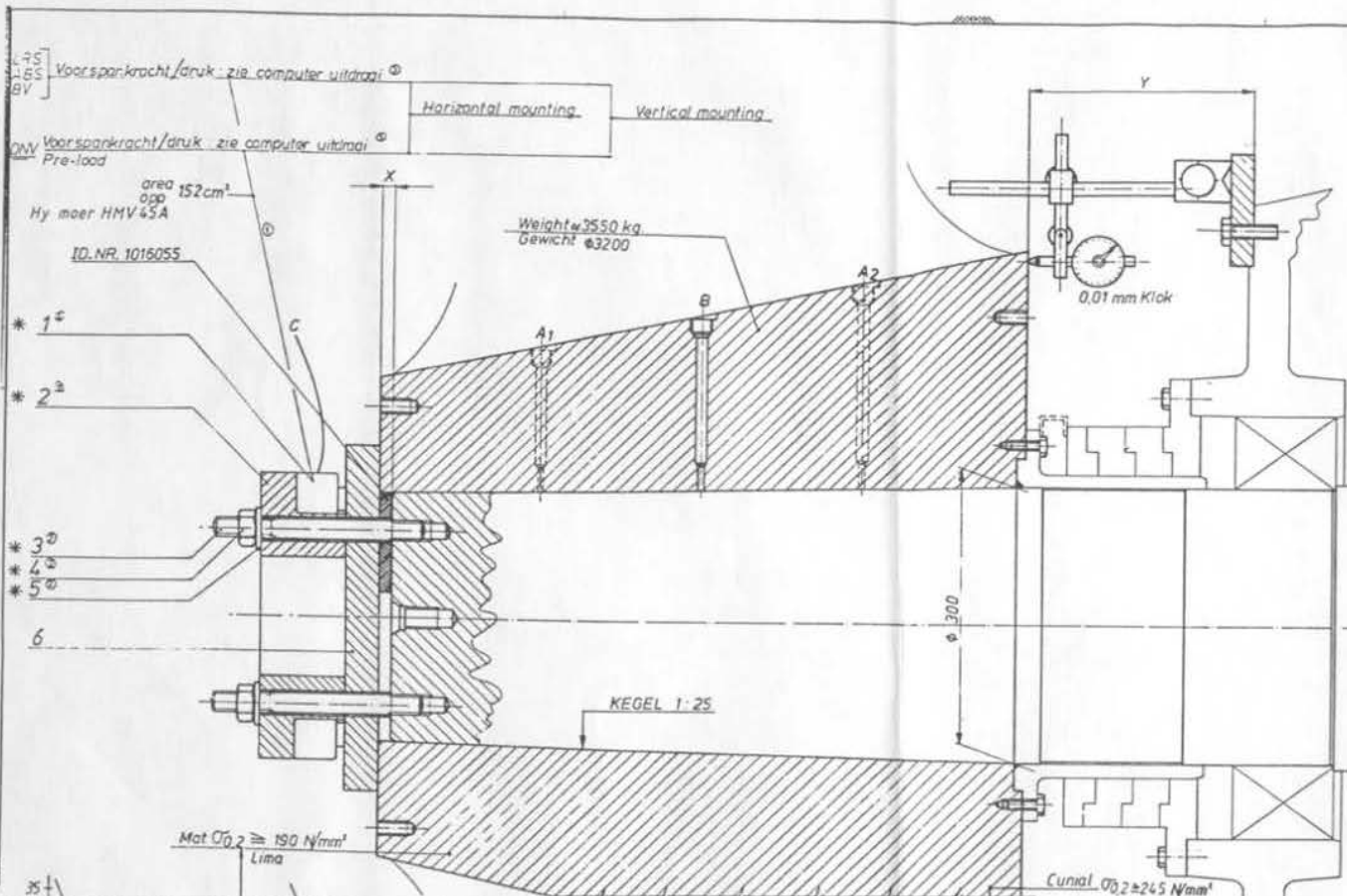
TITLE : TOOL
TYPE : ASSEMBLY NR.1016061
LIST : T073010018

PAGE : 1
DRAWING : 1016061
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	HYDRAULIC NUT	W007250330	1,0
2	GLAND	T001016057	1,0
3	STUD	T003000538	8,0
4	PART NOT APPLICABLE	T002999998	1,0
5	PLAIN WASHER	W007375031	8,0
6	PART ON OTHER PARTS LIST	T002999990	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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DRAWING ARE FOR ILLUSTRATION ONLY

END OF LIST



WED. J. H. B. O. P. B. N. G. E. N.			
5	6	LETTER	PAKLET
9367/92	10527	1	N 413/91
		2	N 408/89
		3	N 412/89
		4	8216/89

Details		Proceduur No. / Schroot No.	
Naam Project	Project naam	Par.	Date
Order number		Surveyer	
aanstaander			
Classification Bureau			
Surveying certificate			
<p>1. Startingsproeven, adjust indicatoren te zien. Voorspanndruk (tabel en microklak op B).</p> <p>2. Hub / hingelings distance first assembly te schroefmaat / hals afstand eerste montage te.</p> <p>3. Pressen te schroefmaat (first assembly) A1. Dit nodig om aansluiting te bereiken te A1.</p> <p>4. Corresponding pressure A2 / Corresponderende druk bij A2.</p> <p>5. Corresponding pressure C / Corresponderende druk bij C.</p> <p>6. Hub / hingelings distance second assembly te schroefmaat / hals afstand 2e montage te.</p> <p>7. Pressen te schroefmaat (second assembly) A1. Dit nodig om aansluiting te bereiken te A1.</p> <p>8. Corresponding pressure A1 / Corresponderende druk bij A1.</p> <p>9. Corresponding pressure C (for mat) / Corresponderende druk bij C (for mat).</p> <p>10. Difference A1 - A2 / verschil A1 - A2.</p> <p>11. Difference X - allowed max. / X - afwijking toegestaan max.</p> <p>12. Distance ring - machine A1 / Afstand ring - machine A1.</p>			

TEK NA INVULLEN NAAR K.C.

* DIESE TEILE 1x MIT JEDEM SCHIFF MITLIEFERN!

FÜR DIE MADE „X“ und „Y“ SIEHE BESCHREIBUNG —
ID-NR. 200.6192

BETRIEB		OPDRACHT		MATERIAL		HOMA		LVS		CHECKLIST	
ATRIEL	1:25	DELTA	19750421	1	1	1	1	1	1	1	1
REVISION	J.E. LEAD	19750421									
GEWISSTELDE	1/16	1/16									
GEWISSTELDE	1/16	1/16									
PROPELLERMONTAGE											
LIPS THRUSTERS		FORMAAT		TOEGANG NR.		ID-NR.		LVS		CHECKLIST	
A1		A1		1016061		1016061					

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.8.1

PROPELLER



LIPS THRUSTERS DRUNEN B.V.

2.8.1 PROPELLER

The monobloc propeller is keyless taper fitted on the propeller shaft.

For propeller mounting and assembly see chapter 2.8.

For design data, blade dimensions and blade finishing tolerances see drawing W009953103.

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.8.1

PROPELLER



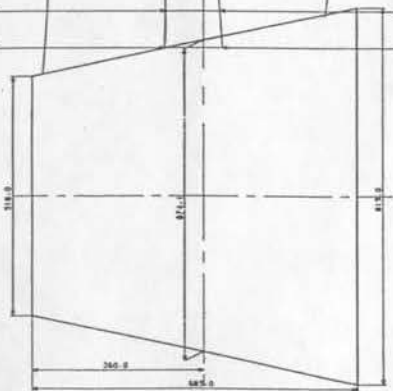
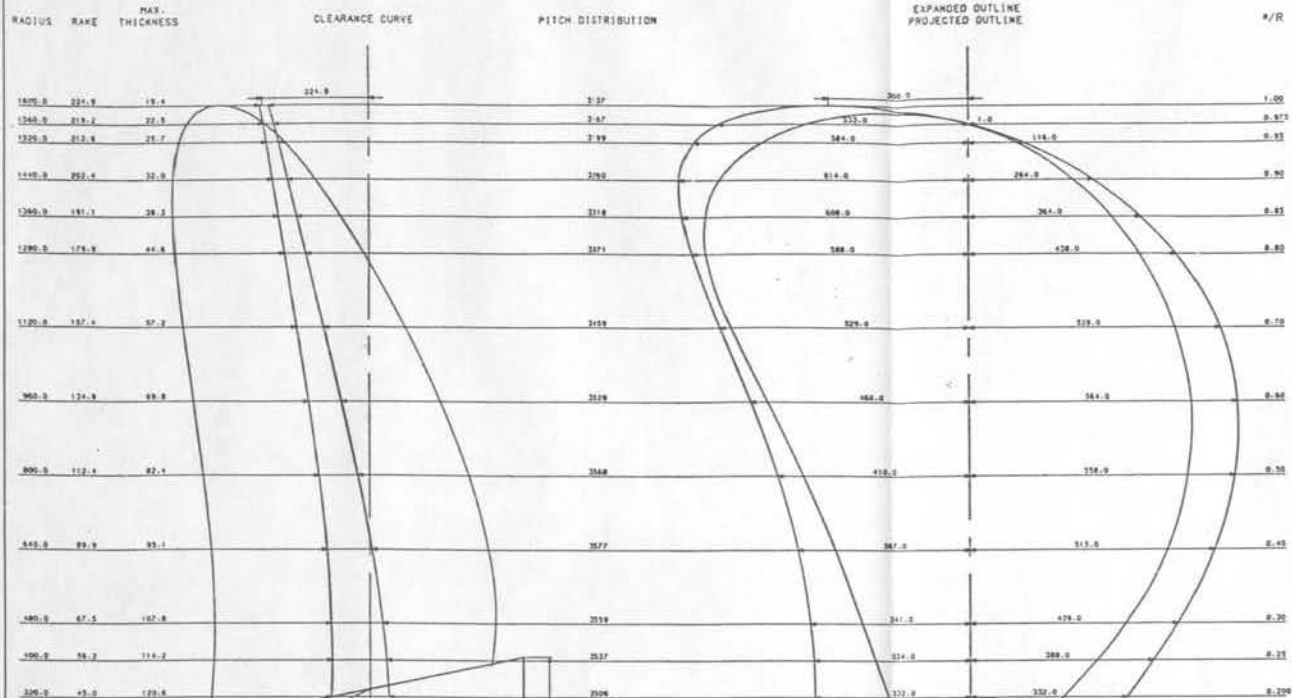
LIPS THRUSTERS DRUNEN B.V.

2.8.1 PROPELLER

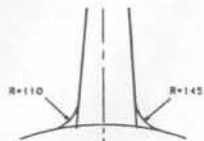
The monobloc propeller is keyless taper fitted on the propeller shaft.

For propeller mounting and assembly see chapter 2.8.

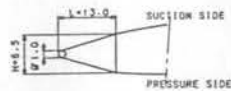
For design data, blade dimensions and blade finishing tolerances see drawing W009953103.



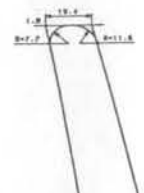
FOR HUB DETAILS SEE DWG. 1015041 A1 7
LIPS THRUSTERS



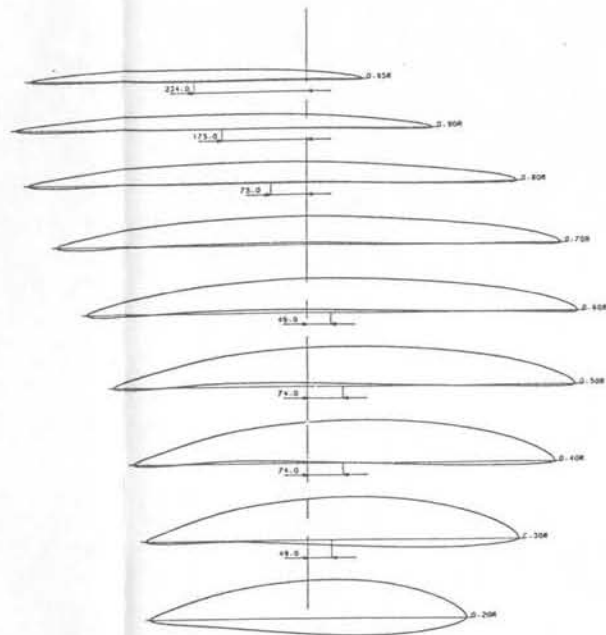
DETAIL BLADE ROOT FILLETS
(NOT TO SCALE)



DETAIL ANTI SINGING EDGE AT T.E.
FROM 0.5R TO TIP - FULL AT 0.5SR
(NOT TO SCALE)



DETAIL BLADE TIP
(SCALE 1:1.0)



PROPELLER DATA	
DIAMETER	3200 MM
PITCH, mm	3413 MM
NUMBER OF BLADES	4
DIRECTION OF ROTATION	OUTWARD-TURNING (DRAWN RIGHT HANDED)
EXPANDED BLADE AREA RATIO	0.371
SKEWANGLE	15.2 DEGR
MASS	= 3338 KG
MASS MOM. OF INERTIA PROP. IN AIR	= 15.77 KGM ²
MASS MOM. OF INERTIA OF ENTR. WATER	= 593 KGM ²
ENGINE OUTPUT	2206 KW
PROPELLER REVOLUTIONS	177.00 RPM
CN 0.25	0.0823
CS 0.25	0.7100
CLASSIFICATION	A-B-S. ICE C
PITCH SELECTED FOR 2096 KW AT PROPELLER 177.00 RPM TRIAL CONDITION.	
BLADE FINISHING TOLERANCES IN ACCORDANCE WITH ISO CLASS 1	

MATERIAL SPECIFICATION AND MECHANICAL PROPERTIES					
MATERIAL DESIGN		ISO 9-METRIC			
TENSILE STRENGTH	YIELD STRESS	ELONGATION	TENSILE ELONG. TEST TEMPERATURE		
MIN. 530 N/MM ²	MIN. 250 N/MM ²	MIN. 19 %	MIN. 20 °C		
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HYDRODYNAMIC DESIGN DEPARTMENT			F.P. PROPELLER FOR AGOR 24 RESEARCH VESSEL HALTER MARINE INC. 107262/63		
LIPS PROPELLER WORKS DRUNEN, THE NETHERLANDS			DRAWN BY: A. HAKEN CHECKED BY: [] DATE: 1/5.0 NO: M009553103		

M009553103

TITLE : PROPELLER, SHIP, FIXED
TYPE :
LIST : W009953205

PAGE : 1
DRAWING :
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	PROPELLER, SHIP, FIXED	W009953103	1,0
2	PROPELLER, SHIP, FIXED	W009953104	1,0
3	HEXAGON SOCKET SCREW PLUG	W006564007	3,0
4	COPPER SEALING RING	M731000290	3,0

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E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 2.9

CATHODIC PROTECTION



LIPS THRUSTERS DRUNEN B.V

2.9 ANODE PLAN

The cathodic protection of the thruster wet-side is provided by means of zinc anodes.

