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Technical Note No. 156
(E.A.M. No. 113)

German Ground Radar Equipment
Transmitter T-106 (FREYA)

Unclassified

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~~EQUALS~~
~~U.S. SECRET~~

by

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Summary

This note describes a captured Transmitter Type T-106 with particular reference to its operating frequency and tuning range. So far as could be ascertained, 125 megacycles per second is the spot frequency with a possibility of adjustment to give a slightly greater frequency if required. The peak power output was found to be of the order of 15 to 20 K.W.

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1. Introduction

The object of this investigation was to determine the frequency and tuning range of the Freya Transmitter, T-106. This information had been requested by Air Ministry A.D.I. (S)

The transmitter described in this report was captured intact in North Africa, no damage having been inflicted by the enemy. Two spare T.S.41 oscillator valves were also captured with the equipment and were used in the tests. (see Reference 1)

* Throughout this note read GTU 100 instead of TU100 and GTN 100 instead of TN 100

2. Description of Transmitter

The transmitter consists of three removable units in a weather proof metal case. The three units are:-

The modulator unit, T.S.102, shown in Fig.3.

The R.F. power oscillator unit, T.U.100, shown in Fig.2.

The oscillator valves filament supply and high voltage smoothing unit, T.N.100.

The physical arrangement of these units in the transmitter casing is pictured in Fig.4.

2.1 Modulator Type T.S.102

The T.S.102 Modulator Unit consists of two R.S.391 pentodes and an S.T.V.280/40 Stabilovolt in a self-contained bias supply. Referring to Diagram 9029-B the action of the modulator is as follows:-

A 500 c/s. tone at 17 volts R.M.S. is applied to the primary of a step-up transformer, the secondary of which is permanently tuned to the tone frequency. The voltage at the secondary is of the order of 1,350 volts peak-to-peak. This voltage is applied, through a 50K. resistor, to the grid of V-124. This valve and V-125 are both biased negatively at 220 volts. The action of V-124 is to square off the sine wave input, the screen voltage being at a low potential, (130V) presumably to shorten the grid base in order to assist in the squaring action.

The anode load of V-124 consists of an iron cored coil, 122, which produces a sharply differentiated wave form at the anode as shown in Diagram 9028-B Fig.D. This differentiated wave is applied to the grid of V-125 which is biased at approximately cut-off. The positive pulses cause V-125 to conduct momentarily, suddenly cutting off the valve again as the pulse goes negative. This action causes a large positive surge in the iron cored coil (123) in the anode circuit, (see diagram 9028-B Fig.E). This large positive surge is of the order of 2,500 volts and is used to lift the standing - 2 K.V. bias on the R.F. oscillator grids. This modulation pulse is approximately 8-9 μ secs. wide at the base and is roughly triangular in shape,

/being

2.3 Power Unit Type T.N.100

The supply unit T.N.100, is merely a 10.6 volt filament supply transformer for the T.S.41's, and additional filtering for the 8 K.V. H.T. supply.

3. Tests on Transmitter

3.1 In testing the transmitter a B.F.O. and three stages of amplification were used to supply the 500 c/s. tone to the modulator. Using one of the T.S.41's found in the set and replacing the other valve, (which was faulty owing to broken filament supports) with one of the spares, the transmitter was found to oscillate at 125 Mc/s. This does not necessarily signify that the transmitter was being used on this spot frequency when captured, since a lamp load was used in this test and the aerial coupling condenser was adjusted to match the load to the oscillator. With a different load, the frequency would be slightly altered in matching this new load. Also, as stated previously, one of the oscillator valves was changed which has a decided effect on the frequency.

3.2 The frequency test on the transmitter was made using all possible combinations of the four available T.S.41 valves. The frequency was measured at the high end of the band with the anode lecher bar as short as possible, (Fig.5) and at the low end of the band with the lecher bar extended (Fig.6). The results are as follows:-

T.S.41 Valves Combination	Frequency in megacycles		
	Highest	Lowest	Range (Mc/s.)
1 - 2	125.5	121.1	4.4
1 - 4	126.1	122.0	4.1
5 - 4	127.2	123.1	4.1
2 - 4	126.3	122.3	4.0
2 - 5	126.8	122.3	4.5
1 - 5	126.9	122.0	4.9

From these results it is apparent that only a small band of approximately 4.5 Mc/s. can be tuned using the

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available lecher bar. Referring to Fig.6, it can be seen that the physical arrangement of the adjustable lecher bar is such as to make it impracticable to tune the lower frequencies, since the lecher bar and the choke in the H.T. lead dangerously approach the earthed chassis. Also, from the mechanical arrangement of this choke it can be assumed that the oscillator was not designed to cover a band even as wide as the 4.5 Mc. band obtained on test. By varying the aerial load a frequency as high as 128.3 Mc/s. was obtained using the valve combination 5 - 4. The minimum frequency measured was 121.1 Mc/s. using valve combination 1 - 2.

