AIR PUBLICATION

116C-0801-1D

GROUP 116: RADIO

SUB-GROUP C: NAVIGATIONAL AND LANDING AIDS (GROUND)

U.H.F. C.A.D.F.
D.F. AND COMMON STATION EQUIPMENT

GENERAL AND TECHNICAL INFORMATION

FOR USE IN THE

ROYAL AIR FORCE

(Prepared by the Ministry of Aviation)

NOTE TO READERS

The subject matter of this publication may be affected by Defence Council Instructions, Servicing schedules (Volume 5 or "General Orders and Modifications" leaflets in this A.P., in the associated publications listed below, or even in some others. If possible, Amendment Lists are issued to correct this publication accordingly, but it is not always practicable to do so. When an Instruction, Servicing schedule, or leaflet contradicts any portion of this publication, the Instruction, Servicing schedule, or leaflet is to be taken as the overriding authority.

The inclusion of references to items of equipment does not constitute authority for demanding the items.

Each leaf, except the original issue of preliminaries, bears the date of issue and the number of the Amendment List with which it was issued. New or amended technical matter will be indicated by black triangles positioned in the text thus:- ◀------▶ to show the extent of amended text, and thus:- ▶◀ to show where text has been deleted. When a Section, or Chapter is issued in a completely revised form, the triangles will not appear.

SECURITY

◀ This publication was originally graded RESTRICTED but AL 25 gave instructions for this marking to be deleted wherever it occurs.▶

LIST OF ASSOCIATED PUBLICATIONS

<u>U.H.F. CADF FGRI. 23078 and TGRI (AT). 26006</u>

Introduction and theory	AP	116C-0801-1A
Multifrequency receiver equipment	AP	116C-0801-1B
Pretuned receiver equipment	AP	116C-0801-1C
Display units	AP	116C-0801-1E
U.H.F. CADF display console Types 14414, 14414A, 14415 and 14415A	AP	116C-0801-1F
Stations Type A and B	AP	116C-0801-1G
Stations Type C, G and D	AP	116C-0801-1H
Stations Type F and E	AP	116C-0801-1J
Stations Type J, K and M	AP	116C-0801-1K
Stations Type L and LL	AP	116C-0801-1L
Transportable station	AP	116C-0801-1M
Autotriangulation	AP	116C-0804-1 series

CONTENTS

SECTION 4 TEST EQUIPMENT

Chapters

MODIFICATIONS

Modifications to the d.f. and common station equipment contained in this publications are detailed in numerical order below, together with applicable equipment, class and modification label erasure number.

MOD. NO.		MOD. LABEL ERASURE NO.	CLASS OF MOD.
5736/2 5731/1 6529	Generator reference pulse -943-5889	2 1 3	B/0
5738/1 5957	Amplifier, R.F. -943-5900 (combining amplifier)	1 2	B/0 B/2
5739/1 6384 6255	Amplifier, D.C. -943-5890 (bearing display amplifier)	1 2 -	B/0 B/0 B/2
5768 6888	Power supply -932-4856 (man a.f. power supply)	1 2	B/2 A/1
5769	Convertor signal data -943-5893 (resolver)	1	B/2
6254 6450 9717	Comparator signal -943-5894	1 2 3	B/2 B/3 C/3
6563	Delay line -943-5933	1	B/3
6850	Switch electronic -999-1343 (aerial splitting unit)	2,3	B/3
0910 6846 7286 7331	Calibrator direction finder -943-5905 (test oscillator)	5 2,4 3 1	C/3 B/3 B/3 B/3
6847	Gate electronic -943-6164 (aerial switch box)	1,2	B/3
6848	Amplifier R.F. -943-5899 (u.h.f. amplifier)	2,3	B/3
6887	Generator pulse -943-5934	1	B/3
7235 7979	Cabinet electrical equipment fitted -932-4861 and 4862	1 3	B/3 B/3
7572	Interconnecting box -943-5897	1	B/3
9203	Amplifier, D.C. -433-0812 (bearing display amplifier)	1	B/3

MOD. NO.		MOD. LABEL ERASURE NO.	CLASS OF MOD.
7279	Cabinet electrical equipment fitted -932-4858	2	B/3
0909	Aerial array -943-6162	-	C/3
7239	Oscillator R.F. -943-6165	1	B/2

CHAPTER 1

CABINETS DESCRIPTION

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GENERAL DESCRIPTION

INTRODUCTION

1. The single channel d.f., two channel d.f. and aerial switching cabinets are mechanically similar in construction and differing electrically only in the number of sub-units fitted to carry out d.f. and aerial switching functions in various types of C.A.D.F. stations as follows:

(a) Two channel d.f. cabinet 5820-99-932-4861. Contains two sets of d.f. units and aerial switching units to resolve two d.f. channels in C.A.D.F. stations, e.g. station Types A, C, G, J, K and M.

(b) Single channel d.f. cabinet 5820-99-932-4862. Contains one set of d.f. units and aerial switching units to operate in C.A.D.F. stations with a multi-frequency or pre-tuned receiver cabinets, e.g. station Types B, D, L and LL.

(c) Aerial switching cabinet 5820-99-932-4858. Contains a set of aerial switching units only to operate in C.A.D.F. stations with single pre-tuned or twin frequency pre-tuned receiver and d.f. cabinets e.g. station Types E and F.

2. The d.f. cabinets contain d.f. units and a set of switching units which generate 18 one millisecond aerial switching pulses per second. These pulses are fed to the pulse distribution box (5825-99-943-5897) to the aerial switch boxes and cause the commutation of the d.f. unipoles.

3. The chain of d.f. units in the d.f. cabinets convert the d.f. signals into d.c. voltages, with amplitudes proportional to the north/south and east/west co-ordinates of the d.f. bearing. The co-ordinate voltages are then fed via the display selection unit (6120-99-932-4855) to the G.P.O. distribution box and display console in the control tower or to the auto-triangulation branch channel cabinet.

4. All three types of equipment are fitted in an (empty) cabinet electrical equipment 5975-99-932-4843 and a number of smaller units. This chapter describes the overall function of the cabinets in the C.A.D.F. system. Table 1 below shows the type of cabinet for the relevant station type:

TABLE 1 SINGLE AND TWO CHANNEL D.F. CABINETS: STATION COMPLEMENT

Station Type (1)	FGRI 23078/No. (2)	Aerial switching cabinet (3)	d.f. cabinet (single channel) (4)	d.f. cabinet (two channel) (5)
A	1			Chan. 1 and 2
B	2		Chan. 1	
C	3			Chan. 1 and 2
D	4		Chan. 1	
E	9	Chan. 3		
F	5	Chan. 3		

Cont'd on page 2

TABLE 1 SINGLE AND TWO CHANNEL D.F. CABINETS: STATION COMPLEMENT (cont)

Station Type (1)	FGRI 23078/No. (2)	Aerial switching cabinet (3)	d.f. cabinet (single channel) (4)	d.f. cabinet (two channel) (5)
G	10			Chan. 1 and 2
J	6			Chan. 1 and 2
K	7			Chan. 1 and 2
L	8		Chan. 1	
LL	12		Chan. 1 and 2 (two cabinets)	
M	11			Chan. 1 and 2

Note...

Channels not mentioned have d.f. facilities in combined receiver and d.f. cabinets (see 116C-0801-1C).

MECHANICAL DESCRIPTION (figs. 1 and 2)

5. The cabinets are installed in the d.f. building at the d.f. site. Connections with other station equipment are detailed in the appropriate station publication. Electrical connections to the remainder of the C.A.D.F. station are made through connectors on top of the cabinet (table 2).

6. Two doors are provided at each side, and once opened, these may be lifted off their hinges and removed to facilitate access to the internal units in stations where other cabinets are adjacent. Each righthand door was originally fitted with a striker plate to operate switches SA or SB (fig. 3). These have now been removed (Mod No. A7777) and a warning label fitted to the cabinet.

7. The blower motor mounted in the top of the cabinet (fig. 3) extracts air which has been drawn in through filters fitted near the bottom of each door. It runs all the time the main equipment is on; with clean filters the air flow is 140 cu.ft./min.

8. Apart from the power unit at the bottom, the individual units which are mounted in the cabinet are in the form of 18 in. vertical chassis of various widths. Electrical connections to the units are made via plug and socket type connectors to the main cable form. After removal of the electrical connections to a unit, the unit may be removed by slackening the stag headed screws which hold the unit to the frame, lifting the unit upwards and then withdrawing it from the cabinet.

9. The units are referenced by letter coding relating to (figs. 5, 6 and 7) their physical position in the cabinet. The framework is referenced by the letter 'A'. Starting on one side of the cabinets, units occupying the higher physical level are given the reference 'B' and the units on the lower level are referenced 'C.'

10. At the rear of the cabinet, the higher level has units referenced 'D' and the lower level uses reference 'E'. At the bottom of the unit the main power unit is referenced 'FA' although the controls for this unit are on the same side as 'B' and 'C' units.

11. A further letter is used, as a suffix to the level - indicating level, the left hand unit starting with the letter 'A'. Thus a unit occupying the third position from the left of the upper level of the cabinets front side is referenced 'BC'. Plugs and sockets are referenced by sequential numbering on each chassis, regardless of the type of connector i.e. multi-contact or co-axial. (figs. 8 and 9 refers.)

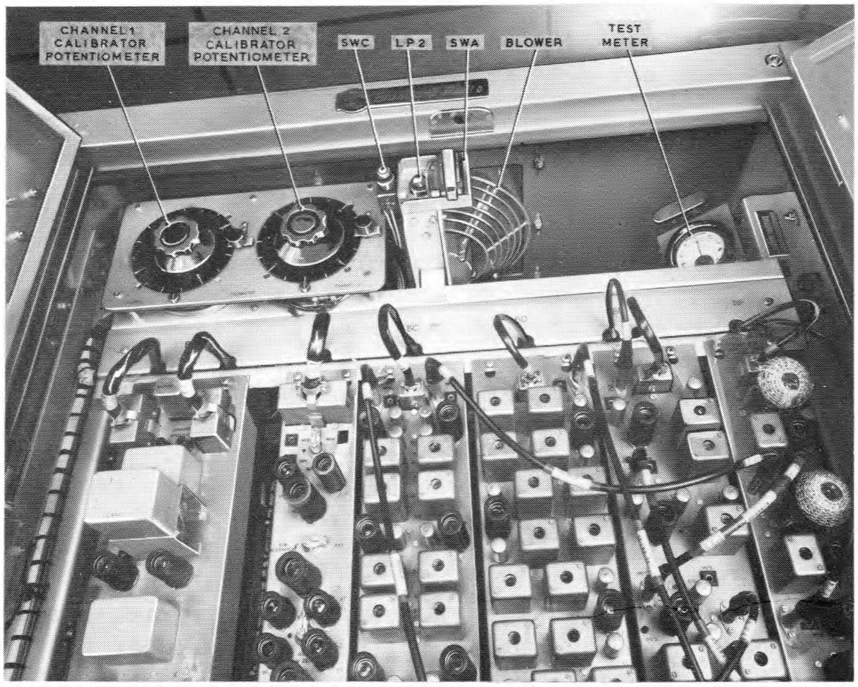


Fig. 3 D.f. cabinet: calibrator potentiometers and test meter

TABLE 2 EXTERNAL CONNECTIONS

Reference (1)	Cabinet fitting (2)	Termination (3)	Function (4)
AA1	6 way	Auto triangulation branch channel cabinet ITS2 and 4)	d.f. outputs to triangulation channel 1
AA2	6 way	)	d.f. outputs to triangulation channel 2
AA3	25 way	Pulse distribution box PL8	Aerial switching pulse outputs
AA4	12 way	Display selection unit PL2	D.F. out
AA6	12 way	Multi-frequency receiver cabinet	Control switching
AA7	2 way	Constant voltage transformer	Regulated 230V mains input
AA8	12 way	Pre-tuned receiver cabinets SKAA1 and SK6	
AA9	Co-ax)	Multi-frequency receiver channel 1)	D.F. and Aux. signal input channel 1
AA10	Co-ax)	)	
AA11	Co-ax)	Multi-frequency receiver channel 2)	D.F. and Aux. signal input channel 2
AA12	Co-ax)	)	

12. The d.f. units fitted to the cabinets 5820-99-932-4861 (two channels and 5820-99-932-4862 (single channel) are as shown in Table 3. Cabinet position and A.P. references are also given.

TABLE 3 D.F. UNITS FITTED TO SINGLE AND TWO CHANNEL D.F. CABINETS

Sub-unit (1)	Reference (2)	Single channel (cabinet position) (3)	Two channel (cabinet position) (4)	AP116C-0801 (5)
Resolver	5825-99-943-5893	BB	BB and CB	1D Sect 2, Chap 9
Signal comparator	5825-99-943-5894	BC	BC and CC	1D Sect 2, Chap 8
Delay line	5825-99-943-5933	BD	BD and CD	1D Sect 2, Chap 7
RF oscillator	5825-99-943-6165	BF	BD and CF	1D Sect 2, Chap 5
Combining amplifier	5825-99-943-5900	BE	BE and CE	1D Sect 2, Chap 6
Reference signal generator	5825-99-999-5889	BA	BA and CA	1D Sect 2, Chap 4
Meter and calibrator unit	S, T and C type 1-LRU-239-H	Above level B	Above level B	
Bearing display amplifier	5825-99-933-0812	EA	EA and EB	1D Sect 2, Chap 10
Power supply (main)	6120-99-932-4856	FA	FA	) 1D Sect 2, Chap 11
Power unit 75V	6130-99-943-5903	EC	EC	)

13. The aerial switching units fitted to the aerial switching cabinet 5820-99-932-4858 are given in Table 4. Cabinet position and A.P. references are also given.

Note...

The units contained in the aerial switching cabinet are also contained in the single and two channel d.f. cabinets with the exception of the resistor assembly 5905-99-933-1218 (level CC).

TABLE 4 UNITS FITTED TO THE AERIAL SWITCHING CABINET

Sub-unit (1)	Reference (2)	Cabinet position (3)	AP116C-0801 (4)
Oscillator AF	5825-99-943-5936	DA	1D Sect. 2, Chap. 1
Divider Network	5820-99-933-1117	DB	1D Sect. 2, Chap. 2
Generator pulse (3 off)	5825-99-943-5934	DC, DD, DE	1D Sect. 2, Chap. 2
Buffer amplifier (3 off)	5825-99-943-5895	DF, DG, DH	1D Sect. 2, Chap. 3
Power supply main	6120-99-943-4856	FA	1D Sect. 2, Chap. 11
Power unit - 75V	6130-99-943-5903	EC	1D Sect. 2, Chap. 11
Resistor assembly	5905-99-933-1218	CC	

D.F. SIGNAL CIRCUIT DESCRIPTION (Fig. 4)

14. There are two signal inputs (DF and AUX) to the rack of the single channel d.f. cabinet and a duplicate set for the two channel d.f. cabinet. Since the two channel version duplicates the single channel only, one set of signal paths will be described. The auxiliary signal provides a reference for the phase modulated d.f. signal, to enable unwanted phase modulation of the d.f. signal, due to speech modulation etc. to be cancalled out.

15. The auxiliary signal, at the intermediate frequency of 2 Mc/s is fed to the r.f oscillator sub-unit, where it is mixed with the crystal-controlled 130 Kc/s output of the oscillator. This produces an output at an intermediate frequency of 1.87 Mc/s which is then fed to the combining amplifier.

16. The d.f. signal at the intermediate frequency of 2 Mc/s is fed direct with the 1.87 Mc/s output from the r.f. oscillator. The output from this mixed stage is at 130 Kc/s, carrying all the original phase modulated d.f. information, now having the frequency stability of the 130 Kc/s oscillator in the r.f. oscillator. Any unwanted phase modulation of the incoming signal occurring simultaneously at the d.f. and auxiliary aerials does not appear on this output, having been cancelled out when mixing the two inputs together in the combining amplifier.

17. The overall phase excursion of the d.f. signal at this stage may be greater than 360°, this being more than the signal comparitor can handle. To overcome this the phase shift between consecutive d.f. aerial element is compared. This is achieved by the use of a delay line and mixer.

18. The 130 Kc/s output from the first mixer in the combining amplifier is fed direct to the mixer situated after the delay line. The 130 Kc/s is also fed to the second mixer in the combining amplifier where it is mixed with 50 Kc/s from a local oscillator. This produces an 80 Kc/s output which is applied to the delay line.

19. The delay to the 80 Kc/s signal is 1ms, this being the period of aerial commutation. The output of the delay line is then mixed with the direct 130 Kc/s signal to produce a 50 Kc/s d.f. output, this output being phase modulated with the phase difference of the r.f. signal between successive d.f. aerial elements.

20. The 50 Kc/s output is fed to one input of the signal comparitor, the other output being fed from 50 Kc/s oscillator. The two signals are limited, squared and differentiated to produce triggering pulses which are applied to a bi-stable flip flop. The output of the bi-stable consists of a positive and negative going square wave with a mark-space ratio determined by the phase relationship of the d.f. signal to the 50 Kc/s reference signal. A small portion of the 50 Kc/s reference signal is fed to the d.f. input so that when there is no d.f. signal, the mark-space ratio of the outputs will be unity.

21. The two square waves, in anti-phase are applied to the resolver. Sine and cosine reference voltages are also fed to the resolver from the reference signal generator. The resolver converts this information into d.c. potentials whose polarities and amplitudes correspond to the sine and cosine components of the bearing angle.

22. Low level d.f. information in this form is then fed to the bearing display amplifier. This provides cathode follower outputs to feed the local display indicator and the auto triangulation fixer service branch channel cabinet.

23. The reference signal-generator is fed with the one milli-second switching pulses, these being used to synthesize a sine wave having a frequency of 55.5 c/s i.e. the overall switching frequency. The phase of the output waveform with respect to the switching pulses is controlled by

the calibrator thereby enabling the alignment of the d.f. circuits to give information which is geographically correct.

AERIAL SWITCHING CIRCUIT (FIG. 4)

24. The a.f. oscillator (5825-99-943-5936) contains a 1 Kc/s oscillator, squarer and mono-stable flip flop from which a sharp positive going trigger pulse is developed. This pulse which has a duration of 10-20 microseconds occurs once every milli-second, is required for triggering the three cascade pulse generators (5825-99-943-5934).

25. The pulse generator utilizes six high speed, primed trigger, cold cathode valves. When the circuit is triggered six sequential switching pulses are provided for controlling the aerial switching circuits and the reference signal generator (see para. 23). There are eighteen aerial switching circuits and therefore, to obtain the requisite number of switching pulses, three pulse generators are used. The generators are connected in cascade and having the output from the last generator feeding back to the first, thus forming an overall ring of an eighteen counter-circuit. All three pulse generators obtain stabilized voltages required for their operation from the divider network (5820-99-933-1117).

26. The output pulse from each generator are applied to buffer amplifiers (5825-99-943-5895). The buffer amplifier consists of six identical cathode follower stages interposed between the pulse generators and the aerial switching circuits. The requisite number of controlling pulses are obtained from three buffer amplifiers.

CONTROLS (FIG. 8)

27. Control of the d.f. cabinet functions are via the controls for the receiver cabinets, whether they are under local (d.f. site) or remote (control tower or A.T.C.C. control).

28. The ON/OFF function of the cabinet is controlled by earthing lines to relays RLA, RLB and RLC in the main d.f. power supply, assuming that switch S2 on the power unit has been made. The -50V control voltage for the relays is from the appropriate receiver or the 50V power unit relay control in stations Type L and LL and applied to the d.f. power supply (main) via PL.F.A.1/5. The earthing lines for relays RLA, RLB and RLC are connected via SKFA2/22 (Chan. 1); SKFA2/23 (Chan. 2) and SKTA2/24 (Chan. 3 and 4) respectively. Channels 3 and 4 are two channels that are used exclusively for triangulation purposes. Even if Channels 3 and 4 are not used, an earth return for the coil of relay RLC is provided by the energized contacts of either RLA or RLB.

29. When relays RLA, RLB and RLC are energized, a.c. mains supply is switched to the following circuits:

(1) Blower fan (via SW6).

(2) Transformers TR3, TR4 and TR5 via SW7, SW8 and SW9 respectively to provide 6.4V a.c. for switching and valve heaters for channels 1 and 2.

(3) Via gate switches SA and SB, SW4 and SW5 respectively to power circuits generating 250V and 350V h.t. for channels 1 and 2.

(4) Via SW4 for bearing display amplifiers and the -75V power supply.

30. Relay RLC can be operated independently of relays RLA and RLB where triangulation channels are to be used without channels 1 and 2. In this case the h.t. and heater supplies are applied to the switching units only and resistor assembly CC is used (para. 43).

31. It will be noted that although relay RLA controls the switching of channel 1 h.t. supplies, the actual switching is via RLD which in turn is controlled by 30 second thermal delay X1. Similarly relay RLB controls the channel 2 h.t. supplies and is under the control of relay RLE and X2. The switching units are under control of relay RLF.

Monitoring facilities

32. Monitoring facilities is by the front panel meter M1 and switch S1, which monitors the following voltages:

(1) +250V d.c.

(2) +350V d.c.

(3) -75V d.c. (routed into the unit via SK.FA2/4).

(4) -50V d.c.

(5) 230V a.c. mains supply.

Centre check on/off

33. The action of the centre check is achieved by open circuiting the 50 Kc/s output from the delay line, by operation of relay RL1/1 which is situated in the delay line. The relay is operated by the application of an earth from the control unit in the receiver cabinet in the local condition or from control equipment in the control tower.

Reference signal generator: phase reversal

34. The operation of push button switch SA or SB on the reference signal generator, energizes or de-energizes the double pole contacts of relay RL1/2, which causes a 180° phase shift to be introduced to the circuit and cause a reversal of the observed bearings at the c.r.t. indicator. This is a requirement when aligning the indicator scale.

POWER SUPPLIES

35. H.T. and valve heater supplies for all units are from the main power supply unit FA at the bottom of the cabinet.

36. Gate switches, SWA and SWB are fitted to the cabinet doors at the top. Indicator neons, LP2 and LP3, are provided adjacent to these switches. If the equipment is being operated with the doors open, which is made possible by manually setting the gate switches, the neon lamps provide warning that power is switched ON.

37. Anti-condensation heater lamps LP4 to LP9 are supplied with 230V a.c. when the power unit supply indicating lamp is illuminated and SW3 (heating switch) on, but the main equipment is off as far as local and remote control is concerned. This heating replaces that normally provided by the units themselves and so prevents damp and deterioration.

38. The blower motor operates when both the main equipment and SW6 are ON.

39. Recessed on a panel to the right above unit BD (fig. 3) at the front of the cabinet is a centre-zero meter (200-0-200 microA) and test jack. These components are not connected internally to other circuits, but enable many tests to be carried out whilst setting up the equipment. A flexible twisted lead is run from the jack to test points on various units for this purpose.

40. The power units for the cabinet (power supply, main d.f. 6120-99-932-4856) and power supply -75V (6130-99-943-5903) are used in all three versions of cabinets.

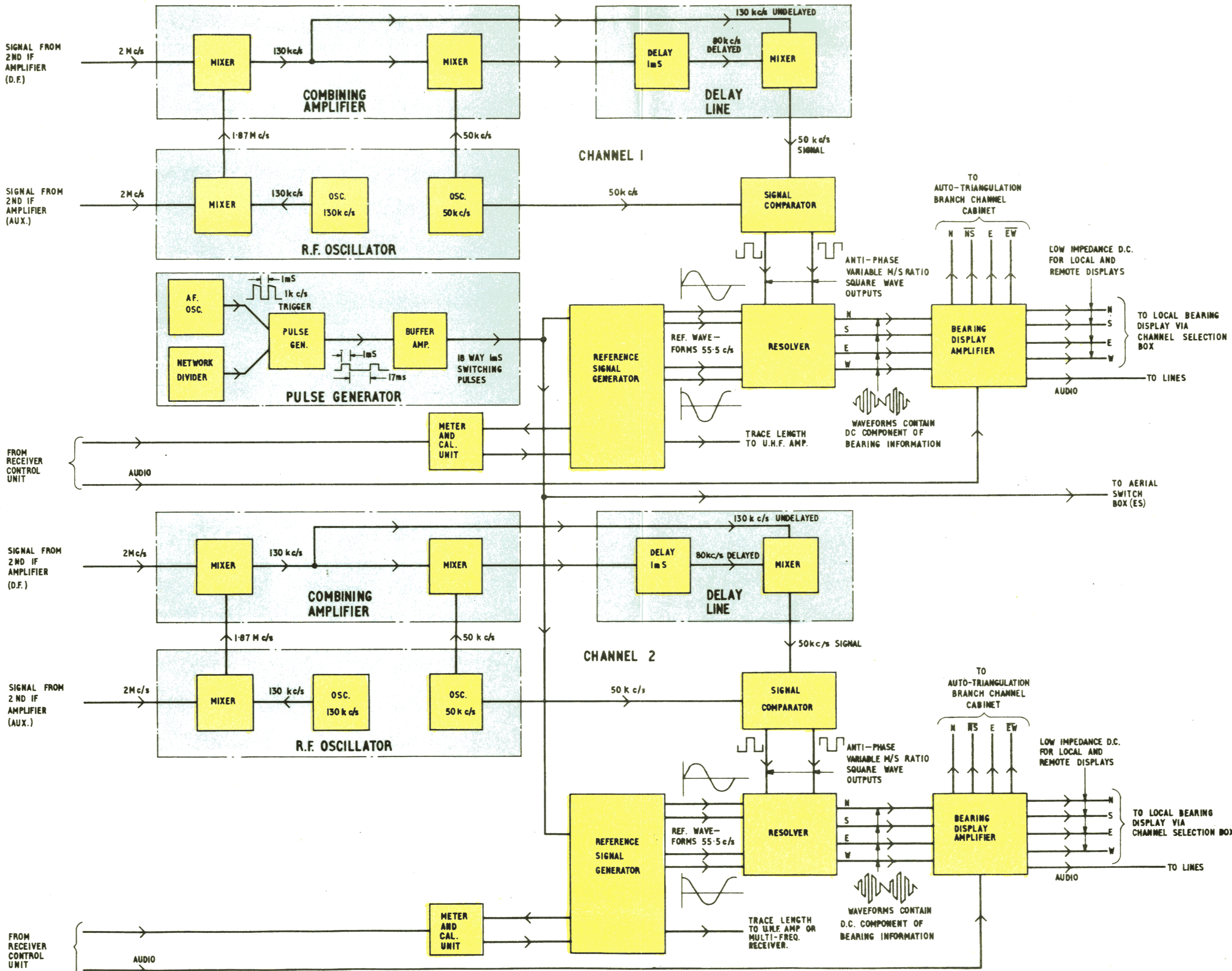
41. The main d.f. power supply provides three sets of h.t. outputs and heater voltage, (fig. 8) two of which are fed to the d.f. units of channel 1 and if fitted, channel 2 respectively. The third set of outputs is fed to the switching units, which are common to all channels. The main d.f. power supply incorporates relays RLA, RLB and RLC for routing the outputs of the power supply to the units of the required channel and the switching units. If triangulation channels 3 and 4 are incorporated in the equipment and are the only channels operating the control circuits of the power unit route the supplies to the switching units only.

42. The -75V power supply is used to provide a bias within the cabinets. The output voltage connections of the -75V power supply is also shown in fig. 8.

43. To ensure the correct loading of h.t. supplies in the aerial switching version of the cabinet, resistor assembly 5905-99-933-1218 is mounted in position CC. Plugged via SK.CC1 the unit provides loading of the 250V h.t. and -75V d.c. supplies from the power unit main d.f. and power unit -75V respectively. Without this unit fitted, high out-of-tolerance voltages are obtained.

44. All power supplies routed within the cabinet are provided by the main power unit and power unit -75V with the exception of a -50V relay switching

supply from other cabinets at the d.f. site. A switching earth obtained from the pre-tuned receiver and d.f. cabinets via the pulse distribution box provides the ON/OFF switching of the aerial switching cabinet. For a detailed description of the power supplies see Sect. 2, Chap 11 of this handbook.



AIR DIAGRAM-MIN
116C-0801-MD139

BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE

ISSUE 1 (Prepared by the Ministry of Technology)

U.H.F. C.A.D.F.
F.G.R.I. 23078

D.630677. 373292. SW. 1/69

D.F. cabinet : block diagram

Fig. 4

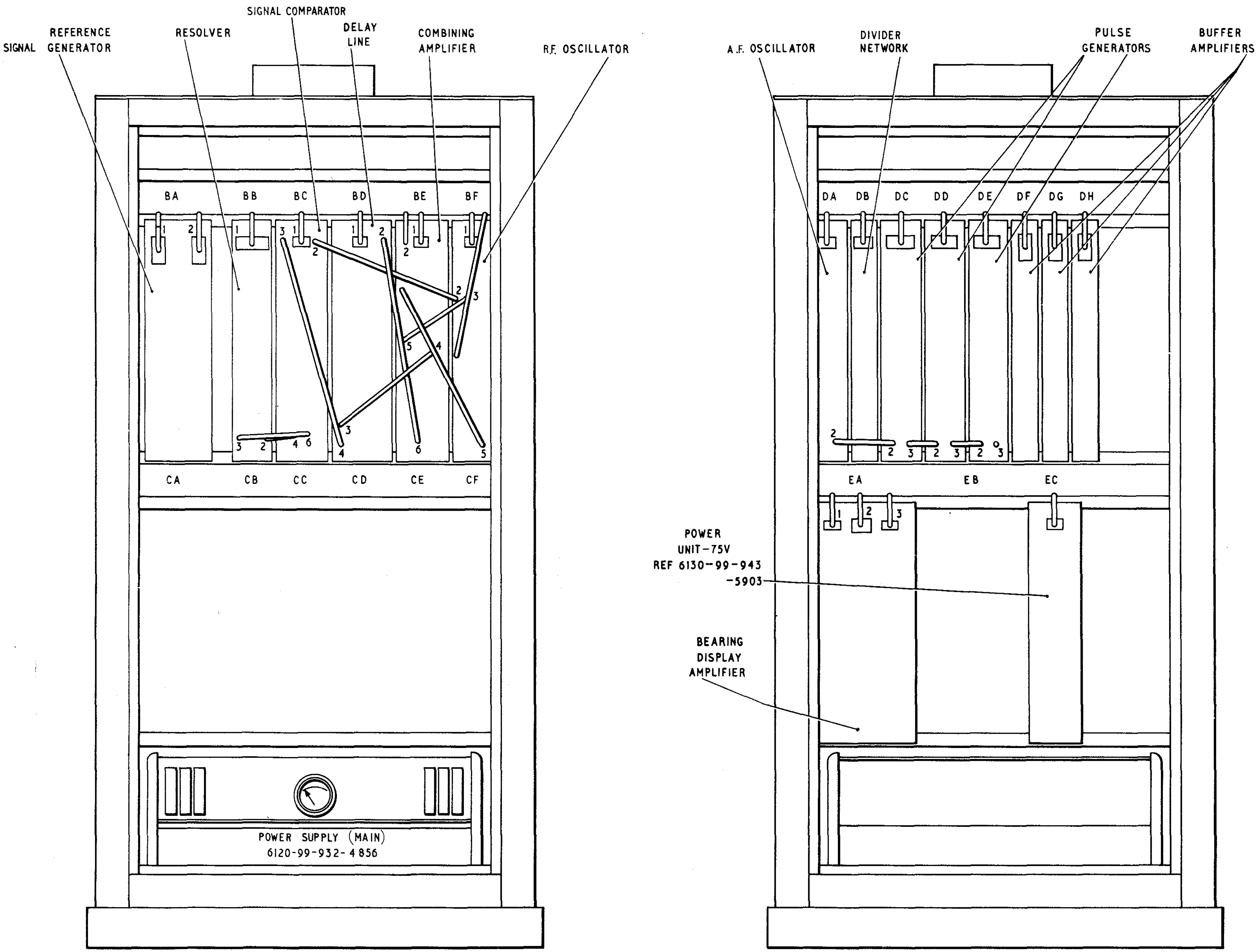


Fig. 5 F.G.R.I. 23078 — Single D.F. cabinet — layout Fig. 5

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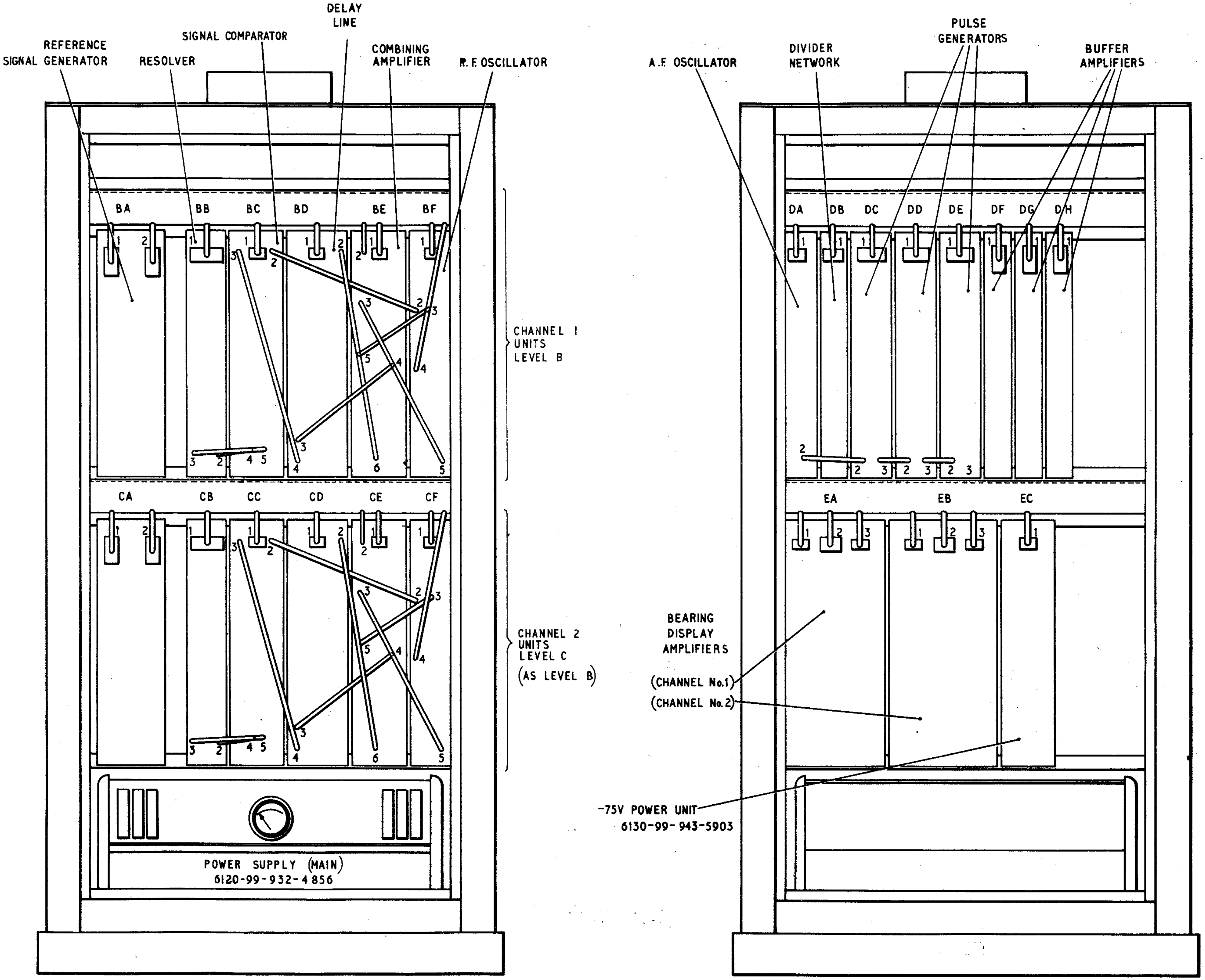

Fig.6 D.630677. 373292. SW. 1/69 F.G.R.I. 23078. Twin D.F. cabinet: layout Fig.6.

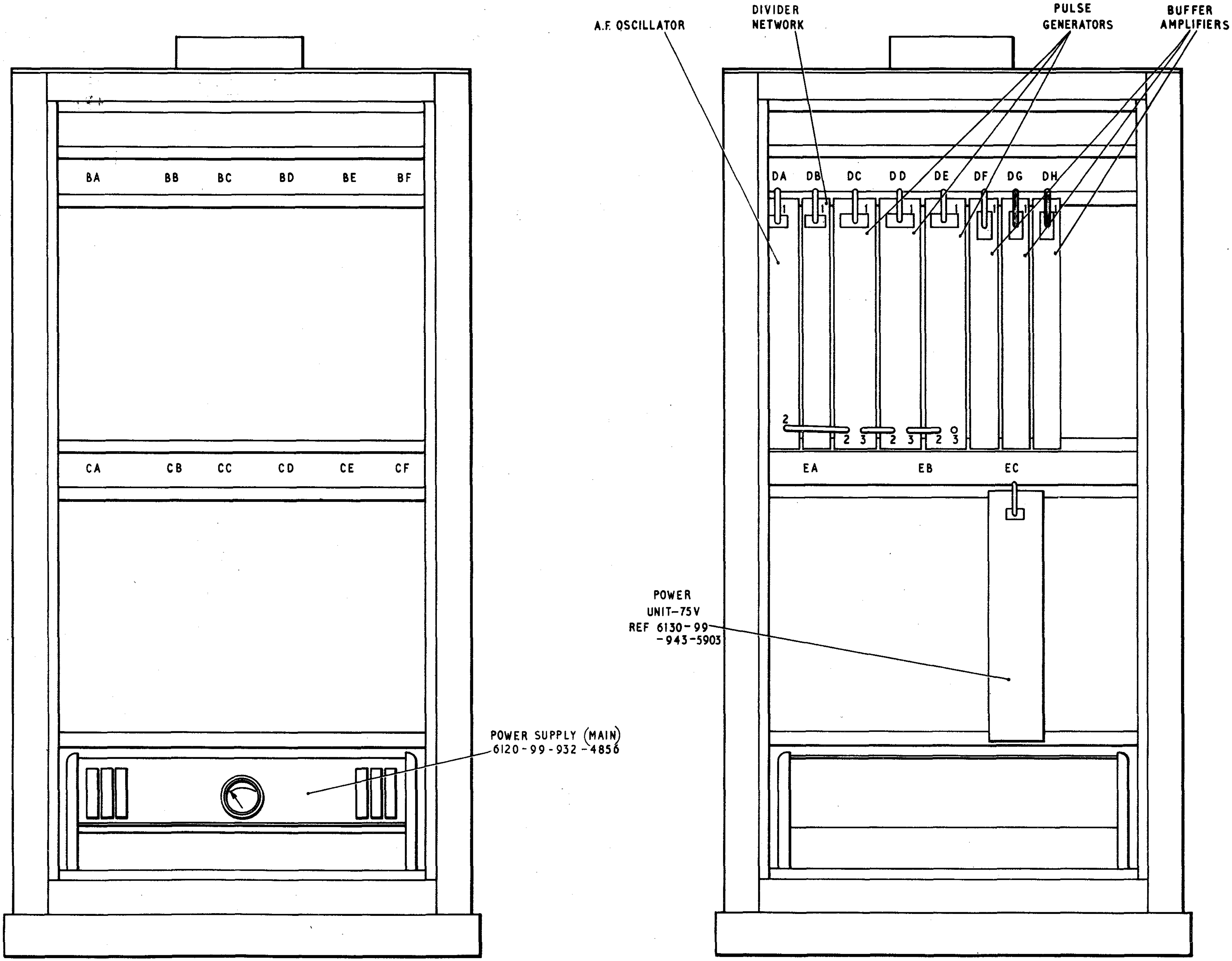

Fig. 7 D.630677. 373292. SW. 1/69 F.G.R.I. 23078 – Aerial switching D.F. cabinet – layout Fig. 7

AIR DIAGRAM–MIN
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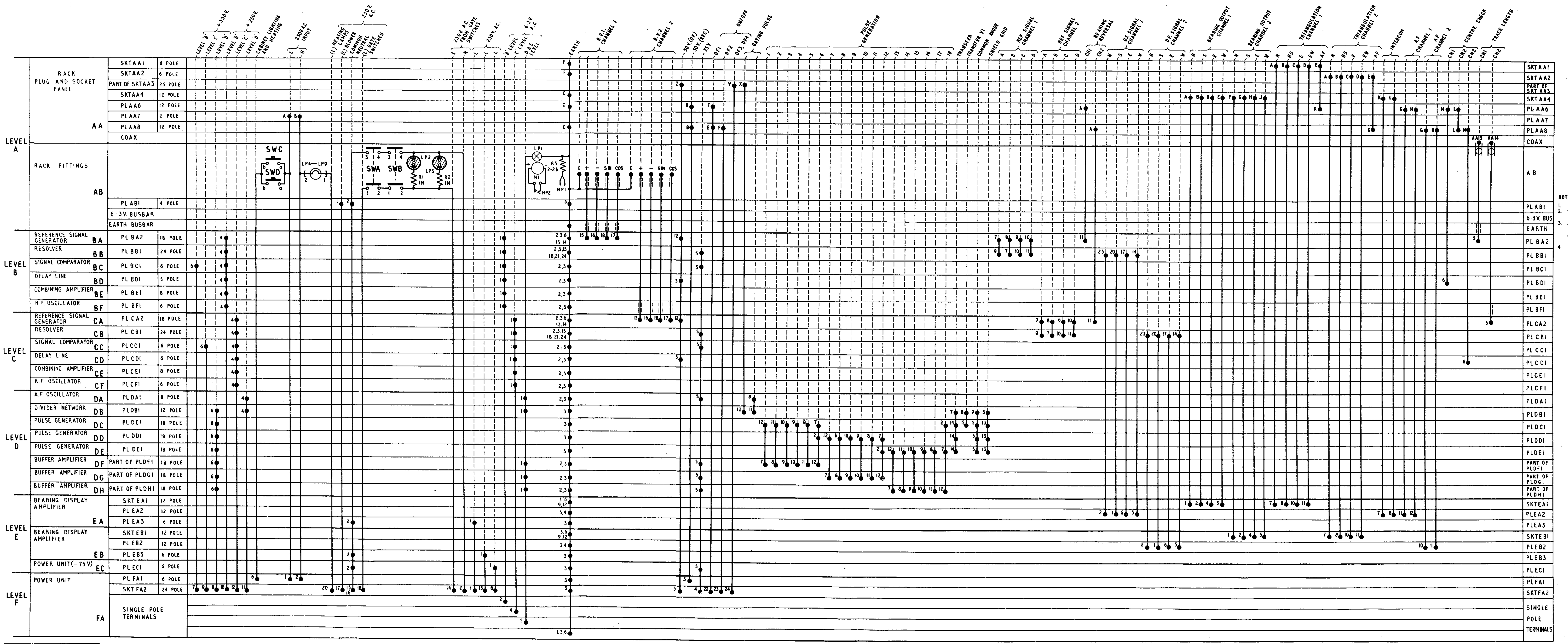
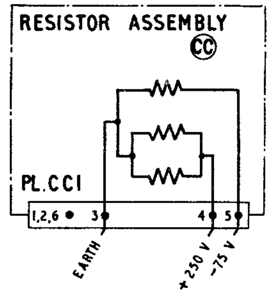
FIG 8
A.L. 29 NOV 75

F.G.R.I. 23078 CADF; D.F. cabinet : Power distribution and control circuits

Fig.8



NOTES
1. TWO CHANNEL D.F. CABINET (932-4861) AS SHOWN
2. SINGLE CHANNEL D.F. CABINET (932-4862) OMITS ALL UNITS ON LEVEL C AND UNIT EB ON LEVEL E.
3. AERIAL SWITCHING CABINET (932-4858) OMITS ALL UNITS IN LEVELS B AND C AND UNITS EA AND EB AT LEVEL E, ADD RESISTOR ASSEMBLY AT CC AS BELOW.
4. SPARE POLES NOT SHOWN.



AIR DIAGRAM-MIN
116C-0801-MD13
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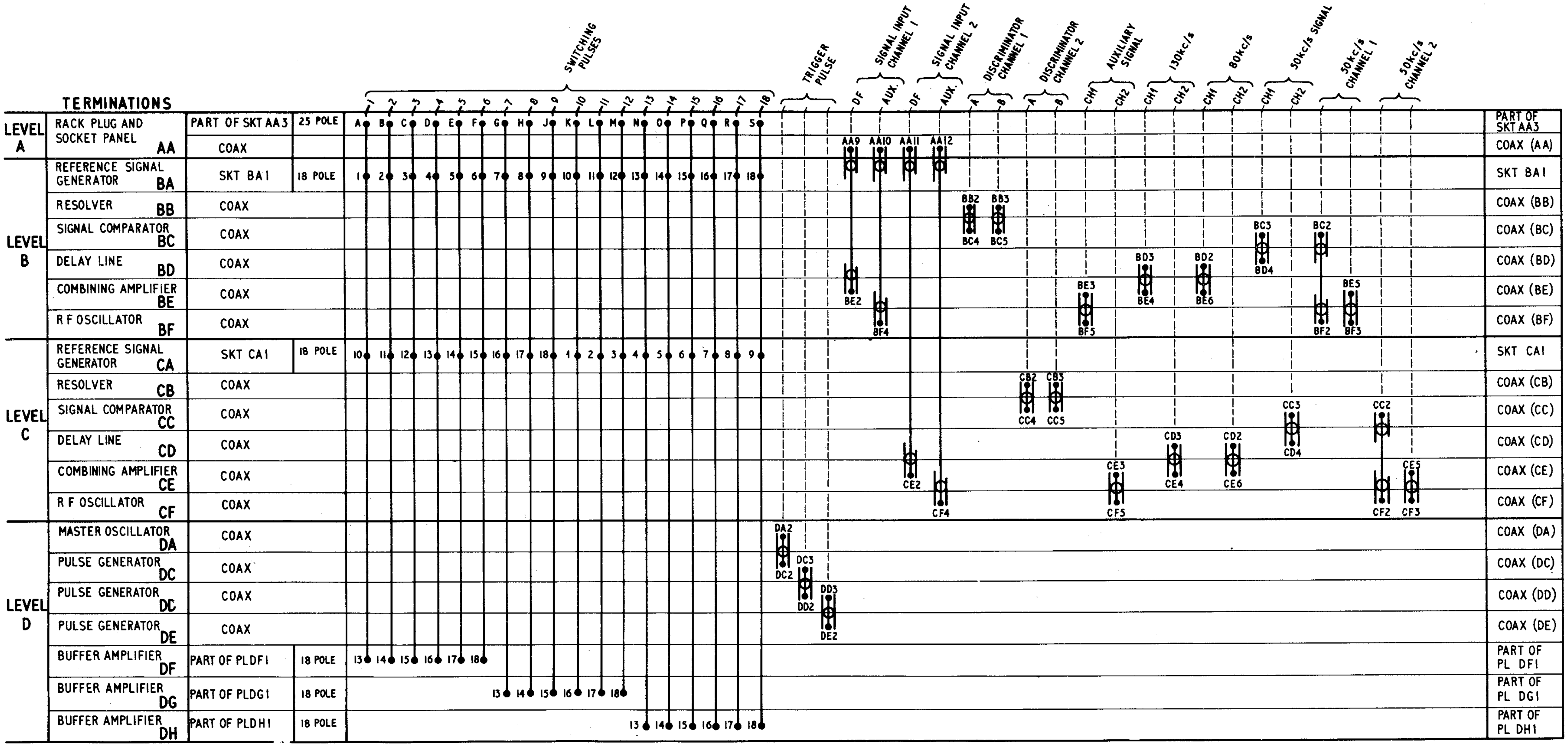
D.630677 373392 SW. 1 69

FGR1.23078 D.F. cabinets: interconnections part A

Fig. 9



NOTE:-
SPARE POLES NOT SHOWN.

F.G.R.I. 23078 - D.F. cabinets: interconnections - part B

Fig. 10

AIR DIAGRAM-MIN
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D.630677. 373292. SW. 1/69

Chapter 1

A.F. OSCILLATOR (5825-99-943-5936)

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UNIT DESCRIPTION

Introduction

1. The a.f. oscillator (master oscillator) contains a 1 kc/s oscillator, squarer and mono-stable flip-flop from which a sharp positive-going trigger pulse is developed. This pulse, which has a duration of 10-20 μs and occurs once every milli-second, is required for triggering the three cascade-arranged pulse generators (5825-99-943-5934) which, in turn,, control the aerial switching circuits and the reference generator (5825-99-943-5889).

2. The a.f. oscillator unit is used in four different types of rack assemblies as follows:—

(1) Aerial switching cabinet (5820-99-932-4858)—position in rack DA.

(2) Two channel d.f. cabinet (5820-99-932-4861)—position in rack DA.

(3) Single channel d.f. cabinet (5820-99-932-4862)—position in rack DA.

(4) Switching rack within the d.f. cabin of transportable equipment TGRI 26006/1—position in rack CA.

Note . . .

A spare a.f. oscillator is located in the switching rack of TGRI 26006/1 transportable equipment—position in rack BC.

Construction

3. Construction of the unit is based on an 18 in. mild steel strip designed for vertical mounting on the front of the cabinet or rack. The vertical edges of the metal strip are bent at right angles to form a simple channel section, thus increasing the rigidity of the unit and affording some protection of the components within the channel. The unit is secured to the equipment rack or cabinet via two keyhole slots at the top and two plain slots at the bottom of the unit. This arrangement enables the unit to be readily de-

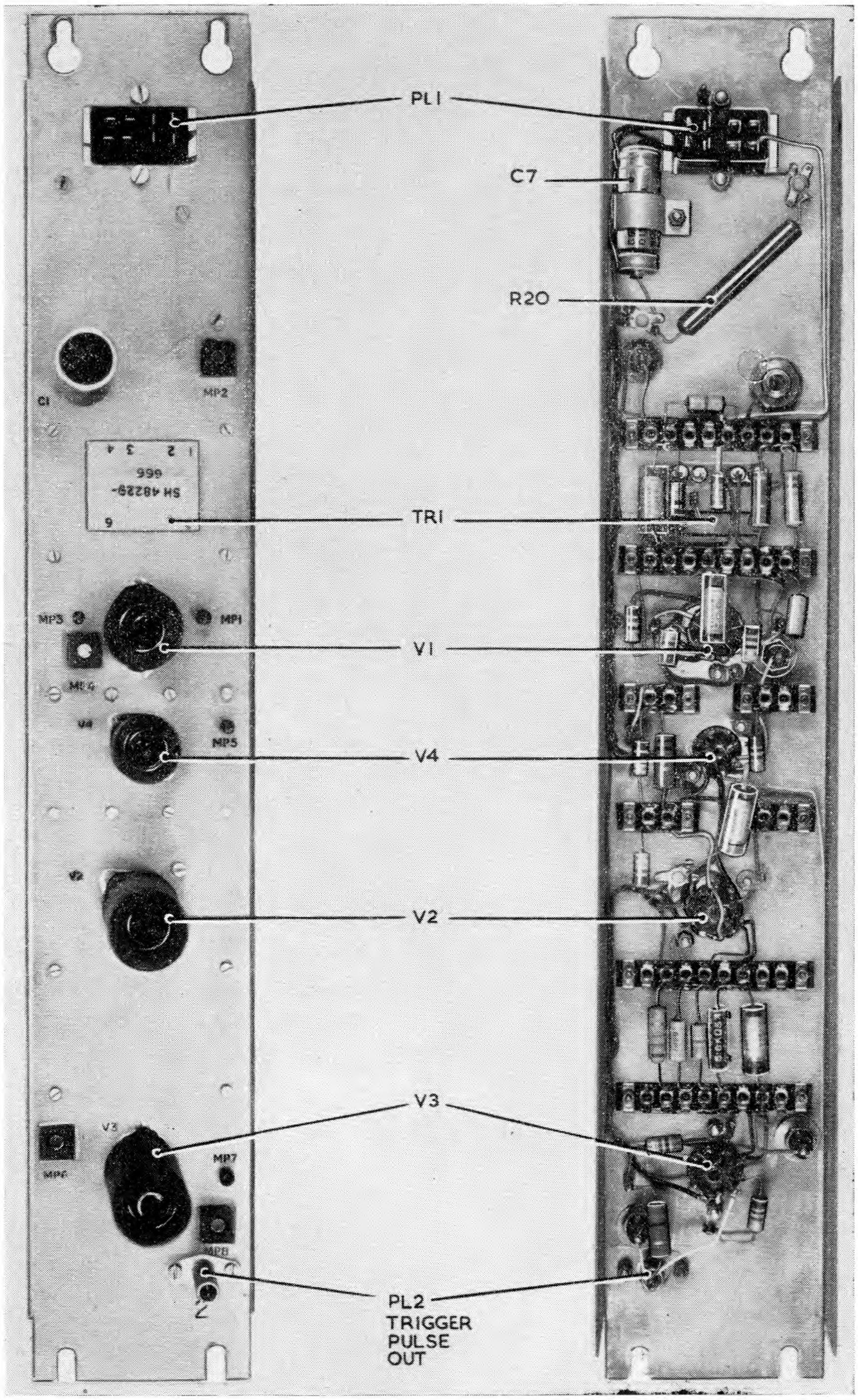

Fig. 1. A.F. oscillator: front and rear views

tached from the rack for servicing, once the electrical connections are removed, by slackening the Phillips-headed screws and then lifting the unit upwards and withdrawing it from the rack.

4. Plug and socket connections on the unit are allocated sequential numbers regardless of whether the connector is a multi-pole connector or a coaxial plug or socket. These numbers are signwritten on the front of the unit adjacent to each connector. The location of the connectors, as well as the location of all valves and metering points, is shown in fig. 1, which gives both front and rear views of the master oscillator strip unit.

Brief electrical description

5. A block diagram of the a.f. oscillator is shown in fig. 2. V1a is an oscillator producing a 1 kc/s sinusoidal waveform that is then squared (V1b) and passed through a differentiating network. The negative-going spikes are subsequently removed by a clipper diode (V4a). The resultant output is not, at this stage, sufficiently well defined to be of use since the trailing edge of each spike follows an exponential discharge curve due to the differentiating process. The spikes are therefore applied to a mono-stable flip-flop circuit (V2) having a restoration time of 10-20 μs. The output of V2—well defined trigger pulses having a width of approximately 15 μs with a period of 1 ms—is then clamped by diode V4b and passed via cathode follower stage V3a to the gating circuits within the pulse generator unit.

Circuit description (fig. 4)

6. One half of double triode V1 and associated components form a modified Hartley oscillator producing a sinusoidal waveform at 1000 c/s ± 2%. The output of the oscillator is fed to the second half of V1 where it is limited to develop an approximately square wave. A small amount of the oscillator output is also taken from the junction of R3, R15 and fed out of the unit at PL1/8 for use as a gating voltage facility.

7. The square wave output from V1b is short-RC differentiated by C5,R6. The negative component of the resultant spikes is removed by the clipper diode V4a, and the positive component is applied via C6 to trigger the grid of V2a at 1 ms intervals.

8. Valve V2 and associated components together form a mono-stable flip-flop for the production of the main positive-going trigger pulse, the values of C8,R12 dictating a time constant of approximately 15μs. The pulse is delivered to the grid of cathode follower V3a via C9,R13. Valve V4b, across V3a input, clamps the pulse at earth potential and thus ensures positive d.c. restoration. Valve half V3b is not used.

9. The pulse is routed out of the unit at PL2, and has a duration of between 10-20 μs, a peak amplitude of approximately 50V, and occurs once every millisecond.

10. Metering points MP1, 3, 5 and 7 give access to valve cathodes; all waveforms are checked at MP2, 4, 6 and 8.

SERVICING

Test apparatus

11. The following items of the test equipment are required for full third line servicing at G.R.S.C. establishments; they should also be available for first and second line servicing.

(1) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(2) Oscilloscope CT316, 10S/16605 or CT 414, 6625-99-943-1632.

(3) Multimeter Type 9980 or Type 12889.

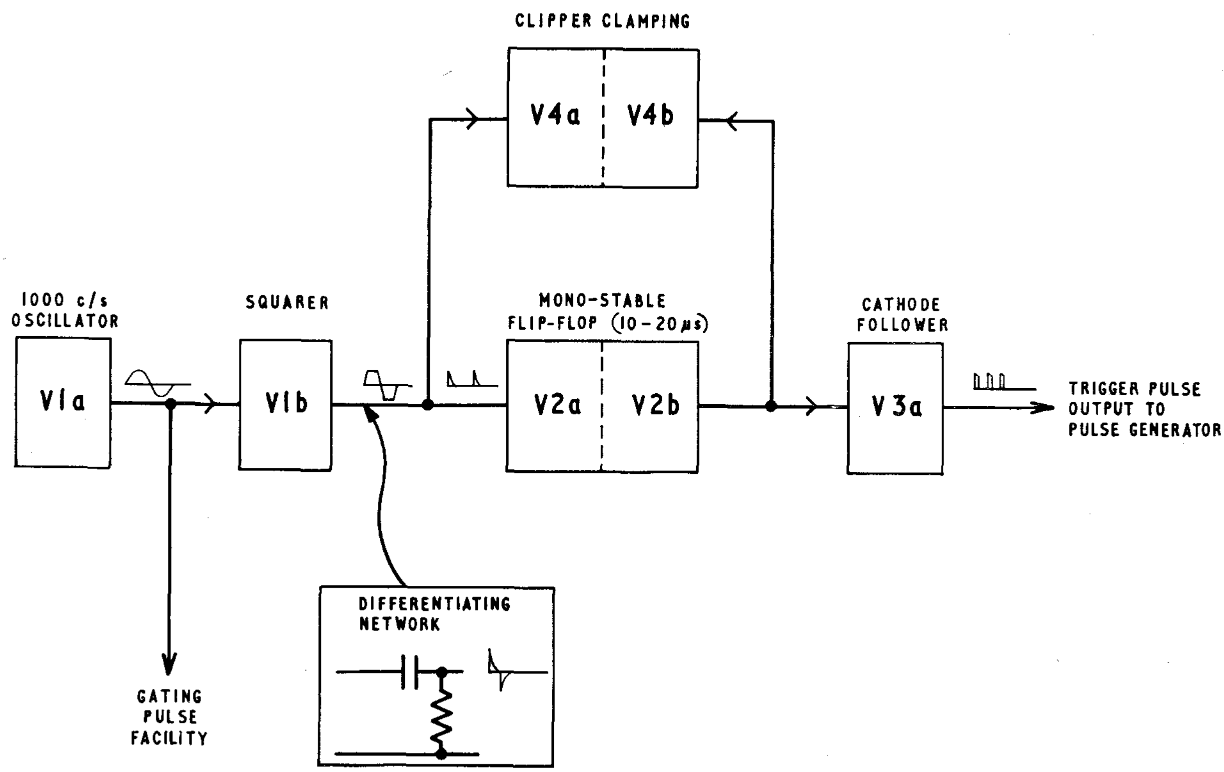

Fig. 2. A.F. oscillator: block diagram

Tests for serviceability

12. Preliminary serviceability checks, made with the unit in position in the cabinet, are performed by monitoring at the metering points. Measurements at metering points MP1, 3, 5 and 7 are taken with the built-in meter on the cabinet (meter deflections are to the right), but voltages at metering points MP2, 4, 6 and 8 are measured with a peak-reading valve voltmeter (calibrated in sinusoidal r.m.s. values). All readings should approximate to those given in Table 1.

TABLE 1

Typical voltage and current readings

MP No.	Reading
1	10-20
2	115V
3	15-20
4	5·5V
5	115-140
6	72V (peak)
7	115-140
8	65V (peak)

13. The unit can be removed from its rack for replacement or servicing by removing the two connectors and slackening off the four Phillips-headed screws, and then lifting the unit clear of the rack.

Dismantling instructions

14. There are no complicated mechanical devices or tuning mechanism, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted directly on the chassis) is self-evident. For the location and identification of components refer to component layout diagram fig. 5.

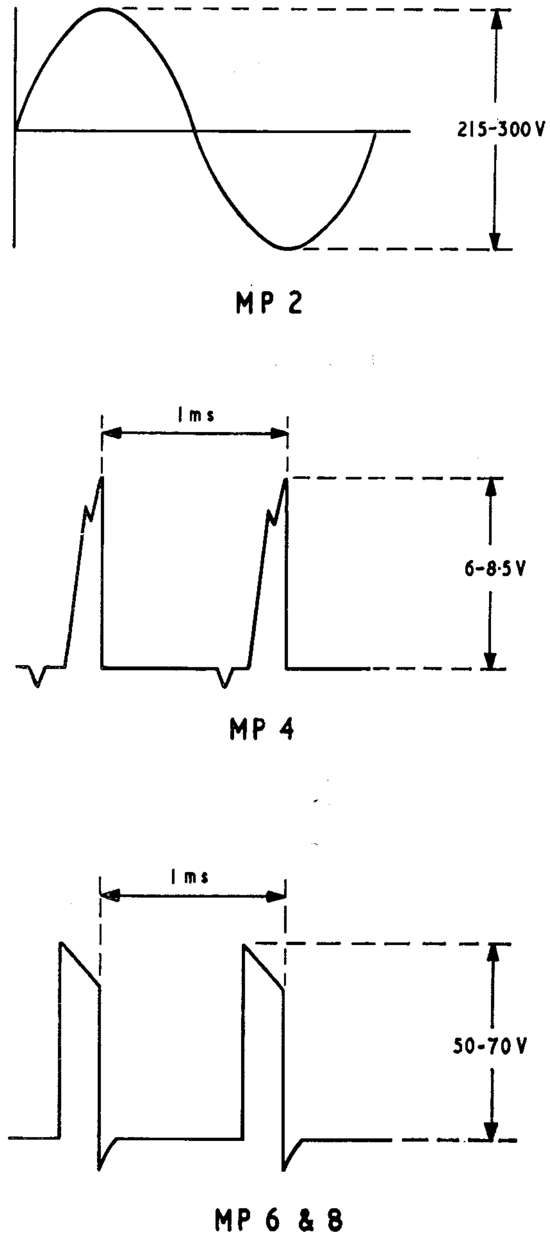

Fig. 3. Waveforms at MP 2, 4, 6 and 8

FAULT DIAGNOSIS

Fault finding procedure

15. Before using test apparatus to trace or locate a fault, ensure that all connections are secure (PL1,PL2) and that valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter and carry out voltage and current checks at the metering points given in Table 1. Waveforms, monitored at MP2, 4, 6 and 8, should approximate to those shown in fig. 3.

16. In the absence of any signal at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Table 2).

Servicing data

17. To assist in servicing and fault finding of the master oscillator unit, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. It is recommended that the voltages and currents given are used only as a guide to the correct operation of the unit. The typical values given may vary slightly from one unit to another and should be replaced at the time of installation or major overhaul with readings actually obtained from a known working unit to form the basis of a maintenance log book.

Supply voltages and currents

18. The approximate values of current consumption of the unit are given in Table 2.

TABLE 2

Supply voltages and currents

Circuit	Check point (to earth)	Voltage	Current
HT supply	PL1/4	250V d.c.	19mA
HT „	R20/C7	230V d.c.	
HT „	R2/C1	220V d.c.	
Heaters	PL1/1	6·3V a.c.	1·2A

Valve voltages

19. Typical valve voltages at various valve pins are given in Table 3. The measurements are made with a valve voltmeter with the unit in the no signal condition. All voltages are positive unless otherwise indicated.

Valve complement

20. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 4, may also be used if available.

TABLE 3

Valve voltages

	Pin No.								
Valve	1	2	3	4	5	6	7	8	9
V1a	—	—	—	—	—	218	−3·6	0·06	—
V1b	185	−100	0·04	—	—	—	—	—	—
V2a	—	—	—	—	—	228	−0·05	14·2	—
V2b	155	14	14·2	—	—	—	—	—	—
V3a	228	2·9	6·3	—	—	—	—	—	—
V4a	0·95	—	—	—	—	—	earth	—	—
V4b	—	earth	—	—	2·9	—	—	—	—

TABLE 4

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Type Commercial	CV No.
V1, V2, V3	6060	4024	5960-99-000-4024	12AT7	455
V4	5726	4007	5960-99-000-4007	6AL5 (short bulb)	140

Common faults

21. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. In this unit, no adjustment or re-alignment is necessary after changing of valves.

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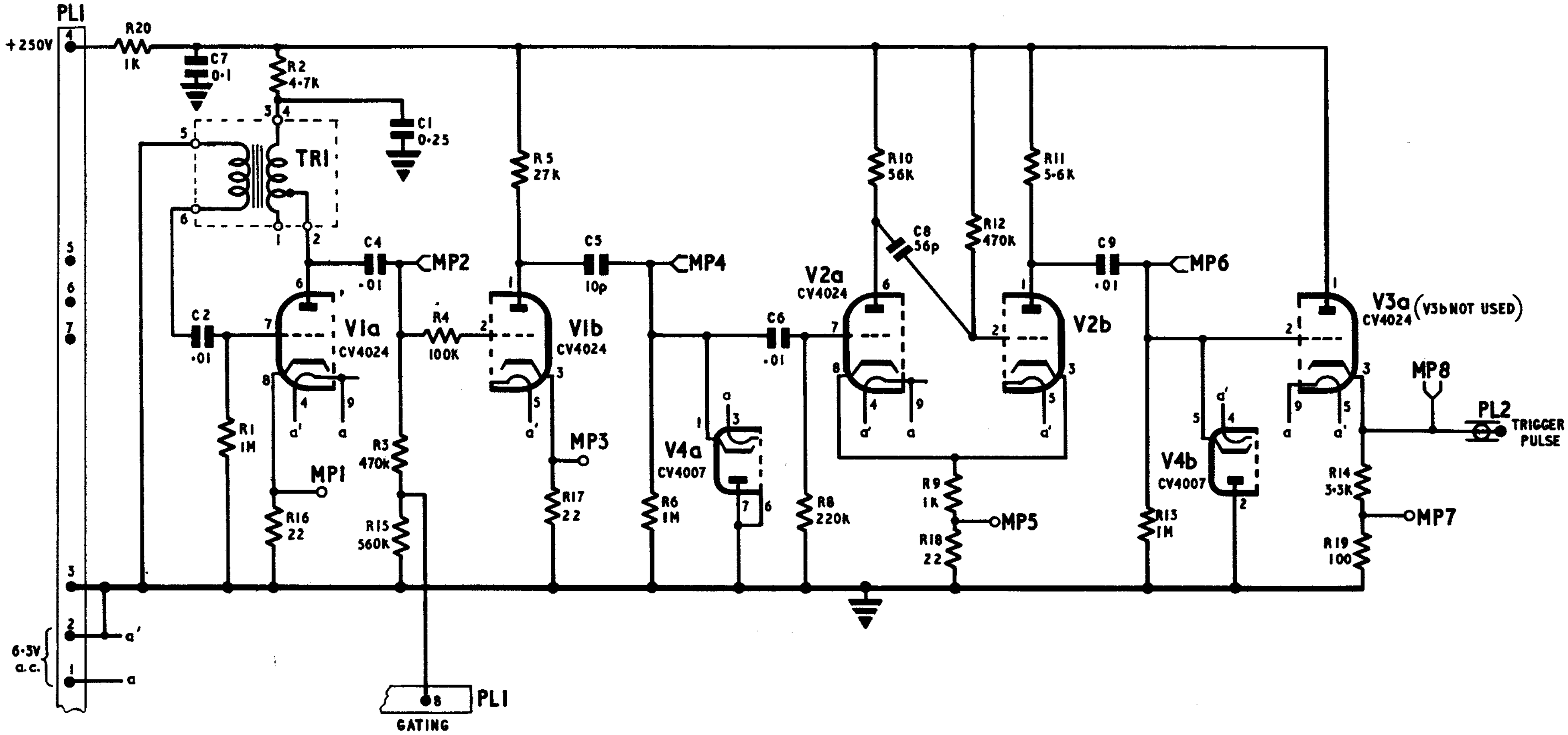

Oscillator A.F 5825-99-943-5936: circuit.

Fig. 4

AIR DIAGRAM-MIN
116C-0801-MD60
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by the Ministry of Aviation

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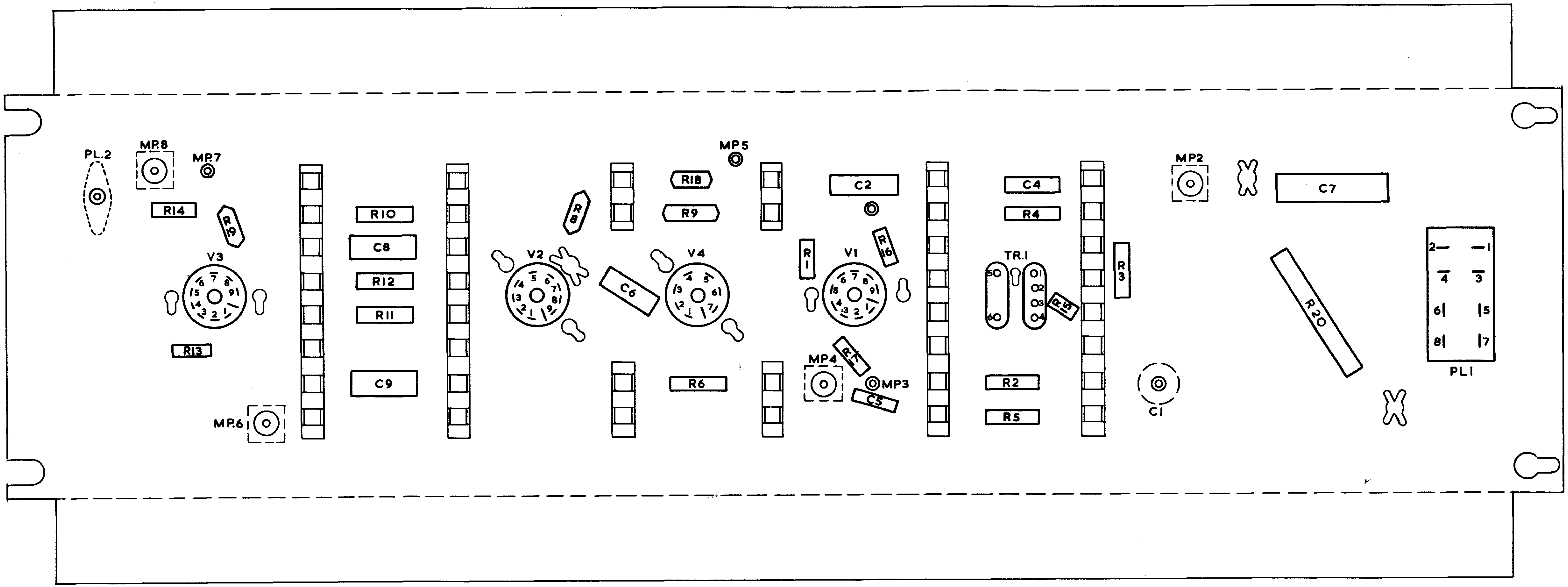

Oscillator A.F. 5825-99-943-5936: component layout.

Fig.5

AIR DIAGRAM-MIN
116C-0801-MD61
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Chapter 2

PULSE GENERATOR 5825-99-943-5934

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UNIT DESCRIPTION

Introduction

1. The pulse generator is a ring counter circuit utilizing six high-speed, primed-trigger, cold-cathode valves. When the circuit is triggered by the 1 ms pulse from the master oscillator (5825-99-943-5936), six sequential switching pulses are provided for controlling the aerial switching circuits and the reference generator (5825-99-943-5889). Because there are 18 aerial switching circuits, the requisite number of switching pulses are obtained from three pulse generators connected in cascade and having the output from the last generator feeding back into the first, thus forming an overall ring-of-eighteen counter circuit.

2. All three pulse generators obtain the stabilized voltages required for their operation from the divider network (5820-99-933-1117). The output pulses from each generator are applied to the aerial switching circuits and the reference generator via a buffer amplifier (5825-99-943-5895).

3. The pulse generator is used in four types of rack assemblies as follows:—

(1) Aerial switching cabinet (5820-99-932-4858)—rack positions DC, DD and DE.

(2) Two channel d.f. cabinet (5820-99-932-4861)—rack positions DC, DD and DE.

(3) Single channel d.f. cabinet (5820-99-932-4862)—rack positions DC, DD and DE.

(4) Switching rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—rack positions CC, CD and CE.