The zinc anodes are mounted on the well-box.

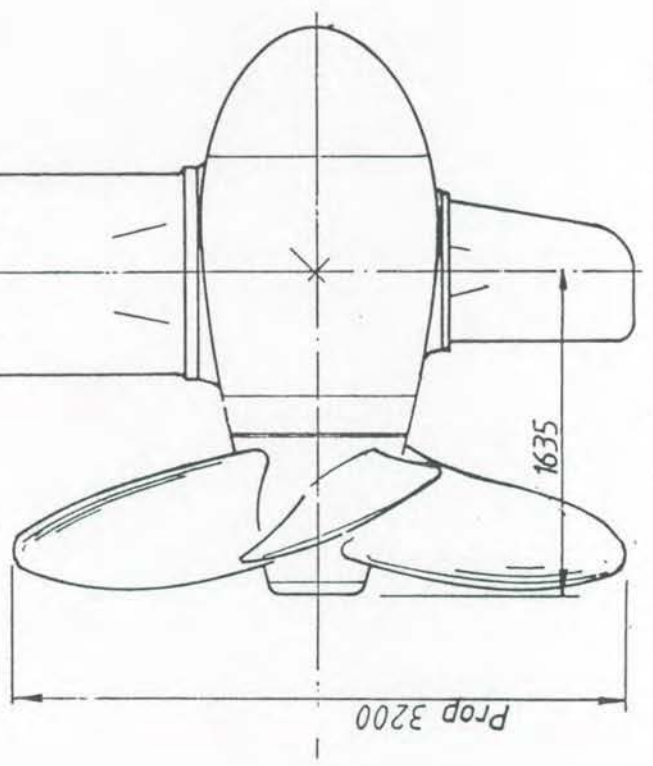
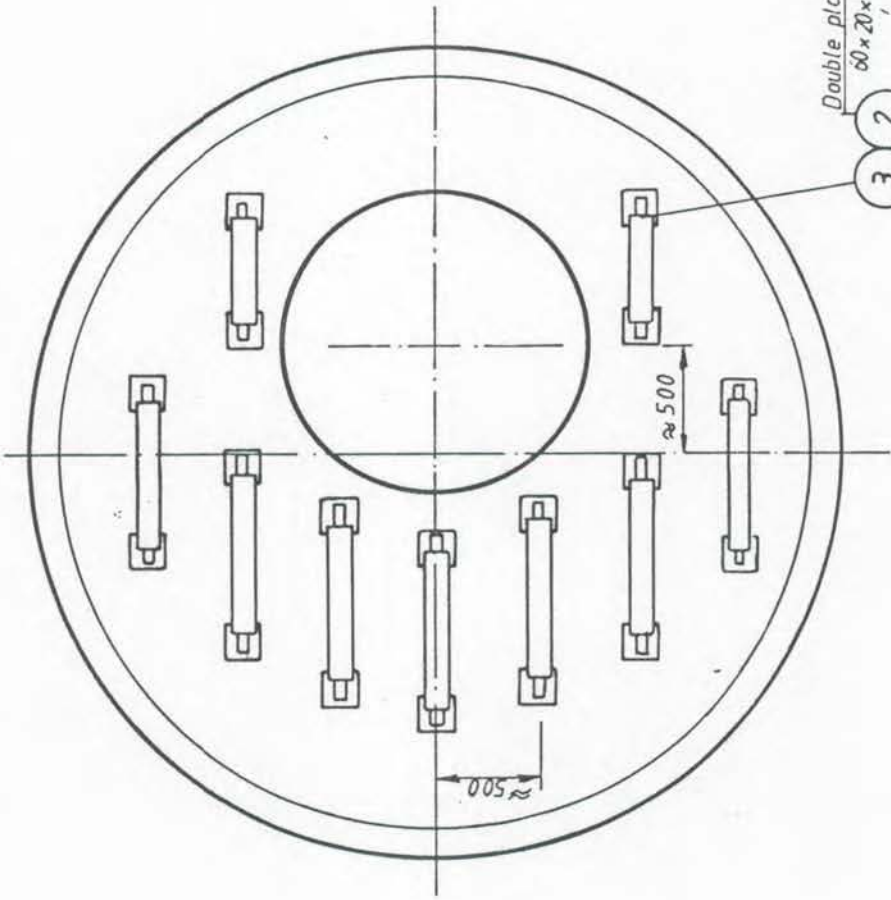
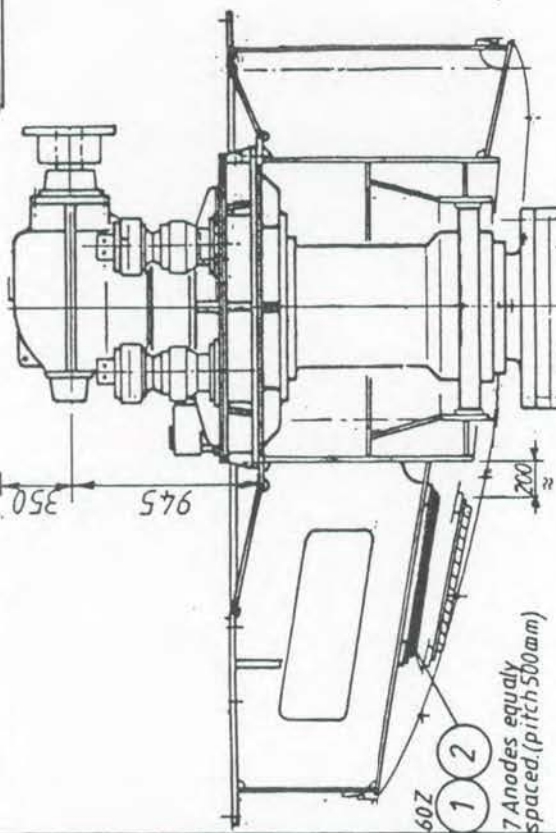
These anodes are sufficient for a period of five years in normal conditions.



Anode plan TYPE 2500

Suitable protection for 5 years. Material: zinc

ID.NR. 2016967 ①



Weights:
60 Z = 27 kg.
35 Z = 16 kg

For dimensions anodes see 2002416

INDEX 1 N 0.78 (R)

TITLE : ANODE
TYPE : ASSEMBLY NR.T002016967
LIST : T073010017

PAGE : 1
DRAWING : 2016967
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	ZINC ANODE	W008997015	7,0
2	BAR, FLAT, BRIGHT	M301012586	1500,0 MM
3	ZINC ANODE	W008996883	2,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

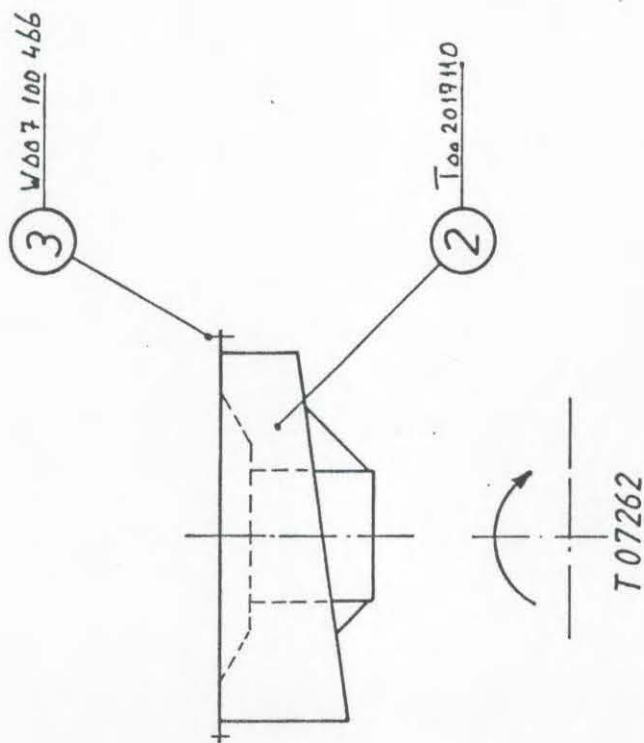
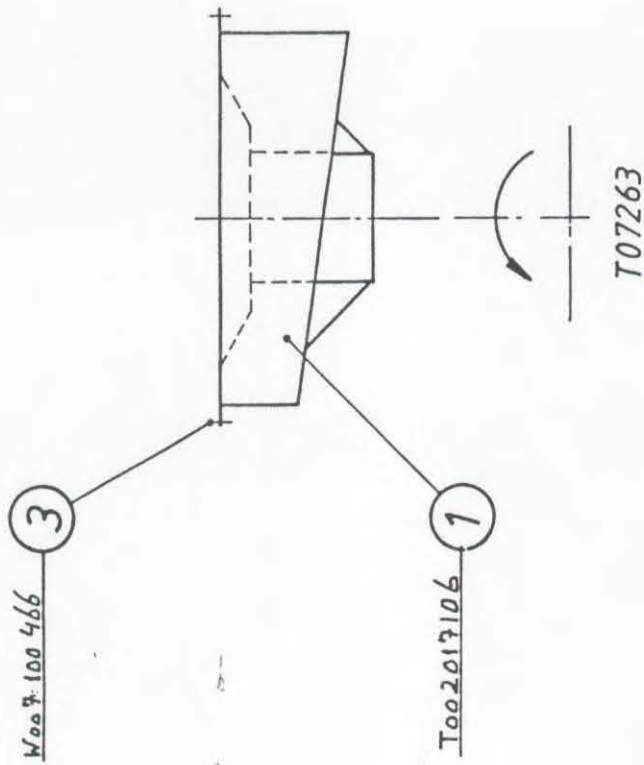
E N D O F L I S T

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 3

WELL-BOX

	TITLE	INDEX
	<u>WELLBOX CPL.</u>	DRAWING NUMBER <u>3002698</u>



P.S.

S.B.