4. Conclusions

From the foregoing tests it can be assumed that the Freya Transmitter in this case was designed to be used on a spot frequency of say 125 Mc/s., the oscillator tuning being only a fine adjustment of frequency to compensate for non-uniform valve characteristics and slight variations in aerial loads. It must not be overlooked, however, that there is a possibility of substituting a shorter anode lecher bar and slightly different H.T. choke arrangement, thereby obtaining a higher frequency band, but so far there is no evidence that this has been attempted.

5. Reference

R.A.E. Technical Note No.157 (E.A.M.No.111) "Examination of German Valves used in Ground Radar Equipment".

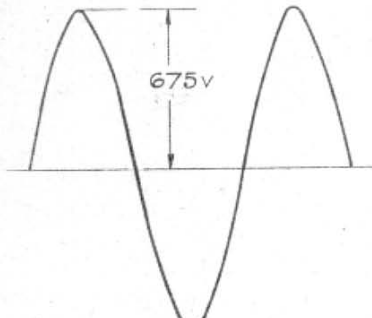
6. List of Photographs and Diagrams attached to this Note

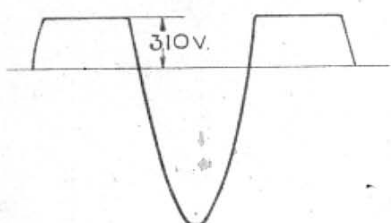
- Fig.1 Output Waveform demodulated R.F.Pulse) Negative No.
- " 2 Oscillator Unit TU100 removed from case) 49237
- " 3 Modulator Unit TS102) Negative No.
- " 4 Complete Transmitter with front covers) 49238
- removed)
- " 5 Oscillator-anode lecher short) Negative No.
- " 6 Oscillator-anode lecher extended) 49239
- Modulator Waveforms - Diag.No.9028-B
- Modulator Circuit Diagram - Diag.No.9029-B
- Oscillator Circuit Diagram - Diag.No.9030-B
- Power Unit Circuit & Wiring Diagram - Diag.No.9033-B

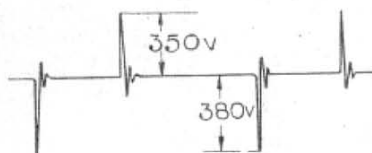
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File S.4761

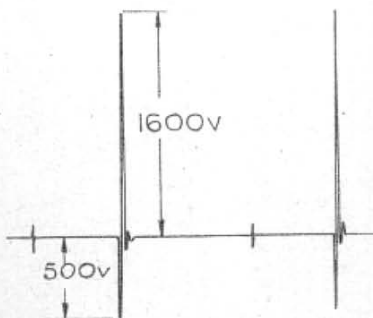
11th October 1943.
(No.119)

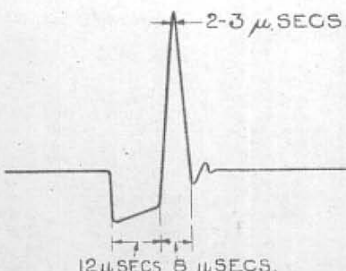
A  500~ MODULATOR L/P
17V. RMS.