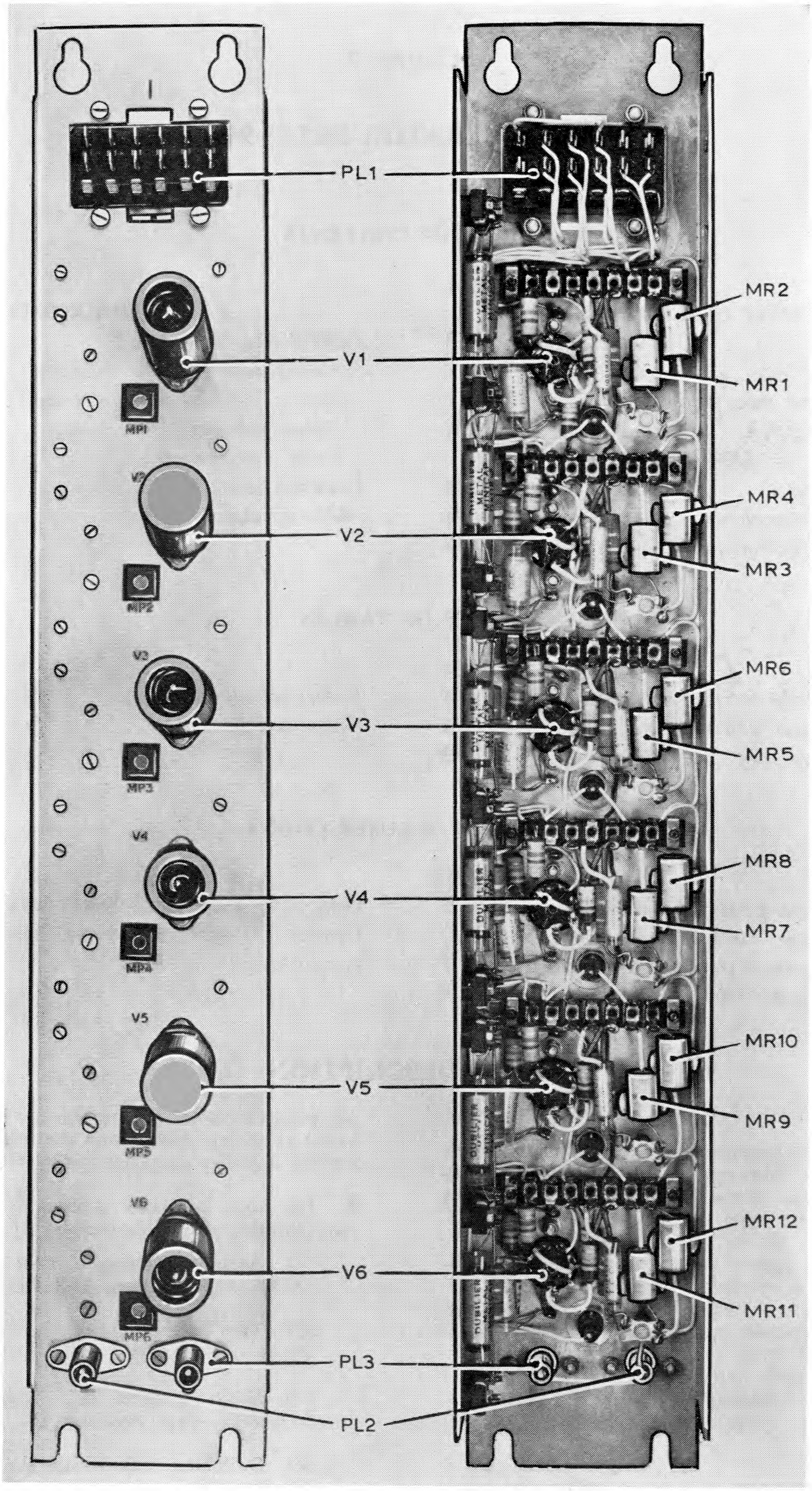


Fig. 1. Pulse generator: front and rear view

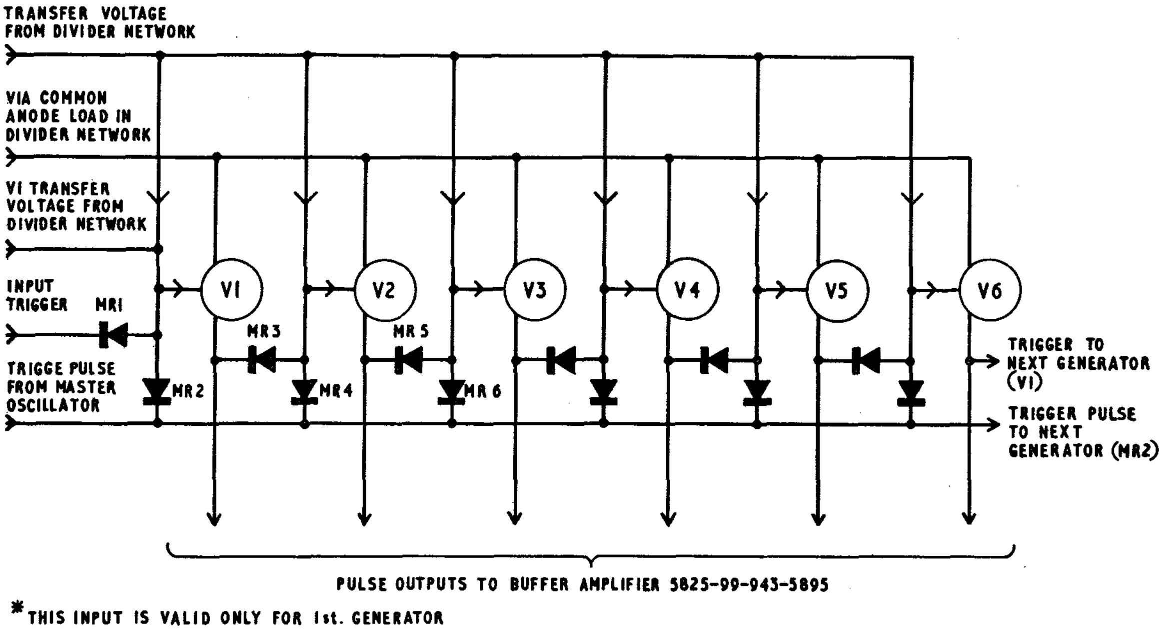


Fig. 2. Pulse generator: block diagram

Construction

4. Construction of each unit is based upon an 18 in. mild steel strip designed for vertical mounting on the front of the cabinet or rack. The vertical edges of the metal strip are bent at right angles to form a simple channel section, thus increasing the rigidity of the unit and affording some protection of the components within the channel. The unit is secured to the equipment rack or cabinet via two keyhole slots at the top and two plain slots at the bottom of the unit. This arrangement enables the unit to be readily detached from the rack for servicing, once the electrical connections are removed, by slackening the Phillips-headed screws and then lifting the unit upwards and withdrawing it from the rack.

5. Plug connections on the unit are allocated sequential numbers regardless of whether the connector is a multi-pole connector or a coaxial plug. These numbers are signwritten on the front of the unit adjacent to each connector. The location of the connectors, as well as the location of all valves and metering points, is shown in fig. 1, which gives both front and rear views of one pulse generator strip unit.

Brief electrical description

6. A block diagram of one pulse generator (ring-of-six configuration) is shown in fig. 2. At the instant of switching on, only V1 strikes and conducts and thus partially prepares a coincidence gate (MR3) to V2. Upon receipt of a trigger pulse from the master oscillator, MR4 fully opens the gate and the potential at the junction of MR3, MR4 rises to a value that is sufficient to cause V2 to strike. When V2 conducts, the voltage drop across the common anode load (located in the divider network) becomes such that V1 is extinguished. The coincidence gate (MR5) to the next valve V3 is now partially prepared, and 1 ms later the next trigger pulse causes V3 to strike and, subsequently, V2 to extinguish—and so on round the ring. Thus each valve is allowed to remain in the struck condition for a period of 1 ms only, during which time a 1 ms pulse of approximately 80V is developed across the striking cathode of each valve in turn. The cycling action in a ring-of-eighteen counter circuit is therefore 18 ms, giving a switching frequency at the aerial array of 55·5 c/s.

Circuit description (fig. 5)

7. The complete ring-of-eighteen counter circuit consists of three pulse generators in cascade, the last in the chain feeding back into the first. Each pulse generator contains six identical stages which have the following main elements:—

(1) Coincidence gate circuit (e.g. MR1, MR2, R2 for V1).

(2) Cold-cathode valve (fig. 3).

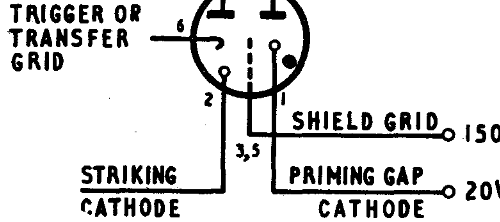


Fig. 3. High-speed primed trigger cold-cathode valve

8. All the valves obtain their supply voltages from the divider network (5820-99-933-1117) via plug PL1 on the pulse generator. In addition to the striking anode-cathode electrodes of each valve, there are two priming gap electrodes that ionize the gas in the vicinity of the trigger grid/cathode gap. This provides for an immediate response of the valve but does not affect the breakdown potential of the main gap.

9. The priming gap electrodes are connected between h.t. and earth via two current limiting resistors (e.g. R25 and R31 for V1). The shield grid electrode is held at a constant positive potential and, except when in receipt of a trigger pulse, so is the trigger grid. These two voltages are obtained from the divider network via PL1/13 and 14 respectively.

◄**10.** The first valve (V1) in the first pulse generator of the train is caused to strike before the other valves by operation of the divider network (Chap. 11) as follows. When the equipment is first switched on, 350V h.t. is applied to all relevant units including the pulse generator units. In order to ensure that the firing sequence of the pulse generators is not incorrectly triggered by initial transient circuit conditions, the divider network delays the application of the transfer grid voltage to (V1), and the common anode supply to all valves, for between 4 to 10 seconds after the h.t. is applied. After the delay, the transfer grid (V1) voltage is applied first, and then the common anode voltage is applied, thus causing V1 to fire. As soon as the common anode voltage is applied, a relay interlock in the divider network disconnects the transfer grid (V1) voltage, leaving the pulse generator circuit primed for the beginning of the switching sequence. The shield grid supply to all valves, and the transfer grid voltage common to V2, V3, V4, V5 and V6, is not subject to the delay. The level of the common transfer grid voltage can be adjusted by RV1 in the divider network.►

11. Fig. 5 shows the circuit for one pulse generator, but it should be noted that R1 is used for the first valve of the first pulse generator only; R37 is redundant in the first generator but routes the constant potential to V1 in the second and third generators.

12. Two selenium rectifiers and a 560k ohm resistor form a coincidence input gate to the trigger grid of each valve. Assuming that V1 is conducting, the cathode potential across R4 is in the region of +80V, which is applied to the cathode of MR3. In the absence of a trigger pulse from the master oscillator, MR4 is conducting because the trigger pulse line is virtually connected to earth via a low-value resistor in the cathode follower stage of the master oscillator. Thus MR3 is reverse biased by the +80V (its anode being virtually at earth potential), and the gate is prepared or primed. The other valves in the pulse generator are not conducting, so that their cathode potentials are virtually at earth and the corresponding coincidence gates are not primed.

13. Upon receipt of the trigger pulse from the master oscillator, MR4 is reverse biased so that C4 is allowed to charge via R5. When the trigger grid of V2 is sufficiently positive the valve strikes, immediately doubling the current through the common anode load resistor in the divider network and thus doubling the volts drops across it. The input gate to V1 is virtually at earth, due to conduction through MR1 and the 15k ohm cathode resistor in the preceding stage, so that the drop in anode potential cuts off the valve. Simultaneously V2, with a higher positive potential on its trigger grid, builds up +80V across R8 according to the time constant R8,C5. The time constant of V1 anode circuit (C3,R3) prevents the possible restriking of V1 until V2 has reached a stable state.

14. When V2 is fully conducting, the potential at V2 cathode is approximately +80V, which reverse-biases MR5 and thus primes the input gate to V3. Upon receipt of the next trigger pulse, MR6 is reverse-biased and V3 strikes. The cathode of each valve in turn is therefore maintained at +50 to +80V for the period of time between each trigger pulse, i.e. 1 ms. These cathode pulses are used to control the aerial switching gates.

SERVICING

Test apparatus

15. The following items of test equipment are required for full third line servicing at G.R.S.C. establishments; they should also be available for first and second line servicing:

(1) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(2) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(3) Multimeter Type 9980 or Type 12889.

Test for serviceability

16. Preliminary serviceability checks, made with the unit in position in the cabinet or rack, are performed by monitoring at the metering points. The waveform readings should be taken with the oscilloscope and the voltage measurements with the peak-reading valve voltmeter, which is calibrated in sinusoidal r.m.s. values. The readings should approximate to those given in Table 1.

TABLE 1

Typical readings at metering points

MP No.	Type of waveform	Typical amplitude
1-6	Square waves having a width of 1 ms and recurring at 17 ms	50V

17. Each pulse generator can be removed from its rack for replacement or servicing by removing the three connectors, slackening off the four Phillips-headed screws, and then lifting the unit clear of the rack.

DISMANTLING INSTRUCTIONS

18. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self-evident. For the location and identification of components refer to the component layout diagram fig. 6.

FAULT DIAGNOSIS

FAULT FINDING PROCEDURE

19. Before using test apparatus to trace or locate a fault, ensure that all connections are secure (PL1, PL2, PL3) and that all valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter and carry out the checks to establish the readings given in Table 1. The waveforms at the metering points should approximate to those shown in fig. 4.

20. In the absence of any pulse output from the unit, the obvious starting point is to check the supply voltages derived from the divider network. These are given in Table 2.

21. If one of the valves is completely unserviceable then the whole of the ring counter switching will stop, and generally the valve preceding the faulty valve will strike and remain in the struck condition. This fault can readily be detected by observation after removing the valve cans.

22. When tracing a less obvious fault it is sometimes advantageous to connect two of the generators as a ring-of-twelve, or one generator as a ring-of-six, by connecting the cathode output of the last valve (PL1/16) to the diode gate input of the first (PL1/2). Thus a fault can be isolated to a particular unit in the chain.

SERVICING DATA

23. To assist in servicing and fault finding of the pulse generator units, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. It is recommended that the voltages and currents given are used only as a guide to the correct operation of the unit. The typical values given may vary slightly from one unit to another and should be replaced at the time of installation or major overhaul with readings actually obtained from a known working unit to form the basis of a maintenance log book.

Supply voltages and currents

24. The input voltages to the unit, and the current drawn by the h.t., are given in Table 2.

Note...
With the exception of the h.t. supply, all supplies are derived from the divider network (5820-99-933-1117).

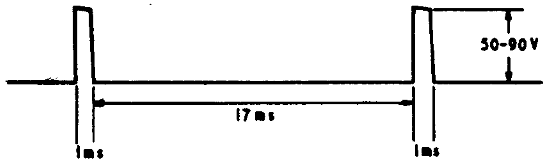


Fig. 4. Waveform at MP1-6

TABLE 2

Supply voltages and currents

Pin No. of PL1	Supply	Voltage (d.c.)	Current
5	Common anode	300	-
13	Shield grid	150	-
14	Transfer grids	165	-
15	Transfer grid (VI)	160	-
6	HT	350	24 mA

Valve voltages

25. Although in theory all valve voltages should be the same, in practice slight differences occur because of the inherent variation between valves. Tables 3 and 4 actual figures taken from an operational unit and indicate the order of variations. The measurements are made with a valve voltmeter with the unit functioning in position in the cabinet or rack. All d.c. voltages are positive.

TABLE 3

Valve voltages (d.c.)

Valve	Pin. No.						
	1	2	3	4	5	6	7
V1	21.0	12	150	295	150	155	190
V2	19.5	12	150	295	150	155	185
V3	21.5	12	150	295	150	155	185
V4	21.5	12	150	295	150	155	190
V5	20.0	12	150	295	150	155	185
V6	19.0	12	150	295	150	155	185

TABLE 4

Valve voltages (a.c.)

Valve	Pin. No. 1	2	3	4	5	6	7
V1	-	51	0.72	7.8	0.72	24	0.17
V2	-	50	0.75	8.1	0.72	22	0.36
V3	-	51	0.72	8.0	0.72	21.5	0.74
V4	-	48	0.72	8.2	0.72	21.5	1.25
V5	-	50	0.72	7.1	0.72	20	0.95
V6	-	51	0.72	7.9	0.72	21	0.75

Valve complement

26. The valve types for replacement are given in Table 5.

TABLE 5

Valve complement

Valve	CV No.	J.S. CAT. No.	Commercial Type No.
V1-6	2224	5960-99-000-2224	G1/371K

COMMON FAULTS

27. The most obvious fault likely to occur is failure or deterioration of any one of the valves. This type of fault is dealt with in para 21. No adjustment or realignment procedures are necessary after a valve has been replaced in the pulse generator. Another common fault that can develop is the spurious striking of any one of the valves. To trace this fault to a valve:

(1) Switch-off the 350V and 250V h.t. circuit breakers on the Rec/DF Cabinet

(2) Remove cans from all valves on the pulse generators.

(3) Switch on the 350V h.t. supply.

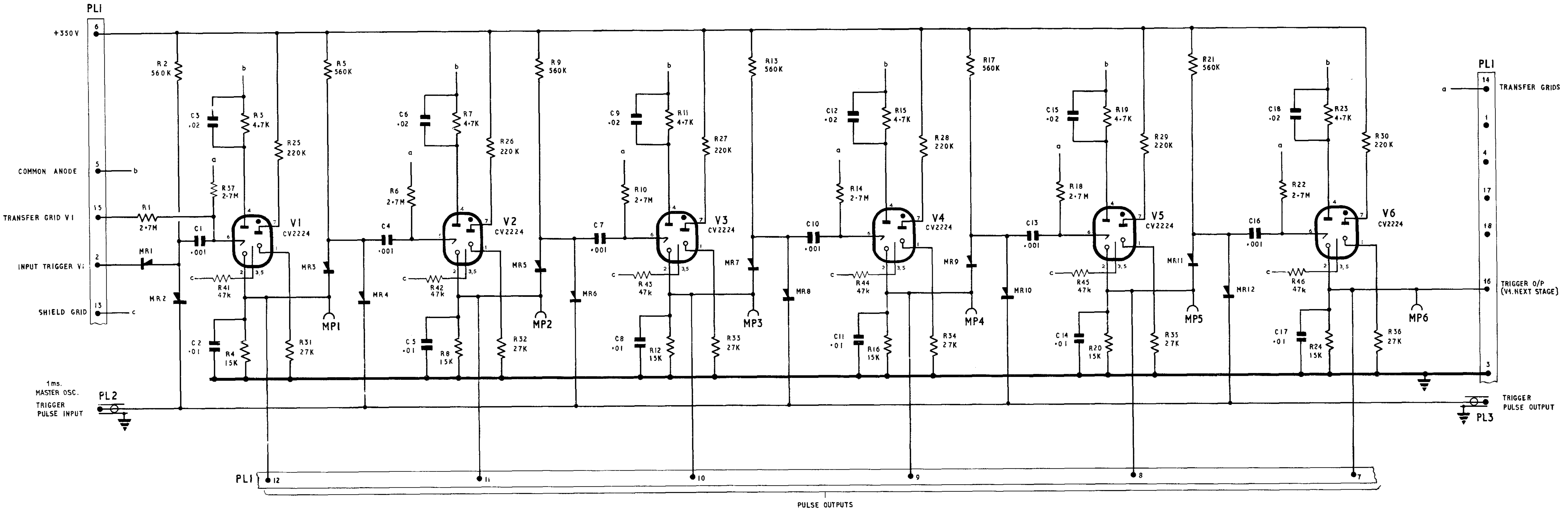
The h.t. supply is now available to the pulse generator via the divider network but there is no h.t. supply to the master oscillator. With this condition, the first valve only (V1 in the first unit) is struck and remains in the struck condition. Any other valves that are seen to strike must be replaced. After replacement, switch on the 250V h.t. supply and check that all valves strike in cyclical order.

MODIFICATIONS

28. The following modification is applicable to the pulse generator 5825-99-943-5934:

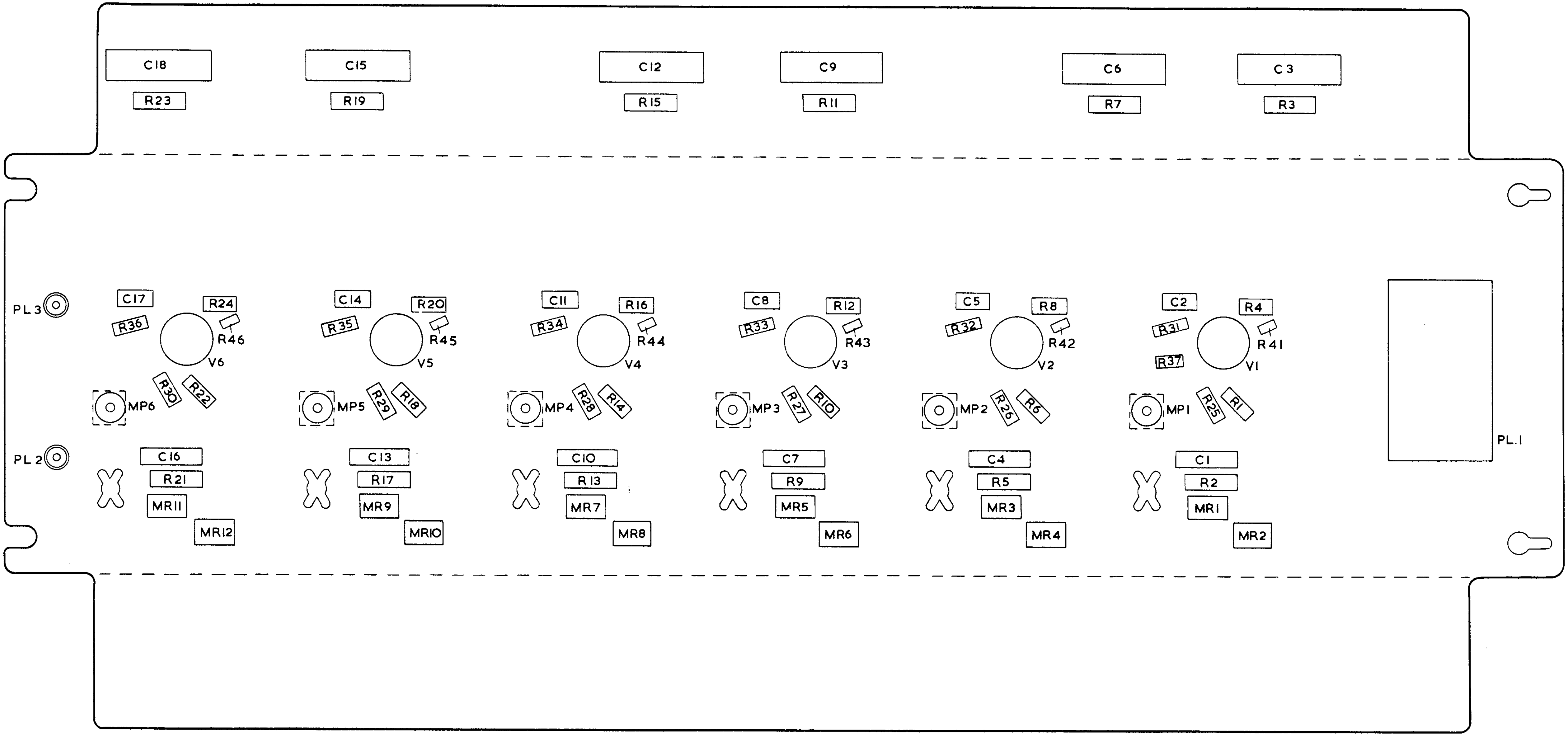
6887 ... ... To provide a more reliable start up circuit, by including resistors R37 and R41 to R46.

(continued on next page..................)



Generator, pulse, 5825-99-943-5934: circuit

Fig. 5



Generator, pulse 5825-99-943-5934 : component layout

Fig.6

Chapter 3

BUFFER AMPLIFIER (5825-99-943-5895) AND PULSE FUSE BOX (6110-99-933-1143)

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UNIT DESCRIPTION

Introduction

1. The buffer amplifier consists of six identical cathode follower stages interposed between the six pulse outputs from a pulse generator (5825-99-943-5934) and the aerial switching circuits which these pulses control. Because there are 18 aerial switching circuits, the requisite number of controlling pulses are obtained from three pulse generators; three buffer amplifiers are therefore employed to amplify the 18 pulse outputs. In TGRI 26006 equipments, the outputs from the buffer amplifiers are now routed to the aerial switching circuits via a pulse fuse box, which is described at the end of this chapter.

2. The buffer amplifiers are used in four types of rack assemblies as follows:—

(1) Aerial switching cabinet (5820-99-932-4858)—located in rack positions DF, DG and DH.

(2) Two channel d.f. cabinet (5820-99-932-4861)—located in rack positions DF, DG and DH.

(3) Single channel d.f. cabinet (5820-99-932-4862)—located in rack positions DF, DG and DH.

(4) Switching rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—located in rack positions CF, CG and CH.

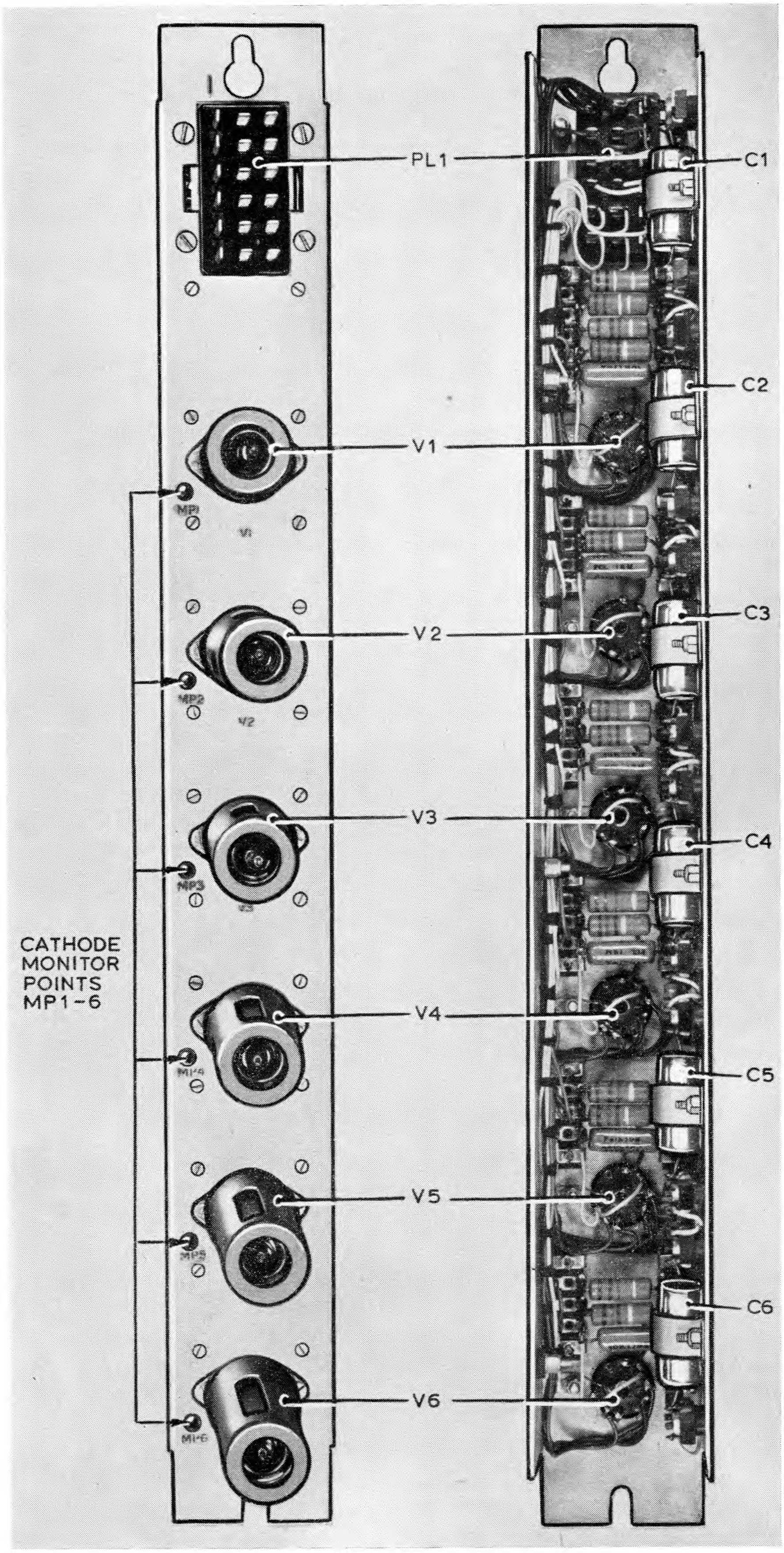


Fig. 1. Buffer amplifier : front and rear view

CONSTRUCTION

3. Except that each buffer amplifier has only one electrical connector (PL1), the construction of the unit is almost identical to that for the master oscillator (5825-99-943-5936) described in Chapter 1. The location of the connector and all valves and metering points is shown in fig. 1, which gives both front and rear views of the buffer amplifier strip unit.

BRIEF ELECTRICAL DESCRIPTION (fig. 2)

4. Each stage of the buffer amplifier caters for one output of the six from a pulse generator and, because of the cylic operation of the pulse generator, only one stage of the buffer amplifier is under pulse conditions at any one time. The approximately 50V positive input to the valve grid reduces the standing grid/cathode bias to approximately zero, and the slightly smaller amplitude output pulse is taken to the aerial switching circuits to open an aerial switching gate.

CIRCUIT DESCRIPTION (fig. 5)

5. The six outputs from a pulse generator are received at the poles of PL1 given in Table 1. These inputs are fed through a capacitor and grid stopper for each valve. The grids of the valves are taken to the junction of voltage divider R19, R20, which is at approximately -24V, the standing bias on the valves is due to a combination of this -24V on the grids and the slight positive bias on the valve cathodes, thus making the effective grid/cathode bias approximately -31V.

6. The approximately 50V positive input pulse from the pulse generator is applied to each valve in turn and tends to drive the grid positive. However, the bias is reduced to approximately zero because of the negative feedback current from the unbypassed cathode resistor; thus the output pulses from the valves are slightly smaller in amplitude than the input pulses.

7. The cathode loads of the valves are comprised of the 10k ohms resistors and the aerial network components to which they are connected.

TEST APPARATUS

8. The following items of test equipment are required for full third line servicing at G R S C establishments; they should also be available for first and second line servicing:

(1) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(2) Oscilloscope CT316, 10S/16605, or CT414, 6625-99-943-1632.

(3) Multimeter Type 9980 or Type 12889.

TESTS FOR SERVICEABILITY

9. Preliminary serviceability checks should be made by first checking at all the metering points with the valve voltmeter, when the unit is operating

normally in position in the cabinet. All meter indications should be approximately zero. Next, check with the oscilloscope that each of the six outputs is available at the poles of PL1 given in Table 1. (The current may be checked AT MP1-6 with a 200-0-200 μA f.s.d. meter and should be approximately 90 μA).

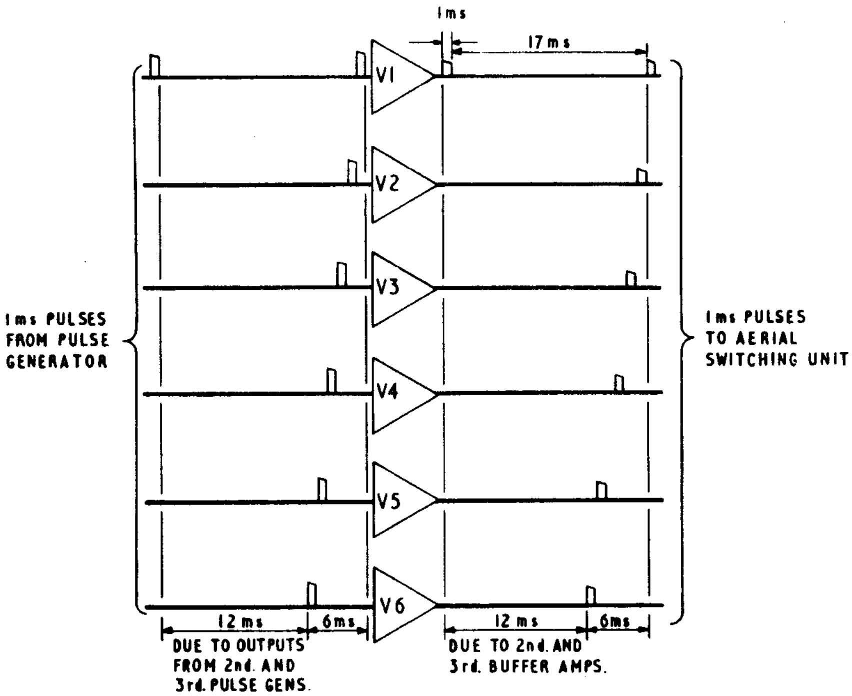


Fig 2. Buffer amplifier: block diagram

TABLE 1

Buffer amplifier inputs and outputs

Valve	Plug PL1 Pole No. Input	Output
V1	12	18
V2	11	17
V3	10	16
V4	9	15
V5	8	14
V6	7	13

Input and output waveforms should approximate to those shown in fig. 3.

10. The unit can be removed from its rack for replacement or servicing by removing the connector and slackening off the two Phillips-headed screws, and then lifting the unit clear of the rack.

DISMANTLING INSTRUCTIONS

11. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self-evident. For the location and identification of components, refer to the component layout diagram fig. 6.

FAULT DIAGNOSIS

FAULT FINDING PROCEDURE

12. Before using test apparatus to trace or locate a fault, ensure that PL1 is secure and that all valves are securely seated in their valve bases. Refer to the servicing section of this chapter and carry out a check for an output waveform at the points given in Table 1. Also make reference to para. 17 and fig. 3.

13. In the absence of any signal at all from the unit (provided that the pulse generators are functioning correctly), the obvious starting point is to check the supply voltages to and within the unit (Tables 2 and 3).

SERVICING DATA

14. To assist in servicing and fault finding of the buffer amplifier, tabulated lists of typical voltages and currents are given together with the valve complement for the unit.

Supply voltages and currents

15. The approximate voltages and values of current consumption for the unit are given in Table 2.

TABLE 2

Supply voltages and currents

Circuit	Check point	Voltage	Current	
			Signal	No signal
HT supply (+ve)	PL1/4 or 6 and earth	350V d.c.	0.6 mA	16 mA
HT supply (-ve)	PL1/5 and earth	-75V d.c.	0.23 mA	0.23 mA
Heater supply	PL1/1 and PL1/2	6.3V a.c.	4.5 A	4.5 A

Valve voltages

16. Voltages at the various pins of the valves should approximate (under no signal conditions) to those given in Table 3. Voltages should be checked with the valve voltmeter. All measurements are d.c. and positive unless otherwise stated.

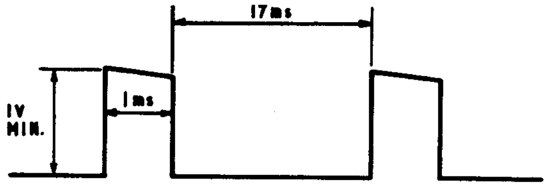


Fig. 3. Waveform at MP1-6

TABLE 3

Voltages at valve pins

	Pin No.								
Valve	1	2	3	4	5	6	7	8	9
V1-6	-	24V	8V	6.3V a.c.	6.3V a.c.	-	350V	350V	8V

(continued on next page..................)

17. With normal pulse inputs from the associated pulse generator, the waveform at each valve pin 2 should be a square wave with an amplitude of approximately 50V, 1 ms pulse width and 17 ms spacing between each pulse. The output from pin 3 (or pin 9) should be similar but of smaller amplitude.

Valve complement

18. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, given in Table 4, may be used if available.

TABLE 4

Valve complement

Valve	'T' range	CV No.	J.S. CAT No.	Commercial	CV No.
V1-6	6132	4055	5960-99-000-4055	6CH6	2127

Common faults

19. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. In this unit, no adjustment or re-alignment is necessary after replacing valves.

PULSE FUSE BOX
(6110-99-933-1143)

General

20. The pulse fuse box (fig. 4) carries 18 fuses and metering points that are interposed between the outputs of the buffer amplifiers and the pulse distribution box (3825-99-943-5897) preceding the aerial switching circuits. The box, which is installed only in equipments of the TGRI 26006 series, is mounted on the d.f. cabin wall at the right hand side of the switching rack.

21. The box is secured to the d.f. cabin wall by means of four fixing screws. Plug PL1 at the top of the box connects with a cable from the switching rack, and SK1 at the bottom of the box connects with a cable to the pulse distribution box (aerial system).

22. Each fuse is located in one of the pulse signal lines between the buffer amplifier and the pulse distribution box, and serves to protect the associated pulse distribution circuit and aerial switching diodes in the event of flash-over of the pentode valve in the buffer amplifier.

23. Fig. 7 shows that the metering point associated with each fuse gives access to the circuit side of the fuse, and thus facilitates rapid location of a ruptured fuse. The value of each fuse link is 50 mA (5920-99-059-0134).

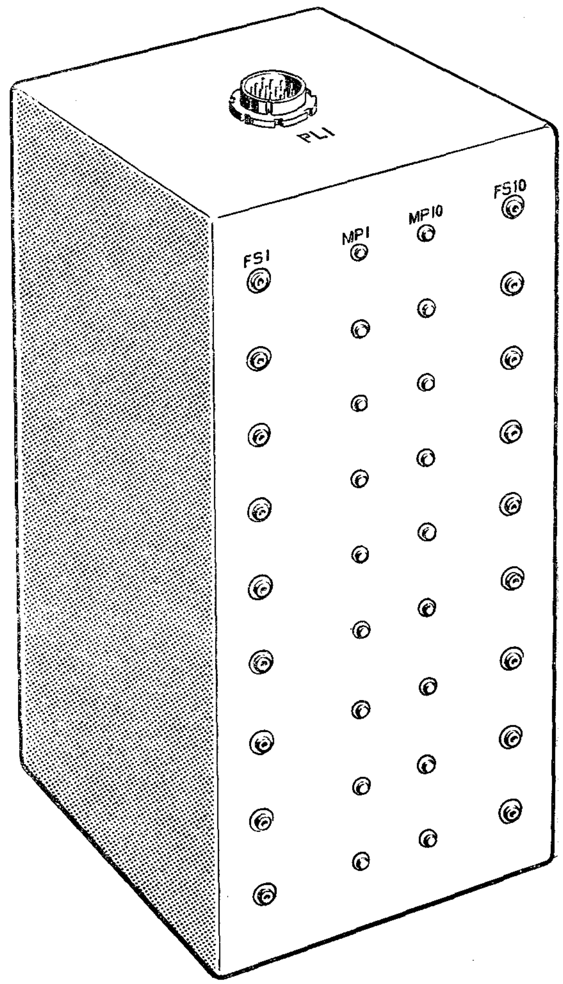
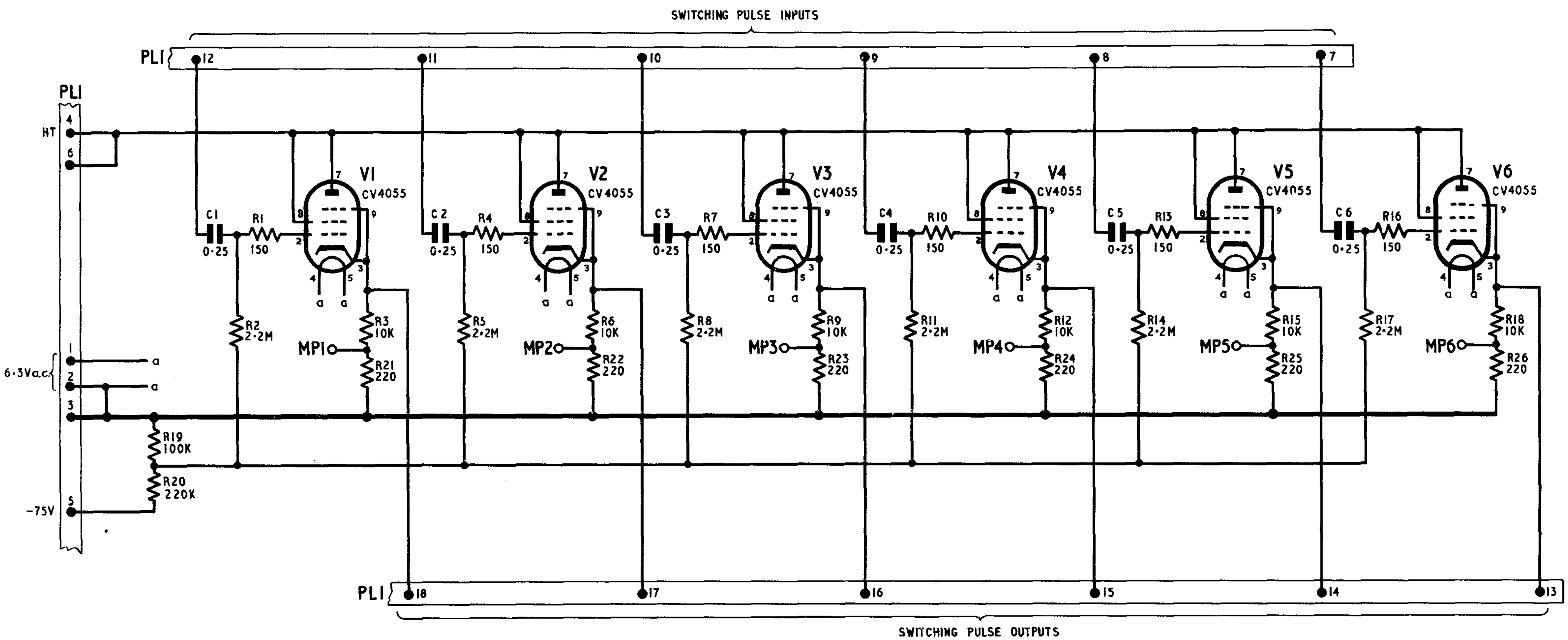


Fig. 4. Pulse fuse box



Coupler pulse generator 5825-99-943-5895 (buffer amplifier): circuit Fig. 5

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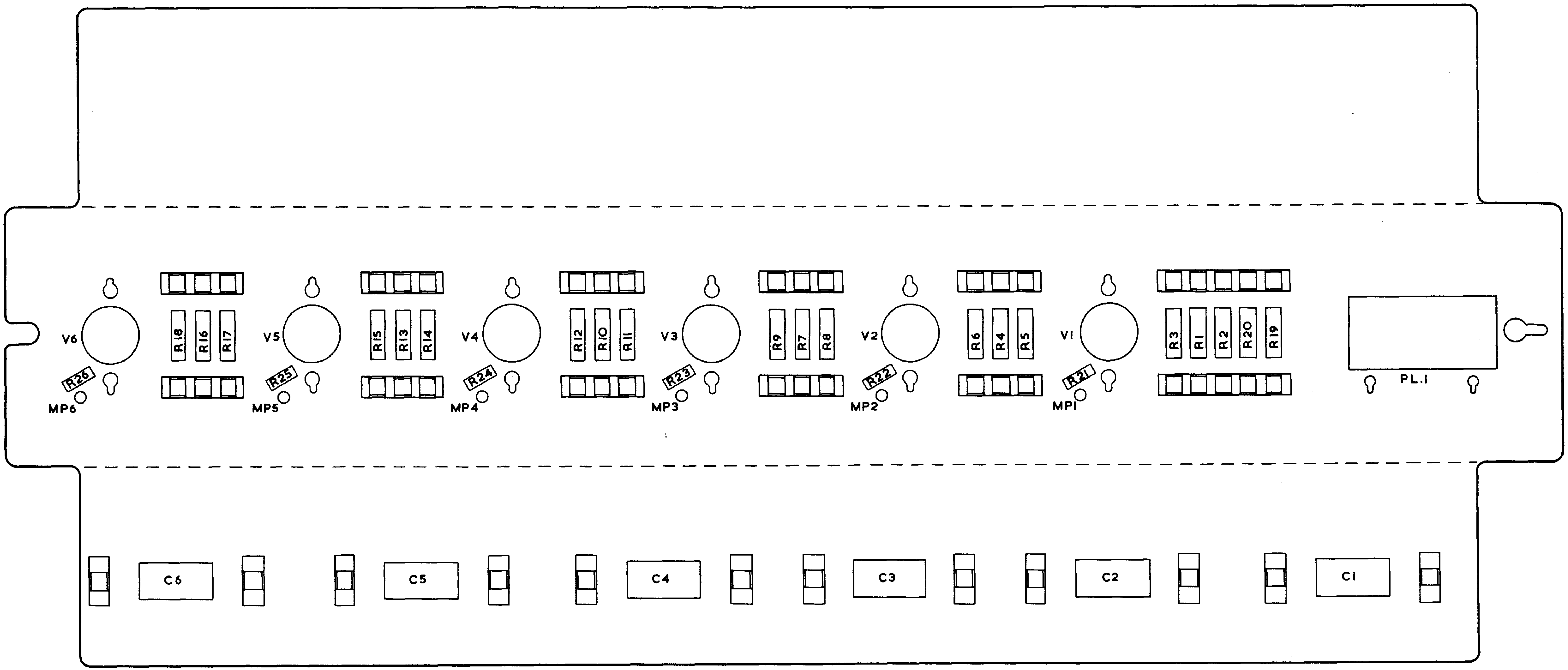
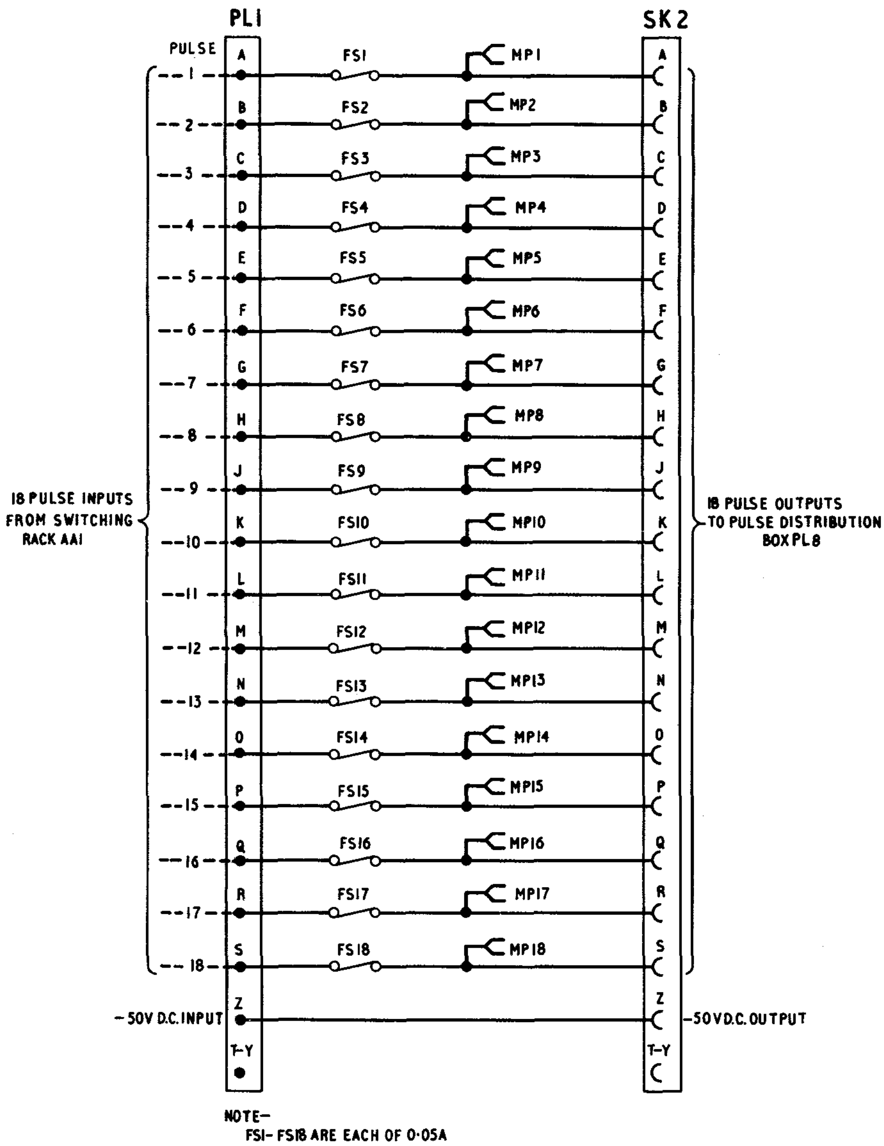


Fig.6 D.89715. 171854. SW. 11/66 Coupler, pulse generator 5825-99-943-5895 (Buffer amplifier) : component layout Fig.6



Distribution box 6110-99-933-1143, Fig.7
(pulse fuse box): circuit

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Chapter 4

REFERENCE SIGNAL GENERATOR (5825-99-943-5889)

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UNIT DESCRIPTIONS

Introduction

1. The reference signal generator combines the 18 cyclic 1 ms pulses from the outputs of the three pulse generators (5825-99-943-5934), after being suitably amplified by the three buffer amplifiers (5825-99-943-5895) and passed via the pulse distribution box (5825-99-943-5897), and synthesizes the pulses into a sine wave. The sine wave is amplified and passed to a symmetrical phase-shifting network in order to produce quadrature waveforms. The quadrature waveforms are then applied to a push-pull amplifier and the resultant reference waveforms are routed out of the unit to the resolver unit (5825-99-943-5893), which uses them to obtain bearing information for the c.r.t. indicator.

Note . . .

In a two channel system, two reference signal generators receive the 18 cyclic 1 ms pulses in order to produce reference waveforms for two resolvers and their respective c.r.t. indicators.

2. The reference signal generator is located in the following types of rack assembly:—

(1) Two channel d.f. cabinet (5820-99-932-4861)—rack positions BA and CA.

(2) Single channel d.f. cabinet (5820-99-932-4862)—rack position BA.

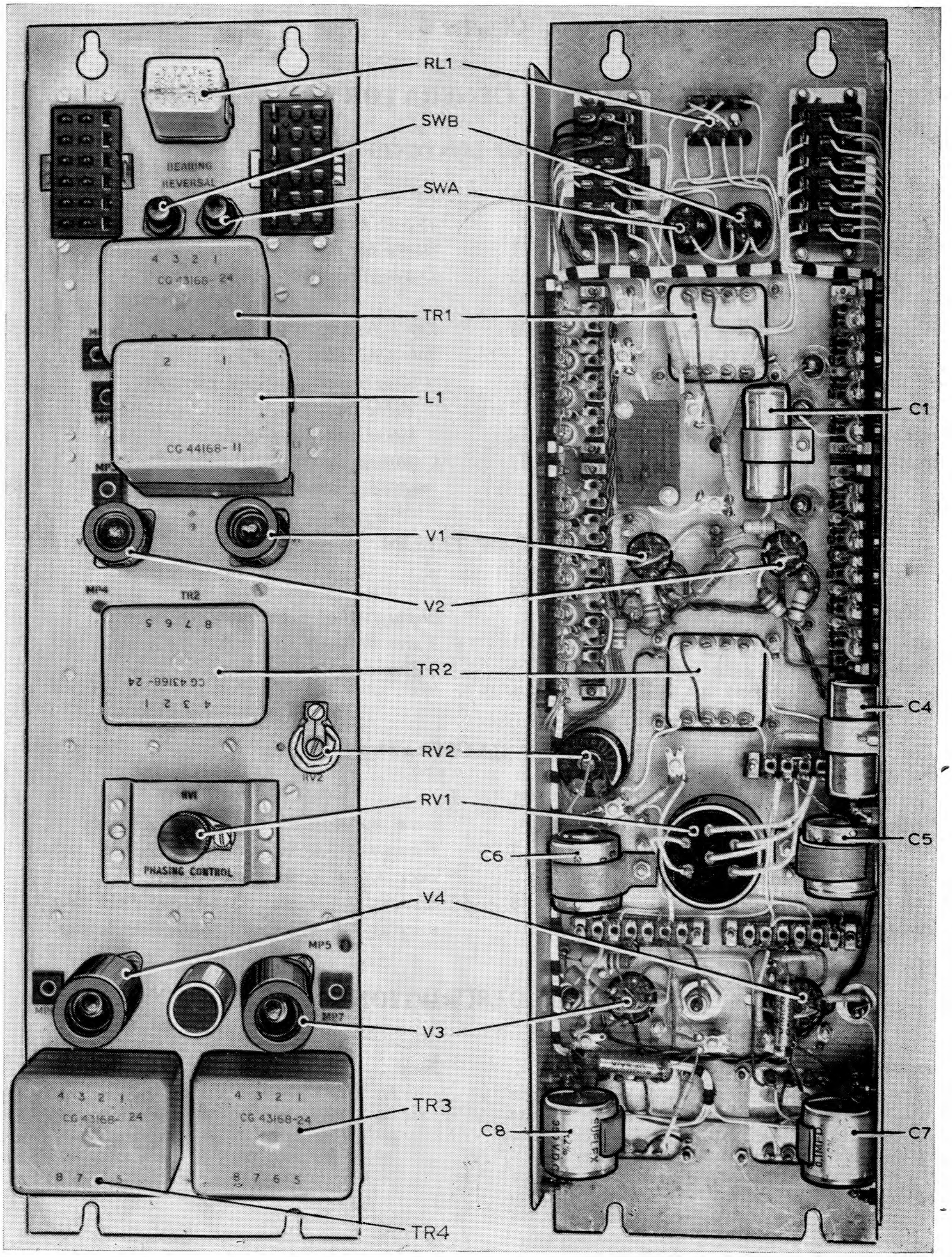


Fig. 1. Reference signal generator: front and rear views

(3) Single pre-tuned receiver and d.f. cabinet (5820-99-932-4857) - rack position CA.

(4) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845) - rack position DH.

(5) R.F. and d.f. rack within the d.f. cabin of transportable equipments of the TGRI 26006 series - rack position CB.

CONSTRUCTION

3. Construction of the unit is based on a mild steel strip, as descrined for the master oscillator in Chap. 1. The location of all connectors, valves and metering points is shown in fig. 1, which gives both front and rear views of the reference signal generator.

BRIEF ELECTRICAL DESCRIPTION

4. A block diagram of the reference signal generator is shown in fig. 4. The 18 pulse inputs to the unit are synthesized into a sine wave by means of a combining network of rectifiers and attenuating resistors. The synthesized sine wave is fed through a cathode follower stage (VI) to a calibrator potentiometer and quadrature-phasing (phase-shift) network used for d.f. circuit alignment purposes. The waveform is push-pull amplified by V2 and passed to a symmetrical phasing network to give sine and cosine reference waveforms. To obtain anti-phase outputs (required by the resolver unit), the reference waveforms are fed via push-pull output stages V3a, V3b, V4a, V4b.

CIRCUIT DESCRIPTION (fig. 5)

5. The 18 cyclic 1ms pulses from the three pulse generators are applied to 18 input circuits of the reference generator via SKT1. Each input circuit consists of a resistor and a rectifier, and all the input circuits are connected to cathode follower V1 through a common resistive load consisting of R43, R19 and RV2. The value of the resistor in each input circuit is chosen so as to obtain a combined order of attenuation that will produce an approximately sinusoidal waveform (fig. 2).

Note...
Resistor R43, forming part of the resistive load, is shorted out when the CADF system is used in conjunction with another form of direction finder (such as an Adcock system), where both systems display their bearings on a common, compensated c.r.t. indicator.

6. Also forming part of the input circuits (but located in the u.h.f. amplifier 5825-99-943-5899 , AP 116C-0801-1C, Sect. 2, Chap. 2) is the frequency-conscious trace length control circuit. This consists of a variable resistor with a scale calibrated in signal frequency, and enables the input to V1 to be attenuated to a value that gives a trace length (at the c.r.t. indicator) compatible with the frequency in use. A similar but automatically controlled trace length device is also located in the multi-frequency receiver cabinet (5820-99-932-4860). In this case, the trace length control is ganged to the tuning mechanism and is automatically varied when the frequency is

changed. RV2 is an amplitude control to ensure that sufficient trace length can be obtained when certain frequencies are selected.

◀ WARNING...
Indiscriminate use of RV2 may introduce octantol errors and mask fault conditions in the d.f. processing unit. ▶

7. The output of V1 is applied to transformer TR1 via C1 and harmonic filter network L1, C12, C13 (which tends to introduce some distortion of the waveform), and the output of the transformer, routed via contacts of RL1, is fed out of the unit at PL2/15, 16 to calibrator potentiometer. This potentiometer is located as follows:-

(1) Two channel d.f. cabinet - on the cabinet.

(2) Single channel d.f. cabinet - on the cabinet.

(3) Single pre-tuned receiver and d.f. cabinet - on the control unit.

(4) Twin pre-tuned receiver and d.f. cabinet - on the cabinet.

(5) TGRI 26006 series - on the control panel of the meter and calibrator unit.

The two outputs from the calibrator potentiometer are routed back into the reference signal generator via PL2/17, 18 and combined via C2, R23 and R24 before being fed to the grid of V2. The components C2, R23, R24 and the calibrator potentiometer together form a phase-shift network that is used for d.f. aerial alignment.

8. The double-pole changeover contacts of RL1 are interposed in the output of TR1 so as to enable a 180° phase shift to be introduced to the circuit and thus cause a reversal of the observed bearings at the c.r.t. indicator (a requirement when aligning the indicator scale). Relay RL1 is energized from the -50V supply when push button SA is pressed. Because there is a change of phase in the output signal of the multi-frequency receiver when operating on frequencies 296-343.9 MHz, an earth is automatically provided to RL1 via PL2/11 whenever any one of these frequencies is selected so that the bearing output also is reversed, thus compensating for the phase reversal. Under such a condition, operation of pushbutton SB causes the bearing trace to be reversed in order to align the c.r.t. indicator scale.

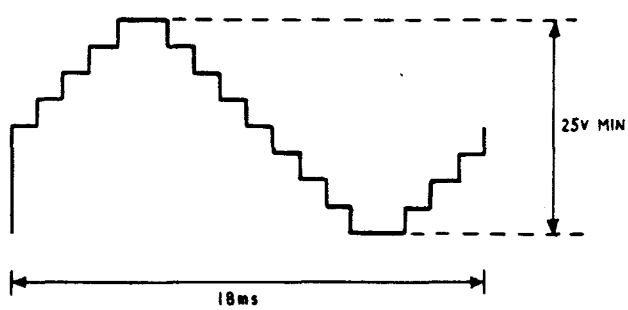


Fig. 2. Synthesized sine wave at MP1

9. The output from V2 feeds the primary circuit of TR2. This transformer provides a push-pull output that is fed to amplifier V4a, V4b, and via the symmetrical phasing network to amplifier V3a, V3b. The symmetrical phasing network, consisting of R29, R30, C5, C6, RV1a and RV1b, is set to give a 90° phase shift of the waveform so that the outputs from V3, V4 are sine and cosine respectively. The associated output transformers TR3, TR4 are approximately tuned by C8, C7 respectively, and provide the required anti-phase of the sine and cosine outputs to the resolver unit. Substantial negative feedback is applied direct from the output transformers to the grids of V3a, V3b and V4a, V4b by resistors R41, R42 and R36, R37 respectively.

10. The switching frequency of the waveforms is 55.5 Hz and capacitors C9 and C10 are included across the inputs of the final stages of the unit to filter out higher frequencies. The original stepped waveform is gradually smoothed into a conventional sine wave because of the lack of response of the circuit as a whole.

SERVICING

TEST APPARATUS

11. The following items of test equipment are required for full ▶◀ servicing ▶◀ :

(1) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(2) Oscilloscope CT316, 10S/16605, or CT414, 6625-99-943-1632.

(3) Multimeter Type 9980, or Type 12889.

(4) D.C. test supply (+100V).

(5) Beat frequency oscillator - 55.5 Hz.

(6) Resistor, 5.1k ohms.

TESTS FOR SERVICEABILITY

12. Preliminary serviceability checks, made with the unit in position in the cabinet, are performed by monitoring at metering points MP1-7. Measurements are taken with the peak-reading valve voltmeter (calibrated in sinusoidal r.m.s. values) and the waveforms are monitored with the oscilloscope. Readings should approximate to those given in Table 1 (with the unit operating normally).

13. The unit can be removed from its rack for replacement or servicing by removing the two connectors and slackening off the star headed screws, and then lifting the unit clear of the rack.

TABLE 1

Typical readings for waveforms at metering points

MP No.	Reading	Type of waveform
1	9.0V	Stepped 55.5 Hz
2	3.8V	Stepped 55.5 Hz
3	0.47V	Stepped 55.5 Hz
4	105μA	
5	110μA	
6	13.0V	Quadrature 55.5 Hz sine wave
7	13.0V	Quadrature 55.5 Hz sine wave

CHECKS ON INPUTS OF COMBINING NETWORK

14. (1) Connect the valve voltmeter between V1 pin 1 and earth.

(2) Connect the +100V d.c. test supply to pins 1-18 of SKT1 in turn and note each reading at the meter. With RV2 set to maximum, the readings should be as given in Table 2.

(3) Upon completion of the checks, return RV2 to the approximate position it occupied previously. The potentiometer is finally adjusted when the unit is in position in the rack, by ensuring that the trace length control on the u.h.f. amplifier is set for the appropriate frequency and then adjusting RV2 until a compatible trace length is displayed at the c.r.t. indicator.

◀ WARNING...
Indiscriminate use of RV2 may introduce octantol errors and mask fault conditions in the d.f. processing unit. ▶

TABLE 2

Voltage reading for each input circuit

With supply on pin:	Reading	With supply on pin:	Reading
1	85V	10	85V
2	88V	11	82V
3	90V	12	77V
4	90V	13	75V
5	92V	14	72V
6	92V	15	72V
7	90V	16	75V
8	90V	17	77V
9	88V	18	82V

55.5 Hz CHECK (1)

15. (1) Inject a 55.5 Hz, 3V r.m.s. test signal at PL2/3 and set RV2 to maximum.

(2) Connect PL2/15 to chassis earth with a suitable lead and crocodile clip.

(3) Using the valve voltmeter, check that the output at PL2/16 is not less than 1.7V.

(4) Check with the oscilloscope that the output at PL2/16 reverses in phase when pushbutton SA is pressed. Release SA and connect PL2/11 to chassis earth; check that output at PL2/16 is again reversed in phase.

(5) Reset RV2 as given in para. 14(3).

55.5 Hz CHECK (2)

16. (1) Inject a 55.5 Hz 1V r.m.s. test signal at PL2/17.

(continued on next page................)

(2) Set RV1 to maximum and, using the valve voltmeter, check for the following a.c. voltages at the pins of V3 and V4, and the tags of TR2, given in Table 3.

(3) Note the output voltages at PL2/7, 8, 9 and 10 (18V a.c. minimum).

(4) Upon completion of the checks, return RV1 to the approximate position it occupied previously. Final adjustment of the control (assuming that none of the components TR1, R23, R24 or C2 has been replaced, which would affect the setting of the calibrator potentiometer) is carried out with the reference signal generator in position in the rack. The procedure is as follows:—

(a) Set the calibrator potentiometer (located as given in para. 7) to north and note the bearing on the c.r.t. indicator.

(b) Rotate the potentiometer to east, note the bearing on the c.r.t. indicator, and return the potentiometer to north.

(c) If the bearing on the c.r.t. indicator is greater or less than 90°, adjust RV1 on the reference signal generator to correct approximately two thirds of the error.

(d) Repeat (a), (b), (c) until exactly 90° shift in bearing is indicated by the c.r.t.

TABLE 3

Test voltage checks, TR2, V3, V4

Check point	Reading a.c.
TR2, tag 5	13V
TR2, tag 1	8·0V
TR2, tag 4	8·0V
V3, pin 7	2·3V
V3, pin 2	2·3V
V4, pin 7	2·3V
V4, pin 2	2·3V

Harmonic filter check

17. (1) Switch off the power supplies.

(2) With a suitable lead and crocodile clips, short pin 1 to pin 2 on V1.

(3) Turn RV2 to maximum.

(4) Connect the beat frequency oscillator to PL2/5.

(5) Connect the valve voltmeter to PL2/15 and 16, and short pin 16 to chassis earth. Connect the 5·1k ohms resistor between PL2/15 and chassis earth.

(6) Adjust the output voltage of the b.f.o. to 8V and set the frequency to 55·5 c/s.

(7) Note the reading at the valve voltmeter.

(8) Adjust the frequency of the b.f.o. to 110 c/s and then to 165 c/s. The readings at the valve voltmeter should not be greater than 5% of the reading obtained when the b.f.o. input was 55·5 c/s.

(9) Remove all test equipment, shorting links and the test resistor.

(10) Reset RV2 as given in para. 14(3).

Dismantling instructions

18. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted directly on the chassis) is self-evident. For the location and identification of components, refer to the component layout diagram fig. 6.

FAULT DIAGNOSIS

Fault finding procedure

19.◄Prior to using test apparatus to locate a fault, ensure the connections SKT1, PL2 are secure and that valves are seated in their valve bases. To check for correct operation of the unit, refer to the servicing section of this chapter and carry out voltage and current checks at metering points given in Table 1. Waveforms monitored at M.P.1, M.P.6 and 7 should approximate to those illustrated in fig. 2 and fig. 3 respectively. The waveforms at M.P.2, M.P.3 are similar to that illustrated in fig. 2 but are attenuated and show progressive smoothing.►

20. In the absence of any signal at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Table 4).

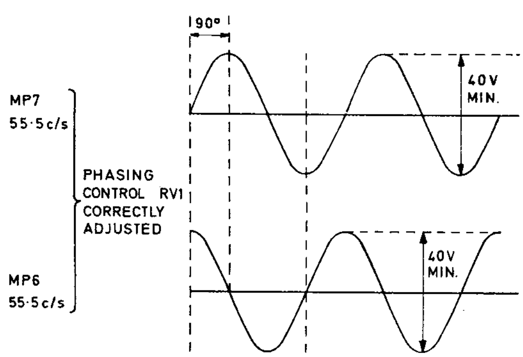


Fig. 3. Waveforms at MP6-7

Servicing data

21. To assist in servicing and fault finding of the reference signal generator, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. It is recommended that the voltages and currents given are used only as a guide to the correct operation of the unit. The typical values given may vary slightly from one unit to another, and should be replaced at the time of installation or major overhaul with readings obtained from a known working unit so as to form the basis of a maintenance log book.

Supply voltages and currents

22. The approximate values of current consumption of the unit under no signal condition are given in Table 4.

TABLE 4

Supply voltages and currents

Circuit	Check point	Voltage	Current
H.T. supply	PL2/4 and earth	+250V d.c.	35mA
Heaters	PL2/1 and earth	6·3V a.c.	1·2A

Valve voltages

23. Typical valve voltages at various valve pins are given in Table 5. The measurements are made with a valve voltmeter, and with the unit in the no-signal condition. All voltages are positive d.c.

TABLE 5

Valve voltages

Valve	Pin No.	Voltages
V1	5, 7	250
	2, 6	4·2
V2	5, 7	155
	2, 6	1·3
V3	1, 6	240
	3, 8	9
V4	1, 6	240
	3, 8	9

Valve complement

24. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 6, may be used if available.

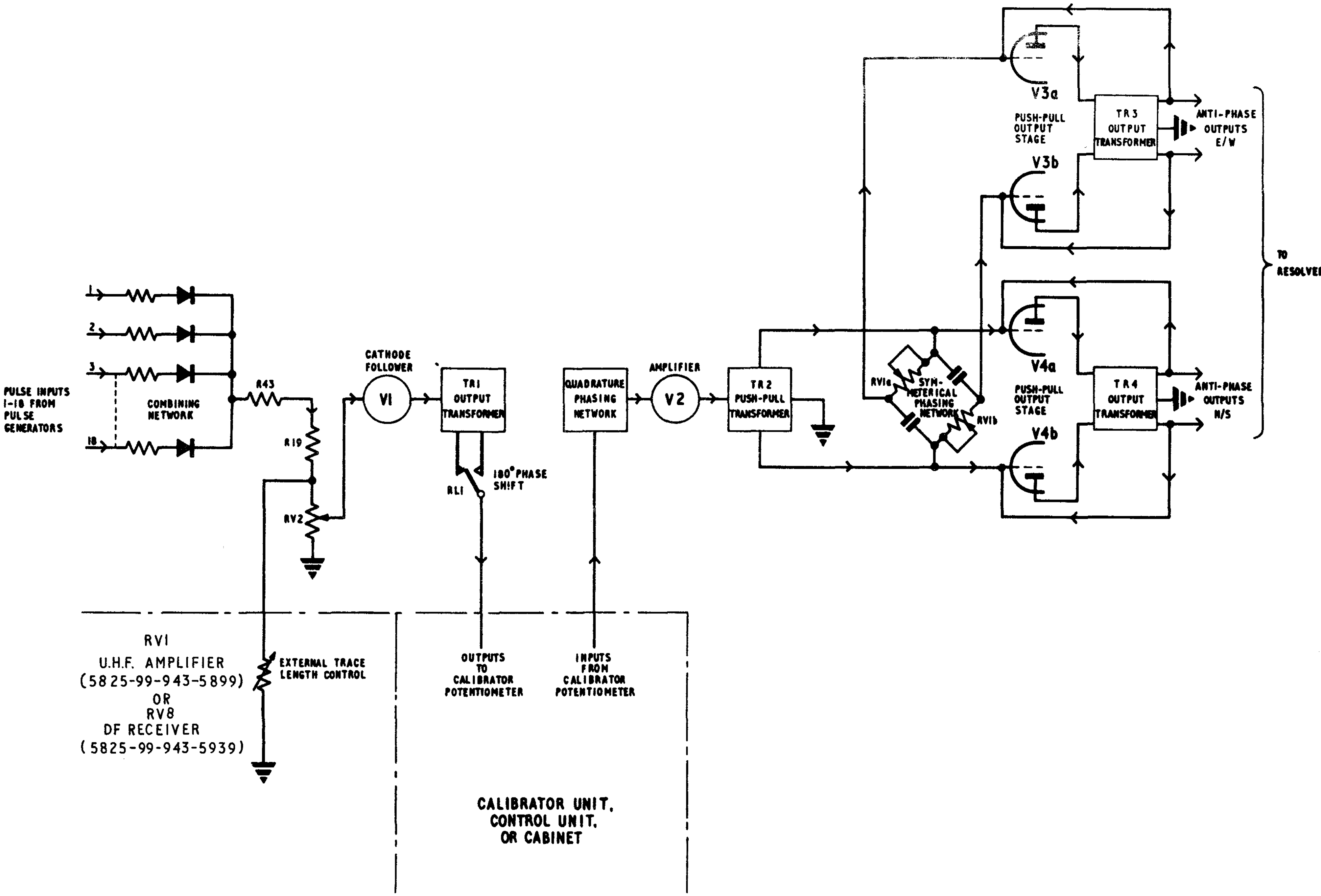
TABLE 6

Valve complement

Valve	'T' range	CV No.	Type		
			J.S. Cat. No.	Commercial	CV No.
V1, V2	6064	4014	5960-99-000-4014	6AM6/8D3	138
V3, V4	6067	4003	5960-99-000-4003	12AU7	491

Common faults

25. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. No realignment is necessary in this unit after changing a valve, although it might be necessary to adjust the amplitude control RV2 as given in para. 14(3).



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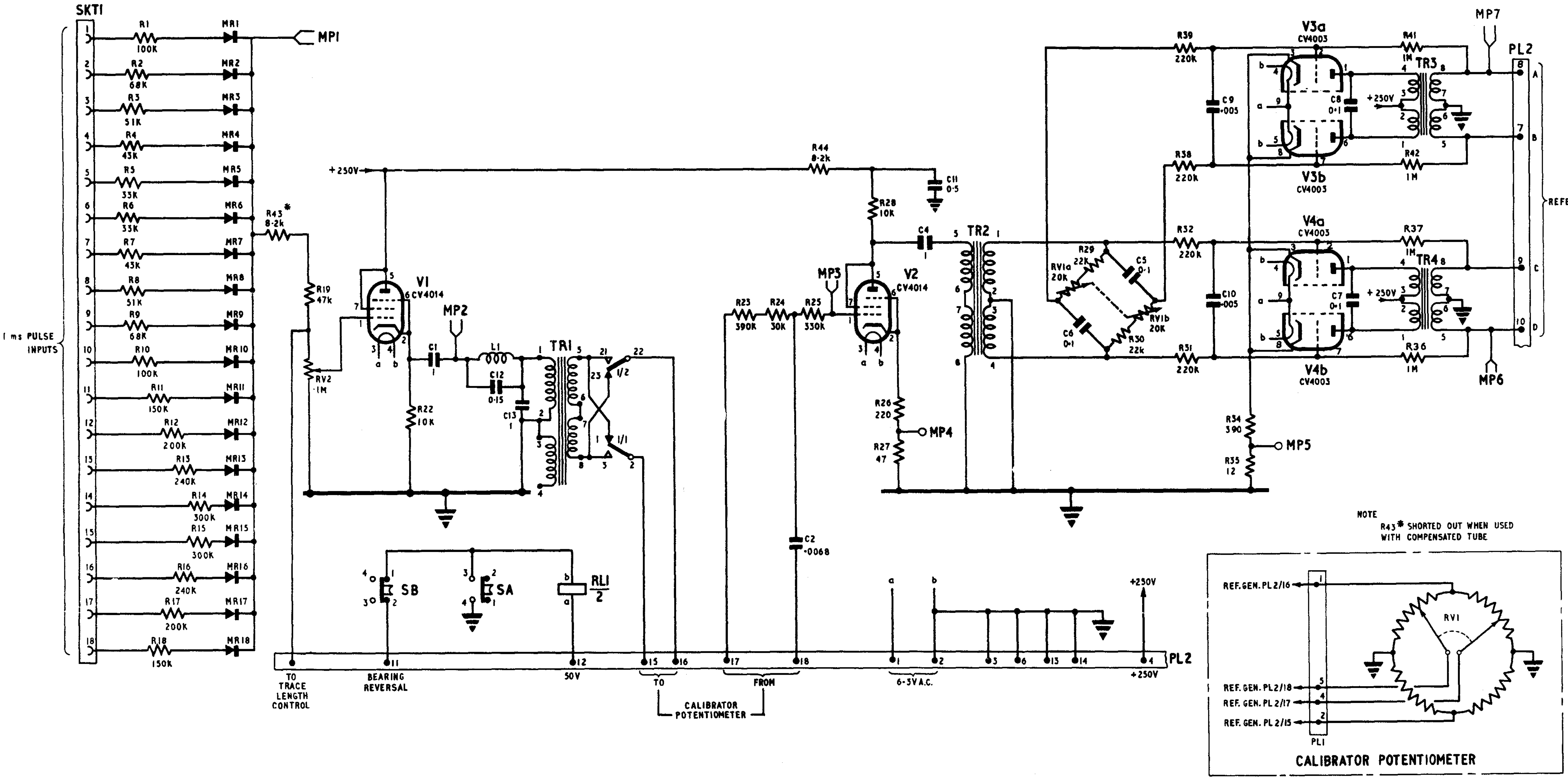
Generator, signal 5825-99-943-5889
(reference signal generator) : block diagram

Fig. 4



Generator, signal 5825-99-943-5889 (reference signal generator): circuit

Fig. 5

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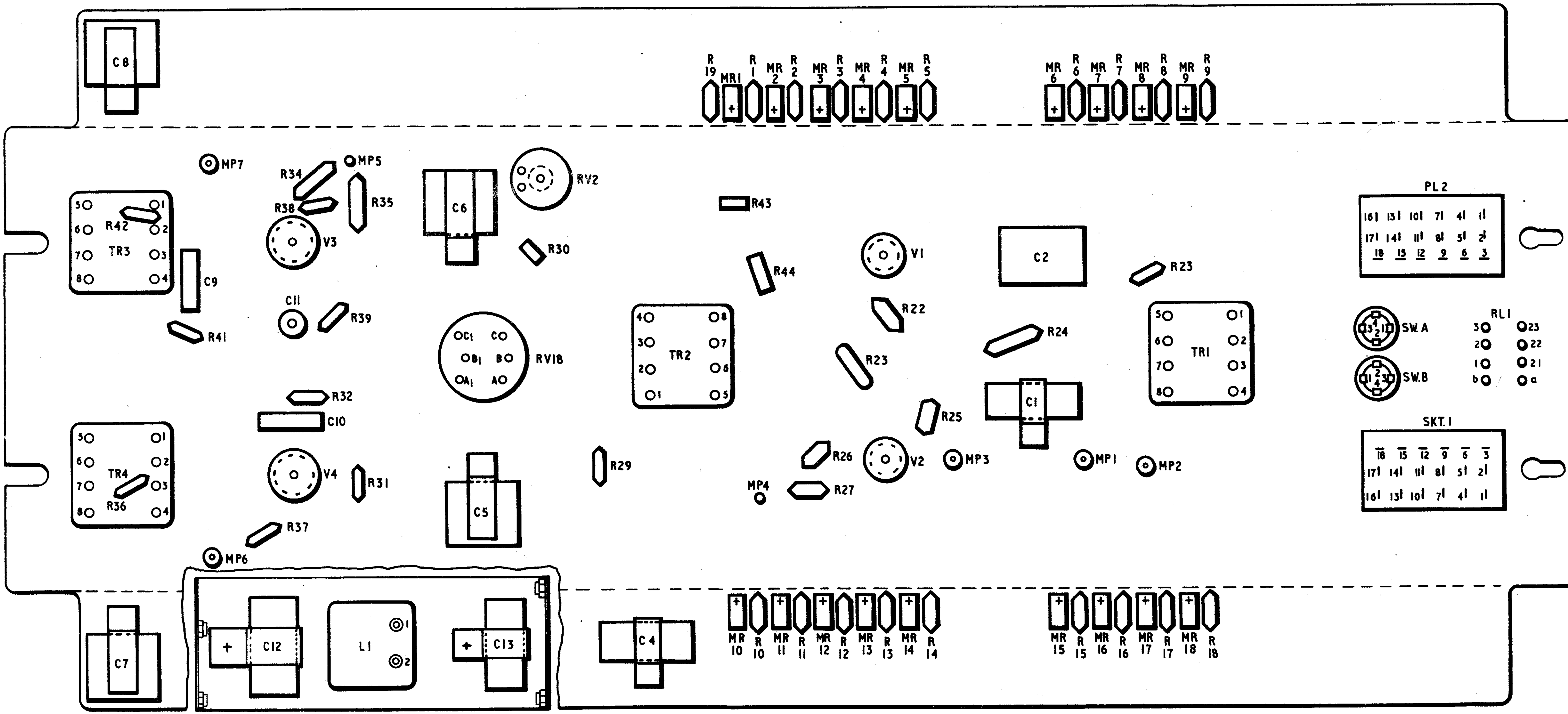

Fig. 6. Generator signal 5825-99-943-5889 (reference signal generator): component layout Fig. 6.

