Trigones - CFEM. BNo. T1

Form No 409 a

DET NORSKE VERITAS

SURVEY REPORT

Ship	Signal letters
Builders	Yard No.
Owners	Port of Registry

4 off SYNCHRONOUS ALTERNATORS

At the request of A/S Norsk Elektrisk & Brown Boveri, Oslo, the undersigned has surveyed and tested:

4 off synchronous alternators, type WAB 1240 D 6, 1442 KW, 2060 KVA, 600 V, cos Ø 0,7, 1982A, 1200 RPM, 60 p/s No. K 138522/23/24/25

Heat test, overload tests, voltage tests and insulation test were carried out.

The results are in accordance with attached test report dated 10.10.1975 and satisfy Det norske Veritas' requirements.

The alternators were stamped:

No. K 138522 NV 1.10.75 AL OSL
No. K 138523 NV 6.10.75 AL OSL
No. K 138524 NV 7.10.75 AL OSL
No. K 138525 NV 3.10.75 AL OSL

The alternator shafts are made of material tested to Rules and were stamped:

NV 4059 1-2-3-4

TO BE FORWARDED FOR THE USE OF THE SURVEYOR WHO ATTENDS TO THE ASSEMBLY OR FITTING ON BOARD

The following notation is to be made in the Register Book:*)

.....

Place. Oslo

7th October 1975

COPY OF THIS REPORT

for the Ship handed/sent to

for the Owners handed/sent to

DET NORSKE VERITAS OSLO DISTRIKT

Surveyor

NV 20.000 5.68

*) To be answered by the surveyor if a notation shall be made

NEBB
BROWN BOVERI

ALTERNATOR CERTIFICATE

Yard: TRIGONES - CFEM Hull no: T1

The delivery includes	4	pc(s). alternator(s), type	WAB 1240 D.6			no. K:	138522-25
2060	kVA	600	Volt	cosφ	0,7	1982	Amp.
1200	r/min	60	Hz				
4 pc(s). equipment(s) for excitation and voltage regulation.							
Type	S3bI - 3Z						

1 Temperature rise test

The alternator is in accordance with the specification tested at 1/1 load, cosφ=0,8 and 60 Hz

until stable temperature is reached. The temperatures are dertermined by resistancemeasurement R and thermometer T.

The following overtemperatures have been reached:

Alternator no.	K 138522	K 138523	K 138524-25
Armature winding (R)	46,8	46,8	46,8
Excitation winding (R)	56	56	56
Slip rings (T)	34	34	34
Air (T)	31,2	31,2	31,2
Insulation test M.ohm	200	200	200

Armature-resistance at 22,3 °C before temperature rise test 0,000892 ohm.

Armature-resistance after temperature rise test *) ohm.

Rotor-resistance at 22,3 °C before temperature rise test 0,3930 ohm.

Rotor-resistance after temperature rise test 0,4821 ohm.

All windings and high voltage parts have been megged with a 1000 Volts megger.

The windings have class F insulation.

2 Over load is not carried out.

The alternator has been tested with 150 % of rated current for 2 minutes,

at rated voltage and rated speed, cosφ = 0,6

3 High voltage test

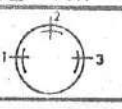
The windings of the alternator are high voltage tested, each phase against the other two and frame, with 2000 Volt for 1 minute.

The exitation winding is tested with 2000 Volt for 1 minute.

4 Excitation

No - load:	30 Volt	65 Amp.
Full - load:	82 Volt	168 Amp.

Alternator air gap:



1. 8,8 mm 2. 8,8 mm 3. 8,8 mm

Installation Instruction

for

Marine Alternator type WAB

The installation instruction should be carefully written before the mounting is started.

NEBB
AKTIESELSKAPET
NORSK ELEKTRISK & BROWN BOVERI
OSLO

NEBB	Marine alternators type WAB with shaft flange 1 pedestal bearing Installation instructions	NM 402720 E

IT IS NECESSARY THAT THESE INSTRUCTIONS ARE AT HAND AT THE PLACE OF MOUNTING, AND THE COMPLETE INSTRUCTION SHOULD BE CAREFULLY READ BEFORE MOUNTING.

CONTENTS:

29.9.1971	Changed:	
Sett:		

5 No-load and short-circuit

U_o - Volt	I_f - Amp.	I_o - Amp.	I_f -Amp.
300	29,0	1982	76,8
400	39,4	1500	57,6
540	54,6	1000	38,4
600	62,4	500	18,8
660	70,8		
720	85,8		

6 Overspeed test

The alternators have been sustained in their own bearings for 2 minutes at 1,25 times the rated speed.

7 Balancing

The rotating parts of the alternator are well balanced at all rated speeds. See VDI 2060 and DIN 45665.

8 Lubrication

The lubrication of the bearings is effective at all speeds.

Grease and oil are not admitted to the windings of the alternator.

9 Shaft current

re are not induced harmful shaft currents of a degree which could cause damage to the bearings in the alternator or the auxiliary machinery.

10 Inspection

The alternators are inspectied under production and on the test - bed by: Det norske Veritas.

The alternator shaft is stamped with NV. Osl. 4059-1-2-3-4. 11.4.75 WF.

The alternator housing is stamped with NV: Osl. AL. 1.10. 6.10. 7.10. 3.10.75

O. no: 445.301 Oslo, 10.10.75

Comments: *) Heating test is in accordance with the specification IEEE. No. 115.

DET NORSKE VERITAS OSLO DISTRIKT 7/10 75

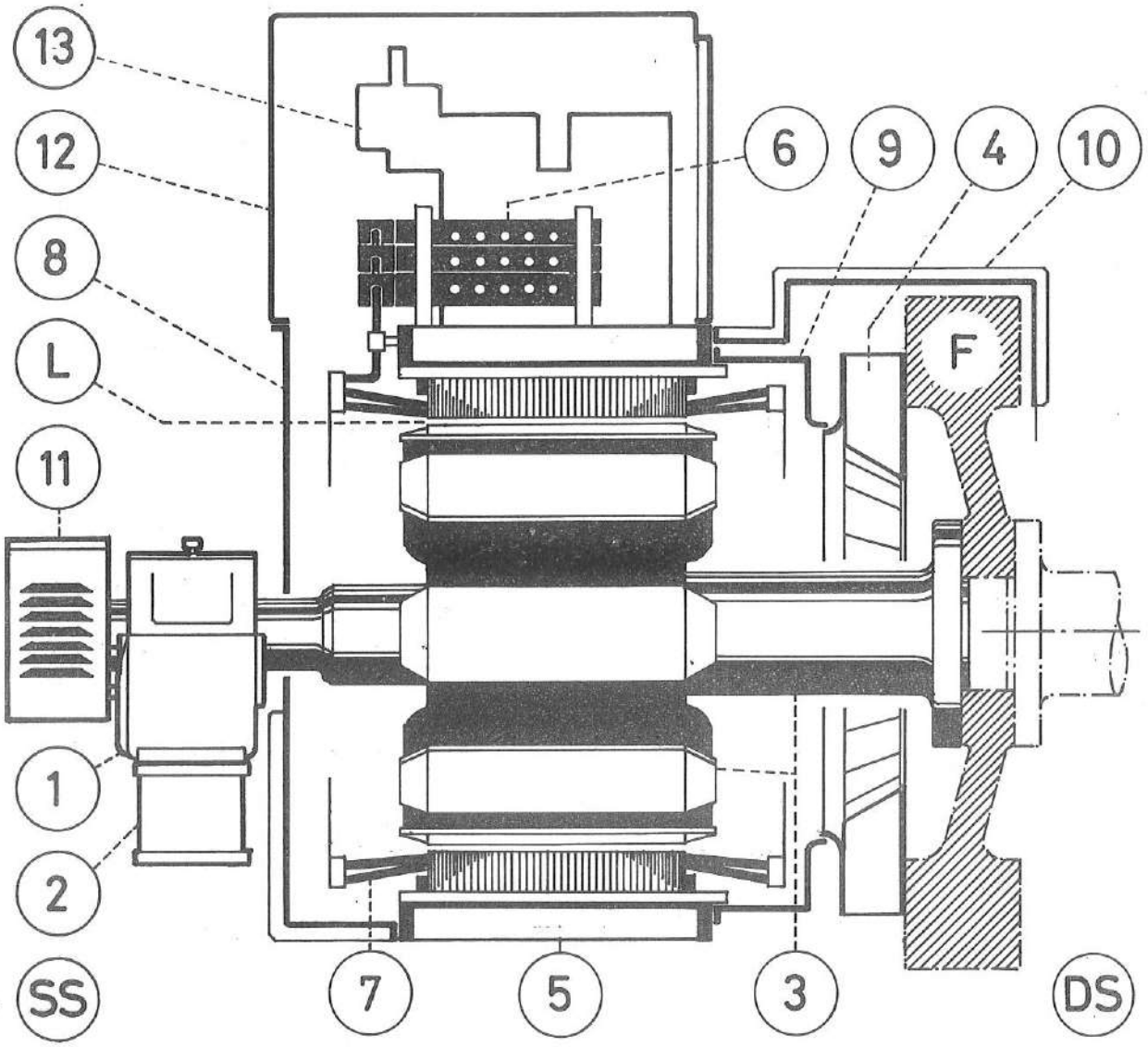
Group leader - Marine Section R. Lønnkvist

Department Head

NEBB

Marine alternator type WAB with shaft flange - 1 pedestal bearing
General index of alternator.

NM 402702 E



DS = Driving end
SS = Slipring end
F = Flywheel of Diesel
1 = bearing housing (split)
2 = Pedestal
3 = Rotor
4 = Fan (split)
5 = Stator
6 = Stator terminals
7 = Stator winding
8 = Shield ss (3 parts)
9 = Air deflector (split)
10 = Shield (split)
11 = Slipring housing
12 = Top canopy
13 = Regulator

29.9.1971	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Mounting of stator and positioning of rotor

NM 402706 E

Stator feet and bedplate must be cleaned and free of metal swarf etc.

The alternator to be placed on the bedplate so that the winding ends (i.e. the connections between the windings and terminal box) are facing away from the driving side.

Place pressboard or similar in the stator core. This protects the core when the rotor is lifted into the stator.

The lifting loops must not touch the stator winding nor have direct contact on the shaft. It is especially important that the bearing seats are not damaged. Take great care, and observe that the rotor is held quite steady when changing holds.

Should circumstances with regard to room and lifting require insertion of the rotor in the stator before the stator has been placed upon the bedplate, the transport of stator/rotor to the bedplate must be executed very carefully.

ALTERNATORS WITH 2 SHIELD BEARINGS:

These machines are delivered fully mounted from NEBB, and have only to be aligned in relation to the driving engine. The stator to be finally secured.

ALTERNATORS DESIGNED WITH 1 SHIELD BEARING:

Before proceeding we recommend locating the rotor in the flywheel lifted by a crane inside the bearing place.
Correct height of shaft at bearing place is indicated by the crank webs of the diesel's crankshaft.
The stator is built up until correct air gap between rotor and stator is present, and then temporarily fastened.
The bearing is built up under the shaft.
In this way one will get the alternator in almost the correct position. Control and alignment is made from this position.
Both pedestal bearing and stator to be finally secured.

ALTERNATORS DESIGNED FOR 1 OR 2 PEDESTALS:

Rotor/bearing to be fully aligned and controlled.
Pedestal bearing to be secured.
The stator is aligned, controlled and secured with rotor as base (that by correct air gap).
Mounting/de-mounting requires a certain height between alternator shaft's centre and bedplate. Bearings are therefore normally mounted on a pedestal and the junction between the bearing and bearing pedestal is fully secured by NEBB.

29.9.1971	Changed:	
Sett:		

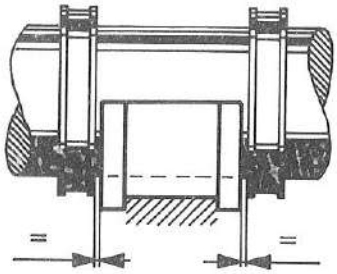
NEBB

Marine alternator type WAB
Axial location of the bearing.

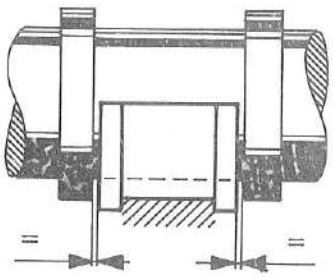
NM 402716 E

BEARING WITH RING OIL LUB.	BEARING WITH FLUSHING OIL LUB.

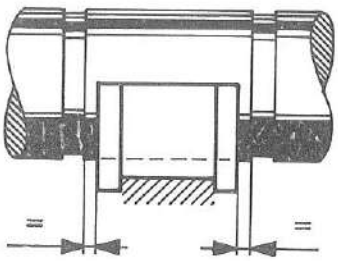
Thrust bearing



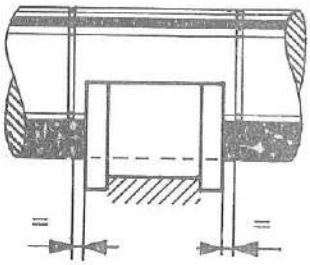
Thrust bearing



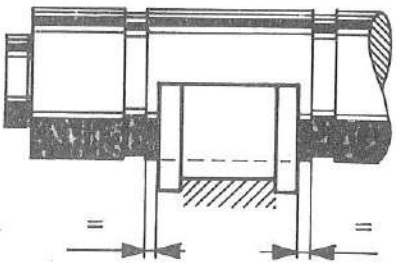
Support bearing (driving side)



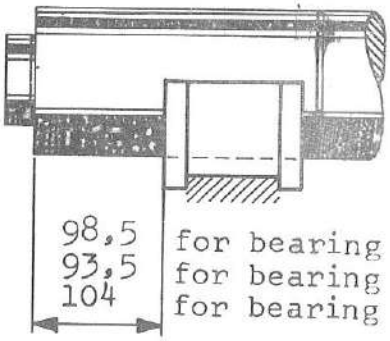
Support bearing (driving side)



Support bearing (slip ring side)



Support bearing (slip ring side)



for bearing ø 95
for bearing ø125
for bearing ø140

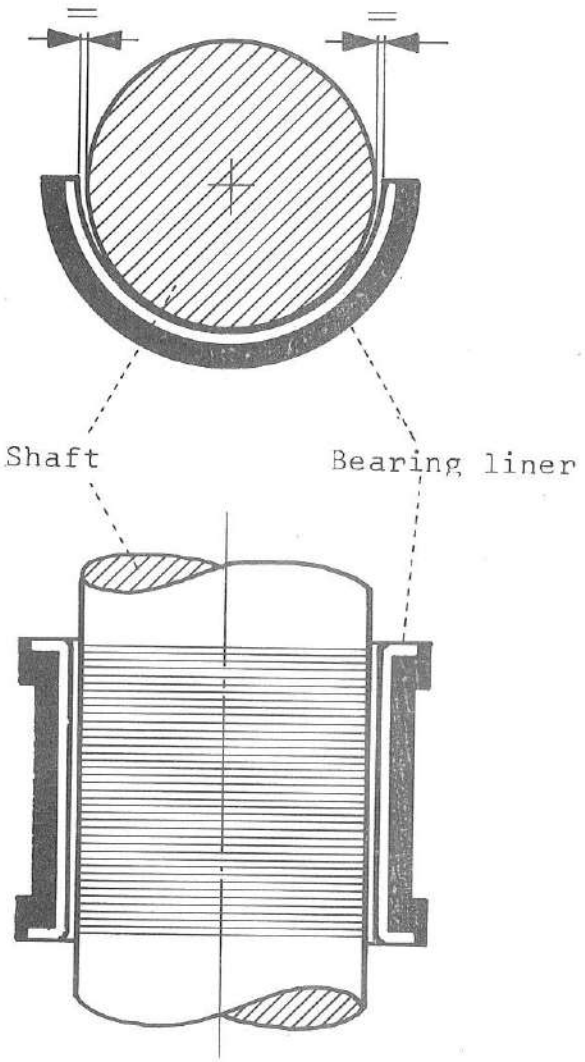
29.9.1971	Changed: 22.2.1972	
Sett:		

NEBB

Marine alternator type WAB
Alignment of bearing

NM 402704 E

Positioning by feelers



Apply Colour to shaft

The bearing's fixing screws have to be carefully fastened before alignment!

The parallel position of the bearings in relation to the shaft should be checked with a feeler at all 4 corners between shaft and bearing liner, and also by applying colour to the shaft. When the shaft is turned, the colour shall be worn off uniformly over the whole length of the bearing liner.

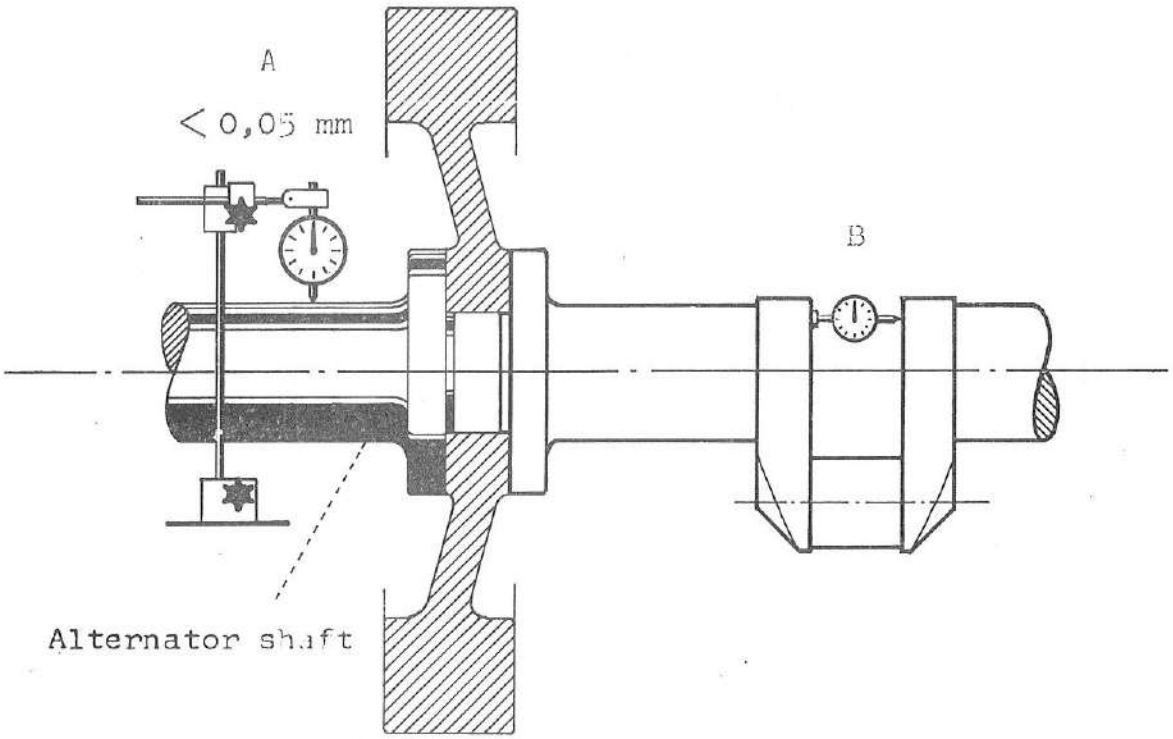
The bearing liner has been machined ready for use, and shall normally not be scraped. Parallelism with the shaft is obtained by aligning the bearing housing.