B  675V
TRANS^F SECONDARY

C  310V
GRID OF V-124

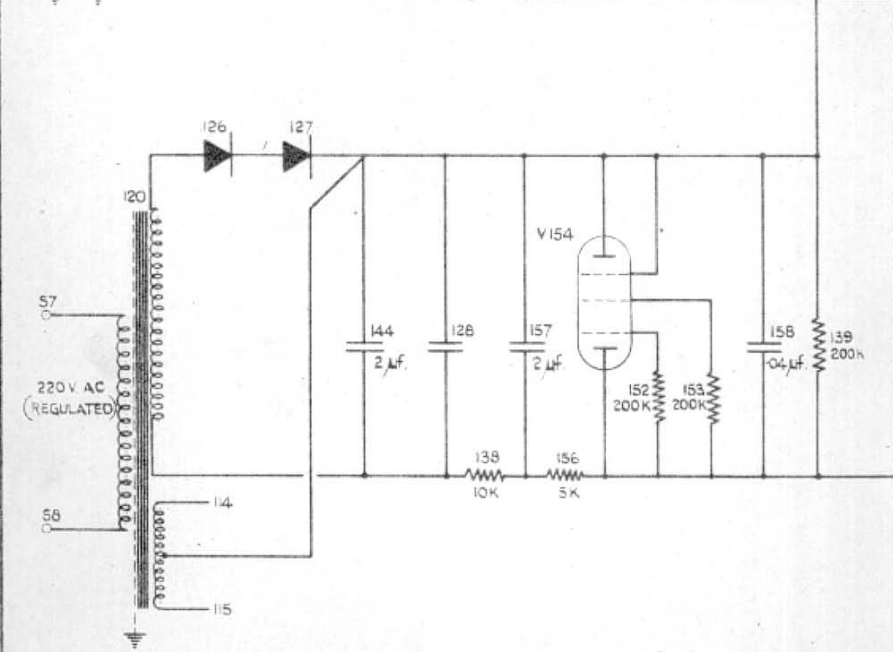
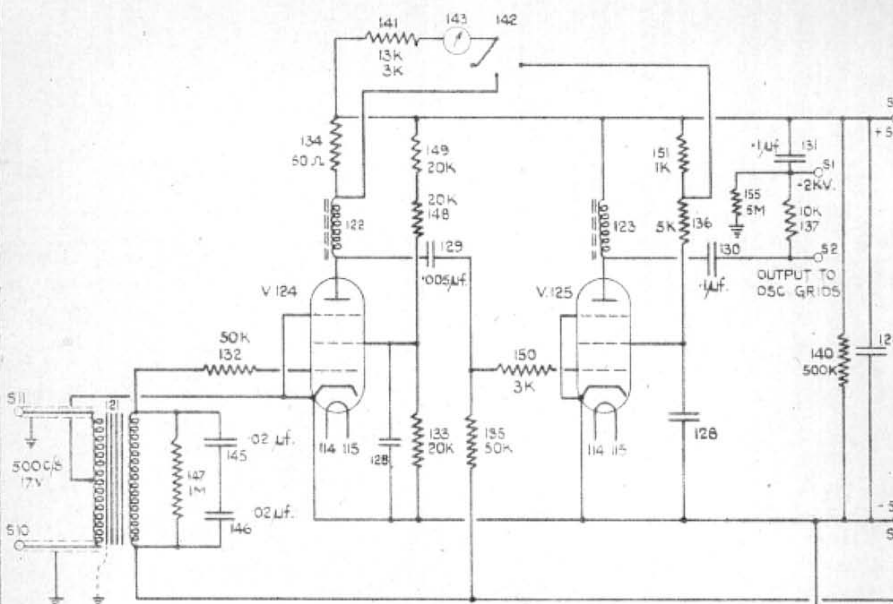
D  350V
380V
ANODE OF V-124
GRID OF V-125