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Chapter 5

R.F. OSCILLATOR (5825-99-943-6165)

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UNIT DESCRIPTION

Introduction

1. The r.f. oscillator contains a 50 kc/s oscillator and a.g.c. stage, and a 130 kc/s oscillator, mixer and amplifier. The 50 kc/s signal is routed out of the unit for mixing purposes at the signal comparator (5825-99-943-5894) and the combining amplifier (5825-99-943-5900). The 130 kc/s signal is mixed with the 2 Mc/s auxiliary signal from the auxiliary receiver 2nd i.f. amplifier (5825-99-943-5891) and the resultant 1·870 Mc/s signal is routed out of the unit for mixing purposes at the combining amplifier.

Note . . .

When the d.f. circuits are fed from a multi-frequency receiver, the auxiliary signal input to the r.f. oscillator is at 1·975 Mc/s. In this case, the resultant offset auxiliary signal output to the combining amplifier is 1·845 Mc/s.

2. The r.f. oscillator is used in the following rack assemblies:—

Note . . .

In a two channel system, two r.f. oscillators are used in order to provide 50 kc/s and 1·870 Mc/s (or 1·845 Mc/s) outputs for the signal comparator and combining amplifier in each of the two channels.

(1) Single pre-tuned receiver and d.f. cabinet (5820-99-932-4857)—rack position BD.

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—rack position DC.

(3) Single channel d.f. cabinet (5820-99-932-4862)—rack position BF.

(4) Two channel d.f. cabinet (5820-99-932-4861)—rack positions BF and CF.

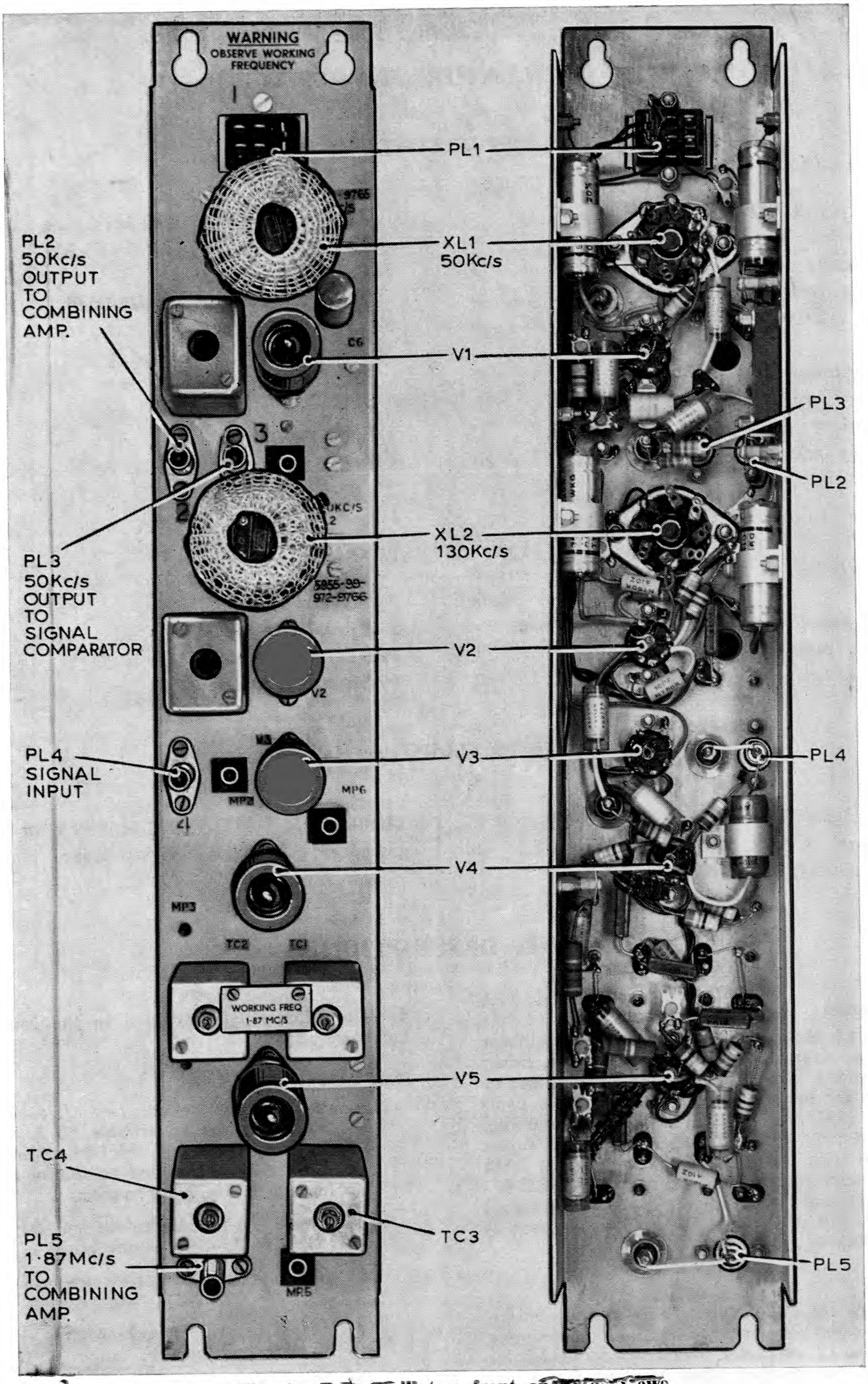


Fig. 1. R.F. oscillator: front and rear views

(5) R.F. and d.f. rack within the d.f. cabin of transportable equipments of the TGRI 26006 series - rack position CG.

CONSTRUCTION

3. Construction of the unit is based on a mild steel strip, as described for the master oscillator in Chap. 1. The location of all connectors, valves and metering points is shown in fig. 1, which gives both front and rear views of the r.f. oscillator strip unit.

BRIEF ELECTRICAL DESCRIPTION

4. A block diagram of the r.f. oscillator unit is shown in fig. 3. The output of the 50 kHz oscillator V1 is routed directly out of the unit via PL2 and PL3 for use at the signal comparator and combining amplifier respectively. The output of V1 is also taken to parallel-connected diodes V3 and MR1. This stage functions as an a.g.c. circuit, some of the output from V1 anode being rectified and fed back to V1 suppressor as negative bias.

5. The output of the 130 kHz oscillator V2 is applied to frequency changer V4, where it is mixed with the 2 MHz signal from the auxiliary receiver 2nd i.f. amplifier. (If a multi-frequency receiver is used, then the 130 kHz signal is mixed with 1.975 MHz). The resultant output from V4 anode is fed via two 1.870-1.975 MHz bandpass filters (TC1, TC2) to the grid of amplifier V5. The final 1.870 (or 1.975) MHz signal from V5 is fed through two more bandpass filters before being routed out of the unit at PL5.

CIRCUIT DESCRIPTION (fig. 4)

6. The 50 kHz crystal-controlled oscillator stage (VI) is used in conjunction with an a.g.c. double diode V3, included to prevent over-drive of the crystal XL1. Diode MR1 is in parallel with V3 as an added precaution. Some of the output of V1 anode is fed to these diodes, which rectify the signal; the negative pulses are fed back to the suppressor grid of V1 as negative bias via R4, R5 and reservoir capacitor C6. The level at PL2 or PL5, with each plug terminated by a test impedance of 1000 ohms, is approximately 1 volt.

7. Valve V2 is a 130 kHz electron-coupled crystal-controlled oscillator and, like V1, has a tuned anode circuit. The 130 kHz output from V2 anode is fed via C11 to voltage divider R15, R16, the junction point of which provides a low-level input to the grid of frequency changer V4. The 2 MHz (or 1.975 MHz) enters the unit at PL4 and is applied to the cathode of V4 via C17. This signal may be monitored at MP2 but, at this point, the 130 kHz signal will be superimposed. The resultant output of V4 anode is shunt fed, by the combination of r.f. choke L3 and capacitor C25, to a pair of bandpass filter circuits (TC1, TC2), which are tuned to pass the lower sideband of 1.870 MHz or 1.845 MHz. Filter coupling is by mutual inductance so as to obtain a reasonably symmetrical characteristic.

8. The output of bandpass filter TC2 is taken via C19 to voltage divider R22, R21, which is included to provide a reduced-level input signal to amplifier stage V5, and thus avoid excessive gain from this stage. The final output of V5 is shunt fed to two more 1.870 MHz or 1.845 MHz bandpass filter circuits, which provide a nominal 70 ohms output source to plug PL5. The signal is fed from PL5 to the combining amplifier.

SERVICING

TEST APPARATUS

9. The following items of test equipment are required for full third line servicing at GRSC establishments; they may also be available for first and second line servicing:-

(1) Signal generator CT452, Marconi Type TF 144/H/I/S.

(2) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(3) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(4) Multimeter Type 9980 or Type 12889.

(5) Resistor, 470 ohms ½ watt, fitted with crocodile clips.

(6) Resistor, 68 ohms ½ watt.

(7) Tuning tools (provided).

(8) Resistor, 26 ohms, to build up signal generator termination to 78 ohms, fitted with coaxial socket for connection to coaxial plug PL4.

TESTS FOR SERVICEABILITY

10. Preliminary serveability checks should be made by first checking metering points MP1, 2, 5 and 6 with the peak-reading valve voltmeter (calibrated in sinusoidal r.m.s. values), when the unit is operating normally in position in the cabinet. The currents at metering points MP3 and MP4 are measured by means of the meter in the d.f. cabinet, using the patch cord. Meter deflections are to the right. Waveforms are checked with the oscilloscope. All readings should approximate to those given in Table 1.

TABLE 1

Typical waveforms, voltages and currents at metering points

Metering point	Readings Voltage	Current	Type of waveform
MP1	15.5V		50 kHz sine wave
MP2	2.30V		2 MHz (or 1.975 MHz) auxiliary input with a small amount of 130 kHz sine wave
MP3		95-140	
MP4		70-90	
MP5	1.10V		1.870 MHz (or 1.845 MHz) output with a small amount of 2 MHz (or 1.975 MHz) signal
MP6	30V		130 kHz sine wave

11. The unit can be removed from its rack for replacement or servicing by removing the connectors and slackening off the four star-headed screws, and then lifting the unit clear of the rack.

REALIGNMENT PROCEDURE

12. The realignment procedure described in the following paragraphs is normally undertaken only at third line servicing. The unit can be tested on the bench with the aid of separate h.t. and heater supplies, or by using jumper leads from the cabinet supplies.

Tuning inductor L1 (50 kHz)

13. (1) Remove the unit from the equipment and connect it to the supplies.

(2) Remove the 50 kHz bar crystal XL1 from the unit.

(3) Connect the signal generator to pin 1 on V1. Set the generator for a level of 1 volt at 50 kHz.

(4) Connect the valve voltmeter to metering point MP1. Using the special tuning tools, unlock and adjust L1 for maximum output as indicated by the meter.

(5) Remove the generator and refit the crystal.

(6) If necessary, retrim L1 with the 50 kHz oscillator functioning normally (i.e. without input from the generator).

(7) Relock the dust core.

Tuning inductor L2 (130 kHz)

14. (1) Remove the 130 kHz bar crystal XL2 from the unit.

(2) Connect the signal generator pin 1 on V2. Set the generator for a level of 1 volt at 130 kHz.

(3) Unlock and adjust L2 for maximum output as indicated by the valve voltmeter (connected to MP6).

(4) Disconnect the generator and refit the crystal.

(5) Retrim L2 slightly with the oscillator functioning normally (i.e. without input from the generator).

(6) Relock the dust core.

Tuning TC1, 2, 3, 4 (1.870 or 1.845 MHz)

15. (1) Remove V2 and connect the signal generator to PL4. Set the generator for a frequency of 1.870 MHz and an output of approximately 1 volt. If the input to the unit is from the multi-frequency receiver, then set the generator for a frequency of 1.845 MHz.

(2) Unlock the tuning cores of TC1, 2, 3, 4 with a 6 BA spanner and connect the 470 ohms damping resistor between chassis earth and pin 3 on TC2.

(3) Adjust the trimmer on TC1 for maximum output as indicated by the valve voltmeter, when connected between chassis earth and pin 3 on TC3.

(4) Connect the 470 ohms resistor between chassis earth and pin 3 on TC1. Adjust TC2 for maximum output as indicated by the valve voltmeter, when connected between chassis earth and pin 3 on TC3.

(5) Replace the meter with the 470 ohms resistor on pin 3 of TC3. Connect a 68 ohms load resistor across PL5 and shunt it with the valve voltmeter. Trim TC4 for maximum output.

(6) Transfer the 470 ohms resistor to pin 3 on TC4 and chassis. Trim TC3 for maximum output.

(7) Repeat the trimming operations as necessary then relock all the trimmers and check the response curve. This should be reasonably flat between ±20 kHz and should be approximately 3 dB down at ±30 kHz (centred on 1.870 or 1.845 MHz). Also check the overall gain by observing that, for an input of 0.8V, 1.870 or 1.845 MHz at PL4, an output of 0.8V is obtained into the 68 ohms load at PL5.

DISMANTLING INSTRUCTIONS

16. There are no complicated mechanical devices or tuning mechanism, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self-evident. For the location and identiciation of components refer to component layout diagram fig. 5.

(continued on next page..................)

FAULT DIAGNOSIS

Fault finding procedure

17. Before using test apparatus to trace or locate a fault, ensure that all connections are secure (PL1 to PL5) and that valves are securely seated in their valve bases. For checking the correct operation of this unit, refer to the servicing section of this chapter and carry out voltage, current and waveform checks at the metering points given in Table 1. The waveforms should approximate to those shown in fig. 2, and should agree with the description in Table 1.

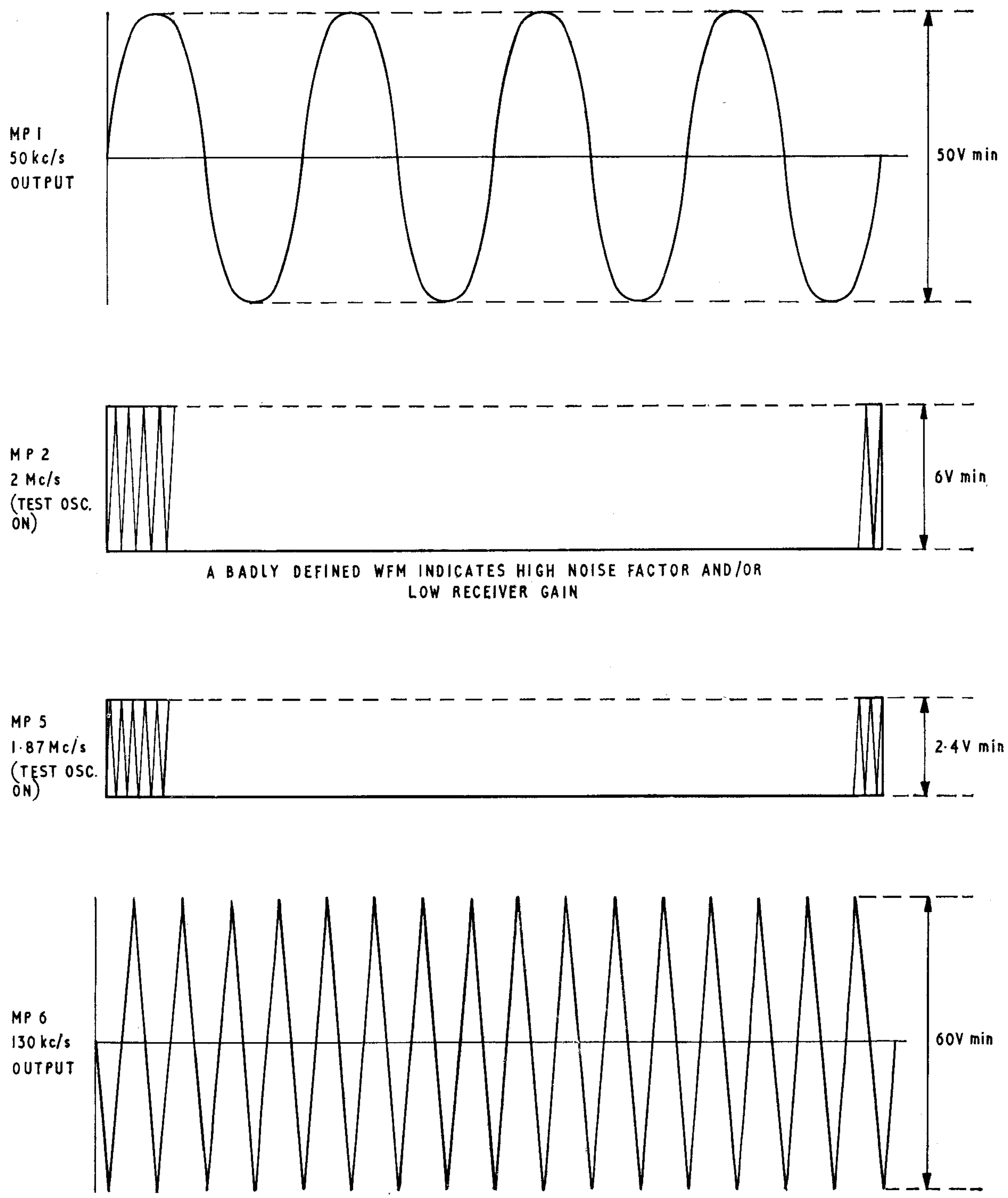


Fig. 2. Waveforms at MP1, 2, 5 and 6

18. In the absence of any output at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Tables 2 and 3).

Servicing data

19. To assist in servicing and fault finding of the r.f. oscillator unit, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. The typical values given may vary slightly from one unit to another and should be replaced at the time of installation or major overhaul with readings actually obtained from a known working unit to form the basis of a maintenance log book.

Supply voltages and currents

20. The input voltages to the unit are given in Table 2.

TABLE 2

Supply voltages and currents

Circuit	Connection point	Voltage	Current
H.T. supply	PL1/4 and earth	+250V d.c.	19mA
Heater supply	PL1/1 and PL1/2 (earth)	6·3V a.c.	1·5A

Valve voltages

21. Typical valve voltages are given in Tables 3 and 4. The measurements are taken with the valve voltmeter and all a.c. measurements are taken under normal full signal conditions. All d.c. measurements are positive unless otherwise stated.

TABLE 3

Valve voltages (d.c.)

Valve	Pin No. 1	2	3	4	5	6	7
V1	0·60	0	—	—	235	0·06	80
V2	25	25	—	—	240	0	105
V3	0	−0·75	—	—	0	—	—
V4	0	2·5	—	—	232	2·5	155
V5	0	1·75	—	—	220	1·75	200

TABLE 4

Valve voltages (a.c.)

Valve	Pin No. 1	2	3	4	5	6	7
V1	1·8	0	—	—	21	—	—
V2	5·4	2·7	—	—	28	—	—
V3	—	21	—	—	—	—	—
V4	2·15	0·82	—	—	8·1	0·82	—
V5	0·3	—	—	—	13·0	—	—

Valve complement

22. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 5, may be used if available.

TABLE 5

Valve complement

Valve	'T' range	CV No.	J.S. Cat. No.	Type Commercial	CV No.
V1	6064	4014	5960-99-000-4014	6AM6/8D3	138
V2	6064	4014	5960-99-000-4014	6AM6/8D3	138
V3	5726	4007	5960-99-000-4007	6AL5 (Short-bulb)	140
V4	6064	4014	5960-99-000-4014	6AM6/8D3	138
V5	6064	4014	5960-99-000-4014	6AM6/8D3	138

Common faults

23. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. If V1 or V3 are replaced it may be found necessary to retune L1, as described in para. 13; if V2 is replaced, L2 may need retuning (para. 14); if V4 is replaced, it may be necessary to retune TC1 and TC2 (para. 15). In the case of replacement of V5, it will probably be necessary to retune TC1, TC2, TC3, TC4 as described in para. 15.

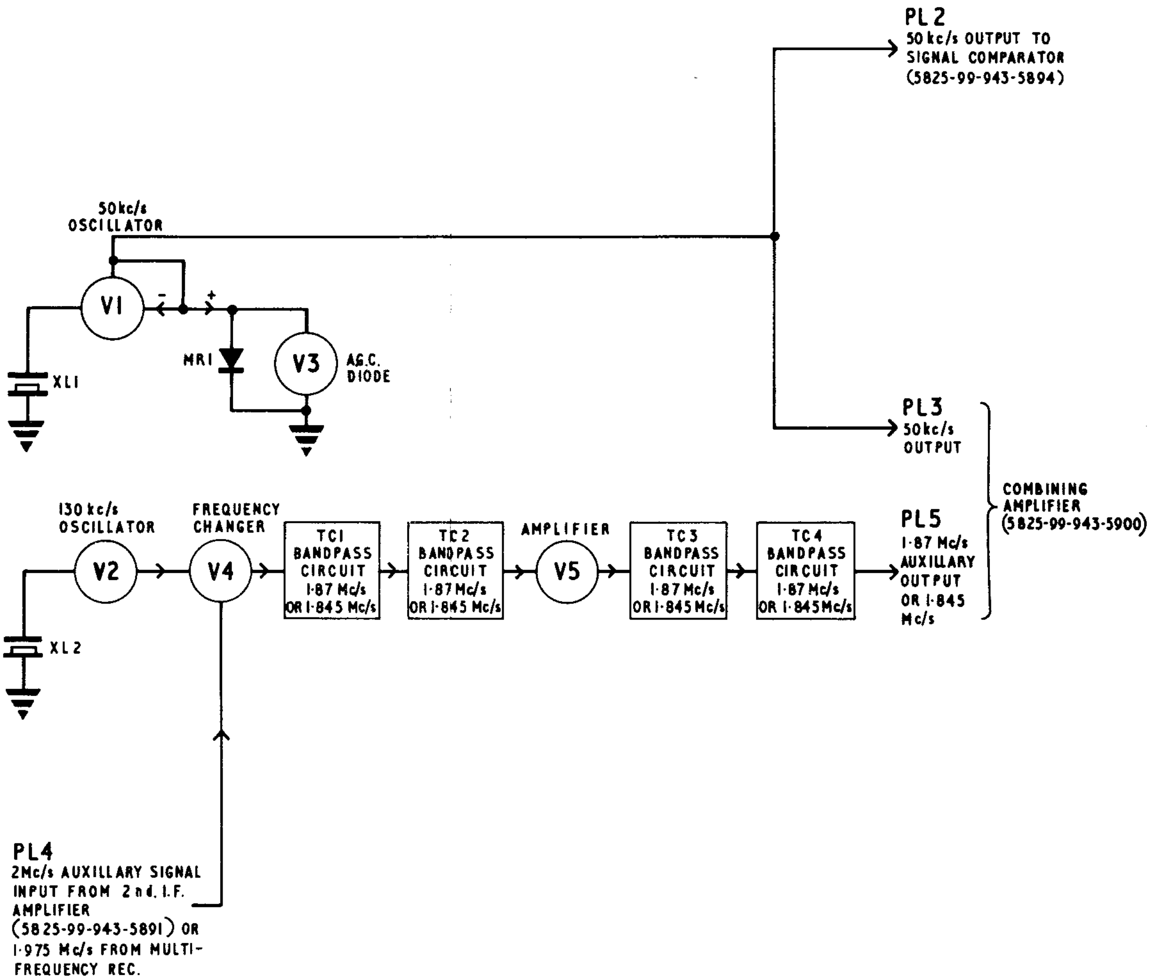
24. In general, replacement of components associated with either of the two oscillators or the bandpass filter circuits will normally necessitate realignment of the respective tuned circuits.

◄Modifications

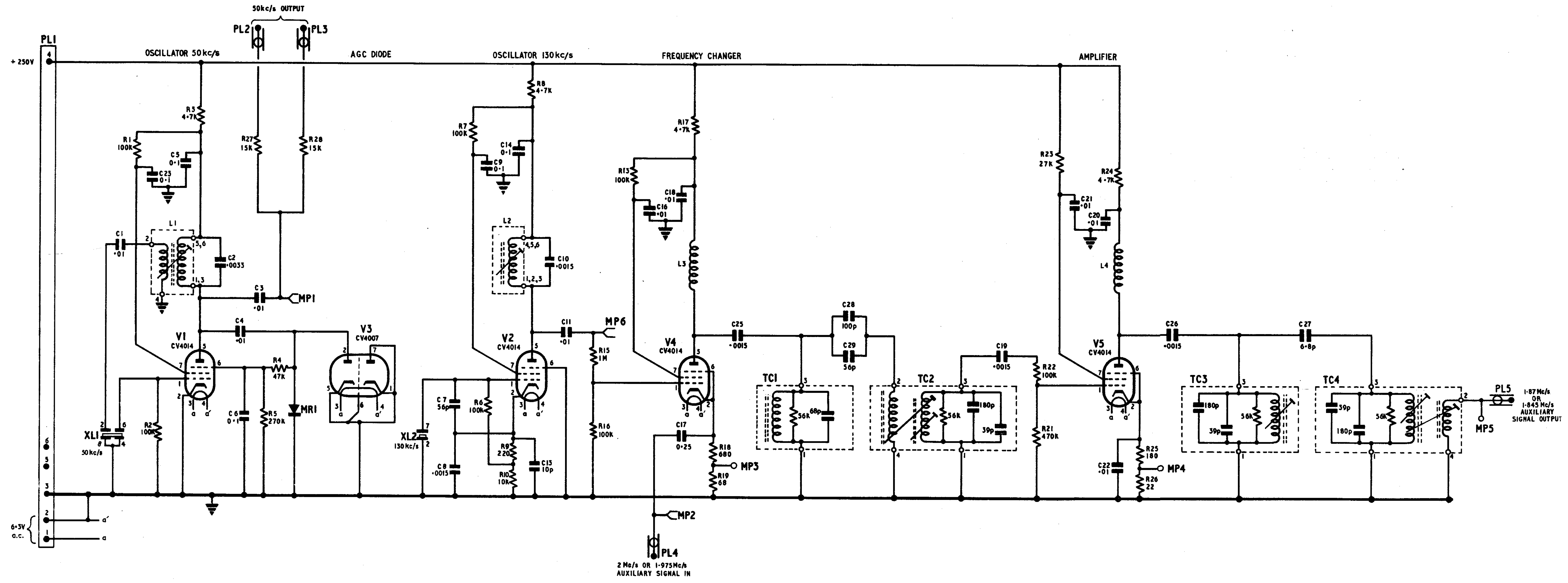
25. The following modification is applicable to the r.f. oscillator 5825-99-943-6165:

7239 ... ... Addition of warning labels regarding frequency.►

(669) Dd. 713465 510 10/69 T.T.P. Ltd. 483/9



R.F. oscillator 5820-99-943-6165 : block diagram Fig.3

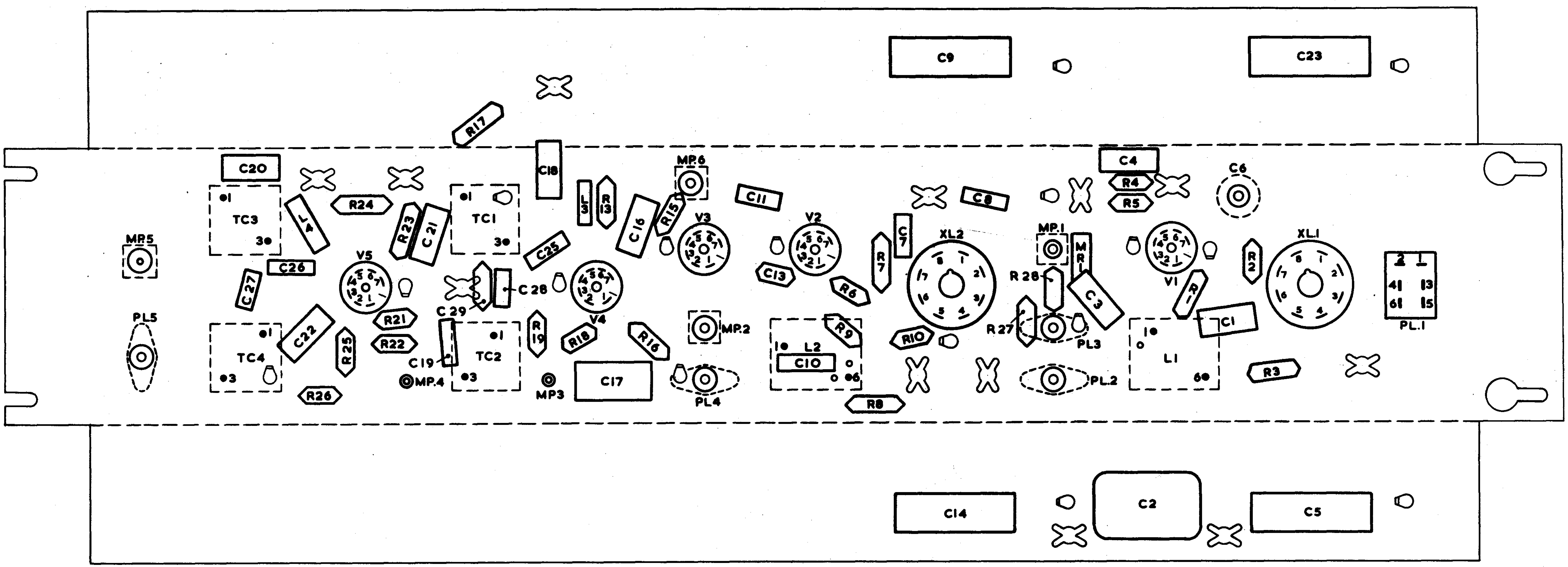


Oscillator, R.F 5825-99-943-6165 : circuit

Fig.4

AIR DIAGRAM-MIN
116C-0801-MD67
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
Prepared by the Ministry of Aviation

D 460077. 172082. S.W. 12/66



Oscillator, R.F. 5825-99-943-6165: component layout

Fig. 5

D 460077. 172082. S.W. 12/66

Chapter 6

COMBINING AMPLIFIER (5829-99-943-5900)

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UNIT DESCRIPTION

Introduction

1. The combining amplifier performs two functions, as follows:

(1) It mixes the 2 Mc/s d.f. signal—received from the i.f. amplifier (5825-99-5891)—with the 1·870 Mc/s offset auxiliary signal—received from the r.f. oscillator (5825-99-943-6165)—in order to produce a 130 kc/s output for application to the delay line unit (5825-99-943-5933). The output is for use at the end of the delay line, and is therefore an undelayed signal.

Note . . .

When the d.f. circuits are fed from a multi-frequency receiver, d.f. signal input to the unit is at 1·975 *Mc/s and the offset auxiliary signal is at* 1·845 *Mc/s.*

(2) It offsets a small portion of the 130 kc/s signal by mixing it with a 50 kc/s input from the r.f. oscillator (5825-99-943-6165). The resultant 80 kc/s signal is fed out of the unit to the delay line. A total delay of 1 ms is required for this signal; part of the delay is carried out in the combining amplifier and the remainder in the delay line unit.

2. The combining amplifier is used in the following rack assemblies:

Note . . .

In a two channel system, two combining amplifiers are used in order to provide 130 *kc/s and* 80 *kc/s signals to the relay lines of both channels.*

(1) Single pre-tuned receiver and d.f. cabinet (5820-99-932-4857)—rack position BE.

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—rack position DD.

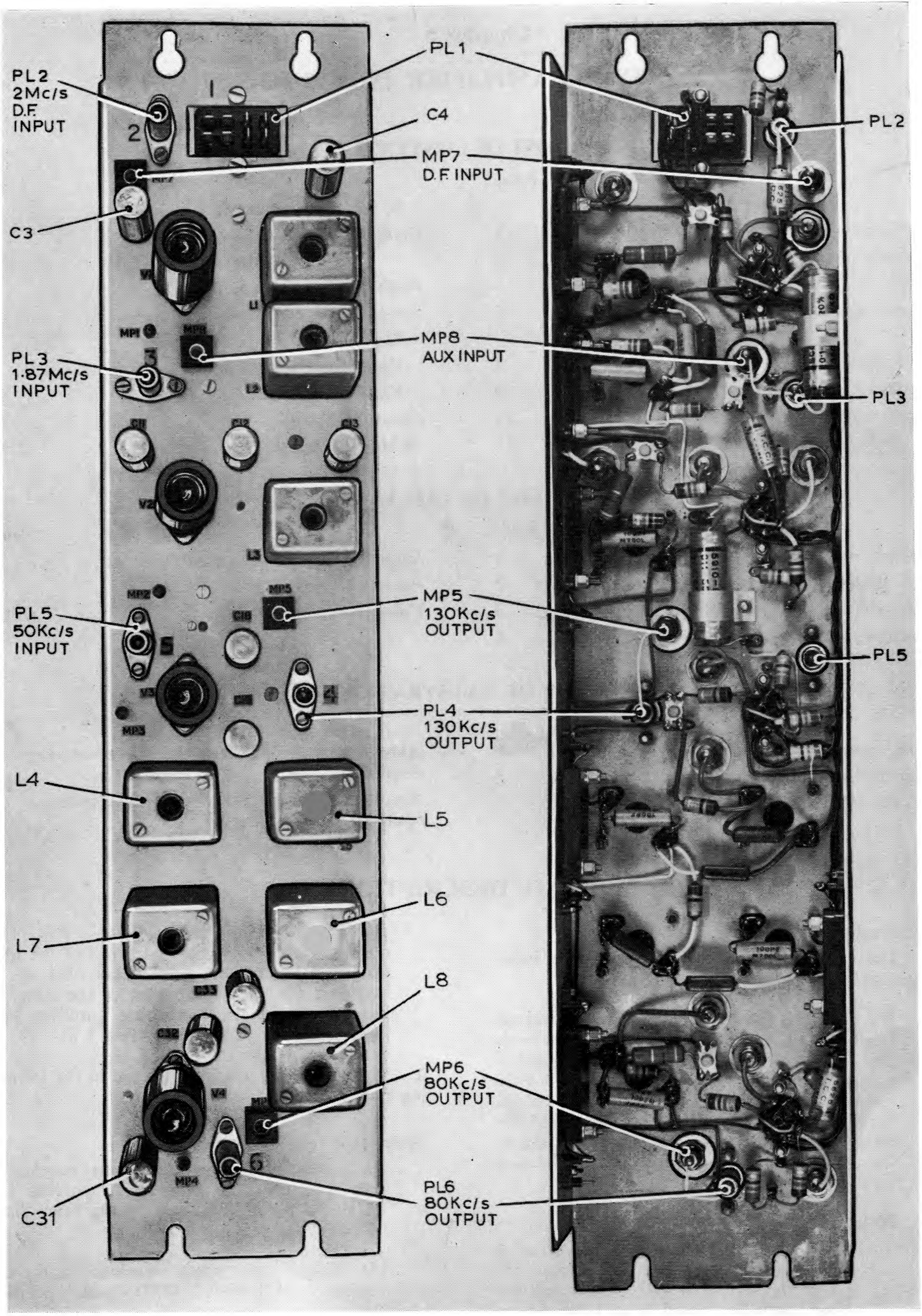


Fig. 1. Combining amplifier: front and rear views

(3) Single channel d.f. cabinet (5820-99-932-4862) - rack position BE.

(4) Two channel d.f. cabinet (5820-99-932-4861) - rack positions BE and CE.

(5) R.F. and d.f. rack within the d.f. cabin of transportable equipments of TGRI 26006 series - rack position CF.

CONSTRUCTION

3. Construction of the unit is based on a mild steel strip, as described for the master oscillator in Chap. 1. The location of all connectors, valves, and metering points is shown in fig. 1, which gives both front and rear views of the combining amplifier strip unit.

BRIEF ELECTRICAL DESCRIPTION

4. A block diagram of the combining amplifier is shown in fig. 2. Frequency changer V1 receives a 2 MHz d.f. input from the 2 MHz i.f. amplifier (or a 1.975 MHz input if a multi-frequency receiver is used), and a 1.870 MHz auxiliary signal input from the r.f. oscillator (or a 1.845 MHz auxiliary signal input if a multi-frequency receiver is used). The resultant 130 kHz output of V1 is applied to buffer amplifier V2 and to coupling transformer L2. Valve V2 passes the output to the delay line unit via an impedance matching transformer L3, whilst the 130 kHz output of L2 is mixed in V3 with a 50 kHz signal derived from the r.f. oscillator unit. The output of V3 is filtered by two pairs of bandpass circuits (L4, L5 and L6, L7), leaving the lower sideband of 80 kHz these circuits also serve to delay the signal for a small part of the required delay time, the remainder of the delay being effected in the delay line unit. The 80 kHz output is fed to the delay line unit via buffer amplifier V4 and impedance matching transformer L8.

CIRCUIT DESCRIPTION (fig. 4)

5. Frequency changer V1 receives the 2 MHz (or 1.975 MHz) d.f. signal at its control grid via terminating resistor R1 and the combination of coupling capacitor C1 and grid leak R2. Simultaneously, the 1.870 MHz (or 1.845 MHz) offset signal from the r.f. oscillator is applied to the cathode of the valve via a similar terminating arrangement of R5 and C2. The output of V1 consists of the lower sideband of 130 kHz (selected by the capacity-coupled bandpass circuits L1, L2 and associated capacitors and damping resistors), and is applied at low level to buffer amplifier V2 via voltage divider R10, R11, C10. In addition, the secondary winding of L2 applies this same 130 kHz signal to the cathode of V3 via C17. The tuned anode circuit of V2 is highly damped by the 10k ohms resistor R14, and transformer L3 steps down the output impedance to 70 ohms. The output level from L3 is approximately 1 volt, and is fed out of the unit at PL4 to the delay line unit.

6. A second input of 50 kHz, obtained from the r.f. oscillator unit, is applied to the grid of V3 via PL5. This signal is mixed with the 130 kHz present at the cathode. The output of V3 is the lower sideband frequency of 80 kHz, which is selected by a pair of capacity-coupled bandpass circuits consisting of L4, L5 and associated capacitors. The pair, which has an amplitude response to approximately - $1\frac{1}{2}$ db at ±2 kHz, is the first of a total

of eight pairs comprising the delay line; the second pair, L6,L7, is also incorporated in the unit and the remainder are in the delay line unit (Chap. 7, fig. 4).

7. Each pair of bandpass circuits is buffered by a high-value resistor, e.g. R24, or by a valve amplifier. One of these amplifiers (V4) feeds the 80 kHz signal via matching transformer L8,PL6 and a low impedance line to the delay line unit: The output is approximately 1 volt.

SERVICING

TEST APPARATUS

8. The following items of test equipment are required for full third line servicing at GRSC establishements; they should also be available for first and second line servicing:

(1) Signal generator CT452, Marconi type TF 144/H/I/S. (Three required for third line servicing.)

(2) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(3) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(4) Multimeter Type 9980 or Type 12889.

(5) 200-0-200 μA meter of internal resistance 243 ohms built out to 2.5k ohms.

(6) Resistor, 68 ohms ½ watt.

(7) Resistor, 26 ohms, to build up signal generator termination to 78 ohms; fitted with a coaxial socket for connection to the various plugs of the unit.

(8) Tuning tools (provided).

TESTS FOR SERVICEABILITY

9. Preliminary serveability checks, made with the unit in position in the cabinet or rack, may be performed by first injecting a 2 MHz signal (or 1.975 MHz signal, if a multi-frequency receiver is used) into PL2, and PL4 of the r.f. oscillator, using a parallel connection from the signal generator. The input level of the generator should be approximately 0.5V (unmodulated). With the combining amplifier operating normally, a check can be made at metering points MP5 to MP8; readings should approximate to those given in Table 1. The waveform readings should be taken with the oscilloscope, and the voltage measurements with the peak reading valve voltmeter.

10. The cathode current indication for each valve may also be observed, using metering points MP1 to MP4, with the unit this time in the no-signal condition. MP1 to MP4 are monitored by means of the meter in the d.f. cabinet, using the patch-cord. Meter deflections are to the right.

TABLE 1

Typical readings at metering points

MP No.	Voltage	Current indication	Type of waveform	Signal Input
1		70-100		
2		100-130		No signal condition
3		60-70		
4		100-130		
5	◀5.0V▶		130 kHz sine wave	
6	◀0.75V▶		80 kHz sine wave	
7	◀3.0V▶		2 MHz (or 1.975 MHz sine wave)	
8	1.10V		1.870 MHz (or 1.845 MHz) and a residual amount of 2 MHz (or 1.975 MHz signal)	Normal i.f. amp. inputs

11. The unit can be removed from its rack for replacement or servicing by removing the connectors and slackening off the four star-headed screws, and then lifting the unit clear of the rack.

REALIGNMENT PROCEDURE

12. The realignment procedure described in the following paragraphs is normally undertaken only at third line servicing. The unit can be tested on the bench with the aid of separate h.t. and heater supplies, or by using jumper leads connected to the cabinet supplies.

130 kHz alignment (L1-3)

13. (1) Set the signal generator to a frequency of 130 kHz at a level of approximately 0.5V and connect it to PL2.

(2) Connect the valve voltmeter, together with the 68 ohms load resistor, across PL4 (or between MP5 and earth).

(3) Using the tuning tool provided, adjust L1 to L3 in turn for maximum output as indicated by the meter, locking each core after adjustment.

(4) Observe the overall gain by setting the signal generator to a level of 1 volt and check that the output into the load is approximately 1.9V.

(5) Connect the signal generator to PL5 and check that the level obtained is approximately the same as that given in (4).

80 kHz alignment (L4-8)

14. (1) Set the signal generator to a frequency of 80 kHz ± 100 Hz at a level of approximately 0.5V and connect it to PL5.

(2) Connect the valve voltmeter, together with the 68 ohms load resistor, across PL6 (or between MP6 and earth).

(3) Using the tuning tool, adjust L4 to L8 in turn for maximum output as indicated by the meter, locking each core after adjustment.

(4) Observe the overall gain by setting the generator to a level of 1 volt and check that the output into the load is approximately 1.5V.

DISMANTLING INSTRUCTIONS

15. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self-evident. For the location and identification of components refer to component layout diagram fig. 5.

FAULT DIAGNOSIS

FAULT FINDING PROCEDURE

16. Before using test apparatus to trace or locate a fault, ensure that all connections are secure (PL1 to PL6) and that valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter and carry out the checks to establish the readings given in Table 1. The waveforms at the relevant metering points should approximate to those shown in fig. 3.

17. In the absence of any signal at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Tables 5 and 6).

18. If the unit tests given in paras. 9 and 10 do not give satisfactory results, the unit should be removed from the cabinet and bench-tested as follows:

Note...

This test is normally carried out at third line servicing.

(1) Using two signal generators, inject 2 MHz at 0.5V to PL2 and 1.870 MHz at 0.5V to PL3.

(2) Connect the 68 ohms resistor between PL4 and earth.

(3) Measure and tabulate the a.c. voltage readings, using the valve voltmeter, at the coil pins given in Table 2.

(4) Using a third signal generator, inject 50 KHz at 1.5V to PL5.

(5) Disconnect the 68 ohms resistor from PL4 and connect it between PL6 and earth.

(6) Measure and tabulate the a.c. voltage readings, using the valve voltmeter, at the coil pins given in Table 3.

The readings given in Tables 2 and 3 should enable location of a fault to a particular component or stage of the unit.

TABLE 2

A.C. voltage measurements of 130 KHz stages

Coil	Pin No.	Reading	
L2	3	Greater than 3V	(for fault (location
L2	2	Greater than 0.3V	(only
L3	2	Not less than 0.55V into 68 ohms load	

19. For third line servicing purposes the 200-0-200 micro amps meter should be used to check the cathode currents given in Table 4. (The readings given in Table 1, using the meter in the d.f. cabinet, are equivalent readings only).

TABLE 3

A.C. voltage measurements of 80 KHz stages

Coil	Pin No.	Reading
L5	2	0.7V)
L5	3	3.5V) for fault location only
L6	3	0.5V)
L7	3	0.3V)
L8	2	Greater than 0.4V into 68 ohms load

TABLE 4

Cathode currents at MP1-MP4

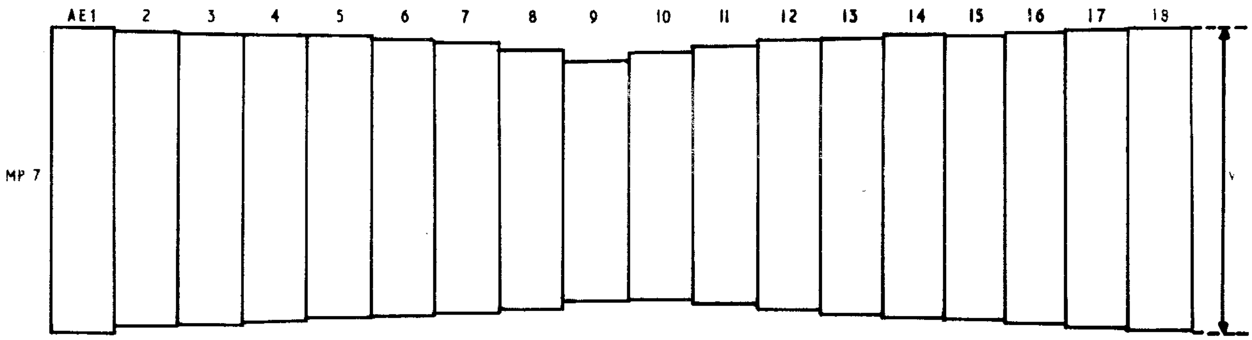
Metering point	Cathode current micro amps	Relevant valve
MP1	89	V1
MP2	118	V2
MP3	60	V3
MP4	110	V4

SERVICING DATA

20. To assist in servicing and fault finding of the combining amplifier unit, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. The typical values may vary slightly from one unit to another and should be replaced, at the time of installation or major overhaul, with readings actually obtained from a known working unit to form the basis of a maintenance log book.

Supply voltages and currents

21. The input voltages to the unit and the approximate current consumption are given in Table 5.



◀ MP7 Eighteen pulses of 2 MHz, approximately even amplitude of 3V (test oscillator on).

1. If aerial 1 is nearest test aerial, the signals from the aerials farthest from the test aerial (AE9) will have a slightly reduced amplitude because of mutual interaction of the aerials.

2. If one of the buffer amplifier stages is faulty, one of the 2 MHz pulses will be missing.

MP5 130 KHz undelayed (test oscillator on). Similar to MP7 but more even pulses of approximately 5V amplitude.

MP6 80 KHz delayed (test oscillator on). Similar to MP5 but of approximately 0.75V amplitude. ▶

MP8 1.87 MHz (test oscillator on). Refer to waveform MP5 in Chapter 5 (R.F. oscillator).

Fig. 2 Waveforms at metering points

TABLE 5

Supply voltages and currents

Circuit	Connection point	Voltage	Current
H.T. supply	PL1/4 and PL2/2 (earth)	+ 250V d.c.	23mA
Heater supply	PL1/1 and earth	6.3V a.c.	1.2A

Valve voltages

22. Typical voltages for the various pins of the valves are given in Table 6. The measurements are taken with the d.c. calibrated valve voltmeter with the unit in the no-signal condition. All measurements are d.c. and positive.

TABLE 6

Valve voltages

Valve	Pin No. 1	2	3	4	5	6	7
V1	-	2.4	-	-	240	2.4	195
V2	-	1.9	-	-	220	1.9	210
V3	-	1.8	-	-	70	1.8	122
V4	-	1.9	-	-	225	1.9	205

Valve complement

23. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 7, may be used if available.

TABLE 7

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Commercial Type	CV No.
V1-V4	6064	4014	5960-99-000-4014	6AM6/8D3	138

COMMON FAULTS

24. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. If any of the valves are replaced it is possible that the various tuned circuits associated with them will need to be realigned as given in paras. 12 to 14. Realignment of a tuned circuit is inevitable if any component associated with the tuned circuit is replaced.

MODIFICATIONS

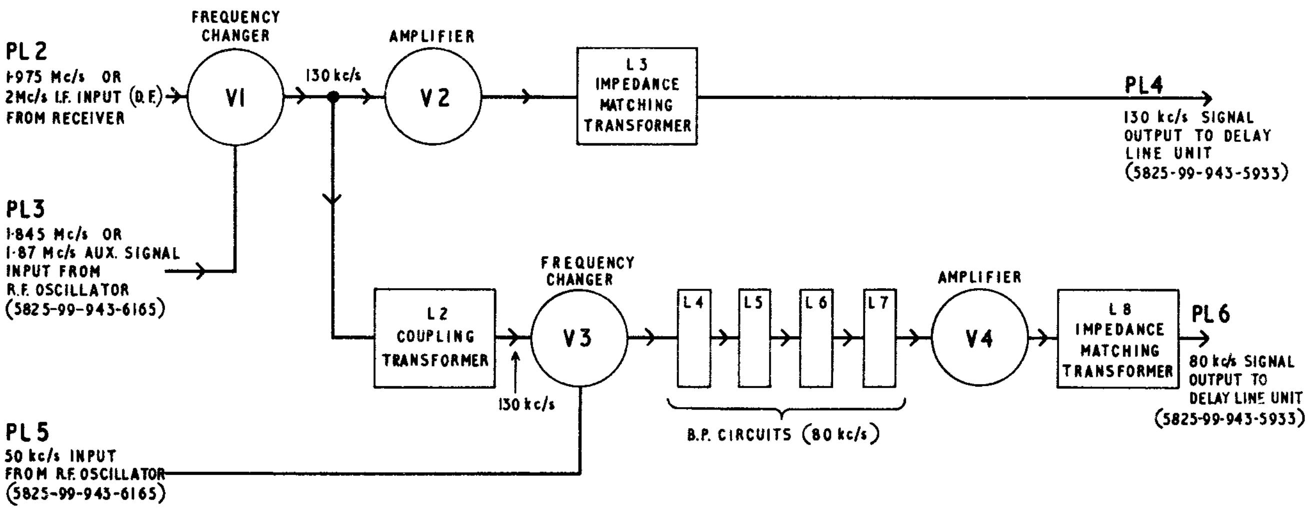
25. The following modifications are applicable to the combining amplifier 5825-99-943-5900.

5738/1 ... To improve time sharing performance

5957 ... To remove time sharing facility.

CAUTION...

The above modifications are noted in this chapter for guidance only and reference should be made to AP 2531P, Vol. 2, when checking the modification state of CADF equipment.



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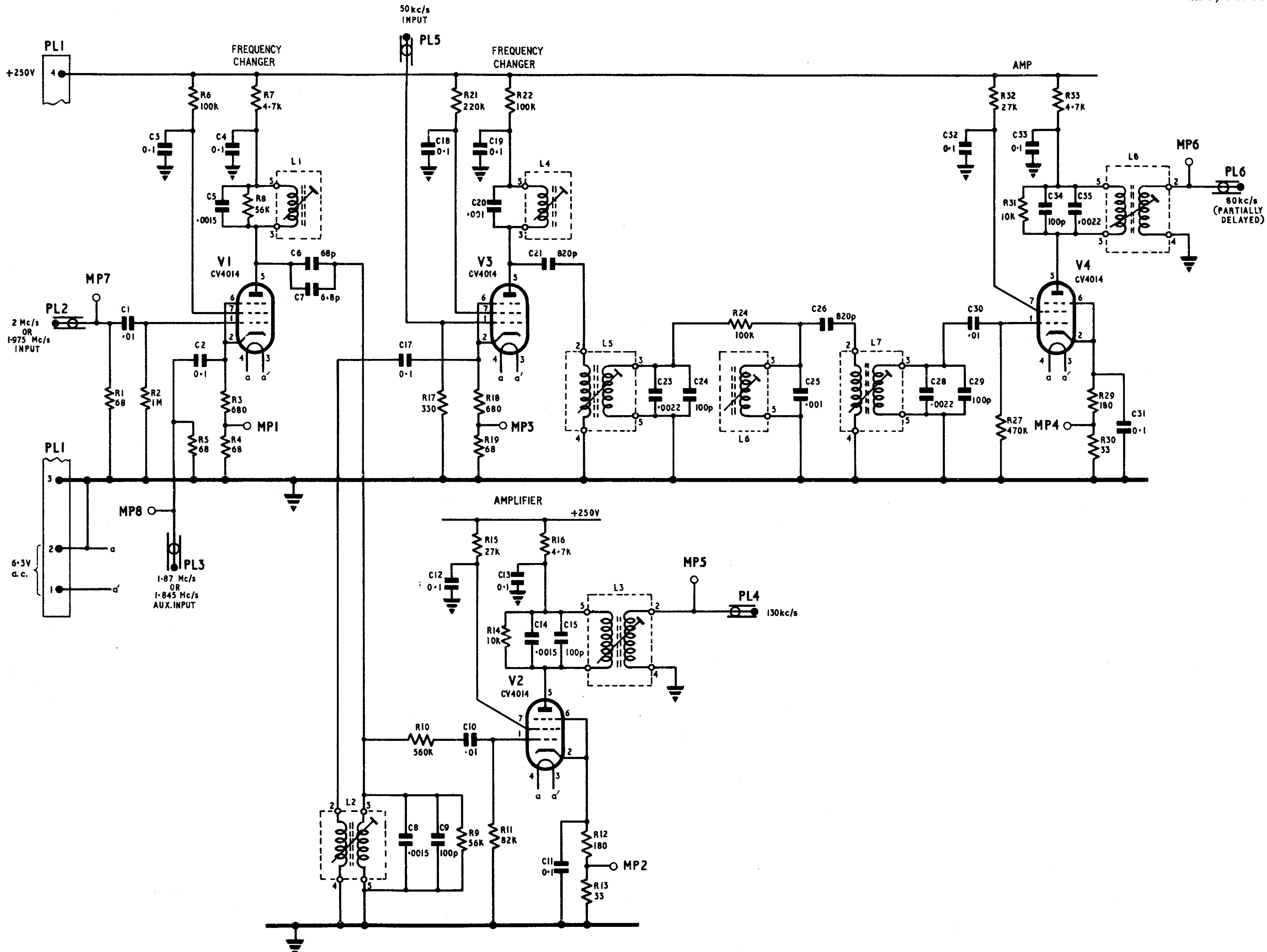
ISSUE 1 Prepared by the Ministry of Aviation

Amplifier R.F. 5825-99-943-5900 (combining amplifier): block diagram

Fig.3



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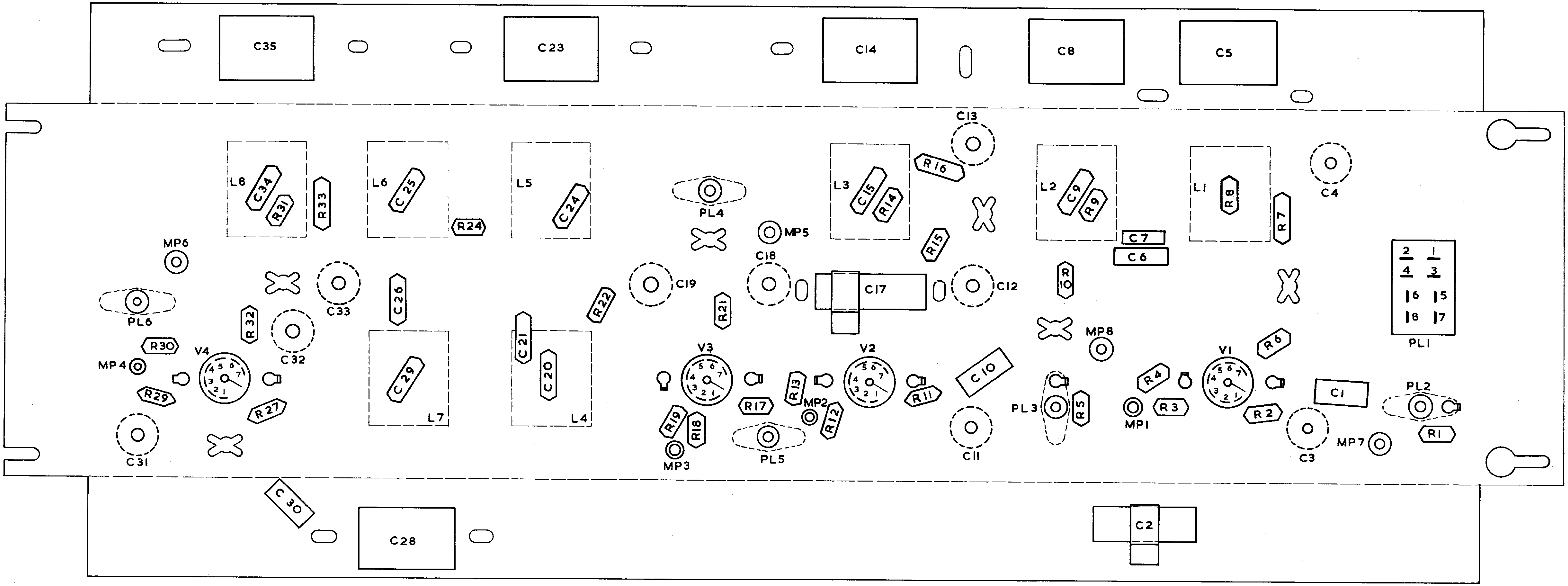
Amplifier, R.F. 5825-99-943-5900 (combining amplifier): circuit Fig. 4



Amplifier, R. F. 5825-99-943-5900 (combining amplifier): component layout

Fig. 5

Chapter 7

DELAY LINE (5825-99-943-5933)

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UNIT DESCRIPTION

Introduction

1. The delay line unit receives the 130 kc/s and 80 kc/s outputs from the combining amplifier (5825-99-943-5900). These signals carry the phase modulation imposed on the aerial system. The 80 kc/s signal has a total delay of 1 ms by the time it is applied to the grid of a mixer stage within the unit, the delay being partly effected in the combining amplifier and the remainder in the stages preceding the mixer stage. The 130 kc/s signal is undelayed, and is mixed with the 80 kc/s signal in the mixer stage.

2. The delay performed by the delay line unit is necessary because the comparator (Chap. 8) will not accept without ambiguity signals having a phase excursion greater than $\pm 180°$. The phase excursion (or deviation) imposed on the incoming carrier by the aerial array is related to the diameter of the array, and at the 400 Mc/s end of the band will exceed $\pm 360°$. By comparing the phase difference between successive adjacent unipoles, the maximum phase excursion is reduced to within $\pm 180°$.

3. Since the 1 ms delay imposed on the 80 kc/s signal is equal to the time interval between the switching of each unipole in the aerial array, the 80 kc/s signal component from a given unipole in the aerial array arrives at the mixer stage at the same time as the 130 kc/s signal component from the next unipole. Because of the commutated aerial switching sequence, a phase difference exists between the two signals applied to the mixer. This phase difference varies according to the direction of the signal source relative to any adjacent pair of unipoles. The output of the mixer stage has a phase that is related to the phase difference of the two signals, and is applied via a 50 kc/s bandpass circuit to an amplifier. The amplifier incorporates a 0° to 360° phase-shift facility to enable correct phasing of the signal input to the signal comparator (5825-99-943-5894).

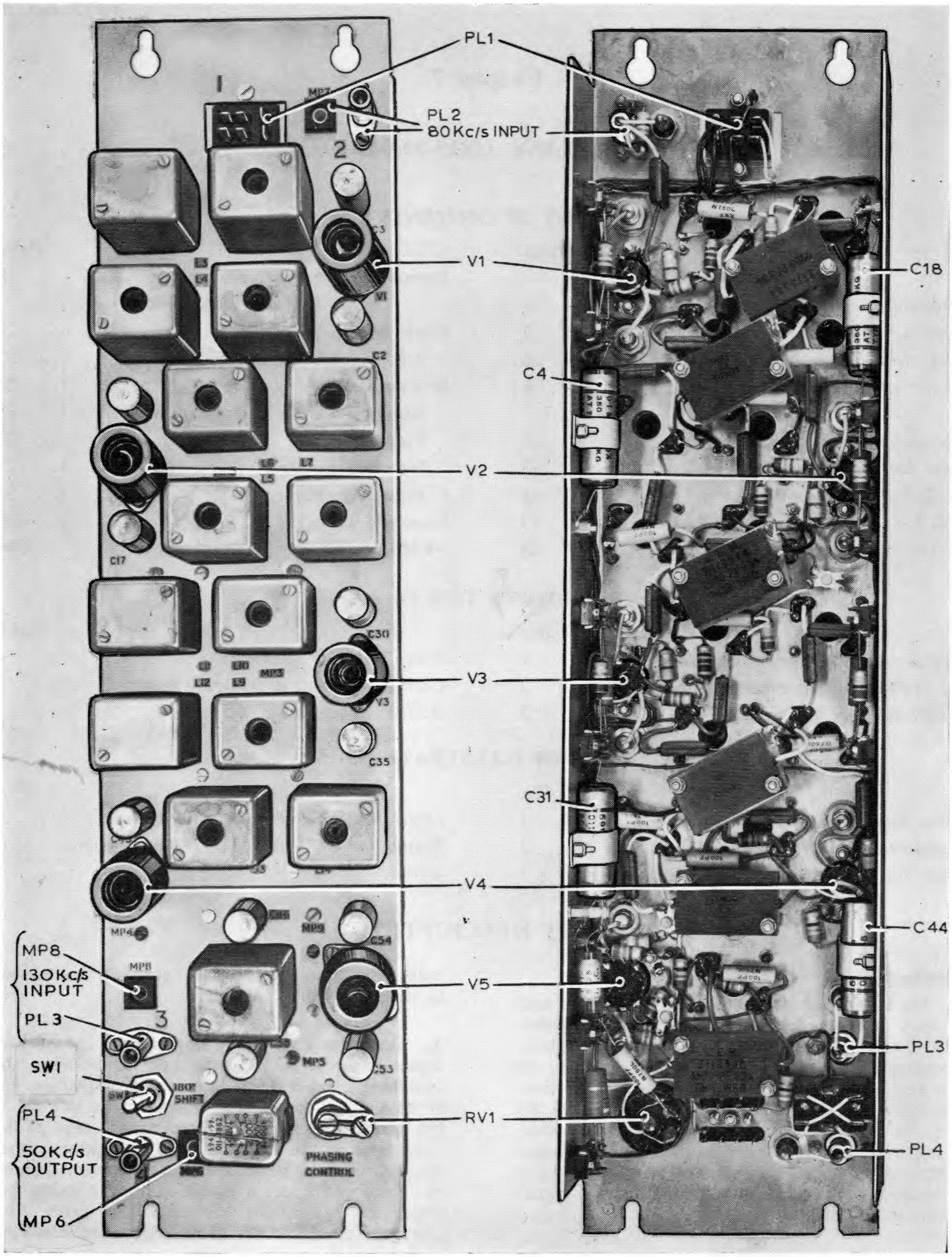


Fig. 1. Delay line: front and rear views

4. The delay line unit is used in the following rack assemblies:

Note . . .

In a two-channel system, two delay line units are used in order to provide the 50 kc/s signals described in para. 3 *to the signal comparator units in each channel.*

(1) Single pre-tuned receiver and d.f. cabinet (5820-99-932-4857)—rack position BC.

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—rack position DE.

(3) Single channel d.f. cabinet (5820-99-932-4862)—rack position BD.

(4) Two channel d.f. cabinet (5820-99-932-4861)—rack positions BD and CD.

(5) R.F. and d.f. rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—rack position CE.

Construction

5. The construction of the delay line unit is similar to that described for the master oscillator in Chap. 1. The location of all connectors, valves and metering points is shown in fig. 1, which gives both front and rear views.

Brief electrical description (fig. 3)

6. The 80 kc/s partially delayed output from the combining amplifier is fed to buffer amplifier V1 of the delay line, and then to similar buffer amplifier stages V2 and V3 via pairs of bandpass filter circuits, each tuned to 80 kc/s. These bandpass filters also serve to delay the signal, so that the total delay is 1 ms at the output of L12. L12 feeds the grid of mixer valve V4, which also receives at its cathode the 130 kc/s undelayed signal from the combining amplifier.

7. The phase of the output of V4 is related to the phase difference between the two input signals at any instant; the frequency is selected at 50 kc/s by the bandpass pair L13,L14. This output signal is fed to terminating amplifier V5 and matching transformer L15, which provide an overall gain of unity into a nominal load of 70 ohms. The amplifier stage V5 provides for a variable 360° phase shift, thus enabling correct phasing of the final 50 kc/s input to the signal comparator unit.

Circuit description (fig. 4)

8. The first three stages of the delay line are identical buffer amplifiers V1,V2,V3 with two pairs of bandpass filter circuits following each buffer (L1 to L12), each tuned to 80 kc/s. Each of these directly-coupled pairs, which are buffered by high value resistors R9,R19,R29, has a response of approximately $-1\frac{1}{2}$ db ± 2 kc/s, and the overall gain of the stages is approximately unity.

9. The 80 kc/s signal from the combining amplifier is fed to V1 via PL2 and the combination of terminating resistor R1 and coupling capacitor C11. The signal arrives at the grid of V4 via the intermediate buffers and bandpass pairs, which also provide a total delay to the signal of 1 ms. The second input to V4 (the 130 kc/s undelayed signal from the combining amplifier) is applied via PL3 and C44 to V4 cathode. The phase of the resultant output from V4 is dependent on the phase difference between the two input signals to the valve, as outlined in para. 2 and 3; the output phase is therefore related to the phase shift of the received signal between two adjacent unipoles in the aerial array. This directional information is passed to V5 in the form of a phase-modulated 50 kc/s signal, the frequency being selected by bandpass pair L13,L14.

10. Double triode amplifier V5 provides an overall gain of unity into a nominal 70 ohms load, and incorporates a variable 360° phase shift facility. The phase shift is necessary for correct phasing of the signal when applied to the signal comparator unit (Chap. 8), and is achieved by means of switch SW1, which provides 180° of shift by reversing the secondary coupling of L15, and negative feedback components C59, R41, which utilize the 180° phase difference existing between the input and output circuits of V5a. The phase shift across the valve is adjustable by means of control RV1. The values of C59,R41 and buffering resistor R40 are arranged to maintain the gain of the valve at unity. Valve V5 feeds matching transformer L15, which is connected to PL4 via relay contacts RL1/1. The relay is energized when the CENTRE CHECK switch at the control unit (or at the remote panel) is set to ON, and serves to disconnect the 50 kc/s d.f. signal from the signal comparator unit so as to enable centre check of the c.r.t. indicator.

11. The metering points distributed throughout the unit enable checks for correct operation to be made. MP1 to MP5 and MP9 are provided to measure the cathode currents of the valves; MP6 to MP8 are for checking the input and output waveforms.

SERVICING

Test apparatus

12. The following items of test equipment are required for full third line servicing at G.R.S.C. establishments; they may also be available for first and second line servicing:

(1) Signal generator CT452, Marconi type TF.144/H/I/S. (Two are required for third line servicing.)

(2) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(3) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(4) Multimeter Type 9980 or Type 12889.

(5) 200-0-200 μA meter of internal resistance 243 ohms built out to 2·5k ohms.

(6) Resistor, 68 ohms ½ watt (load resistor).

(7) Resistor, 26 ohms ½ watt, to build up signal generator termination to 78 ohms; fitted with a coaxial socket for connection to the plugs of the unit.

(8) Tuning tool Type 73/4215AL.

Tests for serviceability

13. Preliminary serviceability checks, made with the unit in position in the cabinet or rack, may be performed by first injecting a 2 Mc/s signal into PL4 of the r.f. oscillator and PL2 of the combining amplifier, using a parallel connection from the signal generator. The input level of the generator should be approximately 0·5V (unmodulated). With the delay line unit operating normally, monitor metering points MP6 to MP8. Readings should approximate to those given in Table 1. The waveforms should be taken with the oscilloscope and the voltage measurements with the peak-reading valve voltmeter.

14. The cathode current indication for each valve may also be observed using metering points MP1 to MP5 and MP9, this time with the unit in the no-signal condition. MP1 to MP5 and MP9 are monitored by means of the meter in the d.f. cabinet, using the patch cord for connection. Meter deflections are to the right and readings should correspond to those given in Table 1.

TABLE 1

Typical readings at metering points

MP No.	Voltage	Current indication μA	Type of waveform	
1		80		No signal condition
2		80		
3		80		
4		80		
5		80		
6	0·90V		50 kc/s sine wave	Normal i.f. amp. inputs
7	0·50V		80 kc/s sine wave	
8	3·30V		130 kc/s sine wave	
9		60		No signal condition

15. The unit can be removed from its rack for replacement or servicing by removing the connectors and slackening off the four Phillips-headed screws, and then lifting the unit clear of the rack.

Realignment procedure

16. The realignment described in the following paragraphs is normally undertaken only at third line servicing. The unit can be tested on the bench with the aid of separate power supplies, or by means of jumper leads from the cabinet supplies.

80kc/s alignment (L1 to L12)

17. (1) Set the signal generator to a frequency of 80 kc/s ±100 c/s at a level of 0·5V and connect the generator to PL2.

(2) Connect the valve voltmeter between pin 1 of V2 and earth.

(3) Using the tuning tool, adjust L1 to L4 in turn for maximum output as indicated by the meter. Lock each core after adjustment.

(4) Connect the valve voltmeter between pin 1 of V3 and earth and repeat (3) for L5 to L8.

(5) Connect the valve voltmeter between pin 1 of V4 earth and repeat (3) for L9 to L12.

(6) With the signal generator still set to 0·5V, and the valve voltmeter connected as in (5), check the overall gain; the output level should be approximately 0·57V.

Note . . .

The bandwidth of the signal at the control grid of V4 is only ±750 c/s to the 3 db points, so that accurate adjustment is essential. If there is doubt after the foregoing alignment procedure is completed, the unit should be replaced in the cabinet and an unmodulated signal fed to both receivers simultaneously. This arrangement ensures that an accurate 80 kc/s output is available from the combining amplifier and, where necessary, slight retrimming of L1 to L12 can then be effected. In the case of third line servicing, refer to para. 22, *which deals with this section of the unit in more detail.*

50 *kc/s alignment* (*L*13 *to L*15)

18. (1) Set the signal generator to a frequency of 50 kc/s at a level of 0·5V and connect the generator to PL3.

(2) Connect the valve voltmeter, together with the 68 ohms load resistor, between PL4 and earth.

(3) Using the tuning tool, adjust L13 to L15 in turn for maximum output as indicated by the meter. Lock each core after adjustment.

(4) Check the overall gain with the signal generator set to 0·4V; the output level should be approximately 1V.

Dismantling instructions

19. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self-evident. For the location and identification of c omponents, refer to component layout diagram fig. 5.

FAULT DIAGNOSIS

Fault finding procedure

20. Before using test apparatus to trace or locate a fault, ensure that all connections are secure (PL1 to PL4) and that all valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter and carry out checks to establish the readings given in Table 1 and the waveforms in fig. 2.

21. In the absence of any signal at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Tables 3 and 4).

A.C. voltage measurements

22. For less obvious faults, a.c. voltage measurements should be carried out as follows:

Note . . .

These tests are normally undertaken only at third line.

(1) Using two signal generators, inject 80 kc/s at 1 volt into PL2 and 130 kc/s at 1 volt into PL3.

(2) Connect the 68 ohms load resistor between PL4 and earth.

(3) Using the peak-reading valve voltmeter connected across the load resistor, check that the overall gain is not less than 0·7V.

(4) Make the a.c. voltage measurements at the pins of the coils given in Table 2 and check that the readings obtained approximate to those given in the table.

(5) With the signal generators connected as in (1), check with the oscilloscope that the 50 kc/s output is present at PL4.

(6) Operate RL1 and check that the 50 kc/s signal disappears from PL4 but appears, instead, across R47.

(7) Reconnect the oscilloscope to PL4 and check that rotation of the PHASING CONTROL RV1 does not vary the amplitude of the output by more than ±10%. Also check that the output phase inverts when SW1 is operated. Reset RV1 approximately to its original position.

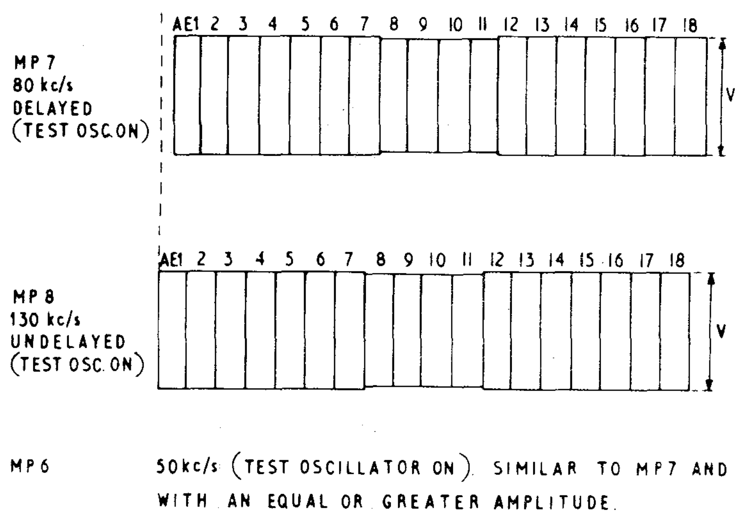


Fig. 2. Waveforms at MP6,MP7,MP8

23. The unit must be located in the cabinet or rack in order to finally adjust RV1. This PHASING CONTROL will also require adjustment if any component replacement has taken place which could affect the phasing of the signal from the delay line unit. Adjust as follows:

(1) Inject an unmodulated carrier into the d.f. and auxiliary receivers.

(2) Insert a centre-zero meter into MP8 of the signal comparator unit.

(3) Adjust PHASING CONTROL RV1 on the delay line unit until the meter reads zero.

TABLE 2

A.C. voltage measurements at coil pins

Coil	Pin No.	Voltage	Coil	Pin No.	Voltage
L2	2	6·0	L10	2	7·0
L2	3	50	L10	3	50
L3	3	1·5	L11	3	1·5
L4	3	1·0	L12	3	1·0
L6	2	6·0	L14	2	5·5
L6	3	50	L14	3	6·0
L7	3	1·5	L15	2	0·8 into 68Ω
L8	3	1·0	L15	4	0·8 into 68Ω

Servicing data

24. To assist in servicing and fault finding of the delay line unit, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. The typical values may vary slightly from one unit to another and should be replaced, at the time of installation or major overhaul, with readings actually obtained from a known working unit to form the basis of a maintenance log book.

Supply voltages and currents

25. The input voltages to the unit and the approximate current consumption are given in Table 3.

TABLE 3

Supply voltages and currents

Circuit	Connection point	Voltage	Current
H.T. supply	PL1/4 and earth	+250V d.c.	40 mA
Relay supply	PL1/5 and PL1/6	−50V d.c.	15 mA
Heater supply	PL1/1 and PL1/2 (earth)	6·3V a.c.	1·5A

Valve voltages

26. Typical voltages for the various pins of the valves are given in Table 4. The measurements are taken with a d.c. calibrated valve voltmeter with the unit in the no-signal condition. All measurements are d.c. and positive.