29.9.1971	Changed:	
Sett:		

NEBB

Marine alternator type WAB with shaft flange - 1 bearing
Alignment of shaft

NM 402705 E



In order to have sufficient margin for fine adjustment the alignment should be based on keeping the permissible deviation as close to 0 as possible.

A: Distortion clock to be placed against the alternator shaft in order to check radial distortion.
Max. permissible radial distortion = 0,05 mm.

B: Indication clock to be placed between the crank webs of the diesel's crankshaft in crank casing for cylinder nearest alternator.
By turning, the distortion of the clock at bottom is compared to that at the top. The distortion indicates the height of the alternator bearing.

In the same way the alternator's position sideways is checked by comparing the distortion of clock at both side positions.

Diesel manufacturer's instruction for max. and min. distance between the crank webs must be carefully observed!

Avoid mounting the alternator bearing too high as this might lead to over-load of the bearing.

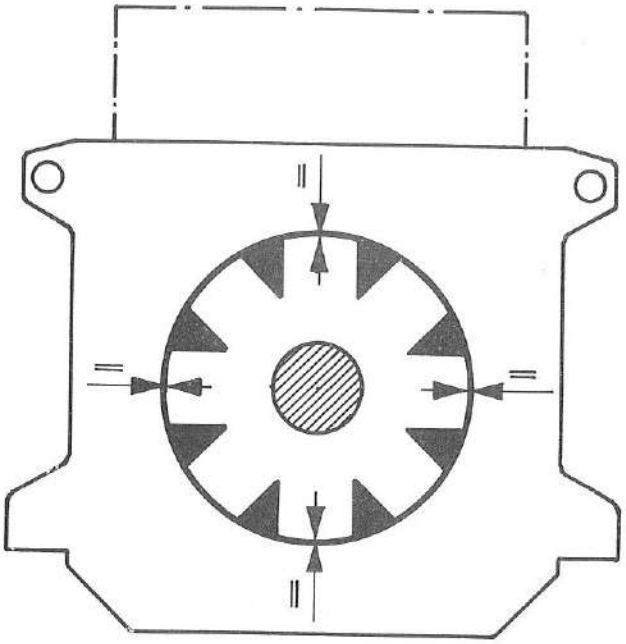
29.9.1971	Changed:	
Sett:		

NEBB

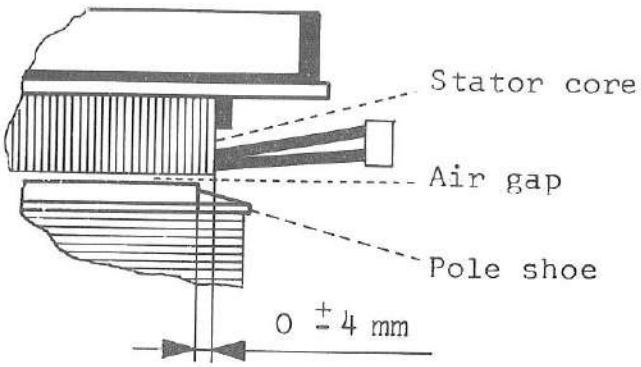
Marine Alternator type WAB
Checking of air gap between stator and rotor

NM 402709E

A



B



A: Air gap between stator core and pole shoe must be constant through the core, and alike at the top, bottom and at both sides. Bedplate bolts for stator are fastened before checking by long feeler through the very core (not necessary for alternators designed for 2 shield bearings).

Max. permissible deviation = 0,4 mm.

B: Axially the pole shoe shall lay in the middle of the stator's core, i.e. that edge down to trapped ridge at pole shoe is even with the end of stator core.
Max. permissible deviation = ± 4 mm.

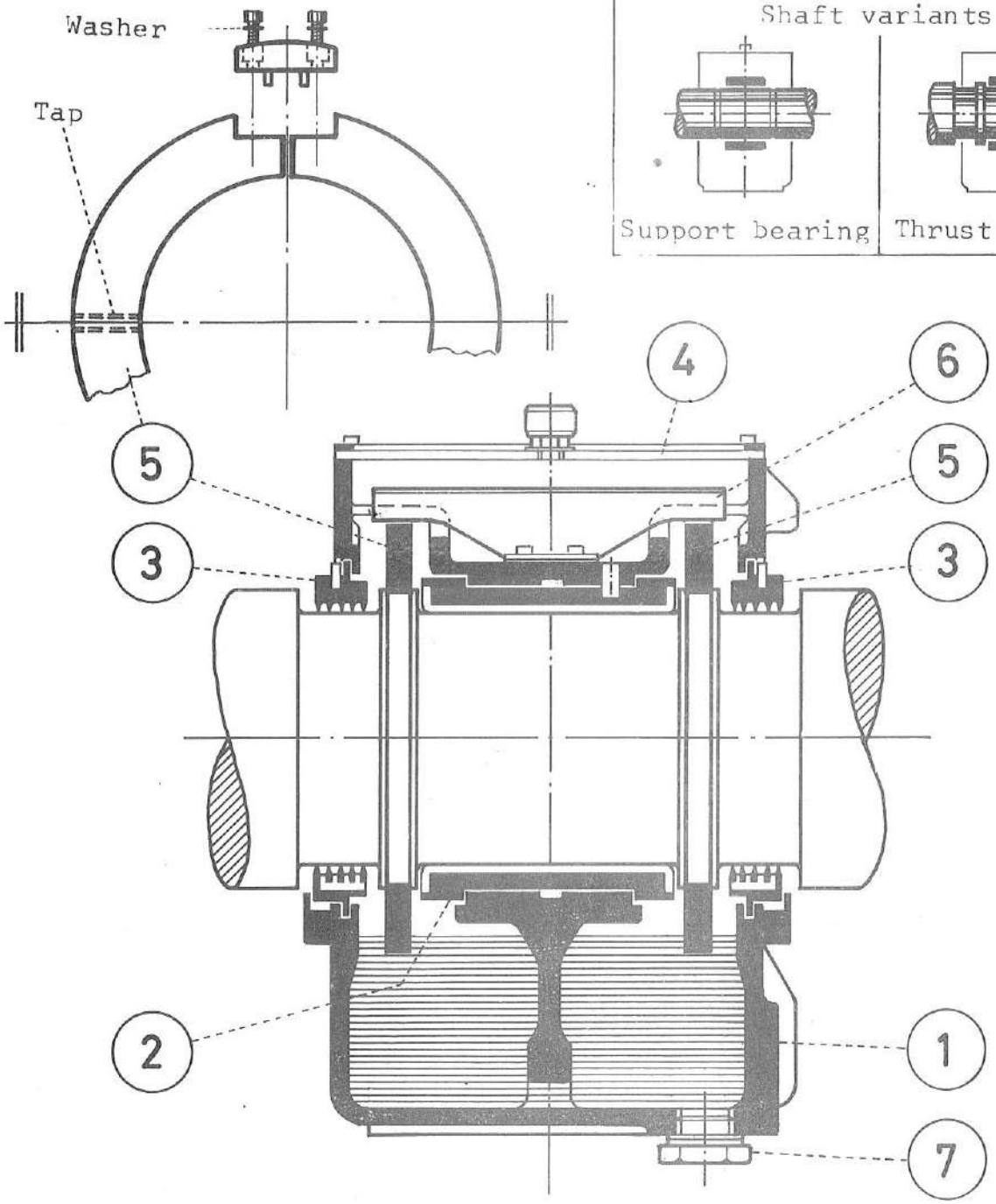
The stator is secured on the bedplate.

29.9.1971	Changed:	
Sett:		

NEBB

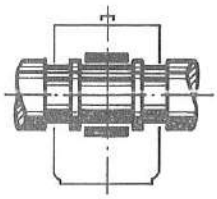
Marine alternator type WAB
Cut through bearing with oil ring lubrication

NM 402712 E



Shaft variants

Support bearing



Thrust bearing

1 = Pedestal bearing (split)
2 = Bearing liner (split)
3 = Scraper (split)
4 = Top cover
5 = Lubrication ring (split)
6 = Oil scraper
7 = Bottom plug

29.9.1971	Changed:	
Sett:		

NEBB

Marine alternator type WAB
Final mounting of bearing with oil ring lubrication

NM 402 713 E

When the lower part of the pedestal bearing is aligned and secured at bedplate, the final mounting of bearing may take place.

All bearing parts must be cleaned. Apply some oil to the bearing part of the shaft.

Please note carefully that the marking of the bearing liner halves are correct and are lying the same way. The bearing liner is lying the right way when the hole in the top of the upper liner corresponds with the guide pin in the bearing housing's upper part.
See drawing NM 402712.

Split lubrication rings are mounted in the guiding ways at the shaft. Observe the marking of the junction elements. Lubrication rings are locked onto the shaft by means of taps (screws). Fasten all screws properly.

The bearing is fitted with split scrapers of bronze. Upper and lower parts have been marked with same number. Apply a little oil onto the shaft. Drained lower part is pushed down into way at the end of the bearing housing.

If the ring is narrow the shaft may be lifted a little. Use Permatex sealing compound in division joints and screw the ring halves togheter. Any noise from the scrapers during driving will disappear after a short time.

Oil is filled in the bearing up to mark.
Oil viscocity is indicated on a sign at the bearing housing.

Permatex to be put into the joints of the bearing housing. Upper half is placed in position. Observe that guiding pin for bearing liner and guiding pin for scrapers enter. Location pins in junction are put in and fixing bolts are fastened.

Oil scraper is mounted and aligned to minimum radial clearance between scraper and lubrication rings. Observe that oil scraper is mounted according to the alternator's sense of rotation.

Permatex is put onto the top flat of the bearing housing before the top cover with ventilation plug is put in position.

Ensure during testing that the oil ring deliver sufficient oil, and that the oil level is in accordance with the marked oil level.

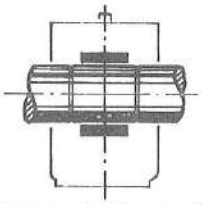
29.9.1971	Changed:	
Sett:		

NEBB

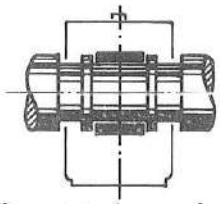
Marine alternator type WAB
Cut through bearing with flushing oil lubrication.

NM 402714 E

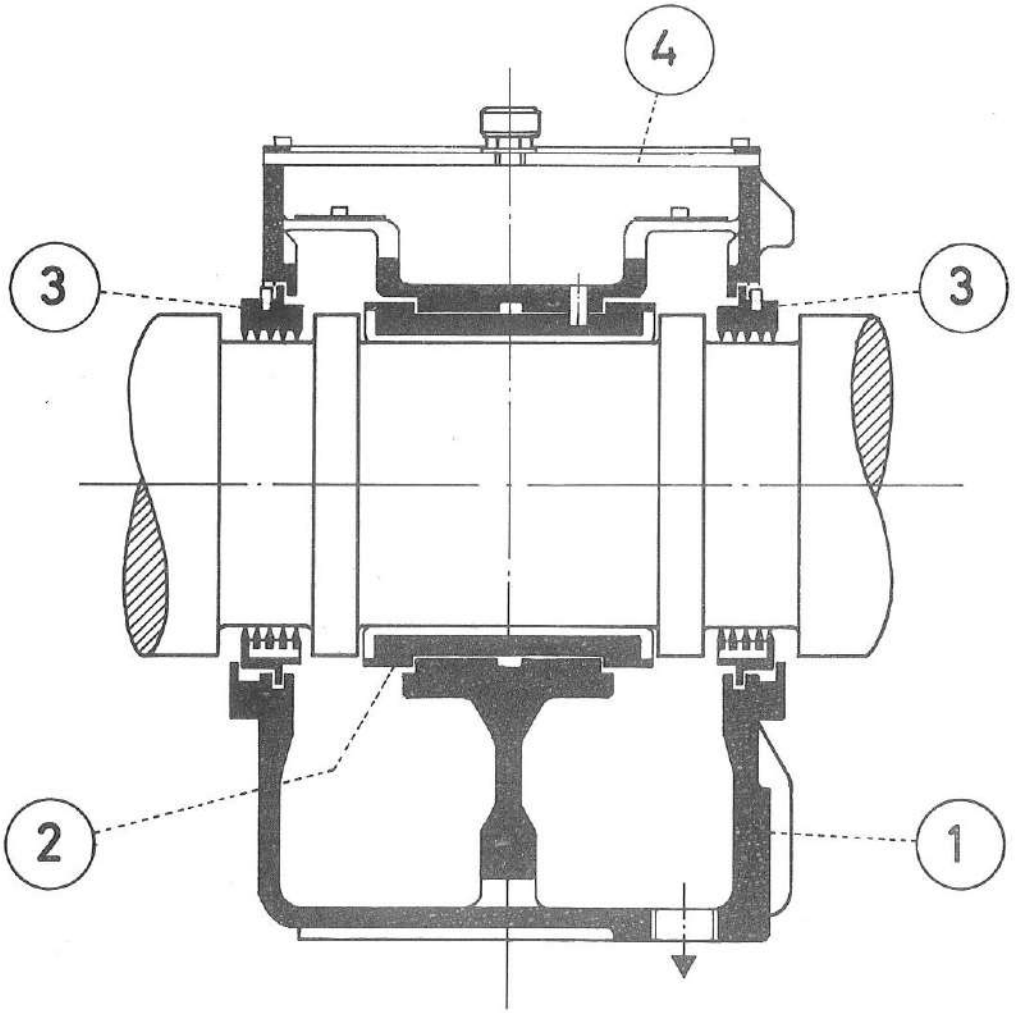
Shaft variants



Support bearing



Thrust bearing



1 = Pedestal bearing (split)
2 = Bearing liner (split)
3 = Scraper (split)
4 = Top cover

29.9.1971	Changed:	
Sett:		

NEBB	NM 402715 E
Marine alternator type WAB Final mounting of bearing with flushing oil lubrication	

When lower part of pedestal bearing is finally aligned and secured the final mounting of the bearing may take place at bedplace.

Bearing parts must be cleaned. Apply a little oil on to the bearing part of the shaft.

Observe that marking of bearing liner halves are correct and are lying the same way. The bearing liner is lying the right way when the hole in top of the upper liner corresponds with the guiding pin of the upper part of the bearing housing. See drawing NM 402714.

The bearing is fitted with split scrapers of bronze.
Upper and lower part are marked with same number.
Apply a little oil to the shaft. Drained lower part is pushed down into way at the end of the bearing housing.
If the ring is narrow the shaft may be lifted a little.
Use Permatex sealing compound onto the joints of the ring and screw the parts together. Any noise from scrapers during driving will disappear after a short time.

Permatex is used on the top flat of the bearing housing before top cover with ventilation plug is put in position.

Oil inlet to be connected on right or left side just below the centre of the bearing.

Oil outlet to be connected at the bottom of the bearing.
Observe that the outlet pipe has sufficient inclination (3 - 5 mm per running meter) and that the pipe contains no water trap or air pockets or narrow passes.

During testing, the oil supply must be set in such a way, that the bearing do not overfill with oil.
Oil viscocity is indicated on a sign at the bearing housing.

29.9.1971	Changed:	
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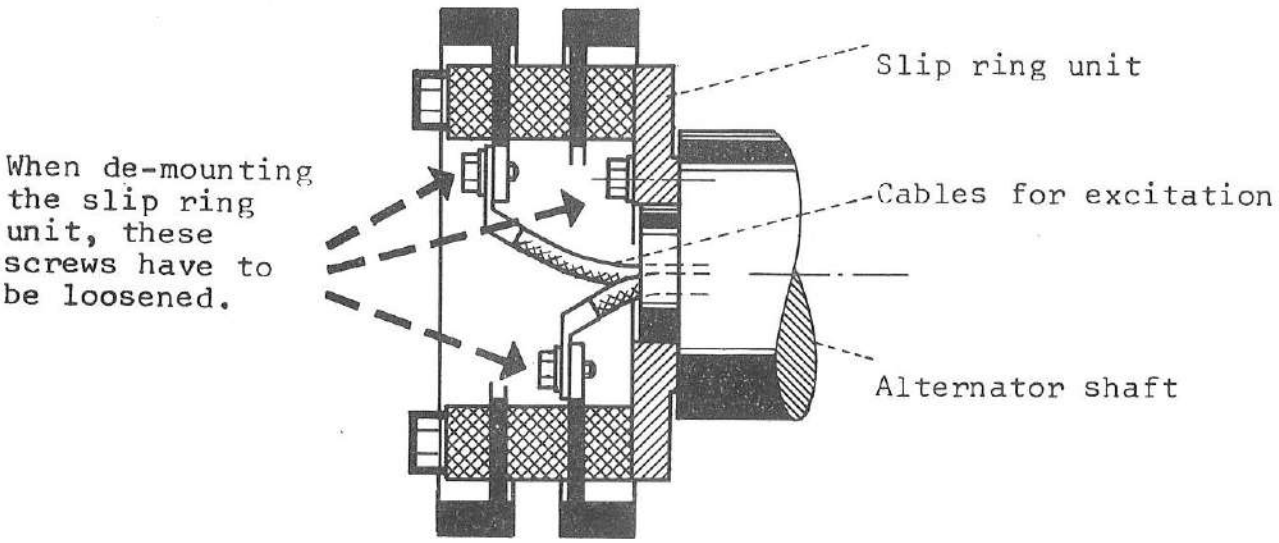
NEBB

Marine alternator type WAB
Building up of slip ring unit

NM 402710 E



Slip ring unit is mounted at the end of the alternator shaft. The slip rings must be given special care during transport and mounting of rotor, so that they are prevented from blows or other mechanical stress.