E  1600V
500V
ANODE OF V-125

F  2-3 μ SECS.
12 μ SECS B μ SECS.
MODULATION PULSE AT S

Unclassified

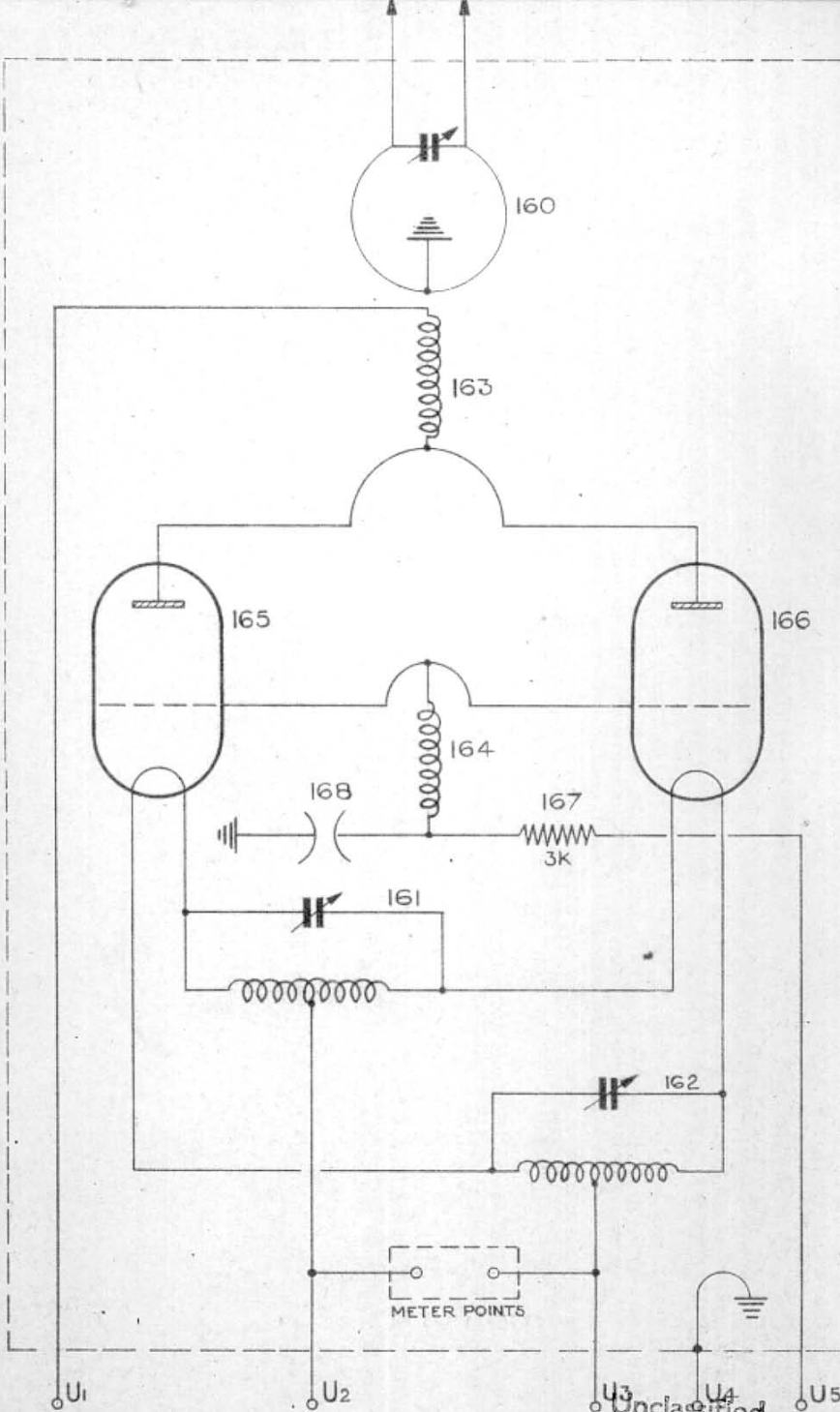
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NAME CAPTURED GERMAN GROUND RADAR EQUIPMENT. TRANSMITTER T.106. (FREYA).
MODULATOR T.S.102