TABLE 4

Valve voltages

Valve	Pin No. 1	2	3	4	5	6	7	8
V1	—	1·79	—	—	220	1·79	208	—
V2	—	1·85	—	—	220	1·85	208	—
V3	—	1·88	—	—	220	1·88	208	—
V4	—	2·45	—	—	238	2·45	190	—
V5	140	—	2·0	—	—	225	—	3·0

Metering points

27. For third line servicing purposes, the 200-0-200μA meter should be used to measure the cathode currents of the valves. Typical readings are given in Table 5.

TABLE 5

Cathode currents at metering points

Metering point	Cathode current μA	Relevant valve
MP1	80	V1
MP2	80	V2
MP3	80	V3
MP4	80	V4
MP5	80	V5b
MP9	60	V5a

Valve complement

28. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 6, may be used if available.

TABLE 6

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Commercial Type	CV No.
V1-V4	6064	4014	5960-99-000-4014	6AM6/8D3	138
V5	6060	4024	5960-99-000-4024	12AT7	455

Common faults

29. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. If any of the valves are replaced it is likely that the tuned circuits associated with the replaced valves will need to be realigned as given in the relevant paras. 16-18. Replacement of components associated with any tuned circuit will invariably involve subsequent realignment of the tuned circuits.

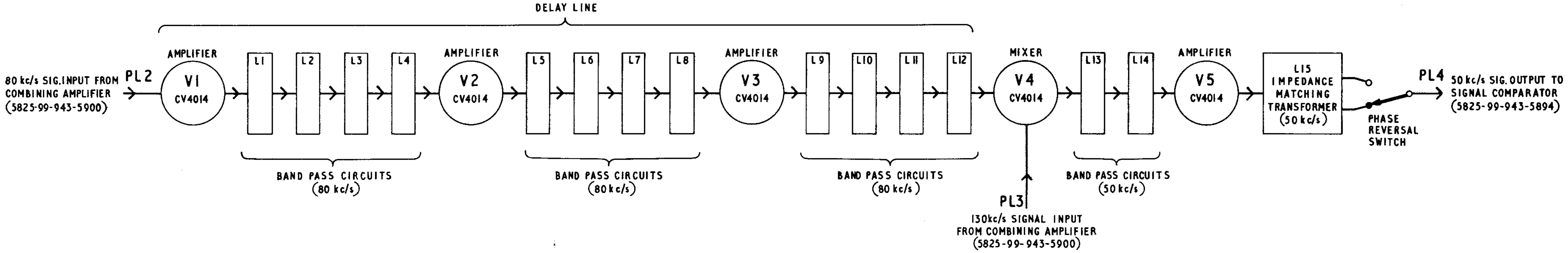
Modifications

30. The following modification is applicable to the delay line 5825-99-943-5933.

6563 ... ... Prevention of instability.

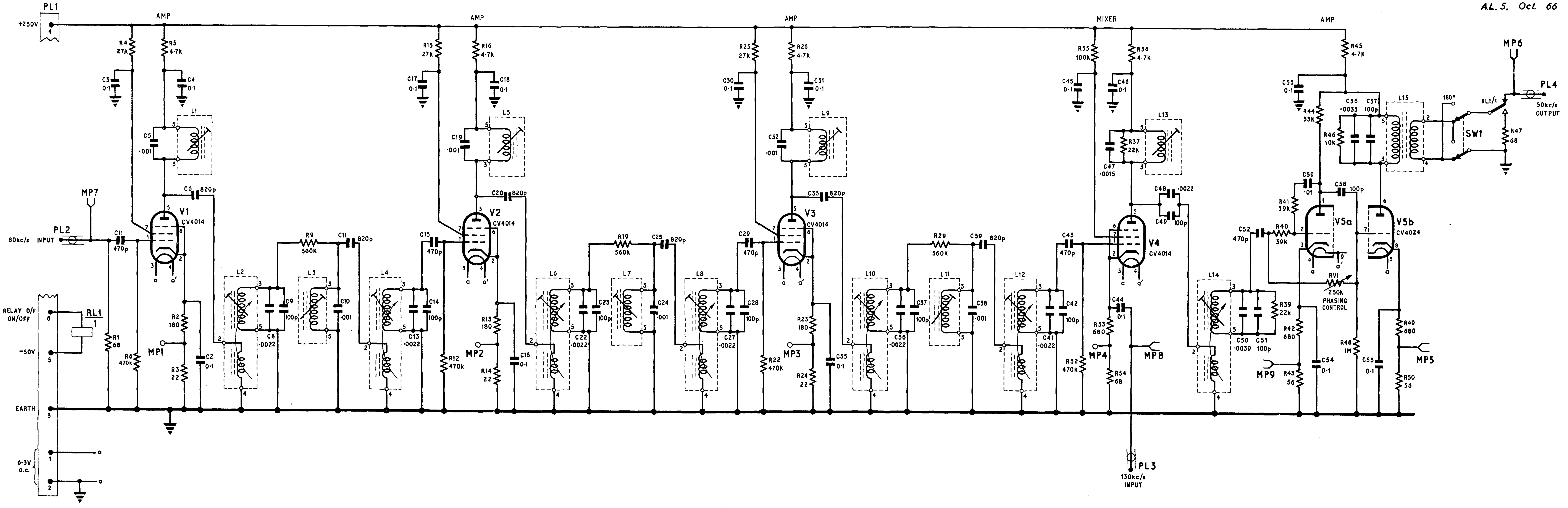
Caution . . .

The above modification is noted in this chapter for guidance only, and reference should be made to A.P.2531P, Vol. 2, when checking the modification state of CADF equipment.



Delay line 5825-99-943-5933 : block diagram

Fig.3



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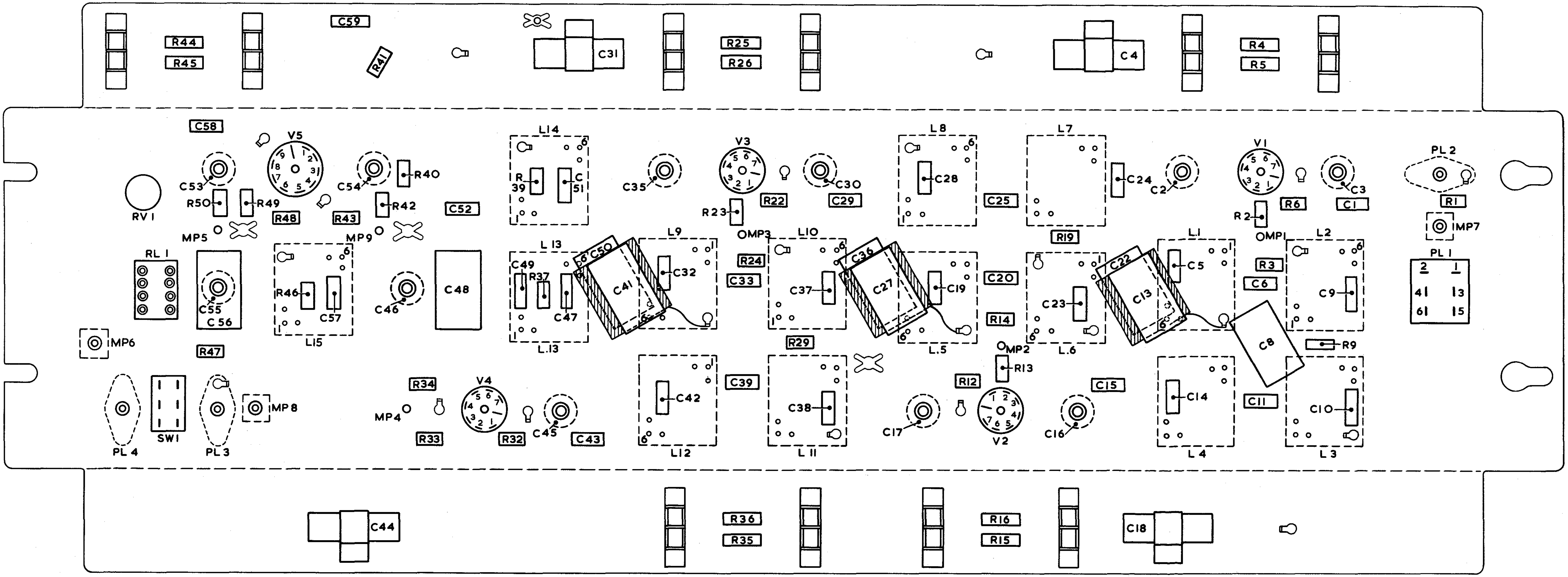
Delay Line 5825-99-943-5933: circuit

Fig. 4



Delay line 5825-99-943-5933: component layout

Fig. 5

Chapter 8

SIGNAL COMPARATOR (5825-99-943-5894)

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UNIT DESCRIPTION

Introduction

1. The signal comparator produces two square-wave outputs for use in the resolver unit (5825-99-943-5893), which combines them with the sine and cosine reference waveforms derived from the reference signal generator (5825-99-943-5889) in order to provide waveforms containing d.c. components of bearing information.

2. The two square-wave outputs are in anti-phase, and are derived from two 50 kc/s sinusoidal inputs. One of these two inputs is the constant-phase signal generated by the crystal-controlled oscillator in the r.f. oscillator (5825-99-943-6165); the other input is the phase-modulated signal from the delay line unit (5825-99-943-5933). The two inputs are applied to identical input channels, in which they are squared and differentiated to produce trigger pulses for a bi-stable flip-flop circuit. The two outputs from the flip-flop comprise the anti-phase square-wave outputs of the unit. The phase modulation, carried by the 50 kc/s input from the delay line, as imposed by the aerial system is translated by the signal comparator into pulse-width variations of the square-wave outputs. Under 'no d.f. signal' conditions the on/off ratio of the square pulses is unity.

3. The signal comparator is located in the following rack assemblies:—

(1) Single pre-tuned receiver and d.f. cabinet (5820-99-932-4857)—rack position BB.

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—rack position DF.

(3) Single channel d.f. cabinet (5820-99-932-4862)—rack position BC.

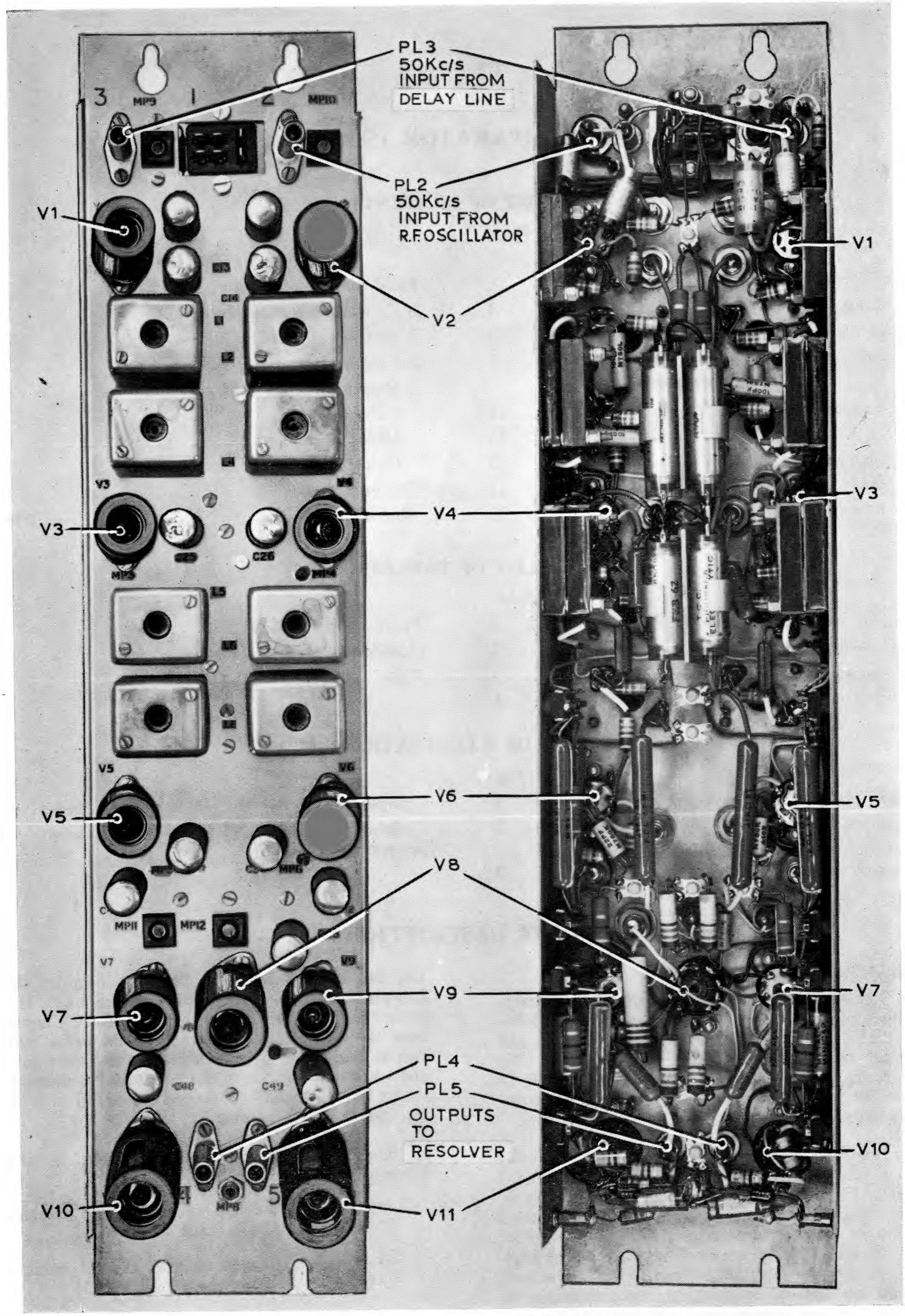


Fig. 1. Signal comparator: front and rear views

(4) Two channel d.f. cabinet (5820-99-932-4861)—rack positions BC and CC.

(5) R.F. and d.f. rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—rack position CD.

Construction

4. The construction of the unit is based on a mild steel strip, as described for the master oscillator in Chap. 1. The location of the connectors and all valves and metering points is shown in fig. 1, which gives both front and rear views of the signal comparator unit.

Brief electrical description (fig. 3)

5. Each of the two inputs to the unit is a 50 kc/s sine wave, one of which is the constant-phase (unmodulated) signal from the r.f. oscillator, and the other is the phase-modulated signal from the delay line unit. With no d.f. modulation, the two 50 kc/s signals are 180° out of phase. Both inputs are processed by identical channels; the channel processing the 50 kc/s signal input from the r.f. oscillator is described.

6. The signal is applied to the grid of amplifier V2 and the output is filtered by bandpass pair L2, L4. From L4, the signal is passed via a 30 dB limiter (V4), which reduces the amplitude of the signal so as to remove unwanted modulation components and adjust the pulse height. The signal is then fed to squarer V6 via another bandpass pair L6, L8, and the resultant square-wave is differentiated by C40, R42 and passed to pulse-forming diode V9a, which removes the positive spikes from the waveform. The remaining negative spikes are used as trigger pulses for one half of bi-stable flip-flop V8.

7. The anti-phase square-wave outputs are fed to buffer amplifier V11 or V10 after d.c. restoration by diodes V9b or V7b (one diode and buffer per channel). The outputs of the buffer amplifiers are fed to the resolver unit.

8. When there is no carrier being applied to the d.f. and auxiliary receivers, there will be no 50 kc/s output from the delay line unit, and therefore no input to the grid of V1 in the signal comparator. Under this condition, some of the 50 kc/s input from the r.f. oscillator is fed via R10 to the cathode of V1, thus producing an output of V1 anode that is 180° out of phase with the signal produced at V2 anode. The flip-flop thus continues to produce a square-wave output, the mark-space ratio of which is unity. This action of the signal comparator is necessary for the production of zero d.c. components of bearing information, which are required in the output waveforms of the resolver unit (Chap. 9).

Circuit description (fig. 4)

9. The signal comparator receives two 50 kc/s inputs, one being the constant-phase signal derived from the crystal-controlled oscillator in the r.f. oscillator (applied to PL2), and the other the phase-modulated signal from the delay line unit (applied to PL3). The 50 kc/s input due to the r.f. oscillator is taken to the grid of amplifier V2, the output of which is filtered by bandpass pair L2, L4. From L4 the signal is fed to 30 dB limiter V4, which reduces the amplitude of the signal so as to remove unwanted modulation components. Low modulation frequencies are decoupled by capacitor C22 in the cathode circuit of the valve. The output of V4 is taken to squarer stage V6 via another pair of 50 kc/s bandpass circuits (L6, L8). The action of V6 is similar in operation to V4; when the positive half-cycle of the input signal rises above a certain value, the valve draws grid current through R30 thus biasing the grid negatively, and on the negative half-cycle the output of the valve is determined by the cut-off voltage. Valve V6 saturates at a lower amplitude than V4 so as to produce a square-wave output. C36 decouples the screen grid of V6 for low modulation frequencies.

10. The square-wave output of V6 is differentiated by C40, R42 to give a positive- and negative-spiked waveform. The positive spikes are removed by pulse-shaping diode V9a and the remaining negative-going spikes are fed as trigger pulses to one half of bi-stable flip-flop V8. In the absence of an output signal, V9a is arranged to be non-conductive—its cathode being held slightly positive with respect to its anode by the ratio of the values of its cathode-to-anode potential dividers, i.e. R42, R40, R64; R50, R48, R51, R63 respectively (fig. 4 inset details the configuration of the overall potential divider network associated with V9a).

11. The 50 kc/s input due to the delay line is passed through identical circuits (amplifier V1, limiter V3, squarer V5, pulse shaper V7a) to produce trigger pulses for the other half of the flip-flop V8. The variation in time between the trigger pulses from V7a is relative to the phase modulation imposed on the 50 kc/s input to PL3 by the d.f. chain.

12. In the absence of a d.c. signal from the delay line unit, or when only a 50 kc/s carrier is present at PL3, the flip-flop V8 produces square waves with an on/off ratio of unity. In the former condition, some of the input signal to V2 is fed via divider R10, R9, and C5 to the cathode of V1, thus producing an output at V1 anode which is 180° out of phase with the signal produced at V2 anode. By this means, trigger pulses for flip-flop V8 are produced at the anodes of V7a and V9a which are also 180° out of phase.

13. Bi-stable multivibrator V8 is of conventional design and produces square-wave anti-phase outputs having an amplitude of approximately 150V peak-to-peak for both signal and no-signal conditions. Each output is taken to a buffer amplifier via a d.c. restoration diode. The diodes clamp the negative-going halves of the waveforms to the −75V line, thus approximately balancing the

150V peak-to-peak square waves about earth potential. The buffer amplifiers feed the resolver unit via low impedance lines and plugs PL4, PL5. Grid stoppers R57, R58 and cathode resistors R59, R60 are included in the grid/cathode circuits of buffers V10 and V11 to prevent spurious oscillations.

14. The combinations of R65, C50 and R66, C51 (situated in the outputs of the unit) serve as integrating circuits for metering purposes, i.e. they convert the waveform to a 55·5 c/s sine wave for each output, and these may be monitored with a centre-zero meter. The meter will read zero when the on/off ratio is unity. Clipping diodes MR1, MR2 are connected to divider R68, R66, R65, R67 (situated across the output lines), their cathodes being taken to the common cathodes of V8 which provide a convenient bias of approximately 23V. By clamping the junctions of R65, R67 and R66, R68 to approximately 23V, the diodes ensure that the amplitudes of the two outputs are the same.

SERVICING

Test apparatus

15. The following items of test equipment are required for full third line servicing at G.R.S.C. establishments; they should also be available for first and second line servicing:—

(1) Signal generator CT452, Marconi type TF.144/H/I/S.

(2) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(3) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(4) Multimeter Type 9980 or Type 12889.

(5) 200-0-200 μA meter of internal resistance 243 ohms, built out to 2·5k ohms.

(6) Tuning tool (type 73/4215).

(7) Resistor, 26 ohms ½ watt, to build up signal generator termination to 78 ohms; fitted with coaxial socket for connection to the plugs of the unit.

Tests for serviceability

16. Preliminary serviceability checks, made with the unit in position in the cabinet or rack, are performed by first injecting a 2 Mc/s signal into PL4 of the r.f. oscillator and PL2 of the combining amplifier, using a parallel connection from the signal generator.

Note . . .

If a multi-frequency receiver is used, the injected signal should be at 1·975 Mc/s.

17. The input level of the signal generator should be approximately 0·5V (unmodulated). With the signal comparator operating normally, a check can be made at metering points MP9-MP12. Readings should approximate to those given in Table 1. The waveforms should be taken with the oscilloscope and the voltage measurements with the peak-reading valve voltmeter.

18. The cathode current indication for each valve may also be observed at MP1-MP7, with the unit this time in the no-signal condition. MP1-MP7 are monitored using the meter in the d.f. cabinet and the patch cord facility. Meter deflections are to the right and should correspond to the values given in Table 1.

TABLE 1

Typical readings at metering points

MP No.	Voltage	Current indication	Type of waveform	Condition
1		96		No-signal
2		96		,, ,,
3		80		,, ,,
4		80		,, ,,
5		120		,, ,,
6		120		,, ,,
7		195		,, ,,
8	0V (on centre-zero meter)			Normal i.f. amp. inputs.
9	0·90V		50 kc/s sine wave (delay line)	
10	1·40V		50 kc/s sine wave (r.f. oscillator)	
11	10·0V		50 kc/s trigger pulse	
12	10·0V		50 kc/s trigger pulse	

19. The unit can be removed from its rack for replacement or servicing by removing the connectors and slackening off the four star-headed screws, and then lifting the unit clear of the rack.

Realignment procedure

20. Unit realignment, described in the following paragraph, is normally undertaken only at third line servicing level. The unit can be tested on the bench with the aid of separate power supplies, or by using jumper leads connected to the cabinet supplies.

50 kc/s alignment

21. (1) Connect the signal generator to PL3 and set it for a frequency of 50 kc/s. The voltage level should be set so that no limiting occurs in the circuits. If the circuits are completely mistuned, it may be necessary to start with a generator output level of 0·5V and then reduce this level as tuning progresses.

(2) Connect the valve voltmeter between pin 5 of V5 and earth, taking care not to short the anode pin to earth.

(3) Using the tuning tool, adjust L1, L3, L5 and L7 in turn for maximum output as indicated by the meter, locking each core after adjustment.

(4) Check the overall gain of the circuits. With the signal generator output at 1 mV, the output level as indicated by the meter should not be less than 70V.

(5) Transfer the signal generator to PL2 and the valve voltmeter to pin 5 of V6.

(6) Using the tuning tool, adjust L2, L4, L6 and L8 in turn for maximum output as indicated at the meter, locking each core after adjustment.

(7) Check the overall gain of the circuits. With the signal generator output at 1 mV, the output level as indicated by the meter should not be less than 70V.

Dismantling instructions

22. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self evident. For the location and identification of components, refer to component layout diagram fig. 5.

FAULT DIAGNOSIS

Fault finding procedure

23. Before using test apparatus to trace or locate a fault, ensure that all connectors are secure (PL1-PL5) and that all valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter and carry out checks to establish the readings given in Table 1 and the waveforms in fig. 2.

24. In the absence of any signal at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Tables 3 and 5).

A.C. voltage measurements

25. For less obvious faults, a.c. voltage measurements should be undertaken at the various pins of the coils and valves in order to localize the fault:—

(1) Inject a 50 kc/s signal at 1 volt from the signal generator into PL3 and check that the readings obtained with the valve voltmeter approximate to those given in the first half of Table 2 (for coil checks) and to those given in Table 4 (for appropriate valve pin numbers).

(2) Transfer the signal generator to PL2 and check the readings obtained with the second half of Table 2 and appropriate valve pin numbers in Table 4.

TABLE 2

A.C. voltage measurements at coil pins

For PL3			For PL2		
Coil	Pin No.	Voltage	Coil	Pin No.	Voltage
L1	3	36V	L2	3	20V
L3	2	4·5V	L4	2	3·0V
L3	3	22V	L4	3	12V
L5	3	80V	L6	3	78V
L7	3	55V	L8	3	55V

Waveform checks

26. With the signal generator connected to PL2 and set for an output of 50 kc/s at 1 volt, check that the trigger pulses at MP11 and MP12 are as shown in fig. 2, and that they are approximately 180° out of phase with each other; also check that the output waveforms at PL4 and PL5 are as shown in fig. 2, and that they are also 180° out of phase.

Servicing data

27. To assist in servicing and fault finding of the signal comparator, tabulated lists of typical voltages and currents are given together with the valve complement for the unit. The typical values may vary slightly from one unit to another and

TABLE 7

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Commercial type	CV No.
V1-V6	6064	4014	5960-99-000-4014	6AM6/8D3	138
V7	5726	4007	5960-99-000-4007	6AL5(short bulb)	140
V8	6060	4024	5960-99-000-4024	12AT7	455
V9	5726	4007	5960-99-000-4007	6AL5(short bulb)	140
V10-V11	6132	4055	5960-99-000-5055	6CH6	2127

Common faults

32. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. If any one of the valves V1 to V6 is replaced, the associated tuned circuit(s) will probably require realigning (paras. 20 and 21 refer). Replacement of components associated with any of the tuned circuits will invariably involve subsequent realignment. If the output pulses from the unit are not 1:1 on/off ratio under test conditions, i.e. zero reading on the centre-zero meter inserted into MP8 (Table 1), the phasing of the signal entering the unit at PL3 from the delay line unit is incorrect.

33. To obtain the correct phasing of the input signal to PL3:—

(1) Inject an unmodulated carrier of 2 Mc/s from the signal generator into the 2nd i.f. amplifier of the d.f. and auxiliary receivers. (If a multi-frequency receiver is used, the input signal should then be at 1·975 Mc/s).

(2) Insert the centre-zero meter into MP8 of the signal comparator.

(3) Adjust the phasing control RV1 on the delay line unit until the meter indicates zero.

34. Under normal operating conditions, it is also advantageous to connect the oscilloscope to one side of the integrating circuit and thus determine the degree of phase modulation at the output of the signal comparator unit. The amplitude of the sinusoidal waveform is proportional to the depth of modulation.

Modifications

35. The following modifications are applicable to the signal comparator 5825-99-943-5894:

6254 ... Prevention failure of capacitors.

6450 ... To improve setting accuracy of phasing by introducing MR1, MR2, R67 and R68.

9717 ... To improve stability by increasing the wattage of resistors R47 and R48.

Caution . . .

The above modifications are noted in this chapter for guidance only, and reference should be made to A.P.2531P, Vol. 2, when checking the modification state of CADF equipment.

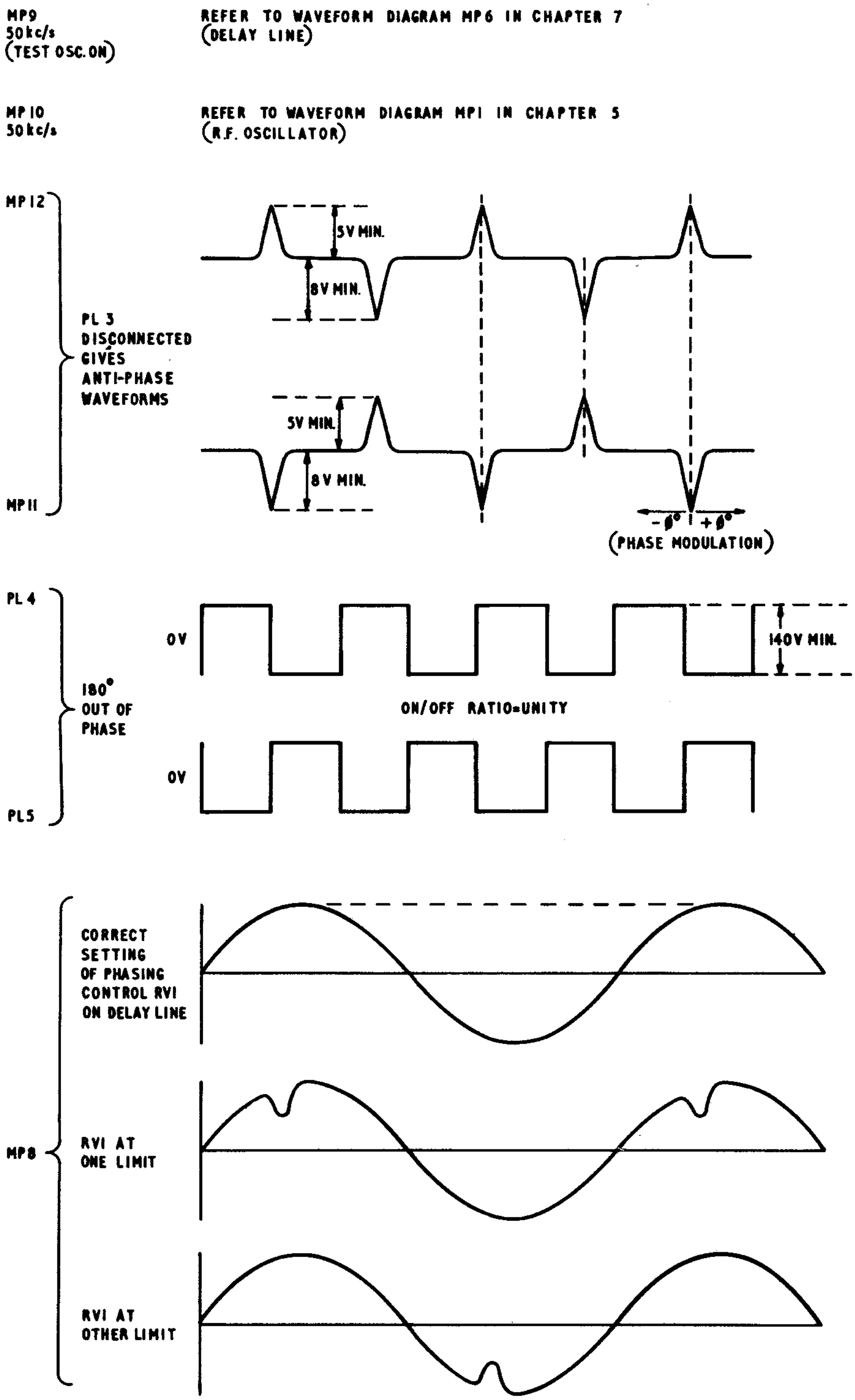
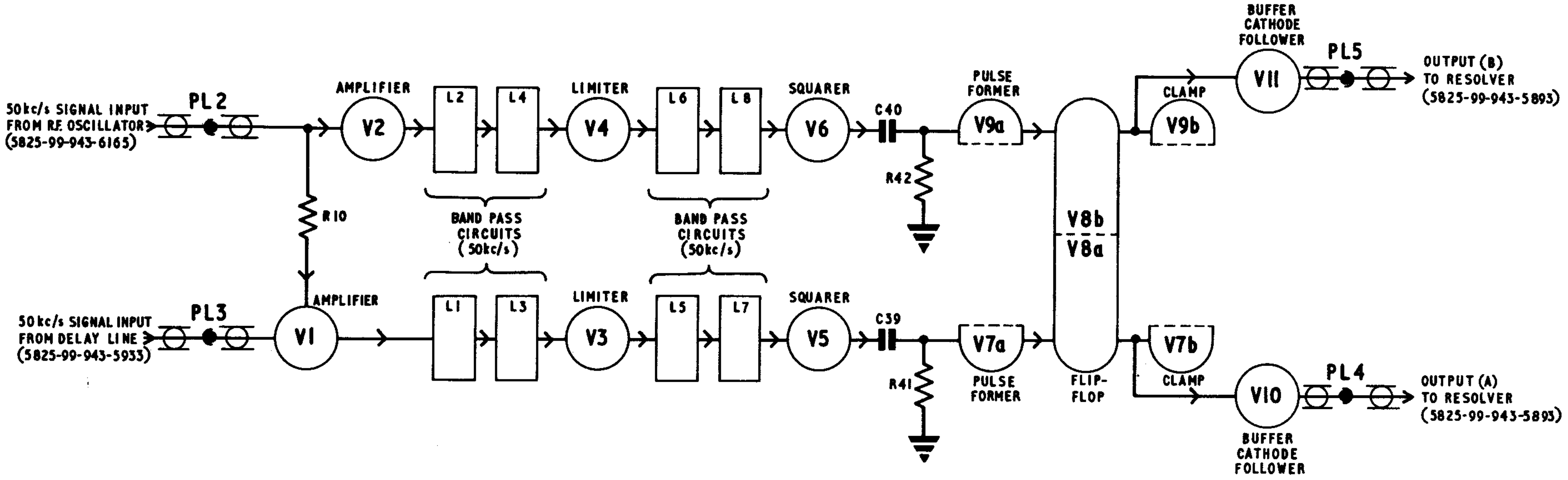


Fig. 2 Metering point and output waveforms Fig. 2



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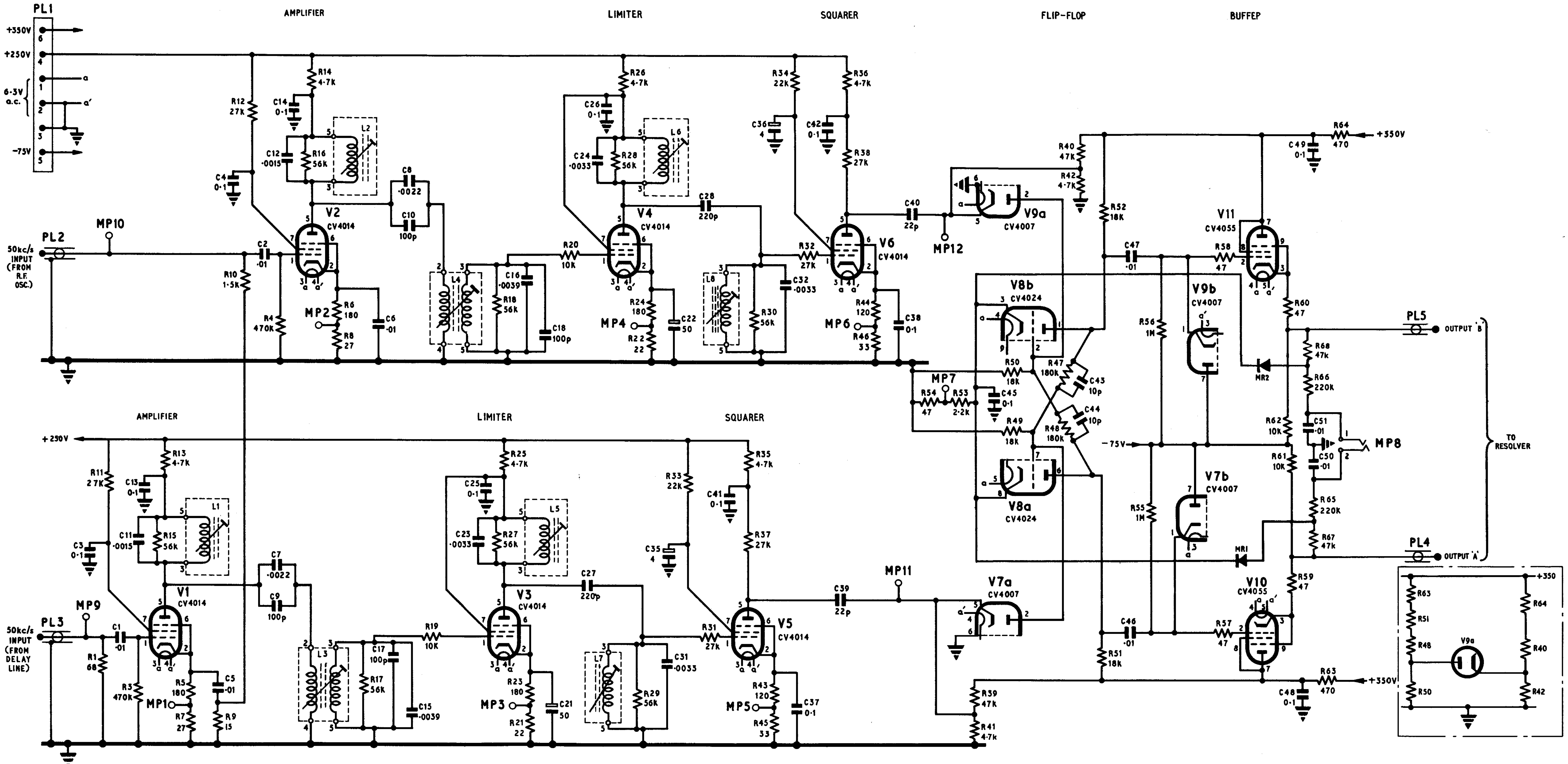
ISSUE 1 Prepared by the Ministry of Aviation

Signal comparator 5825-99-943-5894: block diagram

Fig.3



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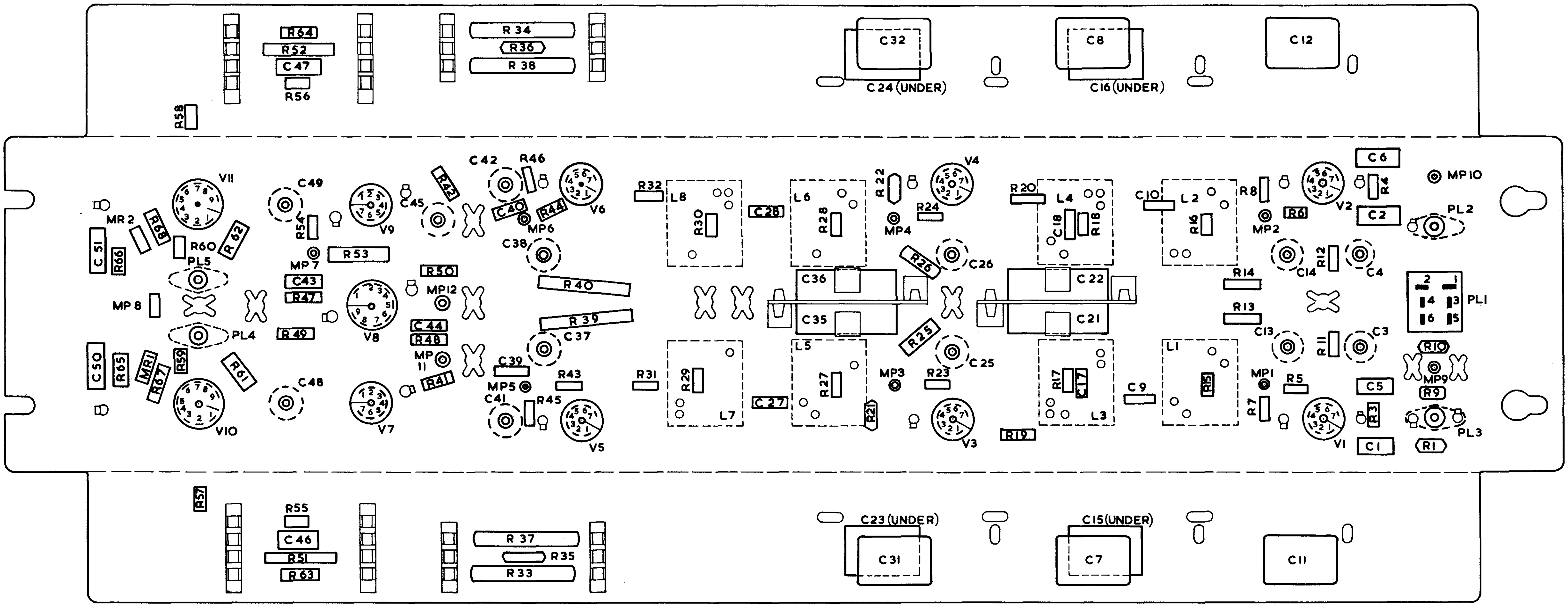
ISSUE 1 Prepared by the Ministry of Aviation

Comparator, signal 5825-99-943-5894 : circuit

Fig. 4



Comparator, signal 5825-99-943-5894: component layout

Fig. 5

Chapter 9

RESOLVER (5825-99-943-5893)

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UNIT DESCRIPTION

Introduction

1. The resolver unit converts the bearing information received from the signal comparator (5825-99-943-5894) into d.c. potentials that have a sign and amplitude corresponding to the sine and cosine components of the bearing angle. In addition to the anti-phase, square-wave inputs from the signal comparator, the resolver unit also receives the sine and cosine reference waveforms from the reference signal generator (5825-99-943-5889). The bearing information is contained in the square-wave pulses in the form of variable pulse widths, and is due to the phase modulation imposed on the signal by the commutation of the aerial system.

2. The resolver unit may be considered as four identical sections arranged in two pairs; north/south and east/west. Each section produces a mean d.c. potential for feeding to one of the deflection circuits of the c.r.t. indicator via the bearing display amplifier (5825-99-933-0812 or 5825-99-943-5890).

3. The unit is located in the following rack assemblies:—

(1) Single pre-tuned receiver and d.f. cabinet (5820-99-932-4857)—rack position BA.

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—rack position DG.

(3) Single channel d.f. cabinet (5820-99-932-4862)—rack position BB.

(4) Two channel d.f. cabinet (5820-99-932-4861)—rack positions BB and CB.

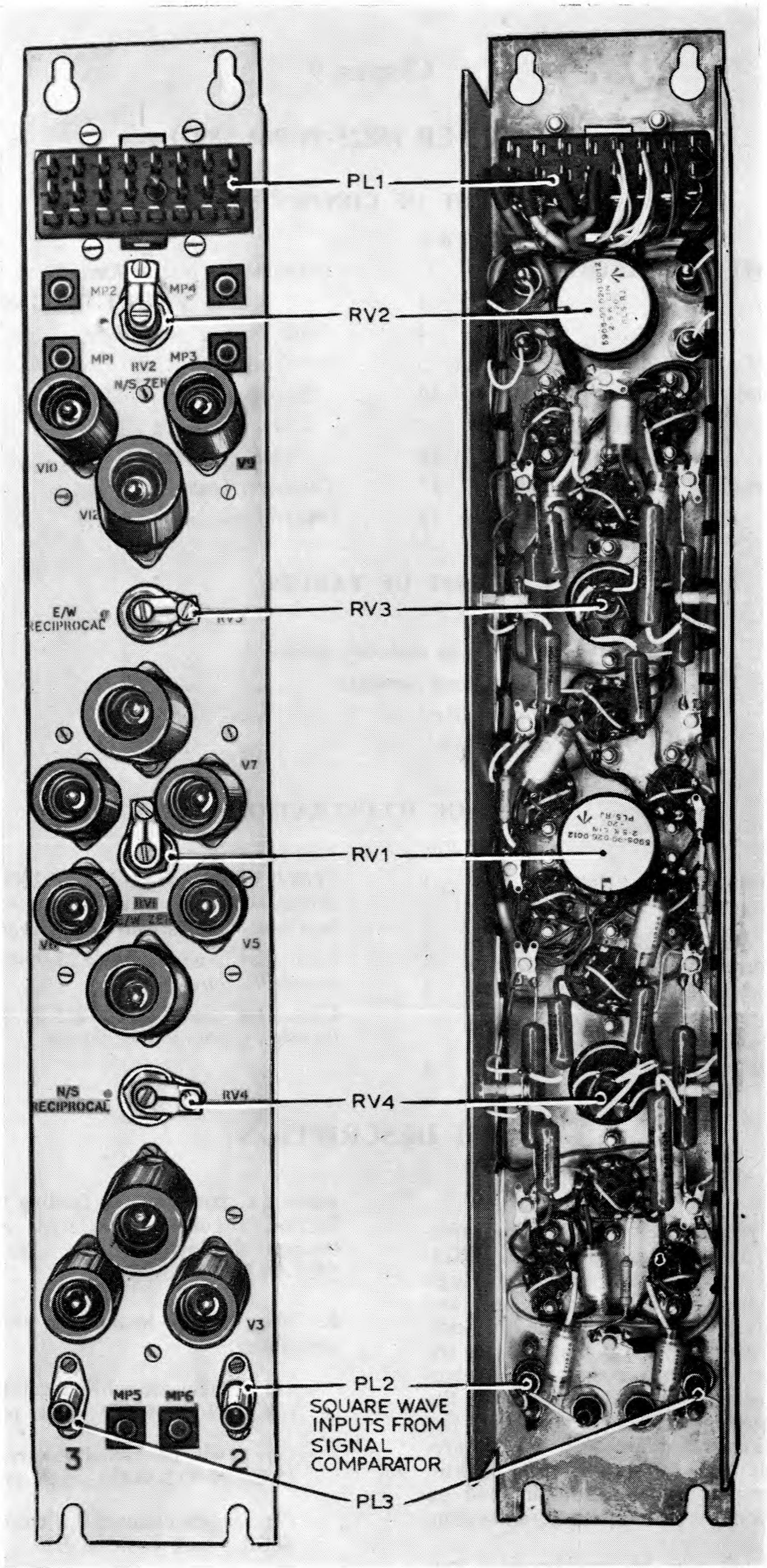


Fig. 1. Resolver unit: front and rear views

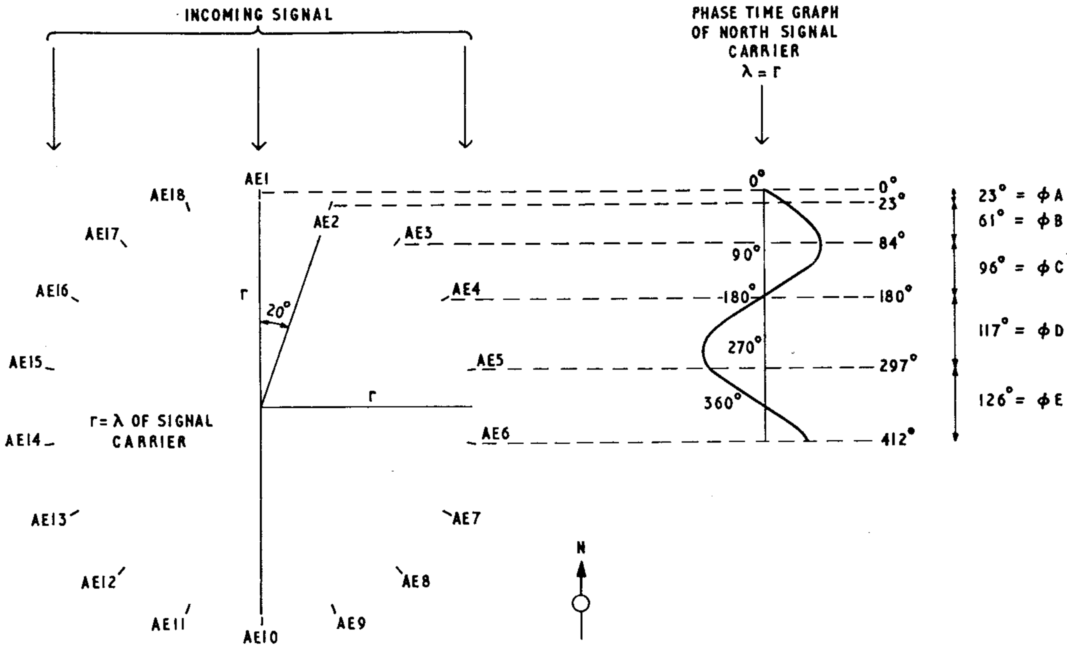


Fig. 2. Plan view of aerial array

(5) R.F. and d.f. rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—rack position CC.

Construction

4. The construction of the resolver unit is similar to that of the master oscillator described in Chap. 1. Front and rear views are given in fig. 1.

Theory and brief electrical description

5. From fig. 2 it can be seen that if aerial element 1 (AE1) is the start of the aerial switching sequence, the north bearing signal will be advanced in phase through 23°, 84°, 180°, 297° and 412° etc. (assuming that AE1 is the reference point, that the switching sequence progresses clockwise, and that the wavelength (λ) of the received signal is equal to the radius of the aerial array). The signal comparator cannot distinguish between angles over 180° and those under 180°; the phase excursion or deviation (φ) between two adjacent unipoles is therefore utilized. Under these conditions, the maximum phase excursion is 126°.

6. The comparison between the signals received from two adjacent unipoles is effected in the delay line unit (Chap. 7) by delaying the input signal by 1 ms (the sampling time of each unipole), and then mixing the delayed signal with the undelayed signal. The stepped phase-modulation of the output signal from the delay line unit is related to the phase differential between successive adjacent unipoles, and is used in the signal comparator to produce two anti-phase square waves at 50 kc/s. The mark/space ratio of these square waves will vary according to the phase differential between successive adjacent unipoles. The bearing information contained in the anti-phase square waves is applied to the north/south and east/west sections of the resolver units.

7. The simplified circuit shown in fig. 3 represents one of the four identical sections of the resolver unit. The anti-phase square wave outputs of the signal comparator are applied via resistors R1 and R5 to the grids of V1A and V1B respectively. The anti-phase sinusoidal outputs of the reference generator are applied to the cathodes of the diodes V3 and V4. Considering the action of V1A and V3, the output of V1A developed across R3:

(1) When the input from the signal comparator is −75V, V1A will be cut-off and point 'Z' will be at −75V.

(2) When the input from the signal comparator is +75V, point 'X' will rise to the potential applied to the cathode of V3 (approximately), allowing V1A to conduct. Point 'Z' will attain a potential nearly equal to that reference signal generator output at that instant.

The waveform at 'Z' will closely follow the waveform at 'X', this being shown (fig. 3a) for one complete commutation of the aerials, i.e. 18ms. The waveform occurring at 'Y' due to the anti-phase inputs is shown at fig. 3b, the combined waveform at point 'Z' is shown at fig. 3c. The input from the signal comparator has a unity mark/space ratio, i.e. a no signal condition exists. Under this condition the integrated output will have a net value of zero. It should be noted that the waveforms in fig. 3 are representative only, within the period of time shown there will be nine hundred cycles of the square wave.

8. Under modulation conditions, i.e. whilst an r.f. signal is received, the mark/space ratio of the 50 kc/s square wave is varied in relationship to the phase modulation imposed by the commutation of the aerial system. Fig. 4 shows how the mark/space ratio will vary, over one period of commutation, for the relationship for two resolver legs in quadrature being shown. Within this illustration each cycle of the square wave in fact consists of 50 cycles each having a mark/space ratio as that indicated. The signal to provide the conditions shown would be from the North, (aerial array orientated as fig. 2) integration of the waveforms providing a net positive voltage from the North section and zero voltage from the East section. The South section would produce an equal but opposite potential to that of the North section, whilst the West section would again produce zero output.

9. In this form of illustration it will be seen that the amplitude and polarity of the average value of the waveform is proportional to the density of the coloured areas, the greater the density the more positive the output, the lower the density the more negative the output.

10. Fig. 5 enables an impression to be gained, from the relative densities of the waveforms, of the outputs from two resolver legs in quadrature for any direction of received signal. The variations of mark/space ratio for both figs. 4 and 5 are appropriate to an r.f. carrier of wavelength equal to the radius of the aerial array.

11. When the wavelength of the received carrier is not equal to the radius of the aerial array the phase relationships, and hence the variation of mark/space ratio will be different. To provide compensation for this the maximum amplitude of the reference generator output is varied in relationship to the carrier frequency, by means of the 'trace length control' situated on the u.h.f. amplifier (pre-tuned receiver) or on the r.f. amplifier (multi-frequency d.f. receiver).

Circuit description (fig. 6)

12. The resolver unit consists of four identical circuits, which make up the north, south, east and west sections of the unit. These circuits are arranged in two pairs, one for east/west deflection and the other for north/south deflection. The anti-phase square-wave inputs are applied to PL2 and PL3 and feed both the east/west and north/south sections. The push-pull reference waveforms for the east/west sections are applied simultaneously to the cathodes of V3, V4 (west section: ref. A and ref. B respectively) and V6, V5 (east section: ref. A and ref. B respectively).

13. The voltage at pin 2 of V1 rises due to the square-wave input at PL2 until it is equal to the value of the reference waveform present at V3 cathode. At this point V3 conducts, via C5 to earth, thus limiting the potential at pin 2 of V1. Simultaneously, the voltage at pin 7 of V1 is held at −75V because of the anti-phase square-wave input at PL3. Only the left-hand half of V1 therefore conducts, giving rise to a positive pulse at its cathode. The amplitude of the pulse is dependent on the ref. A waveform. At some later instant in time, the condition of V1 grids is reversed and only the right-hand half of V1 conducts, which also gives a positive pulse at V1 cathode. The amplitude of the pulse in this instance is dependent on the ref. B waveform, which is 180° out of phase with ref. A, so that the pulse is less positive. For a mark/space ratio of unity, the resultant waveform at the cathode of V1 is as shown in fig. 3.

14. The east section of the unit produces a similar waveform to the west section but the positive and negative pulses are reversed. The north and south sections also produce similar waveforms to the east and west sections but consist of cosine functions.

15. RV1, situated in the east/west section, provides an h.t. balancing adjustment for the output valves V1, V2 so that similar characteristics can be obtained from each section. RV2 performs an identical function for the north/south section. Thus RV1 and RV2 are effectively zero controls, enabling the spot on the c.r.t. indicator to be centred. RV3 and RV4 are reciprocal balance controls, each serving as a fine zero adjustment. If the signal ampliitudes at the grids of V2 are not identical, the slight difference can be offset by adjustment of RV4 and any difference at the grids of V11 can be offset by adjustment of RV3.

Note . . .

The integration network represented by R and C following point 'Z' in fig. 3 exist in practice partly in the resolver (R13 to R16) and partly in the bearing display amplifier.

SERVICING

Test apparatus

16. The following items of test equipment are required for full servicing:—

(1) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(2) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(3) Multimeter Type 9980 or Type 12889.

(4) Power supply, −30V d.c.

(5) Four leads fitted with crocodile clips.

(6) Two G.P.O. sockets (with poles shorted together).

Tests for serviceability

17. Preliminary serviceability checks should first be made at the metering points while the unit is operating normally in position in the cabinet.

Voltages are measured with the peak-reading valve voltmeter calibrated in sinusoidal r.m.s. values, and the readings should be taken with the trace length control (located on the UHF amplifier unit) set to maximum attenuation. Waveforms should be monitored with the oscilloscope, and all readings should approximate to those given in Table 1.

TABLE 1

Typical readings at metering points

Metering point	Typical voltage	Type of waveform
MP1-MP4	13·0	Double envelope at 55·5 c/s, enclosing a 50 kc/s square wave
MP5 & MP6	51·0	50 kc/s square wave

18. The unit can be removed from its rack for replacement or servicing by removing the connectors and slackening off the four star-headed screws, and then lifting the unit clear of the rack.

Functional tests

19. (1) Insert the shorted G.P.O. sockets in PL2 and PL3.

(2) Set the multimeter to the 100V d.c. range and connect the negative terminal to PL1/14 and the positive terminal to earth.

(3) Connect the −30V d.c. supply to PL1/7 and check at the meter that there is negligible change in voltage. Repeat the check with the −30V supply connected to PL1/9.

(4) Connect the −30V supply simultaneously to PL1/7 and 9; the meter reading should be −20V d.c. ± 3V.

(5) Connect the multimeter negative terminal to PL1/17, and repeat checks (3) and (4).

(6) Connect the negative terminal of the multimeter to PL1/20.

(7) Connect the −30V supply to PL1/10 and check at the meter that there is negligible change in voltage. Repeat the check with the −30V supply connected to PL1/11.

(8) Connect the −30V supply simultaneously to PL1/10 and 11; the meter reading should be −20V d.c. ± 3V.

(9) Connect the negative terminal of the multimeter to PL1/23 and repeat checks (7) and (8).

(10) Using the four crocodile-clip leads, connect pins 7, 9, 10 and 11 of PL1 to pin 3 of PL1 (earth).

(11) Remove the shorted sockets from PL2 and PL3.

(12) Set the multimeter to the 100V d.c. range and connect the negative terminal to PL1/14 and the positive terminal to earth.

(13) Connect the −30V supply to PL2 and PL3 in turn, and check at the meter that there is negligible change in voltage.

(14) Connect the −30V supply to PL2 and PL3 simultaneously; the meter reading should be −23V d.c. ± 3V.

(15) Repeat checks (13) and (14) with the multimeter connected in turn to PL1 pins 17, 20 and 23.

Dismantling instructions

20. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self evident. For the location and identification of components refer to component layout diagram fig. 7.

FAULT DIAGNOSIS

Fault finding procedure

21. Before using test apparatus to trace or locate a fault, ensure that all connections are secure (PL1 to PL3) and that all valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter and carry out checks to establish the readings given in Table 1.

22. In the absence of any signal at all from the unit, the obvious starting point is to check the supply voltages to and within the unit (Tables 2 and 3).

23. For less obvious faults, the functional tests given in para. 19 should be carried out. These tests should enable the fault to be localized to a particular section of the resolver unit.

Servicing data

24. To assist in servicing and fault finding of the resolver unit, tabulated lists of typical voltages and currents are given together with the valve complement for the unit.

Supply voltages and currents

25. The input voltages to the unit and the approximate current consumption are given in Table 2.

TABLE 2

Supply voltages and currents

Circuit	Connection point	Voltage	Current
H.T. supply	PL1/4 and PL1/3 (earth)	+250V d.c.	33 mA
Bias supply	PL1/5 and PL1/3 (earth)	−75V d.c.	33 mA
Heater supply	PL1/1 and PL1/2 (earth)	6·3V a.c.	4·5A

Valve voltages

26. Typical voltages for various pins of the valves are given in Table 3. The readings should be taken with potentiometers RV1, RV2, RV3, RV4 set to their mid-position and with the unit in the no-signal condition. All measurements, which are d.c. and positive, should be taken with a d.c.-calibrated valve voltmeter.

TABLE 3

Valve voltages (d.c.)

Valve	Pin No. 1	2	3	4	5	6	7	8	9
V1	230		4·5			230		4·5	
V2	230		4·5			230		4·5	
V11	230		4·5			230		4·5	
V12	230		4·5			230		4·5	

Valve complement

27. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 4, may be used if available.

TABLE 4

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Commercial	CV No.
V1, V2	6158	4068	5960-99-000-4068	—	—
V3-V10	5726	4007	5960-99-000-4007	6AL5	140
V11, V12	6158	4068	5960-99-000-4068	—	—

Common faults

28. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. If any one of the valves is replaced it may be necessary to adjust the zero controls RV1 to RV4. This is done by first setting each control to the mid-position and then observing the c.r.t. indicator and adjusting RV1 and/or RV2 until the spot is central on the screen. RV3 and RV4 provide for fine adjustment. The equipment must be operating normally in the cabinet but without d.f. modulation present.

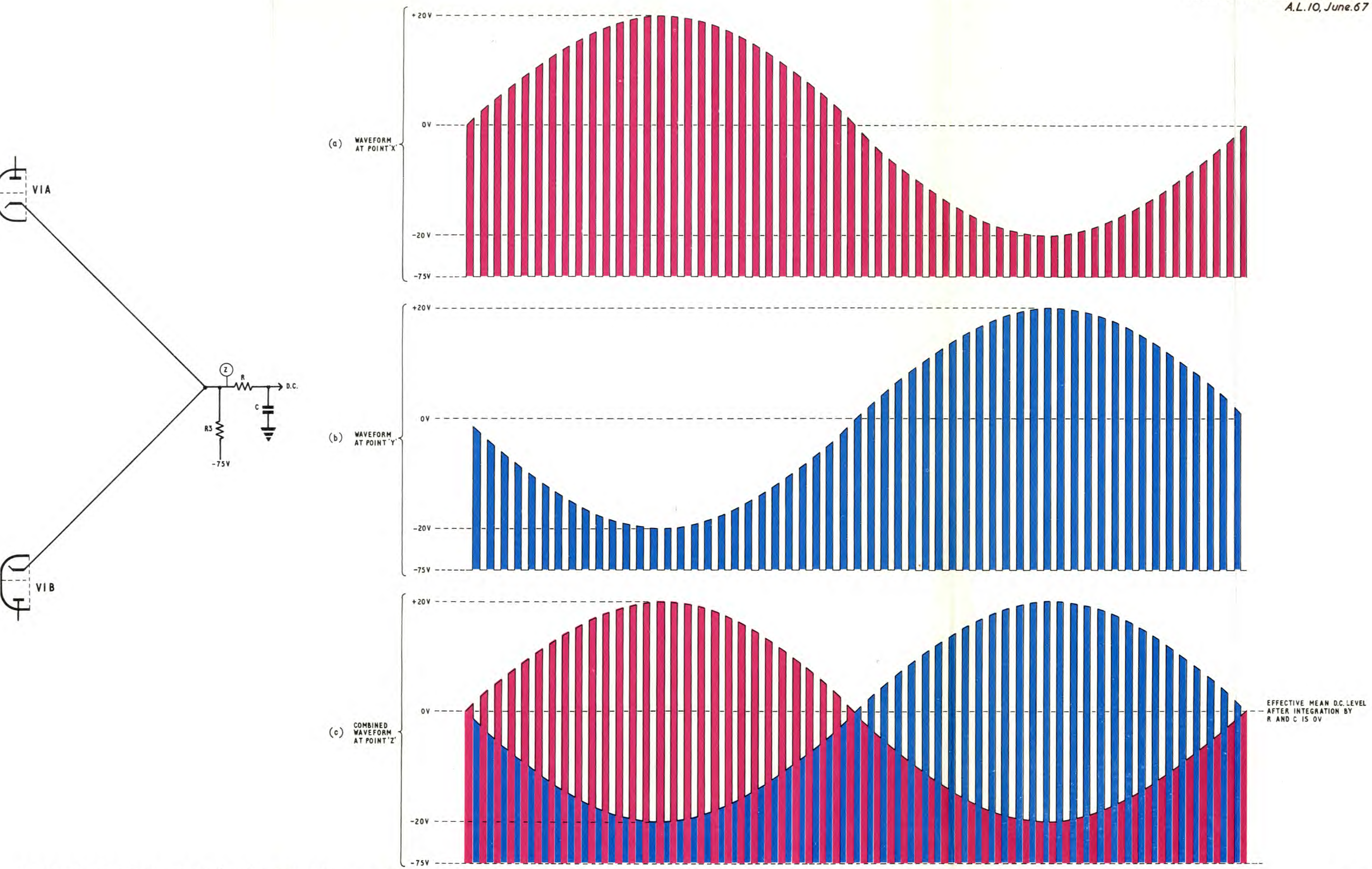
Modifications

29. The following modification is applicable to the resolver 5825-99-943-5893.

5769 ... To prevent failure of resistors RV1 and RV2 (replacement).

Caution . . .

The above modification is noted in this chapter for guidance only and reference to A.P.2531P, Vol. 2, is mandatory when checking the modification state of CADF equipment.



FGRI. 23078 & TGRI. (AT) 26006/1: simplified circuit and output waveforms (no signal) for one resolver leg

Fig.3

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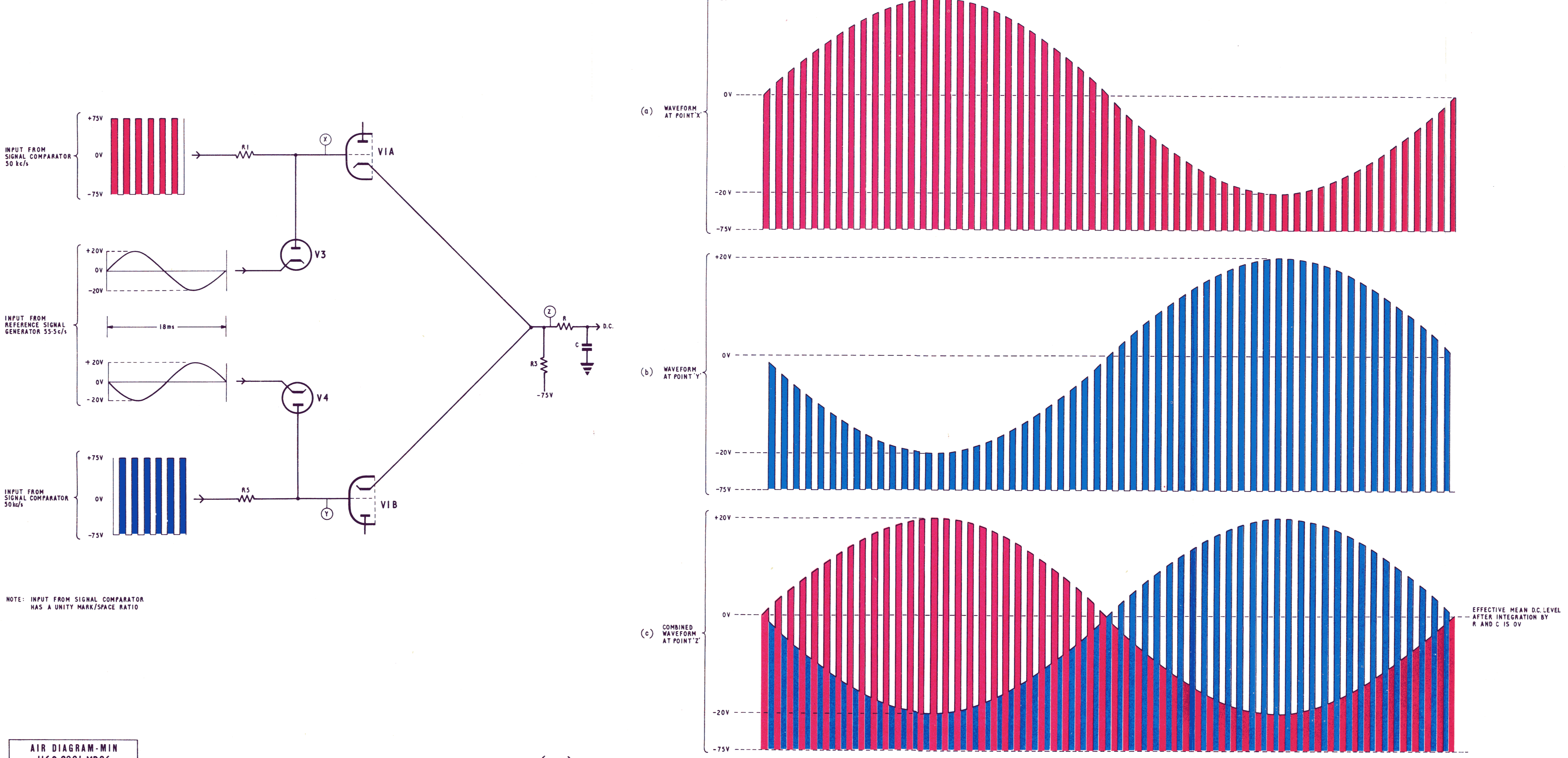

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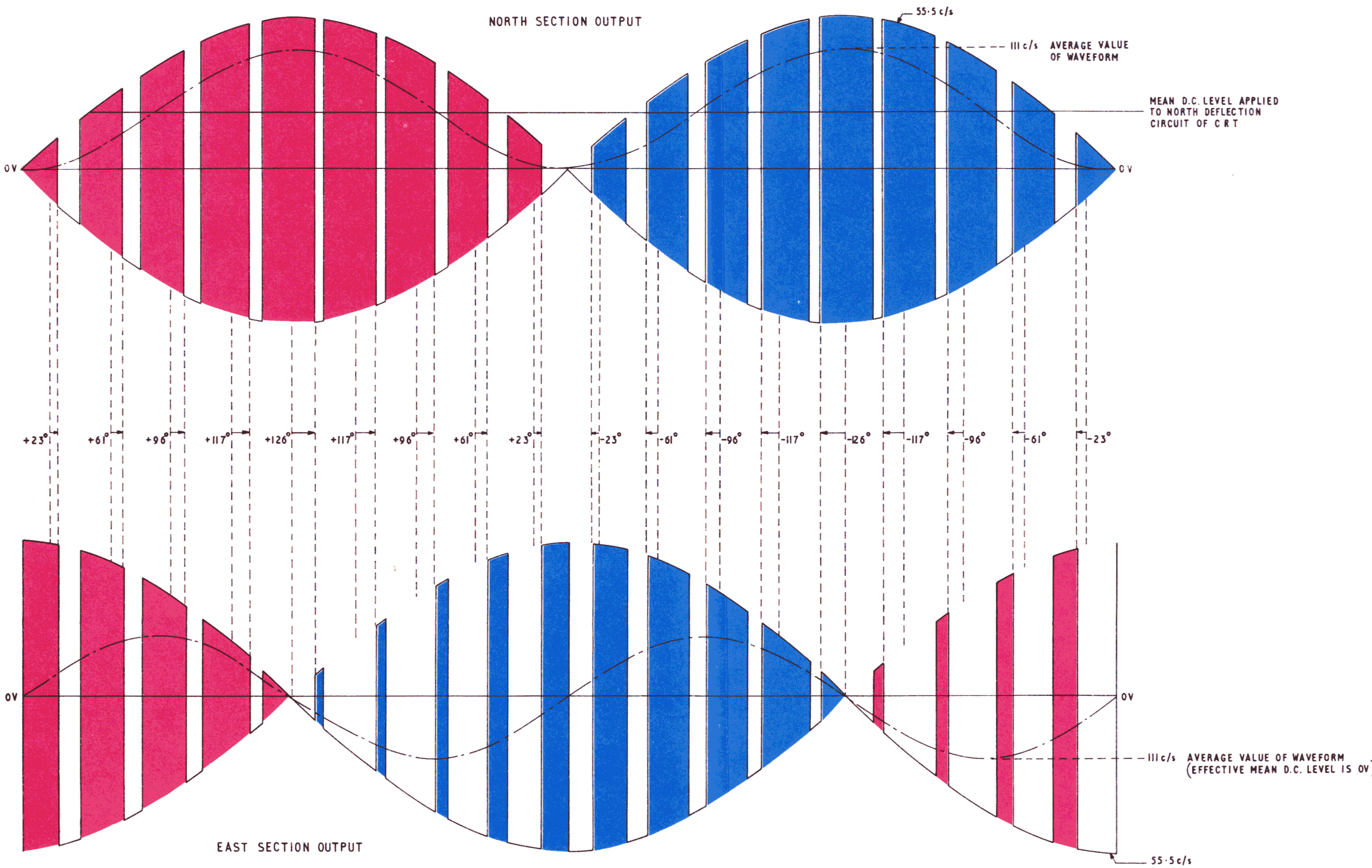
FGR1. 23078 & TGR1.(AT) 26006/1: simplified circuit and output waveforms (no signal) for one resolver leg

Fig.3



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FGRI.23078 & TGRI.(AT) 26006/1 : representative output waveforms for two resolver legs under a signal condition

Fig.4

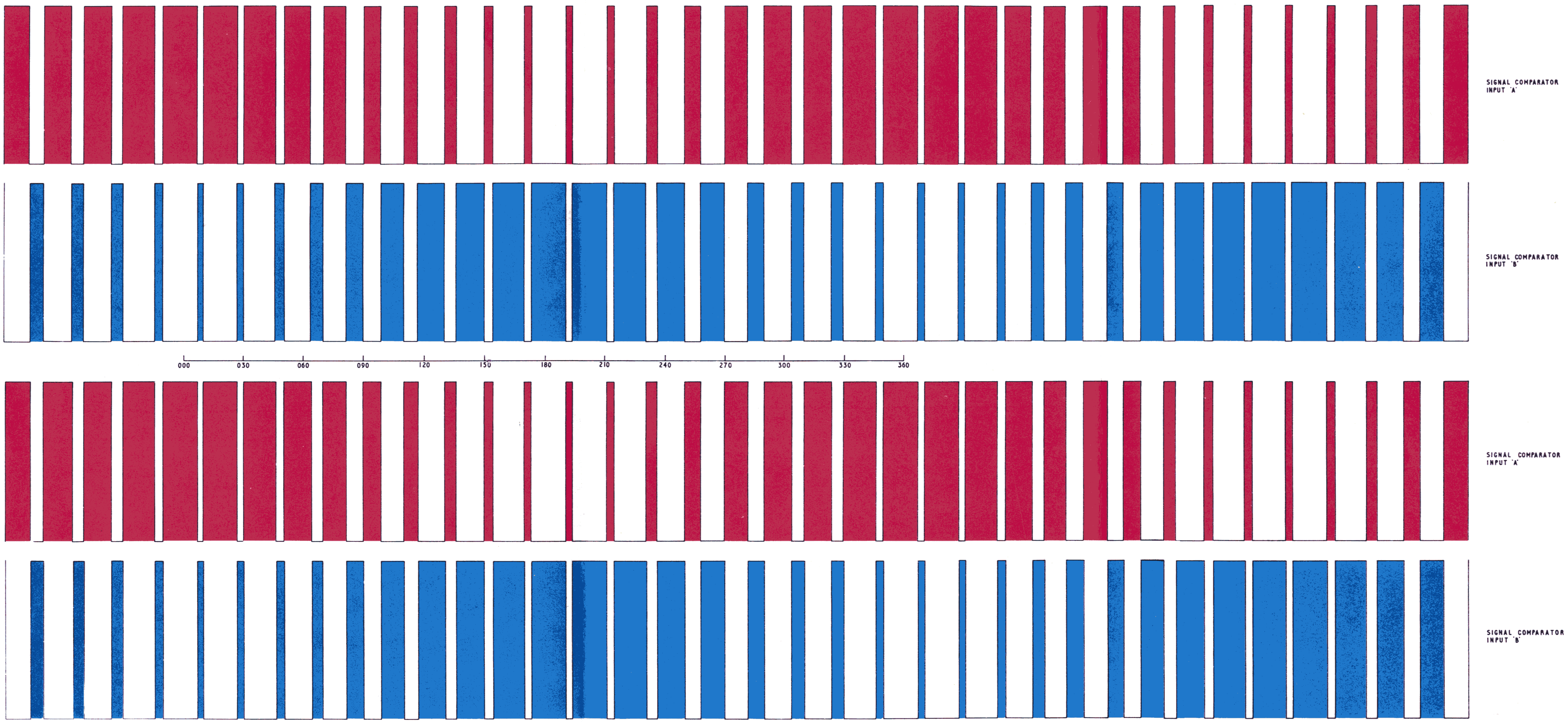


Fig. 5 (side 1) FGRI. 23078 & TGRI. (AT) 26006/1 : representative output waveforms for two resolver legs under any signal condition Fig.5 (side 1)

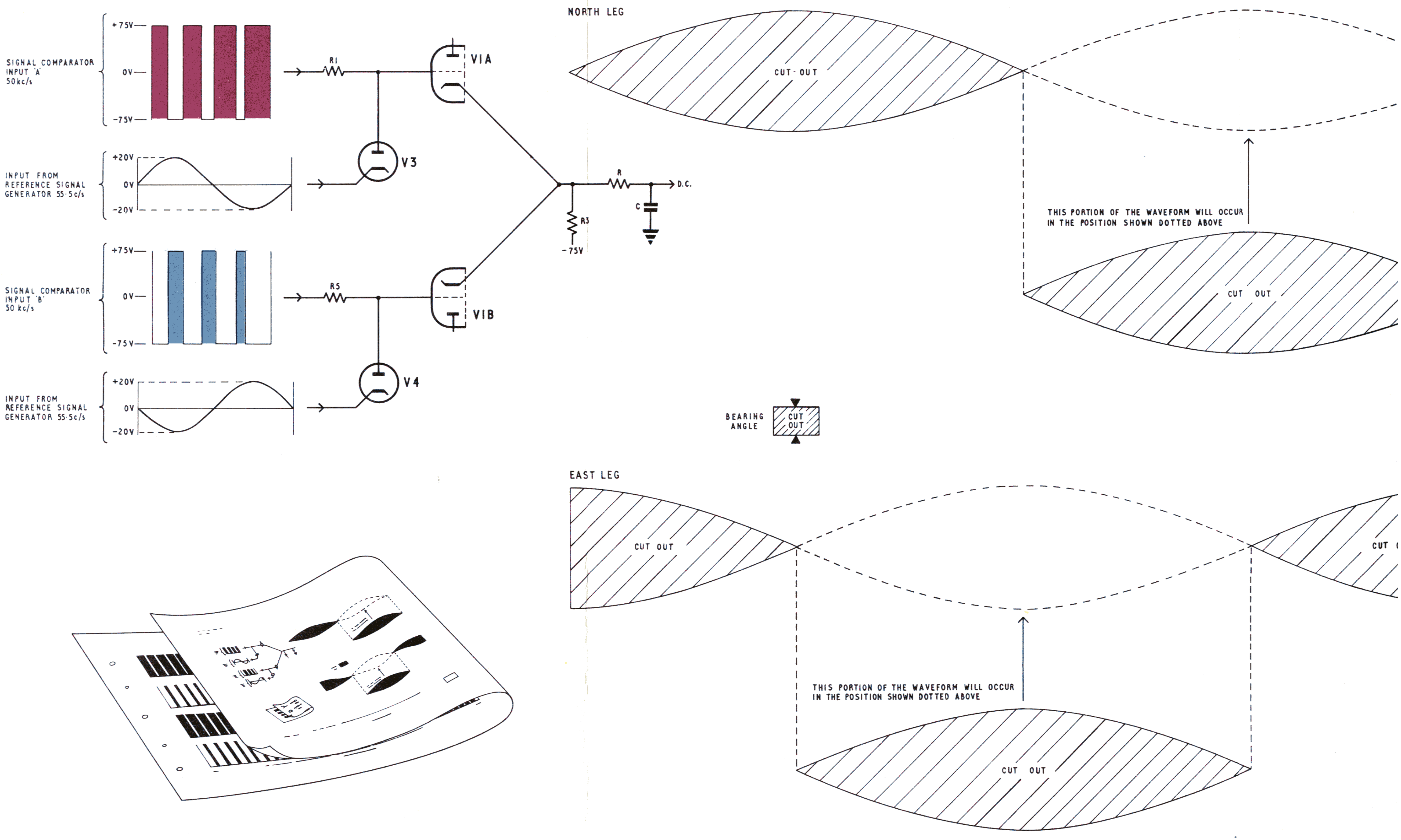
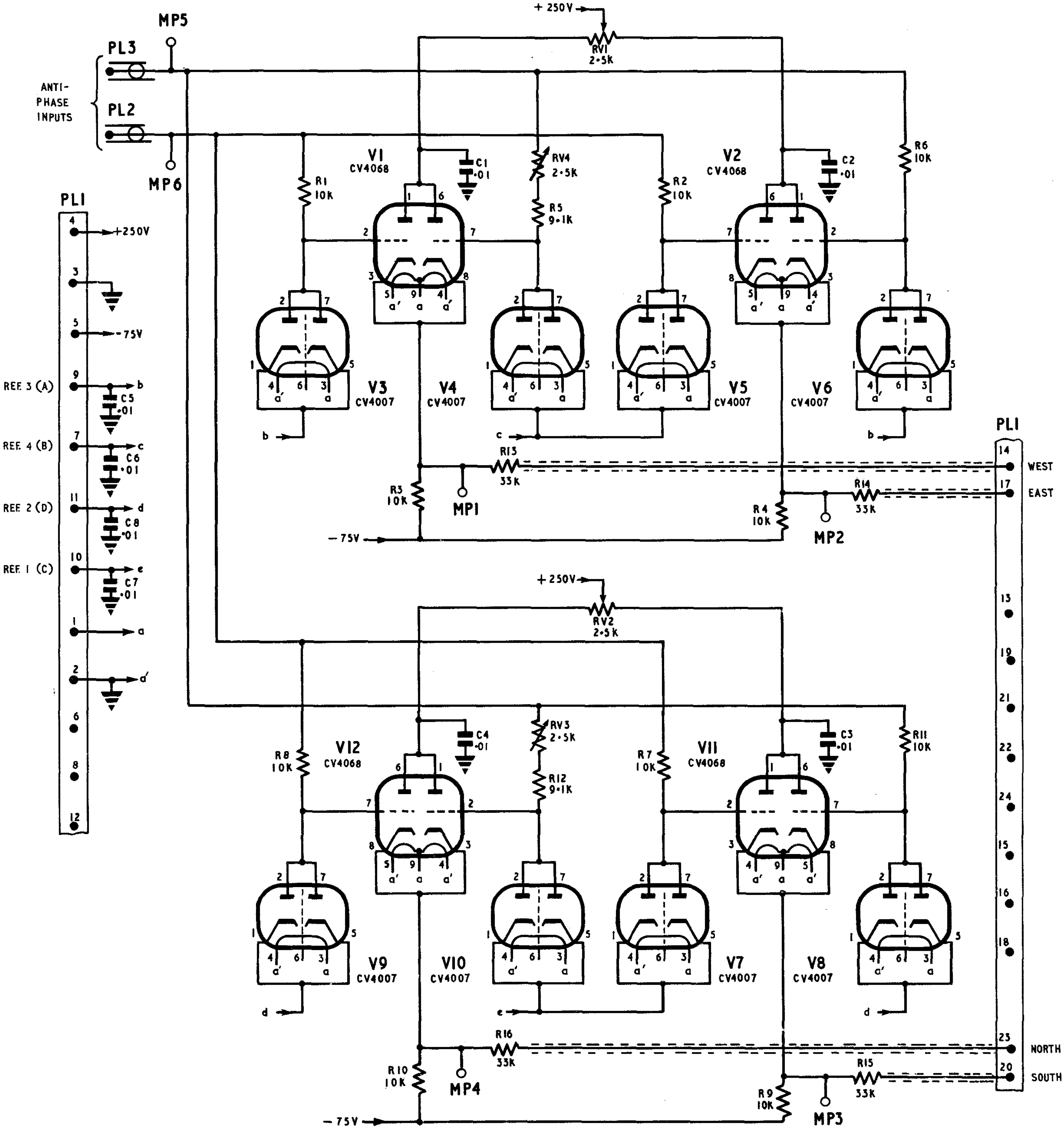


Fig. 5 (side 2) FGRI.23078 & TGRI.(AT) 26006/1: representative output waveforms for two resolver legs under any signal condition



Converter, signal data

5825-99-943-5893 (resolver): circuit

Fig. 6

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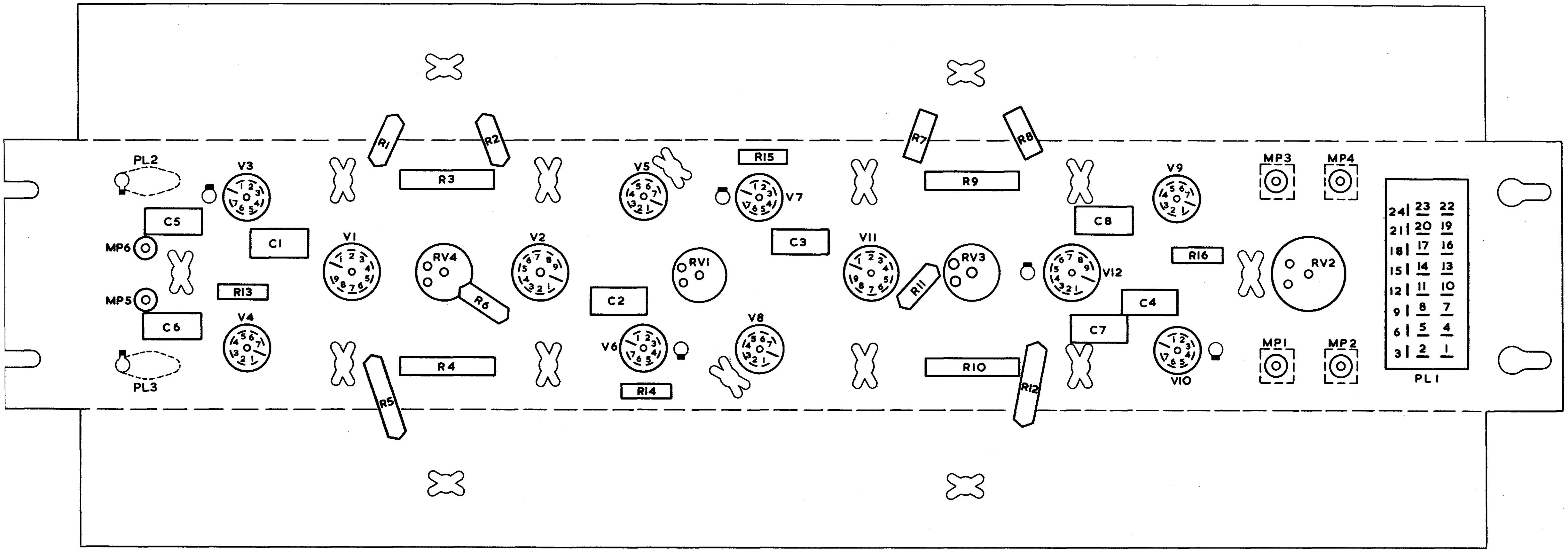

Converter, signal data 5825-99-943-5893 (resolver): component layout

Fig. 7

Chapter 10

BEARING DISPLAY AMPLIFIER

LIST OF CONTENTS

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LIST OF ILLUSTRATIONS

UNIT DESCRIPTION

Introduction

1. The bearing display amplifier receives the north-south and east-west signals from the resolver unit (5825-99-943-5893). The amplified signals are of high amplitude for application where triangulation equipment is used, but the signals are also passed via attenuators to cathode follower stages in order to reduce them to a level suitable for operation of the c.r.t. indicator.

