R.D.J. M.24

Unclassified

COPY No ------

[redacted]

[redacted]

44/5712

This Document is Unclassified & not as indicated within. C.R.R. 17/1/1955.

U C 5712

R. A. E.

RADIO DEPARTMENT

TECHNICAL NOTE

No RAD. 224

(Attention is called to the penalties attaching to any infraction of the Official Secrets Act.)

This document is the property of H. M. Government.

It is intended for the use of the recipient only, and for communication to such officers under him as may require to be acquainted with the contents of the report in the course of their duties. The Officers exercising this power of communication will be held responsible that such information is imparted with due caution and reserve.

Any person other than the authorised holder, upon obtaining possession of this document, by finding or otherwise, should forward it, together with his name and address, in a closed envelope to The Secretary, Ministry of Aircraft Production, Church House, Westminster, S.W.1. Letter postage need not be prepaid, other postage will be refunded.

All persons are hereby warned that the unauthorised retention or destruction of this document is an offence against the Official Secrets Acts 1911 – 1920.

This Document is Unclassified & not as indicated within [redacted]
C.R.B. 17/1/1955.

Unclassified

Technical Note No. Rad. 224

Technical Note No. Rad. 224
November, 1944.

ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH

German Ground Radar Equipment

Display Unit Type OB110 for Seetakt and Freya Installations

by

W. Langrish

SUMMARY

This note describes the operation and construction of display unit type OB110. The unit is fitted with one cathode ray tube (screen diameter 3⅝") and shows any 20 kms of the trace on the Main Display Unit (MB110) which the operator wishes to view. The cathode ray tube contains two complete sets of electrodes, thus making possible the simultaneous display of Radar and I.F.F. signals.

CONTENTS

1. Introduction

This apparatus was examined and rebuilt where necessary as part of a programme of reconstructing complete Seetakt and Freya installations. The Display Unit OB110 is used, together with the Precise Range Measuring Unit (reference 8.15) for the precise measurement of range on any target indicated by the chief operator who is in charge of the Main Display Unit NB110 (reference 8.01).

Some repair work was necessary including the replacement of broken leads and resoldering dry joints. Many of the original soldered joints were poor and, in general, the workmanship was not good.

No German RFG5 half wave valve rectifier valve was available and a British U17 (VU113) was substituted.

2. General Description

The OB110 is mounted with the Precise Range Measuring Unit in a cast light alloy box, the whole forming an apparatus known as "Gerat 0".

The mechanical construction of the unit, illustrated in Figs. 1 and 2 is extremely rigid, all members being pinned and screwed together. The apparatus is fixed in its protective box by means of slide rails on the bottom bed plate which has two locating holes at the rear, the whole being secured by two captive screws.

The mains transformer and certain other heavy items are mounted on bakelised fabric panels, and the mechanical layout of these panels follows closely the electrical layout of the circuits, which can be indicated roughly as follows:-

(a) Large Bottom panel - Power Supply apparatus (excluding valves) (Figs. 1 and 2).

(b) Small panel at rear of (a) and above the mains transformer - Power supply valves - (Figs. 1 and 2).

(c) Large panels in front of and higher than (b) - 500 cycle amplifier shelf (Figs. 1 and 2).

(d) Panel at top of frame on the left hand side - D.C. apparatus of C.R.T. (Fig. 1).

(e) Small panel at front below C.R.T. and switch - Brilliance, focus and balance potentiometer panel (fig. 1).

(f) Very small panel at left hand side of C.R.T. - X and Y shift potentiometer panel (Fig. 1).

(g) Small panel above C.R.T. - Time base and black-out circuits. (Figs. 1 and 2).

The servicing of this unit is very difficult, as panels (a), (b) and (c) are inaccessible and interconnections between the panels are numerous and straggling. When the unit is pushed into its outer box, connections are automatically made by means of sixteen contacts. Contacts Nos. 1-8 are concerned with the 500 cycle part of the apparatus and are placed in a vertical line down the middle of one of the back members (Fig. 2). Contacts Nos. 9-14 carry 50 cycle A.C. supplies and are situated in the middle of the bed plate (fig. 2). Contacts 15 and 16 are concentric plugs situated on either side of the previously mentioned set of contacts, and carry the video signals straight to the Y-plates of the cathode ray tube.

The 8-way Jones plug visible in Fig. 2 was added during the course of reconstruction, to carry the supplies which are normally fed to contacts Nos. 1-14. This was necessary because the outer box was not available.

The cathode ray tube is intended to be viewed through a lens in the outer cover giving a threefold magnification, but this part of the apparatus was completely wrecked, and was not replaced.

Further optical apparatus is situated on top of the main frame and is used to produce a zero line of light on the rear face of the cathode ray tube, thus reducing parallax errors and enabling the reference mark to be clearly visible when working in a darkened cabin. A narrow slit covered with green glass is illuminated by means of a small tubular lamp (Soffittenlampe) and the image so formed on the screen of the C.R.T. may be focussed by adjusting the slit and the lens system.

3. Power Supply Circuits

A diagram of the power supply circuits is shown in Fig. 3. The whole power supply with the exception of the filament heating for the C.R.T. is derived from the large transformer (No. 307) which is mounted through the bottom bakelised fabric panel (a), para 2. This transformer is situated well away from the C.R.T. to reduce interference to a minimum.