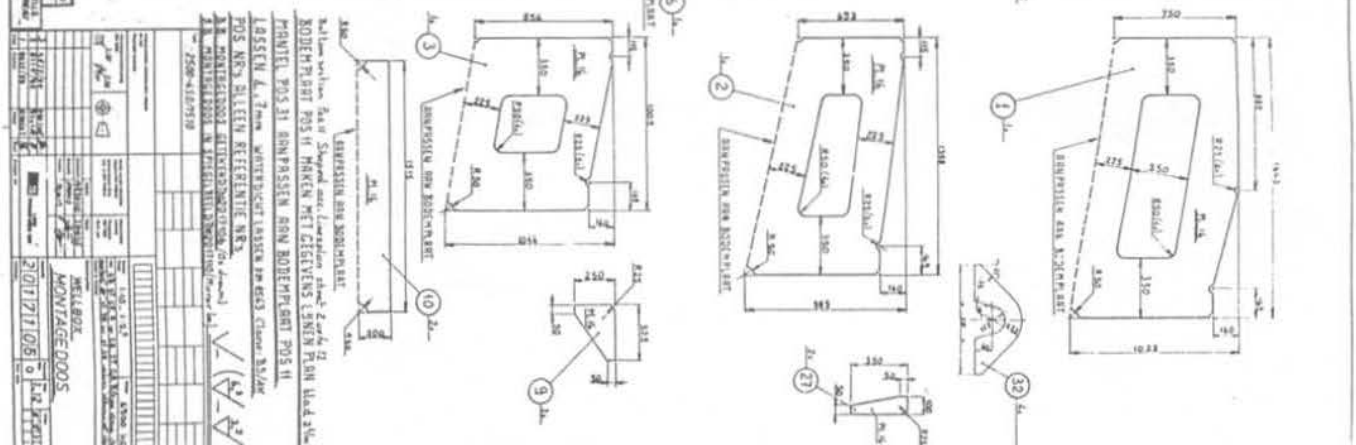
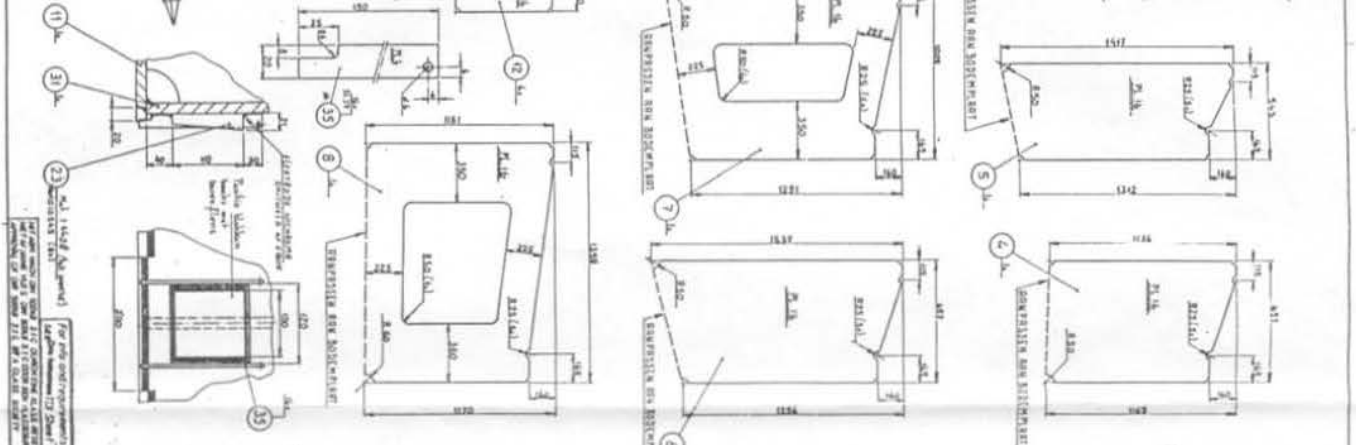
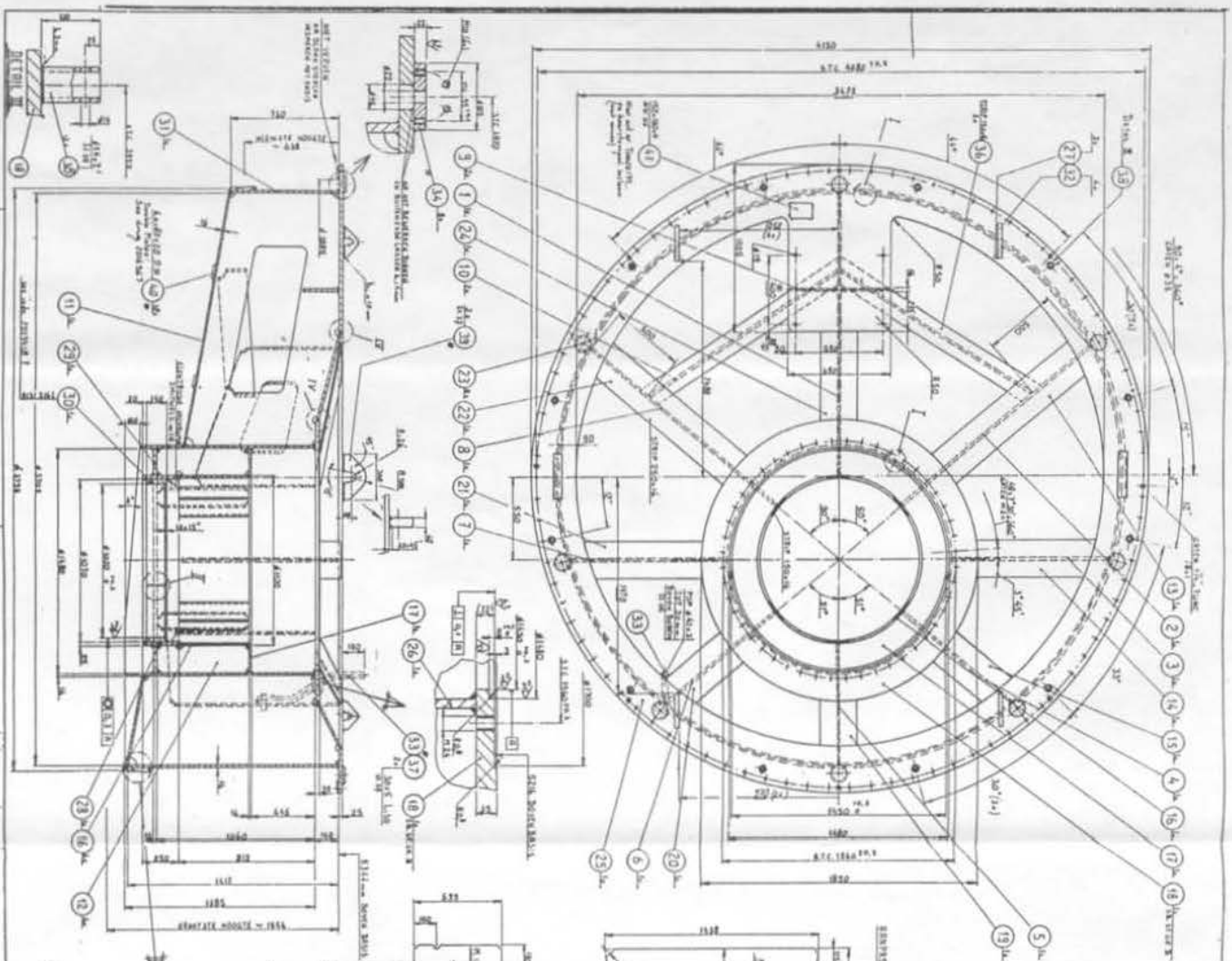
TITLE : WELL BOX
TYPE : ASSEMBLY NR.T003001818
LIST : T073010080

PAGE : 1
DRAWING : 3001818
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	WELL BOX	T002017106	1,0
2	WELL BOX	T002017110	1,0
3	HEXAGON SCREW	W007100466	16,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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E N D O F L I S T



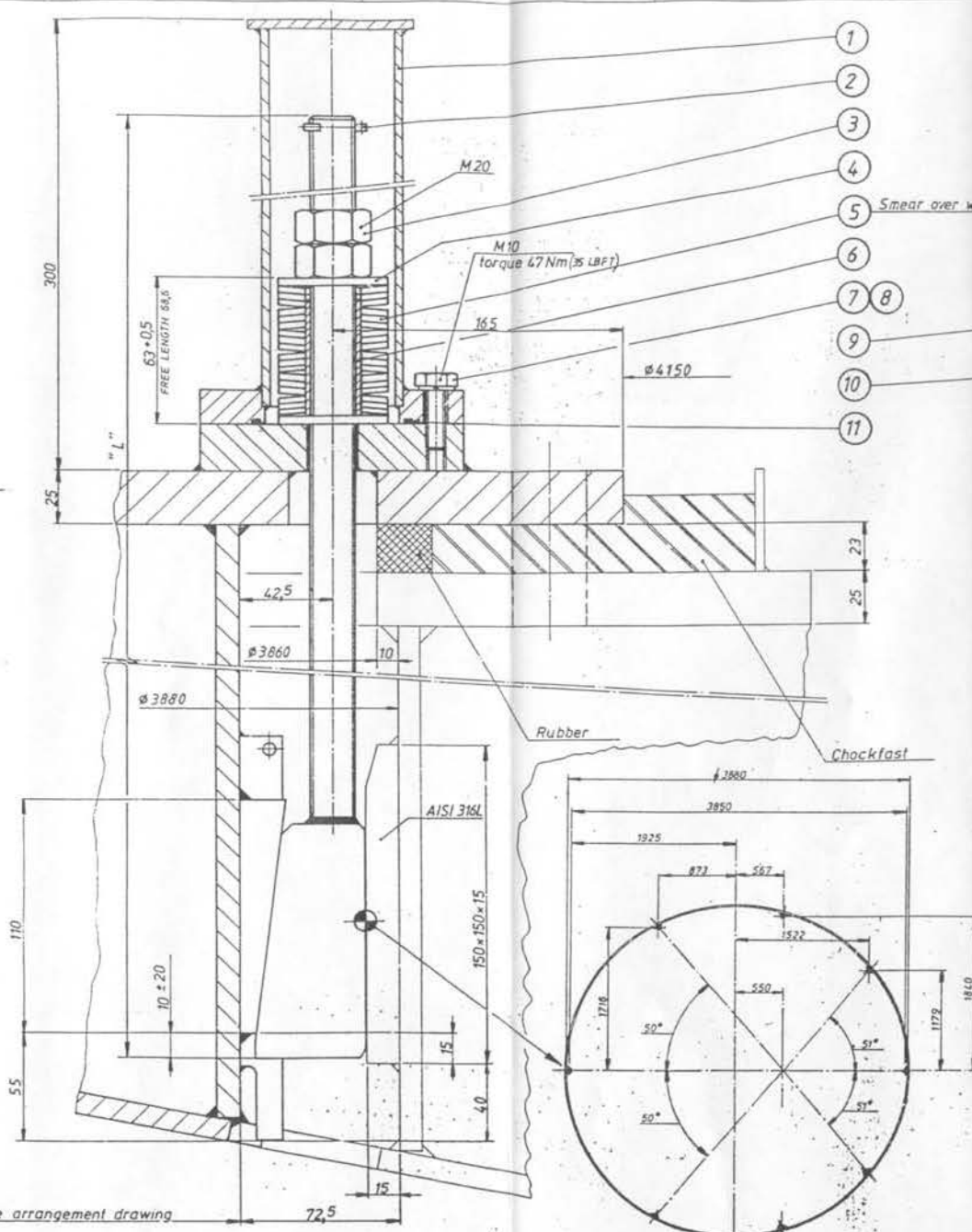
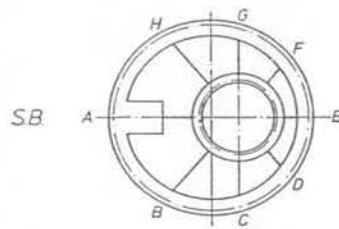
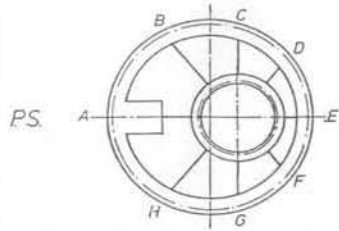
1. Lager
 2. Lager
 3. Lager
 4. Lager
 5. Lager
 6. Lager
 7. Lager
 8. Rolle
 9. Rolle
 10. Rolle
 11. Rolle
 12. Rolle
 13. Rolle
 14. Rolle
 15. Rolle
 16. Rolle
 17. Rolle
 18. Rolle
 19. Rolle
 20. Rolle
 21. Rolle
 22. Rolle
 23. Rolle
 24. Rolle
 25. Rolle
 26. Rolle
 27. Rolle
 28. Rolle
 29. Rolle
 30. Rolle
 31. Rolle

Pos.	Bezeichnung	Menge	Material	Größe	Gründ.	Gründ.
1	Lager	1	St 50	100x100	10	10
2	Lager	1	St 50	100x100	10	10
3	Lager	1	St 50	100x100	10	10
4	Lager	1	St 50	100x100	10	10
5	Lager	1	St 50	100x100	10	10
6	Lager	1	St 50	100x100	10	10
7	Lager	1	St 50	100x100	10	10
8	Rolle	1	St 50	100x100	10	10
9	Rolle	1	St 50	100x100	10	10
10	Rolle	1	St 50	100x100	10	10

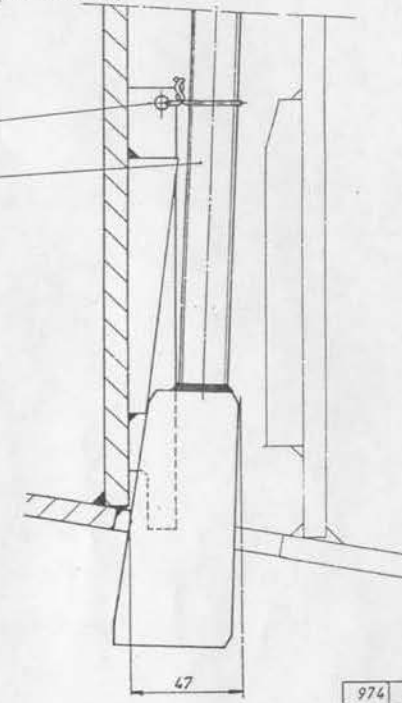
LIPS THRUSTERS DRUNEN B.V.