2. Two types of bearing display amplifier (5825-99-933-5890 and 5825-99-933-0812) are presently in use with the equipment. Circuit differences between each are minor, the main difference being that the 0812 produces a d.c. voltage (which can be used to feed triangulation equipment) of approximately 260V, on a north bearing. The d.c. voltage produced by the 5890 is approximately 200V, on a north bearing. The design of the 5890 will be modified eventually to conform with the 0812, which will be used by the R.A.F. and is therefore described in this Chapter.

3. The bearing display amplifier is used in the following rack assemblies:—

(1) Single pre-tuned receiver and d.f. cabinet 5820-99-932-4857)—position in rack CC.

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—position in rack EE.

(3) Single channel d.f. cabinet (5820-99-932-4862)—position in rack EA.

(4) Two channel d.f. cabinet (5820-99-932-4861)—position in racks EA and EB.

(5) Switching rack of TGRI 26006 series—position in racks BA and BB.

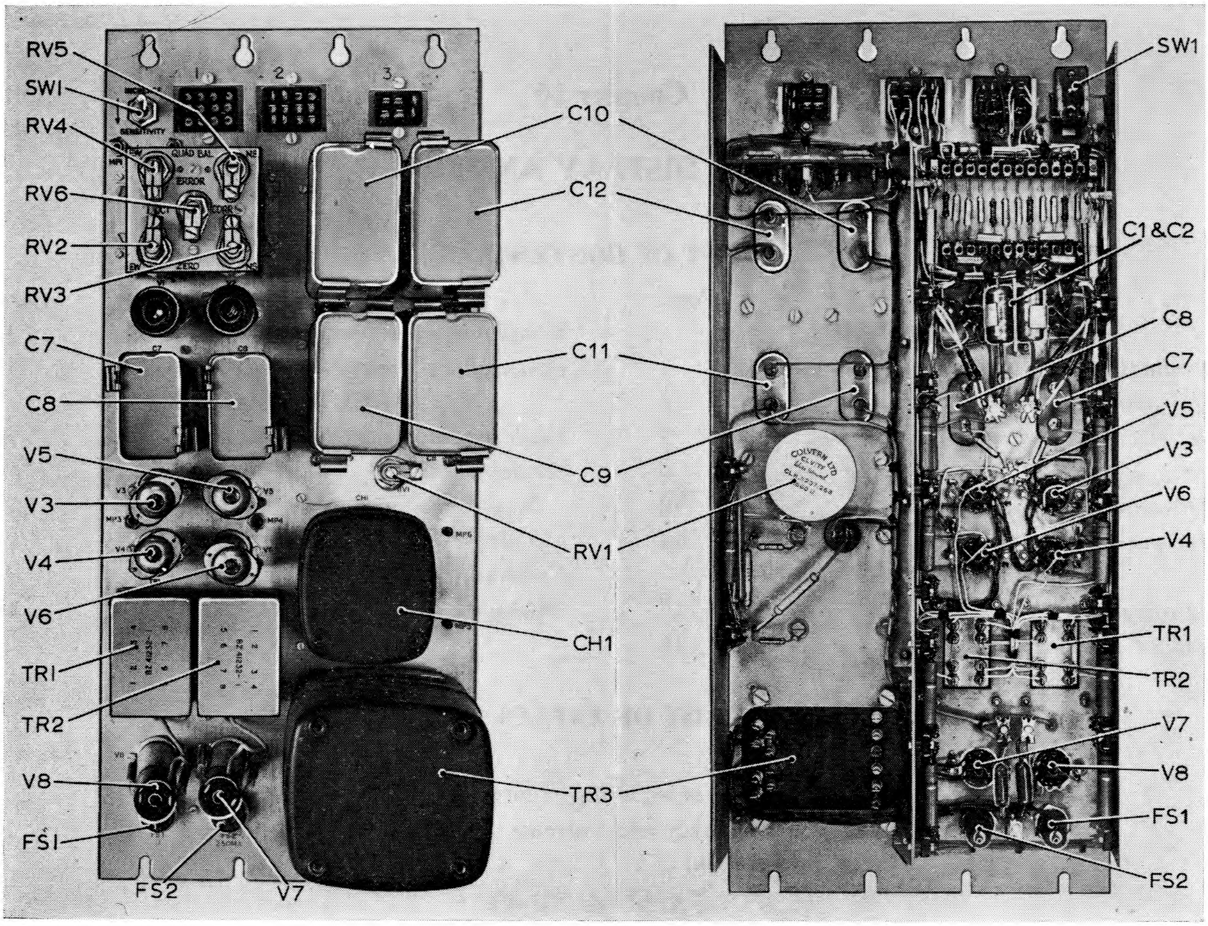

Fig. 1. Bearing display amplifier: front and rear views

Construction

4. Construction of the unit is similar to that described for the master oscillator in Chapter 1. The location of all connectors and valves is shown in fig. 1, which gives both front and rear views of the bearing display amplifier.

Brief electrical description (fig. 4)

5. Two separate but similar signal channels d.c.-amplify the north-south and east-west low-level input signals from the resolver (5825-99-943-5893). After d.c. amplification, the signals are applied via attenuator pads to cathode-followers and then routed out of the unit to the c.r.t. indicator. The high level voltages obtained from the d.c. amplifiers are brought out of the unit also, and may be used for directly feeding the input circuits of triangulation equipment. Supply voltages are obtained from an integral power unit.

Circuit description (fig. 5)

6. The internal power supply is energized by a 230V a.c. mains input. Secondary windings on TR3 provide 6·3V a.c. for the valve heaters, and 380V a.c. which is applied to two separate rectifier circuits containing V7 and V8; these two circuits produce +400V d.c. and −230V d.c. supplies, respectively.

7. Two balanced input signal voltages of ±4V amplitude, referred to +6V, are fed from the resolver unit to the north-south and east-west channels in the amplifier. The north-south signal is applied to the unit at PL2/1 and 2, and the east-west signal at PL2/5 and 6. The amplitudes of the input voltages are proportional to the sine and cosine of the angle of bearing of the received signal. In the input stage of each channel is an integrator network; R5,C1 and R6 comprise the network in the north-south channel, and R7,C2 and R8 comprise the network in the east-west channel. The bandwidth of each network is approximately 3 c/s, resulting in a display indication speed of approximately $\frac{1}{3}$s. Adjustment of north-south and east-west quadrantal balance is effected with RV5 and RV4 respectively.

8. The integrated north-south and east-west signals are amplified by V1 and V2 respectively. Each valve is operated to provide a gain of approximately 20; the signal excursion of the anode voltage of each valve is approximately 200V. To cater for triangulation equipment, the north-south anode voltages are routed out of the unit via resistor network R55,R56,R59, and the east-west anode voltages are routed out via resistor network R57,R58,R60. Zero balance of the north-south and east-west channels is obtained by adjustment of RV3 and RV2 respectively.

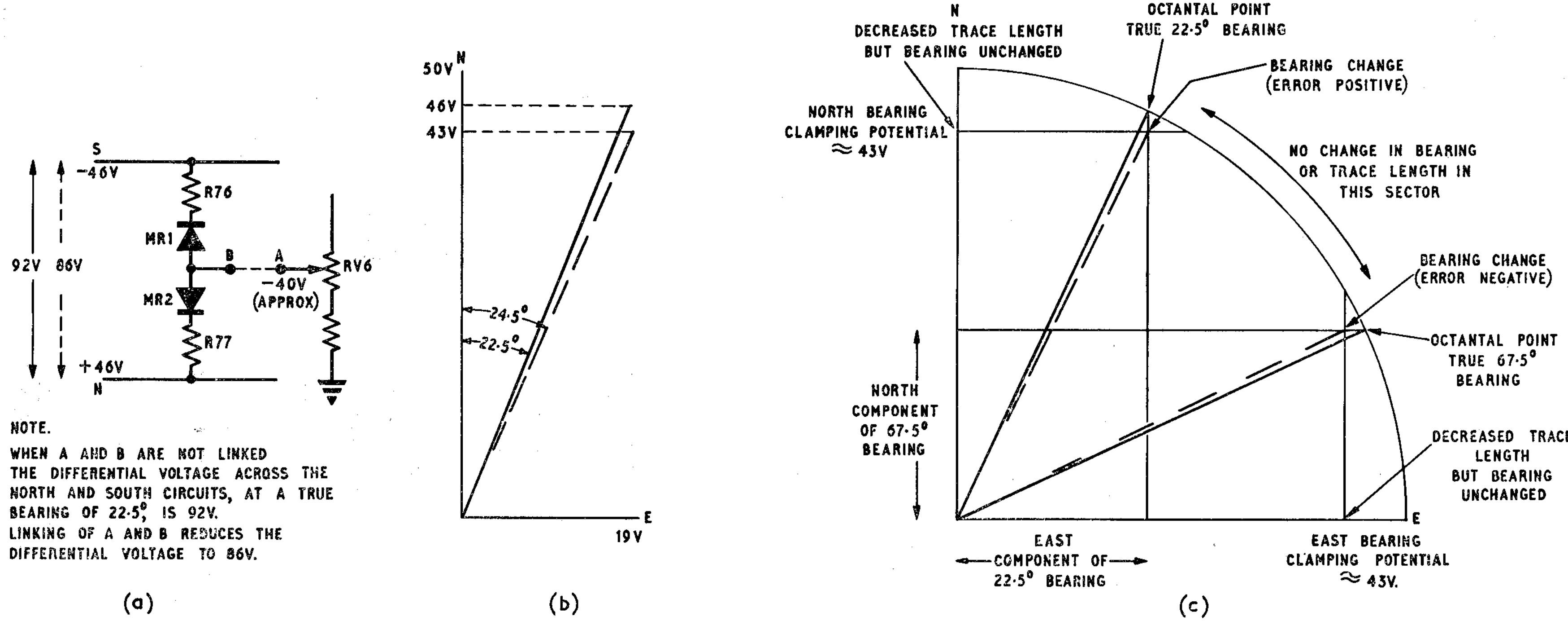

Fig. 2. Octantal error

9. Attenuator pads and cathode-followers are interposed in each channel in order to reduce the anode signal voltage to a form suitable for operating the display equipment. The attenuators (R15,R19,R16,R20 and R17,R21,R18,R22) reduce the voltage applied to the cathode-followers in each channel to approximately 100V. The output voltages of the four cathode-followers are balanced by adjustment of RV1 which forms part of a potential-divider network connected between earth and the −230V output of rectifier V8. By returning the junction of R19,R20, and R21,R22 to the slider of RV1, the potentiometer can be adjusted to provide a suitable bias for the cathode-followers so that their mean grid voltage is at earth potential.

Octantal error

10. Some of the cathode-ray-tube scales used by the R.A.F. have graduations which are non-linear at the octantal points. These scales were originally intended for use with other direction-finding systems which used an elevated H Adcock aerial, and had an inherent octantal error. This error was a maximum of approximately 2° at the octantal points and changed sign at alternate octantal points in azimuth. The C.A.D.F. system, however, is linear, and when a non-linear scale is used it is necessary to introduce an octantal error that corresponds to the graduations of the scale.

11. This error is introduced by connecting a link between A and B (fig. 5) so that a voltage, determined by the adjustment of RV6, is applied to the junction of clamping rectifiers MR1,MR2 and MR3,MR4. The function of these rectifiers is best understood by considering the potentials applied to the c.r.t.

Note . . .

Approximate values are used in the following description to simplify the explanation.

These potentials are of the form $\pm 50\sin\theta$ and $\pm 50\cos\theta$, where θ is the bearing angle, and $-\sin\theta$, $+\sin\theta$, $-\cos\theta$ and $+\cos\theta$ correspond to west, east, south and north components, respectively, of the bearing.

For a bearing of 22·5°,
$50\cos 22{\cdot}5° = 46$V for the north potential
$50\sin 22{\cdot}5° = 19$V for the east potential

To introduce an error of +2°, the north and east components should be,
$50\cos 24{\cdot}5°$ 45V for the north potential
$50\sin 24{\cdot}5°$ 21V for the east potential

Thus to introduce the error, the north potential should be **decreased** by 1V and the east potential **increased** by 2V, but the form of clamping circuit used can only decrease the cardinal voltages. However, the required result is obtained at the octantal points by decreasing, by 3V, the north potential only.

12. The decrease of potential is effected by applying a predetermined clamping potential to the junction of the clamping rectifiers. A simplified circuit of the clamping arrangement used for the north-south channel is shown in fig. 2(a). An identical arrangement is used for the east-west channel. The slider of RV6 (common to both channels) is adjusted to obtain a potential of approximately −40V with respect to earth. At a true bearing of 22·5°, the north and south circuit voltages are +46V and −46V, respectively, with respect to the potential of the slider of RV6. The voltage conditions of the circuit bias rectifier MR1 so that it conducts and clamps the south circuit voltage at −40V. The differential voltage across the two circuits is decreased to 86V so that the positive voltage, with respect to earth, on the north plate of the c.r.t. is reduced to 43V as required. When this north component is combined with the east component of 19V (unclamped at 22·5°) the bearing displacement of approximately 2° is obtained as shown in fig. 2(b).

13. Although this method introduces the required error, it should be noted that a reduction of the length of the trace occurs at and between the octantal points which include the cardinal points. A simplified diagram showing the effect, in the north to east quadrant, of the error on trace length and direction of bearing change is given in fig. 2(c).

Output circuit

14. The d.f. output from the cathode-follower stages, which are designed to feed directly into post-office lines, are fed out of the unit via the primaries of TR1 and TR2 respectively. The transformers enable speech intelligence to be superimposed on the d.f. information. The output line circuit has been designed so that the line-to-earth current does not exceed 25mA during a possible fault condition.

SERVICING

Test apparatus

15. The following items of test equipment are required for full servicing:—

(1) Valve voltmeter CT54, 6625-99-943-2418, Marconi type TF.1041A.

(2) 200-0-200μA f.s.d. test meter (built out to 2·5k ohms) with leads 33/4793 A and B.

(3) D.C. calibrator set, T.S1/11,10S/17176.

(4) Multimeter Type 9980 or Type 12889.

(5) Two load resistors 36k ±5%, ½W (RC2-D).

(6) Variac.

(7) Capacitor, 16μF, 600V.

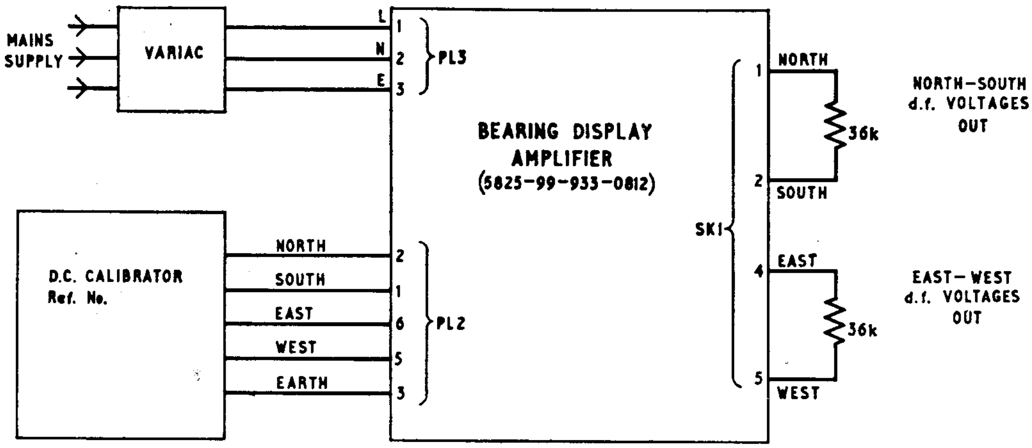

Fig. 3. Connection of test equipment

Tests for serviceability

16. Preliminary serviceability checks should be made by first checking with the multimeter the voltages at metering points MP5 and MP6 when the unit is operating normally in position in the cabinet. All readings should approximate to those given in Table 1.

TABLE 1

Typical voltages at metering points

Metering point	Voltage readings
MP5	+435V ±30V d.c.
MP6	−465V ±30V d.c.

17. The unit can be removed from its rack for replacement or servicing by removing the connectors, slackening off the four star-head screws, and then lifting the unit clear of the rack.

Re-alignment procedure

18. The re-alignment procedure described in the following instructions is normally undertaken only at third line servicing. The unit can be tested on the bench with the test equipment connected as shown in fig. 3.

Note . . .

The test procedure is the same in nearly all respects for both types of bearing display amplifier. Accordingly, only one procedure is given, but where the procedure (or required result) is not applicable to both amplifiers the test instructions are prefaced by the relevant Ref. No. of the amplifier to which they apply.

(1) (5825-99-933-5890) With the multimeter switched to a suitable resistance range, check that potentiometers RV1,RV2,RV3,RV4 are functioning correctly. (5825-99-933-0812) Temporarily remove the shorting link between terminals A and B and, with the multimeter switched to a suitable resistance range, check that potentiometers RV1,RV2, RV3,RV4,RV5,RV6 are functioning correctly. Set RV4 and RV5 fully clockwise (maximum resistance).

(2) With TR3 primary connections set to the 0V and 230V taps, switch on the mains and adjust the variac for 230V input to the unit.

(3) Connect the test meter to MP5 and record the reading. The true voltage reading is obtained by multiplying the reading by 3. Limits: meter reading +145 ±10 = +435V ±30V.

(4) Connect the test meter to MP6 and record the reading. The true voltage reading is obtained by multiplying the reading by 3. Limits: meter reading −155 ±10 = −465V ±30V.

(5) Switch on the d.c. calibrator and set the TRACE ON/OFF switch to OFF and the output switch to LOW ÷ 10.

(6) Connect the valve voltmeter between PL2/1 and earth and adjust the mean voltage control on the d.c. calibrator so that a reading of +6V is obtained. As a check, measure between PL2/2,5,6 and earth and ensure that the four readings are the same.

Caution . . .

The next instruction includes a step which increases the sensitivity of the test meter and care must be taken to avoid an overload on the meter.

(7) Plug the meter jack into MP1 and, if necessary, adjust RV3 for zero deflection on the test meter. Increase the sensitivity of the

meter by actuating SW1 (the switch bridges a 1M resistor) and, if necessary, adjust RV3 for zero deflection. Release SW1.

(8) With the valve voltmeter, measure and record the voltages (with respect to earth) on V1a and V1b anodes. Limits: 190V ±15V.

(9) Plug the meter jack into MP2 and repeat the procedure given in (7), adjusting RV2 as necessary.

(10) With the valve voltmeter, measure and record the voltages (with respect to earth) on V2a and V2b anodes. Limits: 190V ±15V.

(11) With the valve voltmeter switched to the 10V d.c. range, measure the voltage (with respect to earth) of V3,V4,V5,V6 cathodes. Average these readings and adjust RV1 so that the mean reading is at earth potential, but ensure that the voltage on any cathode does not exceed ±5V with respect to earth.

(12) (5825-99-933-5890) Rotate the bearing switch on the d.c. calibrator to give a north bearing and set the TRACE ON/OFF switch to ON. With the valve voltmeter connected between PL2/1 and PL2/2, adjust the TRACE LENGTH control to give a reading of 8V at the meter. Plug the test meter jack into MP1 and record the reading (the f.s.d. of the meter is 200V -0- 200V). Limits: 155V ±12·5V.

(5825-99-933-0812) Rotate the bearing switch on the d.c. calibrator to give a north bearing and set the TRACE ON/OFF switch to ON. With RV5 and RV4 adjusted fully clockwise (maximum resistance), and with the valve voltmeter connected between PL2/1 and PL2/2, adjust the TRACE LENGTH control to obtain a reading of 8V. Plug the test meter jack into MP1 and record the reading (the f.s.d. of the meter is 200V -0- 200V. Limits: 155V minimum.

(13) Plug the test meter jack into MP3 and record the reading at the test meter. Limits: 100V ±5V.

(14) (5825-99-933-5890) Plug the meter jack into MP4. Rotate the bearing switch on the d.c. calibrator to give an east bearing. Note the reading at the test meter and adjust RV4 to obtain the reading recorded in (13). Ensure that the slider of RV4 is at the approximate mid point of its traverse.

(5825-99-933-0812) Rotate the bearing switch on the d.c. calibrator to give an east bearing. With the valve voltmeter connected between PL2/5 and PL2/6 adjust the TRACE LENGTH control to obtain a reading of 8V. Plug the meter jack into MP4 and record the meter reading. Limits: 100V ±5V.

(15) Plug the meter jack into MP2 and record the reading of the test meter. Limits: 155V minimum.

(16) Measure the grid bias by connecting the multimeter in turn between pins 2 and 3 of valves V3,V4,V5,V6 with the bearing switch on the d.c. calibrator set to north, south, east and west respectively. During each measurement, rotate the bearing switch two positions either side of the relevant bearing and ensure that the bias measured on the original bearing is a minimum. Limits: −1·5V minimum.

(17) On the d.c. calibrator set the TRACE ON/OFF switch to OFF. With the multimeter switched to the 25V a.c. range, and connected in series with the 16μF capacitor, measure and record the ripple voltage (with respect to earth) of V3,V4,V5,V6 cathodes. Limits: 0·85V r.m.s. maximum.

(18) Switch off the mains supply, remove FS1 and connect the multimeter, switched to the 1A range, across the fuse holder. Ensure that the TRACE ON/OFF switch is OFF. Switch on the mains supply and measure and record the a.c. input current. Limits: ▶ 330mA ±30mA. Switch off the mains and ◀ replace FS1.

(19) Remove FS2. Connect the multimeter, set to the 1A range, across the fuse holder. Switch on the mains supply and measure and record the a.c. input current. Limits: 100mA ±10mA.

(20) Replace FS2. Reconnect the link between terminals A and B (5825-99-933-0812).

Dismantling instructions

19. There are no complicated mechanical devices on the unit, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis) is self-evident. For the location and identification of components refer to the component layout diagram fig. 6.

FAULT DIAGNOSIS

Fault finding procedure

20. Before using test apparatus ensure that the plug and socket connections are secure and that valves are securely seated in their bases. For checking the correct operation of this unit, refer to the servicing section of this chapter and implement voltage tests at the metering points given in Table 1.

21. In the absence of any output from the unit the obvious starting point is to check the mains supply voltage to, and the power supply voltages within, the unit.

Servicing data

22. To assist in servicing and fault finding of the bearing display amplifier, typical voltages are given together with the valve complement of the unit.

Supply voltages and currents

23. The mains input voltage and current consumption is given, together with the valve heater voltages and currents obtained from the internal power supply, in Table 2.

TABLE 2

Alternating voltages and currents

Circuit	Connection point	Voltage	Current
▶ Mains supply	PL3, poles 1 and 2	230V	330mA ◀
V1-V6 heaters	TR3 secondary, taps 12 and 13	6·3V	4·2A
V7 heater	TR3 secondary, taps 6 and 7	6·3V	0·8A
V8 heater	TR3 secondary, taps 8 and 9	6·3V	0·8A

Valve complement

24. When replacing valves, it is recommended that the 'T' range is used; the commercial types with similar characteristics, given in Table 3, may be used if available.

TABLE 3

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Commercial Type	CV No.
V1		4024	5960-99-000-4024		
V2		4024	5960-99-000-4024		
V3	6132	4055	5960-99-000-4055	6CH6	2127
V4	6132	4055	5960-99-000-4055	6CH6	2127
V5	6132	4055	5960-99-000-4055	6CH6	2127
V6	6132	4055	5960-99-000-4055	6CH6	2127
V7	6443	4044	5960-99-000-4044	R18	2235
V8	6443	4044	5960-99-000-4044	R18	2235

Common faults

25. The most obvious faults likely to occur are the failure of high stability resistors and deterioration of any one of the valves. Deterioration of V1 and V2 is indicated if the sliders of potentiometers RV3 and RV2, respectively, reach the end of their tracks during the zero adjustment of the valve circuits.

Modifications

26. The following modifications are applicable to the bearing display amplifier 5825-99-943-5890:

5739/1 ... Adds octantal error corrector and increased triangulation level output. Resistors R59 and R60 are reduced in value from 2·7 M ohm to 2·2 M ohm.

6255 ... Increases the output from triangulation channel and replaces valves V1 and V2. This modification changes the reference No. to: 5825-99-933-0812.

6384 ... Elimination of initial bearing error. Replacement of capacitors C1 and C2.

Bearing display amplifier 5825-99-933-0812:

9203 ... Improved adjustment of RV1 by repositioning in circuit between R53 and R54.

Caution . . .

The above modifications are noted in this chapter for guidance only and reference to A.P.2531P, Vol. 2, is mandatory when checking the modification state of CADF equipment.

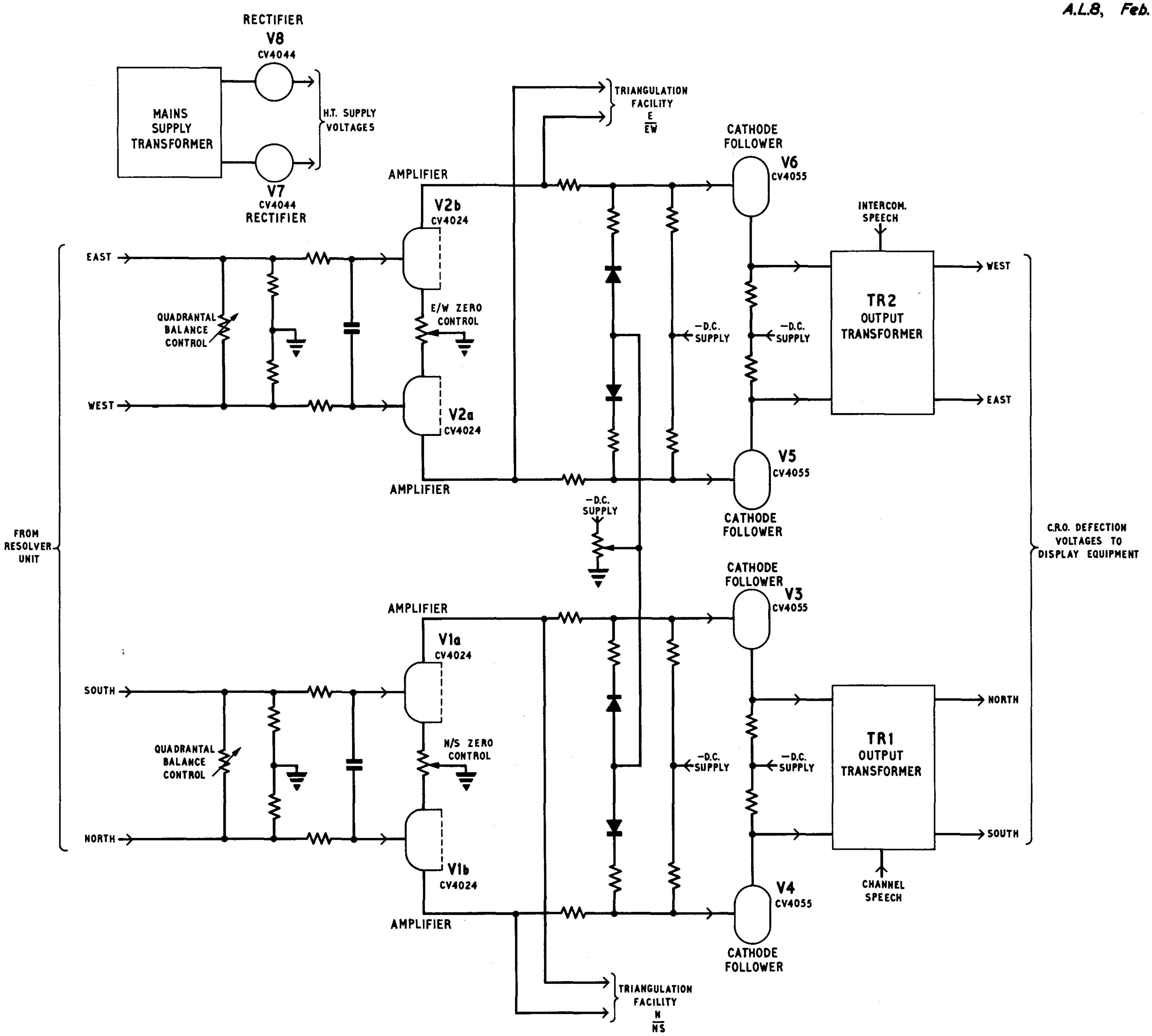

Fig. 4 Amplifier, d.c. 5825-99-933-0812 (bearing display amplifier): simplified circuit Fig. 4

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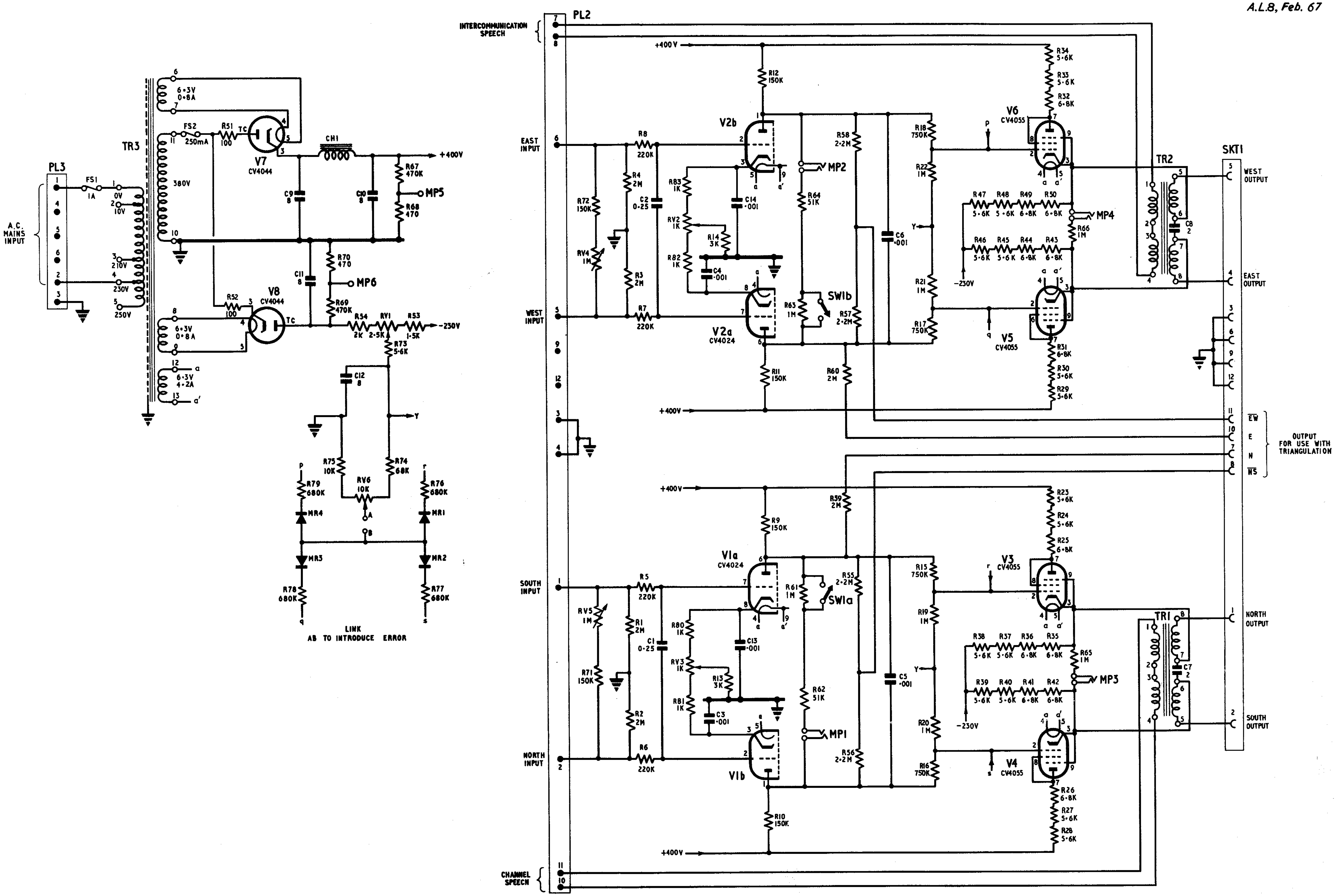

Amplifier, d.c. 5825-99-933-0812 (bearing display amplifier) : circuit

Fig. 5

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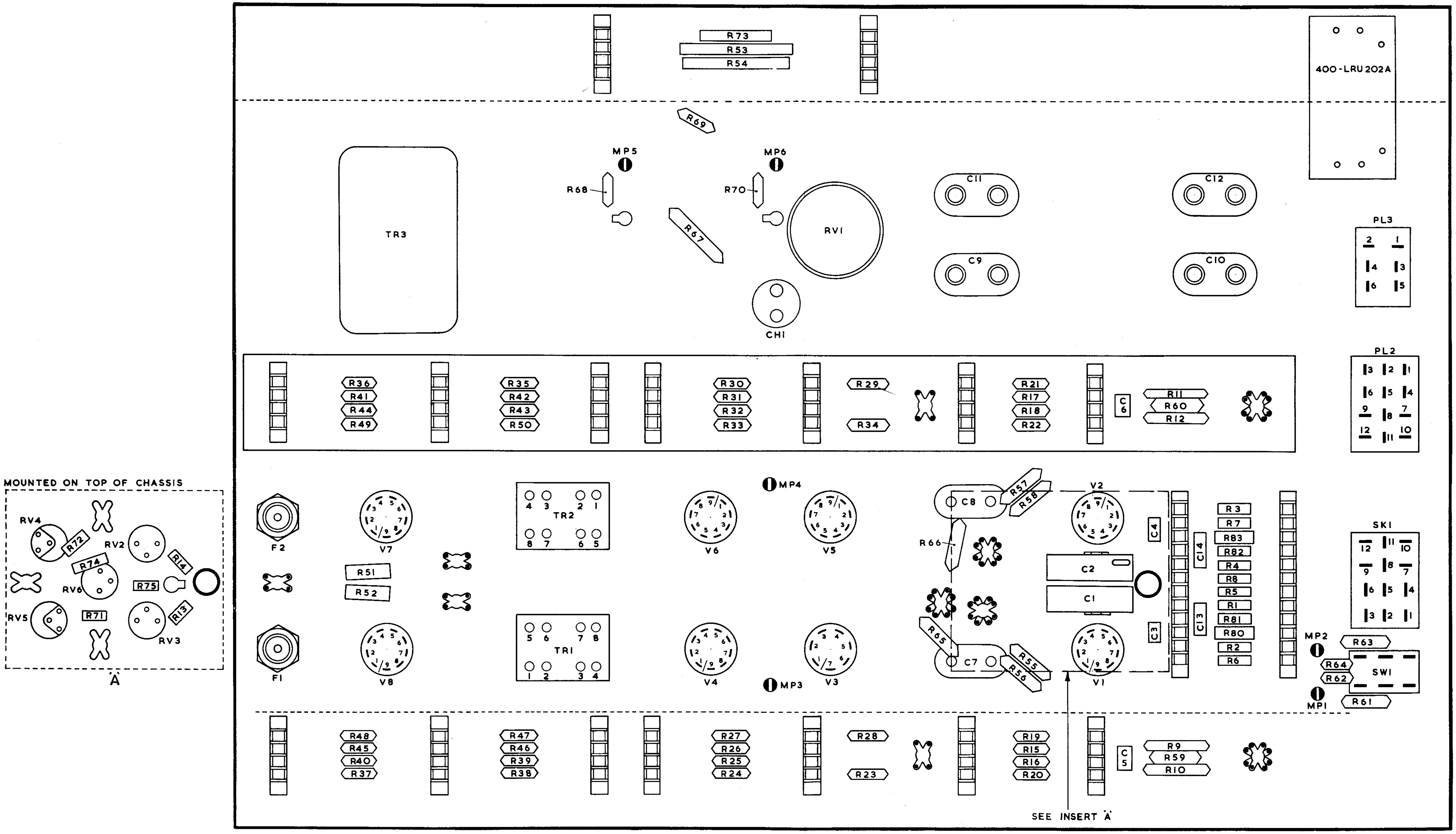


D.461010. 270339. S.W. 5/67 Amplifier, d.c. 5825-99-933-0812 (bearing display amplifier) : component layout

Fig. 6

Chapter 11

POWER SUPPLIES

CONTENTS

TABLES

ILLUSTRATIONS

INTRODUCTION

1. This chapter describes three of the power units that are used in the CADF equipment. These units are as follows:-

(1) Main d.f. power supply (6120-99-932-4856).

(2) Power supply, -75V (6130-99-943-5903).

(3) Divider network (5820-99-933-1117).

2. The four main d.c. voltages required by the CADF equipment are:-

(1) +350V h.t. supply.

(2) +250V h.t. supply.

(3) -50V control voltage.

(4) -75V bias supply.

All other d.c. voltages present in the CADF equipment are derived from these supplies.

MAIN D.F. POWER SUPPLY

GENERAL DESCRIPTION

3. The main d.f. power supply is used in the fixed version of the equipment and provides the +350V, +250V and -50V supplies and in addition, provides a 6.3V a.c. valve heater supply. The main d.f. power supply is not used in the transportable equipment; instead the +350V, +250V and -50V supplies are provided by separate power units, described in AP 116C-0801-1M, Sect. 2, Chap. 4.

4. The main d.f. power supply provides three separate outputs of h.t. and heater voltages. Two are fed to the d.f. units of channel 1 and, if fitted, channel 2. The third set of outputs is fed to the switching units which are common to all channels and operate the cyclic switching of the aerial array. The main d.f. power supply incorporates auxiliary control circuits for routeing the outputs of the power supply to the units of the required channel and the switching units. If the triangulation channels 3 and 4 are incorporated in the equipment and are the only channels selected, the control circuits of the power unit route the supplies to the switching units only.

5. The main d.f. power supply is fitted as follows:-

(1) Single channel d.f. cabinet (5820-99-932-4862) - rack position FA.

(2) Two channel d.f. cabinet (5820-99-932-4861) - rack position FA.

(3) Aerial switching cabinet (5820-99-932-4858) - rack position FA.

6. The main d.f. power supply is a unit designed for horizontal mounting. Basically, it consists of a shallow-base on which are mounted the chokes and transformers. Two vertical support plates, with edges bent at right angles to increase the rigidity, are mounted at each end of the base chassis. Spacing bars between the support plates further increase the strength of the construction. The components associated with switching, monitoring and protection facilities are mounted on a sloping front panel fixed between the two support plates. The chassis is mounted on rollers to permit easy withdrawal from the cabinet. The locations of all connectors, valves and main components are shown in fig. 10.

Mains supply connections and output voltage inter-connections

7. The connection of the mains supply input for fixed equipment is shown in fig. 6. The connections are the same for the single channel d.f. cabinet, two channel d.f. cabinet and the aerial switching cabinet.

8. The interconnections of the output voltages from the power supplies in the fixed equipment are shown in fig. 7.

CIRCUIT DESCRIPTION (fig. 9)

9. Rectifier circuits produce the output supply voltages of +250V and +350V, and the control voltage of -50V. The +250V and +350V out-

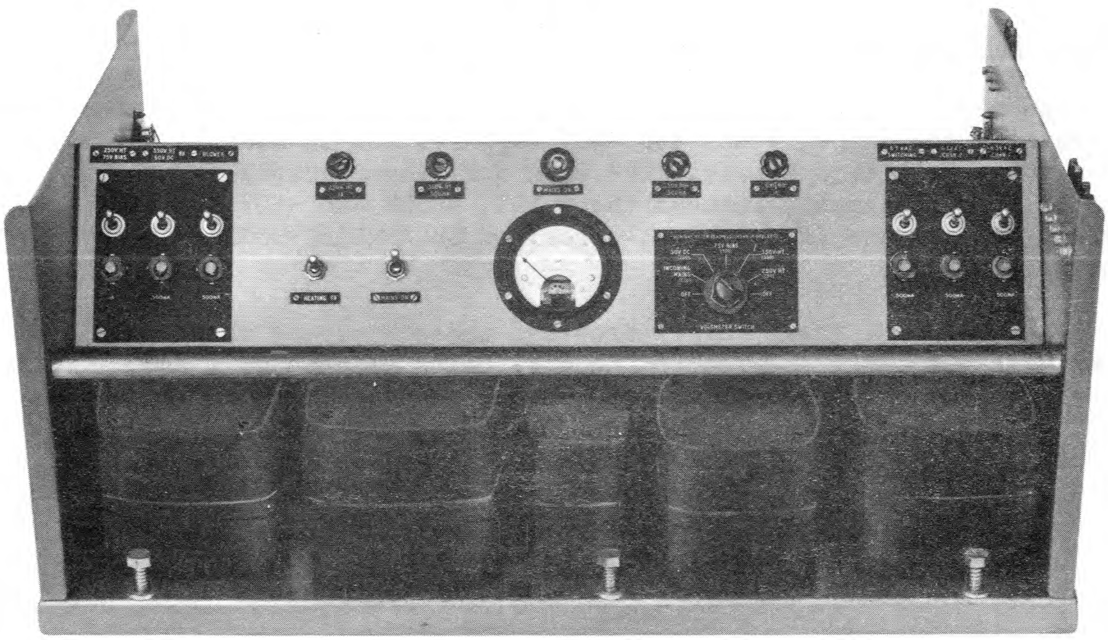


Fig. 1. Main d.f. power supply: front view

puts are switched by operation of relays to the units of channel 1, channel 2 and the common switching units. The -50V supply is fed out direct to the units shown in fig. 7. Metering facilities are incorporated for the measurement of a.c. and d.c. levels. General circuit protection is afforded by fuses and circuit breakers. The unit contains thermal switches which delay the connections of the power supply output voltages to other units for approximately 30 seconds after the power supply has been switched on.

10. This unit provides the following output voltages:-

(1) 350V, 60 mA (channel 1).

(2) 350V, 60 mA (channel 2).

(3) 350V, 120 mA (switching).

(4) 250V, 260 mA (channel 1).

(5) 250V, 260 mA (channel 2).

(6) 250V, 45 mA (switching).

(7) -50V, 250 mA

(8) 6.4V a.c. 14A (channel 1).

(9) 6.4V a.c. 14A (channel 2).

(10) 6.4V a.c. 14A (switching).

11. The circuit is shown in fig. 9. The a.c. mains supply is connected to the unit via PL1/1 and 2 and switched by the MAINS ON switch SW2. Presence of the mains energizes the MAINS ON lamp LP1. The live side of the mains input to the cabinet is also switched by the cabinet light switches SWC and SWD (fig. 6); the switches are operated by the cabinet door. With the switches closed (door open), the live side of the mains is applied to PL1/6, protected by a 1A fuse FS4, and then fed out via SKT2/20 to lamps LP4-9, which provide illumination of the cabinet. With the cabinet doors closed and the equipment in the standby condition, these lamps can be used for anti-condensation purposes by operating the HEATING switch SW3 on the mains d.f. power supply.

12. The power supply is operated by earthing the coils of relays RLA, RLB, or RLC. The coils of these relays are energized from a -50V control voltage applied to PL1/5. The earthing functions are connected via SKT2/22 (CH.1), SKT2/23 (CH.2) and SKT2/24 (CH.3 and 4). Channels 3 and 4 are two channels that are used solely for triangulation purposes and are operated from the remote site (the triangulation centre). If channels 3 or 4 are not used, an earth return for the coil of RLC is provided by either RLA3 (channel 1) or RLB3 (channel 2).

13. When RLC is energized, the a.c. mains supply is switched by contacts RLC1 and RLC3-4 to the following circuits:

(1) A blower fan, supplied via SKT2/16 and 17, switched by SW6 and protected by 0.5A fuse FS7.

(2) Transformer TR3, which provides 6.4V a.c. to the switching busbars. The a.c. mains supply to TR3 is switched by SW7, which is protected by 0.5A fuse FS8.

(3) Transformer TR4, which provides 6.4V a.c. to channel 2 busbars. The a.c. mains supply to TR4 is switched by SW8 and relay contacts RLB1, and protected by 0.5A fuse FS9.

(4) Transformer TR5 which provides 6.4V a.c. to channel 1 busbars. The a.c. mains supply to TR5 is switched by SW9 and relay contact RLA1. The circuit is protected by 0.5A fuse FS10.

(5) The gate switch, via SKT2/15 and 18.

14. When the gate switch (fig. 6) is closed the a.c. mains supply is reconnected to the unit via SKT2/2 and 14, and two cabinet lamps LP2 and LP3) are energized. The live side of the mains is connected via relay contacts RLA2 and RLB2 to channel 1 bearing display amplifier and channel 2 bearing display amplifier via SKT2/1 and 13, respectively. Both sides of the a.c. mains supply from the gate switch are applied to transformers TR1 and TR2, from which the 250V, 350V and -50V outputs are obtained.

The 250V output

15. The output is controlled by SW4 which switches the a.c. mains voltage to the primary winding of TR1, taps 1 and 2. The circuit is protected by 1A fuse FS5. A connection from tap 1 is made to SKT2/6 for the -75V power supply. A secondary voltage of 310V is obtained across taps 3 and 5 of TR1. This voltage, protected by 1A fuse FS1, is applied to a full-wave bridge rectifier MR1. The negative side of output of the rectifier is earthed. Smoothing is provided by CH1, C1A-D and CH2, C2A-D. The 250V output of the circuit is switched by RLE2, RLF2 and RLD2 to SKT2/12 (250V h.t. channel 2), SKT2/11 (250V h.t. switching) and SKT2/10 (250V h.t. channel 1).

The 350V and -50V outputs

16. Both outputs are controlled by SW4, which switches the a.c. mains voltage to taps 1 and 2 on the primary winding of TR2. The circuit is protected by 1A fuse FS6. For the 350V output, a secondary voltage of 414V is obtained across taps 3 and 5 of TR2. This voltage, protected by a 500 mA fuse FS2, is applied to a full-wave bridge rectifier MR2. The negative side of the output of the rectifier is earthed. Smoothing is provided by CH3, C3A-B and CH4, C4A-B. The 350V output of the circuit is switched by RLE3, RLF3 and RLD3 to SKT2/9 (350V h.t. channel 2), SKT2/8 (350V h.t. switching) and SKT2/7 (350V h.t. channel 1).

17. For the -50V output, a secondary voltage of 70V is obtained across taps 6 and 7 of TR2. This voltage, protected by a 500 mA fuse FS3, is applied to a full-wave bridge rectifier MR3. The positive side of the output of the rectifier is earthed. Smoothing is provided by CH5 and C5. The output of -50V is connected to SKT2/5.

Switching of h.t. and heater voltages

18. Switching of the h.t. and heater supplies to external units is effected by the same relays (RLA, RLB, RLC) that switch the mains supply circuits. Relay RLA controls the h.t. and heater supplies for channel 1 units, relay RLB controls the h.t. and heater supplies for channel 2 units, and relay RLC controls the h.t. and heater supplies for switching units. Each of the three relays is used in conjunction with a thermal delay switch for switching of the h.t. supplies. The function of these delay switches is to ensure that the +350V and 250V outputs cannot be applied to channel 1, channel 2 and switching units until approximately 30 seconds after the valve heater supplies are connected to the units.

19. Different switching is employed where the triangulation channels 3 and/or 4 are to be used without channels 1 or 2 in circuit. In this case, the h.t. and heater supplies are applied to the switching units only, and are controlled by independent operation of RLC via a control voltage connected to SKT2/24. If channels 3 and 4 are not required, the h.t. and heater supplies to the switching units will be connected automatically when either channel 1 or channel 2 is selected.

20. Although relay RLA controls the switching of channel 1 h.t. supplies of +250V and +350V, the actual switching is effected by relay RLD, the operation of which is delayed by the thermal delay switch X1. When RLA is energized, the 6.4V supply from busbar connectors 1 and 2 (TR5) is applied to the heater circuit of X1 via closed contact RLD2 of the de-energized relay RLD; also, the -50V control voltage is applied via contact RLA4 to the open switch contacts of X1. Approximately 30 seconds (the thermal delay time of X1), after the 6.4V busbar voltage is applied to X1, the switch contacts of X1 close and the control voltage operates RLD. Operation of RLD disconnects the heater circuit of X1, by opening RLD2, but at the same time provides a self-locking function by means of RLD1.

21. Although relay RLB controls the switching of channel 2 h.t. supplies of +250V and +350V, the actual switching is effected by relay RLE, the operation of which is delayed by the thermal delay switch X2. When RLB is energized, 6.4V from busbar connectors 3 and 4 (TR4) is applied to the heater circuit of X2 via closed contact RLE2 of the de-energized relay RLE; also, the -50V control voltage is applied via contact RLB4 to the open switch contacts X2. Approximately 30 seconds (the thermal delay time of X2) after the 6.4V busbar voltage is applied to X2, the switch contacts of X2 close and the control voltage operates RLE. Operation of RLE disconnects the heater circuit of X2, by opening RLE2, but at the same time provides a self-locking function by means of RLE1.

22. The method of connection of +250V and +350V h.t. supplies to the external switching units is similar to that used for channel 1 and channel 2 units, the difference being that the -50V control voltage is applied direct to the thermal delay switch X3. When RLC is energized, 6.4V from busbar connectors 5 and 6 (TR3) is applied to the heater circuit of X3. The -50V control voltage is applied direct from PL1/5 to the open switch contacts of X3. Approximately 30 seconds (the thermal delay time of X3) after the 6.4V busbar voltage is applied to X3, the switch contacts of X3 close and the control voltage operates RLF. Operation of RLF disconnects the heater circuit of X3, by opening RLF2, but at the same time provides a self-locking function by means of RLF1.

Monitoring facilities

23. The following voltages can be monitored on the front panel meter, M1.

(1) +250V d.c.

(2) +350V d.c.

(3) -75V d.c. (routed into the unit via SKT2/4 from power supply, -75V).

(4) -50V d.c.

(5) 230V a.c. mains supply.

SERVICING

24. The following test equipment is required to enable full servicing of the main d.f. power supply:

Note...

Where component-reference number numbers are given they refer to the connection of test apparatus shown in fig. 2.

(1) Load resistors:

(a) R1 200 ohms ± 5% 12.5W

(b) R2 5.8 k ohms ± 5% 21W

(c) R3 2.92 k ohms ± 5% 42W

(d) R4 5.8 k ohms ± 5% 21W

(e) R5 1.0 k ohms ± 5% 62.5W

(f) R6 3.85 k ohms ± 5% 16.3W

(g) R7 1.0 k ohms ± 5% 62.5W

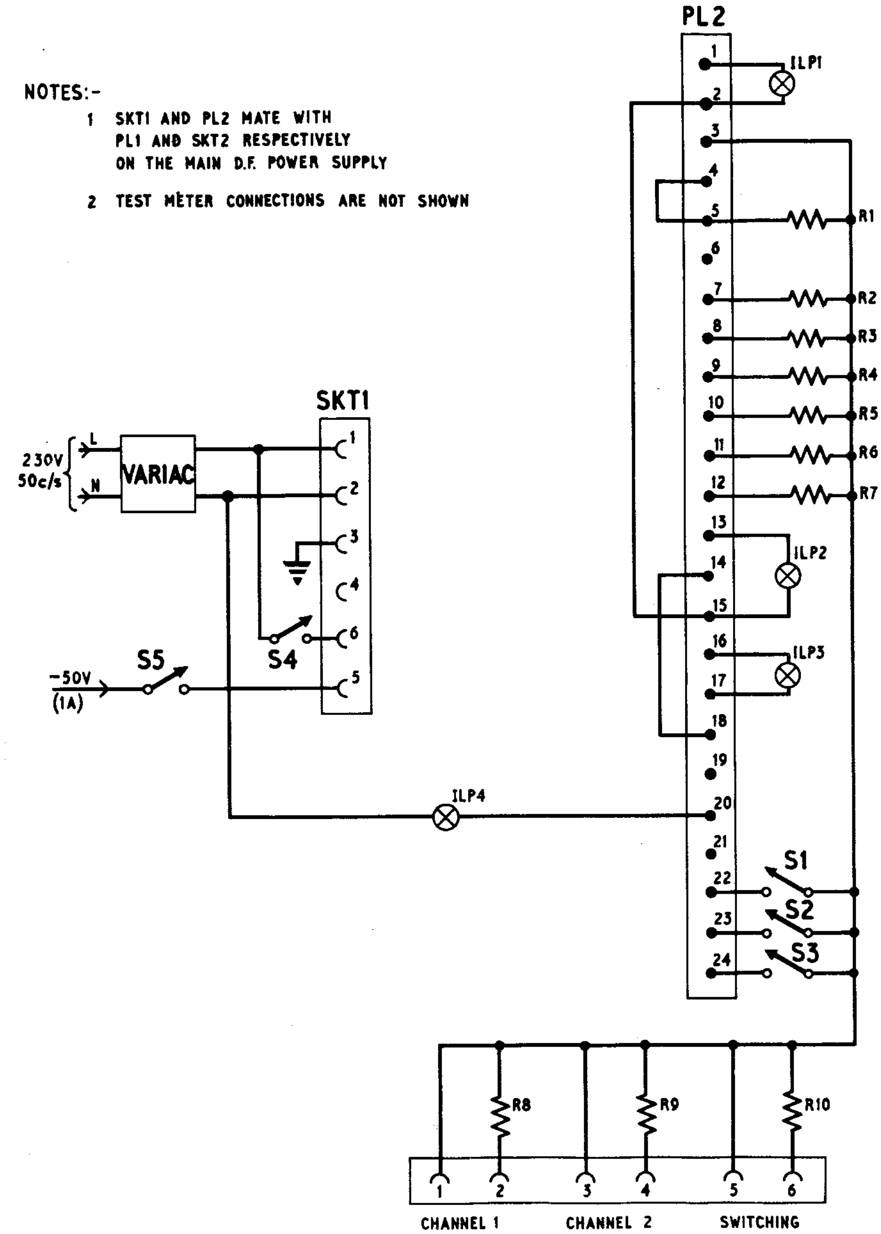


Fig. 2 Main d.f. power supply, test jig connections

(h) R8 0.457 ohms* ± 5% 90W

(i) R9 0.457 ohms* ± 5% 90W

(j) R10 0.457 ohms* ± 5% 90W

*Including resistance of leads.

(2) Indicator lamps:

(a) LP1 230V 15W (approximately)

(b) LP2 230V 15W (approximately)

(c) LP3 230V 15W (approximately)

(d) LP4 230V 15W (approximately)

(3) B.S. grade 1 voltmeter, f.s.d. 400V d.c., 100V d.c., 10V a.c.

(4) B.S. grade 1 voltmeter, f.s.d. 400V a.c., 10V a.c. (moving coil preferred) and connected with a spring return switch as shown in fig. 5.

(5) Variac.

(6) (a) sockets Type LP183094)
(b) clips Type LP18724) six off
(c) connectors Type LP776707)

(7) Megger 500V d.c.

(8) Power supply, -50V d.c., current output 1A.

(9) Five single pole switches.

(10) Stop watch (for measurement of time intervals between 20 and 40 seconds).

(11) 24 way plug (to mate with SKT2).

(12) 6 way socket (to mate with PL1).

TESTS FOR SERVICEABILITY

25. Preliminary serviceability checks should be made by first checking the voltage at specified metering points or the currents at fuse holders when the units are operating normally in position in the cabinet. For interconnection of the mains supplies and output voltages of the power supplies, reference should be made to figs. 6 and 7.

TEST PROCEDURE

26. The test procedure is as follows:-

(1) Ensure that the correct lamp and fuses are in the unit.

(2) Set switch SW2 (the MAINS ON switch) and switches SW4-9 to the 'on' position.

(3) Disconnect the earth connection (pin 3) on PL1 and SKT2.

(4) With the megger, measure the insulation resistance between earth and every pin on PL1 and SKT2. Limits: not less than 40 megohms.

(5) Reconnect the earth connection (pin 3) on PL1 and SKT2.

(6) Connect the items of test apparatus and the test voltage supplies to the unit as shown in fig. 4.

Note...

Fig. 2 does not show the connections for the voltmeter.

(7) Connect the voltmeter across each of the load resistors in turn. The f.s.d. of the voltmeter for each load resistor should be as follows:

(a) R2 to R7 400V d.c.

(b) R1 100V d.c.

(c) R8 to R10 10V a.c.

Note...

These load resistors must not be removed until all tests have been completed.

(8) Connect the test jig (fig. 2) to the main d.f. power supply and set SW2 on the main d.f. power supply to the 'on' position and ensure that LP1, the MAINS ON neon, becomes energized.

(9) On the test jig, close test switches SW1 and SW5 and ensure that relays RLA and RLC, on the main d.f. power supply, operate. Start the stop watch and ensure that between 20 and 40 seconds after the relays operated, relays RLD and RLF operate.

(10) After RLD and RLF have operated ensure that:

(a) operation of RLA and RLC causes transformers TR1 and TR2 to become energized.

(b) transformers TR3 and TR5 become energized as indicated by voltages appearing between busbar connectors 5 and 6, 1 and 2 (fig. 9), respectively.

(c) h.t. voltages (with respect to earth) are applied to SKT2/7, 8, 10 and 11.

(d) -50V d.c. is applied to SKT2/5.

(e) test jig indicator lamps LP1 and LP3 are energized.

(11) With the specified 400V a.c. B.S. grade 1 voltmeter connected across PL1/1 and 2, ensure that the input mains voltage is 230V ± 1% (adjust the variac if necessary), then make the following voltage measurements, ensuring that the results of the measurements are within the specified limits:

Measurement point	Limits
Across SKT2/5 and 3	48V to 55V d.c.
Across SKT2/7 and 3	340V to 355V d.c.
Across SKT2/8 and 3	340V to 355V d.c.
Across SKT2/10 and 3	240V to 255V d.c.
Across SKT2/11 and 3	240V to 255V d.c.
Across busbar connectors 1 and 2	6.20V to 6.45V a.c.
Across busbar connectors 5 and 6	6.20V to 6.45V a.c.

(12) On the test jig, open SW1 and ensure that:

(a) relays RLA and RLD become de-energized.

(b) the voltages across busbar connectors 1 and 2 and the voltages (with respect to earth) at SKT2/7 and 10 are disconnected.

(c) test jig indicator lamp LP1 becomes de-energized.

(13) On the test jig, close SW2 and ensure that relay RLB operates. When RLB operates, start the stop watch and ensure that relay RLE operates within 20 to 40 seconds.

(14) After RLE has operated, ensure that:

(a) transformer TR4 becomes energized as indicated by voltages appearing between busbar connectors 3 and 4 (fig. 9).

(b) h.t. voltages (with respect to earth) are applied to SKT2/9 and 12.

(c) test jig indicator lamp LP2 becomes energized.

(continued on next page.........)

Voltages and currents

29. Voltages and currents of the unit are given in the following tables. Where rectified outputs are stated, the voltage figures appertain in conditions in which the power supply is correctly loaded and, where applicable, switched. Voltage readings are to be taken with a B.S. grade 1 voltmeter.

30. The front panel meter readings of the main d.f. power supply are given in Table 2.

TABLE 2

◀ Main d.f. power supply: front panel meter readings

Meter switch positions	Meter reading	Concessed figures for single channel stations
Incoming mains	227-235	227-235
50V d.c.	190-215	190-235
75V bias	300-320	300-360
350V H.T.	340-360	340-380
250V H.T.	240-260	240-280 ▶

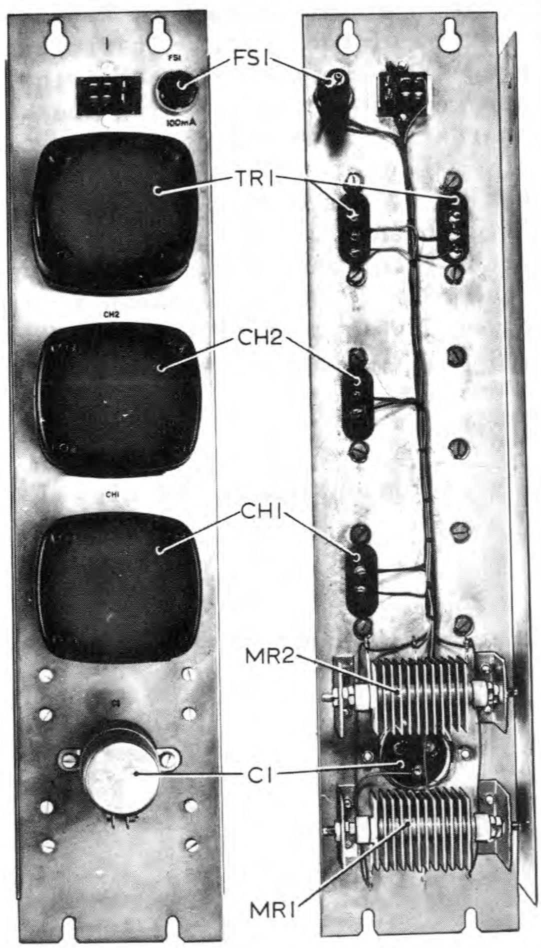


Fig. 3 Power supply -75V: front and rear views

75V POWER SUPPLY

GENERAL DESCRIPTION

31. The -75V power supply is used to provide a bias within both the fixed and transportable versions of CADF. It is situated as follows:-

(1) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845) - rack position EF.

(2) Single channel d.f. cabinet (5820-99-932-4862) - rack position EC.

(3) Two channel d.f. cabinet (5820-99-932-4861) - rack position EC.

(4) Aerial switching cabinet (5820-99-932-4858) - rack position EC.

(5) Power rack within the d.f. cabin of transportable equipments of the TGRI 26006 series - rack positions BA and BG.

32. The construction of the -75V power supply unit is based on a mild steel strip designed for vertical mounting on the front of the cabinet or rack. The vertical edges of the metal strip are bent at right angles to form a simple channel section, thus increasing the rigidity of the unit and according some protection of the components within the channel. The unit is secured to the equipment cabinet or rack by keyhole slots at the top, and plain slots at the bottom of the unit. This arrangement enables the unit to be readily detached from the rack for servicing, once the electrical connections have been removed, by slackening the star-head screws and then lifting the unit upwards and withdrawing it from the rack.

33. The interconnection of the output from the -75V supply is shown for the fixed equipment in fig. 6 and 7. The mains supply connections to the -75V power supplies, and the interconnection of the output voltages of the -75 power supplies for the TGRI 26006/1 are shown in fig. 8. The mains is supplied from the power supply control (5820-99-935-1101), which is described in AP 116C-0801-1M, Sect. 2, Chap. 4.

CIRCUIT DESCRIPTION

34. The power supply is conventional, the cir-

(continued on next page ....)

cuit is shown in fig. 10. The a.c. mains input (fig. 6) is applied via PL1/1 and 2 to taps 1 and 2 of TR1 primary winding. A secondary voltage of 105V, developed across taps 4 and 5, is connected to a full-wave bridge rectifier circuit containing MR1 and MR2. The positive side of the rectifier output is protected by FS1 (150 mA) and smoothed by CH1, C1A, CH2 and C1B. The negative output of the supply, rated at 75 mA, is connected across PL1/5 and 3 (earth). The output voltage can be monitored (fig. 7) on the main d.f. power supply.

Servicing

35. The following test equipment is required for full servicing of the −75V power supply:

(1) Load resistor 1 k ohms ± 5% 5·6W.

(2) B.S. grade 1 voltmeter f.s.d. 100V d.c.

(3) B.S. grade 1 voltmeter f.s.d. 400V a.c. 10V a.c. (moving coil preferred) and connected with a spring return switch as shown in fig. 5.

(4) Variac.

(5) Megger 500V d.c.

Tests for serviceability

36. Preliminary serviceability checks should be made by first checking the voltage at specified metering points or the currents at fuse holders when the units are operating normally in position within the cabinets. For interconnection of the main supplies and output voltage connections refer to figs. 6, 7 and 8.

Test procedure

37. The test procedure is as follows:

(1) Check that the correct fuses are in the unit.

(2) Disconnect the earth connection (pin 3) on PL1.

(3) With the megger, measure the insulation resistance between earth and each pin of PL1. Limits: not less than 40 M ohms.

(4) Reconnect the earth connection (pin 3) of PL1 and then make the following connections to the plug.

(a) Connect a 230V, 50 c/s mains supply, via the variac, across pins 1 and 2.

(b) Connect the specified 400V a.c. B.S. grade 1 voltmeter across pins 1 and 2.

(c) Connect the specified 1 k ohms ± 5% 5·6W load resistor across pins 3 and 5.

Note . . .
This load resistor must NOT be removed until all tests have been completed.

(5) Switch on the mains supply.

(6) Ensure that the input mains voltage is 230V ± 1% (adjust variac if necessary).

(7) Connect the specified 100V d.c. B.S. grade 1 voltmeter across PL1/3 and 5 and measure the voltage. Limits: 73V to 83V d.c.

(8) Switch off the mains supply and disconnect the 400V a.c. voltmeter. Reconnect it across PL1/3 and PL1/5, using terminals 1 and 3 as shown in fig. 5. Switch on the mains supply.

(9) If the indication of the meter is not more than 10V when a steady deflection is obtained, actuate the spring-return switch and check that the indication of the meter is less than 0·1V.

Fault diagnosis

38. Before using test apparatus ensure that the plug and socket connections are secure. Check the correct operation of the power supply with reference to the test procedure under servicing procedure. In the absence of any output from the unit check the mains input to the unit.

39. *Servicing data.* To assist in fault finding typical voltages for the unit are given in Table 3, the rectified output appertaining to a condition in which the power unit is correctly loaded, using a B.S. grade 1 voltmeter.

TABLE 3

Power supply, −75V: voltages and current

Circuit	Connection point	Voltage	Current
Mains input	Across PL1/1 and 2	230V a.c.	
TR1 (rectifier input)	Across taps 4 and 5	105V a.c.	
Rectified output	Across PL1/3 and 5	73V to 83V d.c.	
	FS1		75 mA

DIVIDER NETWORK

General description

40. The divider network is used to stabilize the supply voltages to the pulse generators and containing an R-C timing circuit to delay the application of the stabilized voltages. (Refer to Sect. 2, Chap. 2). The unit is used in both the fixed installations and the TGRI, the positions occupied being as follows:

(1) Single channel d.f. cabinet (5820-99-932-4862)—rack position DB.