A 2A fuse (No. 309) is provided in one side of the 220V, 50 cycle mains supply, and additional protection is provided by a 100mA fuse in the time-base and in the cathode ray tube H.T. circuits.

As in the case of the Main Display Unit NB110 the H.T. and shift supplies are derived from a Telefunken EZ12 valve. The operation of the rather curious circuit employed has already been described. (Ref. 8.01).

The +210V output from this circuit supplies H.T. to the 500 cycle amplifier, time-base and black-out valves, and the +70V and -70V outputs provide shift potentials for the C.R.T.

The E.H.T. supply for the C.R.T. (1500V) is normally supplied by a German RFG5 valve, but as this was not available a British U17 was substituted.

Transformer 307 also supplies heater voltages to the 500 cycle amplifier, time-based and black-out valves and a 12V output to the lamps on the Precise Phase Shifting Unit (OK106) (reference 8.15). The small filament transformer (No. 308) has four 4V outputs, two of which are used to supply the heaters of the C.R.T. and two of which are spare.

4. Time Base Circuit

A diagram of the circuit is shown in Fig. 4 and associated waveforms in Fig. 6.

The 500 cps sine wave is fed from the Master Oscillator ZP100, (reference 8.16) through the precise Phase Shifter, OK. 106 (reference 8.15) to contact B1 on this unit. At this point the amplitude is 1.9V peak to peak.

The amplifying stage with valve 402 has a relatively large negative bias and this, combined with the use of an inductive anode load formed by 405 and 398, gives an output voltage at B3 of the form shown in Fig. 6B. This shows some distortion compared with the initial sine wave due to the presence of some third harmonic. The peak to peak amplitude is 5.4V.

The German "Apparatus Handbook" states that the phase at contact B3 is the same as that at contact B1 and gives this as a reason for the use of an inductive anode load. This statement would appear to be incorrect.

The input to the next stage, valve 305, comes from the contact B4 which is shorted to contact B3 when the unit is inserted in its case. The reason for this method of connection between the two stages is unknown, but suggests the possibility of an alternative method of use. This stage has a normal bias arrangement, with a 700K ohms resistance in series with its grid. This tends to flatten the positive peaks of the voltage wave form at the anode of the valve. The use of the transformer 372 as an anode load introduces further distortion as shown in Fig. 6C. The output from the secondary of this transformer which is balanced to earth is shown in Fig. 6d and has a peak to peak amplitude of over 700V. The condenser 393 serves to tune the winding in the region of 500 cps. A frequency response curve is shown in Fig. 7.

The linear part of the waveform indicated in Fig. 6d. forms the time base for the unit.

The voltage at the anode of 305, is also fed to the phase shift network 380-386 and thence to the grid of valve 306. This stage has no cathode bias, but has a one megohm resistor in series with its grid. Fig. 6e shows the waveform across the grid leak, 386, which indicates frequency distortion occurring in the transmission of the distorted waveform from valve 305.

The voltage supplied to the grid is over 180V peak to peak and hence the stage 306 squares off the positive and the negative peaks, giving an output waveform as shown in Fig. 6f. This waveform is fed through condensers to the grids of the C.R.T. The phase change through the network 380-386 is such that the positive half of the waveform brightens the trace for the duration of the display.

5. The Cathode Ray Tube Circuit

A diagram of this circuit is given in Fig. 5. The cathode ray tube has two complete sets of electrodes so that there are virtually two C.R.T.'s to be controlled in the same unit. The first anode of each of the two systems is taken to a common point and both third anodes are earthed, but the rest of the electrodes are supplied by separate resistance chains.

As in the main display unit, an attempt has been made to form a balanced load on the X-plates. One plate is connected to earth via a one megohm resistor whilst the other is connected to earth via two 500 K-ohm resistors in series. This would of course be a balanced load were there no other connections. The shift voltage is, however, fed in at the junction of the two 500 K-ohm resistors, from the horizontal shift potentiometer. The presence of this resistance greatly diminishes the deflection potential that would have otherwise been built up across the 500 K-ohm resistor. The resistance between the deflector plates and earth can never exceed 667 K-ohms and it would have been preferable to use a one megohm resistor on each side and connect one directly to the potentiometer slider; as has been done in the case of the vertical shift. No attempt has been made to obtain push-pull amplification of signal voltages or astigmatism correction and the whole equipment for shifting the two traces comprises four 500K-ohm potentiometers shunted across the +70 and -70v stabilised outputs from the power supply.

As in the Main Display Unit, the same sweep and black-out potentials are applied to both systems so that in order that any signals displayed simultaneously on the two traces may coincide it is necessary to choose the D.C. potential applied to the other electrodes so that their sensitivities are as nearly as possible the same. This function is performed by the mechanic in setting up the focus and brilliance controls. It is extremely difficult to obtain a good trace on both systems at once. When adjustment is finished the balance control potentiometer (No.348) enables a final matching up of the echoes to be achieved although this is often at the expense of clearness of focus. This control which is situated on the bakelised fabric panel together with the brilliance and focus potentiometers is accessible only to the mechanic.