CHAPTER 3.1

ADJUSTABLE THRUST BLOCKS



Smear over with grease (water resistant)



974	A
875	B
1080	C
1365	D
1653	E
1775	F
1673	G
1381	H
"L"	code

See description installation of thrustpads:
3003801

LIPS
Crusher - The Specialists

ADJUSTABLE THRUST BLOCKS

3003802

TITLE : ASSEMBLY THRUST BLOCK
TYPE :
LIST : T073010083

PAGE : 1
DRAWING : 3003802
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	BUSH, PROTECTING	T003001701	8,0
2	SPLIT PIN	M717710382	8,0
3	HEXAGON NUT	W007210123	16,0
4	WASHER	T003001702	16,0
5	CUP SPRING	W004020008	144,0
6	PIPE	T003002234	8,0
7	HEXAGON SCREW	M713000431	48,0
8	SINGLE COIL SPRING WASHER	M716100031	48,0
9	LOCKING WIRE	W007550004	3,2 MT
10	THRUST BLOCK	T003003803	1,0
11	O-RING	M730000144	8,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
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END OF LIST



INSTRUCTION NR 3003801
 DATE 19940308

REV. 1
 PAGE 1/4

INSTALLATION OF MOUNTING CAN WITH ADJUSTABLE THRUST BLOCKS

Characteristics: Upper support Chockfast.
 Lower support Grade A, or similar.

If final ass'y well-box with launched ship is required see items 5b up to 11b.

Definition:

The main thrust reaction between well-box and ship is transmitted by thrust pads situated at the lower end of the well-box. Each thrust pad set consists of an inner-, center- and outer member. The inner members, as supplied, are already permanently attached to the well-box. The vertical positions of the center members are adjustable by threaded spindles which protrude from the upper well-box flange. The center members, as supplied, are machined in a wedge shape to facilitate tensioning. The outer members are to be delivered by the shipyard, and must be of stainless steel 316L or equivalent. For dimensions see respective drawing.

Conditions:

- The ship's well must be of corresponding dimensions. Flange is yet undrilled. The pads are wedge shaped and therefore allow for some concentricity deviations.
- The local ship's structure must provide ample stiffness of support for the outer thrust pad. This is naturally the case when a pad is positioned opposite a longitudinal or transverse girder. In the remaining cases a local stiffener must be incorporated in the bottom structure.
- The joint, at the upper support, between ship's well flange and well-box flange, is to be made with a chocking compound according to manufacturer's instructions, including tightening torque of fasteners.

Fitting:

1. Check whether the pads (mounted on the well box) are in the lowered position and secured by locking wires.
2. Place the well-box in the well on height positioning bolts, according respective drawing. Adjust center position and height to obtain best conformity of thrust pads and ship's hull, taking into account the height needed for chockfasting.
3. First apply some grease between the sliding faces of the center member. Retract the center member of thrust pads to about 10 mm below the corresponding inner member by threaded spindle (locking wire might break) and place the outer member (del.yard) of the thrust blocks against the

1	10150/84	A.FERMONT	841208
REVISION	REV. IDENTIFICATION	ORIGINATOR	DATE



center member in such a way that a max. bearing area is obtained (see page 4). Thickness of outer members to be machined accordingly. Tighten nuts to the correct force by measuring the disc spring heights. Check with feeler gauge if bearing area is ok.

- 4. Tack-weld outer pads to ship's well. Also the flange of the ship's well can now be drilled from flange to flange.

Continued for launching with assembled thruster in well-box

- 5a. Lower the center member of the thrust pads by threaded spindle (apply some gentle force on top of rod) to the original mounting position. Lift the well-box carefully out of the ship and place it on an appropriate foundation or lift the well-box to such a height that easy access to the tack welded thrust pads is obtained. Make sure the adjustable thrust pads are kept in the original/lowered position and renew the locking wire if possible.
- 6a. Weld the outer pads to the ship's well, using a stainless steel electrode (Arosta 309Mo or equivalent = ASME SF-A 5.4(E309L-16) at all four sides.
- 7a. Now the well-box can be placed on its original position. (for example on Chockfast recommendations see instructions 2017276) Install the seal (for chockfast compound retention) at the upper flanges. Lower the well-box carefully further in position, check mismatch on pitch circle and stuff the bolt holes (bolts are to be treated for easy removal). Check on height position as noted and adjust positioning studs in flange.
- 8a. Apply chockfast compound according to manufacturer's instructions.
- 9a. After curing, free the bolt holes in the ship's well flange and tighten bolts and nuts to the correct torque value (such as to obtain a surface pressure on the chockfast compound of 3.5 N/mm².)
- 10a. Retract center member of thrust pads in such a way that the correct force is obtained by adjusting the disc springs to their correct height. Lock the nuts, smear water resistant grease on the disc springs and mount the protection caps according drawing.
- 11a. After first seatrials re-adjust the height and lock them again as above. Re-adjust nuts at least every year, or sooner if vibrations seem to occur.

Continued for launching with dismantled well-box.

- 5b. Lower the center member of the thrust pads by threaded spindle (apply some gentle force on top of rod) to the original mounting position. Lift the well-box carefully out of the ship and place it on appropriate foundation. Make sure the thrust pads are kept in the original/lowered position and renew the locking wire. Apply some grease

1	10150/84	A.FERMONT	841209
REVISION	REV. IDENTIFICATION	ORIGINATOR	DATE



INSTRUCTION NR
DATE

3003801
19940308

REV. 1
PAGE 3/4

- between the wedge and on the outside.
- 6b. Weld the outer pads to the ship's well, using a stainless steel electrode (Arosta 309 or equivalent = ASME SF/T-5.4/E309L-16) at all four sides.
-

Now the ship is ready for launching as far as this procedure is concerned.

- 7b. After launching insert the well-box on his right position above the ship's well. (for example on Chockfast recommendations see instructions 2017276) Install the seal (for chockfast compound retention) at the upper flanges. Lower the well-box carefully further in position, check mismatch on pitch circle and stuff the boltholes (bolts are to be treated for easy removal). Check on height position as noted and adjust positioning studs in flange.
- 8b. Apply chockfast compound according to manufactures's instructions.
- 9b. After curing, free the bolt holes in the ship's well flange and tighten bolts and nuts to the correct torque value (such as to obtain a surface pressure on the chockfast compound of 3.5 N/mm².)
- 10b. Retract center member of thrust pads in such a way that the correct force is obtained by adjusting the disc springs to there correct height. Lock the nuts, smear water resistant grease on the disc springs and mount the protectioncaps according drawing.
- 11b. After first seatrials re-adjust the height and lock them again as above. Re-adjust nuts at least every year, or sooner if vibrations seem to occur.

LIPS THRUSTERS

1	10160/94	A.FERMONT	041208
REVISION	REV. IDENTIFICATION	ORIGINATOR	DATE

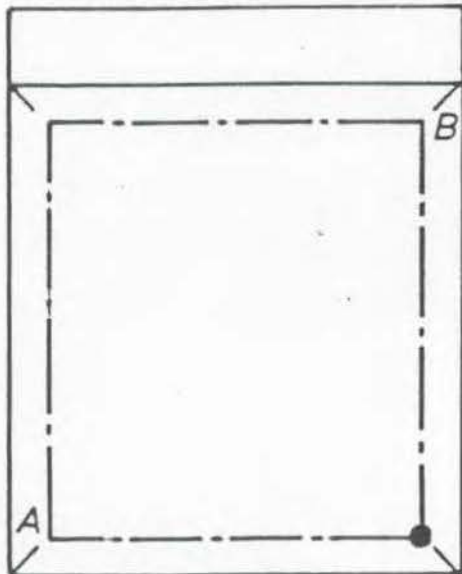
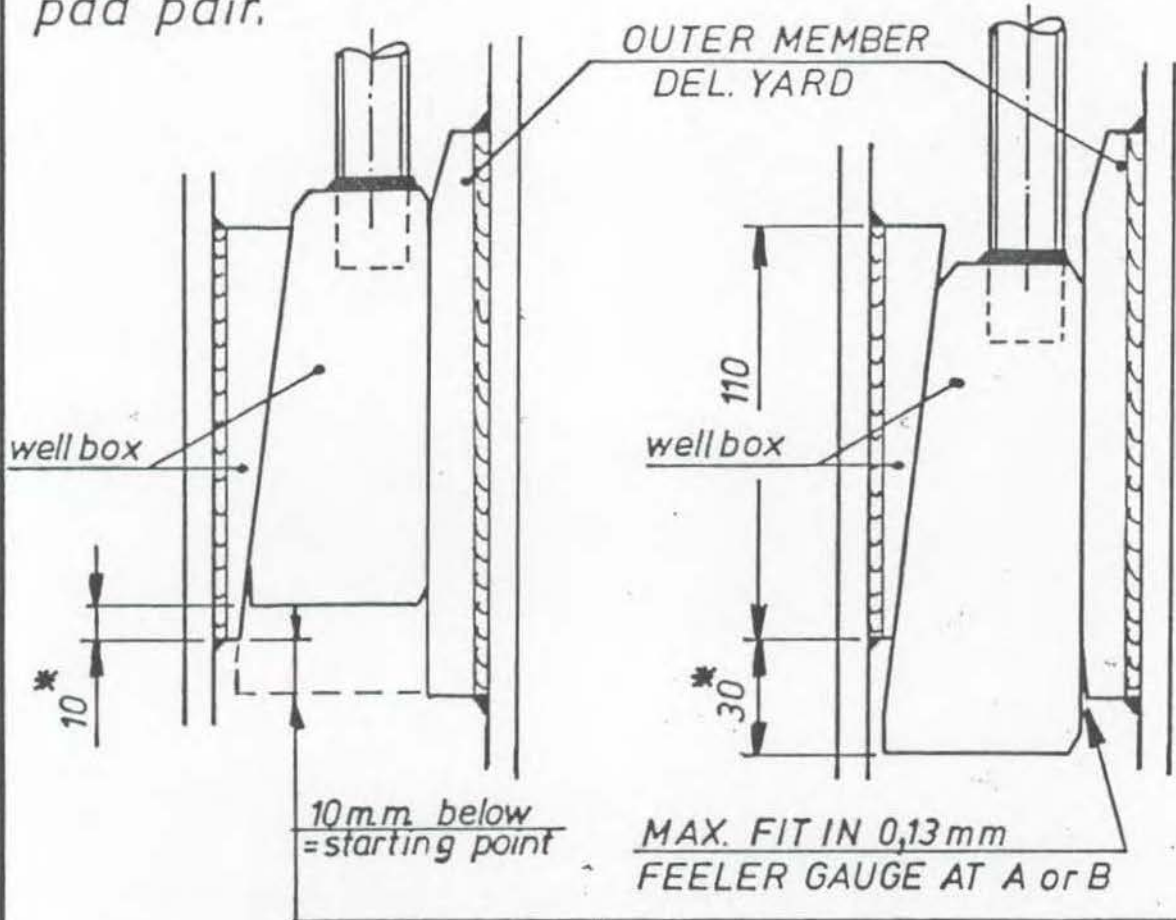


SKETCH OF THRUST BLOCK

3003801

Page 4 - 4

Allowable* difference in height of pads.
Bearing area appr. 50% of total surface at each pad pair.



IF OKÉ TACK WELD OUTER THRUST PAD TO SHIPS WELL.

NB. Bearing area should be about 50% of total bearing area, or as much as can be maximum achieved by accurate fitting.

Index: ①
Date:

LIPS THRUSTERS DRUNEN B.V.

CHAPTER 4

HYDRAULIC STEERING SYSTEM



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HYDRAULIC-DETAIL-DESIGN-SPECIFICATION

RELEASE : 01-02-1991
 CHANGED : 01-03-1992
 SUPERSEDES REL.:

TN 24.006E

PAGE 1 OF 11

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

General

Troublefree operation of any machine or system requires strict adherence to the operating and maintenance instructions supplied by the manufacturer of the equipment. Hydraulic systems can vary widely in design and, as a component part of larger machines or systems are covered by a wide range of operating instructions.

Although general operating and maintenance instructions for such hydraulic systems provide a valuable guide to correct procedures for commissioning and maintenance, they should always be supplemented by specialized instructions relevant to the particular applica-

The tasks associated with the commissioning and maintenance of hydraulic systems and equipment are listed in the table below.

Commissioning	Maintenance		
	Inspection	Servicing	Troubleshooting
Commissioning of a new system or recommissioning of an existing system	Condition and functioning	Continued functioning Reduced wear Changing of wearing parts	Pinpointing and rectification of malfunctions and damage
Installation, filling with fluid, bleeding, basic adjustment, running-in	Observations, measurements, Test run	Cleaning and replacement of components (fluid change, filter inserts, seals)	Fault-finding requires close and logical attention to detail Repair of damage by replacement of components Repair of components by manufacturer

General instructions for working on hydraulic systems

For reasons of safety, no pipe connectors, screw connections or components should be loosened while the system is under pressure. Always lower any loads first, switch off the pumps and depressurize the accumulators. Never work with oily hands.