Should any de-mounting of slip ring unit be absolutely necessary, it should be done as follows:

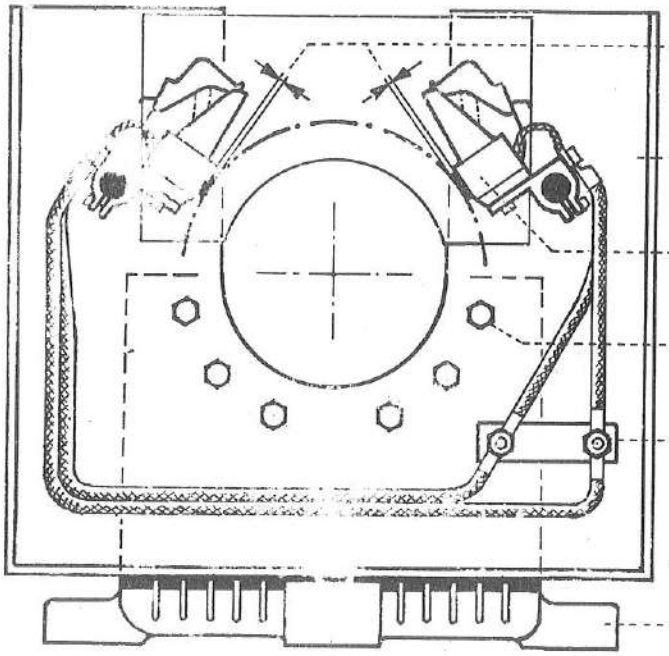
1. Cables for excitation to be loosened.
2. Fixing screws in shaft are loosened.
3. Slip ring unit to be drawn off.

29.9.1971	Changed:	
Sett:		

NEBB

Marine alternator type WAB
Brush device

NM 402717 E



Brush rocker is fastened at the lower part of bearing housing SS (may be de-mounted while alignment is taking place)

Brush holders must be properly fastened and be adjusted axially in such a way that the carbon brushes run in the middle of the slip rings.
Radial clearance between brush holders and slip rings = 1,5 - 2 mm.
Observe that carbon brushes' contact to the slip rings are very carefully polished and that the carbon brushes glide easily in the brush holders.

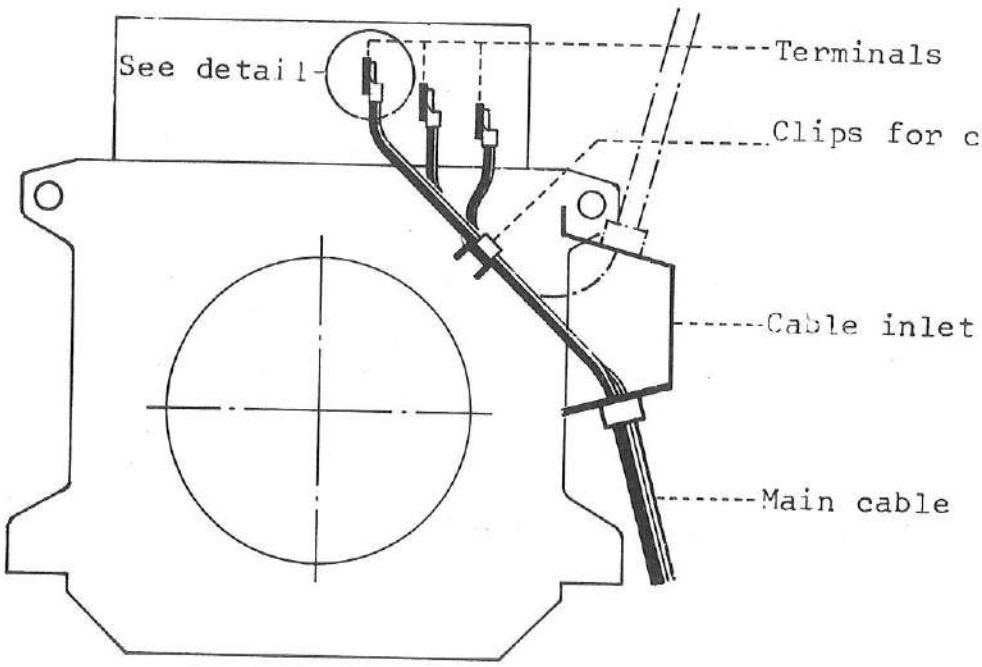
29.9.1971	Changed:	
Sett:		

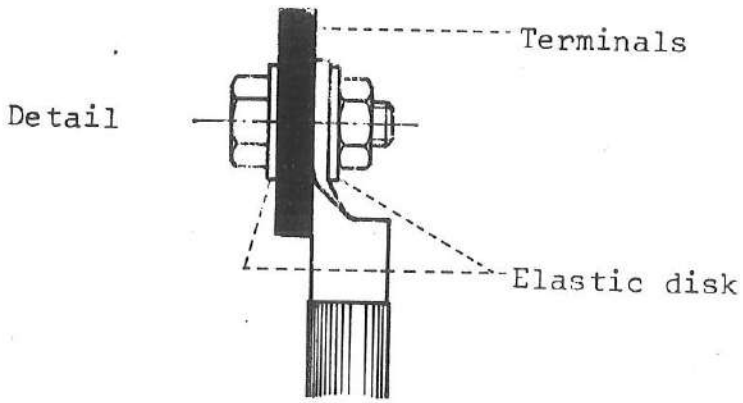
NEBB

Marine alternator type WAB

Cable connection (Main cable)

NM 402711 E





29.9.1971	Changed:	
Sett:		

NEBB	Marine alternator type WAB with 1 pedestal bearing Mounting of various elements.	NM 402724 E

SHIELD SS consists of an upper part and a split lower part.

The two halves of the lower part to be turned in a bit, one by one. The lower parts to be screwed together, then turned further and fastened to stator. Then the upper part is to be mounted.

FAN is split. The halves to be put in position, screwed together and fastened at the flywheel of the driving engine.

AIR DEFLECTOR is split. Lower part to be turned in its position and fastened at stator.

SLIP RING HOUSE to be mounted on the brush rocker.

TOP CANOPY and CABLE INLET to be mounted on stator.

29.9.1971	Changed:	
Sett:		

NEBB

Operation and Maintenance Instruction for Marine Alternator type WAB

NEBB
A/S NORSK ELEKTRISK & BROWN BOVERI
OSLO

IT IS MOST IMPORTANT THAT A REGULAR MAINTENANCE PROGRAMME IS PREPARED FOR THE ALTERNATOR. IN ADDITION TO THE ESSENTIAL MAINTENANCE, PERIODIC CHECKS MUST BE MADE ON THE OTHER COMPONENTS AFFECTING THE SATISFACTORY OPERATION OF THE ALTERNATOR.

ROUTINE INSPECTIONS CAN PREVENT DAMAGE AND BREAKDOWN WHILST THE ALTERNATOR IS IN SERVICE AND A MAINTENANCE SCHEDULE CAN BE EXECUTED ACCORDING TO THE SHIP'S OPERATION.

CONTENTS:

NEBB

Marine Alternator type WAB
Classes of Insulation

NM 402 730 E

The insulation material is divided into classes and these are defined by maximum temperature. The following classes apply to alternators:

insulation class	E	B	F
Max.temperature	120 °C	130 °C	155 °C

The insulation material must not be exposed to temperatures in excess of those stated in the table above.

The permissible temperature rise in the stator and the rotor windings is generally based upon measurement by resistance. Some parts of the alternator will be actually higher than the measured temperature. This has to be taken into consideration, so that : Room temperature + allowed temperature rise does not exceed the maximum temperature for the insulation class.

The respective Classification Societies use different room temperatures as a base in order to determine an allowed temperature rise. The table below indicates the permitted temperature rise in the stator and rotor for the Classification Societies in question.

Class society	Ambient temp.	Temperature rise °C							
		Stator						Rotor	
		Class E		Class B		Class F			
		DP IP23	TE IP23	DP IP23	TE IP23	DP IP23	TE IP23	Class B	ClassF
D.n.V.	45	65		70		90		80	100
L.R.S.	45	65		70		90		80	100
G.L.	45	70		75		95		85	105
B.V.	50	65		75		-		80	-
A.B.S.	50	60	65	70	75	90	95	80	-

D.n.V. = Det norske Veritas
L.R.S. = Lloyds Register of Shipping
G.L. = Germanischer Lloyd
B.V. = Bureau Veritas
A.B.S. = American Bureau of Shipping

For NEBB Marine Alternators the insulation class is indicated on the rating plate.

2.2.1972	Changed·	
Sett:		

NEBB

Marine alternator type WAB
Rotor Winding

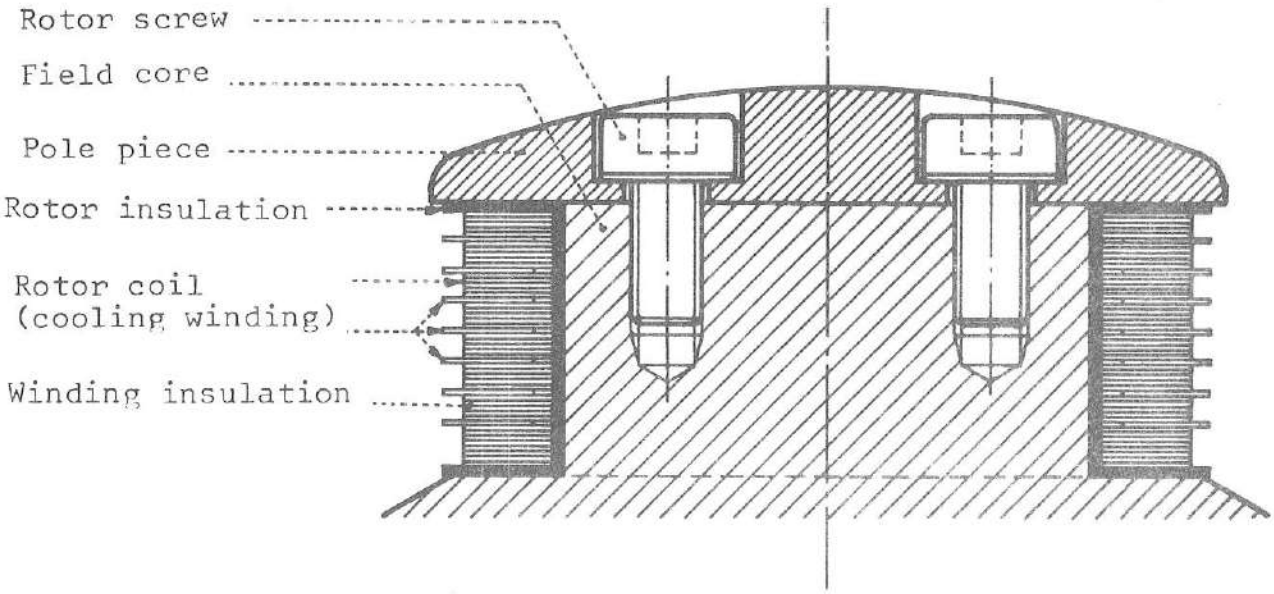
NM 402 731 E

The rotor winding which excites the alternator, consists of coils that are coupled in series and connected to slip rings.

At high speed the rotor winding is subject to large centrifugal forces. The rotor coils of high speed alternators are therefore of necessity secured by supports of non-magnetic material.

The connection cables between the rotor winding and the slip rings are located inside the alternator shaft.

Principal design of rotors and rotor windings:



17.2.1972	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Stator winding

NM 402 744 E

The stator windings of NEBB Marine Alternators are built up in two layers. This is either a coil winding or a bar winding. NEBB Marine Alternators normally incorporate windings of Class B insulation though some NEBB Alternators are also constructed with Class F.
All coils have extra insulation between the phases.

Coil heads are braced by means of supports giving the winding high mechanical strength so that it will be able to withstand vibrations and short circuit power.

The stator winding is open electrically i.e. all the three phases beginning (U-V-W) and ending (X-Y-Z) are brought out.

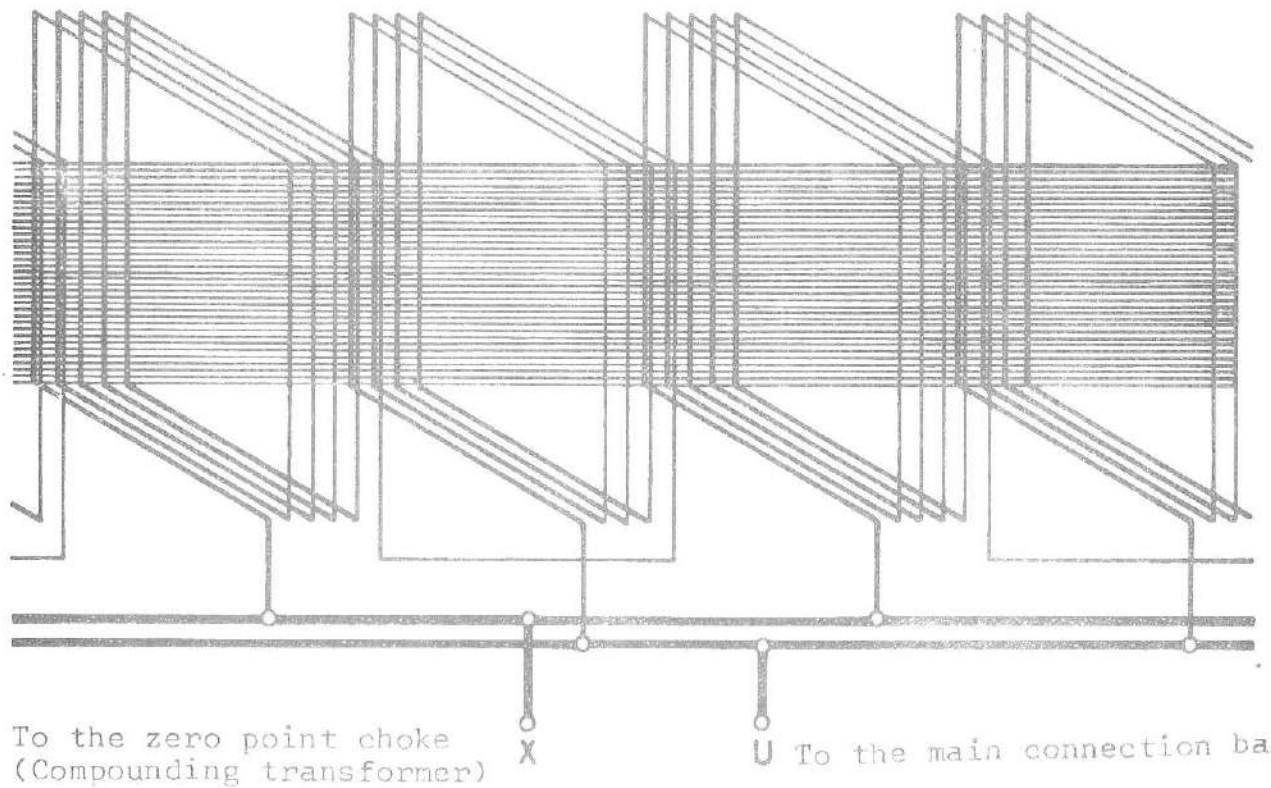
The ends U-V-W are carried forward to connection bars for the outgoing phases R-S-T.
The ends X-Y-Z are carried forward to the zero point choke coil and a short circuit made so that the stator winding is star connected.

The stator winding is flash tested at 2000 volts between each phase and also each phase to earth.

Heating elements are mounted in the coil heads as standard equipment in NEBB Alternators, the heating elements maintaining the temperature at a sufficient level to prevent the absorption of moisture when the alternator is not running.

Resistance elements for temperature measuring and temperature alarm have been installed if specified by the customer.

WINDING ARRANGEMENT SHOWING ONE OF THE THREE PHASES OF A FOUR POLE STATOR WINDING WITH RING CONNECTION.



10.2.1972	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Impregnation

NM 402 732 E

The stator winding and field coils of the NEBB marine alternators are impregnated twice by dipping into oven-hardening varnish. The varnish has a terephtalacid-base, and complies with insulation class F. The impregnation protects against moisture and abrasive substances and gives a smooth surface, making cleaning easier. The varnish fills out all cavities, and thereby increases the heat conducting ability between the copper winding and the sheet metal packet. Further it makes the winding tight.

If by accident damage rises at the winding so that new impregnation is necessary, a varnish which is a non-solvent to the original impregnation must be used.

NEBB should be contacted in the event of serious damage.

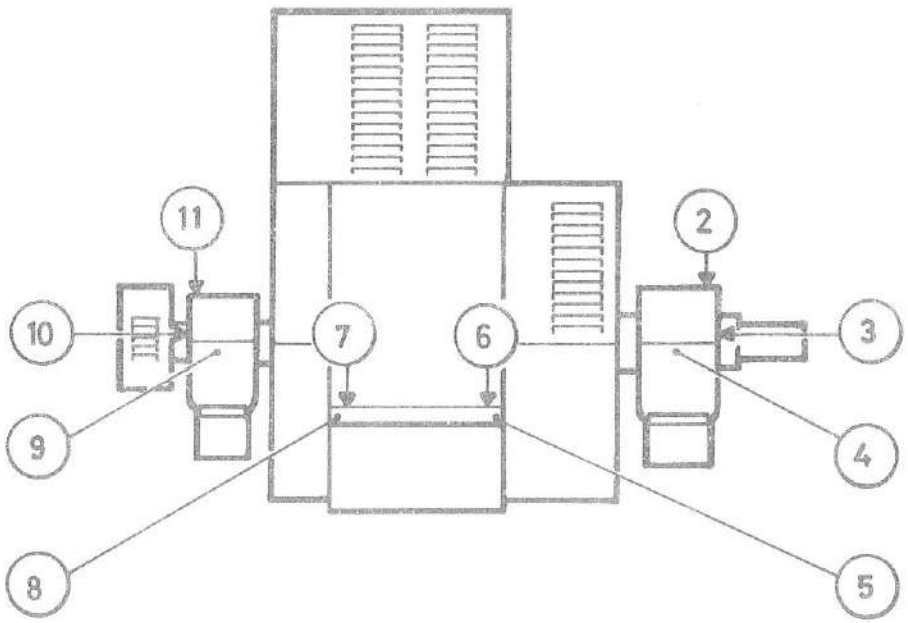
15.3.1972	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Vibration measuring.