The two focus controls on the left hand side of the front panel and the two brilliance controls on the right hand side of the front panel each have a common control accessible to the operator from the outside of the containing box. The two controls in each group, however, are geared together by means of bakelite spur gears which can be slid out of engagement for independent adjustment to satisfy the conditions previously mentioned. These two groups of potentiometers are driven by a dog on an external spindle which engages in a slotted disc carried on one of the potentiometer spindles of each group.

The discs are fitted with spring loaded couplings which will slip before force enough to damage the gears or potentiometers can be applied. In addition the brilliance group has a stop which may be set to limit the available brilliance of the C.R.T. Condenser No.360 in this circuit has only one side connected, the other side going to a free tag. The purpose of this component is unknown.

The video signals are conducted from the I.F. unit via concentric plugs Nos. 15 and 16 to one of the Y-plates of each section of the C.R.T. Shift voltages are applied to the other Y-plates.

6. Operating Data

The following measurements have been made on the unit to date:-

(A) The values given in this set of measurements are all peak to peak and were measured with an oscilloscope.

(a) 500 cps input on b1 -- 1.9V.

(b) terminal b3 --- 5.4V

(c) anode of Time base valve to earth - 336V

(d) primary of Time Base transformer- - 336V

(e) secondary of time base transformer -- 742V

(f) before the grid stopper of valve 306 -- 185V

(g) the grid of the blackout valve 306 -- 80.5V

(h) the anode of the blackout valve 306 -- 87.5V

(i) voltage across the stabilivolt -70V terminal - earth - 77V

(j) the valves of current given in these measurements are peak to peak and were measured by an oscilloscope looking across a shunt. Average values given by avometer.

(a) mains input current - 2.6A average value .575 A

(b) H.T. rectified current - 700 mA - 61.8mA

(c) E.H.T. rectified current - 302.6mA - 11.0mA

(B) The following measurements were made with an avometer:-

(a) Y- sensitivity of tube HR2/100/1.5A = 35.1V/cm

X- " " " " " = 34.7V/cm

(b) Volts on tube base.

Ca-E - 1200VDC
Cb-E - 1200VDC
Ga-E - 850 VDC
Gb-E - 800VDC
$A1_{ab}$-E - 720VDC
$A2_a$ -E - 690VDC
$A2_b$ -E- 630VDC

(c) EHT load = 11mA

EZ12 load = 61.8 mA

(d) Stabilivolt test terminals at rear of chassis

-70-E	-34
+70-E	+72
+140-E	+144
+210-E	+ 214

(e) Heater volts on 1st half of HR2/100/1.5A - 4.4VAC
" " " 2nd " " " " - 4.35VAC

7. Conclusions

This piece of apparatus is interesting, mainly because it differs in many respects from normal British practice. Its mechanical construction is very sound, but many of the electrical components are inaccessible. There is nothing remarkable in the electrical design of the circuits, in fact many are somewhat primitive, and the function of certain parts is incorrectly explained in the German "Apparatus Handbook".

The operator's job is a very trying one. The display tube in the unit has only a 9.5 cm face and the narrow bandwidth of the receiver, together with the fast speed of the time base makes the observation of small amplitude echoes very difficult.

8. Reference and Relevant Reports.

		R.A.E. Technical Note No.
8.01	Coast Watcher and Freya Installations- Main Display Unit NB, 110	RAD. 204
8.02	Freya Transmitter T106	RAD. 156
8.03	Fuse 62 Mechanical Aspects and Turning Gear	RAD. 151
8.04	" " Display Unit OSZ62	RAD. 178
8.05	" " Low Tension Circuits	RAD. 189
8.06	" " Pulse Generators IG62 and IG62.A	RAD. 196
8.07	" " Monitoring Receiver Units KD62 and KD64	RAD. 202
8.08	" " D type Display System	RAD. 203
8.09	" " Examination of Aerial Feeder System and R.F. Circuits.	RAD. 218
8.10	Examination of German Valves manufactured between 1938 and 1943	RAD. 114
8.11	Examination of German Valves and C.R.T.8s	RAD. 155
8.12	German Valve type LDa	RAD. 150
8.13	German Valve type LD2	RAD. 127
8.14	" " " LF1	RAD. 149
8.15	The Precise range Measuring Unit type OK106	RAD. 209
8.16	Master Oscillator Unit type ZP100 of Seetakt and Freya Installations	RAD. 232