(2) Two channel d.f. cabinet (5820-99-932-4861)—rack position DB.

(3) Aerial switching cabinet (5820-99-932-4858)—rack position DB.

(4) Switching rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—rack position CB.

41. The divider network is constructed upon a simple channel section of the same form as that employed for the −75V power supply unit.

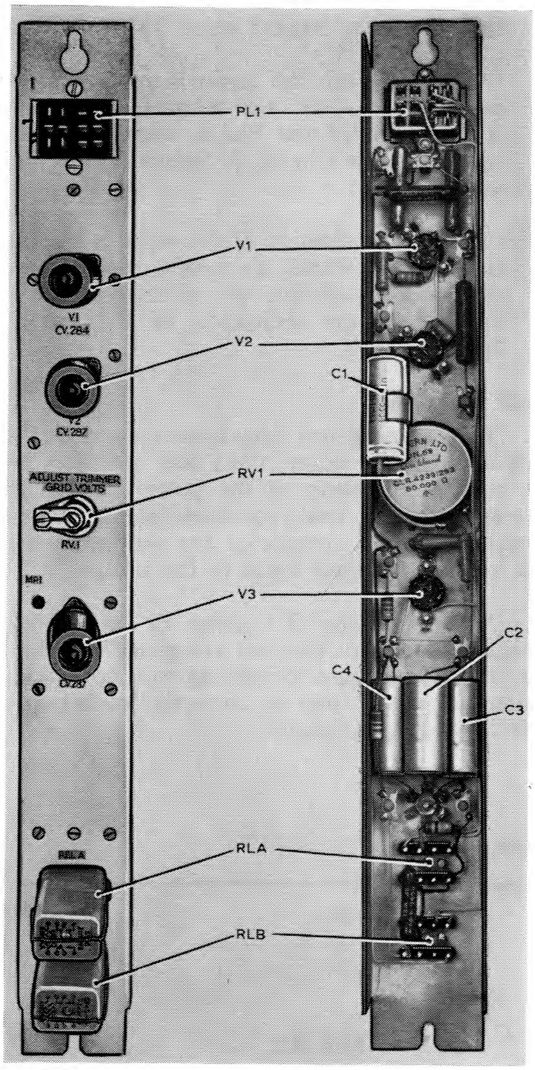


Fig. 4. Divider network: front and rear view

Circuit description

42. The circuit is shown in fig. 12. Resistor R9 is the common anode load for the cold-cathode pulse generator valves in the pulse generator unit (Chap. 2). When 350V is first applied to the divider network, via PL1/6 and 3, current flows through R9 and R14 via relay contact RLB1. The resultant voltage drop across R9 maintains the anodes of the pulse generators, connected via PL1/9, at a potential low enough to stop their operation. The applied 350V h.t. voltage starts to charge the parallel combination of C2, C3 and C4 through R10. A cold-cathode valve V3, and a relay RLA, are connected in series across the three capacitors, and between 4 and 10 seconds after application of the h.t., V3 conducts and energizes RLA.

43. When RLA operates it performs two functions:

(1) Contact RLA1 switches the 350V input via R6 to PL1/8 and thence to the transfer grid of V1 in the pulse generator units.

(2) Contact RLA2 completes the earth return for relay RLB, which is then energized via R11 from the 350V line.

44. When RLB operates, it performs two functions:

(1) The changeover contact RLB1 breaks the earth return connection of R14, so that the potential at PL1/9 rises and the common anode supply becomes available in the cold-cathode valves in the pulse generator unit. V1, in the first ring counter of the pulse generator unit, fires first because it already has the voltage via PL1/8 applied to its transfer grid. When contact RLB1 completes its changeover it performs a self-locking function by completing a further circuit for RLB coil through R12.

(2) Contact RLB2 completes the earth return for R13. This stops conduction of V3, RLA becomes de-energized and contact RLA1 disconnects the h.t. supply from the transfer grid.

45. The stabilized potential at the junction of V1 and V2 is fed, via PL1/5, to the shield grids in the pulse generator units. The potential of the slider of RV1 (normally adjusted to approximately 140V) is fed, via PL1/7, to the transfer grids of V2, V3, V4, V5 and V6 in the pulse generator units. Both supplies become available as soon as the 350V is applied to the unit.

Servicing

46. The test equipment required for full servicing of the divider network is as follows:

(1) Regulated power unit, Solartron Type SRS 151A.

(2) Multimeter Type 9980 or Type 12889.

(669) Dd. 840394 500 7/70 T.T.P. Ltd. 483/9

(3) Stop watch (for measurement of time intervals between 1 and 20 seconds).

(4) Oscilloscope, Tetronix Type 515.

(5) Test lead and socket suitable for connecting items (1), (2) and (4) to the divider network.

(6) Sub-standard microammeter (300μA f.s.d. internal resistance less than 2·5 k ohms, but with an external series resistor connected so that the total resistance is 2·5 k ohms $\pm$ 10%).

(7) 120 pF $\pm$ 20% capacitor with a lead suitable for connection between PL1/9 and the sync. socket of the oscilloscope.

Test procedure

47. The test procedure is as follows:

(1) Ensure that the correct valves are in the unit.

(2) From the specified regulated power unit, apply 350V across PL1/6 and 3 (earth).

(3) Connect the specified multimeter from PL1/5 to earth (chassis).

(4) Connect the specified microammeter from MP1 to chassis.

(5) Ensure that the indication of the multimeter is between 145V and 160V.

(6) Reduce the voltage on PL1/6 to 300V and ensure that the indication of the multimeter does not change by more than 3V.

(7) Increase the voltage on PL1/6 to 350V, and connect the multimeter from PL1/7 to earth.

(8) Adjust RV1 to give an indication of 140V on the multimeter.

(9) Ensure that the indication of the microammeter is 140μA $\pm$ 3%.

(10) Reduce the voltage on PL1/6 to 300V and ensure that the indication of the multimeter is 140V $\pm$ 3V.

(11) Increase the voltage on PL1/6 to 350V; switch off the 350V supply.

(12) Connect the multimeter, switched to the 500V d.c. range, from PL1/9 to earth.

(13) On the oscilloscope, set the vertical amplifier to d.c. probe operation on the calibrated 10V/cm range.

(14) Connect the specified 120 pF capacitor from PL1/9 to the external sync. input of the oscilloscope.

(15) On the oscilloscope, set the sweep circuit controls for positive-going external sync. operation of a single stroke time-base of 2 ms/cm calibrated sweep speed.

(16) Ensure that with the operating conditions of the oscilloscope correctly adjusted, the spot on the screen of the oscilloscope is at the bottom left hand corner of the graticule of the oscilloscope.

(17) Switch on the 350V supply to PL1/6 and simultaneously start the stop watch and measure the time taken for an end section of a square-top pulse to appear on the left hand side of the screen of the oscilloscope; measure the peak value of the pulse. Limits: time interval to be between 4 and 10 seconds; pulse amplitude to be at least 300V peak-to-peak.

(18) Switch off the 350V supply; after a slight pause, switch on again and ensure that the indication of the multimeter is less than 230V before the square-top pulse appears on the screen of the oscilloscope.

(19) Allow the indication of the multimeter to attain a value of 350V.

(20) On the regulated power unit, set the h.t. range switch to the 200/250 position.

Note . . .

The setting of the regulated power unit gives approximately 100V at PL1/6 if the positive output control is left on the 350V setting in the 250/500 volt range.

(21) On the regulated power unit, turn the positive output control counter-clockwise until the internal voltmeter indicates 50V.

Caution . . .

Ensure that at any time the voltage is not reduced to below 50V.

(22) After a slight pause, re-adjust the positive output control to give an indication on the internal voltmeter of 100V, then set the h.t. range switch to the 250/500 volt range.

(23) Ensure that after the end of the delay period — when the square-top pulse has appeared on the screen of the oscilloscope — the indication of the multimeter is equal to the indication of the internal voltmeter on the regulated power unit, and that both readings remain the same until the voltage is removed from PL1/6.

Fault diagnosis

48. To aid in fault finding typical voltages for the unit are given in Table 4, these being when connected to the pulse generator units.

TABLE 4

Divider network: voltages

Circuit	Connection point	Voltage d.c.
Voltage input	Across PL1/6 and earth	350V
Voltage outputs:		
common anodes	Across PL1/9 and earth	300V
transfer grid (V1)	Across PL1/8 and earth	160V
transfer grids	Across PL1/7 and earth	140V (approx.)
shield grids	Across PL1/5 and earth	150V

Valve complement

49. The commercial Type No. and CV No. of the cold-cathode valves used in the divider network are given in Table 5.

TABLE 5

Divider network: valve complement

Valve	Commercial Type	CV No.
V1	QS.70/20	284
V2	150/A2 QS.150/15	287
V3	150/A2 QS.150/15	287

Modifications

50. The following modifications are applicable to the power supply 6120-99-932-4856:

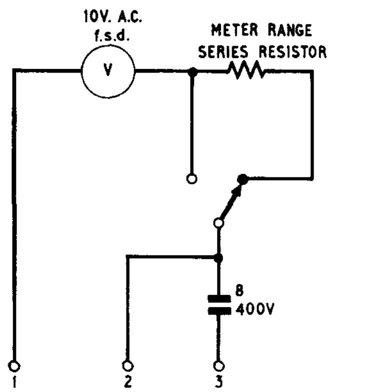
5768 ... To ensure correct wiring.

6888 ... Transfer of lead from socket SK2 to PL1. This modification is associated with mod. 6889 (prevention of electric shock).

◀**51.** Mod. No. A.2690 applies to Power Supply 6120-99-932-4856. This modification substitutes a switch and a delayed-action type fuse link when the circuit-breaker originally fitted becomes unserviceable (fig. 9). These circuit-breakers can no longer be purchased.▶

Caution . . .

The above modifications are noted in this chapter for guidance only and reference to A.P.2531P, Vol. 2, is mandatory when checking the modification state of CADF equipment.



NOTE:-
FOR f.s.d. OF 400V A.C. USE TERMINALS 1 AND 2
FOR f.s.d. OF 10V A.C. USE TERMINALS 1 AND 3

Fig. 5. Test meter circuit

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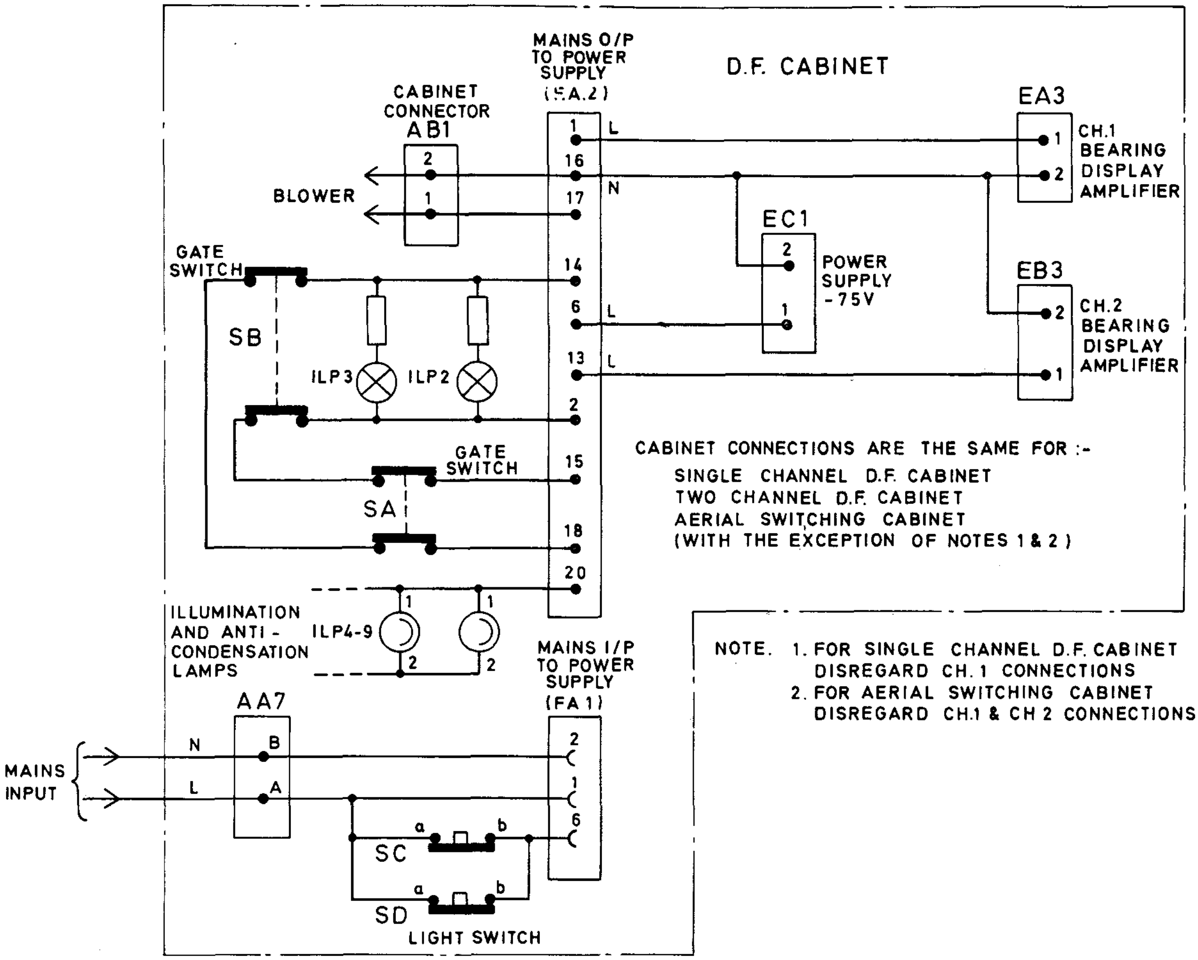

Fig. 6. FGRI series: mains supply connections for main d.f. power supply

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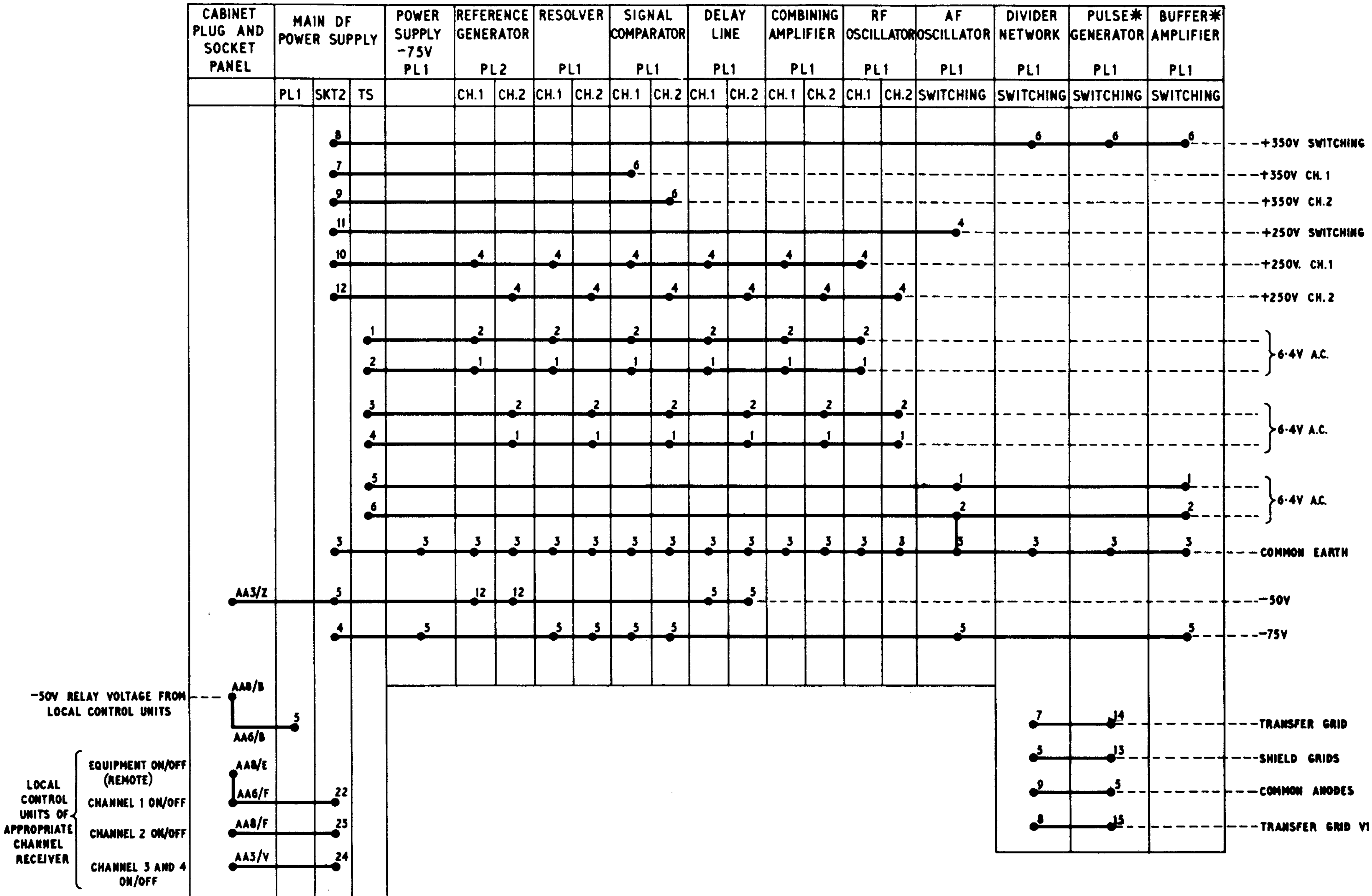
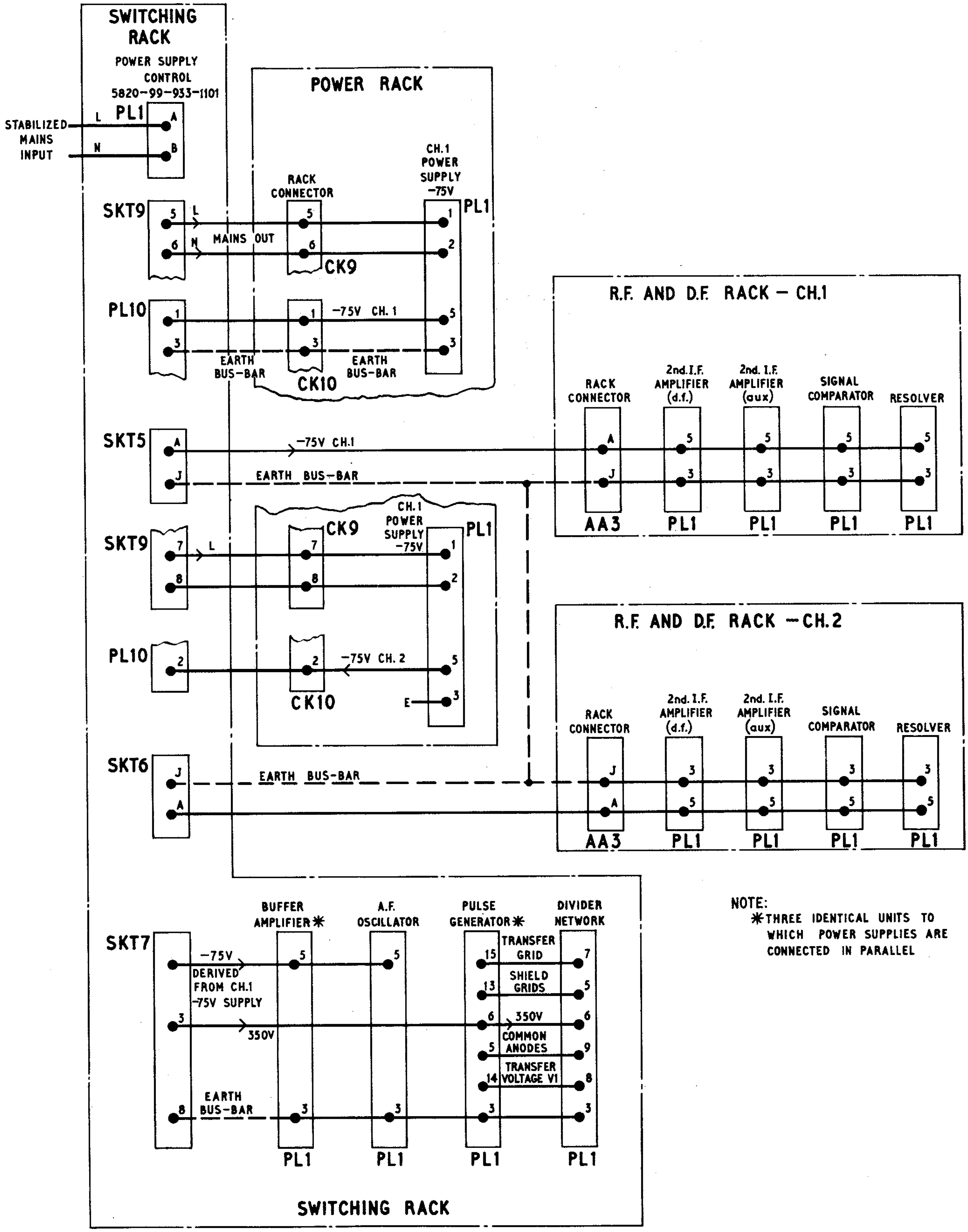


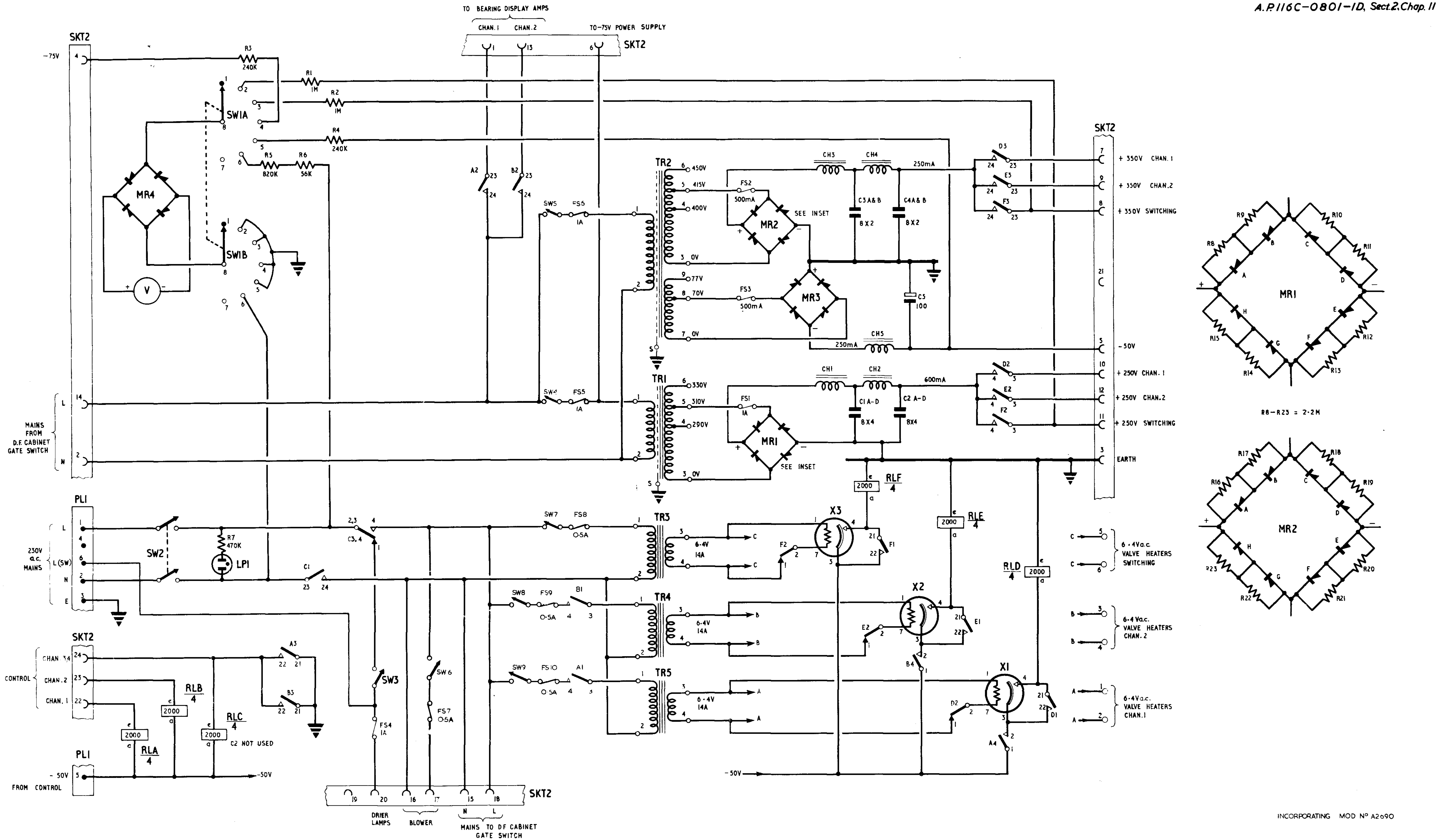
NOTES:-
✱ THREE IDENTICAL UNITS TO WHICH POWER SUPPLIES ARE CONNECTED IN PARALLEL.
THIS DIAGRAM SHOWS THE CONNECTIONS OF THE TWO CHANNEL DF CABINET.
FOR THE SINGLE CHANNEL DF CABINET; DISREGARD ALL CONNECTIONS UNDER CH.2 COLUMNS
FOR THE AERIAL SWITCHING CABINET; DISREGARD ALL CONNECTIONS UNDER CH.1 AND CH.2 COLUMNS

Fig. 7 FGRI. series; power supply: interconnections



TGRI. series equipment; mains supply connections and interconnections of power supply outputs

Fig. 8



INCORPORATING MOD Nº A2090

Fig. 9 Power supply 6120-99-932-4856 (main d.f. power supply): circuit Fig. 9

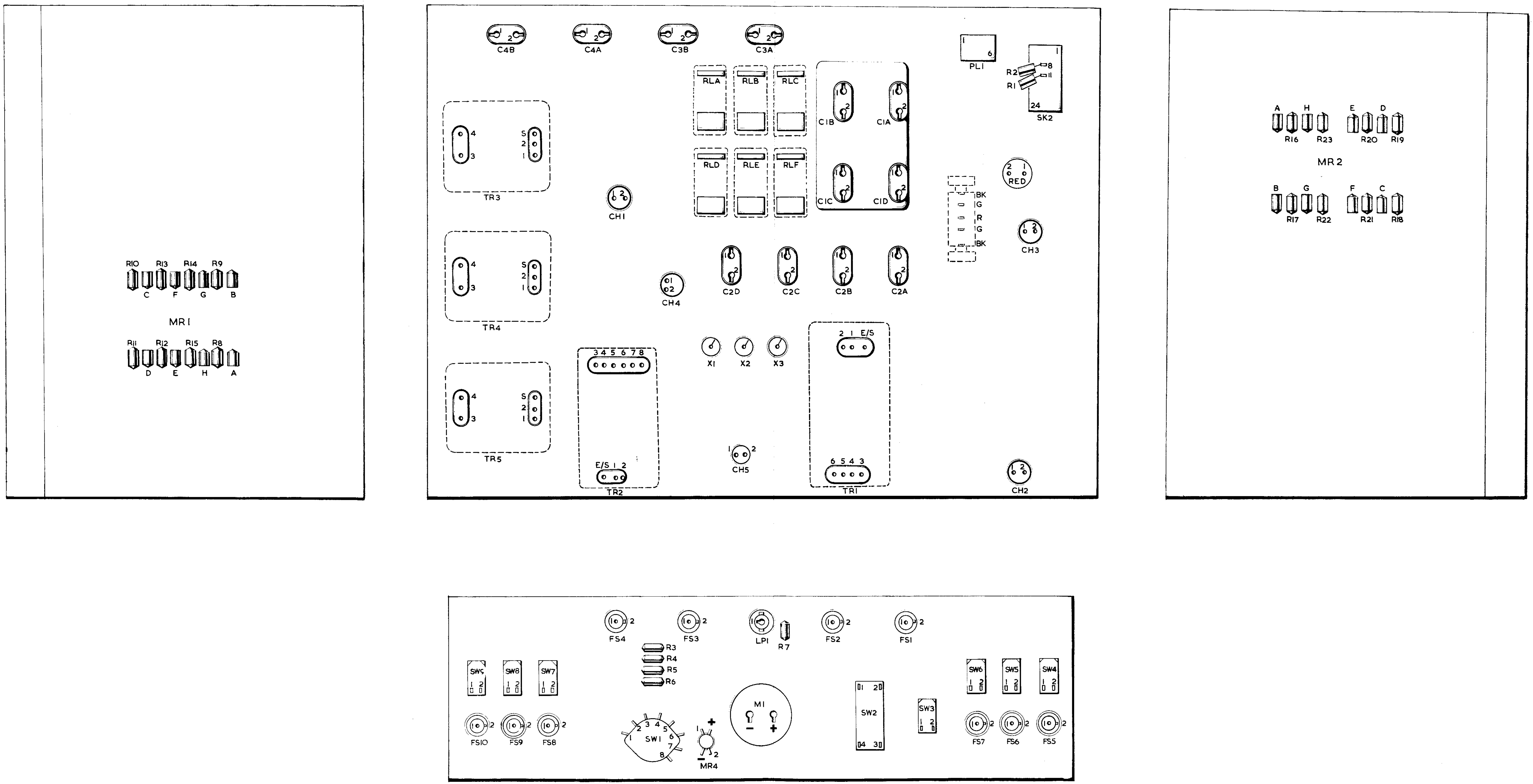
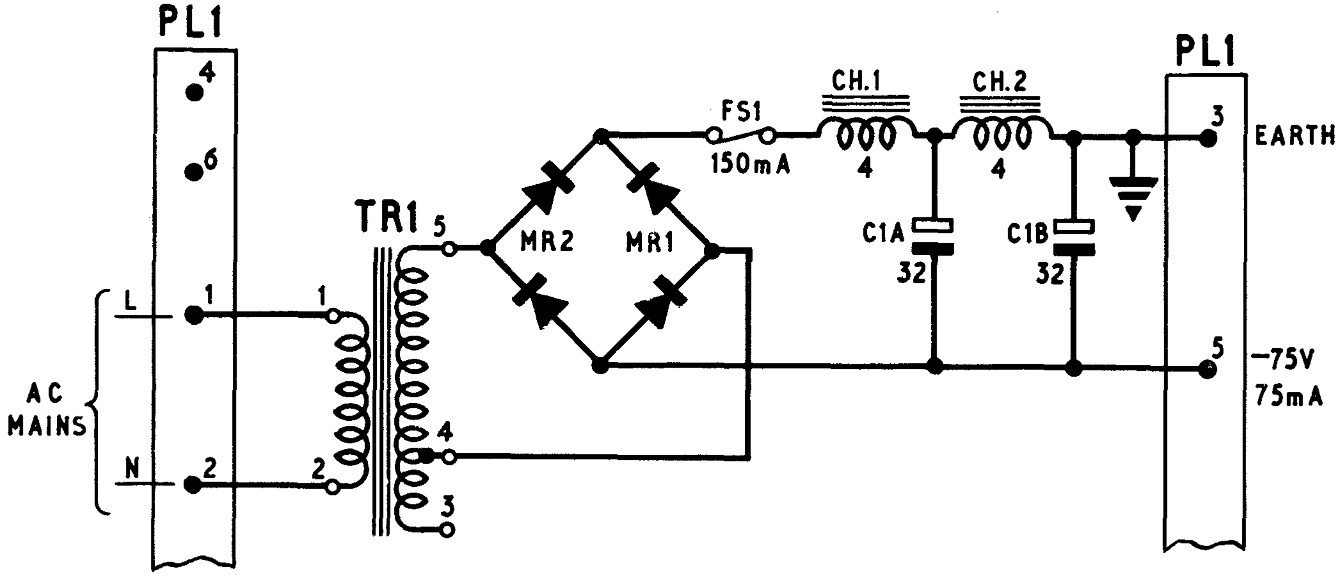


Fig. 10 Power supply 6120-89-932-4856 (main d.f. power supply) component layout Fig. 10



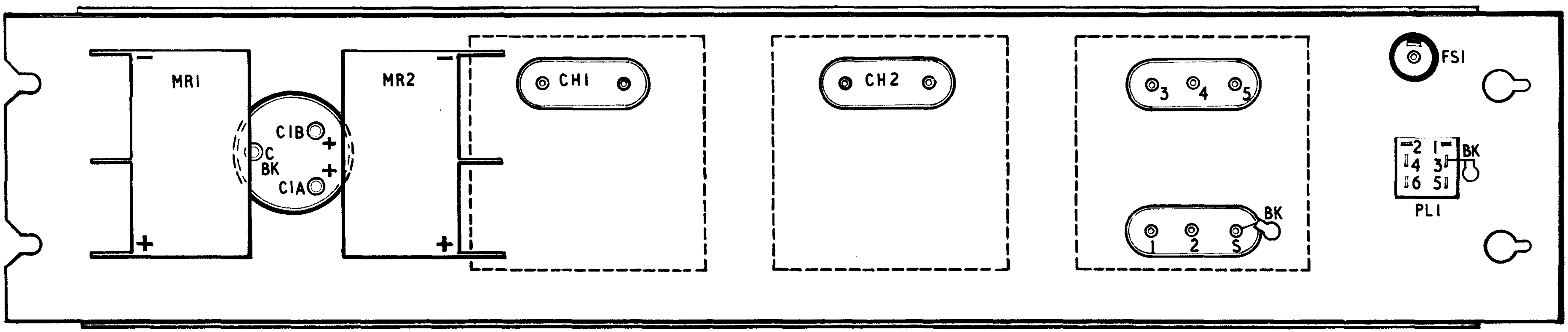
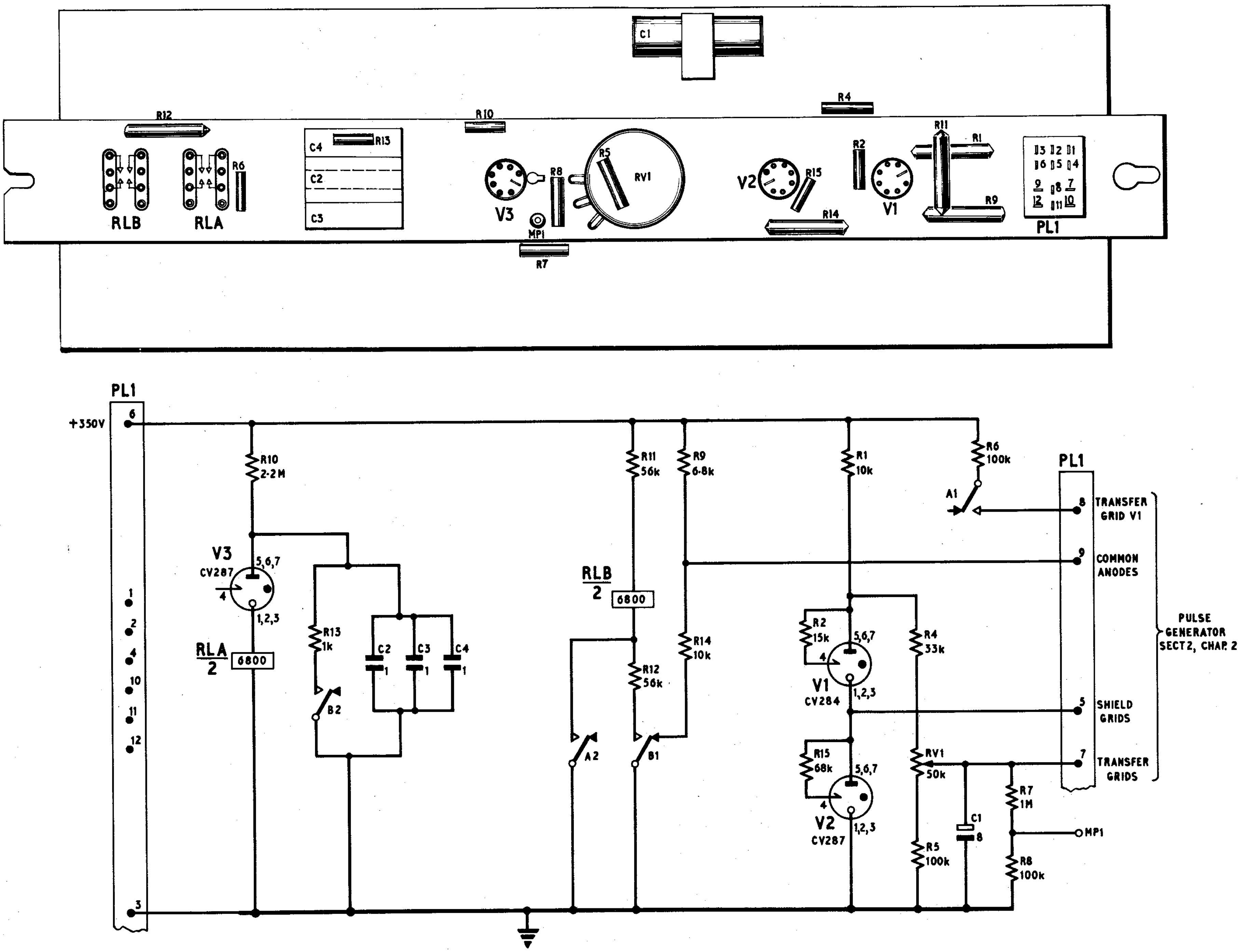


Fig.11. Power supply 6130-99-943-5903(-75): circuit and component layout Fig.11



Receiver sub-assembly 5820-99-933-1117 (divider network) circuit and component layout

Fig.12 Fig.12

Chapter 1

AERIALS

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LIST OF ILLUSTRATIONS

Introduction

1. The aerials and feeders in C.A.D.F. installations provide bearing information to d.f. equipment. This enables the direction of a transmitter operating in the range 225-399·9 Mc/s to be displayed relative to the d.f. site. A test aerial at each installation provides a known fixed bearing when selected for a rapid check.

2. The C.A.D.F. aerial system utilizes a group of fixed unipoles arranged in a circle, the d.f. receiver being connected to one aerial at a time and commutated around the ring of aerials. Eighteen unipole elements are centred on a counterpoise in the ground plane, which extends well beyond the radius of the ring of aerials, illustrated in fig. 1.

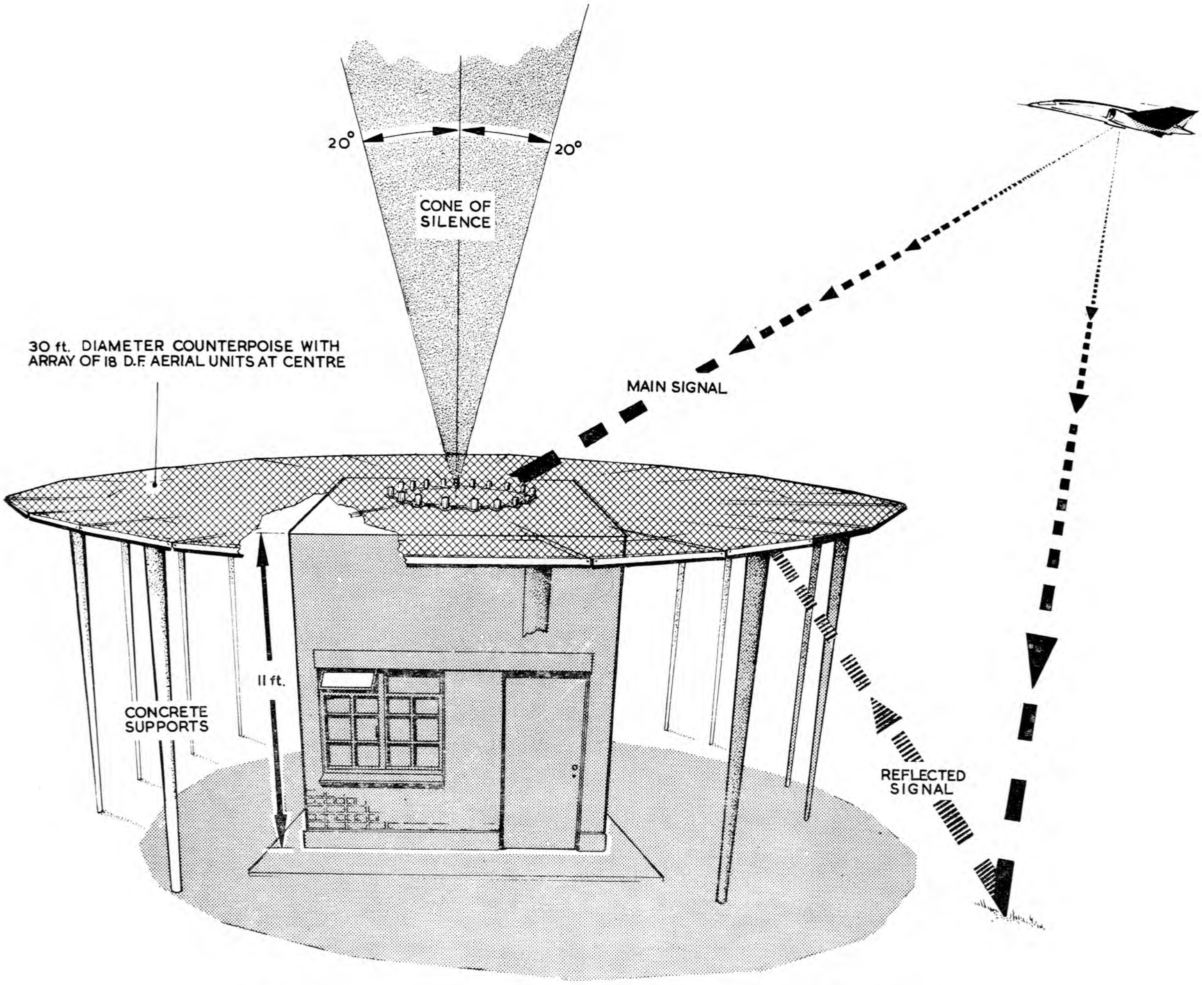

Fig. 1. General view of a typical fixed C.A.D.F. building.

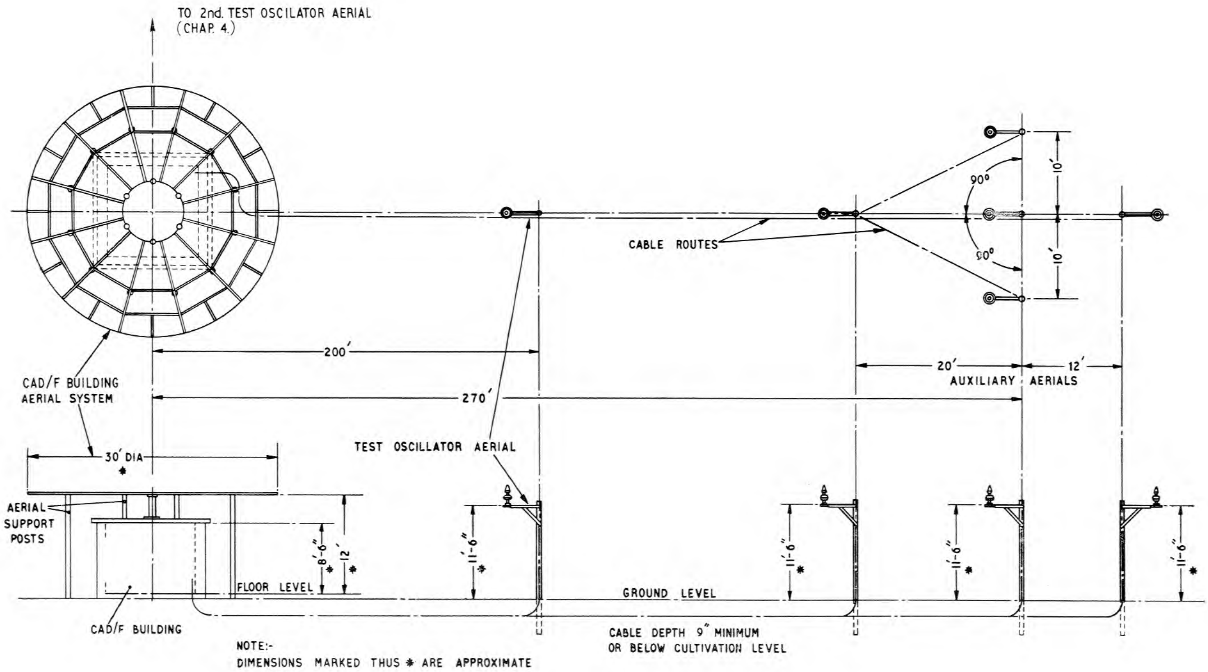

Fig. 2. General view of a typical site layout

3. UHF auxiliary aerials are utilised at CADF installations to feed auxiliary receivers. The output of an auxiliary receiver is mixed with the output from the CADF d.f. receiver so that unwanted phase modulations due to voice-modulated r.f. signals are cancelled. In this way d.f. phase information only, (resulting from the r.f. signal commutation by the main aerial array) is passed to the d.f. circuits. The auxiliary aerial(s) and the test oscillator aerial(s) are usually set 200 to 270 feet away from the CADF building.

AERIAL ASSEMBLIES: FIXED AND TRANSPORTABLE STATIONS

4. The aerial arrays in CADF are one of two types; those used at 'fixed stations' and a 'transportable station'. These are shown in Table 1 with manufacturers' name/code and the corresponding joint services references.

TABLE 1

CADF main aerial assemblies

Description	S.T.C. Code	Description	Ref.	Quantity
		FIXED STATIONS		
Aerial equipment comprising:				1
Counterpoise assembly		Counterpoise aerial		1
Unipole element	140-LRU-93B (modified)	Aerial	5985-99-194-3756	18
		Auxiliary aerial Test oscillator aerial	Type AJE.3	(see Table 2)
		TRANSPORTABLE STATION		
D.F. aerial unit transportable, comprising:-	140-LRU-13E	d.f. aerial unit	5895-99-933-1161	1
Counterpoise assembly				1
Aerial	140-LRU-24A	Aerial assembly	5895-99-993-1163	18
Aerial test	400-LRU-187A	Aerial element		1
Test oscillator aerial	140-LRU-81B	Aerial head Upper Mast		1 1

5. CADF installations are currently arranged in thirteen types to cater for various combinations of facilities. The aerial combinations are shown in Table 2.

TABLE 2

Aerial combinations for station types

Station Type		Auto Triang. Stations	Aerial Array (fixed)	D.F. Aerial Unit (Trans-portable)	Auxiliary Aerial	Test Oscillator Aerial
A	FGRI23078/1		1		2	1
B	/2		1		1	1
C	/3	X	1		3	2
D	/4	X	1		2	1
E	/9	X	1		2	2
F	/5	X	1		1	1
G	/10	X	1		4	2
J	/6		1		2	1
K	/7	X	1		3	2
L	/8		1		1	1
LL	/12		1		2	1
M	/11	X	1		4	2
Transportable	TGRI(AT) 26006/1			1		1

THE AERIAL ARRAY

6. Fig. 1 illustrates a typical fixed CADF station. The aerial array for a transportable station is similar in construction and operation.

7. The array consists of a ring of 18 fixed unipoles, each 6.5 inches high. The unipoles are equally spaced on a pitch circle diameter of 5 ft. 6in. and are fitted concentrically to a wire mesh counterpoise at approximately 11 ft. above ground level. The diameter and height are less in the transportable station.

8. The diameter of the ring of the unipoles at the highest received frequency (399.9 MHz) equals approximately 2λ. Thus with two aerials in line with the incoming signal, the r.f. phase displacement between the two aerials is 140°. This is the maximum displacement under any condition. At the lowest operational frequency, maximum displacement between any pair of aerials is 80°.

9. As the transmitting source subtends an angle from the horizontal (in the vertical plane), the r.f. displacement between any pair of unipoles becomes smaller until an angle of approximately 70° is reached, when the displacement becomes negligible. Therefore the zone in which there is negligible d.f. phase displacement, an indeterminate d.f. receiver output takes the form of an inverted cone (fig. 1 refers) above the d.f. array and is sometimes referred to as the "cone of silence".

THE COUNTERPOISE

10. The counterpoise is fitted to the roof of the d.f. building (approximately 11 ft.) directly below the 18 unipole aerial array and comprises a 30 ft diameter framework covered by wire mesh. The counterpoise is insulated from the main aerial array but used in conjunction with, or as well as, a direct connection to earth.

11. The purpose is therefore, to provide a pseudo earth screen directly below the unipoles. This prevents any distortion of the polar field of the main aerial array, due to mechanisms below it e.g. metal objects, power cables, building structure etc. If the field were distorted it would result in an incorrect d.f. bearing.

12. The d.f. principle of the antenna is of phase displacement, from a direct line of transmission (para 8 and 9). If indirect transmissions appeared at the aerial array, as illustrated in fig 1, this would result in false phase displacement and incorrect d.f. assessment. The counterpoise acts as a shield to this type of signal.

VARIATION IN COUNTERPOISE SIZE

13. In the transportable CADF the counterpoise is constructed of perforated aluminium sheeting and has a diameter of 16 ft 9 inches. The principle of operation is the same as for the fixed CADF counterpoise. The reduced diameter of counterpoise is due to the reduced size of the container (d.f. cabin) housing the mechanisms to be shielded from the aerial array.

14. The size of the counterpoise is therefore largely dependent upon the size of the building or container. Counterpoise of 45 ft are used when CADF is installed in a CRDF (v.h.f. d.f.) building.

THE UNIPOLE ◀ (5985-99-194-3756) ▶

15. Fig 3 illustrates sectioned and planned views of an individual element of the 18 unipole aerial array. The unipole consists of a vertical $\lambda/8$ wide band element (fig 4) with a top loading capacity disc for improvement of response at the lower end of the frequency band. The unipole assembly contains components to minimise re-radiation. There are two biased germanium diodes and an r.f. choke, the choke providing a path for the diode current. During the inoperative period of the unipole, the diodes are non-conductive, thus the unipole behaves as two ineffective sections, resulting in minimum re-radiation.

Note...

◀ Unipoles (aerial array 5825-99-943-6162) have failed due to cracked polythene. When this occurs, Mod 0909 is applied, introducing the redesigned aerial array 5985-99-194-3756. ▶

16. Two aerial feed cables (fig 5 refers) are taken from each unipole, for twin channel operation, one to each aerial switch box. The connectors employed are of identical lengths of uni-radio 67 coax cable. There is one diode in series with each feeder cable.

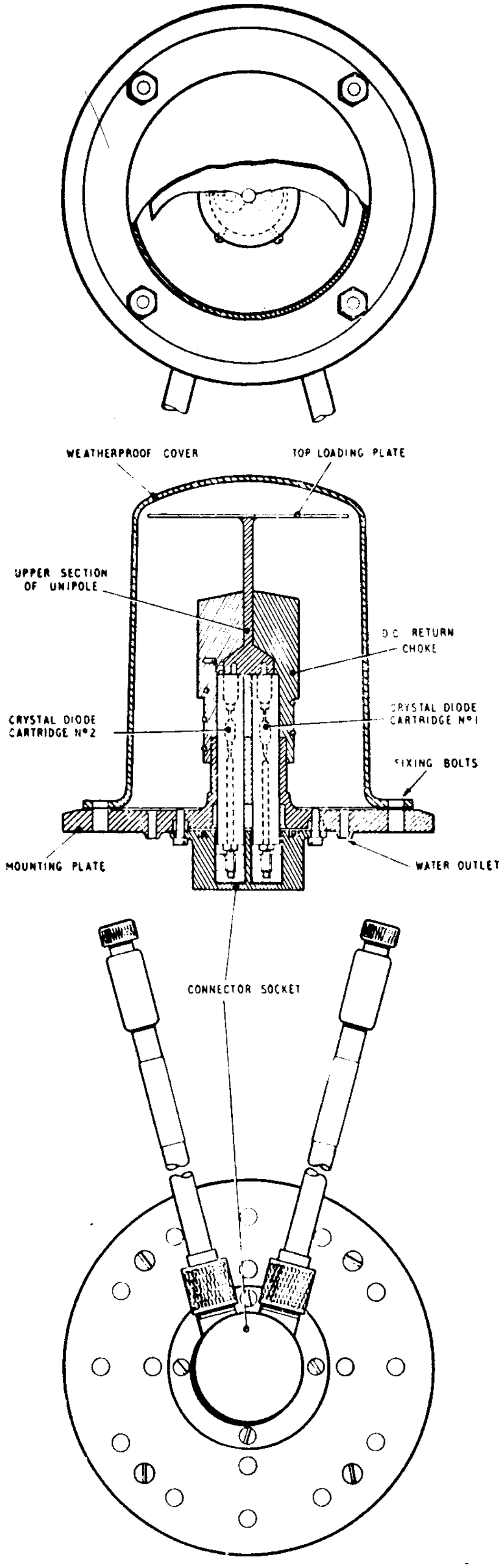

Fig 3. Aerial array unipole: section and plan views.

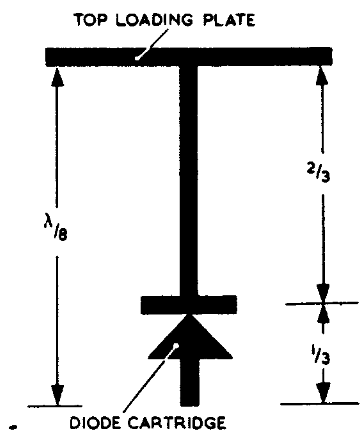

Fig. 4. Simplified unipole circuit.

17. The co-axial connectors are rounted into the CADF building and terminated at two aerial switchboxes, (5825-99-943-6164) for a dual channel station. For a single channel station, the eighteen unused connectors are terminated at a cable housing assembly 5975-99-932-4850. Fig. 6 illustrates these terminations. The aerial switch Box(es) or cable housing assembly are mounted on a board situated in the centre of the ceiling of the d.f. building.

OPERATION OF THE UNIPOLES

18. The two aerial switch boxes are so connected to the eighteen unipole elements and a pulsing network, that diametrically opposite aerials are 'on' at the same time, but feeding separate receivers. The aerial switch boxes contain germanium diodes and components associated with the gating system of the aerials.

19. Through this system each unipole is gated, in turn, by aerial switching the d.f. cabinet routed via the pulse distribution box 5825-99-943-5897. An 18-way cable is used to carry the switching pulses from the main CADF equipment.

20. Each gating circuit in the aerial switch box is opened by the pulse feed it receives and held closed for the remaining period by a fixed negative

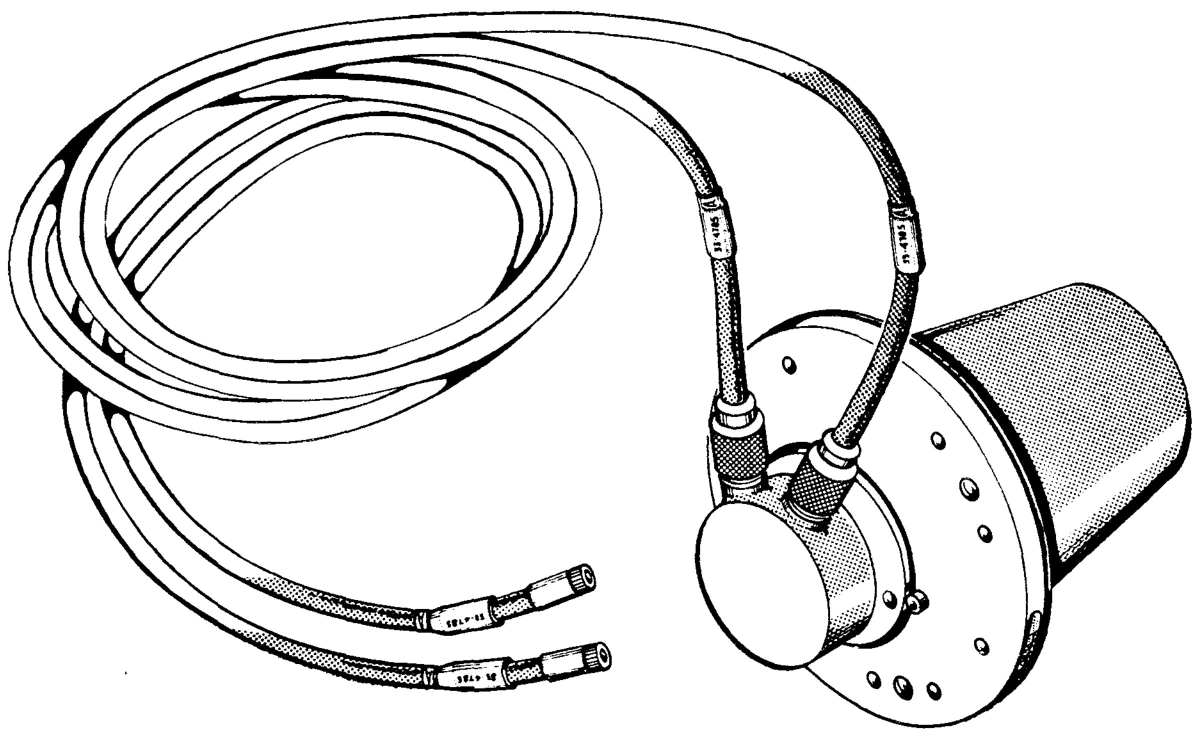

Fig. 5. Assembled unipole and aerial connectors

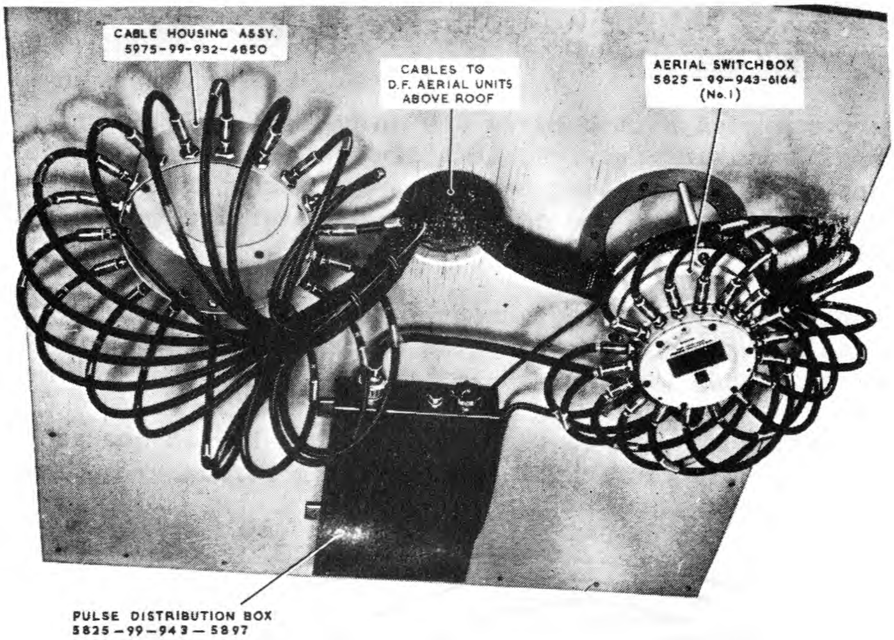

Fig. 6. Aerial array cabling terminations

(continued on next page..................)

tive bias introduced into the pulse feed line by the pulse distribution box. In the closed condition of the gate, the germanium diodes in the aerial element are non-conductive.

21. Upon receipt of a positive going pulse the negative bias is overcome in the aerial switch box gating circuit and germanium diode in the unipole element. The gate opens and permits the passage of the signal received at the unipole.

Servicing and replacement of unipole diodes (fig. 7)

22. The cartridge diodes fitted in the unipole are: 5825-99-943-5882. The diodes can be assessed for serviceability in situ in the aerial as follows:

(1) Disconnect the connectors of the suspect unipole at the aerial switch boxes 5825-99-943-6164.

(2) Connect the negative terminal of a C.T.498, to the centre conductor of the aerial connector and check that the resistance between the conductor and cable screen is approximately 10 to 20 ohms. If the resistance proves to be high, it indicates a faulty diode cartridge in that particular aerial.

23. To replace the diode cartridges:

(1) Remove the four 4BA bolts securing the cable junction box to the unipole. These are accessible from below the counterpoise.

(2) Free the cables from the plastic duct by removing the duct cover.

(3) Carefully remove the junction box from the unipole.

(4) Unscrew the faulty diode cartridge with a 6B.A. box spanner and fit new dioder.

(5) Refit taking care to avoid overtightening and re-test.

Auxiliary and test oscillator aerials

►◄

24. The test oscillator and auxiliary aerials in fixed C.A.D.F. stations are a standard type AJE.3 vertical bi-conical aerial. Normally they are set on the same radial line from the d.f. aerial array, preferably on a sub-cardinal bearing. Feeder cables to the test and auxiliary aerials are laid in a straight line from the d.f. building (fig. 2 refers).

25. In the T.G.R.1(AT) 26006/1 transportable installations the test oscillator aerial is a bi-conical antenna constructed in cage form, on an axial insulated rod. This is to reduce weight. The antenna is mounted on a light aluminium mast. Below the aerial element is mounted an aerial head (counterpoise) which is aligned to be just above the plane of the main d.f. building counterpoise. The aerial is sited on a sub-cardinal bearing 150 ft. from the d.f. cabin.

26. The auxiliary aerial (5895-99-933-1162) is an integral part of the main aerial assembly (5985-99-933-1161), mounted in the centre of the ring of 18 unipoles.

Aerial Type AJE.3 (fig. 8)

27. The aerial unit type AJE.3 is a wideband u.h.f. aerial suitable for operation over the frequency band 225 Mc/s to 400 Mc/s. The features of the aerial are:

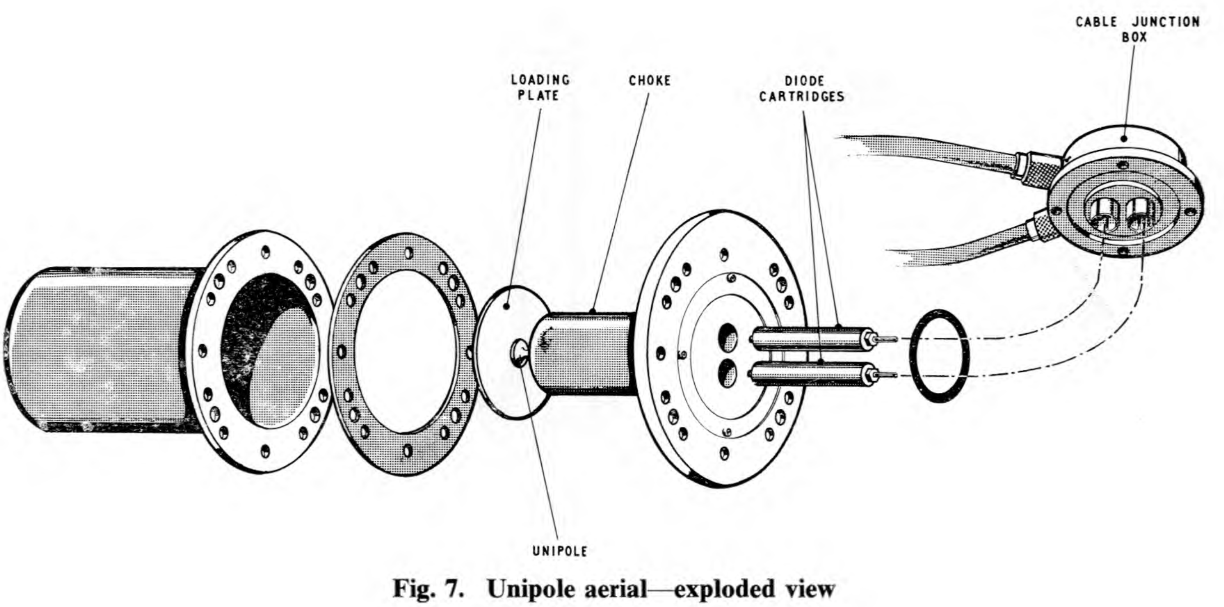

Fig. 7. Unipole aerial—exploded view

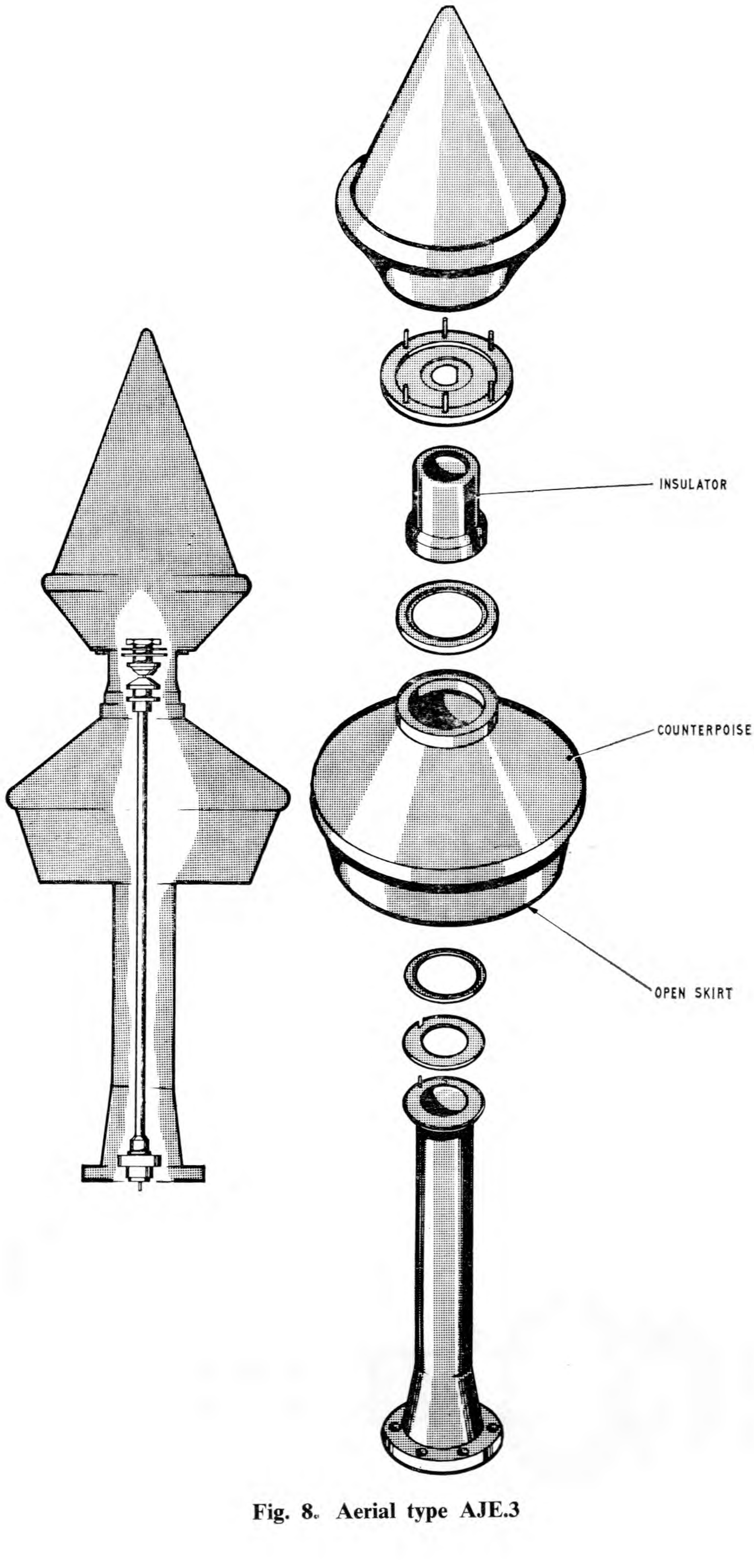

Fig. 8. Aerial type AJE.3

operation over a wide frequency band, omni directional radiation in the horizontal plane, good impedance match into a coaxial line without the need for any matching or Balun arrangement.

Note . . .

A Balun arrangement is a resonant line designed to work between a balanced system which is symmetrical to ground, and an unbalanced system in which one side only is grounded.

28. The aerial is a bi-conical monopole with a counterpoise skirt arrangement. The semi-perimeter length of the aerial is approximately one wavelength at the mid-band frequency. The semi-perimeter length includes the horizontal free length between the skirt and the adjacent point on the vertical axis. The underside of the skirt is open in order to reduce current on the outside of the feeder.

29. The aerial is mounted upright (as illustrated in fig. 8) to receive radio waves that are essentially vertically polarized. In C.A.D.F. fixed stations, the aerials are mounted on top of a pole 200 to 270 ft. away from the main d.f. building. In the mobile station the aerial is similarly mounted but 150 ft. away from the main equipment.

Coaxial feeders

30. The feeders from the aerial systems to the main d.f. equipment for a particular type of C.A.D.F. station are shown in the Tables of cabling in the individual station publication unit.

31. Coaxial cables run from the d.f. building (or cabin) to the test and auxiliary aerial masts are buried to a minimum depth of 9 in. but where cultivation of the surrounding land is possible a depth of 2 ft. 6 in. is usual and the cables are protected with clay cable tiles.

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Chapter 2

AERIAL SWITCHING UNITS

CONTENTS

ILLUSTRATIONS

INTRODUCTION

1. The general purpose of the aerial switching units is to provide, in conjunction with the aerial elements, the commutation of the d.f. signal. Pulses from the pulse generators, are used to operate gating circuits in the eighteen aerial circuits, thus providing a final d.f. signal comprising 1mS samples of the output of each aerial element.

2. The aerial switching units comprise the pulse distribution box and the aerial switchbox.

Circuit operation

3. Fig. 1 illustrates the simplified circuit of one aerial output. The pulse distribution box is supplied with -50 volt d.c. which is applied via R1 to the aerial switch box. The -50V will bias the diodes MRB and MRC such that they will not conduct, thus no signal output will be obtained from the aerial element. Diode MRA will conduct, shunting the junction of MRB and MRC to earth, thereby ensuring no spurious signals are passed to the receivers. Components C1 and R2 form a decoupling and buffer network for the pulse feed.

4. When a positive pulse is received from the appropriate buffer amplifier via R3 of the pulse distribution box, the negative potential at the junction of R1 and R3 is overcome, the diode MRA becomes non-conductive, and the diodes MRB and MRC conductive. A signal output from this aerial element is now obtained via MRB and MRC.

5. Each aerial element has two outputs, the two outputs being fed to separate aerial switchboxes. If one output is fed to the first input of the first aerial switchbox, then the other is fed to the tenth input of the second aerial switchbox. The complete circuit for one aerial element is given in fig. 5. When the installation is equipped with only one channel, the second aerial switchbox is omitted, and the diode cartridges of the unused halves of the aerial elements removed. A modification to the -50 volt supply within the pulse distribution box is also made, see para. 13.

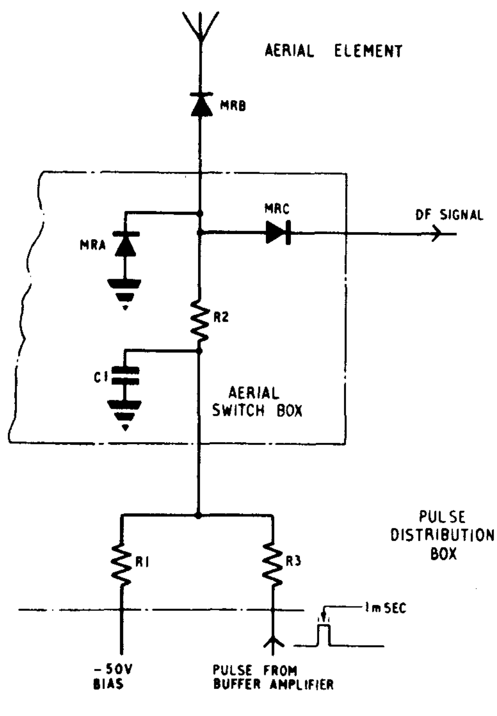


Fig. 1. Simplified aerial switching circuit

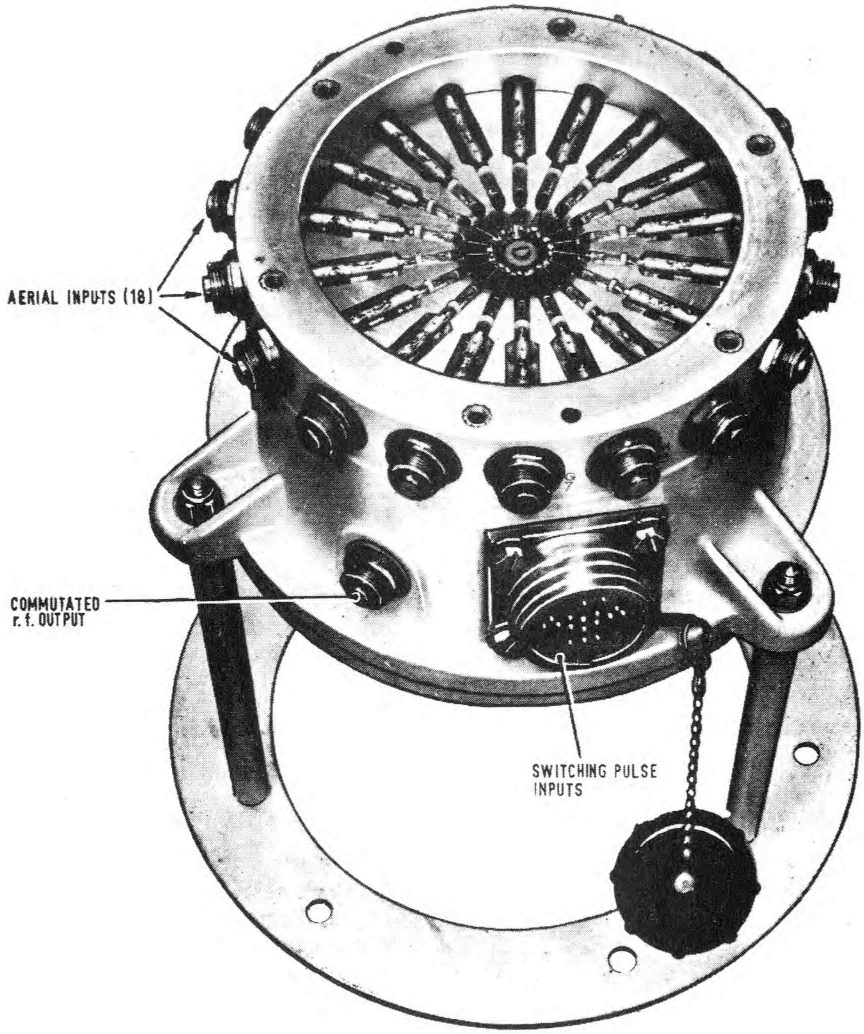


Fig. 2. Aerial switchbox: general view

6. When a positive pulse operates the No. 1 aerial element, via R1 and the aerial switchbox A, the operation of No. 10 aerial element is carried out simultaneously by the positive pulse via R41 and the aerial switchbox B. Thus the commutated outputs of the two aerial switchboxes will be 180° apart, i.e. diametrically opposite aerial elements will be operative simultaneously, one providing the r.f. signal via aerial switchbox A, the other via aerial switchbox B.

7. The outputs of each of the eighteen sections of the aerial switchbox are connected in parallel to provide one output.

8. The commutated d.f. output from the aerial switchbox may be fed to two receivers via an aerial splitter unit, thus from one aerial array a maximum of four separate outputs may be obtained using two aerial switchboxes and two aerial splitting units.