NM402733 E

It is most important that vibrations are kept to a minimum. This applies especially to bearings, windings, regulator components and slip ring brushes etc.
The illustration below shows the most important points considered by NEBB as a base for the measurement of vibration.



The following table has been obtained by means of diagram NM 402734. The table indicates the characteristic for the alternator alone where unbalance is the cause of vibration.

ALTERNATOR R.P.M.	VIBRATION AMPLITUDE $\hat{S}$ µM			
	GOOD	USABLE	DOUBTFUL	NOT ACCEPTABLE
428 500 514 600	0 - 60	60 - 160	160 - 400	400
720 750	0 - 50	50 - 125	125 - 315	315
900 1000	0 - 40	40 - 100	100 - 250	250
1200	0 - 30	30 - 80	80 - 200	200
1500	0 - 25	25 - 60	60 - 160	160
1800	0 - 20	20 - 50	50 - 125	125

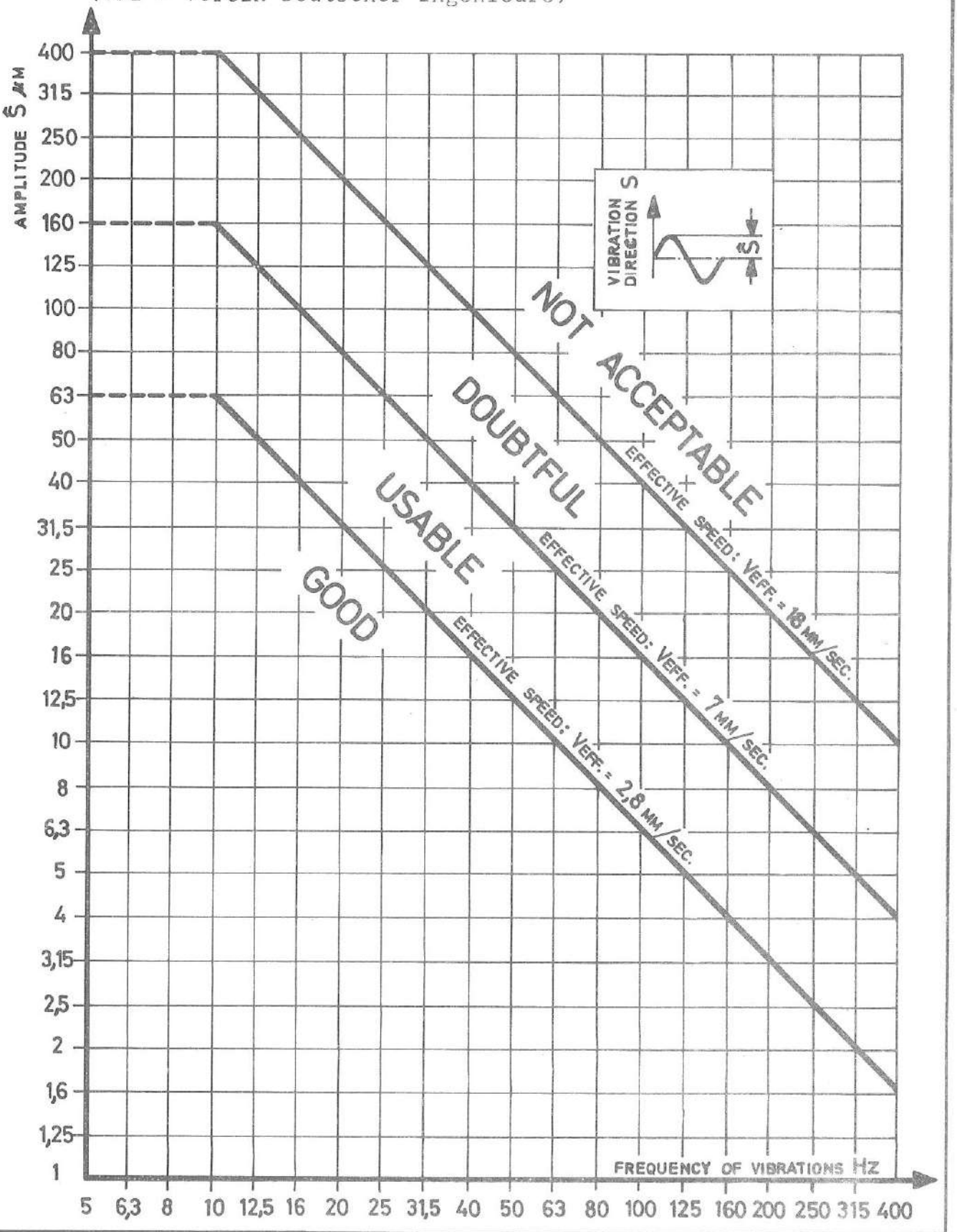
3.2.72	Changed:	
SM		
IS:		

NEBB

Marine Alternator type WAB
Vibration diagram

NM402734 E

The diagram is in accordance with VDI 2056 group T.
(VDI = Verein Deutscher Ingenieure)



28.1.1972	Changed:	
IS:		

NEBB

Marine alternator type WAB
Screw connections, sealings etc.

NM 402 735 E

After the alternator has been run for approx. 3 months, it is most important that all electrical connections and all securing bolts are checked for tightness.

Access to the winding ends and regulating equipment is obtained by removing the side covers of the alternator's top canopy. If necessary the top canopy can be removed.

All control connections, the excitation terminals on the brush rocker and the cable clamps on the brush holders should also be checked for tightness.

As loose screws are sometimes the cause of vibration noise the fan shield and covers must be checked for tightness.

Seals and seal plates around the shaft should reduce the ingress of dirt and moisture.

15.3.1972	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Slip rings and brushes

NM 402 736 E

Bronze Slip rings are built up on insulators on a steel hub. The slip rings' surface should be checked periodically as distortions or inequalities might arise from wear and tear. Radial distortions or surface irregularities should not be more than 0.05 mm.

Slip rings conduct rectifier current and the wear and tear of the negative ring is normally largest. This fact could be compensated by changing polarity of the slip rings. The excitation cables of brush rocker to be changed, and the rotor to be re-polarized by means of battery.

Limited grinding may be undertaken with the sliprings on the shaft. Large distortions or excessive wear and tear necessitate the removal of the slip ring unit and its mounting and turning on a lathe.

The spring pressure on the brushes is related to the carbon quality of the brushes. The normal pressure of the spring is:

For carbon brushes containing metal (CM5H, A12S) 200 - 220 g/cm^2

For electro graphic carbon brushes (EGO) 180 - 200 g/cm^2

It is important that all brushes operate with the same spring pressure with a tolerance of ± 5% so the spring pressure should be checked periodically.

Exceptional operational conditions, e.g. strong vibrations might necessitate heavier brush pressure, but not more than 250 g/cm^2. A heavier brush pressure is gained by reinforced springs in the brush holder. The mechanical wear and tear will increase while the electrical wear and tear will decrease.

Carbon brushes must be changed when 2/3 worn and new brushes must be ground in.

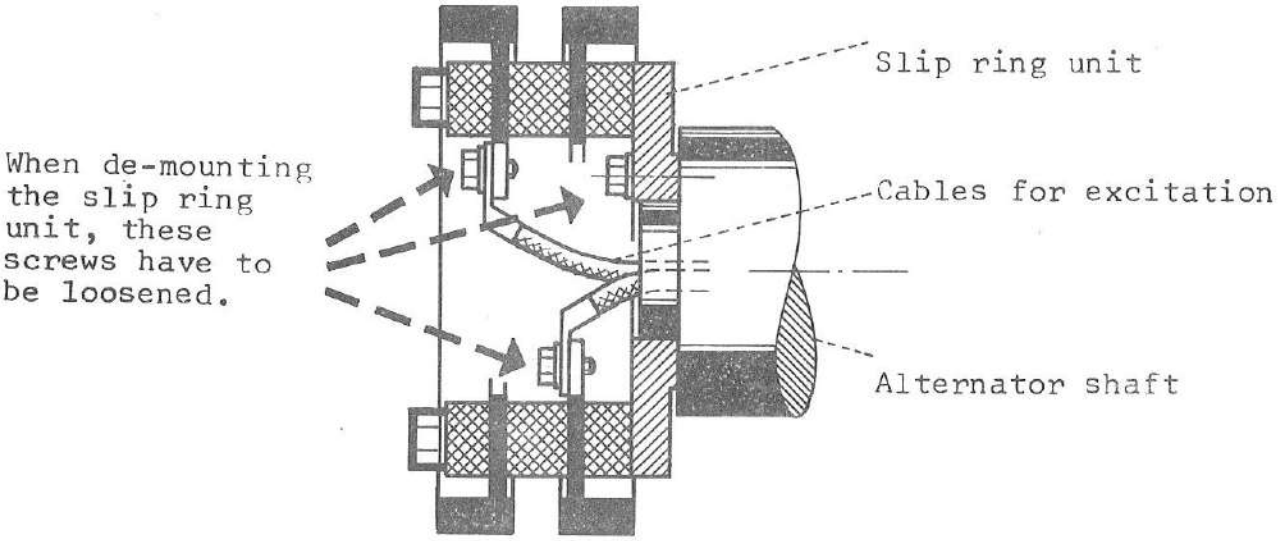
Slip rings and brushes are sensitive elements which demand regular inspection and maintenance.

14.3.1972	Changed:	
Sett:		

NEBB

Marine alternator type WAB
Building up of slip ring unit

NM 402710 E



Slip ring unit is mounted at the end of the alternator shaft. The slip rings must be given special care during transport and mounting of rotor, so that they are prevented from blows or other mechanical stress.

Should any de-mounting of slip ring unit be absolutely necessary, it should be done as follows:

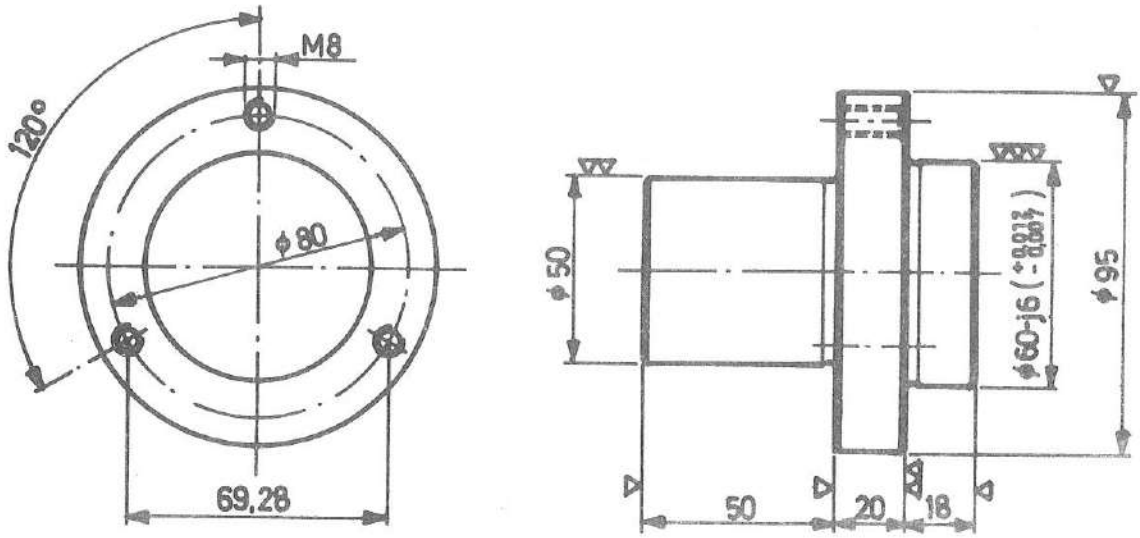
1. Cables for excitation to be loosened.
2. Fixing screws in shaft are loosened.
3. Slip ring unit to be drawn off.

29.9.1971	Changed:	
Sett:		

NEBB

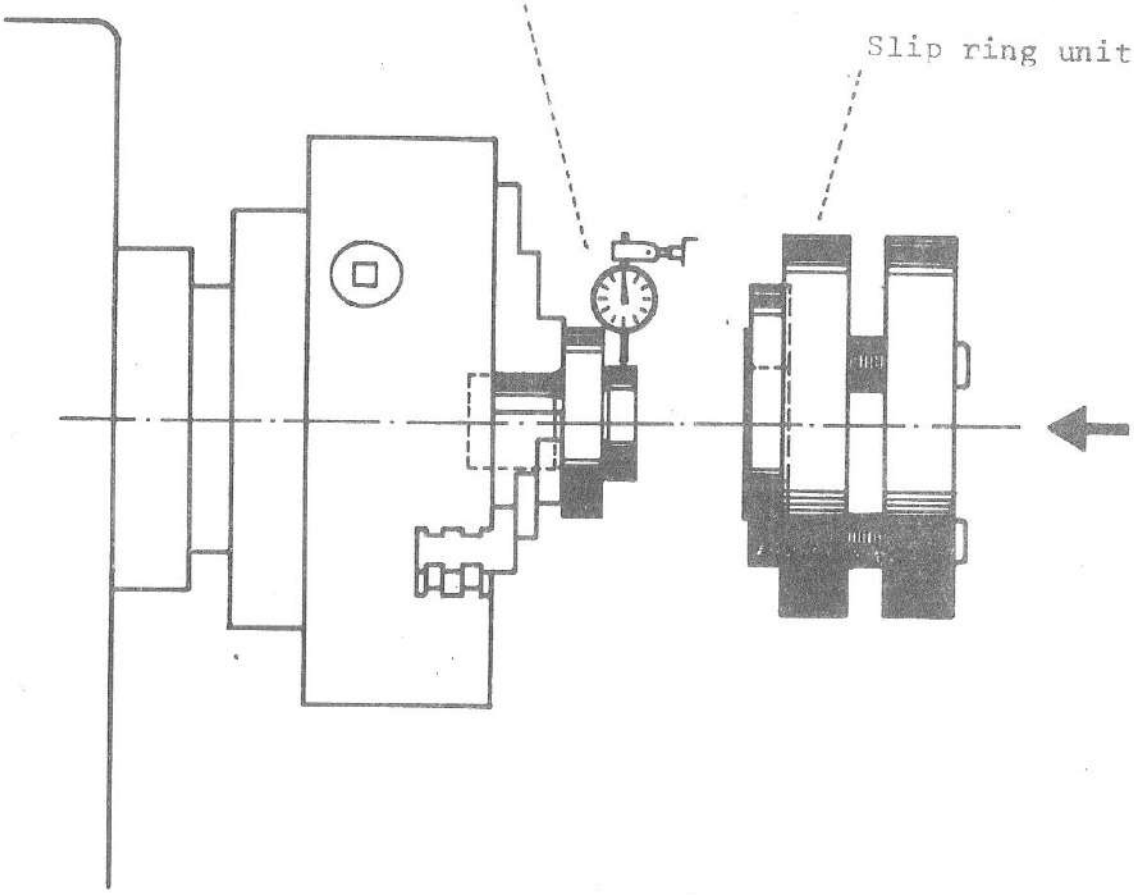
Marine Alternator type WAB
Equalising of sliprings

NM 402 727 E



Fastened in chuck, and
is aligned precisely by
means of a distortion clock

Slip ring unit



6.1.1972	Changed:	
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NEBB

Marine Alternator type WAB
Bearing liner

NM 402 737 E

Reliable operation of the alternator is dependant on the correct mounting and the regular maintenance of the bearings.

In making a routine inspection programme the operating conditions and environment should be taken into account. Regular control is necessary in order to ascertain that bearings are working normally. Check always that there is oil in the bearings before starting.

Ring lubrication bearings are furnished with signs indicating oil level and oil viscocity. Ensure that the lubrication rings are tight to the shaft and that the oil scrapers work satisfactory. To remove oil the bearings can be cleaned by means of white spirit.

Bearings having scav.oil lubrication are normally supplied with oil from the driving engine's lubrication system. Check that oil supply and outlet tube are in order.

When inspecting the condition of the lubrication oil is to be checked. Bearing liners and shaft to be checked so that one can ensure oneself that the bearings' condition is satisfactory.

Keep the bearings clean outside in order to maintain the cooling efficiency of the surface.