APPENDIX 1

PARTS LIST

No.	COMPONENT	DESCRIPTION
301	Cathode Ray Tube	HR2/100/1.5A (A.E.G.
302X	Rectifier valve	U17 (VU113) (British).
303	" "	EZ12 (Telefunken).
304	Stabilivolt	STV280/80
305	Pentode valve	RV12 P2000 (Telefunken).
306	" "	" " "
307	Mains transformer	220/6.3: 1500: 2 x 6.3: 2 x 6.3: 2 x 6.3: 2 x 500v.
308	Heater transformer	220/4; 4; 4 ; 4v.
309	High Voltage fuse	2A
310	" " "	100 mA.
311	" " "	100 mA.
313	Resistance	60K ± 5% ; 4W.
314	Condenser	0.5 µF ± 10% ; 2/6 KV. DC.
315	"	" " " " "
318X	Resistance	10K ± 5% ; 0.25W
320	Condenser	4 µF ± 10% ; 500V. DC.
321	"	" " " "
322X	Electrolytic Condenser	10 µF + 50 - 20% ; 100V. DC.
323	Choke	15H
324	Resistance	6K± 5% ; 35W.
325	Electrolytic Condenser	16 µF ; 250V. D.C.
326	Resistance	200K± 5% ; 0.5W.
327	Electrolytic Condenser	16 µF ; 250V. DC.
328	" "	10 µF + 50 - 20% ; 100V. DC.
329	Resistance	1M± 5% ; 0.5W.
330	"	" "
331	Potentiometer	500K ; 0.5W.
332	"	" "
333	Potentiometer	500K ; 0.5W.
334	"	" "
335	Resistance	1M ± 5% ; 0.5W.
336	"	" " "
337	Condenser	30,000 pF ± 10% ; 500V. DC.
338	Resistance	0.5M ± 5% ; 0.5W.
339	"	" " "
340	"	1M ± 5% ; 0.5W.
341	"	0.5M ± 5% ; 0.5W.
34	"	" " "
343	"	1M ± 5% ; 0.5W.
344	Condenser	10,000 pF ± 10% ; 500V DC.
345	"	" " " " "
346	"	" " " " "
347	"	" " " " "
348	Potentiometer	30K ; 2W.
349	Condenser	10,000 pF ± 10% ; 2K V. DC.
350	"	" " " " "
352	Potentiometer	30K ; 2W.
353	Resistance	100K ± 5% ; 1W.
354	Potentiometer	100K ; 2W.
355	Resistance	100K ± 5% ; 1W.
356	"	200K ± 5% ; 2W.
357	"	200K ± 5% ; 0.5W.

X Replacements.

APPENDIX 1 (continued)

PARTS LIST

No.	COMPONENT	DESCRIPTION
359	Electrolytic Condenser	10 µF + 50 - 20% ; 100V. DC.
360	Condenser	10,000 pF ± 10% ; 2KV. DC.
361	Resistance	30K ; 2W.
362	Potentiometer	30K ; 2W.
363	Resistance	100K ± 5% ; 1W.
364	Potentiometer	100K ; 2W.
365	Resistance	100K ± 5% ; 1W.
366	"	200K ± 5% ; 2W.
367	"	100K ± 5% ; 0.5W.
368	"	" " "
369	Electrolytic Condenser	10 µF + 50 - 20% ; 100V. DC.
370	Resistance	400K ± 5% ; 1W.
371	"	" " "
372	Coupling transformer	
373	Resistance	0.7M ± 5% ; 0.25W.
374	Resistance	100K ± 5% ; 0.25W.
375	Condenser	30,000 pF ± 10% ; 500V. DC.
376	Electrolytic Condenser	10 µF + 50 - 20% ; 20V. DC.
377	Resistance	400 ohms ± 5% ; 0.25W.
378	Condensers.	0.03 µF 250V. DC.
379	Resistance	100K ± 5% ; 0.5W.
380	Condenser	1000 pF ± 10% ; 500V. DC.
381	"	" " " ; 1000V. DC.
382	"	10,000 pF ± 10% ; 500V. DC.
383	Resistance	1M ± 5% ; 0.25W
384	"	" " "
385	"	" " "
386	"	" " "
387	Electrolytic Condenser	2 µF + 50 - 20% ; 250V DC.
388	Resistance	200K ± 5% ; 0.25W.
389	Electrolytic Condenser	2 µF + 50 - 20% ; 250V DC.
390	Resistance	150K ± 5% ; 0.5W.
391	"	100K ± 5% ; 0.25W.
392	Tubular lamp	15V ; 15W.
393	Condenser	100 pF ± 10% ; 500V.
394	"	1000 pF ± 10% ; 500V DC.
395	Resistance	3M ± 5% ; 0.25W.
396	"	1.5K ± 5% ; 0.25W.
397	"	20K ± 5% ; 0.25W.
398	"	2K ± 5% ; 0.25W.
399 X	Electrolytic Condenser	10 µF + 50 - 20% ; 20V. DC.
400	Condenser	0.5 µF ± 10% ; 250V. DC.
401	"	" " "
402	Pentode Valve	RV. 12 P. 2000 (Telefunken).
403	Resistance	20K ± 5% ; 0.25W.
404	Condenser	1 µF ± 10% ; 500V. DC.
405	Choke	120mH ± 10%
W1	Resistance	2M ; 1W.
W2	"	1M ; 0.5W.
W3.	Resistance	2 ohm ; 3W.
W4.	" ;	1 ohm ; 3W.
L1	Neon indicator lamp	230 - 240V ; Osglim.
S1 X	Switch	"Arrow" 250V ; 10A ; 10A; 2 pole on - off.