AERIAL SWITCHBOX 5825-99-943-6164

9. The aerial switchbox (gate, electronic assembly 5825-99-943-6164) is illustrated in fig. 2, the circuit and construction being given in figs. 6 and 7 respectively.

10. One diode cartridge of each aerial element is connected via identical lengths of Uniradio 67 coaxial cable to the aerial switchbox. In multi-channel installations two aerial switchboxes are fitted.

11. Gating pulses are supplied to the aerial switchbox via an eighteenway cable to PL20.

PULSE DISTRIBUTION BOX 5825-99-943-5897

12. The pulse distribution box (Interconnecting box 5825-99-943-5897) combines the positive pulse from the buffer amplifiers, for the pulse generators, with the 50 volt negative supply. This provides a continuous -50 volts to the aerial gates except during the period of the gating pulse. Resistors R21 to R38 and R41 to R58 form part of the cathode loads of the buffer amplifiers; the resistors R1 to R18 and R61 to R78 provide connections to the -50 volt supply. The combined outputs are fed to sockets SK1 and SK3 and thence to the appropriate circuit in the relevant aerial switch-box. The circuit and component layout of the pulse distribution box are given in figs. 8 and 9 respectively.

13. ◀ On some single channel installations the -50 volt supply (green strap) is removed from the unused set of resistors (R41 to R78). This is covered by Mod. No. 7572. On the single channel station type L, however, channel '2' with R41 to R78, is the one used. ▶

AERIAL SPLITTING UNIT 5840-99-999-1343

14. This unit (Switch electronic 5840-99-999-1343), illustrated in fig. 3, consists of an aluminium container which is fitted to the cover of the aerial switchbox. It is used to connect the commutated d.f. output of the aerial switchbox to the inputs of two separate d.f. receivers. This type of aerial splitting unit is fitted in F.G.R.I. 23078 stations having three or four channels. The circuit is given in fig. 10.▶◀

AERIAL SPLITTING UNIT 5825-99-933-1118

15. This unit (Interconnecting Box 5825-99-933-1118) is fitted in the T.G.R.I.26006/1 and is used to bifurcate the auxiliary aerial lead-in to feed the auxiliary receivers of the two channels. The circuit and construction are given in fig. 4.

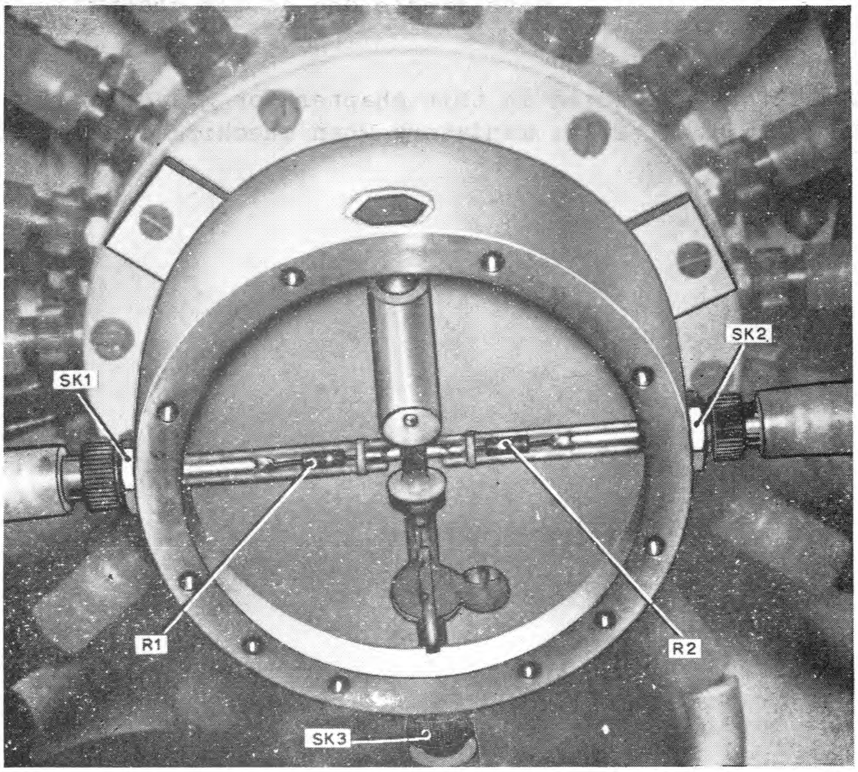
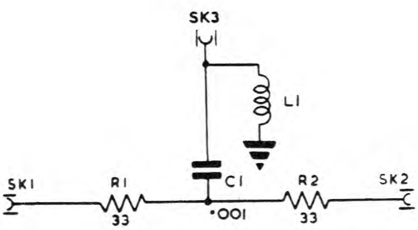


Fig. 3. Aerial splitting unit 5840-99-999-1343: general view

CABLE PROTECTOR 5975-99-932-4850

16. This unit secures the free ends of the eighteen unused coaxial aerial cables of the single channel stations. It is mounted in the position normally occupied by the second aerial switchbox. It consists of a metal ring carrying eighteen Paton sockets.



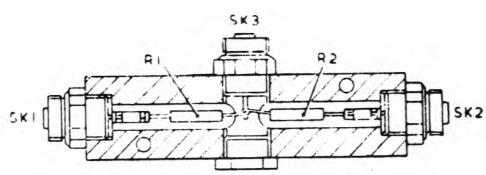


Fig. 4. Aerial splitting unit 5825-99-933-1118: circuit and construction

MODIFICATIONS

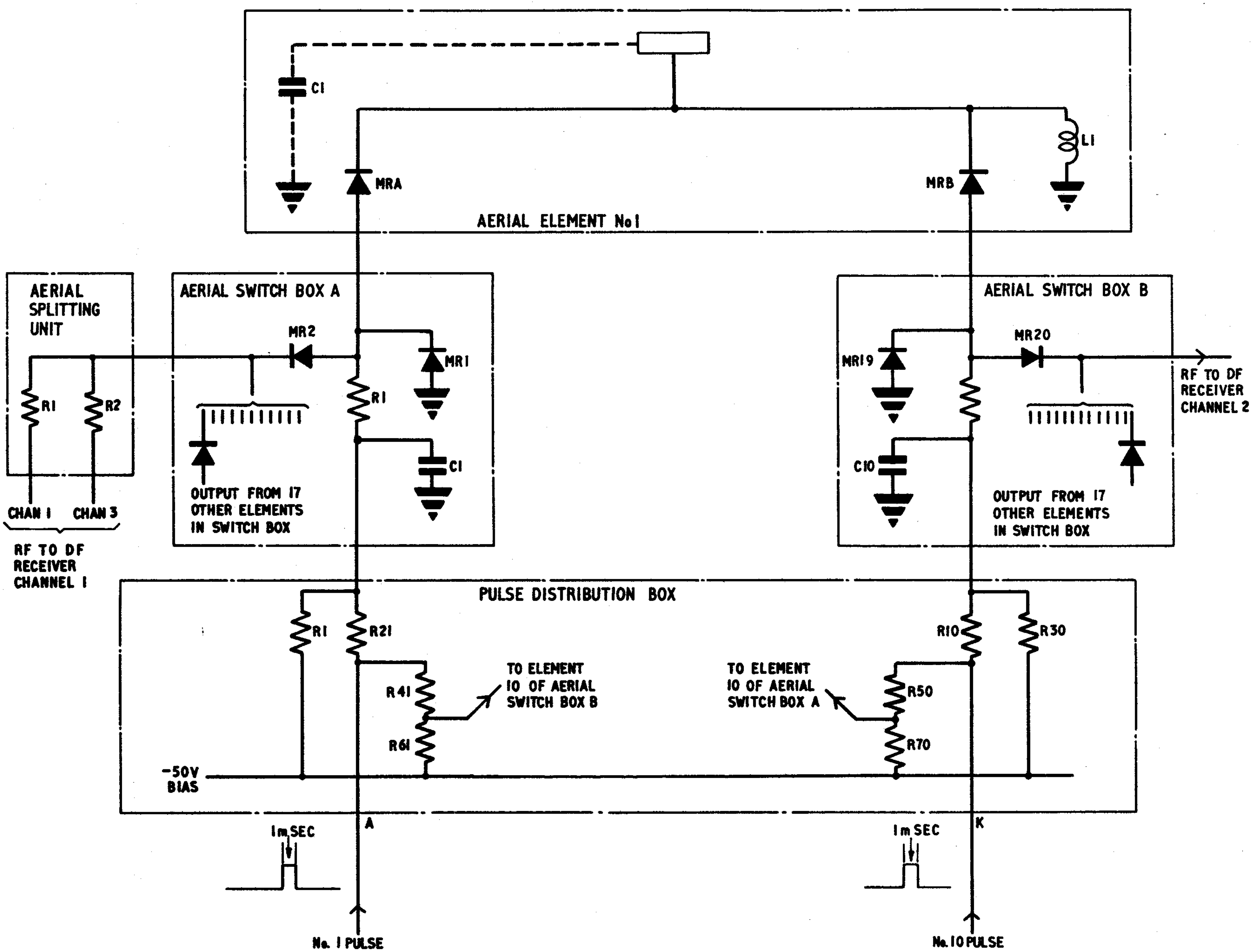
17. The following modifications are applicable to the following units:-

Aerial switchbox 6847	5825-99-943-6164: Replacement of capacitors.
Switch electronic 6850	5840-99-999-1343: Replacement of capacitors.

Pulse distribution box 7572 5825-99-943-5897: To permit use of the box with single and double channel installations

Caution...

The modifications are noted in this chapter for guidance only and reference to AP 2531P, Vol. 2, is mandatory when checking the modification state of CADF equipment.



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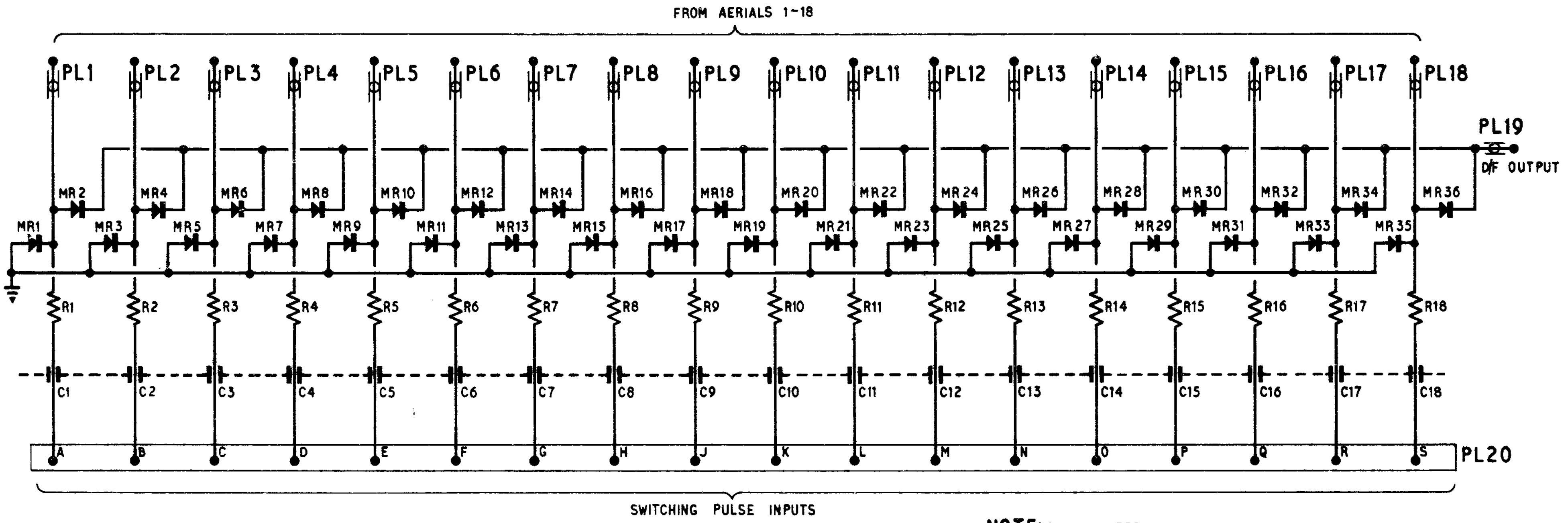
FGRI 23078 and TGRI (AT) 26006/1 Fig.5

Switching circuit for one aerial element



NOTE: R1 – R18 330
C1 – C18 ·001
MR1 – MR36 CV5160

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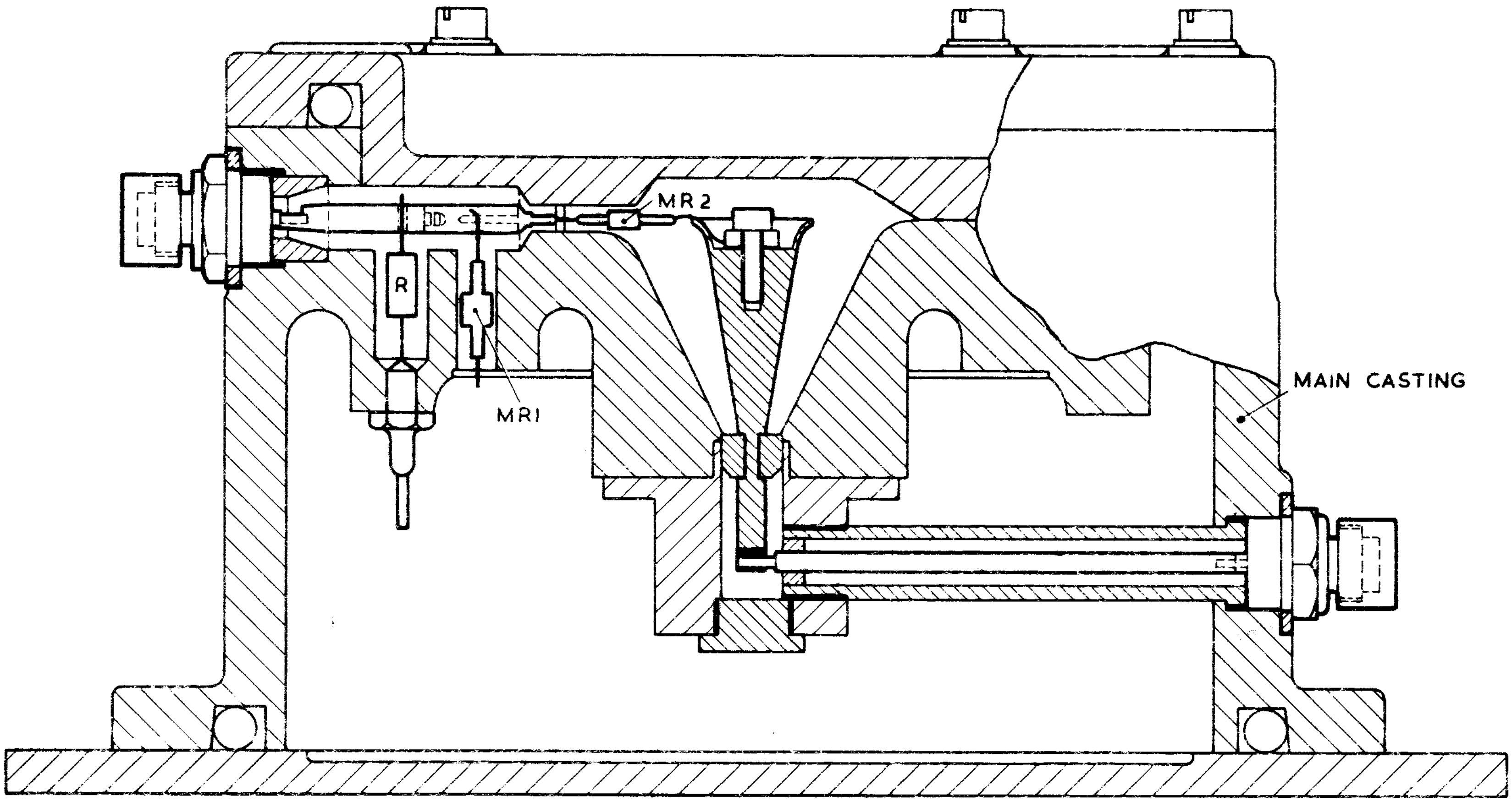
Gate, electronic assembly 5825-99-943-6164 (aerial switchbox): circuit

Fig.6



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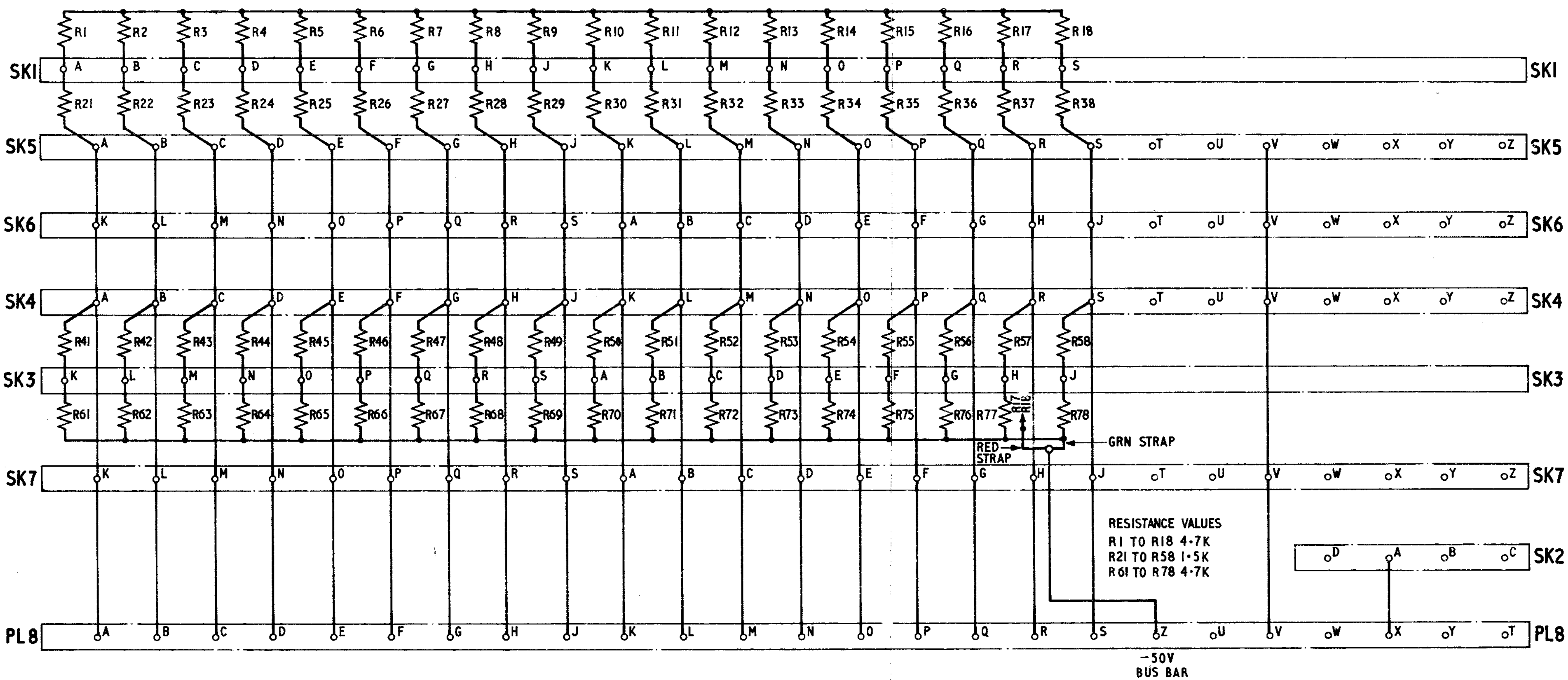
Gate, electronic assembly 5825-99-943-6164 (aerial switchbox) : construction

Fig. 7



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Interconnecting box 5825-99-943-5897 : circuit (pulse distribution box)

Fig.8

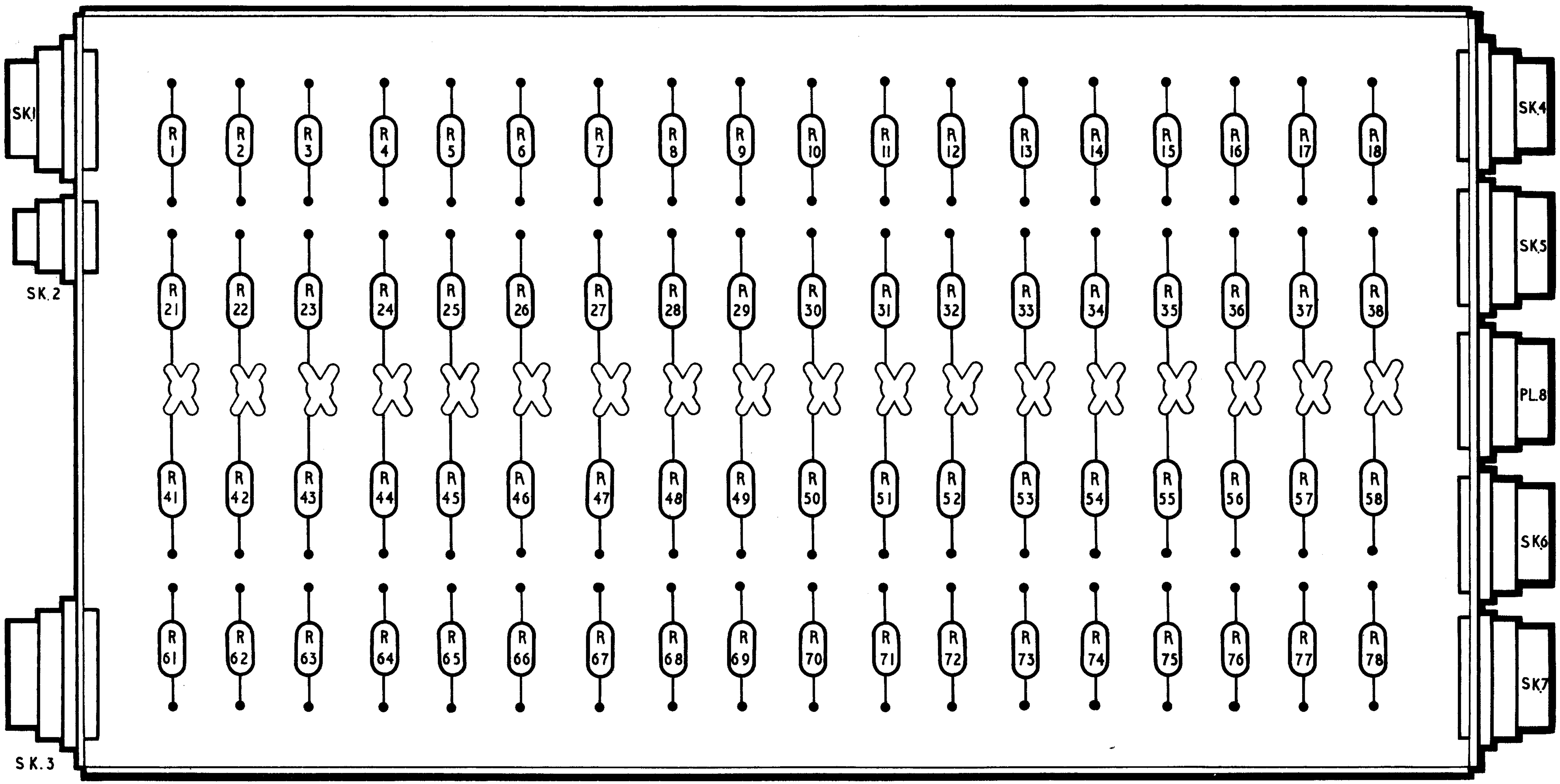
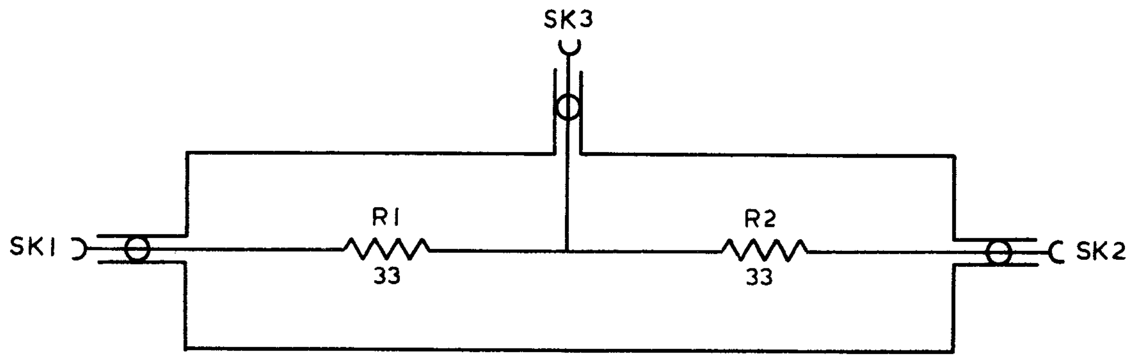


Fig.9 Pulse distribution box : component layout Fig.9



Aerial splitting unit 5840-99-999-1343 : circuit Fig. 10

Chapter 3

TEST OSCILLATOR (6625-99-943-5905)

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UNIT DESCRIPTION

Introduction

1. The test oscillator generates a signal which is fed to the test oscillator aerial. The signal radiated from the aerial is picked up by the aerial array and processed by the d.f. equipment to provide a known bearing for the c.r.t. indicator.

2. The test oscillator, together with its associated power supply, is mounted at the back of a thick aluminium front panel. The oscillator unit and its power supply are well screened, so that the receiver picks up the radiated signal from the test oscillator aerial only; if the receiver were to pick up a signal direct from the unit inaccuracies would occur in the check bearing.

3. The facilities provided by the unit include a meter on the front panel, for monitoring the output level of the last two stages of the unit, and an h.t. control relay which reduces the h.t. supplied to the valves during standby conditions.

4. The control unit associated with one of the cabinets (the actual cabinet depends on the version of the equipment) provides a TEST OSCILLATOR switch that controls the state of the relay in the test oscillator power supply. The relevant cabinets and their associated control units are as follows:—

(1) Single pre-tuned receiver and d.f. cabinet

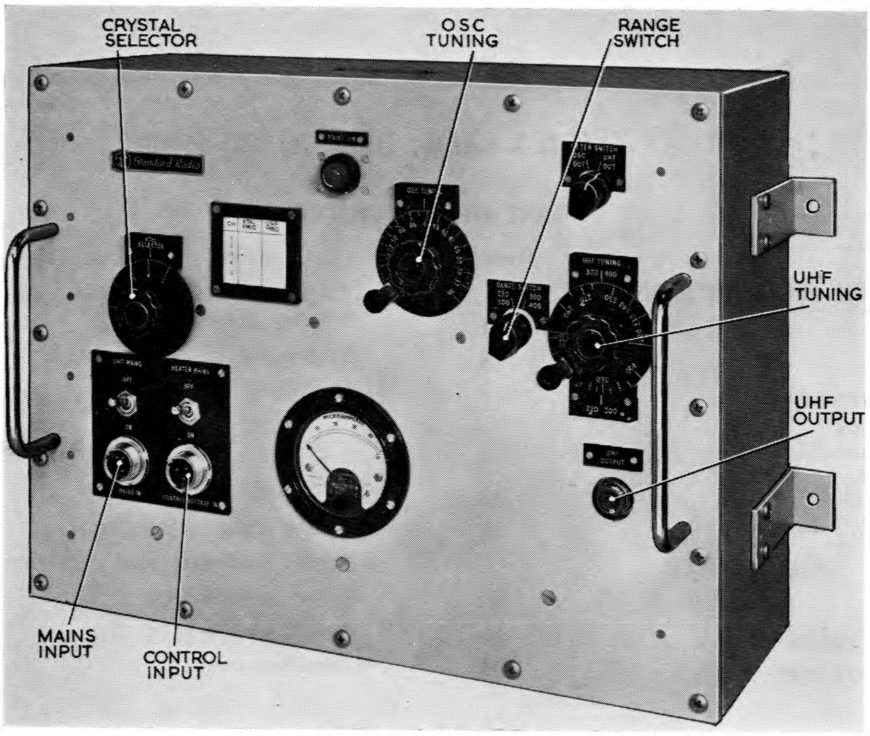

Fig. 1. Test oscillator: front view

(5820-99-932-4857)—control and calibrator unit (5820-99-999-2786).

(2) Twin pre-tuned receiver and d.f. cabinet (5820-99-932-4845)—control unit (5825-99-943-5892).

(3) R.F. and d.f. rack within the d.f. cabin of transportable equipments of the TGRI 26006 series—control unit (5825-99-933-1039).

Construction

5. The electrical components of the test oscillator are contained on three assemblies; the front panel, the power unit, and the oscillator unit. The oscillator unit and the power unit are both secured by screws to the rear of a thick aluminium front panel, the oscillator unit on the upper section of the panel and the power unit on the lower section. The combined assembly is fixed to the test oscillator case by 16 star-head screws, arranged around the periphery of the front panel.

6. The controls, switches, input and output connectors, MAINS ON lamp and output meter are all mounted on the front panel and their location is shown in fig. 1, which gives a front three-quarter view of the test oscillator in its case. A label is provided on the front panel of each test oscillator for noting the crystal frequency and resultant output frequency for each position of its XTAL SELECTOR switch.

Brief electrical description

7. The power unit provides the following inputs to the oscillator unit via socket SKT1:—

(1) 6·3V a.c. —for the valve heaters and MAINS ON lamp.

(2) 60V a.c. —for the crystal oven.

(3) 250V h.t. —Reduced to 30V by the TEST OSCILLATOR switch on the control unit, during standby conditions.

(4) Mains —for the anti-condensation heaters (one in each r.f. compartment).

The block diagram of the oscillator unit is shown in fig. 2.

8. The oscillator valve (V1), with suitable switching of the crystals in the cathode circuits, produces five discreet frequencies in the range 36 to 67 Mc/s, which is one-sixth of the final output frequency (220 to 400 Mc/s). The output of V1 is amplified by V2 and then fed to frequency doubler V3; the output of V3 is applied to frequency trebler V4 the u.h.f. output signal of which is fed to the test oscillator aerial via socket SKT1.

9. The frequency of the oscillator is controlled by the setting of XTAL SELECTOR switch (SW1), and the circuit L1,C5,C6 is tuned by the OSC. TUNING control (ganged capacitors C5,C14,C22). The UHF TUNING control (C27) finely tunes the anode circuit of the output valve (V4). The XTAL SELECTOR switch, OSC. TUNING control and the UHF TUNING control are all mounted on the front panel, which also mounts the RANGE SWITCH

(SW2)—for selecting outputs of 220 Mc/s to 300 Mc/s or 300 Mc/s to 400 Mc/s—and the METER SWITCH (SW1), which selects either the doubler output (OSC. OUT) or trebler output (UHF OUT) for monitoring by the meter (M1).

Circuit description (fig. 3 and 4)

Front panel

10. The front panel has the following components mounted on it.

(1) METER SWITCH (SW1)

(2) Meter (M1)

(3) UNIT MAINS ON/OFF switch (SW2)—connects to power unit (SKT3/PL2)

(4) HEATER MAINS ON/OFF switch (SW3)—connects to power unit (SKT3/PL2)

(5) MAINS IN plug (PL1)—connects to HEATER MAINS and UNIT MAINS switches

(6) CONTROL VOLTAGE IN plug (PL2)—connects to power unit (SKT3/PL2)

(7) MAINS ON lamp (LP1)—connects to power unit (SKT3/PL2)

(8) XTAL SELECTOR switch (SW1)—part of oscillator unit

(9) OSC. TUNING control (ganged capacitors C5,C14,C22)—part of oscillator unit

(10) UHF TUNING control (C27)—part of oscillator unit

(11) RANGE SWITCH (SW2)—part of oscillator unit.

Power unit

11. The power unit (fig. 3) has its own input plug (PL2) and output socket (SKT1); PL2 is fed from the components mounted on the front panel, and SKT1 feeds the outputs of the unit to the test oscillator plug (PL1).

12. The anti-condensation heater mains is applied to PL2 of the power unit via front panel plug PL1 and HEATER MAINS switch SW3; it is routed through the unit, via fuse FS4, to the oscillator unit (SKT1/PL1) where it energizes the four 1·2k ohms anti-condensation heaters (R18-R21). The unit mains is applied to PL2 of the power unit, via front panel plug PL1 and UNIT MAINS switch SW2, and energizes the primary winding of transformer TR1.

13. Transformer TR1 has three secondary windings which provide the supplies to the following circuits:—

(1) H.T. supply from TR1 pins 3 and 4 via fuse FS1. The 250V winding feeds a full-wave rectifier network (MR1a, MR1b), the output of which is passed through smoothing filter network CH1,C1 to resistor R1 and a contact of relay RL1. When RL1 is energized, the 250V is routed via the relay contact direct to pin 4 of SKT1, which connects with the h.t. line of the oscillator unit. In the de-energized position of RL1, resistors R1 and R2 are connected in series/parallel with the load, thus reducing the h.t. voltage available to the valves of the oscillator unit.

(2) Crystal oven supply from TR1 pins 8 and 9 via fuse FS3. The 60V winding feeds via pins 7 and 8 of SKT1 to the crystal oven parallel-connected elements (HR1,HR2) and series thermostat TH1, all situated in the oscillator unit.

(3) Valve heater supply from TR1 pins 6 and 7 via fuse FS2. The 6·3V winding feeds pins 1 and 2 of SKT1, which connect to the valve heater lines of the oscillator unit; the winding also feeds the MAINS ON lamp (LP1), situated on the front panel, via pins 1 and 2 of connector PL2/SKT3.

14. Relay RL1, connected across pins A and B of the CONTROL VOLTAGE IN plug (PL2) on the front panel, is energized by the 50V supply line via the TEST OSCILLATOR switch on the control unit. When the LOCAL/REMOTE switch of the control unit is set to LOCAL, the TEST OSCILLATOR switch (set to ON) completes the earth return to RL1. The REMOTE position selects the remote control unit TEST OSCILLATOR switch.

Oscillator unit (fig. 4)

15. The oscillator valve (V1) is arranged with a choice of five crystals across its cathodes, the required crystal being selected by the XTAL SELECTOR switch SW1 situated on the front panel of the unit. The crystals are contained in a thermostatically controlled crystal oven (HR1, HR2, TH1) that is supplied by the test oscillator power supply. The oven is maintained at 75°C $\pm$ 2½°C, which is the correct temperature for the Type ZDMS crystals. Only this type of crystal should therefore be used. The oscillator circuit is of the conventional Butler type and produces an output frequency between 36 Mc/s and 67 Mc/s, depending on the crystal selected. Inductor L2, situated across the cathodes of double triode V1, tunes out the capacity of the crystal holder and the wiring. The tuned output circuit of V1 (L1,C5, C6) is finely adjusted by the OSC. TUNING control mounted on the front panel of the unit. This control consists of ganged capacitors C5, C14 and C22.

16. The output of V1 is lightly coupled to the grid of amplifier stage V2 by capacitor C7; the low value of C7 prevents damping of the previous tuned circuit. The output of V2 is coupled via C12 to a tuned circuit (L6,C14,C31,C13,R23) and then via C15 to doubler V3. The tuned circuit is adjusted by C14 and damped by resistor R13. The circuit is tuned to the same frequency as the oscillator, and coupling capacitor C15 is of low value in order to prevent further damping of this circuit.

17. Frequency doubler V3 amplifies the signal from tuned circuit L6,C14,C31,C13,R23 and feeds it via C20 to another tuned circuit (L9,C22,C32,C21). This tuned circuit selects the second harmonic of the output frequency of V3 (the same frequency as the oscillator frequency); for example if the oscillator frequency selected by SW1 is 38 Mc/s, the tuned circuit containing C22 will select 76 Mc/s, for application to trebler V4, and attenuate all other frequencies.

18. The input at the cathode of grounded-grid frequency-trebler V4 is of low impedance, therefore the output of the tuned circuit associated with C22 is fed via C24, in order to match the input at V4 to the high impedance output of doubler stage V3. R.F. choke L10 and series-resistor R15 make up the cathode load of V4. The tuned circuit L12,L13,C27, together with the stray capacitances of V4, selects the third harmonic of the output frequency of V4; for example if C22 and its associated components select 76 Mc/s, the tuned circuit containing C27 will select 228 Mc/s, and attenuate all other frequencies. This latter tuned circuit selects a frequency range of 220 Mc/s to 400 Mc/s in two ranges, the fine tuning of both ranges being achieved by adjustment of UHF TUNING control C27. The RANGE SWITCH SW2 is open circuit when set to the 220/300 position and includes the whole of L12 in the tuned circuit, but when set to 300/400 position shorts out half of L12. The output of V4 is fed to the test oscillator aerial via coupling capacitor C26 and a 75-ohms coaxial cable connected to the UHF OUTPUT socket SKT1, which is mounted on the front panel of the unit. Because of the high impedance of C26, the damping of the final tuned circuit is low.

19. Meter M1 has two monitoring states, which are selected by the METER SWITCH SW1. The OSC. OUT position of SW1 connects M1 across the output of V3, enabling the oscillator, amplifier and doubler stages to be tuned by the OSC. TUNING control, with the aid of the meter. The UHF OUT position connects M1 across the output of V4 to enable tuning of the u.h.f. output of the unit by the UHF TUNING control. A rectifier circuit (MR1,C23 or MR2,R16) is incorporated in each monitoring line in order to give a d.c. meter current proportional to the voltage across the tuned circuit.

20. R18 to R21 are four series anti-condensation heaters, one mounted in each r.f. compartment, and are energized by the operation of the HEATER MAINS switch SW3.

21. Filters C3,L3; C8,L5; C16,L8; and L11 prevent u.h.f. leakage to earth, and resistor R22 provides the d.c. return path for the diode MR2.

SERVICING

Test apparatus

22. The following items of test equipment are required for full servicing.

(1) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(2) Multimeter Type 9980 or Type 12889.

(3) Variac (for mains supply to test oscillator).

(4) Grid-dip meter.

(5) Power supply 50V, 50 mA d.c. (for relay control).

(6) Load resistor 75 ohms.

(7) Three crystals type ZDMS—38 Mc/s, 48·5 Mc/s, 66·25 Mc/s.

(8) Jumper leads with crocodile clips for connection of power unit to oscillator unit.

(9) Non-metallic trimming tool.

Tests for serviceability

23. Preliminary serviceability checks, made with the test oscillator connected normally to the equipment, are performed as follows:—

(1) On the control unit, set the LOCAL/REMOTE switch to LOCAL and the TEST OSCILLATOR switch to ON.

(2) Set the test oscillator front panel controls:—

XTAL SELECTOR switch to position 1

METER SWITCH to the OSC. OUT position

RANGE SWITCH to the 220/300 position.

(3) Adjust the OSC. TUNING control for maximum output as indicated by the front panel meter. Check that the setting of the control corresponds to the xtal frequency given on the front panel label, and that the meter reading is not less than 10 μA.

(4) Set the METER SWITCH to the UHF OUT position and adjust the UHF TUNING control for maximum output as indicated by the front panel meter. Check that the setting of the control corresponds to the u.h.f. frequency given on the front panel label, and that the meter reading is not less than 10 μA.

(5) Repeat operations (2) to (4) for the remaining four positions of the XTAL SELECTOR

switch in turn, setting the RANGE SWITCH to the appropriate position for the u.h.f. frequency (shown on the front panel label) used in each case.

(6) Switch off the test oscillator, set the multimeter to the 1A range, and insert it in the mains supply line.

(7) Switch the UNIT MAINS switch to ON and ensure HEATER MAINS switch is OFF.

(8) Measure the current taken by unit (limits 180 mA ±20 mA).

(9) Switch the HEATER MAINS switch to ON and note the new current reading.

(10) Subtract the reading obtained in operation (8) from that of operation (9) to give the anti-condensation heater current (limits 40 mA ±5 mA).

24. The test oscillator can be removed from its case for replacement or servicing by first removing the 16 star-head screws securing the front panel and then taking out the front panel complete with oscillator unit and power unit. The internal plug and socket connections (PL2,SKT1) from the power unit can now be released and the unit removed by unfastening the screws holding it to the assembly.

Re-alignment procedure

25. The unit re-alignment described in the following paragraphs is normally undertaken only at third line servicing. The test oscillator can be tested on the bench with the aid of separate power supplies for mains input at 50V control voltage, or by means of jumper leads from the cabinet supplies.

26. Having removed the oscillator unit and power unit from their case (para. 24), remove the cover of the crystal oven and take out the five crystals, noting their positions so that they may be replaced correctly. Insert the three test crystals as follows:—

(1) 38 Mc/s crystal in position 1.

(2) 48·5 Mc/s crystal in position 2.

(3) 66·25 Mc/s crystal in position 3.

Replace the cover on the crystal oven. Release the power unit from the frame to allow access to the underside of the oscillator.

Alignment of oscillator, amplifier and doubler stages

27. *Preliminary alignment.*

(1) With no power supplies to the test oscillator, rotate the OSC. TUNING control fully counter-clockwise and set trimmers C6, C13 and C21 to their mid position.

(2) Set the grid-dip meter to a frequency of 36 Mc/s carrier wave and position the tuning coil of the meter near the base of L1 and capacitor C5.

(3) Adjust the core of inductor L1 until a dip is obtained on the meter.

(4) Transfer the meter to the next compartment and position it near C14 and L6. Adjust the core of L6 until a dip is obtained on the meter.

(5) Set the grid-dip meter to a frequency of 72 Mc/s and position it near L9 and C22. Adjust the core of L9 until a dip is obtained on the meter.

(6) Set the dial of the OSC. TUNING control to 68 Mc/s and set the grid-dip meter to 68 Mc/s.

(7) Position the meter near L1 and adjust C6 until a dip is obtained.

(8) Transfer the meter to the next compartment and position it near L6. Adjust C13 for a dip at the meter.

(9) Set the grid-dip meter to a frequency of 136 Mc/s and position it near L9. Adjust C21 for a dip at the meter.

28. *Final alignment.*

(1) Connect the mains supply to the unit and operate the UNIT MAINS switch to ON; wait 30 minutes to allow the crystal oven to warm up and stabilize.

(2) Apply the 50V control voltage to the unit. (PL/2, pins A and B).

(3) Set the XTAL SELECTOR switch to position 1 and set the METER SWITCH to the OSC. OUT position.

(4) Set the dial of the OSC. TUNING control to 36 Mc/s.

(5) Rotate the OSC. TUNING control slowly until a reading is obtained on the front panel meter (M1); adjust the control for a maximum reading. The final setting of the control should coincide with the 38 Mc/s mark on the dial.

(6) If the dial setting is not 38 Mc/s, rotate the control to the 38 Mc/s mark and adjust L1,L6 and L9 in turn for a maximum reading on the front panel meter; repeat the adjustments until the maximum meter reading does occur at the 38 Mc/s setting of the OSC. TUNING control.

(7) Set the XTAL SELECTOR switch to position 3 and set the dial of the OSC. TUNING control to 68 Mc/s.

(8) Rotate the control in a counter-clockwise direction until a reading is obtained on the front panel meter; adjust the control for a maximum reading. The final setting of the control should coincide with 66·25 Mc/s on the dial.

(9) If the dial setting is not 66·25 Mc/s, rotate the control to 66·25 Mc/s and adjust C6, C13 and C21 in turn for a maximum reading on the front panel meter; repeat the adjustments until the maximum meter reading does occur at the 66·25 Mc/s setting of the OSC. TUNING control.

(10) Repeat operations (3) to (9) several times until accurate dial settings are obtained.

(11) Set the XTAL SELECTOR switch to position 2 and adjust the OSC. TUNING control for a maximum reading at the front panel meter; check that the setting of the control coincides with the 48·5 Mc/s mark on the dial.

29. The dial settings of the OSC. TUNING control should be within the limits given in Table 1; a compromise in tuning may be necessary in order to obtain all three tuning points of the control within the limits of the table.

TABLE 1

Limits for dial settings of OSC. TUNING control

XTAL SELECTOR	Frequency	Dial setting	Minimum meter deflection
Position 1	38 Mc/s	38 Mc/s $\pm$0·5 Mc/s	10 μA
Position 2	48·5 Mc/s	48·5 Mc/s $\pm$1·0 Mc/s	10 μA
Position 3	66·25 Mc/s	66·25 Mc/s $\pm$2·0 Mc/s	10 μA

Alignment of trebler stage

30. (1) Switch off the UNIT MAINS switch on the front panel and connect the 75-ohms load and valve voltmeter across the output socket (SKT1) of the oscillator unit and earth.

(2) Set the valve voltmeter to the 10V range, the XTAL SELECTOR switch to position 2, the METER SWITCH to the OSC. OUT position and the RANGE SWITCH to the 220/300 position.

(3) Operate the UNIT MAINS switch to ON and adjust the OSC. TUNING control for maximum output as indicated by the front panel meter.

(4) Set the METER SWITCH to the UHF OUT position and adjust the UHF TUNING control (C27) for maximum output as indicated by the front panel meter. The setting of the control should coincide with 291 Mc/s on the 220/300 section of the dial.

(5) If the dial setting is not 291 Mc/s, adjust the bottom core of L12, with the non-metallic trimming tool, until the calibration is correct.

(6) Set the RANGE SWITCH to 300/400 position and adjust the UHF TUNING control for maximum output as indicated by the front panel meter. The setting of the control should coincide with 291 Mc/s on the 300/400 section of the dial.

(7) If the dial setting is not 291 Mc/s, adjust the top core of L12 with the trimming tool until the calibration is correct.

(8) Both core settings of L12 are inter-dependent and therefore operations (2) to (7) should be repeated to ensure the correct tuning is obtained.

(9) Set the XTAL SELECTOR switch to position 1, the RANGE SWITCH to the 220/300 position and the METER SWITCH to the OSC. OUT position.

(10) Adjust the OSC. TUNING control for maximum output as indicated by the front panel meter.

(11) Set the METER SWITCH to the UHF OUT position and adjust the UHF TUNING control for maximum output, indicated by the front panel meter. The setting of the control should coincide with 288 Mc/s on the dial.

(12) If the dial setting is not 228 Mc/s, the bottom core of L12 must be re-adjusted but, as this will affect the settings found in operation (8), a compromise will have to be made.

(13) Set the XTAL SELECTOR switch to position 3, the RANGE SWITCH to the 300/400 position and the METER SWITCH to the OSC. OUT position.

(14) Adjust the OSC. TUNING control for maximum output as indicated by the front panel meter.

(15) Set the METER SWITCH to the UHF OUT position and adjust the UHF TUNING control for maximum output, indicated by the front panel meter. The setting of the control should coincide with 397·5 Mc/s on the dial.

31. The dial settings of the UHF TUNING control should be within the limits given in Table 2; a compromise in tuning may be necessary in order to obtain all four tuning points within the limits of the table. When the tuning points have been found remove the three test crystals and insert the five original crystals in the positions noted at the start of this re-alignment procedure.

TABLE 2

Limits for dial settings of UHF TUNING control

Range switch	XTAL SELECTOR	Oscillator frequency	UHF TUNING dial setting	Minimum panel meter deflection	Minimum valve voltmeter reading
220/300	position 1	38 Mc/s	228 Mc/s ±5 Mc/s	10μA	0·2V
220/300	„ 2	48·5 Mc/s	291 Mc/s ±5 Mc/s	10μA	0·2V
300/400	„ 2	48·5 Mc/s	291 Mc/s ±5 Mc/s	10μA	0·2V
300/400	„ 3	66·25 Mc/s	397·5 Mc/s ±10 Mc/s	10μA	0·2V

Dismantling instructions

32. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing, concerns components for replacement for the oscillator unit or the power unit. The method of removing components (all of which are mounted on directly on one of the chassis' or on the front panel) is self-evident. For the location and identification of components, refer to the component layout diagrams fig. 5.

FAULT DIAGNOSIS

Fault finding procedure

33. Before using test apparatus to trace or locate a fault, ensure that all connections are secure and that valves are securely seated in their valve bases. To check for correct operation of the unit, refer to the servicing section of this chapter and carry out the serviceability checks in order to isolate the fault to the oscillator unit or power unit. In the absence of any signal from the unit, the obvious starting point is to check the supply to the unit and the outputs of the power unit, followed by a check for breaks in the wiring.

Servicing data

34. To asist in servicing and fault finding of the test oscillator, tabulated lists of the typical voltages and currents are given together with the valve complement for the unit. The typical values given may vary slightly from one unit to another, and should be replaced at the time of installation or major overhaul with readings obtained from a known working unit to form the basis of a maintenance log book.

Supply voltage and currents

35. The aproximate voltages and values of current consumption of the unit are given in Table 3. The voltages and currents should be measured with the multimeter.

TABLE 3

Supply voltages and currents

Circuit	Check point	Voltage	Current
Unit mains input	PL1/A and PL1/B	230V a.c.	180 mA ±20 mA
Anti-condensation heater mains	PL1/C and PL1/D	230V a.c.	40 mA ±5 mA
H.T. supply (standby)	SKT1/4 and SKT1/3 (earth)	30V ±10V d.c.	—
H.T. supply (operational)	SKT1/4 and SKT1/3 (earth)	240V ±10V d.c.	—
Oven supply	SKT1/7 and SKT1/8	60V ±10V a.c.	280 mA ±30 mA
Heaters	SKT1/1 and SKT1/2	6·3V ±0·3V a.c.	

Valve complement

36. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 3, may be used if available.

TABLE 4

Valve complement

Valve	'T' range	CV No.	J.S. Cat. No.	Commercial Type	CV No.
V1	6060	4024	5960-99-000-4024	12AT7	455
V2,V3	6064	4014	5960-99-000-4014	6AM6/8D3	138
V4	—	5073	5960-99-000-5073	6AM4	

Common faults

37. The most obvious fault likely to occur is the failure or deterioration of any one of the valves. If any of the valves is renewed, the associated tuned circuit will need to be re-aligned as outlined in para. 25 to 31. Before attempting re-alignment ensure that the controls have not become loose on their shafts and thus caused an apparent error.

38. The OSC. TUNING control consists of a single variable capacitor connected by a bevel gear to a twin-ganged unit; it is important that all three components have exactly the same capacity at 36 Mc/s setting, therefore if they have slipped on their shafts, rotate the control to 36 Mc/s, set all three components to maximum capacity and retighten the grub screws.

Modifications

39. The following modifications are applicable to the test oscillator 6625-99-943-5905:—

6846 ... Replacement of capacitors.

7286 ... To add friction pad to improve tuning dial locking.

7331 ... Prevention of self oscillation and improvement of output metering by increasing R16 to 2·2k.ohm and re-wiring.

Caution . . .

The above modifications are noted in this chapter for guidance only and reference should be made to A.P.2531P, Vol. 2, when checking the modification state of CADF equipment.

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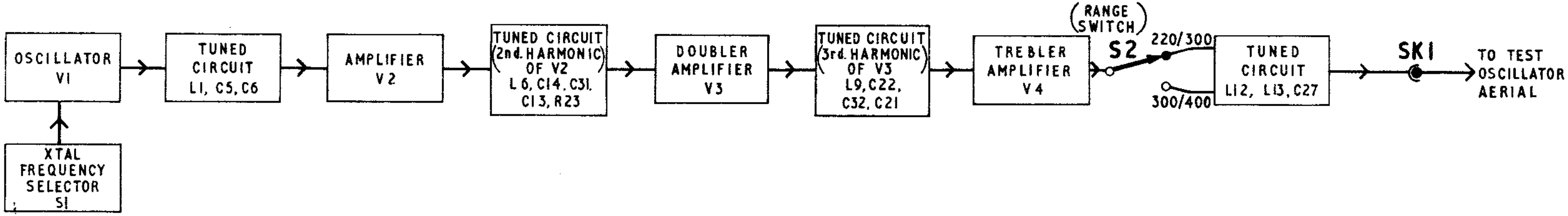
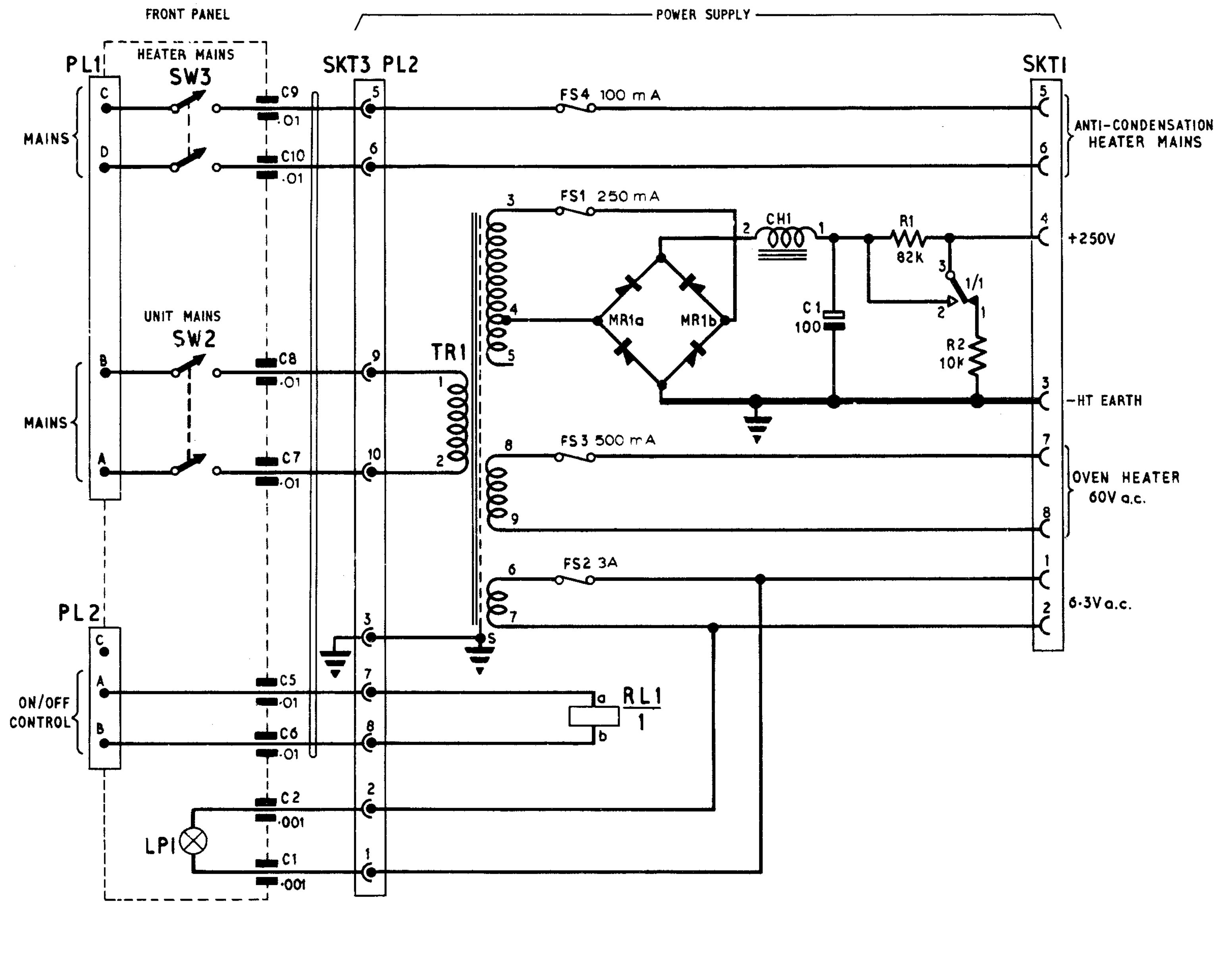


Oscillator unit: block diagram

Fig.2



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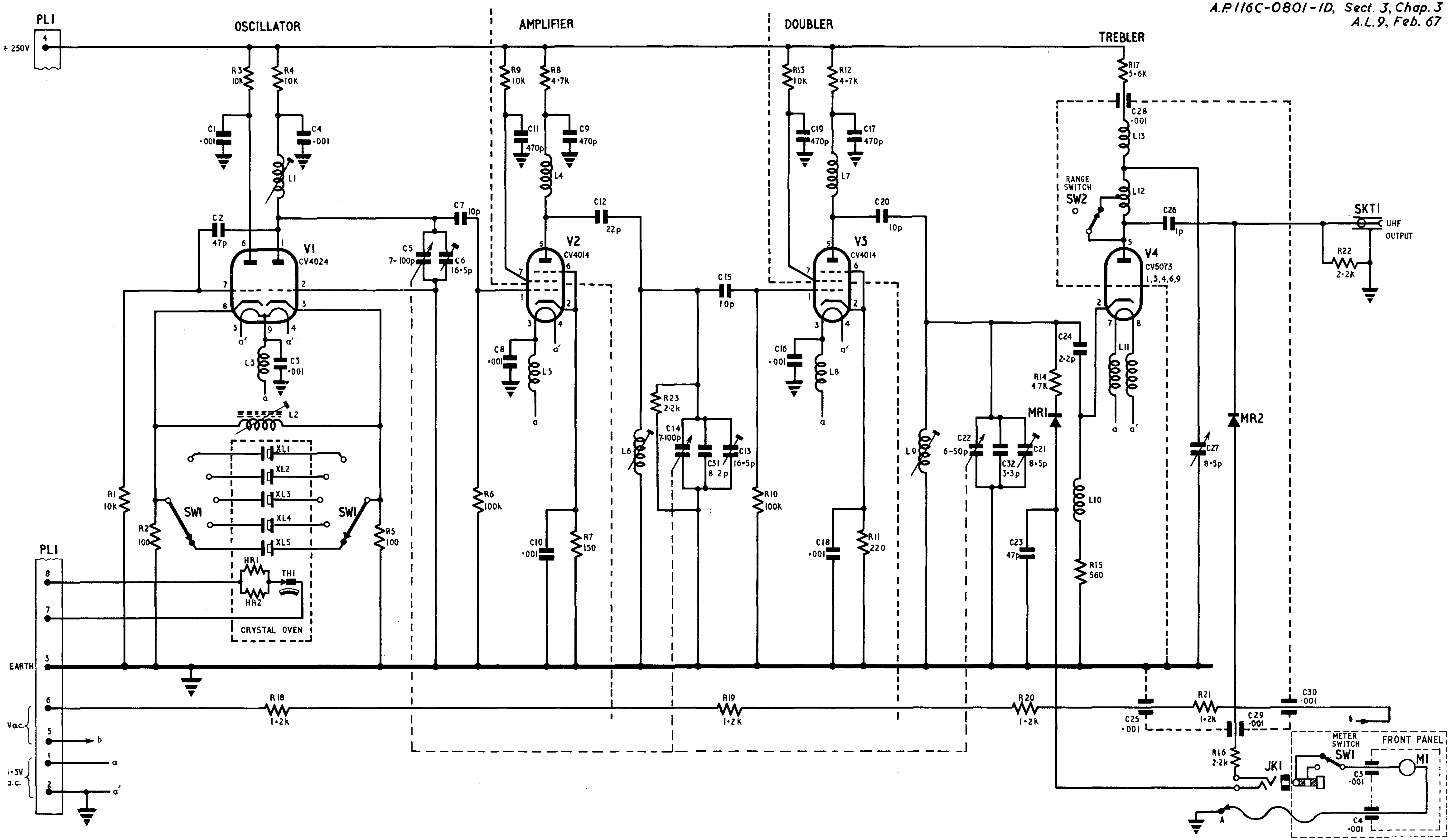
Calibrator, d.f. 6625-99-943-5905 (test oscillator): power supply circuit



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Calibrator d.f. 6625-99-943-5905 (test oscillator) : oscillator circuit

Fig. 4

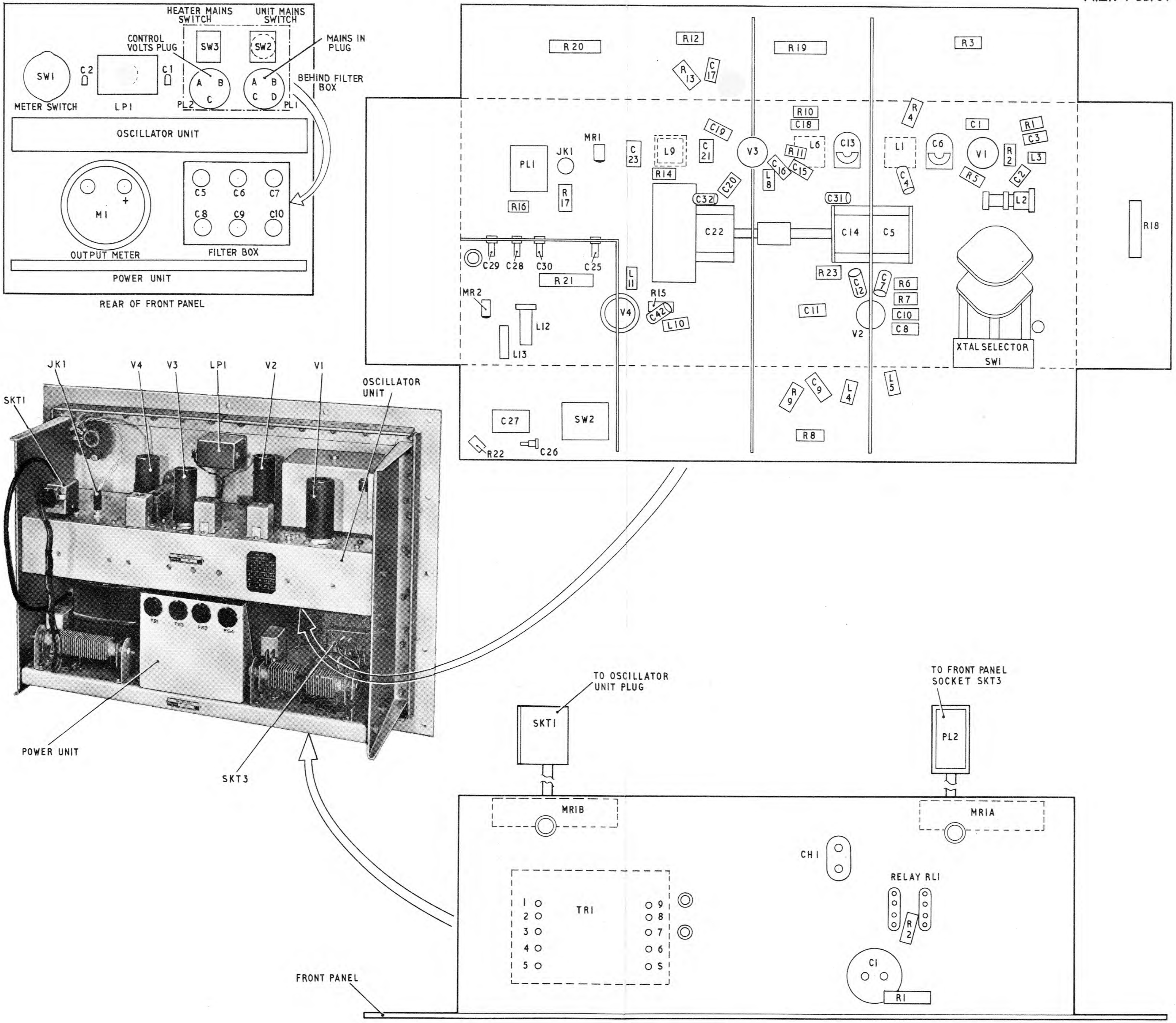


Fig. 5 Calibrator. d.f. 6625-99-943-5905 (test oscillator) : component layout Fig. 5

Chapter 4

DISPLAY SELECTION UNIT

CONTENTS

ILLUSTRATIONS

INTRODUCTION

1. The display selection unit (control, remote switching 6120-99-932-4855) is provided in all FGRI23078 stations, to enable the selection of d.f. information from any one channel at a time, for presentation by the local display indicator.

2. The unit is suspended from a block-board which is mounted in the centre of the ceiling of the d.f. building.

3. A general view of the display selection unit is given in fig. 1.

CIRCUIT

4. The d.f. information is introduced to the selection unit from the bearing display amplifiers of channel 1 and 2 via PL2 (Mk. 4, 12-way plug). The d.f. information of channels 3 and 4 is introduced via PL3 and PL4 (Mk. 4, 6-way plug) respectively.

5. ◀ The inputs to the selection unit are directly connected to a terminal strip TS1, for connection through the top of the unit and via the G.P.O. distribution box in the d.f. building to the control tower.▶ Intercommunication speech is also connected direct from PL1 to TS1.

6. The d.f. inputs are also connected to a 4-pole, 4-way rotary wafer switch. The four outlets of the switch, carrying the N,S,E and W d.f. information of the selected channel, is connected via SK1 (Mk. 4, 12-way socket) to the local display indicator.

7. The interconnections of the display selection unit are given in fig. 2.

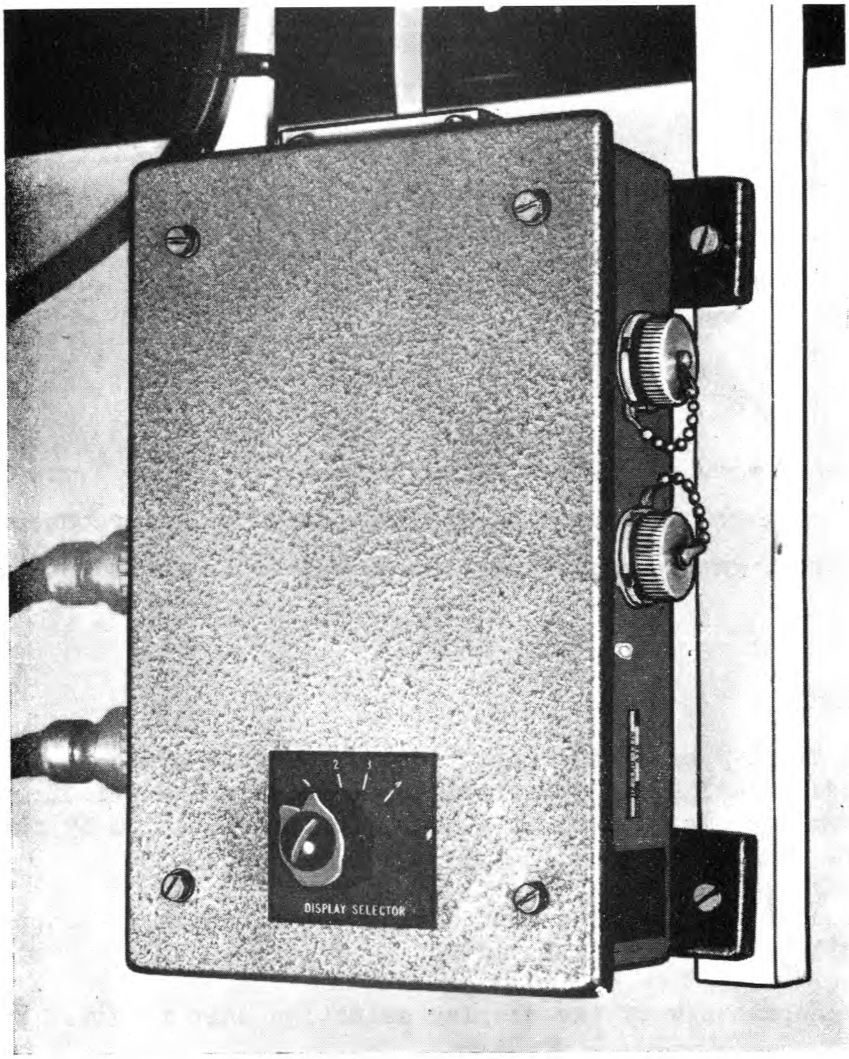
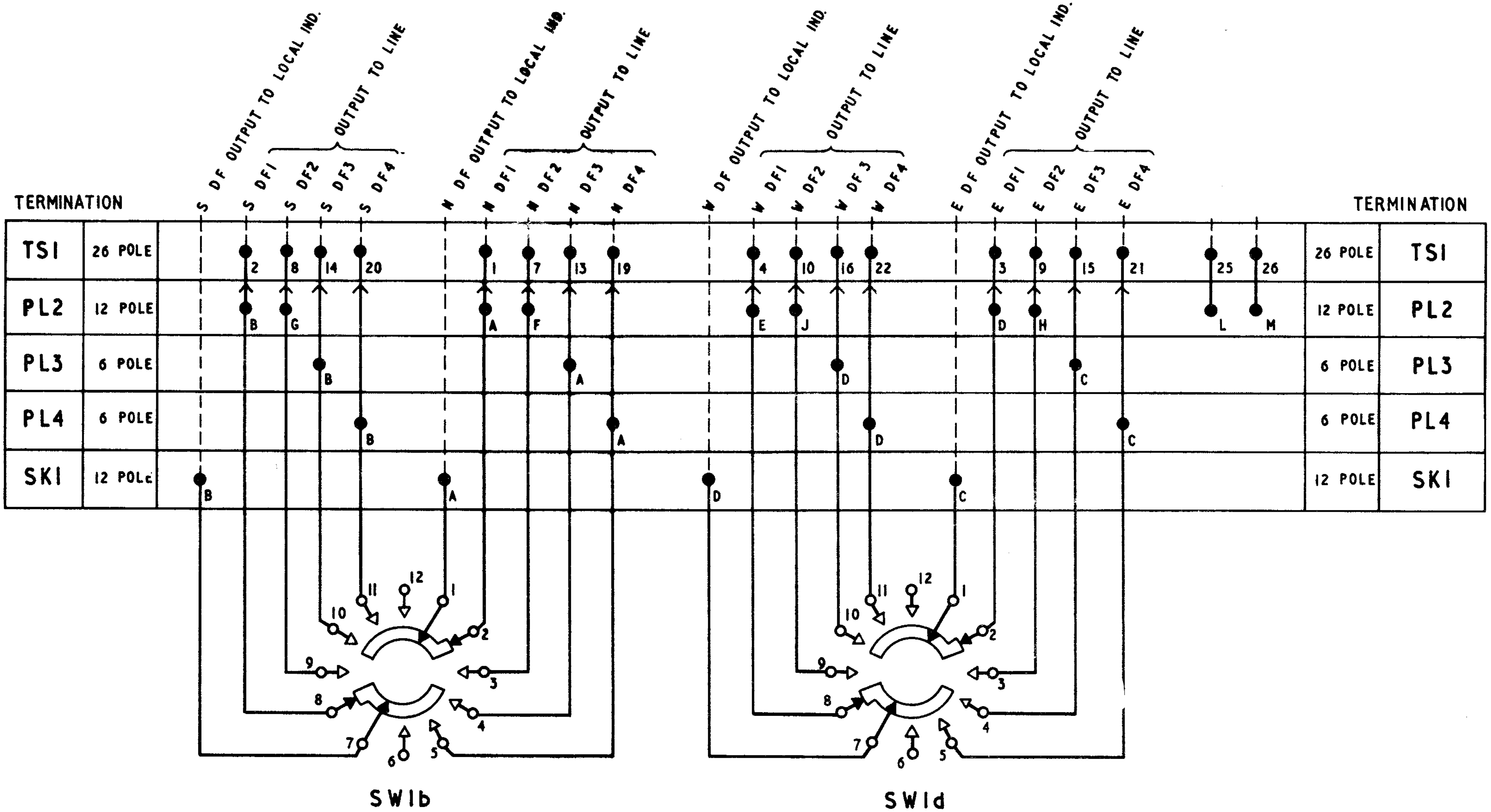


Fig. 1. General view of display selection box

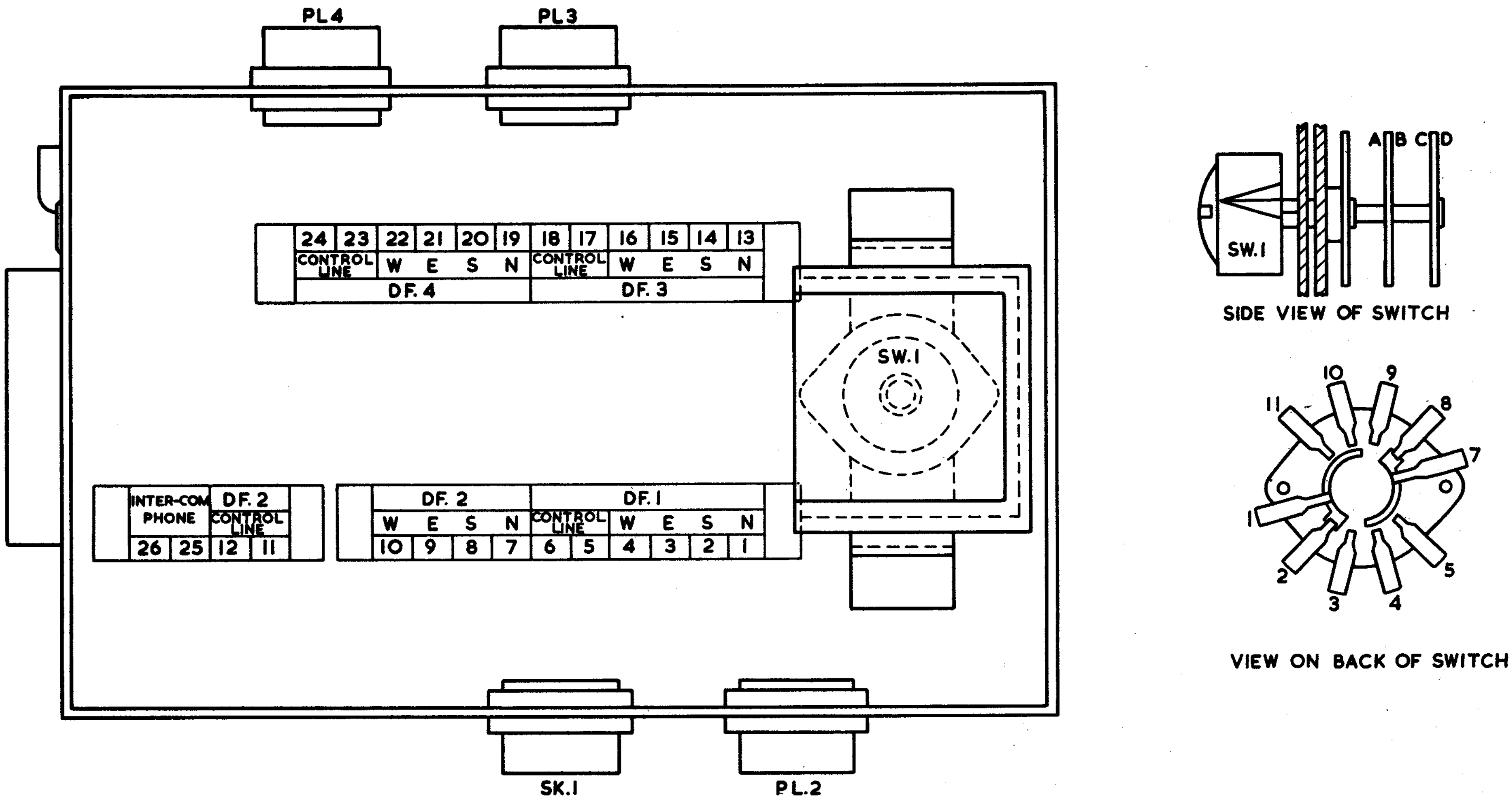
COMPONENT LAYOUT

8. The component layout of the unit is illustrated in fig. 3.



Control remote switching 6120-99-932-4855: interconnections

Fig. 2



Control, remote switching 6120-99-932-4855: component layout Fig. 3

Chapter 5

VOLTAGE STABILIZER (6110-99-933-1036)

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UNIT DESCRIPTION

Introduction

1. The voltage stabilizer is used in the TGRI series of C.A.D.F. equipment. The unit is located on the floor of the container near the door in the left-hand corner. The device consists of an on-load tap changer which provides voltage regulation of an a.c. supply of 200V, 210V, 220V, 230V, 240V or 250V to within ±1% of the nominal value. The unit maintains ±1% accuracy for input variations of ±15% at any load up to 2kVA, and for a frequency range of 45 c/s to 66 c/s. The speed of regulation is 6% of the nominal input voltage per second; for example, if the input voltage changes from 15% above the nominal to 15% below, correction will be completed in 5 seconds.