MATERIAL:	ISSUE NO	29-9-43			
SPEC. NO (LAT. ISSUE)	ALTY NO				
USED ON SCHEDULES	DRAWN	TRACED	CHECKED	DATE	APPROVED

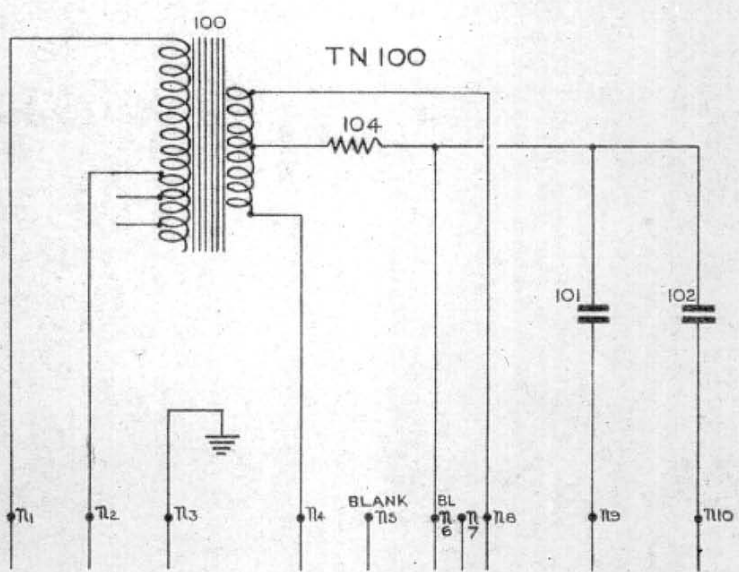
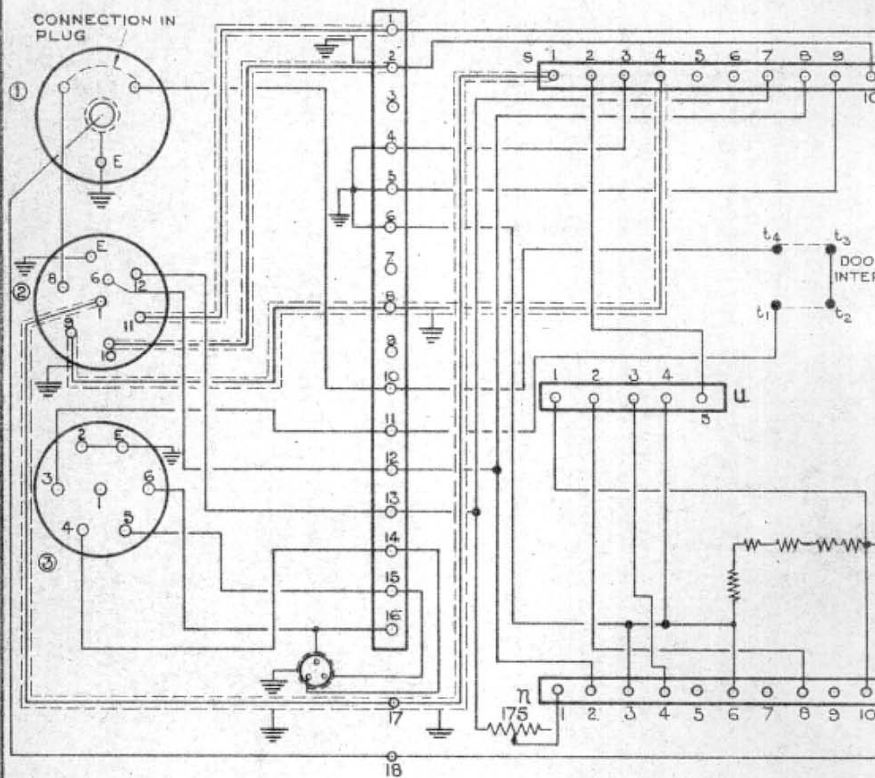


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NAME CAPTURED GERMAN GROUND RADAR EQUIP: TRANSMITTER T106 (FREYA) OSCILLATOR T.U. 100.

MATERIAL: ISSUE NO 1,249 43



NAME CAPTURED GERMAN RADAR EQUIP: TRANS: T106 (FREYA) INTERNAL WIRING AND TN 100 UNIT.

MATERIAL:	ISSUE N ^o	1 29.5.43			
SPEC. N ^o (LAT. ISSUE)	ALT: N ^o				
USED ON SCHEDULES	DRAWN	TRACED	CHECKED	DATE	APPROVED