Unclassified

~~SECRET~~

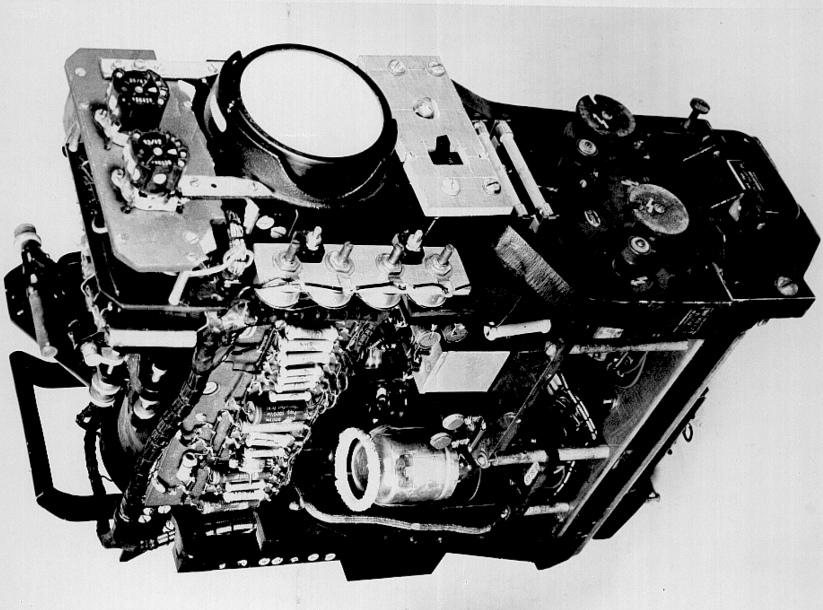


FIG. 1.

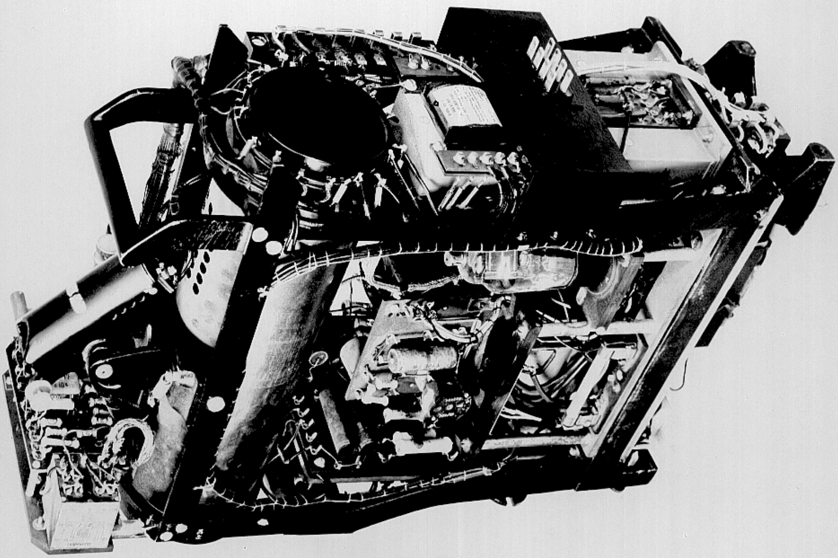
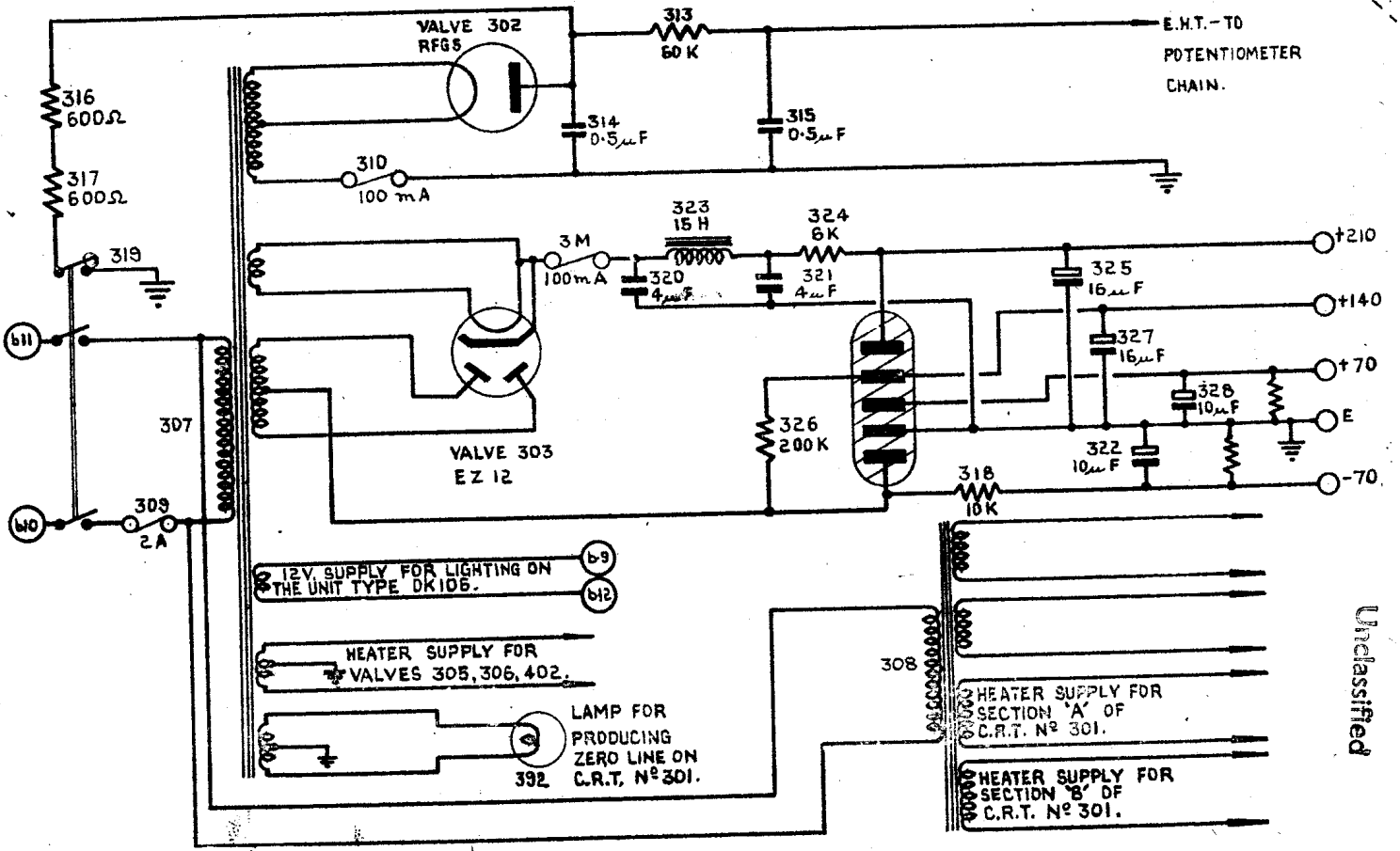