Extreme cleanliness is essential when working on the system. Before releasing screw connections, clean the external surroundings first and cover all openings into the system with protective caps and covers so that no dirt can enter. Try not to use cotton waste when cleaning out fluid reservoirs and always fill the system with fluid through a filter.

When spray-painting or brush-painting the equipment, especially with nitrocellulose paints, all flexible seals and bearings, pivots, etc. of moving parts should be covered.

Installing pipework

When selecting pipe, hoses and screw connectors/flanges, ensure that the pressure rating (i.e. wall thickness, material) is appropriate for the application. Use only seamless precision steel tube.

Before it is installed, the pipe must be cleaned to remove all dirt, scale, sand, swarf, etc. Welded tube must be pickled and flushed. Never use cotton waste for cleaning. Install the pipes carefully so that they are not distorted.

The pipe connections and thread depths in the components and subplates are suitable for all normal connectors. The spotfaces on the bodies have been sized for sealing-edge connectors and for soft-seal connectors (not suitable for O-ring seal connectors).

The thread must not reach to the bottom of the hole. Sealing materials such as hemp and compound are not permitted because they produce dirt which can lead to malfunctions of the equipment.

Note: damaged pipes and hoses must be replaced immediately.

Installing equipment

When installing equipment it is essential to note the correct mounting position, ambient temperature, operating voltage, etc. Freedom from stress and distortion in installation is necessary to prevent jamming in control valves and devices; the mounting surfaces must be properly flat and the fixing bolts be tightened uniformly to the prescribed value of torque.

Accumulators

Accumulators are pressure vessels and are therefore subject to the relevant safety regulations in force at the place of installation.

Before any work is carried out on systems incorporating accumulators (e.g. repairs, connection of pressure gauges, etc) it is essential to depressurize the system first.

No welding, soldering or brazing or any other kind of mechanical work may be carried out on the accumulator vessel. Improper repairs can lead to serious accidents and therefore any repair work necessary on hydraulic accumulators should always be entrusted to the local Trans-Hydro representative.

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Commissioning

Commissioning involves a number of procedures which should all receive careful attention:

- Visual inspection for damage and dirt picked up during delivery.
- Installation and mounting of sets and subassemblies.
- Connection of hydraulic actuators in the machine. Flush out long pipes and hoses.
- Electrical wiring for drives and control, after checking the supply ratings. Connect cooling water if necessary. Check direction of rotation of pumps before starting.
- Filling the fluid reservoir with the prescribed, or otherwise suitable, fluid. Using the correct fluid, especially one of the proper viscosity, is essential for troublefree operation of the system. Further instructions are given on pages 8 and 9.

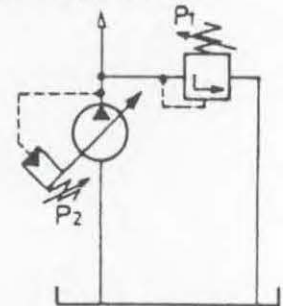
Ensure absolute cleanliness. Clean the filler screw and cap on the storage vessel before opening. Check the fluid reservoir for dirt and clean if necessary.

Examine the fluid for the presence of water. Always leave the strainer in the filler and the elements in built-in filters in position when filling the system with hydraulic fluid.

The inherent contamination of the fluid with which the system is filled must not exceed Class 10 to NAS 1638. Experience has shown that even new fluid can often exceed this value so, in such cases, it will be necessary to use a filter with a special filter. Do not fill beyond the maximum level mark.

- Filling of pump- and/or motor bodies
- Open the cocks in the suction lines
- Valve adjustment
Initially adjust pressure control valves, flow control valves and the pressure regulators of variable-delivery pumps to low settings. Directional valves should be set to the neutral position.
- Accumulators should be charged to the prescribed gas pressure; see page 3.
- Start the drive motor slowly, electric motors by rapid on/off, IC engines at tickover; check the direction of rotation.
- Bleeding of the system at the actuator lines should be carried out at the highest point possible. Operate the direction valves and extend and retract the actuators several times.
Increase the load slowly. Increase the settings of pressure valves and regulators. The system has been properly bled when there is no more foam in the reservoir, no jerky movements of the actuators and no unusual noises.
- Check the fluid level and top up after the bleeding, if necessary.

- Variable-delivery pumps incorporating a pressure regulator are usually protected by an additional pressure relief valve. When making the adjustments, ensure that the lift pressure of the safety valve is much higher than that of the pressure regulator. $P_1 = P_2 + \text{approx. } 30 \text{ bar}$.



- Monitor the steady-state operating temperature when the machine has been in full operation for several hours.
- Final valve adjustment and running-in of the machine according to the manufacturer's instructions. It is impossible to give general instructions for this. Adjustments are made at pressure control valves, pressure switches, flow control valves, pump regulators, time switches, etc.
- Repair any leaks, usually by simply retightening connectors and bolts after a few hours of service.
- Clean or renew the filters. It is a fact that most contamination is collected during the first few hours of service.

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Inspection and Servicing

Trans-Hydro hydraulic equipment has been designed for a long, troublefree service life. It requires very little maintenance but nevertheless it is essential in order to obtain troublefree operation, because practical experience has shown that up to 80% of faults and damage are due to contamination, lack of servicing and incorrect choice of fluid.

The scope of and intervals between inspections and services are generally laid down by the manufacturer of the machine in an appropriate schedule.

The most important points for a hydraulic system are stated here and also summarized in the table on page 4.

Fluid level

Continual checking is necessary because, as the volume of fluid in the system falls below the minimum mark, it can cause a rise in the operating temperature, accumulation of undissolved air and pump failure due to cavitation.

Fluid temperature

The operating temperature depends on several factors such as the mode of operation, the machine operating cycle, circuitry, etc.

In practice the temperatures are normally between 40 and 90°C.

A maximum temperature of 60°C is recommended for mineral oil-based fluids because higher temperatures accelerate the ageing of the fluid and shorten the life of seals and hoses.

The fluid temperature in the reservoir must be monitored continuously.

A gradual rise in temperature is a possible indication of contamination or gumming, or of wear at seals or metal components, and should be taken as a sign to examine all components which might be affected.

Sudden sharp increases in temperature are an alarm signal and the system should be shut down immediately for inspection.

Fluid condition

The ageing of the fluid depends on a number of operating parameters such as temperature, pressure, air humidity, dirty environments, etc.

The ageing of the fluid, and hence its continued usability, can be judged from a simple visual examination.

Changing the fluid

The fluid is first changed immediately after the initial commissioning.

Subsequent changes should be at intervals of approximately 2000 to 4000 hours if the fluid is not analyzed regularly in a laboratory.

It is essential, however, for the maximum operating temperature not to exceed 70°C and for filter changing to be carried out regularly.

Appearance	Contaminants	Possible causes
*Dark in colour	Product of oxidation	Overheating, insufficient fluid changes (possible ingress of other fluid)
*Milkyiness	Water or foam	Ingress of water and or air
*Waterseparation	Water	Ingress of water, e.g. coolant
*Air bubbies	Air	Ingress of air, e.g. due to low fluid or leaky suction
*Floating or sunken contaminants	Solids	Wear, dirt, ageing
*Smell of burnt oil	Products of ageing	Overheating

Laboratory analysis will provide further information

Filter inspection/Filter changing

Filters without blockage indicators

They must be changed for the first time immediately after the initial commissioning. Subsequent changes should be at monthly to six-monthly intervals depending on the operating conditions.

Filters with blockage indicators

These are monitored continuously. The checks made daily when working temperature has been reached. During warming-up it is possible for an alarm to be given because there is still a high flow resistance.

Breather filters

These filter the air which flows in and out of the fluid reservoir as the level fluctuates. The frequency of inspection and element changing or cleaning depends on the condition of the environment.

Accumulators

In addition to the legal tests, it is also necessary to monitor the gas charging pressure; more frequent measurement during the running-in phase is particularly recommended.

The gas charging pressure can be measured with a testing and charging device.

A simple test with the fluid pressure gauge is also possible.

Note: Only ever use nitrogen as the gas.



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HYDRAULIC-DETAIL-DESIGN-SPECIFICATION

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TN 24.006E

PAGE 4 OF 11

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Inspection and Servicing

Adjustment

All pressure control valves, flow control valves, pump regulators and signalling devices such as pressure switches, limit switches, thermostates, etc. are adjusted during the initial commissioning. The settings must be monitored continuously during the initial stages of operations and then subsequently at reasonable intervals.

Fluid/air coolers

Fluid/air coolers must be cleaned regularly at intervals depending on the amount of dirt collected from the surroundings.

Fluid/water coolers

In this case the cleaning intervals depend on the quality of the water, the temperature and the water throughput. Either nylon brushes or chemicals should be employed for cleaning.

Miscellaneous checks

By remaining alert and paying close attention to detail it is possible to detect faults in their very early stages and so prevent them from developing into more serious malfunctions. This is particularly true during the early stages but also remains true throughout the service life of the equipment. A constant lookout should be kept for:

- external leaks
- dirt
- damage, especially to hoses and pipes
- unusual noises from pumps, motors, couplings, mountings, etc.
- proper functioning of instruments.

Inspection and servicing intervals

	Continuous/ Daily	1 week 40 h	1 month 160 h	2 months 500 h	6 months 1000 h	1 year 2000 h	2 years 4000 h
Fluid							
Level	██████████	██████████	██████████	██████████			
Temperature	██████████	██████████	██████████	██████████			
Condition (samples)		██████████			██████████		
Changes					██████████	██████████	██████████
Filters							
Changing of filters without blockage indicators	██████████		██████████	██████████	██████████		
Monitoring of blockage indicators	██████████						
Cleaning of breather filters			██████████	██████████	██████████		
Accumulators							
Check gas pressure, check mounting	██████████			██████████	██████████		
other checks according to legal requirements							
Adjustments							
Pressure control valves, flow control valves, pump regulators, signalling devices	██████████				██████████	██████████	
Coolers							
Cleaning fluid/air coolers				██████████	██████████	██████████	
Cleaning fluid/water coolers						██████████	██████████
Miscellaneous checks							
External leaks	██████████						
Dirt					██████████	██████████	
Damage	██████████						
Noises	██████████						
Instruments						██████████	██████████



Dynamics in hydraulics

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SUPERSEDES REL.:

TN 24.006E

PAGE 5 OF 11

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Trouble shooting

Troubleshooting is the general heading to:

- Fault-finding

i.e. the pinpointing of damage or malfunctions and ascertaining their causes.

- Rectification

i.e. repair or replacement of defective components to eliminate the primary causes of the trouble.

Hydraulic tester

A portable hydraulic tester enables measurements of pressure, flow rate and temperature in a system to be taken.

On request Trans-Hydro will supply you with further details.

Rectification

Most problems are dealt with by the replacement of defective components on site.

The defective components are then generally repaired by the manufacturer or one of his approved agents.

Provided an end-user or installer has sufficient know-how and suitable equipment (such as test benches) it is also possible for him to carry out the repairs himself.

The spare parts lists and instructions for testing and repair which are available for the various items of equipment provide valuable assistance.

Fault-finding

Successful fault-finding in hydraulic equipment necessitates a detailed knowledge of the construction and mode of operation of the individual components and the total system.

It is also greatly facilitated by an ability to read circuit diagrams and functional diagrams and to employ logic.

Of course, hands-on experience is invaluable.

Circuit diagrams, functional diagrams and all other documentation on the system should always be immediately available.

An adequate number of measuring points and suitable instruments are also a great help.

Probably the most common source of trouble with hydraulic systems are leaks.

When they occur at pipe connectors they can often be rectified by simply retightening. In the case of leaks from units of equipment, however, it might be necessary to renew seals and gaskets (see spare parts lists).

Once the immediate damage has been repaired it is essential to seek and eliminate the primary cause of the problem. For example, if equipment has failed due to dirt in the system, change the fluid, examine the filters, etc.

Electrohydraulics

It is very common for control systems of stationary installations to be of the electrohydraulic type.

The combination of electrics with hydraulics naturally makes fault-finding more difficult and needs good cooperation between electricians and hydraulics engineers.

The situation is particularly true in the case of proportional control valves and this is why a wide range of training courses are offered in these specific techniques.

Fault-finding chart

There is no general recipe for success in fault-finding because of the extra-ordinarily diverse nature of the systems.

However, the following charts provide a useful point from which to start.