13.3.1972	Changed:	
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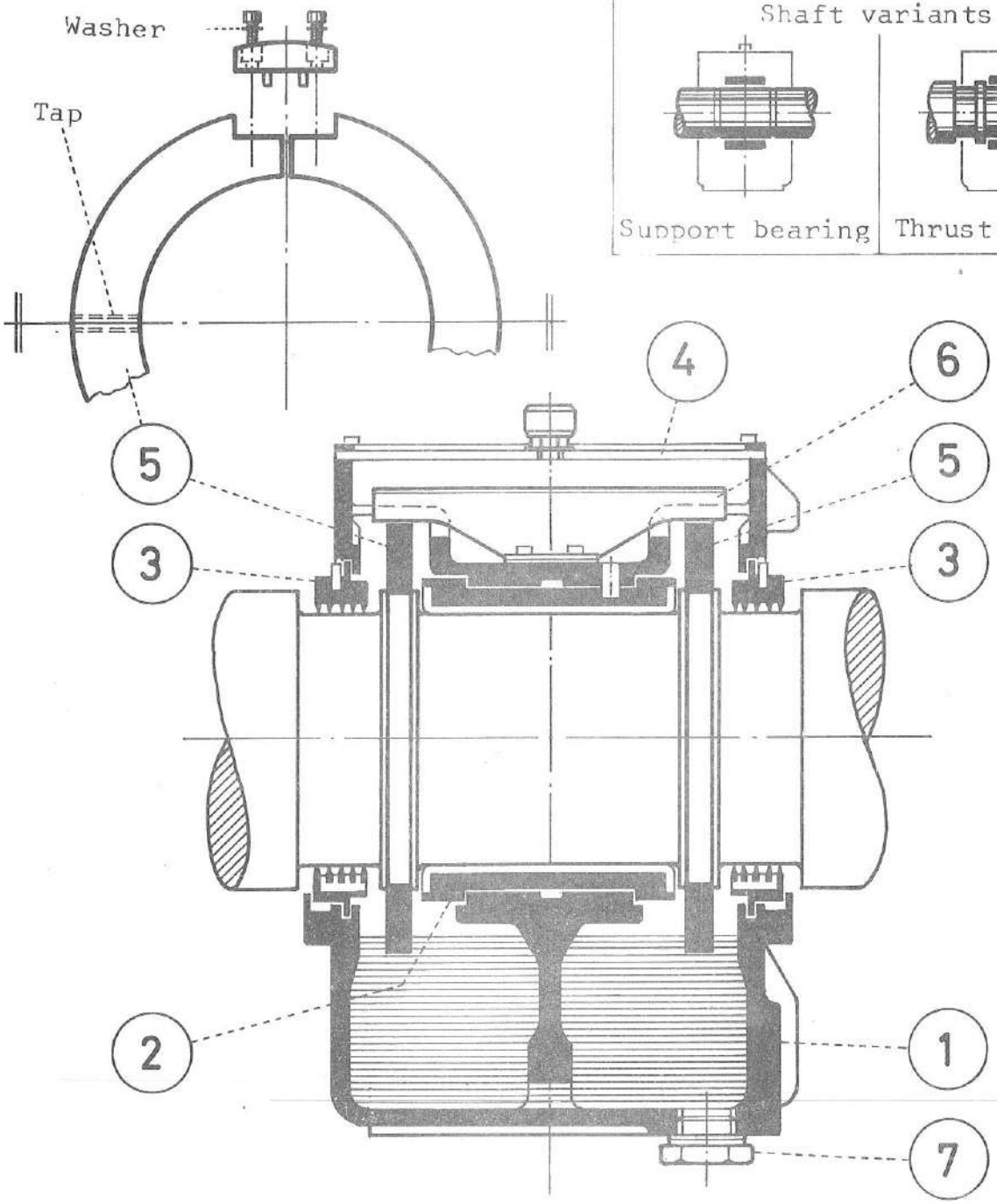
NEBB

Marine alternator type WAB
Cut through bearing with oil ring lubrication

NM 402712 E



Shaft variants

Support bearing | Thrust bearing

1 = Pedestal bearing (split)
2 = Bearing liner (split)
3 = Scraper (split)
4 = Top cover
5 = Lubrication ring (split)
6 = Oil scraper
7 = Bottom plug

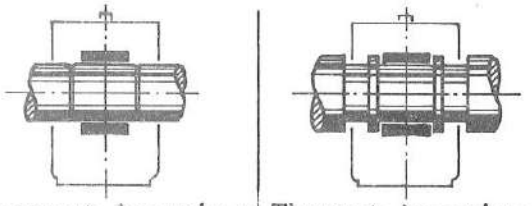
29.9.1971	Changed:	
Sett:		

NEBB

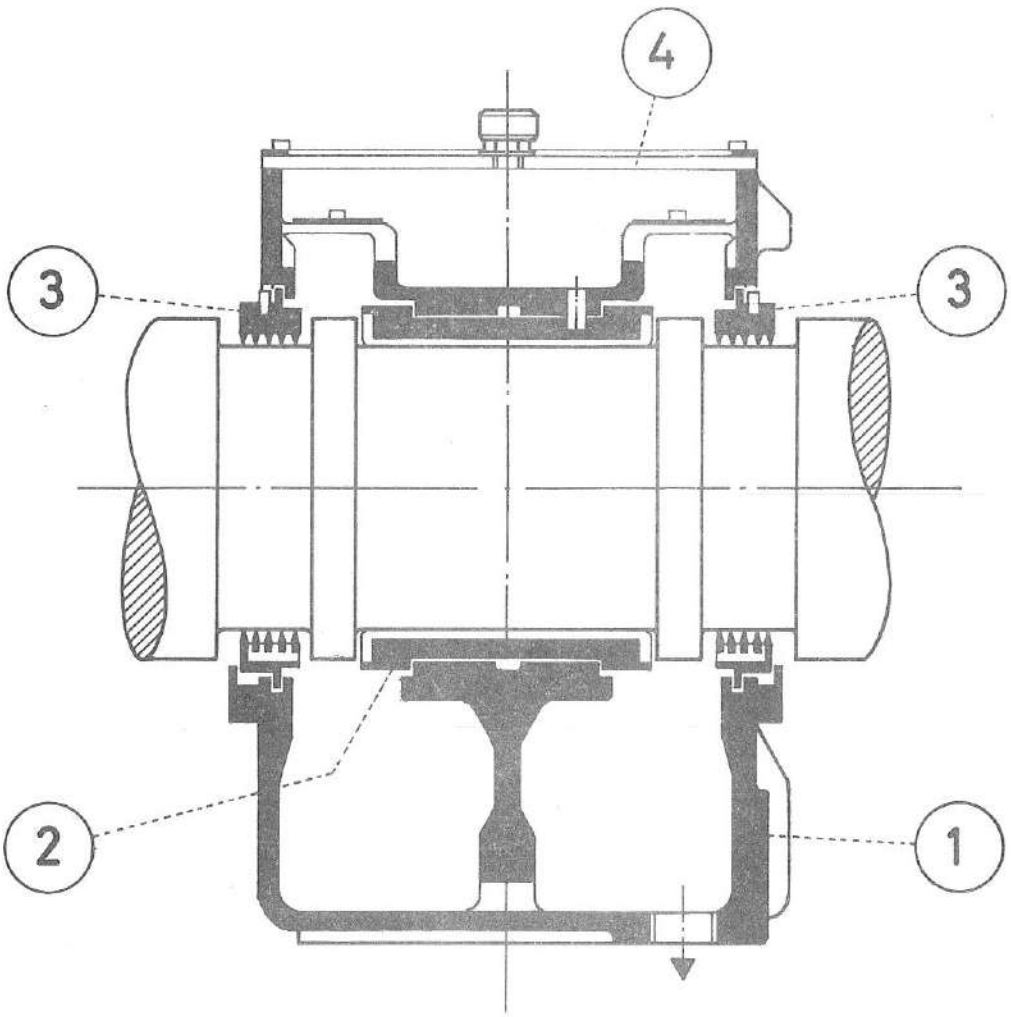
Marine alternator type WAB
Cut through bearing with flushing oil lubrication.

NM 402714 E

Shaft variants



Support bearing | Thrust bearing



1 = Pedestal bearing (split)
2 = Bearing liner (split)
3 = Scraper (split)
4 = Top cover

29.9.1971	Changed:	
Sett:		

NEBB

Marine Alternator type WA3
Ball bearings

NM 402 738 E

NEBB marine alternators with ball bearings are furnished with a lubrication device for after lubrication. The quantity of grease and lubrication interval is indicated on a sign at the lubrication point.
Ball bearings supplied by NEBB use a grease having a lithium base. Lithium grease has unique lubrication qualities but it must not be mixed with other greases having a different chemical base as the lubrication quality and constituency would be destroyed.

If it is necessary to change to another type of grease, the bearing and bearing elements must be cleaned first.
Ball bearings are to be after lubricated after approx 1 hour of operation and then with 3 times the quantity of grease indicated on the lubrication sign. This is to be repeated after 24 hours operation. Later the instructions on the lubrication sign are to be followed.

During operation ball bearings need relatively little maintenance. If unusual sound or an increase in running temperature occurs, the machine must be stopped and checked. It is recommended that the bearing be changed if there is any doubt about the condition. A draw off tool is used to remove the bearing and care must be taken to prevent damage to the bearing seats. The bearing mounting parts are to be cleaned. The new bearing should be heated up to 80°C. The heating should take place in a warming box with the bearing still in its oily packing paper. Blows against the bearing are not advisable. Finally the bearing, bearing cover and grease pipes are to be replenished with fresh grease.

If a ball bearing fails or is defective the reason should be found in order to prevent a repetition of the failure.
If there is no apparent reason the bearing should be returend, without cleaning, to NEBB. Relevant information on the bearings life and operating conditions should also be enclosed.

The bearings should always be checked whenever the alternator is dismantled. The bearings can be washed on the shaft using mineral turpentine (white spirit).
Compressed air and rags canalso be used but the bearing must not be allowed to accelerate when using the compressed air.
Materials which might leave threads or hairs, on the bearing should not be used.
Bearings should only be withdrawn from the shaft if it is necessary to change them

Ball bearing machines that are out of operation for longer periods should regularly be turned in order to avoid damage of vibration in the ballways.

13.2.1972	Changed:	
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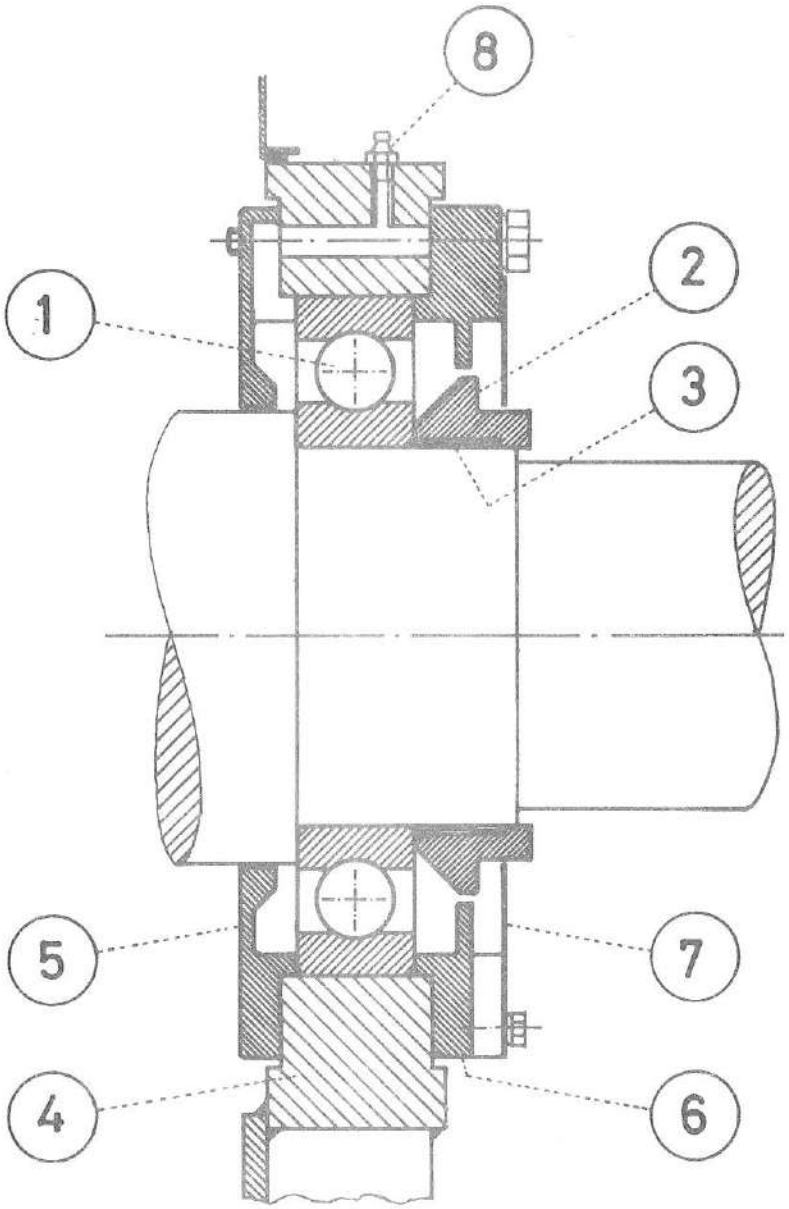
NEBB

Marine Alternator type WAB
Cross sectional view of ball bearing mounted on shaft

NM 402 729 E



1 = Ball bearing
2 = Distance casing
3 = Tolerance ring
4 = Shield bearing (split)
5 = Inner cover
6 = Outer cover
7 = Grease cover
8 = Grease nipple

21.8.1972	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Air cooler, Description

NM 402 739 E

NEBB Marine Alternators are fitted with air to water coolers if specified. The cooler is built in the alternator's ventilation circuit so that the ventilation air passes over the ribbed tubes of the cooler. Cooling water flows through these tubes to cool the air passing over them.

By filling up the cooler the air plug on top of flange chamber (see NM 402 726) is loosened. The air plug is screwed down again when the water has reached the outlet. Check that there is no water leakage from the water inlet and outlet flanges. The water pressure of the cooler is shown on a gauge.

When the alternator is run and also reached its operating temperature the water inlet and outlet connections should be checked. The cooling water flow should be regulated if necessary.

The flange and turning chamber on double tube coolers are furnished with leakage alarm, that indicate for water leakage in the core tubes. The leakage water is caught by the mantel tubes and carried to the leakage chamber which is connected to the alarm.

To clean the cooler the alternator has to be put out of operation. The water supply is closed, and the cooler is drained. The water supply and outlet is disconnected from cooler. Flange chamber and turning chamber are de-mounted. The ribbed tubes are cleaned inside by means of brush, and then rinsed.

The outside of the ribbed tubes is cleaned by compressed air. The alternators must be carefully covered to prevent water and dirt from entering the windings or regulating equipment.

If necessary the complete cooler is dismantled for cleaning. When a solvent is used to clean the cooler the solvent must be non-corrosive and non-caustic to copper and bronze. (Do not use strong alkaline soap or caustic soda.)
Rinse with fresh water.

Carefully reassemble the cooler after cleaning and check all packing and seals before and after restarting the alternator. Regular inspection must be made.

If the alternator is out of operation for any length of time the cooler should be drained. If there is a danger of frost the cooler should be drained when the alternator is not running.

28.2.1972	Changed:	
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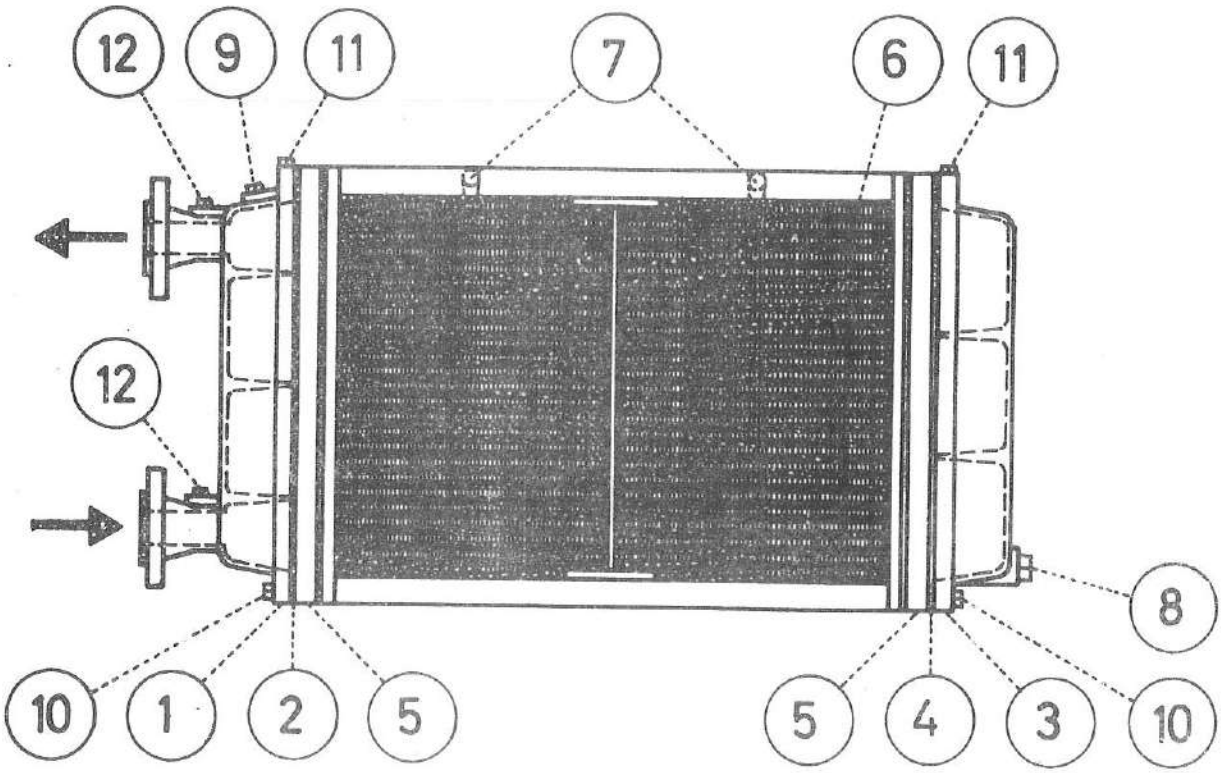
NEBB

Marine Alternator type WAB
Air and water cooler

NM 402 726 E



1 - Flange chamber
2 = Packing for flange chamber
3 = Turning chamber
4 = Packing for turning chamber
5 = End wall
6 = Ribbed tubes
7 = Lifting ring
8 = Drain plug
9 = Air plug (used when filling or draining)
10 = Outlet from leakage chamber in double tube cooler
11 = Air plug for leakage chamber
12 = For thermometer

16.12.1971	Changed:	
Sett:		

NEBB

Marine Alternators
Cleaning the alternator

NM 402 740 E

Cleaning is an important part of all maintenance.
Dust and dirt, oil, corrosive liquids and gasses all contribute to the deterioration of important alternator parts. Dirt and grease could build up to impede the flow of cooling air. The varnish and insulation of the windings can be attacked by corrosive liquids and gasses and also shrinkage of the insulation and impregnation could occur, because of lack of cleaning, to the extent of causing a short circuit.

Normally routine cleaning can be done by drying off windings etc. by means of rags moistured with cleansing liquid, or the cleansing liquid may be sprayed on and dried off by means of rags. Should a major clean be necessary, the purgative should be sprayed on, preferably by means of a high pressure pump so that the dirt is washed away. Dry with rags. Use a cleaning liquid that is especially prepared for washing electrical machines, e.g. Electrocleaner which easily evaporates. Do not use trinchlorine ethylene.

After cleaning the insulation resistance must be measured.

NEBB recommend the fitting of air filters to alternators, which are to operate in an especially dirty or oily atmosphere. Regular cleaning of air filters is necessary for the alternator's cooling and the efficiency of the filters. The intervals between cleaning can be determined by control of the temperature increase of the air through the alternator.
Air filters are cleaned effectively by boiling in water mixed with trisodiumphosphate for about 5 minutes. (approx 1/4 kg trisodiumphosphate per 10 litre water). Caustic soda must not be used.

After cleaning the filters should be held up to the light.
If there is no indication of shadow spots then the filters are clean.
When clean the filters must de dipped in Filtercoke or regular motor oil SAE 30-50. The filters must then be placed on edge or face down to allow the surplus Filtercoke or oil to drain off.