FIG. 2.

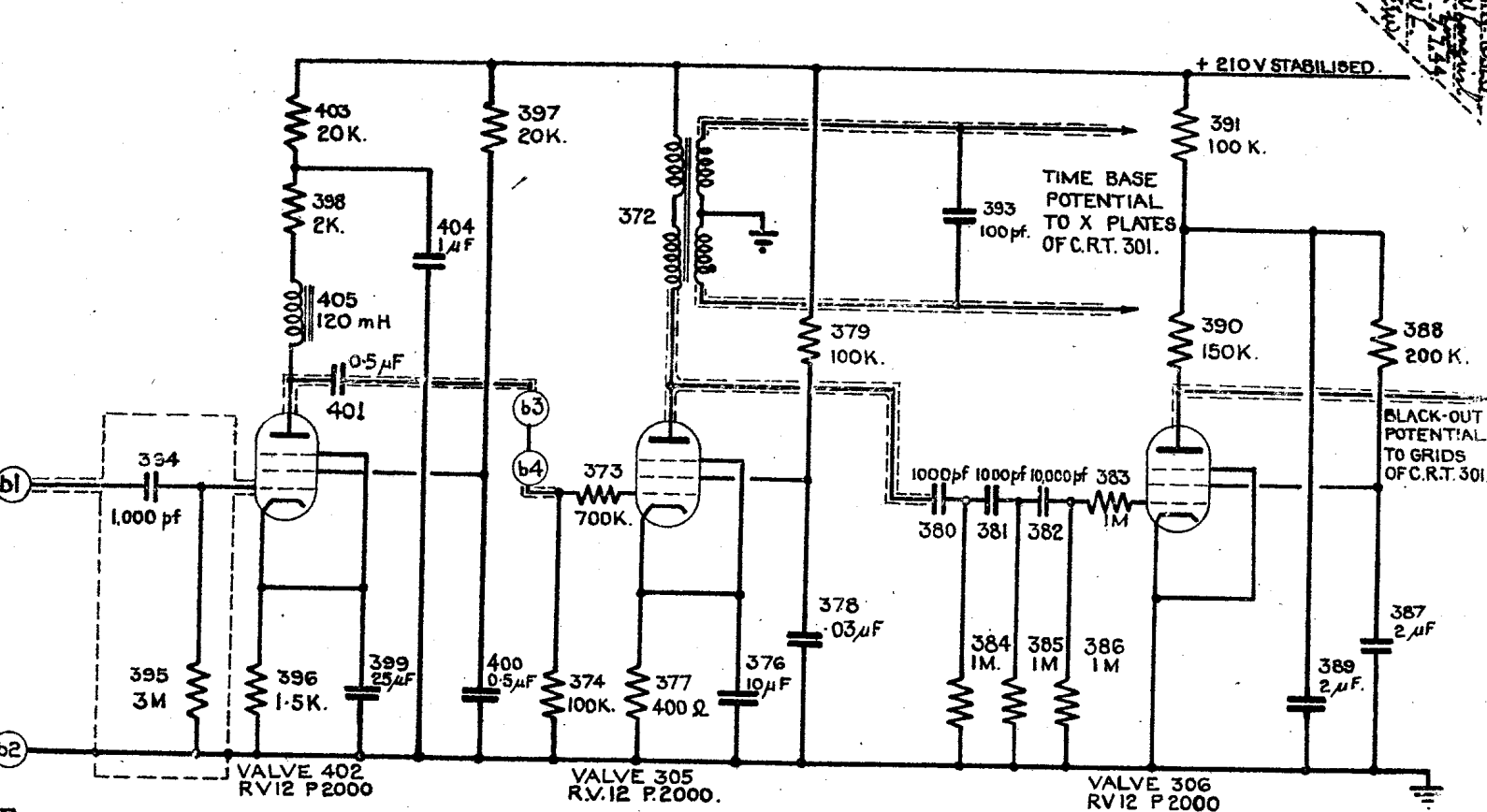
DISPLAY UNIT TYPE OB 110.