Faults and their effects on hydraulic systems						
Source Effect	1 Mech. drive	2 Suction conditions	3 Pump	4 Delivery line	5 Return line	6 Delivery valves
A Excessive noise	<ol style="list-style-type: none"> Coupling out of alignment Coupling loose Coupling defective Pump or motor mountings loose Other drive component defective (V-belt/gear wheel) Pump or motor defective Wrong direction of rotation No anti-vibration mountings 	<p>Excessive resistance in the suction line due to:</p> <ol style="list-style-type: none"> Suction cock closed or only partly open Suction filter blocked or too small Suction line blocked or leaking Suction line too small or too many bends Fluid level too low 	<ol style="list-style-type: none"> Pump speed too high Pump maximum pressure exceeded Supply pump defective Shaft seal or suction-side seals defective Pump defective Delivery and return connections transposed Control system hunting as 1 A8 	<ol style="list-style-type: none"> Pipe mounting loose or absent Incorrect installation Insufficient cross section as 4C 	<p>as 4A</p> <ol style="list-style-type: none"> Return not submerged in fluid Return filter blocked 	<ol style="list-style-type: none"> Valve chatter due to dirty or damaged seat Insufficient damping (unsuitable type) Flow noises when operating Unsuitable characteristic Bad design
B Insufficient output forces and torques (insufficient pressure)	<ol style="list-style-type: none"> Power transmission defective V-belt or toothed belt slipping Wrong direction of rotation Motor defective Key on pump or motor sheared 	as 2A	<ol style="list-style-type: none"> Internal leakage due to wear Unsuitable type Pump defective Control pressure set too low or control device defective 	<ol style="list-style-type: none"> Leaks Excessive line resistance Delivery filter blocked 	<ol style="list-style-type: none"> Excessive line resistance Filter blocked 	<ol style="list-style-type: none"> Operating pressure set too low Internal leaks due to wear Valve seat dirty or damaged Spring broken Unsuitable type (insufficient adjustment range)
C Jerky cylinder or motor movements (pressure and flow fluctuations)	as 1 A1-7	as 2A	<ol style="list-style-type: none"> Defective regulator on variable-delivery pumps Defective pump Back effects on the pump regulator from the system Pilot valves unsuitable 	<ol style="list-style-type: none"> System not properly bled 	as 5B	<ol style="list-style-type: none"> as 6A 1-2 Excessive undamped remote control line Unsuitable remote control valve
D Output drive not running or too slowly (insufficient flow or no flow)	as 1 A 1-7	as 2A	<ol style="list-style-type: none"> Internal leaks due to wear Pump defective Supply and return connections transposed 	as 4B	as 5B	<ol style="list-style-type: none"> as 6B With sequence controls Start valve set too high or defective
E Excessive operating temperature			<ol style="list-style-type: none"> Reduced efficiency due to wear Regulator defective on variable-delivery pumps Excessive speed or delivery 	<ol style="list-style-type: none"> Insufficient line cross section giving excessive frictional resistance Delivery filter blocked 	as 4E	<ol style="list-style-type: none"> Excessive continuous delivery Unsuitable valve types (insufficient cross section) Pressure setting too high Excessive response time
F Foaming of the fluid		<ol style="list-style-type: none"> Suction line leaking Fluid level too low Incorrect reservoir design 	<ol style="list-style-type: none"> Shaft seal or suction-side seals defective Leakage fluid line not submerged 		<ol style="list-style-type: none"> Return line not submerged Eddies, due to poor installation 	
G Cylinder overrun				<ol style="list-style-type: none"> Hoses too elastic Lines not properly bled 		
H Line hammer during control operation				<ol style="list-style-type: none"> as 4A Excessive pipework volume 	Pipework loose	<ol style="list-style-type: none"> Control operations too rapid Throttles or orifices damaged
I Pump starts and stops too frequently			<ol style="list-style-type: none"> Pump defective In accumulator systems: pump too small 			<ol style="list-style-type: none"> Start or stop valve incorrectly set or defective

Faults and their effects on hydraulic systems						
	Source Effect	7 Flow valves	8 Control valves	9 Fluid	10 Drive (motor, cyl.)	11 Miscellaneous
A	Excessive noise	<ol style="list-style-type: none"> 1. Valve vibrating and affecting other control devices 2. Flow noises 3. as 3A 7 	<ol style="list-style-type: none"> 1. Valve clatter due to defective solenoid or low voltage 2. Valve defective due to wear or dirt 3. Excessive flow 4. Control pressure fluctuations 5. Incorrect adjustment on valve with adjustable damping 6. Check electrical control system 	<ol style="list-style-type: none"> 1. Suction difficulties due to: <ol style="list-style-type: none"> a. low fluid level b. high viscosity (low temperature) 2. Dirty fluid damaging and blocking equipment 3. Fluid foaming 	<ol style="list-style-type: none"> 1. Surface wear 2. as 3 A 7 	
B	Insufficient output forces and torques (insufficient pressure)	<ol style="list-style-type: none"> 1. Excessive pressure drop 2. Incorrect adjustment 3. Valve defective 4. Unsuitable type 	<ol style="list-style-type: none"> 1. Incorrect switching point (e.g. does not switch off on zero pressure circulation) 2. Solenoid defective 3. Internal leakage due wear 4. Excessive flow resistance 5. Valve jammed 	<ol style="list-style-type: none"> 1. Viscosity too low therefore leakage excessive 2. Viscosity too high therefore excessive flow resistance 3. Fluid foaming 	<ol style="list-style-type: none"> 1. Internal leakage (e.g. cylinder seals worn) 2. See 10A 3. Excessive internal friction (poor efficiency) 	<ol style="list-style-type: none"> 1. Fault in control circuit with pressure control systems 2. Instruments defective
C	Jerky cylinder or motor movements (pressure and flow fluctuations)	<ol style="list-style-type: none"> 1. Valve dirty 2. as 7A 1 	as 8A	<ol style="list-style-type: none"> 1. Fluid contaminated 2. Fluid foaming 	<ol style="list-style-type: none"> 1. Stick-slip effect due to excessive friction at cylinder seals 2. Speed below minimum for hydraulic motor 	<ol style="list-style-type: none"> 1. Insufficient counterforce on the output side of the drive (e.g. lowering throttle, pressure-drop valve)
D	Output drive not running or too slowly (insufficient flow or no flow)	<ol style="list-style-type: none"> 1. Flow setting too low 2. Unsuitable type (insufficient adjustment range)] 3. Valve blocked (dirty) 	<ol style="list-style-type: none"> 5. Valve jammed 6. Hand valves (cocks) not in flow position 	as 9 B	<ol style="list-style-type: none"> 4. Drive seized (e.g. seized piston) 	Starting requirements not satisfied (defective regulator). Open-circuit in electrical control leads (plug connectors). Signalling devices incorrectly set or defective (e.g. pressure switches) limit switches not operated
E	Excessive operating temperature	<ol style="list-style-type: none"> 1. Flow setting too low (excessive pump delivery through pressure relief valve) 2. Valve defective 	<ol style="list-style-type: none"> 1. Excessive leakage loss 2. Zero-pressure circulation inoperative 3. Valve jammed 	as 9 B	<ol style="list-style-type: none"> 1. Reduced efficiency due to wear 2. Excessive internal friction (poor efficiency) 3. Internal leakage loss 	<ol style="list-style-type: none"> 1. System has insufficient cooling capacity in relation to the installed power or the running time is insufficient 2. No zero-pressure circulation during excessive working intervals (with pump running) 3. Insufficient fluid in the system 4. Cooling water valve inoperative 5. Thermostat set too high 6. No cooling water or fan defective 7. Cooling water temperature too high 8. Ambient temperature too high 9. Deposits in the cooler 10. Insufficient heat dissipation due to enclosure
F	Foaming of the fluid			<ol style="list-style-type: none"> 1. Unsuitable type 		
G	Cylinder overrun		<ol style="list-style-type: none"> 1. Switching time setting too slow 2. Solenoid defective 3. Leakage 4. Valve dirty 		<ol style="list-style-type: none"> 1. Internal leakage 2. insufficient bleeding 	<ol style="list-style-type: none"> 1. Remote-controlled check valve not closing immediately due to <ol style="list-style-type: none"> a. dirty or defective seat b. control fault 2. Limit switch overrun
H	Line hammer during control operation		<ol style="list-style-type: none"> 1. Switching time setting too fast 2. Unsuitable type (too rapid a change in cross section) 	<ol style="list-style-type: none"> 1. Fluid foaming 	<ol style="list-style-type: none"> 1. Excessive masses and forces 2. No damping 	<ol style="list-style-type: none"> 1. No throttling before the switching valves in accumulator systems
I	Pump starts and stops too frequently					In accumulator systems: gas charging pressure too low, bladder (diaphragm) defective; pressure switch set wrongly

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Fluids

Types of fluid

The satisfactory functioning, long life, reliability and efficiency of hydraulic systems are affected greatly by the selection of the most suitable type of fluid.

Hydraulic oils, based on mineral oils, are the most commonly used fluids and for mobile applications it is usual to use heavy duty engine oils for the sake of type standardization. In addition to the hydraulic oils there are also flame-resistant fluids which sometimes impose limitations on the operation of the equipment.

Type designation of hydraulic oils

DIN 51524 and 51525, CETOP guidelines lay down a system of code letters for mineral oil-based hydraulic oils.

The coding system has not yet been fully adopted as an ISO standard.

The code system is as follows:

- H= Ageing-resistant mineral oil without additives (little significance)
- L= Additives for increasing corrosion protection and/or ageing properties
- P= Additives for reducing wear and/or increasing load rating
- V= Additives L + P (to CETOP)
- M= Additive M and high-polymer agents for improving the temperature/viscosity characteristics, expressed by the VI viscosity-index to DIN 51654 (to CETOP)
- D= Detergent and dispersant additives (for cleaning and anti-ageing and keeping foreign matter in suspension)

The most common combinations are:

- HL : for ordinary applications at operating pressures < 200 bar
- HLP : for systems with piston pumps and operating pressures < 200 bar

Viscosity

The viscosity of any pressure fluid, measured in the SI unit of mm²/s, varies with temperature.

A graph with a double logarithmic scale for the viscosity axis will give straight-line characteristics for different types of fluid.

The grading of the fluids according to viscosity is based on a reference temperature of 40°C in the case of ISO-VG, e.g. ISO VG 46 means 46 mm²/s at 40°C.

The viscosity grade is then added to the type designation, e.g. HLP 46.

The principal viscosity grades and notes on the operation of hydraulic systems are contained in the diagram on page 9.

The diagram enables the most appropriate types of oil to be selected for specific operating temperatures.

Hydraulic pumps and motors in particular require an accurate viscosity in order to operate efficiently.

If the viscosity is too high (i.e. thick) there will be cavitation problems, whereas if it is too low there will be excessive leakage, overheating and therefore a further drop in viscosity. In the end the effective limits of lubricity will be reached.

Using engine oils

For the sake of standardization it is frequently the practice to use engine oil in mobile hydraulic systems.

Although such oils are not strictly intended for use as a hydraulic fluid, their use normally presents no problems.

It is advisable, however, to use only heavy duty oils and it is essential to select the correct viscosity grade.

The temperature/viscosity characteristics are similar to those of hydraulic oils.

Engine oil	Viscosity at 40°C	Hydraulic oil
SAE grade	mm ² /s	ISO-VG
10	30-48	32 and 46
20	40-74	46 and 68
30	74-110	approx. 100

Using gear oils

Gear oils can be used in exceptional cases, after prior discussion with the manufacturer, provided they do not contain any sulphurous substances, because they can damage the seals and bearings.

Flame-resistant fluids

Mineral oil-based hydraulic fluids are flammable, so for applications where there is a high risk of fire (e.g. in mines, foundries, etc.) it is necessary to use flame-resistant fluids. Cost and freedom from pollution are other important reasons for replacing mineral oil-based fluids with fluids containing a high proportion of water.

The CETOP coding system for such fluids is as follows:

- A= Oil-in water emulsion with a maximum flammable component of 20%.
Operating temperatures between +5 and +55°C
- B= Water-in-oil emulsion with a maximum flammable component of 60%.
Operating temperatures between +5 and +55°C (not used in West Germany)
- C= Aqueous polymer solutions containing at least 35% water.
Operating temperatures between -20 and +60°C
- D= Non-aqueous fluids (e.g. phosphoric acid ester).
Operating temperatures between -20 and +150°C.