28.2.1972.	Changed:	
Sett:		

NEBB

Marine Alternator type WAB
Insulation resistance

NM 402 741 E

The Classification Societies prescribe the minimum insulating resistance for marine alternators. The formula below is used by Det norske Veritas and Bureau Veritas for a new, clean and dry machine:

$$\text{Min. insulation resistance} \frac{3 \cdot \text{voltage in V}}{\text{power in kVA} + 1000} = \text{megohm}$$

The measurement of insulation resistance should be made after a temperature rise test. This is because the insulation resistance incrased as the temperature falls. The insulation test should be for one minute.

Most often the insulation resistance is measured when the alternator is cold. Under this condition the required resistance should be estimated according to the following rule of thumb.

Min. 2 megohm per kV at 40°C

It is important that the insulating resistance is constant. Measurements which are to be compared to eachother shall be read at same temperature, or be re-calculated for given temperature:

Insulating resistance halved (doubled) for each 10°C the temperature is going up (going down)

The rectifiers in the excitation circuit MUST NOT be meggered. The excitation equipment MUST BE disconnected before measuring the insulation resistance.

ROTOR:

The brushes are lifted up.
Slip ring (+ or +) is measured towards earth.

If the insulation resistance is too low, the connection cables from the rotor winding should be disconnected from the slip rings so that the rotor windings and the slip rings can be measured separately. Any missing insulation resistance can thereby easily be located.

Slip rings are measured between each other and towards earth. Connection cable (+ or-) towards earth)

BRUSH HOLDERS:

The cables to the brush holders are to be disconnected. The brush holders are to be measured between each other and to earth.

STATOR WINDING:

The zero point of the alternator is broken at the coil ends (X-Y-Z) from the winding by being disconnected at the zero point choke coil. The main cables (R-S-T) are to be disconnected and the measuring made at the connecting bars; between phases and each phase to earth.

25.2.1972	Changed:	
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NEBB

Marine alternator type WAB
Removal of the rotor

NM 402 742 E

If the rotor is to be removed examine first the facilities available such as lifting and withdrawal space. If the conditions allow sufficient axial clearance as well as clearance during the withdrawing and lifting of the rotor then the rotor can be withdrawn without moving the stator.

The shield, the air deflector and the fan are removed. The rotor is turned so that two of the poles are lying symmetrically about the vertical axis. Pressboard or similar material for protection is to be put in the bottom air gap between the rotor and stator. Remove the bearing upper cover and loosen from the engine flywheel. Remove the split scraper rings and any bearing lubrication rings. Lift the shaft carefully and remove the bearing liner. Dismantle the bearing housing and lower the rotor carefully to rest in the stator.

Lift the rotor backwards step by step using two cranes or tackles until the lifting gear of the driving side is approaching the stator winding. It will be then necessary to mount auxiliary parts in order to lengthen the shaft, making it possible to lift the rotor far enough out so that one can get a "belly grip" by means of slings around the poles. The centre of gravity of the rotor shall then lie between the lifting straps or slings.

Proposal for auxiliary tools, see NM 402 743.

Alternatively conditions may allow removal of the rotor by lifting the stator (the rotor is still in the stator) and turning it through 90° on the foundation, or it can be transported to another place having more room and better lifting facilities. It would then normally be practical to lift the rotor out towards the driving side of the alternator, i.e. with shaft pivot or shaft flange first.

It is recommended that one or two persons plan and examine the removal in detail and to lead the work and take the necessary pre-cautions required.

Winding and slip rings shall not be subjected to mechanical stress.

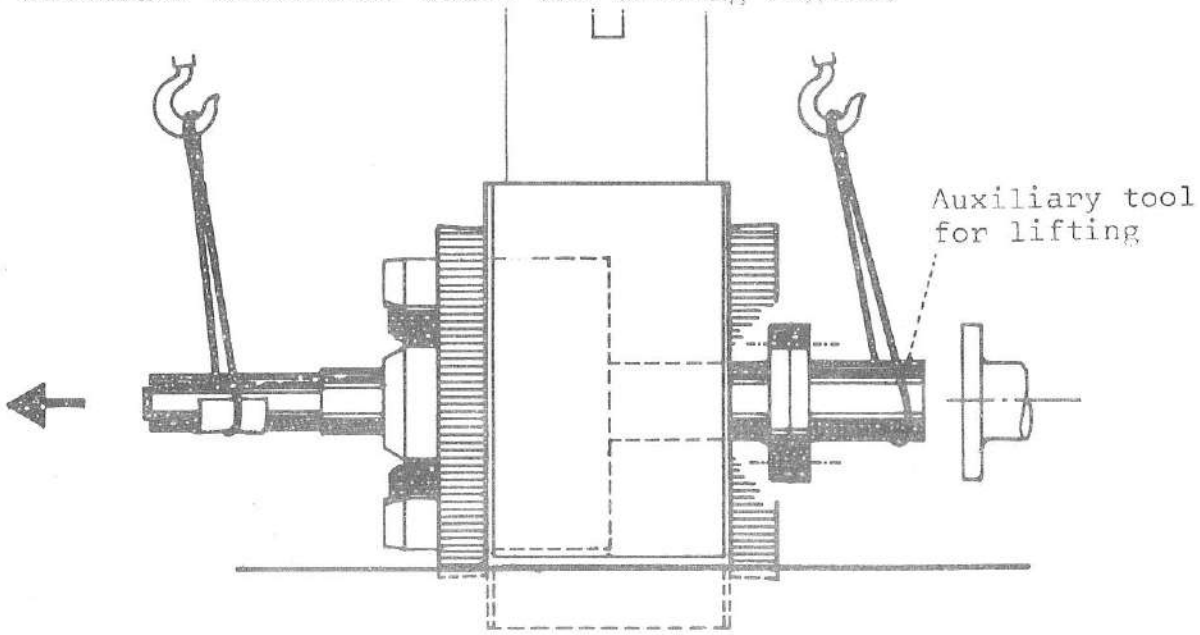
14.3.1972	Changed:	
Sett:		

NEBB

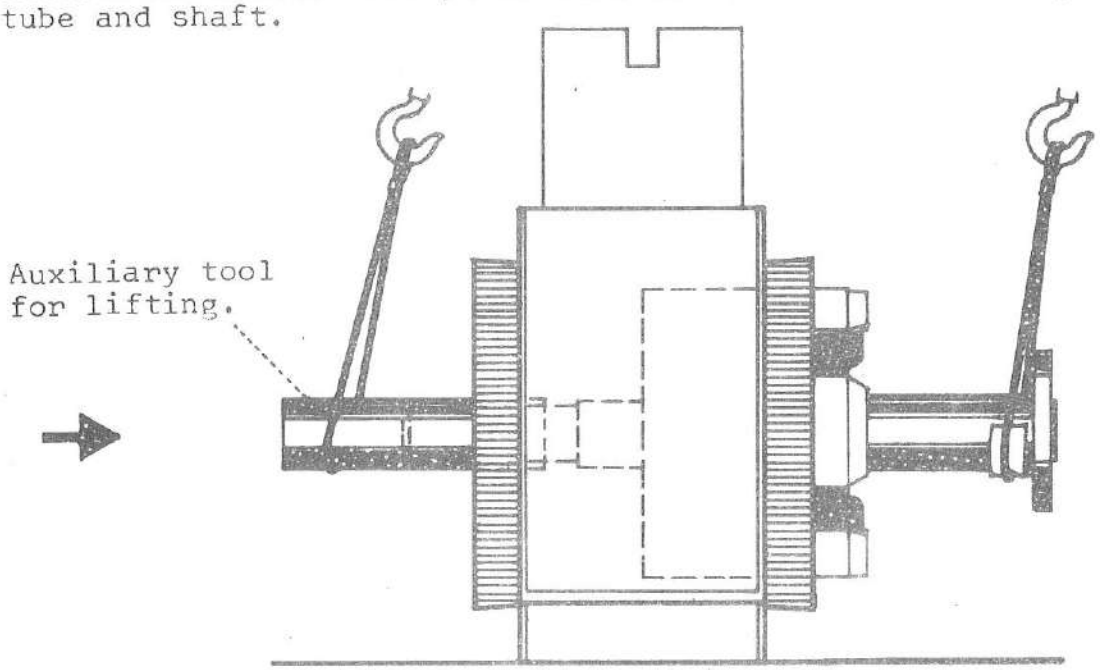
Marine alternator type WAB
Auxiliary tools for lifting of rotor.

NM 402 743 E

Method for removing the rotor without moving the stator.
The rotor is lifted backwards as far as possible, then auxiliary tools may be mounted on the shaft flange or coupling. The auxiliary tool is made of a thick steel tube with welded-on flange. The tool's length depends on the axial distance between the withdrawn alternator shaft and driving engine.



If the alternator is moved from the foundation, the rotor is to be removed from the driving side. As an auxiliary tool for lifting a thick steel tube is to be used which is threaded onto the alternator shaft. Use pressboard or similar as a lining between tube and shaft.



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Sett:		

R 113 - 65 E

INSTRUCTION MANUAL

FOR

STATIC VOLTAGE REGULATOR

TYPE S3bJ-3Z

Revised
May 1971.

Page:

1. Description.

The voltage regulator supplies excitation current to the alternator to maintain constant voltage independant of generator load. The system is autonomous, i.e. the necessary excitation power is taken from the alternator itself. The regulator consists of static elements only.

1.1. General information.

Reference is made to fig. 1 of the application section.

The regulator may be divided into three main parts:

a. The power system, consisting of fuses (1), excitation switch (2), the no-load transformer (3), the compounding transformer (4), the magnetic amplifier (5) and the rectifier (6).

b. The control circuit, providing a DC control current I_C which controls the output of the magnetic amplifier.

c. The voltage build up circuit.

The working principle of the system is as follows:

If the alternator voltage is decreased, this is measured in the control circuit and the DC-control current is decreased. The magnetic amplifier of the supply circuit operates in such a way that a decrease in the control current gives increased voltage to the rectifier bridge and hence the excitation winding of the alterantor. This increased excitation voltage increases the alternator voltage to its correct value. Vice versa an increased alterantor voltage reduces the excitation voltage and as a result constant alternator voltage is obtained.

1.2. Power system.

The power system consists of the following components:

Fuses (1)

These act as short circuit protection for the voltage regulator. They shall be "slow-blow" type.

Excitation switch (2)

This switch enables running of the aggregate with the alterantor deexcitated. Auxiliary contacts on (2) interlocks the main circuit breaker of the alternator. Opening switch (2) automatically opens the circuit breaker.

In some equipments the switch (2) has a tripping coil for automatic deexcitation. This coil is fed from the excitation voltage through contacts on auxiliary protection devices.

No-load Transformer (3)

This is a normal power transformer, with the primary winding connected to the bus bars of the alternator. At rated alternator voltage, the secondary winding of the no-load transformer supplies a voltage which when rectified will give a voltage exceeding the demand at no-load.
The excessive voltage is absorbed in the magnetic applifier (5).

Compounding Transformer (4)

The tasks of the compounding transformer may be summarized as follows:

a. Give an increase in the AC-voltage feeding the magnetic amplifier (5) corresponding to the increased demand for excitation current at load.

b. Give a fast compensation at sudden load variations.

c. Maintain a sufficient sustained alternator short-circuit current.

The transformer has an adjustable air gap and acts as a current-voltage transformer. For a given load current through the primary winding, the secondary voltage increases (more compounding effect) when the air gap is reduced. The secondary voltage U_D adds vectorially to the no-load transformer voltage U_0 consistent with required excitation voltage at the particular load condition. (Figure 4).

Magnetic amplifier (5).

The total voltage ($U_0 + U_D$) always exceeds the demand at a given load. Regulation of the generator voltage is thereby possible through regulation of the voltage absorbed by the magnetic amplifier (transductor) (5). The voltage absorbed in the working windings A-B is controlled by a DC.current through the control winding K - J. A typical control curve (excitation current versus control current at a certain value of power supply voltage) is given in fig. 2. An increase of the control current gives a decrease of the excitation current.

Rectifier (6).

The AC-voltages coming from the magnetic amplifier (5) is rectified in a bridge consisting of 6 silicon diodes.

Diodes may be destroyed by excessive voltages and special precautions are necessary when checking them. See Warning note under item 4.1.

As protection devices each diode is parallelled by a capasitor (7) and a resistor (8).

1.3. Control circuit.

The control current for the magnetic amplifier is determined by the control circuit. The latter consist of the following components (see figures 5 and 7a and the attached complete diagram: Voltage transformers (14) and (15), current transformer (11), stabilizing and compounding resistance (13) and (12), the potentiometer combination (17), (22) and (18), rectifier (16), series resistance (20), reactor (21) and the Zener-reference (19).

Attention is made to the operation of the Zener-diodes. These diodes block the current conduction as long as the voltage from the diodes (16) is below a certain value E_z - the blocking voltage of the Zener diodes. If this voltage is exceeded, the diodes start conducting The control current is now given by:

$$I_C = \frac{E_2 - E_z}{R}$$

(R - the total resistance of the control circuit).

The above mentioned zener diodes acts together with the other components of the control circuit as reference for the complete system.

Voltage Adjustment.

Voltage adjustment is obtained by means of resistors (17) and (18). Adjustment of resistor (17) is restricted, (see item 3.4.). Normal voltage adjustment is done by means of the external voltage adjuster (18), which gives -2 to + 4 % voltage variation.

Generator Voltage - Current Characteristics

To obtain equal sharing of reactive load between parallelled alternators each voltage regulator has a circuit that gives voltage-current-characteristics as

shown in figure 9. The circuit is part of the measuring circuit and consists of resistors (12) and (13) and current transformer (11).

The working principle is shown i figures 7a and 7b. Transformer 11 gives a current proportional to the load current. The current is fed through resistors(12) and (13) where voltage drops $\triangle$ Ustab and $\triangle$ Ukomp is obtained. These voltage drops are added geometrically to the generator voltages. The resulting voltages feeds the measuring transformers (14) and (15).

Figure 8 shows the resulting changes in primary voltages of the transformers. These variations may be controlled by means of an instrument. The changes are depending on the power factor of the generator load. The values given in figure 8 are typical values at 100% current in a 440 V system and resistor (12) and (13) set at maximum values.

Attention is made to the fact that an increase according to figure 8 in the closed regulating system will give a decrease in alternator voltage. Voltage $\triangle$ Ulm14, which is given by the setting of resistor (13), and voltage $\triangle$ Ulm15, which is given by setting of resistor (12), will reduce the generator voltage at power factor 0 (reactive load). For power factor 1,0 (ohmic load) increased setting of resistor (12) increases generator voltage while increased setting of resistor (13) gives a little decrease in generator voltage.

1.4. Voltage build-up Circuit.

The supply circuit of the voltage regulator is because of voltage step-down in transformer (3) and voltage drops in diodes and brushes operable only for voltage above approx. 30 % of rated voltage. The voltage due to residual magnetism normally amounts to 1 - 2 % at rated speed. Therefore a separate circuit, operable at these low voltages is used for voltage build up.

The voltage build-up circuit consists of voltage build-up breaker (31), resistor (33), step up transformer (32) together with fuses (1), switch (2) and rectifier (6) of the supply circuit. This circuit operates when switches (2) and (31) are closed. The circuit is disengaged by means of the current trip in (31). The transformer (32) saturates at a rather low voltage and the primary current is then restricted by the series resistor (33).
By adjusting resistor (33) the voltage at which breaker (31) trips may be adjusted. This voltage must be high enough to make the supply circuit operable (30-40% U_N). A low resistance value of (33) will make the build up procedure more rapid. The optimum setting of resistor (33) is therefore determined by experiments.

Generator equipped for automatic voltage build-up have an additional contactor that disengages the voltage build-up circuit. For rectification separate diodes are used.

For some installations special voltage build-up circuits are used. These circuits differ somewhat from the above descriptions. For further information see complete circuit diagram.

2. Operation.

The voltage regulator is built to operate satisfactorily within + 10% frequency variation. With unloaded generator the frequency may be reduced to - 20 % stationary. If the generator is driven at a lower speed than 80 % it should be deexcitated. Thereby overstressing due to increased excitation current at these lower speed is avoided.

2.1. Excitation.

a. The aggregate is driven at nominal speed.

b. Excitation switch (2) is closed.

c. Voltage build-up breaker (31) is closed.

The voltage build-up circuit will operate to a voltage of 30 - 40 %, where it disengages itself. At this voltages the supply circuit is operable and brings the voltage up to nominal voltage.

Switch (2) and breaker (31) may be closed at zero speed provided the aggregate is rapid brought up to 80 % of nominal speed.

Regulator for automatic voltage build-up needs no operation of breakers provided that switch (2) has not been used for deexcitation.

2.2. Adjustment of generator voltage.

Generator voltage may be adjusted by means of resistor (18). It will however normally be unnecessary to readjust when a suitable position is once set. (Refer items 2.4 and 3.4.).

2.3. Synchronizing.

Synchronizing an alternator to the busbar without danger for black-outs and/or equipment damage necessitates:

a. Alternator voltages approx. equal.

b. Frequencies equal.

c. Phase relationship within small angles.

Point a. is obtained by means of the voltage adjuster. The deviation obtained when leaving the adjusters in fixed positions is normally tolerated.

Point b. and c. are obtained by means of the speed controller of the aggregates. To avoid tripping due to reverse power it is often preferable to synchronize when the synchronoscope shows a little "to fast". Correct phase relationship is shown by marks on the synchronoscope.

2.4. Power sharing between parallelled Alternators.

After synchronizing the power is to be shared. Correct sharing of the active load is obtained by adjusting the speed controller of the engines.

Correct sharing of the reactive load is determined by the voltage regulators. If the alternators have a suitable quadrature droop according to figure 9, this gives stable sharing as shown i figure 6. With fixed no load voltage the reactive power is shared to give equal alternator voltages. The sharing may however be influenced by adjusting the no load voltages of the alternators by means of the voltage adjusters (18).

2.5. De-excitation.

De-excitation is done by means of switch (2).

For some regulators switch (2) may be opened by means of tripping coil controled by external protection devices.

Shut down of the engine with switch (2) closed will give de-excitation as the speed decreases. Such de-excitation is acceptable for diesel engines and turbine engines with shut down period under 1 minute. For longer shut down periods the diodes may be destroyed and/or fuses (1) may blow.

Operating switch (2) without operating the generator circuit breaker beforehand should be avoided. Such operation may give transient disturbances in the system.

3. First Time Operation.

Adjustment as mentioned in this chapter is performed at NEBB. Therefore none or only small adjustments will be necessary during first time operation on board.

3.1. Excitation.

a. Keep alternator running at rated speed.

b. Close excitation switch (2).

c. Close voltage build-up circuit breaker (31).