FIGS. 1 & 2.

ROYAL AIRCRAFT ESTABLISHMENT PHOTOGRAPHIC DIVISION	
NEG. No.	55760.
DATE	24-7-44.

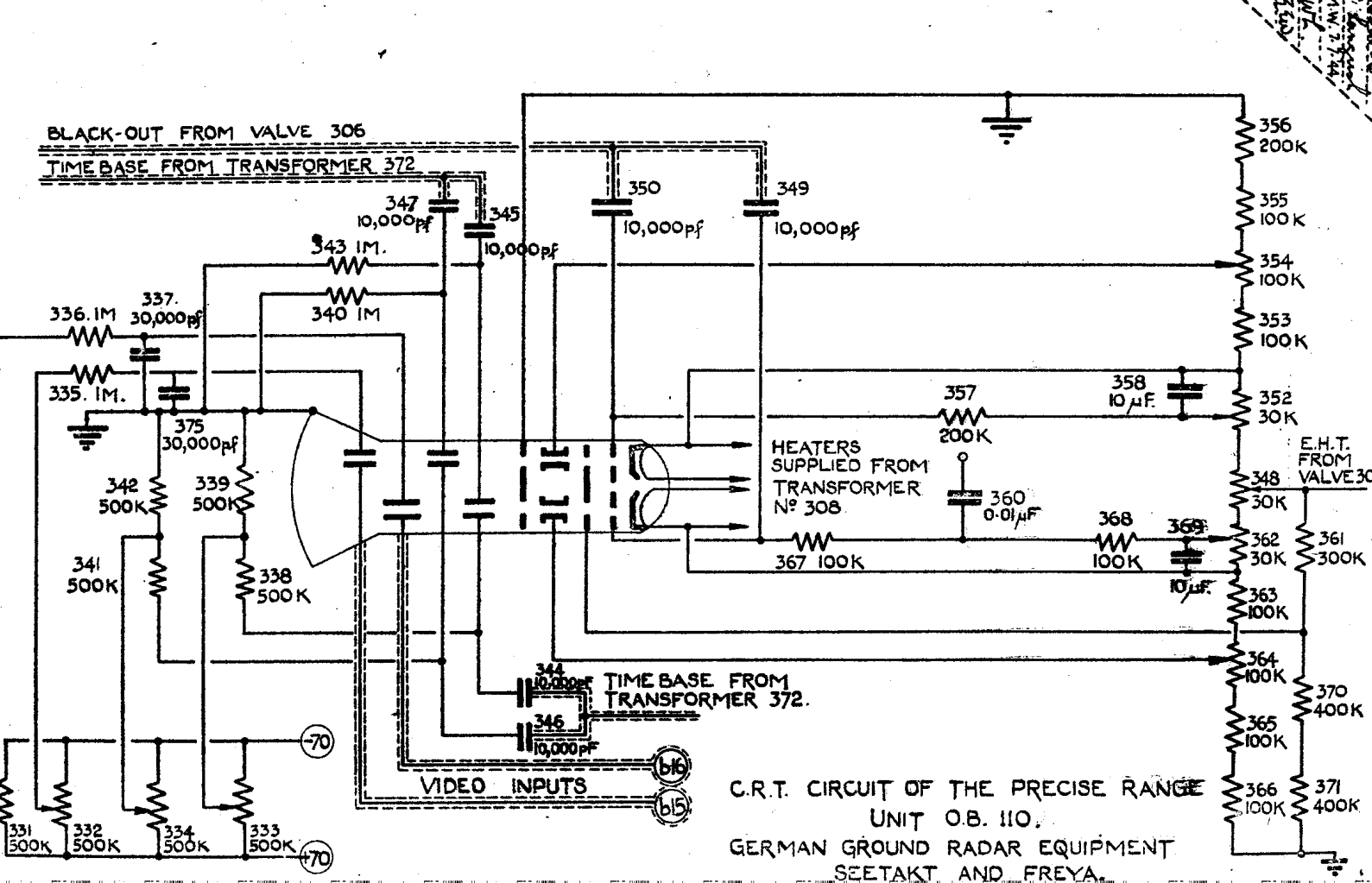


POWER SUPPLIES FOR THE PRECISE RANGE UNIT OBIID. FIG 3.

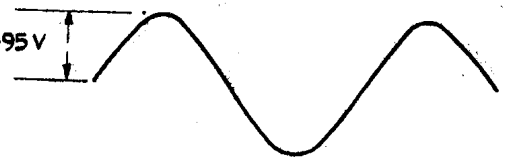


DEFLECTION AMPLIFIER OF THE PRECISE RANGE UNIT O.B. 110.
GERMAN GROUND RADAR EQUIPMENT
SEETAKT AND FREYA.

FIG 4



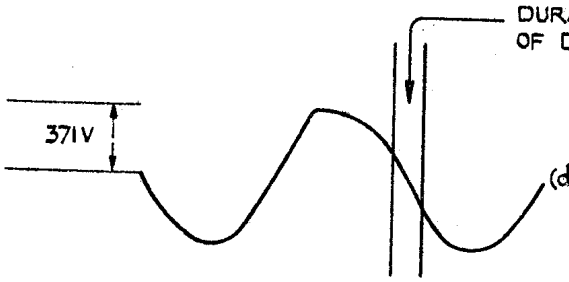
C.R.T. CIRCUIT OF THE PRECISE RANGE UNIT O.B. 110.
GERMAN GROUND RADAR EQUIPMENT
SEETAKT AND FREYA.