The viscosity grades are as follows:

Viscosity grade	Viscosity mm ² /s at 50°C
HS1	1-1,5
HS2	11-14
HS4	20-40
HS8	50-70

Hence, a complete code is, e.g. HS C 4

Note:

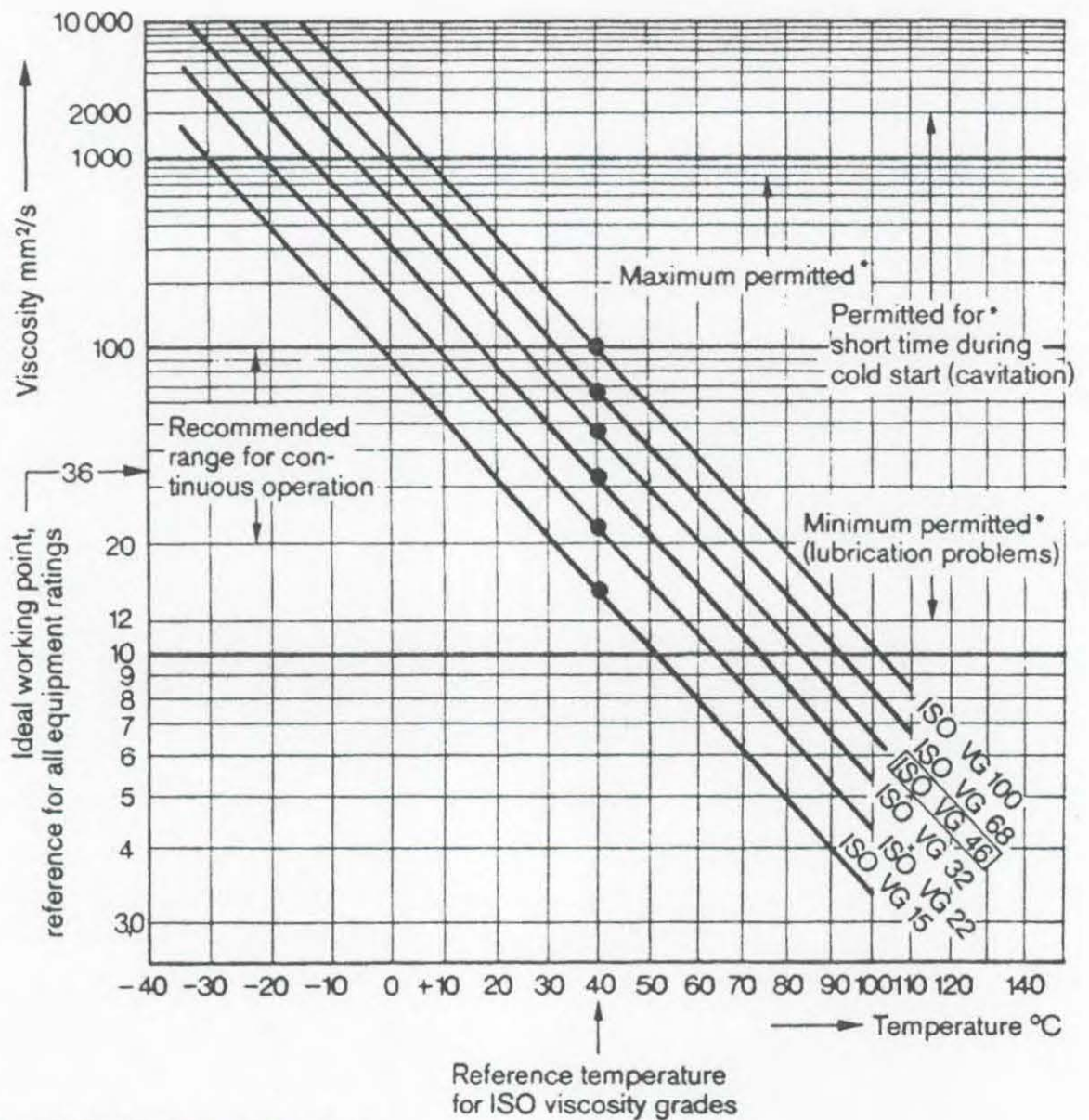
Some properties of flame-resistant fluids are considerably different from those of mineral oil-based hydraulic fluids.

This means that, under certain circumstances, it will be necessary to reduce performance (speeds, pressure, etc.) and service life will be affected.

Compatibility with the materials of the seals and bearings is especially important; it is advisable to consult the manufacturer.

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Fluids



* Note: The individual rating figures given in the equipment catalogs are binding

GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Filters

Function

By far the largest number of premature failures in hydraulic systems are due to contaminated fluid.

The task of the fluid filter is to keep the contamination within limits, i.e. the size and concentration of the dirt particles, in order to protect the equipment from excessive wear.

Degree of contamination and filtration rating

The latest practice in hydraulic equipment catalogues is to state the following:

1. Permitted contamination class of fluid:
Class 10 no NAS 1638

Thus, it primarily defines the amount of fluid contamination which can be tolerated by a system to allow reliable operation.

It is also a very important factor in settling guarantee disputes.

2. Achieved with filter: $\beta_{75} = 75$

The stating of the filter to be used is only a recommendation.

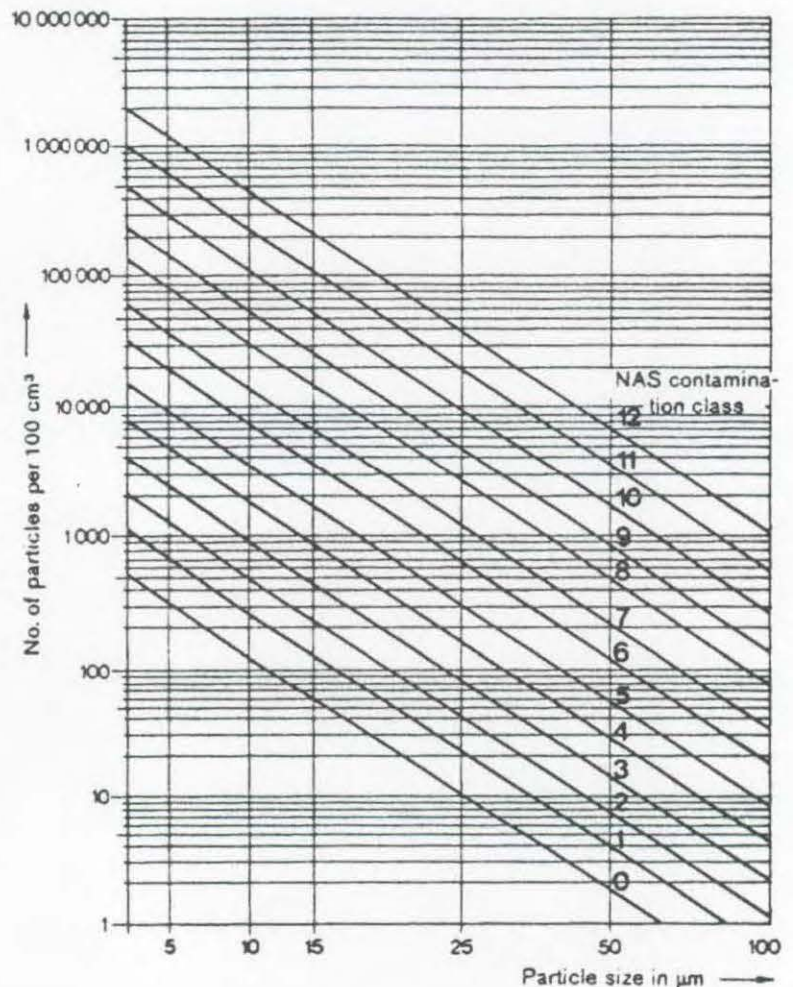
Note: The taking of fluid samples should be in accordance with ISO 4021.

Definition of contamination

The degree of contamination of a fluid is defined by the size of the particles and their concentration.

The count is evaluated according to different standards; the American standard NAS 1638 specifies particles between 5 and 100 μm in size and is the one most commonly used in hydraulics.

Diagram of contamination to NAS* 1638



GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS

Filters

Other standards

- Contamination classes to ISO*) 4406 (CETOP RP 70 H). This standard refers to 2 particle sizes >5 µm and >15 µm. Thus, the code comprises 2 figures. Although this standard is not yet in general use it is growing in importance.
- Contamination classes to SAE*)-ASTM. This standard only covers very slight contamination and is hardly ever used in hydraulics.

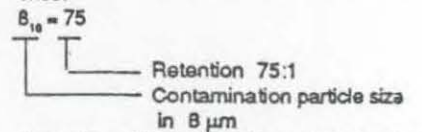
- *)
 NAS = National American Standard
 SAE = Society of Automotive Engineers
 ASTM = American Society for Testing and Materials
 ISO = International Standards Organisation

Filtration rating

Previous methods of defining filtration rating, such as absolute, nominal and mean void size, have been found to be wanting in practice. Hardly any filter material can provide absolute 100% retention referred to one particular particle size and this fact is taken into account by the Beta Value.

The Beta Value

This is based on the multi-pass test to ISO 4572. It determines the retention of a filter exposed to a flow of oil with a specific contamination. Thus:



A retention of 75:1 is used in most definitions although other values are perfectly feasible. Retention can be expressed as a percentage by using the formula

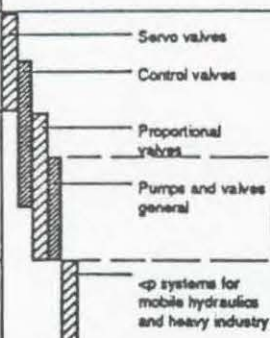
$$\% = 100 - \frac{100}{B}$$

e.g. B = 75

$$\% = 100 - \frac{100}{75} = 98,66\%$$


Retention in this form corresponds to the previous expression: "absolute filtration rating".

Contamination classes and filtration ratings for different hydraulic systems
 The following table is based on practical experience and provides a general guide to the type of filters to be employed in different hydraulic systems.

Contamination class				achieved with filter		Hydraulic system	
NAS	ISO	SAE	B x = 75	Material	Type		
6	15/12	3	3	inorganic, e.g. glass fibre	Delivery filter	 <p>Generally speaking, reliability, service life and control-land life (e.g. with control valves and proportional valves) increase as the degree of contamination decreases.</p>	
7	16/13	4	5		Return or delivery filter		
8	17/14	5	10				
9	18/15	6	20	organic e.g. paper	Return, suction or bypass filter		<p>for p > 160 bar</p> <p>for p < 160 bar</p>
10	19/16	-	25				
11	20/17	-	25..40				
12	21/18	-					

LIPS THRUSTERS

Schmierstofftabelle · Table of lubricants · Tableau de lubrifiants · Table de lubrificantes

	ISO-Viskositätsklasse	ISO viscosity class	ISO-Classe de viscosité	Clase de viscosidad ISO
	Thruster <u>lub.oil</u> system and <u>Pitch</u> control system		Thruster <u>hydraulic</u> steering (and retraction) open - systems	
	AGIP BLASIA 150		OSO 46 (32)	
	Aral Degol BG 150 Aral Degol BMB		ARAL Vitam DE 46 (32) ARAL Vitam HF46	
	BP Energol GR-XP 150 (ISO)		BP Energol HLP 46 ISO (32)	
	Castrol ALPHA SP 150		Hyspin AWS 46 (32) Hyspin AWH 46	
	Chevron, Non-Leaded Gear Compound 150		EP Hydraulic oil 46 (32)	
	SPARTAN EP 150		Nuto H46 (32)	
	GIRAN 150		Hydran 46 ISO (32)	
	Q8 Goya 150		Q8 Hadyn 46 (32)	
	Mobilgear 629		DTE/629 Mobil DTE ISO 46 (32)	
	Shell Omala Oel 150		Tellus T46 (T32)	
	Meropa 150		Rando oil HD 46 (32)	
			(.) for machine room evirons below 10 degrees Celcius	

Flushing of hydraulic systems

number of pages: 4

Introduction

Flushing is a procedure which is vital to the satisfactory operation and life of a hydraulic system. Omission or curtailment of flushing will inevitably lead to rapid wear of components, malfunctioning and breakdowns.

The aim of flushing is to remove contamination from the inside of pipes and components which may be introduced during system assembly. This is accomplished by passing fluid through the system at a velocity much higher than that during normal operation.

Condition of components

All components should be supplied ready for assembly into the system in a clean condition, inhabited with preservative oil and all openings sealed. Temporary sealing devices, plugs etc., should only be removed immediately prior to assembly. Particular attention should be given to piping, which should be free from scale, rust, flux etc.

Piping not in clean condition should either be rejected and replaced or cleaned before assembly. Thorough cleaning before assembly may not be possible in case of very large pipes so that these will require special attention during flushing to attain the required standard of cleanliness.

Site conditions

In some cases, hydraulic systems are assembled in clean-room conditions. In the majority of cases, however, site conditions cannot be controlled and great care must be exercised during system assembly to minimize the ingress of contamination.

Piping and components awaiting assembly should be stored in a dry place or at least elevated and covered, with all ports and openings sealed.

System preparation

System components which may present a restriction to the flow or which may be damaged by the high flushing flow should be bypassed by suitable make-up pieces. These components, which may have been flushed on assembly, include reservoirs, pumps, motors, dead-end components such as cylinders, servo valves, flow regulators and other valves containing small orifices. Filters may be left in place but with their filters removed.

Flushing equipment

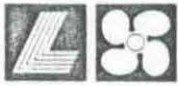
The flushing rig should comprise pumps, reservoir, heaters, filters and hose connections.

The pumps should incorporate adjustable relief valves to be set at a pressure above that required to pass the full pump flow through the system to be flushed.

The reservoir should have a capacity at least equal to three times the pump delivery per minute and preferably of greater capacity than the system to be flushed.

The heaters should be capable of heating and maintaining the flushing fluid temperature to 60°C.

The filters may be of the cleanable or disposable element type. Cleanable elements may be preferred for larger systems.



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Ident.nr: 3004137

Duplex filters are preferred as they permit the change over to a clean element without interrupting the flushing procedure. The filter should incorporate clogging indicators, preferably incorporating an audible alarm. An automatic filter bypass is not preferred. The filter size should be selected to pass the specified pump delivery at a low pressure drop, depending upon the type and should have a generous dirt-holding capacity.