Normally the alternator voltage increases until rated voltage is reached. At an alternator voltage of 30-40% of rated value, the voltage build-up circuit breaker should trip automatically. Tripping voltage may be adjusted on resistance (33). Too low tripping voltage may cause the supply circuit fail to take over.

If approx. correct alternator voltage is not obtained, refer section 4.

3.2. Working Point Setting of Magnetic Amplifier (5).

a. Adjust resistance (18) until rated alternator voltage is reached. The control curve of the magnetic amplifier is normally given from the factory as shown in fig. 2. The required value of I_C is shown to be approx. 80 mA.

b. If I_C at no load differs more than 10 % from the wanted value (warm alternator), change to another secondary tapping of the no-load transformer (3). See fig. 3. (If I_C is too High, reduce the secondary voltage of the no-load transformer).

3.3. Compounding Transformer Adjustment.

The alternator current causes in each phase a voltage drop between terminal 0 and 10. This voltage is transformed to the secondary side and added vectorially to the secondary voltage of the no-load transformer (3) as shown in fig. 4. The adjustment of the transformer is best controlled with zero influence from resistance (12) and (13).

a. Rotate resistance (12) and (13) in anticlockwise direction to end position.

b. Link slide contacts of resistance (12) and (13) together.

c. At 100 % load, p.f. = 1,0, rated speed, the alternator voltage should not rise more than approx. o,5 - 1% above rated value.

d. At 100 % load, p.f. = 0, rated speed, the alternator voltage should not be more than 1 - 1,5 % above rated value.

If this is not the case, adjust the air gap of the compounding transformer (4) to obtain proper value.

3.4. Voltage Range Adjustment.

By adjusting resistance (18) the voltage range at no load should be - 2 to + 4 %.

Practical notes: (See fig. 5.)

a. Rotate resistance (18) to 25-30% from + end. (Mark 3).

b. Adjust resistance (17) at no-load condition until rated value of alternator voltage is reached.

c. Check voltage range.

If the voltage range is too large or too small, the secondary voltage of the transformers (14) and (15) have to be chosen lower or higher.

WARNING!

Slide contact of resistance (17) should not be positioned more than 20% from + end.

3.5. Adjustment of Generator Voltage-Current-Characteristics

To obtain reactive load sharing quadrature droop characteristics are used as explained under item 1.3. The desired characteristics at various loads is shown in figure 9.

(The adjustment of the compounding transformer has influence on the system characteristics. Therefore adjustment according to item 3.3. should precede adjustment of the control circuit.)

Adjustment procedure.

Generator is operated separately.

a. Rotate resistor (12) fully counterclockwise.

b. Set alternator voltage to rated value at no load condition and rated speed.

c. At 100 % load, p.f. = 0, rotate resistor (13) until the alternator voltage drop is 2 - 4%. If this cannot be obtained, the compounding effect of transformer (4) may have to be reduced by increasing the air gap.

d. At 100 % load, p.f. = 0,8 - 0,9, rotate resistor (12) until rated voltage is reached. Not always obtainable. Ideal values are shown in fig. 9.

The generator is parallelled with one or more generators.

a. If only two generators shall operate in parallel, the reactive power sharing is to be controlled at various loads and power factors. If reactive power oscillations occur the reactive power drop must be increased by resistor (13). If such adjustment has little effect on the oscillations, the reactive power drop should be increased by increasing the air gap of transformer (4).

b. When three generators operate in parallel the correct operation of generator 1 and 2 may be controlled by varying the voltage adjuster (18) of generator 3.

When generators 1 and 2 are adjusted satisfactory, generator 3 is controlled against number 1 by varying the voltage adjuster of number 2.

c. Control the voltage variations from no-load to full-load at nominal power factor. Adjust resistor (12) if necessary.

4. Fault finding.

In case of faults in the regulator, it should first be checked that all terminals are securely screwed in and that there are no poor connection or tottering contacts.

4.1. The voltage does not rise when the set is started.

a. Check that the switches (31) and (2) are closed.

b. Check that the fuses (1) are in order and securely screwed in.

c. The residual voltage is too low or has disappeared. If it is absent, the excitation is to be started by connecting a separate DC-voltage- for instance a battery - to the terminals P and N on the regulator terminal board.

Note: Plus connection of battery to P and minus to N.

d. Check for correct external connection to voltage

build-up circuit. Connection to other phases may cause the alternator not to excite.

e. One or more diodes in the rectifier (6) are defective. A defective diode is current conductive in both or none directions. This may be checked by means of an ohmmeter or a pocket battery (4,5 volts) with lamp. For this test the diodes must be disconnected.

NB! WARNING:

No "megger" or high voltage test to be carried out until all diodes and rectifiers are shorted. This concerns item (6), (16), (19) and other additional rectifiers.

f. Check the brush pressure against the slip rings. Examine if there is any dirt or deposits on the slip ring and clean these off.

4.2. The voltage drops when the Stotz circuit-breaker (31) is released.

(For automatic systems when contactor (31) operates.)

a. Check that the no-load transformer (3) has voltage in all three phases. If this is not the case, check for any break in the connections between the busbars and the transformer terminals. Check also that there is voltage at the regulator terminals X-Y-Z.

b. Examine if any of the diodes in (6) are defective. Check as under item 4.1.e.

c. Try increasing the value of resistor (33) a little.

4.3. The voltage is higher than the rated voltage and cannot be reduced.

The reason may be a break or tottering contact in the control circuit. All feeders and components in the circuits (12), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22) and (5) are to be checked. On replacement of components it should be taken care that the connections correspond to the enclosed diagram.

4.4. The voltage differs from the rated voltage, it may be set by the voltage adjustment resistance, but the rated voltage is not achieved.

a. Check that the resistances(17) and (18) are in order.

b. Check that the fuses (1) are in order.

c. Check that the voltage at the regulator terminals X-Y-Z are symmetrical. The voltages between the phases shall be practically alike and must not differ more than max. 10 to 15%. In case of greater differences the primary and secondary phase voltages of transformer (3) and compounding transformer (4) are to be checked.

d. Check that the diodes in (6) are in order. Examine as stated under item 4.1.e.

e. Check the voltage across the Zener-reference (19). It shall for type 7 x ZL12 be 84 $\pm$ 1V when I_C = 50 mA.

4.5. The alternator voltage drops considerably when load is applied.

a. Check for correct phase connection of no-load transformer (3) and compound transformer (4).

b. The compounding is too weak. The air gap of the compounding transformer (4) is too large and must be reduced.

c. This may be due to a high stabilization; reduce it by turning the stabilizing resistance (13) in counterclockwise direction. The stabilization is adjusted when putting the plant into service, and it must not be reduced beyond what is necessary to attain a reliable sharing of the reactive load, see item 3.5.

d. The reason may be that a too large active load is applied, whereby the frequency becomes too low.

4.6. The reactive load (the excitation current) increases in one alternator and decreases towards zero in the other after synchronizing.

The first mentioned alternator is over-excited and the other one is under-excited.

a. Check that the fuses (1) are in order.

b. The reason may be a break or tottering contact in one of the measuring circuit of the regulators. If so, the break or tottering contact is to be found in the measuring circuit of the regulator pertaining to that alternator which has the greatest excitation current and lower power factor.

c. Check that the diodes in (6) are in order. If two or more diodes are defective, the alternator concerned loses its excitation current. If several alternators are operating in parallel, a diode fault will result in one or more alternator being tripped out on account of overcurrent.

d. The stabilizing current transformer (11) is perhaps connected to (12) and (13) with wrong polarity. To be examined on putting the plant into operation. See 3.5.

e. The stabilizing current transformer (11) is perhaps connected to a wrong phase. Normally it shall be connected to phase S.
To be checked when putting the plant into operation.

4.7. Power oscillations.

If power oscillations occur, the source of these should be ascertained.

a. Check the Diesel governors. Examine if the frequency (speed) varies at no-load (regulator hunting).

b. Lock the connecting rods of the Diesel pumps of the sets operating in parallel to give constant fuel. If the oscillations disappear or are considerably damped, the Diesel regulator must be adjusted for instance be increasing the governor's damping.

c. It is to be checked that the speed drop of the Diesels is the same for all sets by increasing load and amounts to 4 - 5% from no-load to full load.

d. It should be ascertained at what loads (in what ranges of load) the oscillations occur. If the oscillations appear at full load conditions, the compounding effect of transformer (4) may be too high.

e. If the plant has more than 2 alternators, it should be examined if the oscillations especially occur when a certain alternator is connected. This is done by connecting alternately two and two alternators in parallel.

NOTE!

When communicating to NEBB, all symptoms and observations should be described as exactly and detailed as possible.

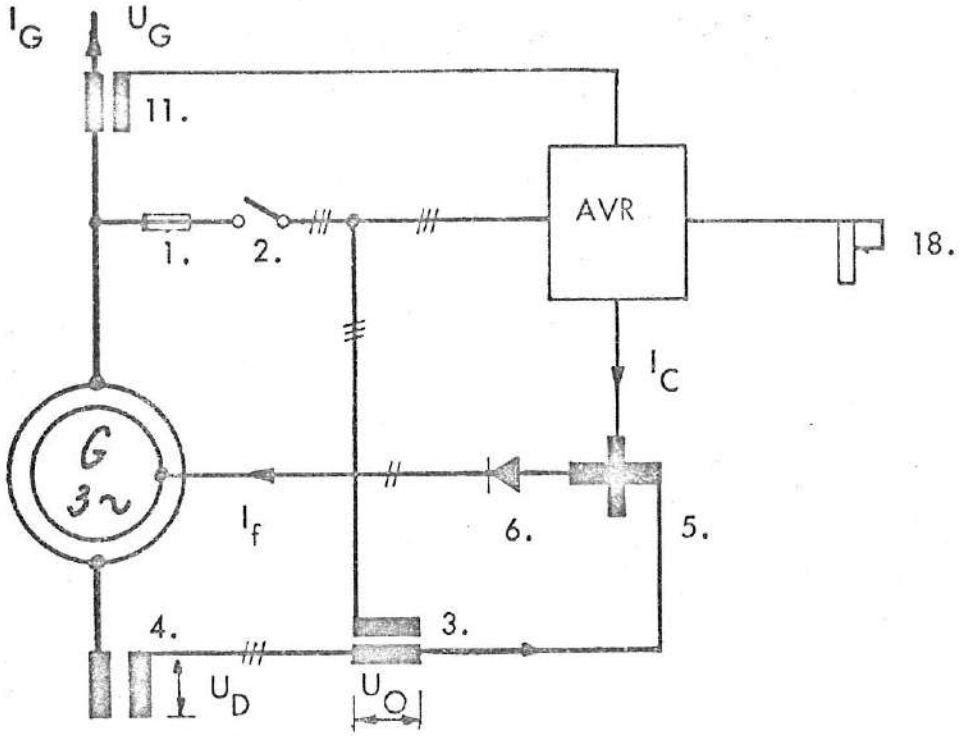


Fig. 1. Regulator main parts.

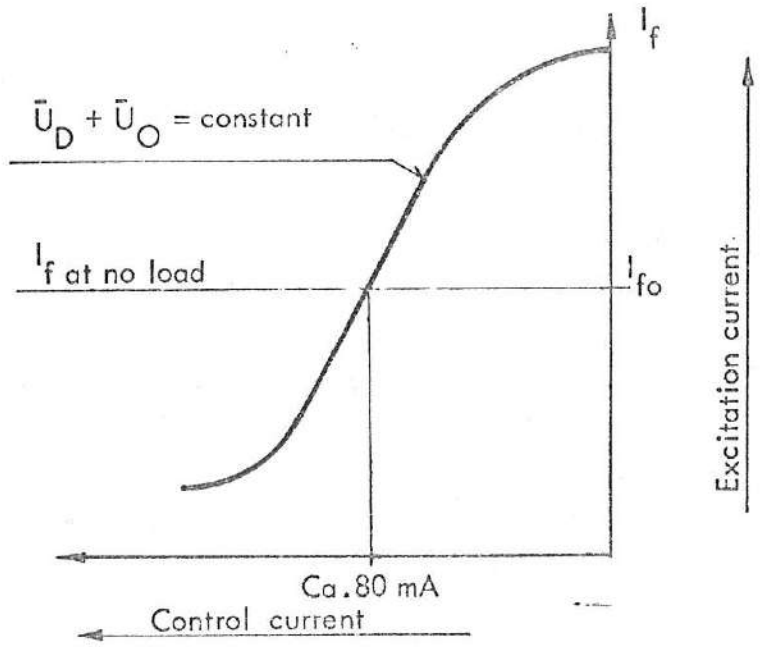


Fig. 2. Control curve of magnetic amplifier.

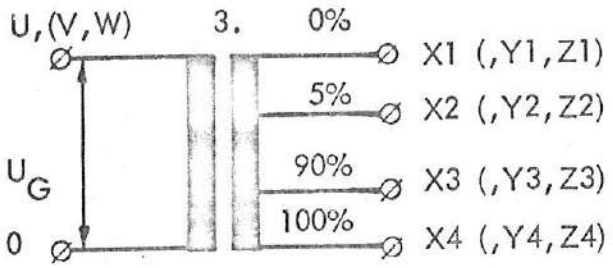


Fig. 3. Transformer (3). Normal tappings.

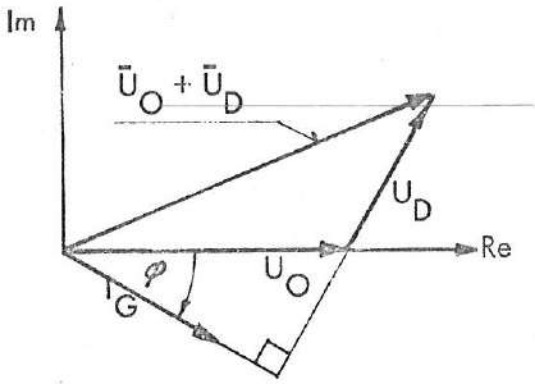


Fig. 4. Vectorial addition of no load transformer voltage U_O and compounding transformer voltage U_D.

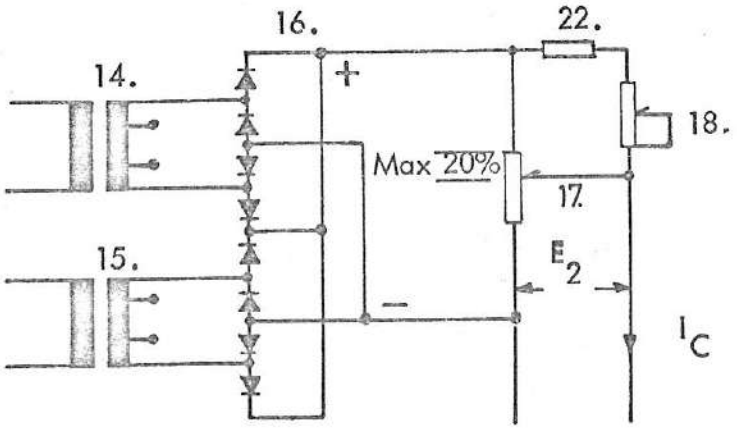


Fig. 5. Voltage range adjuster.

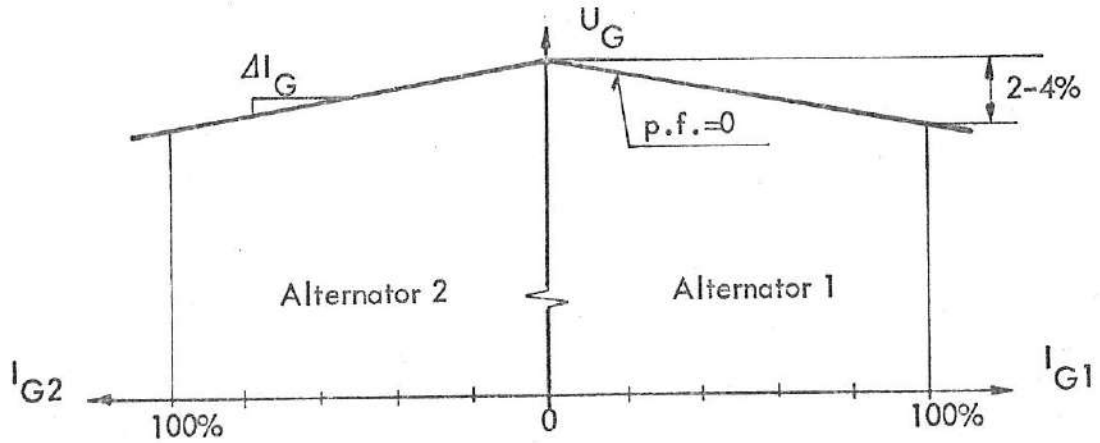


Fig. 6. Quadrature droop.

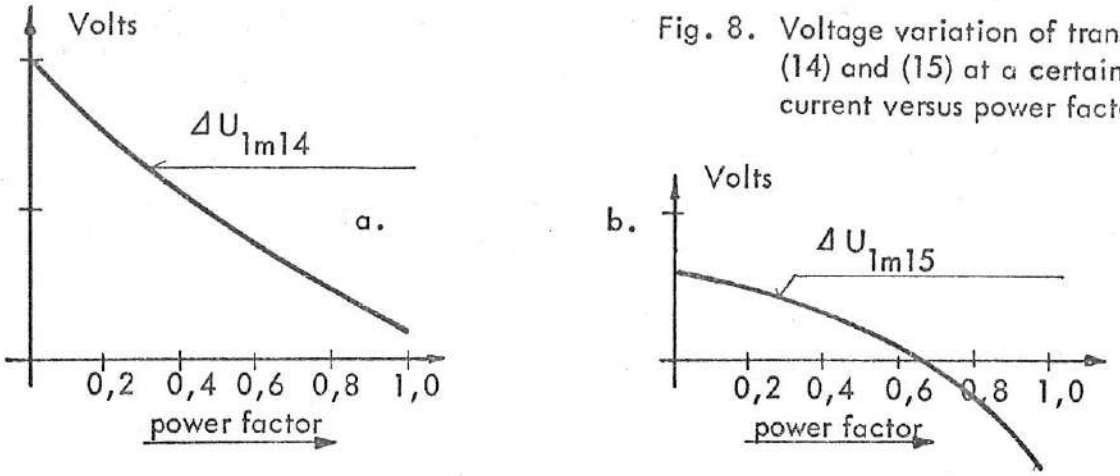


Fig. 8. Voltage variation of transformers (14) and (15) at a certain load current versus power factor.