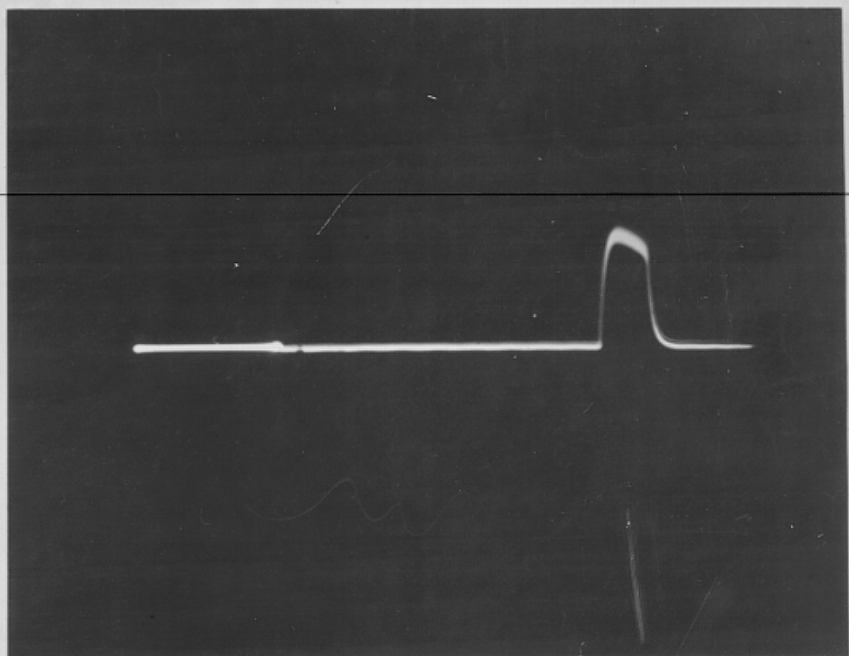


FIG.1. OUTPUT WAVEFORM DEMODULATED R.F.PULSE



FIG.2. OSCILLATOR UNIT T.U.100-REMOVED FROM CASE.

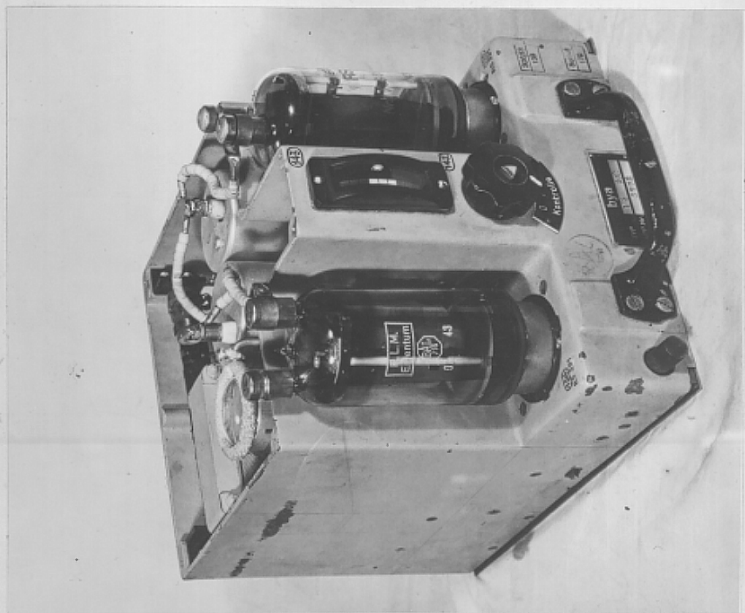
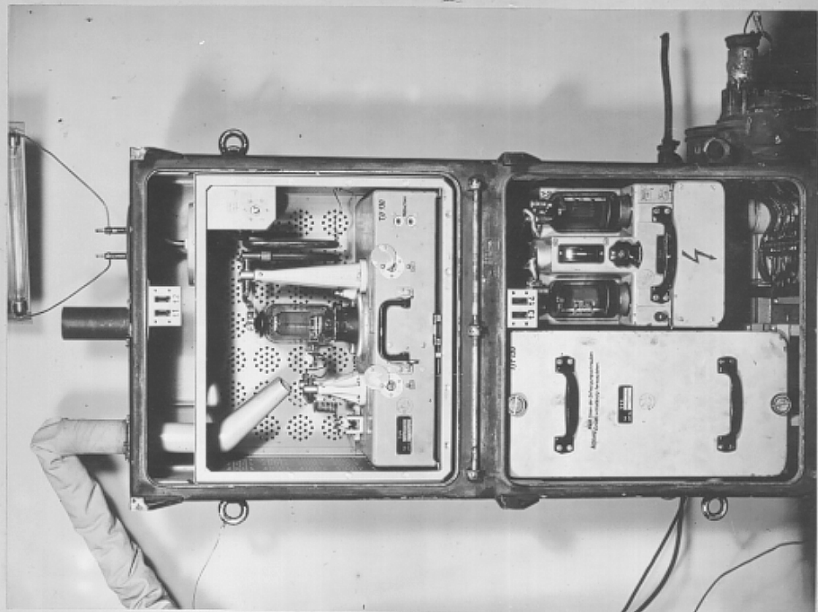


FIG.3 MODULATOR UNIT - T.S.102.



FIG.5. OSCILLATOR - ANODE LECHER SHORT.



NOTE POSITION OF
CHOKES