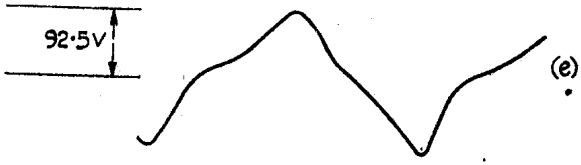
(a) SINUSOIDAL INPUT TO b1 (500 c/s)

(b) OUTPUT OF VALVE 402 AT TERMINAL b3.

(c) ANODE OF VALVE 305.



(d) OUTPUT AT SECONDARY OF TRANSFORMER 372.



(e) WAVEFORM AFTER PHASE RETARDATION IN GRID NETWORK OF VALVE 306

(f) BRIGHTENING PULSE FROM SQUARER VALVE 306

OB 110 WAVEFORMS IN TIME BASE

GERMAN GROUND RADAR EQUIPMENT.
THE PRECISE RANGE DISPLAY UNIT OBIIO.
SEETAKT AND FREYA.

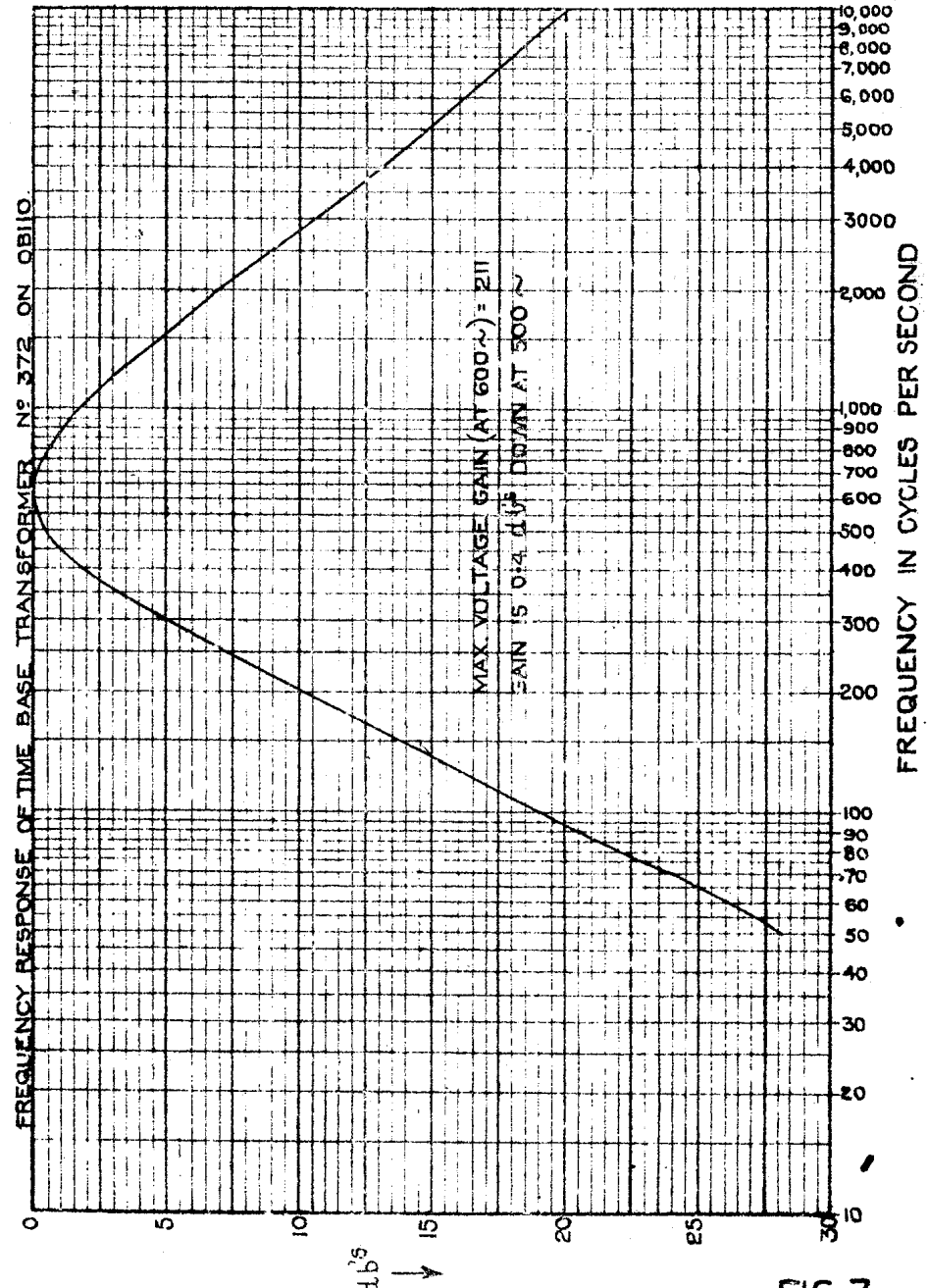


FIG. 7.
DIAG. Nº 10504/B