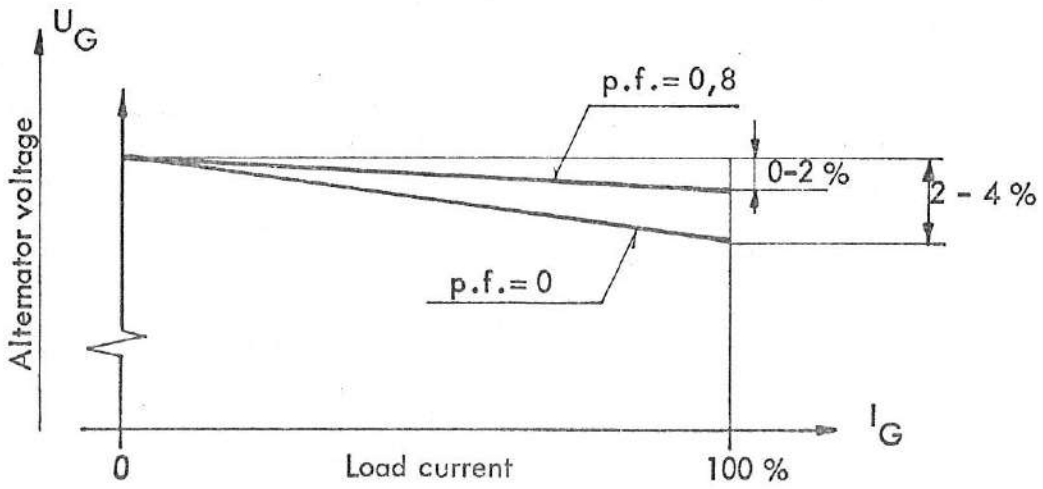


Fig. 9. Voltage- current characteristics.

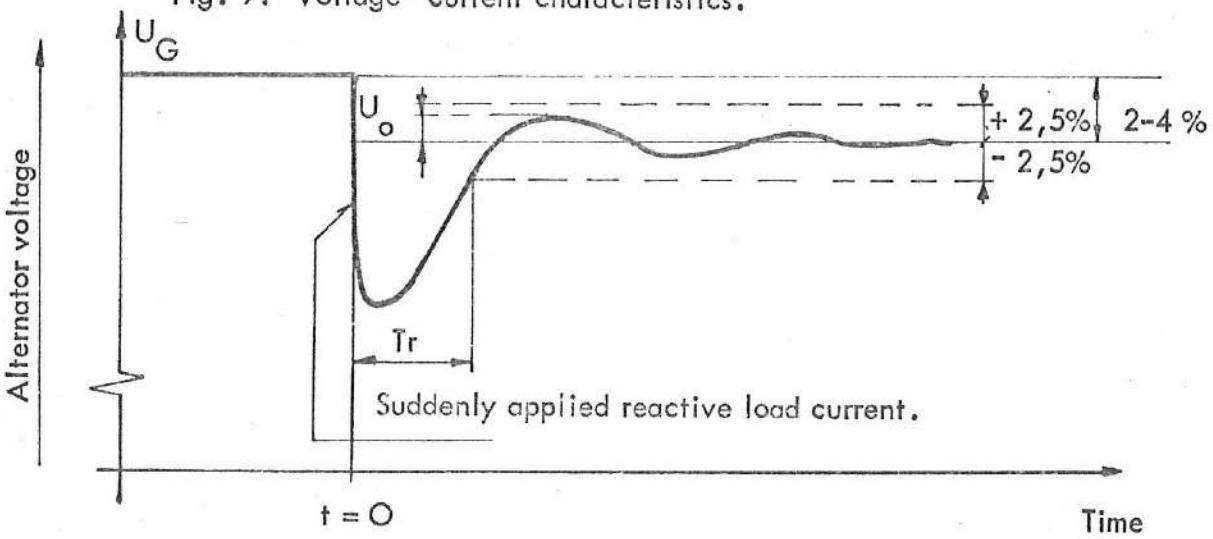


Fig. 10. Time response measurement.

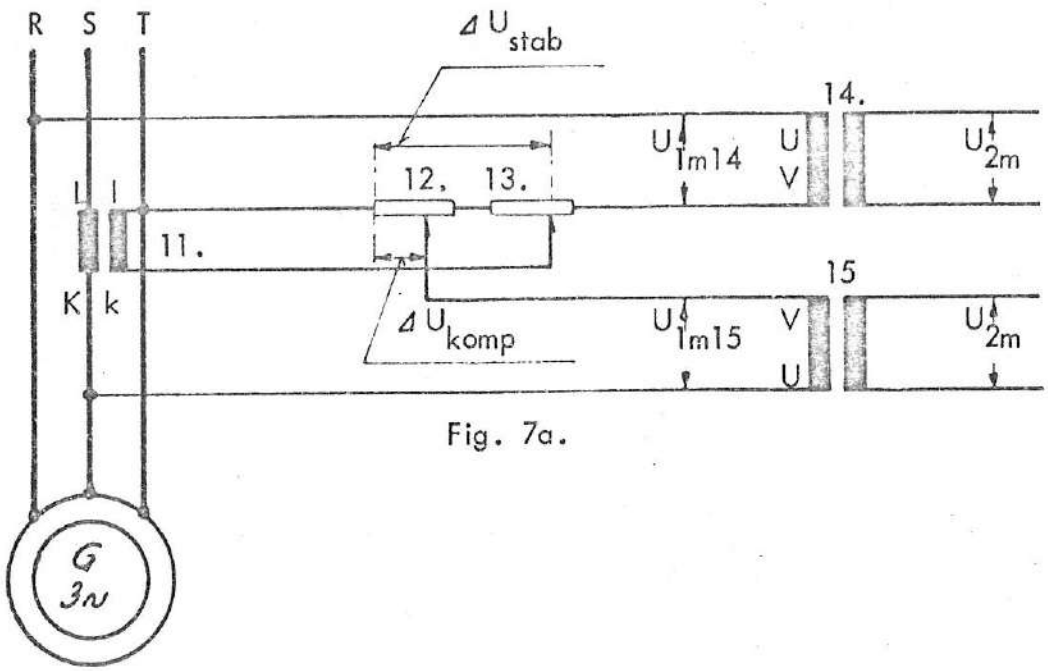
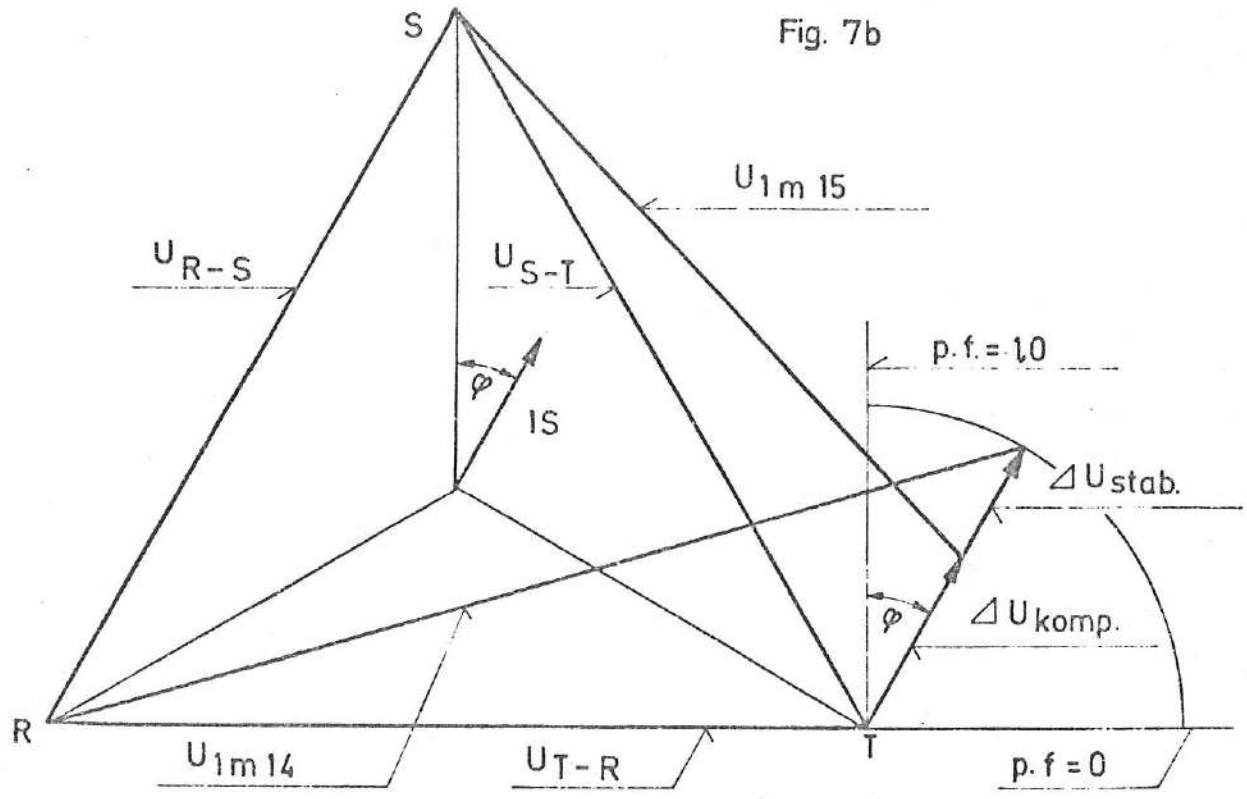
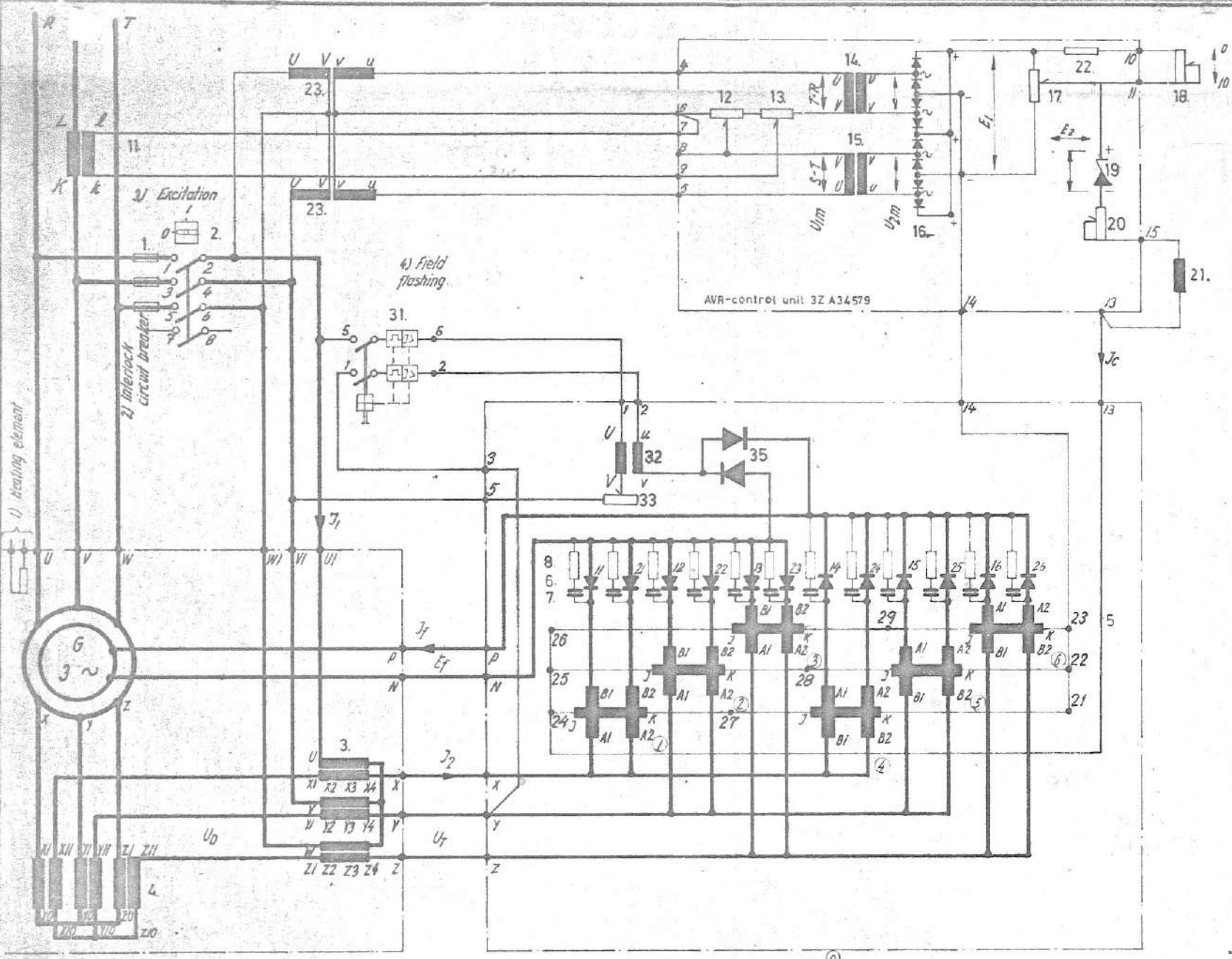

R S T
Δ U stab
14.
U 1m14
U V
U 2m
12. 13.
L l
11.
K k
15
Δ U komp
U 1m15
V U
U 2m
G 3~

Fig. 7a.

Fig. 7b


S
U 1m 15
U R-S
U S-T
p.f. = 1,0
φ
IS
Δ U stab.
φ
Δ U komp.
R
U 1m 14
U T-R
T
p.f = 0



1	Main fu… / Hauptsiche…
2	Excitation. / Erregungsschalter
3	No-load transformer. / Leerlauftransformator
4	Compounding transformer. / Kompoundierungstransformator
5	Magnetic amplifier. / Magnetverstärker
6	Silicon rectifier. / Silizium Gleichrichter
7	Capasitor. / Kondensator
8	Resistance. / Widerstand
11	Current transformer. / Stromwandler
12	Compounding resistance. / Spannungskompound
13	Quadrature droop adjuster. / Blindleistungsstab
14 15	Transformer. / Transformator
16	Rectifier. / Gleichrichter
17	Internal adjuster. / Interner Abgleich
18	Voltage adjuster. / Spannungseinsteller
19	Zenerreference. / Zenerreferenz
20 22	Resistance. / Widerstand
21	Choke. / Glattungsdrossel
31	Field flashing breaker. / Auferregungsautomat
23 32	Transformer. / Transformator
33	Resistance / Widerstand
35	Field flashing diodes. / Auferregungsdioden.

1. Heizelement
2. Verriegelung vom Hauptschalter
3. Erregung
4. Auferregung
5. Entregungsschutz

Transp. av NL 333702

Magnetic ampl. voltage regulator
Type S3bJ-3Z
Diagram.

NEBB OSLO

NL343213

Blad nr.			
	Tegnet	AKj.	30.8.74
	Trac.		
	Kontr.		
	Sett	AK	19.9.74

NEBB

Fortegnelse over komponenter til **REGULERINGSUTSTYR**

Bygg nr. TI CFEM

v/ Compagnie El. Mec.

Anlegg: Compagnie El. Mec. Gen.ordre nr.: 445.301 Reg.ordre nr.: 417.719

Maskin type: WAB 1240D6 Antall: 4 Lev.dato: 10.7.75 Til pröve: 10.6.75

Reg.type: S3bI-3Z Prinsipp: NL343213a Mont.: NL 333 353 Sammenst.: NL 120 727 R3

Komponenter	Ant. pr.stk.	Tekniske data	Best. av	Leverandör	Best. dato	Lev. dato	Bemerkn.
1. Hovedsikr.	3	NH00 600 V 36 AT Bogenschütz		Holdes av kunden			
2. Magn.bryter	1	Telux 40E/0116/6830/RG/1					
3. Matetransf.	1	600:V3/4-36-44 V, 60 Hz 16/126 A, 16,7 kVA		MTF			29/ 27305 P 3
4. Komp.transf.	1	2/14 vdg., 2250/126 A Afe = 105 cm^2, d = 10+10 mm		"			P 4
5 Transduktorer	6	Tr. 110/185b 79- 2/72		AF			
6. Si.likeretter	2	6 x S6AN125 - U909					
7. Kondensator	12	1 uF, 1000 V		Phil.			
8. Motstand	12	27 ohm, 3 W (kull)		"			
23. Transf.	2	600/415-450 V, T25		A.C. Smith			26/95 129P3
11. Strömtransf.	1	2000/1A, 30 VA kl. 3 LGK		Brinch-mann			
12. Komp.motst.	1	20 ohm, 75 W, m/lås		Alnæs			
13. Stab.motst.reaktiv	1	20 ohm, 75 W, m/lås		"			
14.15.Transformatorer	2	450/2-4-86-92 SN 1,1 60 Hz					
16. Styreströmsliker.	2	VGB 0132 CB		BBC			
17. Justermotst.	1	500 ohm, 75 W, m/lås		Alnæs			
18. Spenningsinnst.	1	100 ohm, 75 W		"			
19. Zenerref.	1	7 x ZL12, 84 $\pm$ 1 V					
20. Seriemotst.	1	100 ohm, 75 W m/lås		Alnæs			
21. Glattedrossel	1	9 H, 0,3 A, TN 1,1					Separat i tavle
22. Seriemotst.	1	47 ohm, 10 W		Phil.			
31. Oppmagn.aut.	1	GH M 631 4,0-6,3 A	avd. AGI	BBC			
32. Oppmagn.transf.	1	20-25/25-30 V, SN 1,1					Dobbelt isolert
33. Oppmagn.motst.	1	3,5 ohm, 8,5 A		Alnæs			
35. Diode	2	DS 22-11A/M6		BBC			

NEBB	SPARE PART LIST	CFEM Hull no.T 1

ALTERNATOR

		Article No.
4 pcs.	Carbon brushes EG 260 NM 405063 P.3.	7323521
1 pc.	Brush holder ALG1 - 25/32	7326921
1 "	Brush holder base K 117 - 20/20	7327150

REGULATOR

Diagram NL 343213 a

3 pcs.	Main diode S6AN125 U909 Item 6	9420186
2 "	Control current diode VGB0132 CB Item 16	8100096
1 pc.	Voltage adjuster 100 ohm, 75W, item 18	8120556
1 "	Overload protection switch M 631-40-6,3A Item 31	8134520

DATO: 12.11.75	FORANDRINGER:	ERSTATTET AV:
SIGN.: HA		ERSTATNING FOR:
SETT:		