Flushing velocity and temperature

To ensure the system is flushed as quickly and efficiently as possible, both fluid velocity and temperature should be as high as conveniently possible. A reasonable temperature limit for mineral oils is 60°C, for water-in-oil emulsions and water-glycols it is 50°C and higher temperatures are acceptable for silicone and some other synthetic hydraulic fluids. The fluid velocity should preferably be at least twice the rated velocity of the system and in the turbulent region at all point in the system.

Flushing fluid

The flushing fluid must be compatible with the fluid specified for the system and the system materials, especially the seals. Hydraulic oil, rust inhibited oils of lower viscosity, or special flushing oils can be used for flushing. The special flushing oils which are suitable refined distillates with good solvency power and containing rust inhibitors and additives are used for the removal of system contaminations such as rust preventative compounds and sludges.

Flushing oils containing petroleum solvents such as kerosene or non-petroleum solvents such as carbon tetrachloride and solutions containing water, caustic compounds or other active materials must not be used for flushing.

The fluid should preferably have rust inhabiting and de-watering properties. The fluid specified for the system may be used as the flushing fluid but a flushing fluid of lower viscosity would permit the attainment of turbulent flow at a lower velocity or temperature.

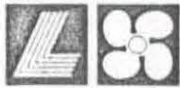
Flushing procedure

With the system prepared as described, fill the system by feeding the fluid to the flushing rig so that the fluid is filtered before entering the system. New oil is often dirty by hydraulic standards.

Circulate the flushing fluid and bleed the system to remove trapped air. Heat the fluid to a temperature as described before.

Flush the system for a period, say half an hour, changing the filter element as required by the operation of the filter clogging indicator or as indicated by the filter pressure drop. It is then an advantage to reverse the flow through the system by interchanging the supply and return lines from the flushing rig.

Continue flushing, reversing the flow periodically, until the system operates for several hours without the filter clogging indicator operating or the limited pressure drop being reached.



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Take fluid samples as required and check that the desired degree of cleanliness has been attained.

If the system comprises several loops, change the flushing rig connections to another loop and repeat the above procedure.

When the system has attained the required degree of cleanliness drain the system, uncouple the flushing rig and remove the bypass pipes. Examine the exposed openings and if any section is found to be unsatisfactory it should be removed for separated cleaning or replacement, and the flushing procedure should then be repeated.

If the flushing fluid is of a lower viscosity than the specified system fluid, check that the reduced viscosity is acceptable to the pumps. If not, reduce the fluid temperature until an acceptable viscosity is attained or change to the specified system fluid.

Complete the assembly of the system by fitting the pumps, cylinders, filter elements and any valves which were bypassed. Refill the system with pre-filtered flushing fluid, preferably new, and repeat the flushing procedure using the system pumps, venting the system to removed trapped air, with special attention being paid to dead-ends.

Operate all valves all valves so that the actuators move through their full travel and continue the flushing procedure until the system operates for several hours without the filter clogging indicator operating, if fitted. Take fluid samples and check that the required degree of cleanliness has been attained.

After completion of the flushing procedure, drain the system and leave the drains open for about half an hour. Examine the reservoir and clean if necessary.

Displacement of oil, if required, should be charged to the system immediately after removal of the flushing oil. Delay may result in rusting of the newly cleaned surfaces.

Displacement oil

When hydraulic oils is used for flushing no displacement oil is required.

If a very light oil is used for flushing or if are quantities of special flushing oil left in the system a displacement oil should be used. Another reason for the use of displacement oil is to remove flushing oil that is highly contaminated with oil soluble materials. Displacement oil should be compatible with and approximately the same viscosity as the operating charge to be installed.

Clean filters and replace all filter elements, pump the displacement oil into the system as soon as possible. Start the pumps, heat the oil to 50°-60°C and continue circulation of the oil until the filters shows no evidence of contamination and then allow to cool. The displacement oil should be pumped out, the pumps and tanks should be cleaned and a final inspection made. System is now ready for new oil.

New system oil

A new charge of hydraulic oil should be installed in the system as soon as possible. The charge should be introduced through filters before circulation. The oil should then be circulated and the equipment operated so that the cleaned



LIPS THRUSTERS DRUNEN B.V.

Ident.nr: 3004137

surfaces will be properly protected.

Except under unusual circumstances, such as major repair or overhaul, hydraulic systems in use are not flushed. Only by a complete inspection of the system and analysis of the oil can the necessity for flushing be determined.

Contamination in service

For fresh water contamination, the operation of a purifiers is usually sufficient to remove contaminations.

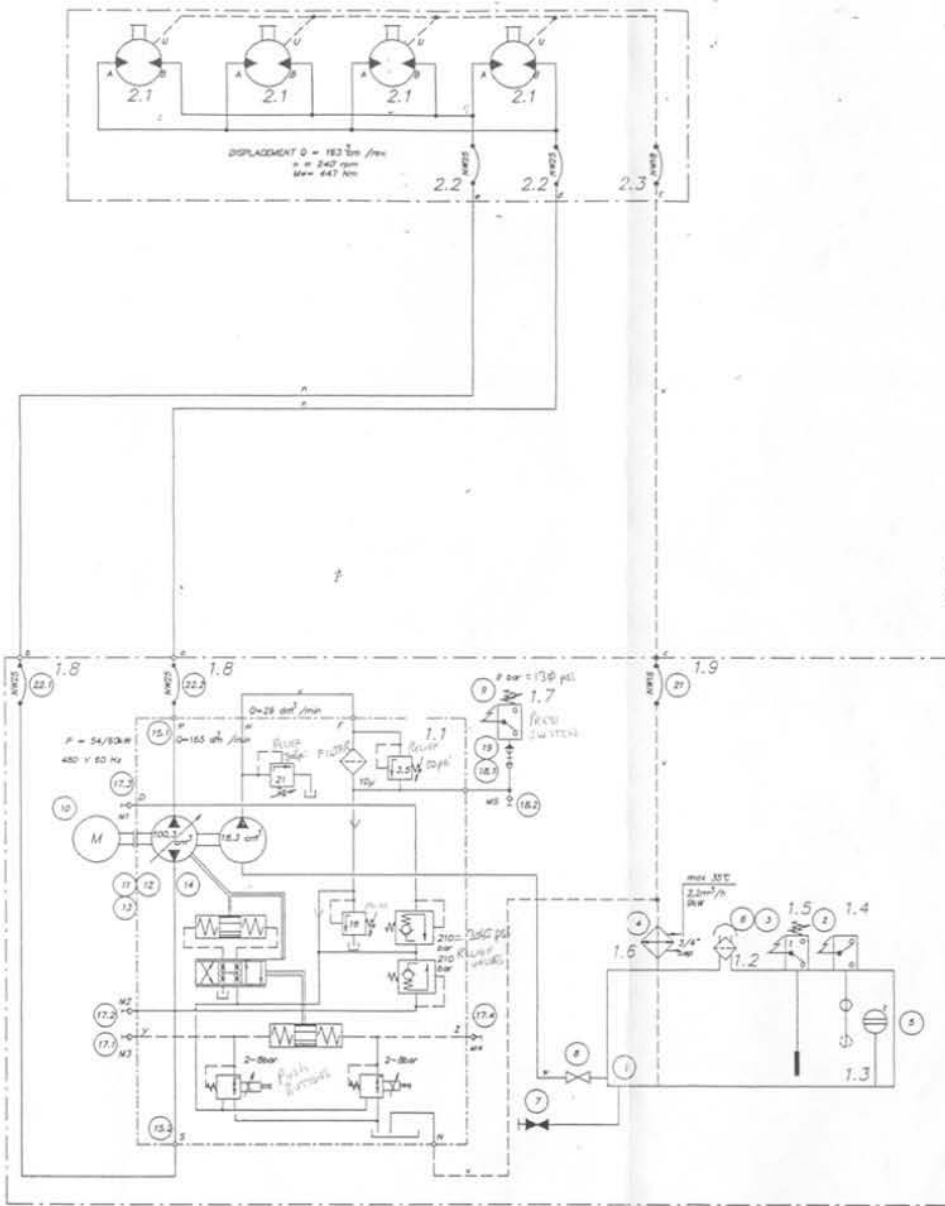
In case of severe sea water contamination or contamination with harmful foreign material, it may be necessary to remove the operating oil and clean and flush the system.

In case of minor contamination applicable portions of the flushing procedure should be followed.

In cases of severe contamination -not including sea water- the whole of the flushing procedure should be followed.

Modifications of flushing time and circulation temperature should be made depending upon the circumstances of the contamination.

Sea water contamination requires a very special procedure for handling. After removal of excess salt water, corrosion inhibitors specifically developed for this type of contamination must be used in the system. Careful cleaning procedures must be followed to obtain a satisfactory condition in the hydraulic system. Following this the whole of the flushing procedure should be followed.



Part No.	Description	Material
20 2	AD HOSE l _g =800	4SP25 B505-800
21 1	LD HOSE l _g =450	15TRH A8A405-450
20		
19 1	PRESSURE GAUGE COUR.	686308
18 2	MEASURING POINT # 2	6M226
17 4	MEASURING POINT R 1/4	686205
18		
15 2	PRESSURE SUCTION FLANGE	QF5.102-0-M
14 1	PISTON PUMP	80V 100R EV 2W5C
13 1	BRACKET	08201-2-801
12 1	FLEX COUPLING	A4800-M-Q78
11 1	BELL HOUSING / FLANGE	PFX430/7/3 - B4200188
10 3	E-MOTOR 355TC	54,76KW 1750RPM 48V 80kg 35w
9 1	PRESSURE SWITCH	0500-80
8 1	BALL VALVE	BV08B 1/2"sp
7 1	BALL VALVE	BV08B 1/2"sp
6 1	FILLERCAP C/W DISATCH	A8B-42V
5 1	OVERWATER/OIL GAUGE	LOST
4 1	COOLER	BOF-201-2-0-4
3 1	TEMP. SWITCH	DMS/28/1 40-100°C
2 1	LEVEL SWITCH	L01800 01 807
1 1	TANK 100 dm ³	08201-1-401

Part No.	Description	Material
100		

Customer: "AGOR NOAA"

HYDRAULIC DIAGRAM

LIPS THRUSTERS DRUNEN B.V.

Drawn: AJR	Desk: 051294	Scale:	Sheet: A1
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Rev.	Date	Checked	Date	Description	Drawing No.	Rev.
0					3004327	

LIPS THRUSTERS CAD CENTER

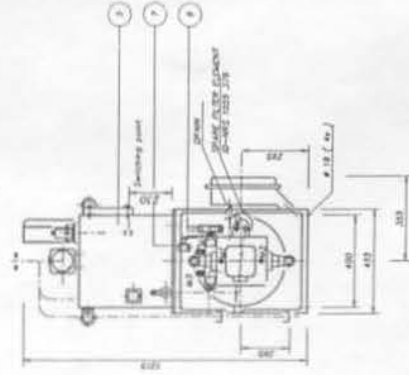
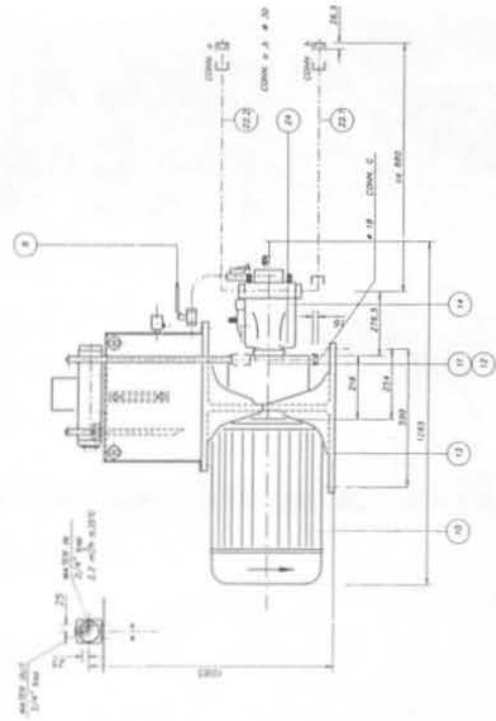
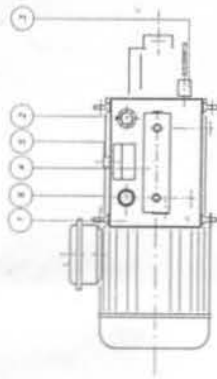
TITLE : HYDRAULIC SYSTEM
TYPE : T07300/01
LIST : T073010070

PAGE : 1
DRAWING : 3004327
ORDERNO.: T07300/01

ITEMNO.	N A M E	PARTNO.	QUANTITY
1	HYDRAULIC POWER PACK	T003004329	1,0

NOTES : - ITEM NUMBERS NOT LISTED HAVE NOT BEEN USED IN THIS INSTALL.
- THE QUANTITIES AND PARTNUMBERS SHOWN ON THE PARTS LIST
ARE BELIEVED TO BE CORRECT, THE QUANTITIES SHOWN ON THE
DRAWING ARE FOR ILLUSTRATION ONLY

E N D O F L I S T



AGOR NOAA
HYDRAULIC POWER PACK
STEERING SYSTEM



Part No.	021284	Rev.	E1/D	Rev.	A1
Drawn		Checked		Approved	
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Drawing No. 3004329					
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