2. The range of regulation is shown in Table 1.

TABLE 1

Input voltage limits for ±1% regulation

Input voltage Maximum	Input voltage Minimum	Output voltage Nominal
230	170	200
241·5	178·5	210
253	187	220
264·5	195·5	230
276	204	240
287·5	212·5	250

Construction

3. Basically, the voltage stabilizer comprises three panels of components and a separate transformer all of which are mounted in a rack measuring approximately 20 inches wide, 7 inches deep and 36 inches high. The panels are normally protected by covers which are held in position by means of Dzus fasteners. The centre panel is hinged on the right-hand side of the rack (viewed from the front) to allow access to components and to facilitate the connection of circuit links. The transformer is mounted at the bottom of the rack and is connected to the tap changing mechanism via a plug and socket. The location of fuses, connectors and controls is shown in fig. 1 which is a front view of the voltage stabilizer with the front covers removed.

Brief electrical description (fig. 2)

4. The main purpose of the block diagram shown in fig. 2 is to illustrate the method of stabilization. For this reason the diagram has been simplified and omits some of the complex switching and control-interlock functions. The a.c.

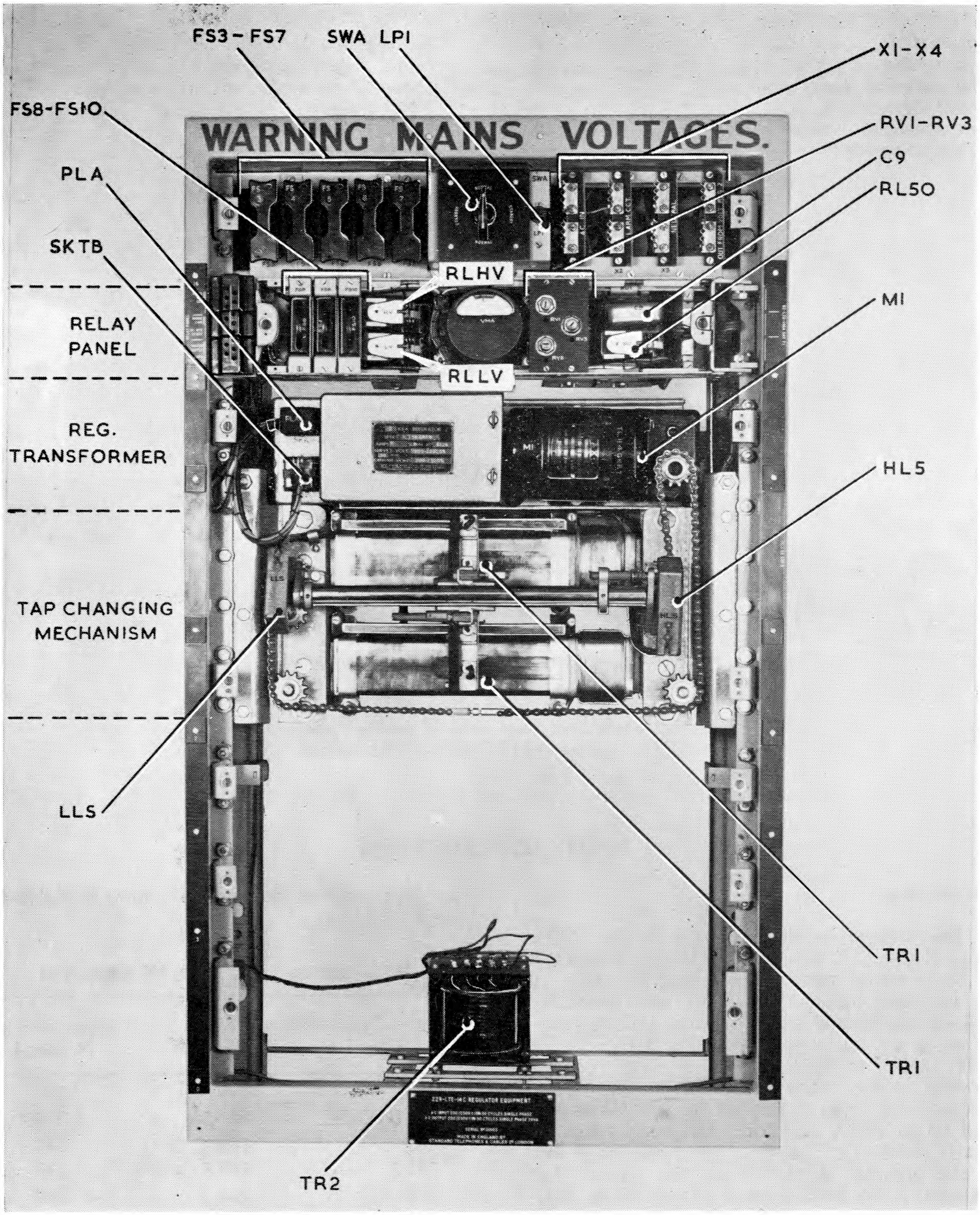

Fig. 1. Voltage stabilizer: front view with covers removed

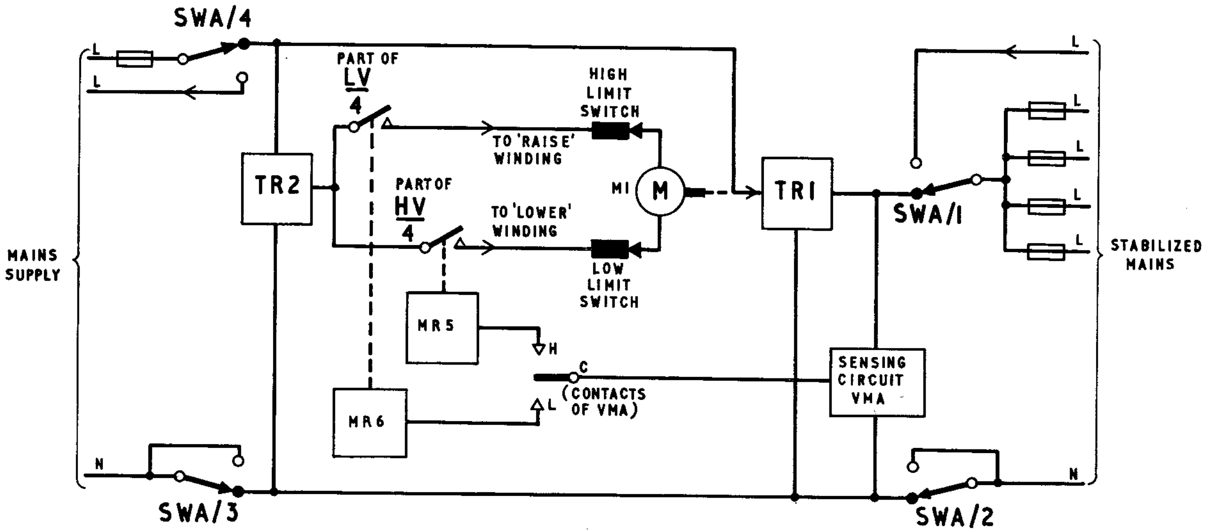

Fig. 2. Voltage stabilizer: block diagram

mains input voltage applied to the stabilizer can be switched internally to bypass the stabilizing circuit. Wiring terminals are provided on the main voltage stabilizer so that should a fault occur the unstabilized mains can be applied to a separate standby stabilizer. The stabilized mains from the standby stabilizer can be wired back to the main stabilizer and switched so that it appears as the output from the main stabilizer. In this way, wiring connections to the load do not have to be changed from one stabilizer to the other.

5. The input voltage to the stabilizer is applied to two auto-transformers, TR1 and TR2. Auto-transformer TR1 supplies the load, whereas TR2 supplies a tap changer motor, M1. The taps on TR2 are set to the nominal value of output voltage required.

6. The output voltage from TR1 is monitored by a sensing circuit that contains a marginal relay VMA. Whilst the output voltage remains within the control limits of $\pm 1\%$, the current in the sensing circuit is such that the tongue of the marginal relay 'floats' between a high (H) contact and a low (L) contact (high and low refer to the level of the stabilized output voltage about the preset nominal). Any deviation from the control limits causes the tongue of the relay to make with one of these contacts. When this occurs, the tongue of the relay switches one end of a 20V auxiliary winding on TR1 to a high or low bridge rectifier circuit, which contains MR5 or MR6 respectively. Each bridge rectifier supplies a relay (MR5 supplies HV, and MR6 supplies LV) that switches the output from TR2 to a 'raise' or 'lower' field winding of the motor. The motor then rotates in the required direction and changes the position of the tap on TR1 (i.e. raises or lowers the output voltage) until the tongue on the marginal relay breaks contact and 'floats.'

7. Mechanically operated limit switches are fitted to the tap changing mechanism. These switches operate and break the motor circuit if the tap changing mechanism reaches the end of its travel before the output voltage is brought within the $\pm 1\%$ limit.

8. Further facilities are provided (which are not shown in fig. 2, refer to fig. 4) for adjustment of the nominal voltage and elimination of hunting of the sensing circuit.

Circuit description (fig. 4)

9. Note that the circuit is divided into two main sections by chain dotted lines. The tap change motor (M1) and the auto-transformer (TR1) with their directly associated components comprise the lower sub unit bolted to the frame as shown in fig. 1. Electrical connections to the sub unit are made by PLA, SKTB and circuit links as shown in fig. 4. The components in the other circuit section (STC Code 82-LTU-146A) are mounted on the hinged centre panel of the stabilizer. Chain-line rectangles are shown on this section of the circuit and depict sub unit assemblies. The circuit identifications of all major components that are part of these sub assemblies are also physically identified on the stabilizer. The position and identification of components on the rear of the centre panel are shown in fig. 3.

Input/output voltage switching

10. The a.c. mains input voltage is protected by a 15A fuse (FS3) and is applied to a four-pole changeover switch (SWA). The positions of the switch are identified as NORMAL and STANDBY. When the switch is set to STANDBY, the input voltage is routed out of the unit and is not subject to stabilization. Table 2 shows the two switch positions and deals with the function of each contact of the switch.

Note . . .

The switching functions listed in Table 2 assume that a standby voltage stabilizer is in use.

TABLE 2

Switching functions of SWA

Pole	Position	Contact in use	Function
SWA1	STANDBY	A1	Incoming stabilized mains from standby stabilizer is switched to the fuse-protected output lines of the stabilizer.
SWA1	NORMAL	A2	Internally stabilized mains is switched to the fuse-protected output lines.
SWA2	STANDBY	B1	Open circuits mains neutral line of unit.
SWA2	NORMAL	B2	Connects input and output neutral lines of mains together (in conjunction with SWA3, contact C2).
SWA3	STANDBY	C1	Open circuits mains neutral line of unit.
SWA3	NORMAL	C2	Connects input and output neutral line of mains together (in conjunction with SWA2, contact B2).
SWA4	STANDBY	D1	Mains live input is switched out to standby stabilizer.
SWA4	NORMAL	D2	Mains live input is switched to stabilizing circuits.

11. The mains input and output connections are wired directly to the stabilzier. The connections are made to three terminal strips mounted at the top front right-hand corner of the rack and identified on fig. 1 (and identified physically on the unit) as X1, X3 and X4. A fourth terminal strip X2 is used to terminate wiring of an external circuit, which can be used to indicate an 'out-of-limit' condition of the stabilizer.

12. When the switch is set to NORMAL, the live side of the unstabilized input voltage is applied via contacts SO5 and SO3 (part of STC Code 82-LTU-146A) and FS2 to the moving element of the tap changing mechanism. This mechanism determines the position of the tapping point at which the mains input is connected at any instant to the double wound auto-transformer TR1.

13. Transformer TR1 has a centre tapped auxiliary winding, which is isolated from the main windings. The output from the auxiliary winding is 20V-0-20V, which after rectification is used to supply the motor control relays. A mains on indicator lamp LP1 connected via resistor R9 across one half of the auxiliary winding, indicates that the a.c. mains voltage has been switched to the transformer.

Tap changing

14. The live side of the output voltage is taken from a fixed point on the auto-transformer. Thus the output voltage depends on the turns ratio, which is determined by the position of the tapping point. The tap changing mechanism shown in fig. 1 consists of the single-phase a.c. motor (M1), which by means of a chain and sprockets drives brush gear over the exposed windings of TR1. The energizing voltage for the motor is obtained from the unstabilized mains input supply. The neutral side of the mains is connected to the junction of the two field windings of the motor, but the live side of the energizing voltage is applied via fuse FS9 and TR2.

15. Taps from 200V to 250V (in steps of 10V) are provided on TR2. The tap selected is determined by the nominal value of the input voltage to be stabilized, or the stabilized output voltage required. The output from TR2 is taken from the 240V tap and is routed via different relay contacts to the two field windings of the tap changer motor. The functions of these relay contacts are described later.

Voltage sensing

16. Relay VMA is connected in a bridge rectifier circuit comprising MR1 to MR4 inclusive. The live side of the control voltage from TR1 is applied to the bridge rectifier via FS8 and RV1, R11 (if required) and RV2, the neutral side is applied via RV3 and R1 to R6 inclusive. Tapping points are provided at the junctions of resistors in the R1 and R6 chain, and the tap selected determines the nominal value of the output voltage.

17. RV3 adjusts the current through relay VMA so that the tongue (C) of the relay floats between two contacts (H, high and L, low), provided the output voltage of TR1 remains within limits of ±1% of the nominal stabilized voltage. Immediately the output deviates from this limit however, the tongue of the relay makes with the appropriate contact. The tongue operates in front of a scale that has a central zero point, which indicates the deviation of the output voltage from the nominal value at any instant.

18. The sensing function commences only after an initial switch-on period which lasts for either 5 seconds or 10 seconds.

Initial switch-on sequence

19. The initial sequence of the switch-on operation is as follows. SWA is set to the NORMAL position, which connects the input mains supply via FS9 to TR2. the 240V output of TR2 is applied, via the closed contacts SO4 and LLS2, to the lower winding of M1. The motor then rotates, and the brush arm of the tap changer is driven to the end of the winding on TR1 that gives the maximum input-to-output voltage step-down ratio. When this point is reached, the low limit switch LLS is actuated and its contacts perform the following functions:

(1) LLS1: complete the loop for an external alarm.

(2) LLS2: breaks the circuit of the lower winding and stops the motor.

(3) LLS3: connects the output from TR2 via resistor R12 to bridge rectifier MR7, which energizes relay SO. The contacts of the relay perform the following functions:

(a) SO1: completes an a.c. latch circuit for the relay via C9.

(b) SO2: this contact is an interlock in the raise winding circuit of the motor and closes in preparation for subsequent switching of the winding.

(c) SO3: this contact, together with associated contact SO5, applies the mains input voltage to TR1.

(d) SO4: breaks the supply to the lower winding.

(e) SO5: this contact, together with associated contact SO3, applies the mains input voltage to TR1.

20. Because the transformer ratio is at maximum step-down ratio, the output voltage from TR1 is well outside the lower limit of $\pm$ 1% (unless the incoming mains voltage is 15% or more above the nominal). Therefore the tongue of relay VMA will make with contact L. In this position, the 20V-O-20V output from the auxiliary winding on TR1 is applied to the bridge rectifier MR6 via fuse FS10. The output from the bridge rectifier energizes relay LV, the contacts of which perform the following functions:

(1) LV1: opens and removes the short circuit from across RV1; this action results in a decrease of current through VMA and thus ensures positive action of the relay.

(2) LV2: completes the circuit of the raise winding via closed contact HV1.

(3) LV3: this contact opens to allow capacitor C10 to charge from the rectified output voltage of TR2 (fed via R10, MR8 and LV4). Immediately relay LV is released and the a.c. supply removed from the motor, C10 discharges through the raise winding via LV3 and R13. This action stops the motor very quickly because the initial discharge current from C10 is high. The exponential discharge, however, is sufficiently rapid to prevent damage to the motor.

(4) LV4: part of the function described in (3).

21. Operation of relay LV causes the motor to drive the brush arm of the tap changing mechanism. The drive is in such a direction that the output voltage is increased until it reaches the value of the norminal voltage. The tongue of relay VMA then breaks from the L contact, so that relay LV de-energizes and the motor stops. The tongue of relay VMA again floats and the tap on TR1 produces an output voltage within the required limits.

Dynamic correction of output voltage

22. With static load conditions, the tongue of the relay VMA floats between the H and L contacts as discussed previously. Assuming that the load conditions now change, such that the output voltage of TR1 increases beyond the 1% limit, the current through relay VMA also increases so that the tongue of the relay makes with the H contact. The contact feeds the voltage from the 20V-O-20V winding on TR1 to MR5 and thus energizes relay HV. The contacts of HV perform the following functions:

(1) HV1: opens and disconnects the discharge circuit of C10 from the raise winding circuit. When relay HV becomes de-energized at the end of the tap changing period, contact HV1 closes and allows C10 to discharge through the raise winding.

(2) HV2: completes the charging circuit for C10 from the output of TR2, via R10 and MR8.

(3) HV3: short circuits RV2 (and R11 if fitted) and increases the current to VMA, thus ensuring positive contact of the tongue of the relay with contact H.

(4) HV4: completes the circuit to the lower winding of the motor. The motor then rotates, changing the position of the tap on TR1, until the output voltage of TR1 falls to within the 1% limit.

23. With the voltage corrected to within the 1% limit, the circuit reverts to normal operation. Should the voltage fall below the lower limit, the tongue of relay VMA switches the voltage from the auxiliary winding of TR1 to MR6, thus energizing relay LV. The functions of the contacts of this relay have been discussed previously.

Limit switches

24. If the tap has been driven to one end of its range without bringing the output voltage to within the 1% limit, either the high limit switch (HLS) or the low limit switch (LLS) operates. These switches have mechanically actuated contacts, the main function of which is to prevent the motor overdriving the tap changing mechanism.

25. Contact LLS3 is concerned only with the initial switch-on sequence; the functions of the remaining LLS contacts are as described previously. Limit switch HLS has only two contacts and their functions are as follows:

(1) HLS1: completes the loop for an external alarm.

(2) HLS2: breaks the circuit of the raise winding and stops the motor.

Fail-safe action of VMA

26. Should a condition arise where both the HV and LV relays operate (for example, due to a fault condition of the contact assembly of VMA), the motor circuit is interlocked to ensure that the motor can rotate only in the direction which lowers the output voltage. This arrangement protects the load against high voltages. The interlock is provided by means of contact HV1, which breaks the circuit of the raise winding.

Mains failure

27. The stabilization action is repeated whenever the output voltage deviates from the nominal voltage by ±1%. The operation of the stabilizer continues normally except when the mains input voltage fails, or is switched off. In either event, relay SO de-energizes and prepares the overall circuit for the initial switch-on sequence, when the mains input is restored. The two stages of the switch-on period take a maximum of 10 seconds. The first stage takes a maximum of 5 seconds, at the end of which the output voltage from TR1 is applied to the load. The second stage takes a maximum of 5 seconds, during which time the output voltage is raised to the nominal level. However, if the mains voltage is at a maximum (+ 15% above nominal) when it fails and is restored at + 15%, the connection to the load is made immediately and at the nominal voltage. The full 10 seconds are taken when the mains voltage fails and then restores at its minimum value (— 15% below nominal).

SERVICING

Tests for serviceability

28. These tests are implemented to maintain satisfactory operation of the voltage stabilizer, and comprise periodic checking of anti-hunting adjustments and periodic maintenance procedure.

Anti-hunting

29. Marginal deviation of the voltage from the ±1% limits could cause intermittent opening and closing (hunting) of the contacts of VMA. The following two rheostats in the stabilized supply to the bridge rectifier (MR1 to MR4) are adjusted to prevent the possibility of hunting:

(1) RV2: this rheostat is adjusted to prevent hunting of relay HV once the relay has operated.

(2) RV1: this rheostat is adjusted to prevent hunting of LV once the relay has operated.

Maintenance

30. The only protective maintenance required on the voltage stabilizer is a periodic check to be implemented at 6-month intervals. The check consists of the following procedure:

(1) Using compressed air, remove all dust adhering to the framework or moving parts of the voltage stabilizer.

(2) Ensure that the drive chain from the motor to the brush gear is not excessively slack; the tension is adjusted by the tension nut located in the centre of the chain. A movement of approximately ¼ in. at the centre of the chain denotes a satisfactory tension. The chain is a Reynolds 110500 chain of two lengths. One length has 43 links and the other has 21 links plus one cranked link (Reynolds No. 30 Berco Part No. L1-14).

(3) Wipe brush tracks with a piece of clean soft rag to remove any remaining particles of dust. If the brush track is very dirty, clean with fine glass paper (grade OO) and wipe with clean soft rag.

(4) Check brushes for wear and renew if necessary. Brushes are of copper graphite composition.

(5) Examine chain and sprockets and brush carriage slide for lack of lubrication. All moving parts should be lubricated very lightly with a fine grade of oil.

Dismantling instructions

31. Although the voltage stabilizer is an electromechanical device, the mechanical components are not complicated. The method of removal is self-evident. Layout and identification of components is shown in fig. 1 and fig. 3.

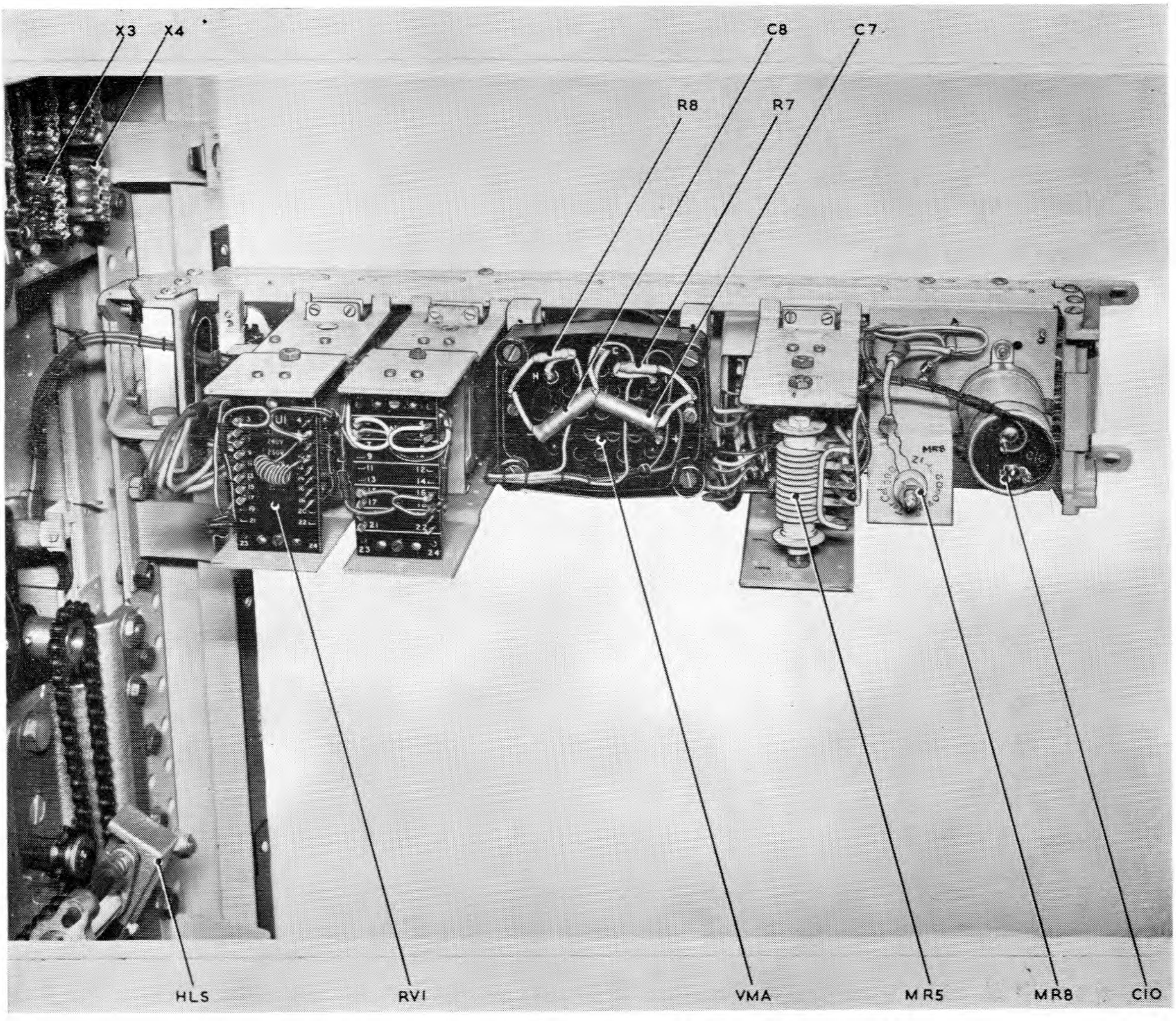

Fig. 3. Voltage stabilizer: rear view of centre panel

FAULT DIAGNOSIS

Servicing data

32. To assist in servicing and fault finding on the voltage stabilizer, details of relays HV, LV and SO are given in Table 3.

Common faults

33. Due to the robust construction of the voltage stabilizer, faults are not common.

TABLE 3

Relay data

Circuit designation	LV	HV	SO
Type	4664 MDZ	4664 MFK	4665 MAS
Winding resistance (ohms)	2000	2000	1000
Normal contact pressure (grammes)	20-25	16-20	16-20
Residual gap (mm)		12	4
Saturate current (mA)	21	22	29
Operate current (mA)	12	10	14

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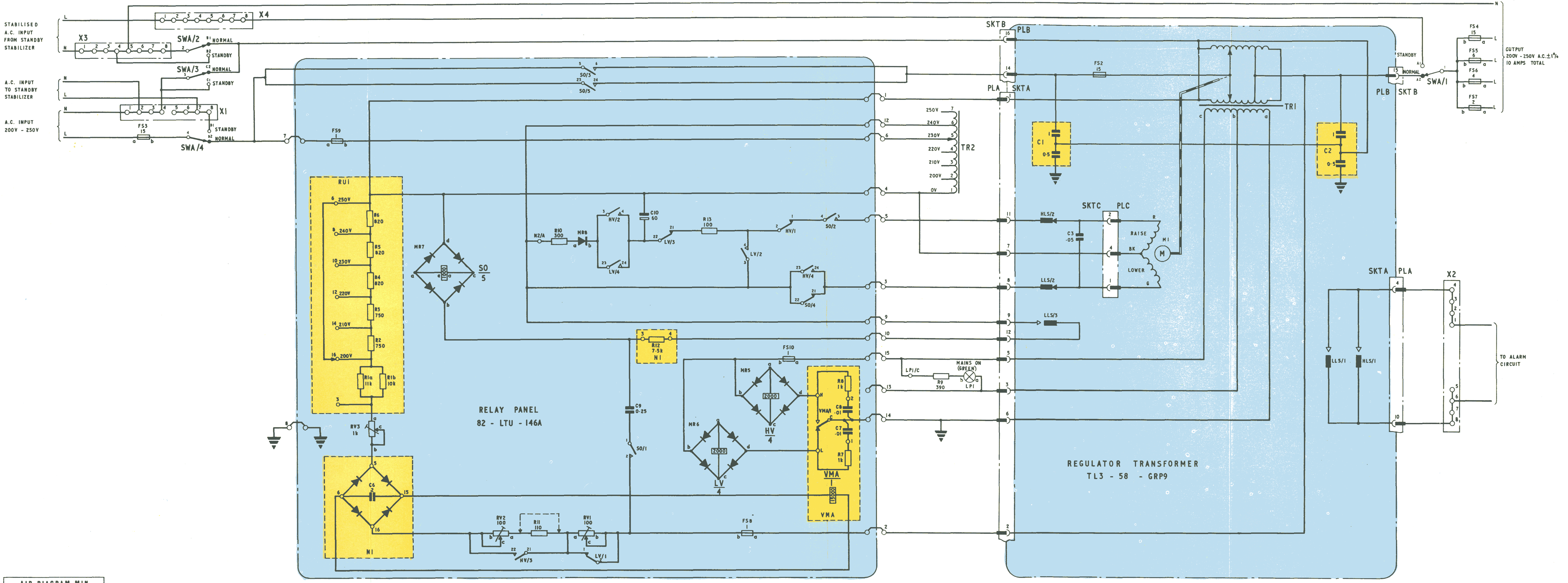

Voltage stabilizer (6110-99-933-1036): circuit diagram.

Fig. 4

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Chapter 6

CONSTANT VOLTAGE TRANSFORMER

(5P/3648)

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Introduction

1. The constant voltage transformer Advance type CV.1000A is a static electromagnetic voltage stabilizer to provide a constant voltage a.c. output, irrespective of fluctuations in mains input voltage.

2. The transformer is used in all station types of CADF FGRI 23078 (fig. 3) to provide a stabilized mains input to the d.f. cabinets, branch channel cabinets and the single pretuned receiver and d.f. cabinet.

3. In CADF auto triangulation installations, (branch channel cabinet and single pretuned receiver and d.f. cabinet) two constant voltage transformers are employed to provide for the greater load. Each transformer has an output capacity of 1000 W.

4. The transformer(s) are housed in the load d.f. building and situated on the right hand wall when approached from the door.

Construction

5. The constant voltage transformer has a conventional transformer main core, constructed of silicon iron laminations to form a three limbed yoke, illustrated in fig. 2(a). The space provided between the limbs is unconventional in that it is divided by a stack of laminations 'M', which perform the function of a high reluctance magnetic shunt.

6. The windings of the transformer are wound about the centre limb of the yoke with the primary and compensating (bucking) windings one side of the magnetic shunt and the secondary windings the other.

7. The transformer is mounted on two channel bars (fig. 1), together with capacitors necessary to ensure a constant voltage output. At each end of the transformer an extended metal cover, slotted to allow for air cooling, protects the capacitors and at the other terminations for the input and output wiring.

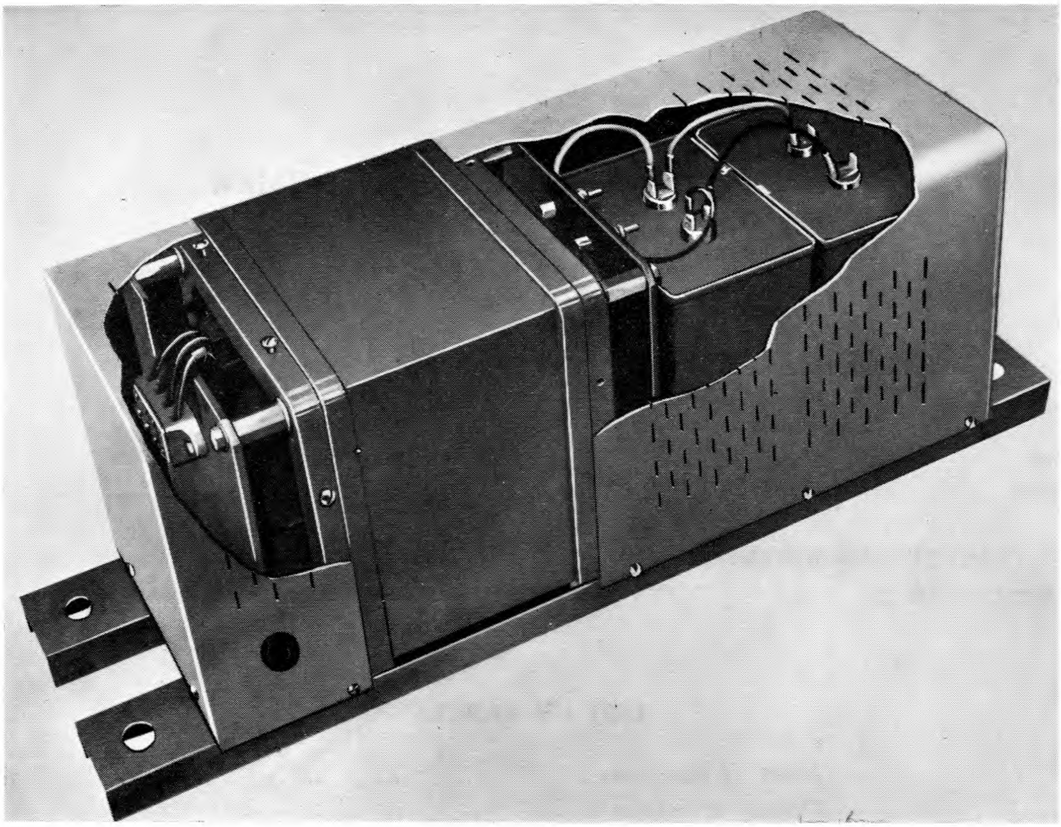


Fig. 1. Constant voltage transformer: general view

CIRCUIT DESCRIPTION

Transformer windings

8. The electrical circuit is comprised of three windings; (illustrated in fig. 2(b) a primary 'P' a secondary 'S' and a compensating or bucking winding 'C'. The compensating winding is connected in series with but wound in opposition to the secondary winding. To ensure a constant voltage output it is necessary to connect a capacitor across the secondary winding. An additional tertiary winding 'T' is provided (not shown in fig. 2(b)) and would only be used where an exceptionally low or high voltage output was required (not in CADF).

Circuit operation

9. When a low voltage input is applied to the primary winding of the transformer, a voltage is induced into the secondary approximately equal to the turns ratio of the transformer. The magnetic shunt 'M' will have little influence on the magnetic field due to the air gap being relatively large compared with the direct path of the centre limb of the main core. Therefore the reluctance (ratio of magnetic force: magnetic flux) of the shunt will be relatively high compared with the main core.

10. As the input voltage is increased, the flux density in the centre limb also increases. The voltage induced into the secondary will correspondingly increase to a point where the inductive reactance XL will approach the reactance XC of the capacitor strapped across it, at the operating frequency.

11. As the secondary circuit aproaches resonance (XL = XC) the voltage across it will rise to a stable predetermined valve. The voltage will rise per turn of secondary over volts per turn of the primary due to the flow of capacitive current through the leakage inductance of the transformer.

12. The rise in voltage will cause the lower portion of the core 'B' to increase towards saturation and hence the relative reluctance to increase accordingly. This allows a greater amount of flux to circulate in the magnetic shunt core 'M' until actual resonance is reached in the secondary circuit, when except for maintaining resonance, iron and copper losses, all the flux produced by the primary core will flow through the shunt 'M'.

13. Any change of primary input voltage will result in a flux density change in the top portion of the core 'A' and hence have little effect on the stable flux produced by the resonant secondary in the lower portion of the core 'B'. The secondary therefore is a constant voltage source, provided resonance is maintained.

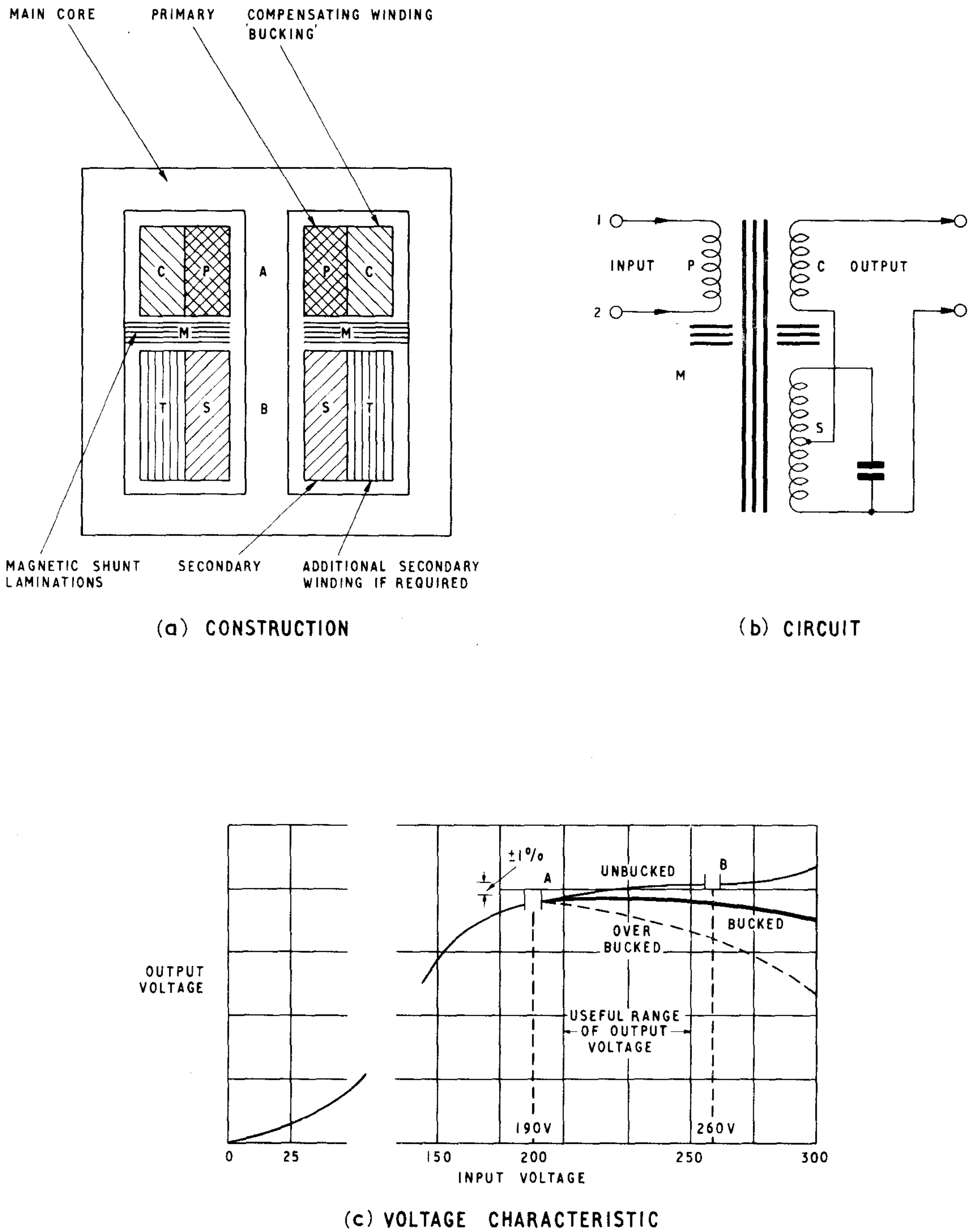


Fig. 2. Details of constant voltage transformer

Compensating winding

14. The output characteristic curve of a typical c.v. transformer is illustrated in the graph of fig. 2(c) and demonstrates the necessity for the compensating winding.

15. A sharp rise to resonance of the secondary circuit is shown by the initial part of the curve (point A). The useful voltage range output is illustrated on the curve between A and B. It will be noted that between these points, there is a gradual rise in output voltage in an uncompensated (unbucked) transformer. This is due to residual coupling between primary and secondary, since complete isolation with the primary is impossible.

16. The output voltage rise between the points A to B may be corrected by the bucking winding wound in voltage opposition to the secondary. This is set at manufacture to produce a compensating voltage approximately equal to the change in voltage in the secondary produced by a rise in the primary. The effect of over compensation is a fall off in voltage output for a corresponding rise in input.

Output characteristics

17. The ◀230V▶ (r.m.s.) output voltage is stabilized to within ± 1% for input voltage variations of ± 15% about 240V. The voltage output will contain approximately 20% distortion and should be taken into account when measuring the output, i.e. an instrument measuring r.m.s. value, such as a dynamometer or moving iron voltmeter. A rectifier type meter will indicate an incorrectly high voltage.

18. For a change of frequency of ± 1% the output voltage will vary by approximately ± 1.5%. This response is linear over ± 5% of the supply frequency.

19. If the c.v. transformer is overloaded the stabilizing action will be affected although it has been designed to stand overloads of approximately 150%. Direct short circuits for a limited period will not harm the transformer and will cause the output voltage to collapse thus protecting itself.

Installation

20. The transformer(s) is mounted on the wall in a well ventilated position with the capacitor compartment below when mounted vertically. This is necessary as the transformer is designed to operate at high flux density and hence with relatively high core temperatures. If the core is exposed after a running period of an hour or so it will feel hot to touch with the bare hand.

WARNING...

FAILURE TO OBSERVE THE CORRECT MOUNTING MAY RESULT IN DETERIORATION OF THE CAPACITOR UNITS

Input and output connections

21. Input and output cabling is via two grommeted side entry holes in the removable cover. Three types of termination may be encountered in the c.v. transformer series but the method of numbering is standard and illustrated in Table 1 and Table 2. Where there is a choice of input arrangements, these are listed under voltage and any link terminals in the adjacent column.

TABLE 1

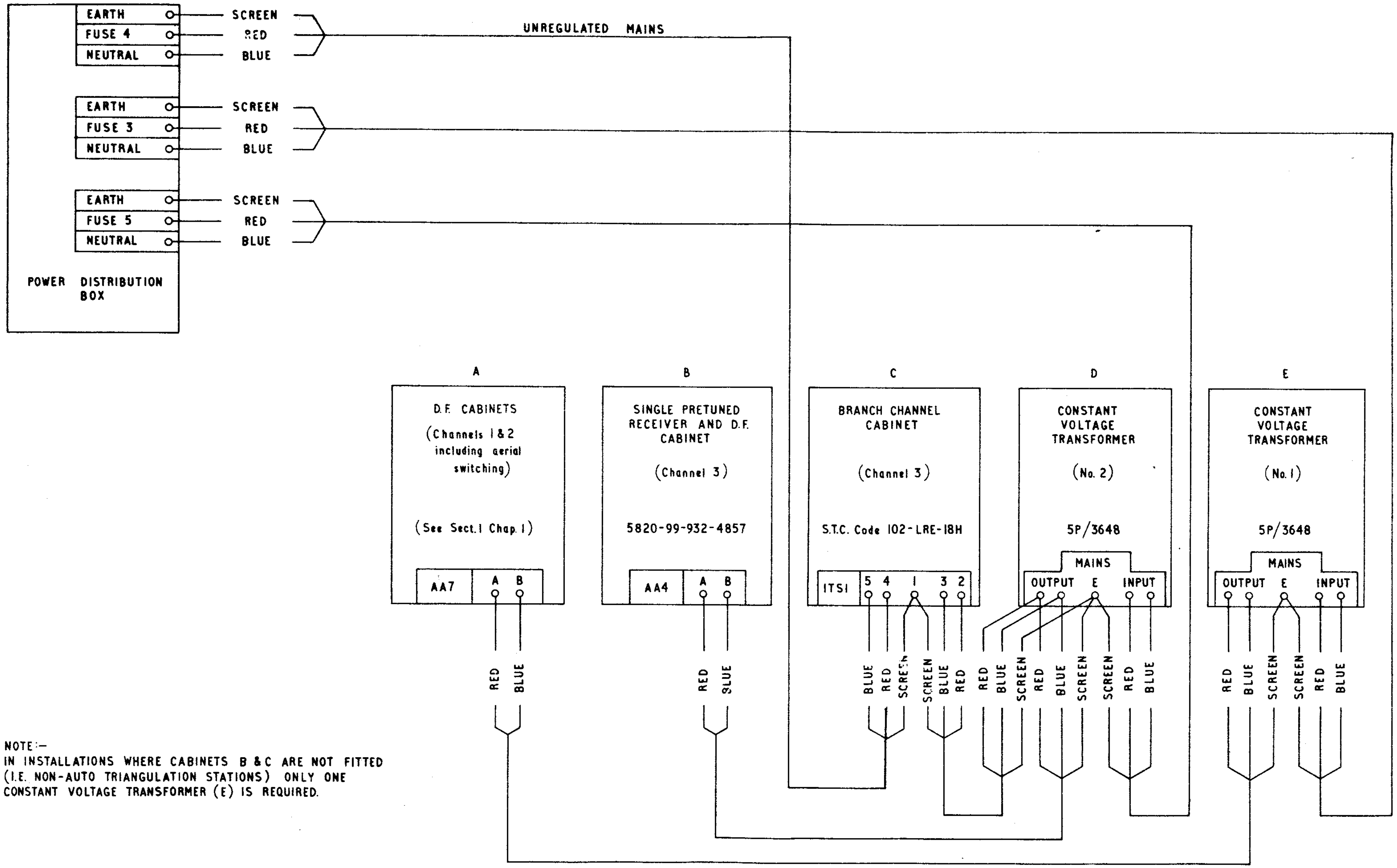
Input Terminations

Input	Voltage	Link terminals	Input terminals
Single	-	-	1-2
Series	High	2-4	1-3
Parallel	Low	1-2, 3-4	-
	Low	-	1-2
Multi-input	Mid	-	1-3
	High	-	1-4
	200	-	2-3
Standard	215		2-4
Tapped	230		1-3
	245		1-4

TABLE 2

Output Terminations

Output terminal type	Output terminals
SOLDERED TAG BOARD	
Output 1	5 - 6
Output 2	7 - 8
Capacitor	9 - 10
SCREW TERMINAL BOARD	
Output 1	5 - 6
Capacitor	7 - 8
TERMINAL BLOCKS	
Output 1	5 - 6
Output 2	7 - 8
Output 3	9 - 10
Capacitor (when term.)	11 - 12



NOTE:–
IN INSTALLATIONS WHERE CABINETS B & C ARE NOT FITTED (I.E. NON-AUTO TRIANGULATION STATIONS) ONLY ONE CONSTANT VOLTAGE TRANSFORMER (E) IS REQUIRED.

F.G.R.I. 23078 C.A.D.F. Constant voltage transformers : interconnections

Fig. 3

0526244 DE40386 SW Ltd., 5/70

Chapter 1

BEARING SIMULATOR (6625-99-946-5431)

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UNIT DESCRIPTION

Introduction

1. The bearing simulator is a self-contained test equipment used for checking the d.f. and display circuits of the C.A.D.F. equipment when the receivers and aerials are not connected. (The test oscillator, described in Sect. 3, Chap. 3, performs a similar function, but requires the aerial system and the receivers to be operational.)

2. The unit provides a phase-modulated signal that is fed into the d.f. chain and processed in the same way as a normal d.f. aerial signal, thus producing a simulated bearing trace on the c.r.t. indicator.

3. A crystal-controlled oscillator in the unit produces a 14·444 c/s signal that is phase modulated by a 55·5 c/s input; this input is a synthesized sine wave (giving a stepped waveform) and is taken from a metering point on the reference signal generator (5825-99-943-5889). The phase modulated 14·444 c/s signal is frequency multiplied by nine and then fed to the combining amplifier (5825-99-943-5900). The TRACE LENGTH control, situated on the front panel of the bearing generator, governs the amount of phase modulation of the oscillator signal and provides for a phase excursion of more than ±360° of the final output signal. The 14·444 c/s signal is thus phase modulated at the same frequency

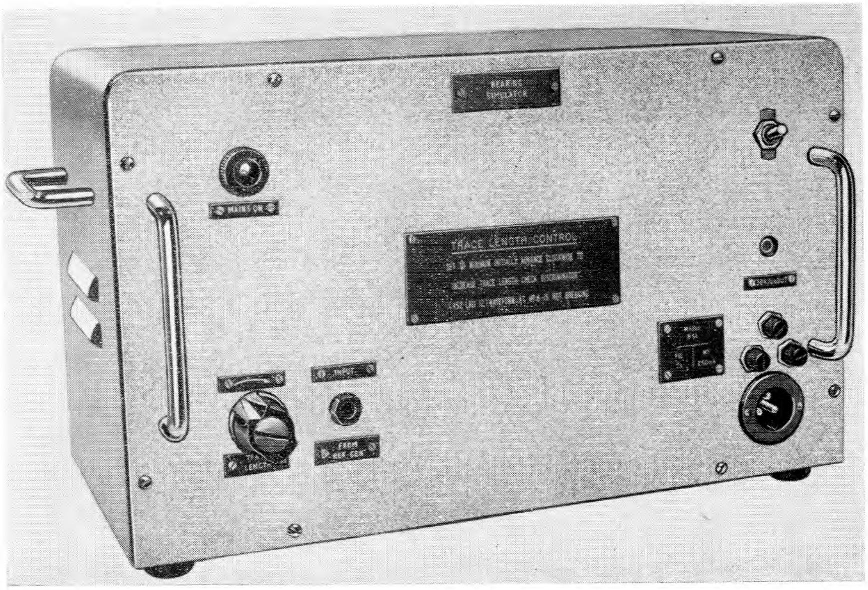


Fig. 1. Bearing simulator: front view

(55·5 c/s) as the cyclical aerial switching phase modulates the normal r.f. signal.

4. The bearing simulator can be used during installation of the C.A.D.F. equipment to test and align the d.f. and display circuits before the aerials are erected. It also provides a means of testing and fault finding when operational requirements prevent using radiated signals from the test oscillator aerial.

Construction

5. The chassis and front panel of the bearing simulator are bolted together, the front panel being secured to the case by eight counter-sunk screws. All the components are mounted on the chassis or front panel of the unit. The case provides ventilation louvres at the back and sides, lifting handles and four rubber feet. The controls, MAINS ON lamp, fuses and input and output connectors are all mounted on the front panel of the unit.

6. The bearing simulator is supplied with the following cord connectors:—

(1) Mains cable with input socket (33-LRA-343A)

(2) Reference waveform input cable (33-LRA.342A)

(3) 130 kc/s output coaxial cable (33-LRA.74R)

Brief electrical description (fig. 9)

7. The bearing simulator contains a crystal-controlled oscillator V3a that generates a 14·444 kc/s signal. This signal is subsequently amplified by V3b and then fed to a phasing network (R27, C25, C24, R28). The output of V3b is also fed to a diode (V4b) for a.g.c. of the oscillator stage. The phasing network produces two outputs in quadrature and these are fed to modulator stages V5 and V6 respectively.

8. Buffer amplifier V1b amplifies the 55·5 c/s stepped sine-wave input to the unit (received from the reference signal generator) and passes it to another amplifying stage (V2b) via a T-filter network (R4, R3, C2). The output of V2b is fed to a phase-splitter (V2a) and to a parallel T-filter (R8, C5, C4, R6 and C6, R7, C3) feedback circuit. Phase-splitter V2a receives a pure 55·5 c/s sine wave and produces two outputs in anti-phase, which it feeds to modulator stages V5 and V6 respectively. The anti-phase inputs phase modulate the 14·444 kc/s signals and the resultant outputs are combined by L1, C31. The phase-modulated output signal from L1, C31 is fed via two frequency trebler stages to the combining amplifier unit.

Circuit description (fig. 10)

9. *Oscillator circuits.* One half of double triode V3 is a crystal-controlled oscillator generating a 14·444 kc/s signal that is amplified by the other half of the valve. The output of V3b is fed to phasing network R27, C25 and C24, R28, which produces two outputs of 14·444 kc/s in quadrature. These signals are fed to the control grids of modulating stages V5 and V6 respectively.

10. The output of V3b is also fed via capacitor C48 to the anode of diode V4b to provide automatic gain control for oscillator V3a. When the output signal of V3b increases in amplitude, the increase is transmitted to V4b anode, which conducts during the positive half waves thus developing a negative bias potential that is smoothed by R42, C22 and fed via R21 to the grid of oscillator V3a. MR2, in parallel with V4b, is included as a safety device so that should V4b cease conducting MR2 will take over and perform the necessary rectification.

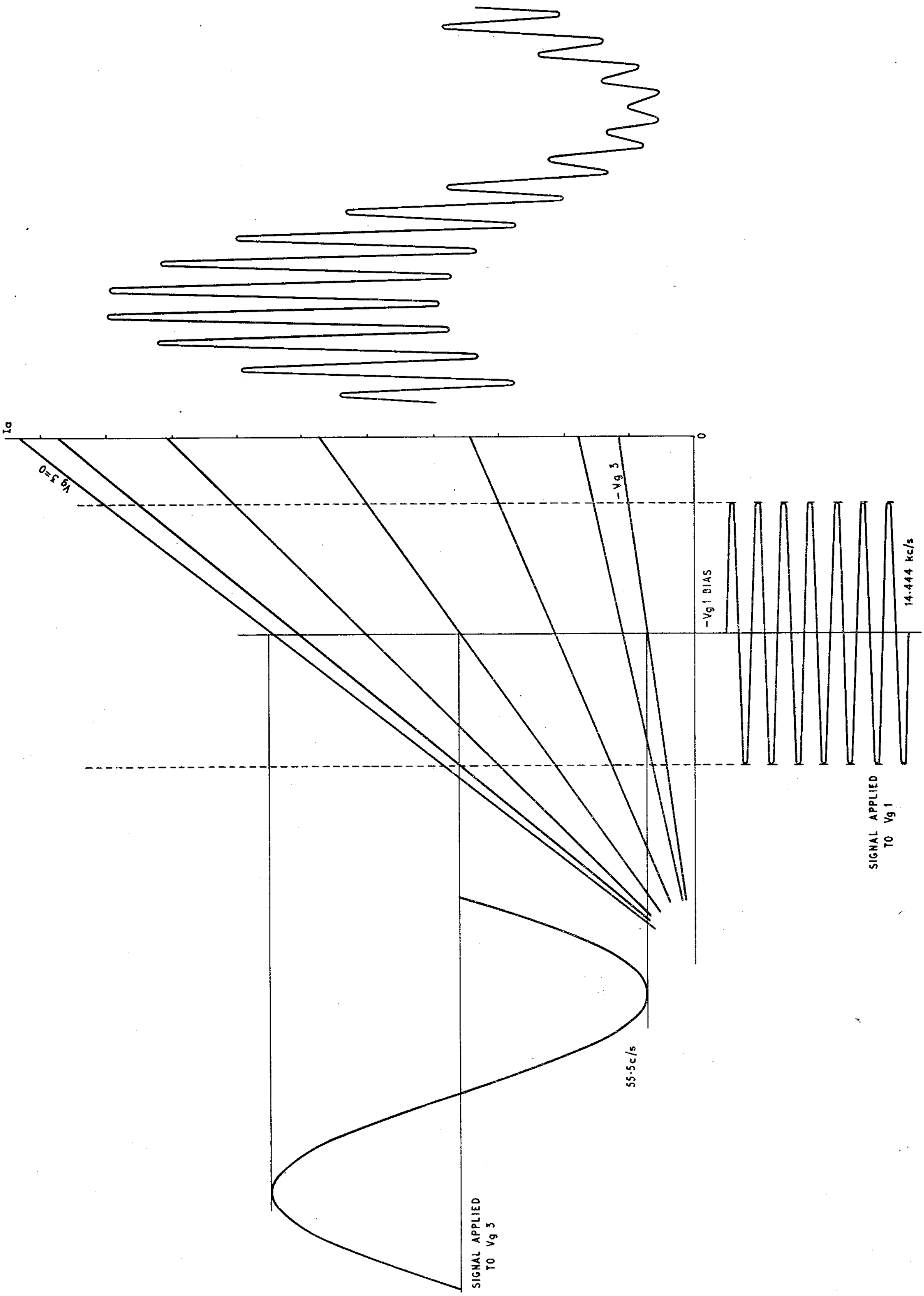


Fig. 2. Output of one leg of modulator: waveform

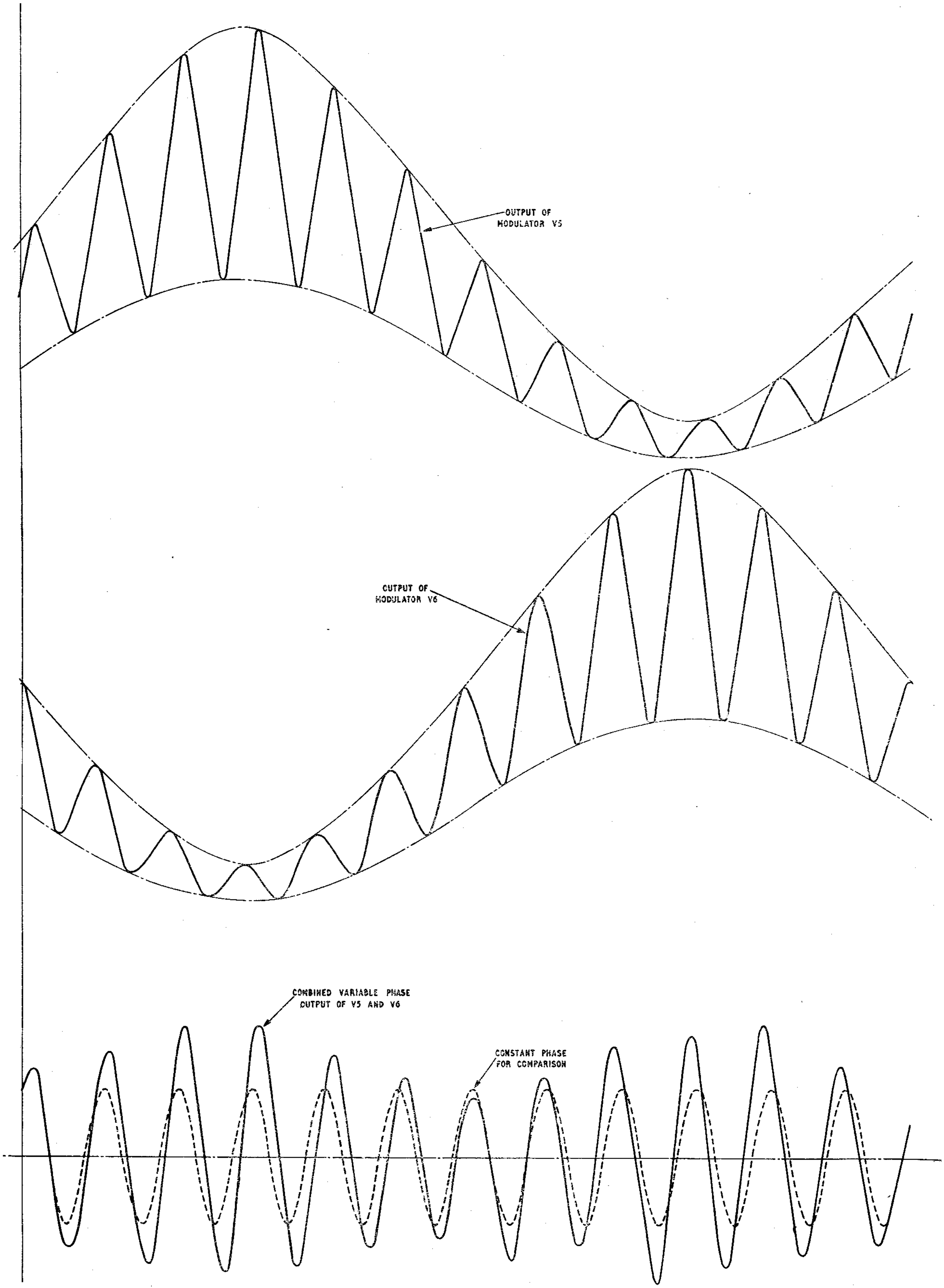


Fig. 3. Combined output of modulator V5, V6: waveforms

11. *Reference waveform input circuits.* The 55·5 c/s stepped sine wave from MP1 of the reference signal generator is fed into the bearing simulator via the INPUT FROM REF. GEN. jack socket JK1. The input is applied to the grid of cathode follower stage V1b via a capacitor (C49) and a potential divider consisting of resistor R1 and the TRACE LENGTH control RV1. The other half (V1a) of the double triode is not used. The output of V1b is fed via coupling capacitor C1 to T-filter R3, R4, C2, which tends to smooth the steps of the waveform. The signal is then fed to amplifying stage V2b; the high-frequency components appearing at the output of the stage are fed back to the grid of V2b in anti-phase via C7, R5 and the parallel T-filter network R8, C5, C4, R6 and C6, R7, C3. The filter network rejects the 55·5 c/s frequency but passes the frequency components on either side, thus attenuating these unwanted components by negative feedback action. Current negative feedback is applied to V2b by the undecoupled cathode bias resistor R10. Amplifier stage V2b has a peak frequency response at 55·5 c/s and produces a pure sine wave output, which it feeds to phase-splitter V2a.

12. Two outputs are taken from V2a, one from the anode load (R15) via C10 and the other from the cathode load (R14) via C11. These outputs are in anti-phase, and are fed to the suppressor grids of modulating stages V5 and V6, respectively, where they phase modulate the 14·444 kc/s oscillator signal arriving at the control grids of the valves.

13. *Phase modulation circuit.* The 14·444 kc/s oscillator signal is fed to phasing components R27 and C25, which give a 45° phase lag in the signal to V5 control grid; it is also fed to phasing components C24 and R28, which give a 45° phase lead in the signal to V6 control grid.

14. The 55·5 c/s signal present at the suppressor grid of V5 or V6 varies the gain of the valve (see fig. 2). Because the signal to V5 is in anti-phase to that at V6, the output of V6 is reduced when V5 output is increased, and vice versa at a rate of 55·5 c/s.

15. The outputs of modulating valves V5 and V6 are combined by their common anode load L1, C31, which produces a resultant waveform (fig. 3) that is phase modulated about the static output of the circuit. The static output is the resultant of V5 and V6 outputs when there is no 55·5 c/s signal present; it is in-phase with the oscillator output signal.

16. The maximum possible phase excursion of the resultant signal is ±45°, and is obtained when either V5 or V6 has zero gain and therefore zero output. The phase excursion of the signal is proportional to the amplitude of the 55·5 c/s modulating signal, which is determined by the setting of the TRACE LENGTH control RV1.

17. *Frequency trebler circuits.* The ±45° phase excursion of the signal from the modulation circuit is insufficient to give a reasonable trace length on the c.r.t. indicator associated with the d.f. equipment. Therefore two frequency trebler stages (V7 and V8) are included in the bearing simulator to increase the carrier frequency from 14·444 kc/s to 130 kc/s, and the maximum possible phase excursion from ±45° to ±405°.

18. The combined output of V5 and V6 is coupled via C34 to the control grid of pentode V7, the anode load of which is a tuned circuit resonant at 43·333 kc/s. The output of V7 is inductively coupled by L2 to the control grid of a second pentode V8 via C40. V8 and its anode load (L3, C42, C43) comprise the second trebler stage, the anode load being another tuned circuit but resonant at 130 kc/s. The output from L3 is fed to PL1 of the unit and then to PL2 of the combining amplifier.

19. *Power supplies.* The bearing simulator has a built-in power unit and requires only a single-phase a.c. supply between 200 and 250 volts. The mains transformer TR1 produces 335 volts a.c. which is then rectified by the bridge circuit MR1 and smoothed by network CH1, C16, C15 providing the 250-volt h.t. supply for the oscillator, modulator and trebler stages. This line also supplies the h.t. for the reference waveform input stages but incorporates extra smoothing (R20, C14) to ensure that there is no 50 c/s ripple, which would produce beats in these circuits.

20. Transformer TR1 also has a 6·3-volt secondary winding which supplies the valve heaters and the unit MAINS ON lamp LP1. The 6·3 volts is rectified by diode V4a, smoothed by network C12, R19, C13 and then fed to the suppressor grids of V5 and V6 via voltage dividers R18, R17 and R18, R16 to provide −2 volts d.c. bias for the grids of the modulating valves.

SERVICING

Test apparatus

21. The following items of test equipment are required for full servicing:

(1) Low-frequency oscillator capable of producing a good sine wave at 55 c/s (Test Set, Oscillator CT373, 6625-99-943-8385).

(2) Valve voltmeter CT54, 6625-99-943-2418 or, if available, valve voltmeter 10ZZ/202134.

(3) Oscilloscope CT316, 10S/16605 or CT414, 6625-99-943-1632.

(4) Multimeter Type 9980 or Type 12889.

(5) Counting type frequency standard (Counter, Electrical Frequency CT488).

(6) Load resistor, 68 ohms, fitted with a G.P.O. coaxial plug type PR8A.

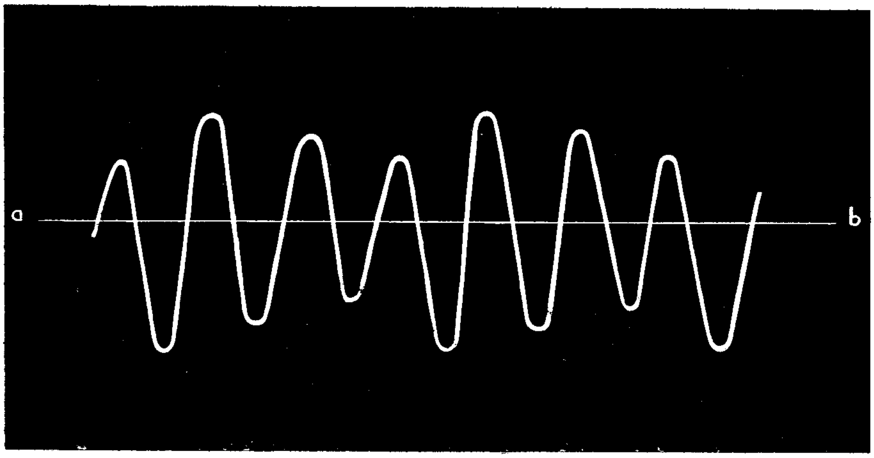


Fig. 4. Amplitude decay 3 c/s—43· 333 kc/s unmodulated waveform

(7) Trimming tool (S.T.C. Code 73-4215AG).

(8) Cord connectors: 33-LRA.343A
33-LRA.342A
33-LRA.74R

Tests for serviceability

22. Preliminary serviceability checks are carried out as follows:—

(1) Connect the oscilloscope to MP1 of the reference signal generator and check that the observed waveform is a stepped sine wave at 55·5 c/s with no pulses missing.

(2) Disconnect the oscilloscope and connect cord connector 33-LRA.342A between the INPUT FROM REF. GEN. socket (JK1) on the bearing simulator and MP1 on the reference signal generator.

(3) Set the TRACE LENGTH control (RV1) on the bearing simulator fully counter-clockwise and connect the 33-LRA.74R cord connector to the 130 KC/S OUT plug (PL1), with the 68 ohms load resistor connected across the free end of the connector.

(4) Connect the valve voltmeter and oscilloscope across the load and check that the meter reading is not less than 0·4V r.m.s.

(5) Rotate the TRACE LENGTH control slowly clockwise to its maximum position to ensure that at least $\pm 360°$ of phase modulation can be imposed on the output waveform as monitored on the oscilloscope (fig. 8).

(6) Set the TRACE LENGTH control on the bearing simulator fully counter-clockwise again.

(7) Connect the frequency counter in place of the valve voltmeter and oscilloscope across the load resistor and check the frequency of the output waveform; this should be 130 kc/s.

23. The bearing simulator can be removed from its case for replacement or servicing by releasing the eight countersunk screws round the edge of the front panel, and then removing the front panel complete with chassis from the case.

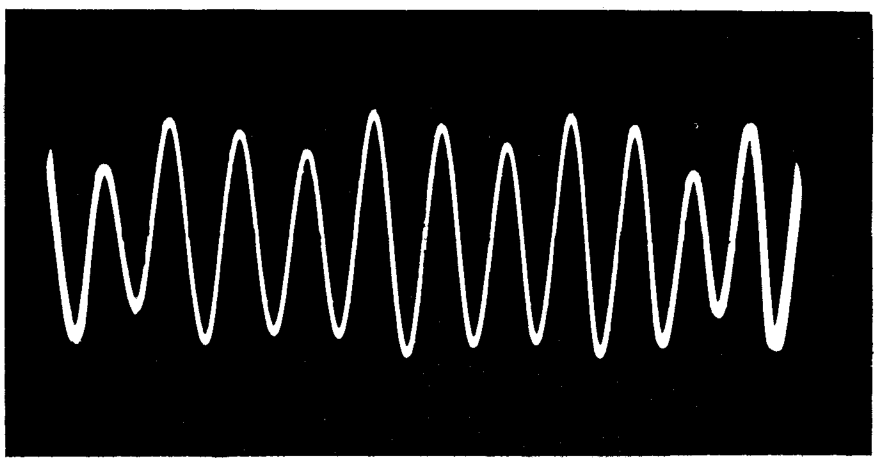


Fig. 5. Amplitude decay over 9 c/s superimposed on 3 c/s variation—130 kc/s unmodulated waveform

Re-alignment procedure

24. The re-alignment procedure described in the following paragraphs is normally undertaken only at third line servicing. The unit can be tested on the bench using the l.f. oscillator for the 55·5 c/s input or using cord connector 33-LRA.342A connected to the reference signal generator in the cabinet.

25. To re-align the bearing simulator carry out the following operations, making reference to Table 1:—

(1) Connect the counting type frequency standard between V3a pin 6 and earth to measure the frequency of the crystal oscillator output and record the result.

(2) Disconnect the counter and rotate the TRACE LENGTH control (RV1) on the bearing simulator to its minimum setting (counter-clockwise).

(3) Connect the valve voltmeter between V7 pin 1 and earth and, using the trimming tool, tune L1 for a maximum reading at the meter; this reading should be not less than 4·0V r.m.s.

(4) Connect the valve voltmeter and oscilloscope between V8 pin 1 and earth and connect the oscilloscope sync. lead to the junction of C47, R41, situated in the output circuit of V3b.

(5) Using the trimming tool, tune L2 for a maximum reading at the meter; this reading should be not less than 2·5V r.m.s.

(6) Check with the oscilloscope that the waveform is balanced about the centre line ab (0 volts) as shown in fig. 4. The waveform decays slightly in amplitude every three cycles, but this is normal and results from selection of the third harmonic of the oscillator frequency giving a progressive reduction in drive to V8 on the 2nd and 3rd cycles.

(7) Connect the frequency counter in place of the valve voltmeter and oscilloscope and check the frequency of the waveform; this should be three times the oscillator frequency, i.e. 43·333 kc/s.

(8) Connect the 33-LRA.74R cord connector to the 130 KC/S OUT plug (PL1) and connect the 68 ohms load resistor across the free end of the connector.

(9) Connect the valve voltmeter and oscilloscope across the load and connect the oscilloscope sync. lead to the junction of C47, R41.

(10) Using the trimming tool, tune L3 for a maximum reading at the meter; this reading should be not less than 0·4V r.m.s.

(11) Check with the oscilloscope that the waveform is balanced about the centre line (0 volts) as in operation (6). There is a reduction in amplitude of the waveform over nine cycles superimposed on the three cycle variation (fig. 5). This amplitude reduction results from selection of the ninth harmonic of the oscillator frequency.

(12) Connect the frequency counter in place of the valve voltmeter and oscilloscope and check the frequency of the waveform; this should be nine times the oscillator frequency, i.e. 130 kc/s.

(13) Connect the 33-LRA.342A cord connector between the INPUT FROM REF. GEN. socket (JK1) on the bearing simulator and the output of the l.f. oscillator.

(14) Reconnect the oscilloscope across the load resistor.

(15) Rotate the TRACE LENGTH control (RV1) on the bearing simulator to its maximum setting (clockwise) and set the l.f. oscillator frequency to 55·5 c/s.

(16) Increase the l.f. oscillator output until the oscilloscope shows $\pm 360°$ phase modulation of the output waveform (fig. 8). Record the l.f. oscillator output voltage; this voltage should not exceed 10V r.m.s. Figs. 6 and 7 show the waveforms for 90° and 180° of phase modulation respectively.

Note . . .

If peaks of maximum phase excursion (points A and B on the diagrams) are not of equal amplitude, the fault is due to one or more of the following causes:—

(a) *Valves V5 and V6 have unbalanced outputs.*

(b) *The quadrature phasing network (R27, C25, C24, R28) is giving unbalanced drives to V5 and V6.*

(c) *The 55·5 c/s anti-phase inputs to V5 and V6 are unbalanced.*

(17) Disconnect the 68-ohms load and plug cord connector 33-LRA.74R into PL2 of the combining amplifier in the C.A.D.F. equipment.

(18) Disconnect the l.f. oscillator and plug cord connector 33-LRA.342A into MP1 of the reference signal generator.

(19) Check that the bearing simulator gives a bearing with a good trace length on the c.r.t. indicator.

(20) Connect the oscilloscope between V2 pin 6 and earth and check that the waveform at this point is a pure sine wave at 55·5 c/s.

(21) Connect the oscilloscope to each side of MP8 in turn of the signal comparator and check that the integrated sine wave is sinusoidal and is not 'breaking'.

26. Table 1 gives the frequencies and typical voltages for re-alignment of the bearing simulator. All voltages are measured with the valve voltmeter and frequencies with the counting type frequency standard.

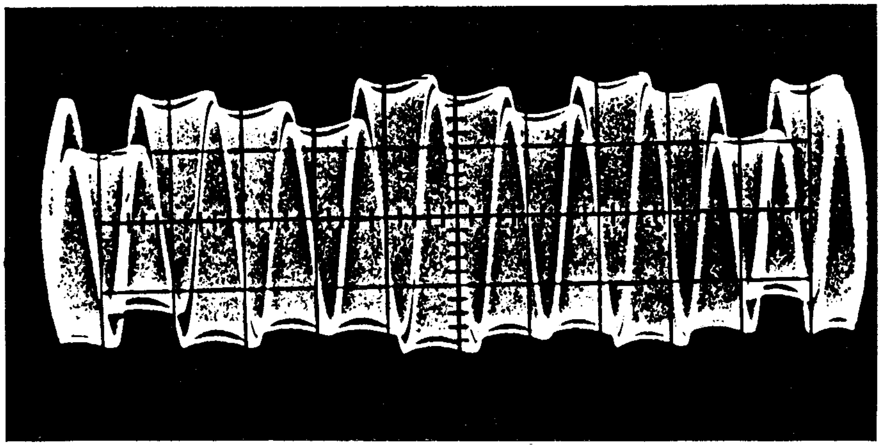


Fig. 6. 130 kc/s final output waveform for ±90° modulation

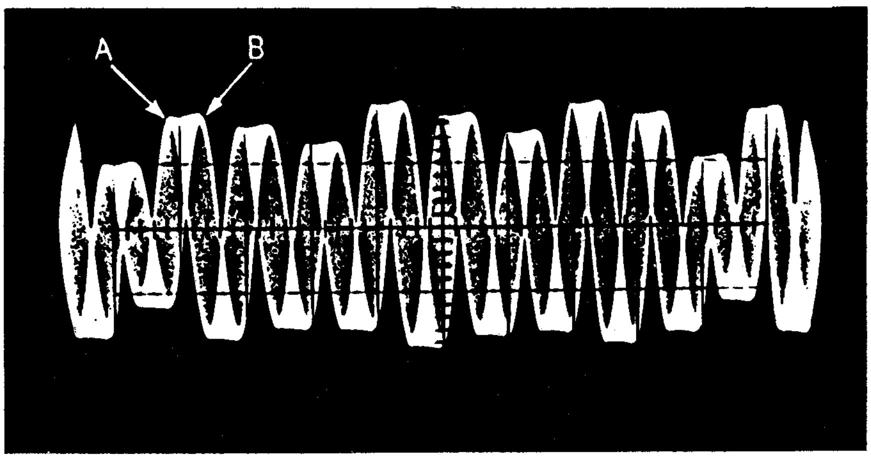
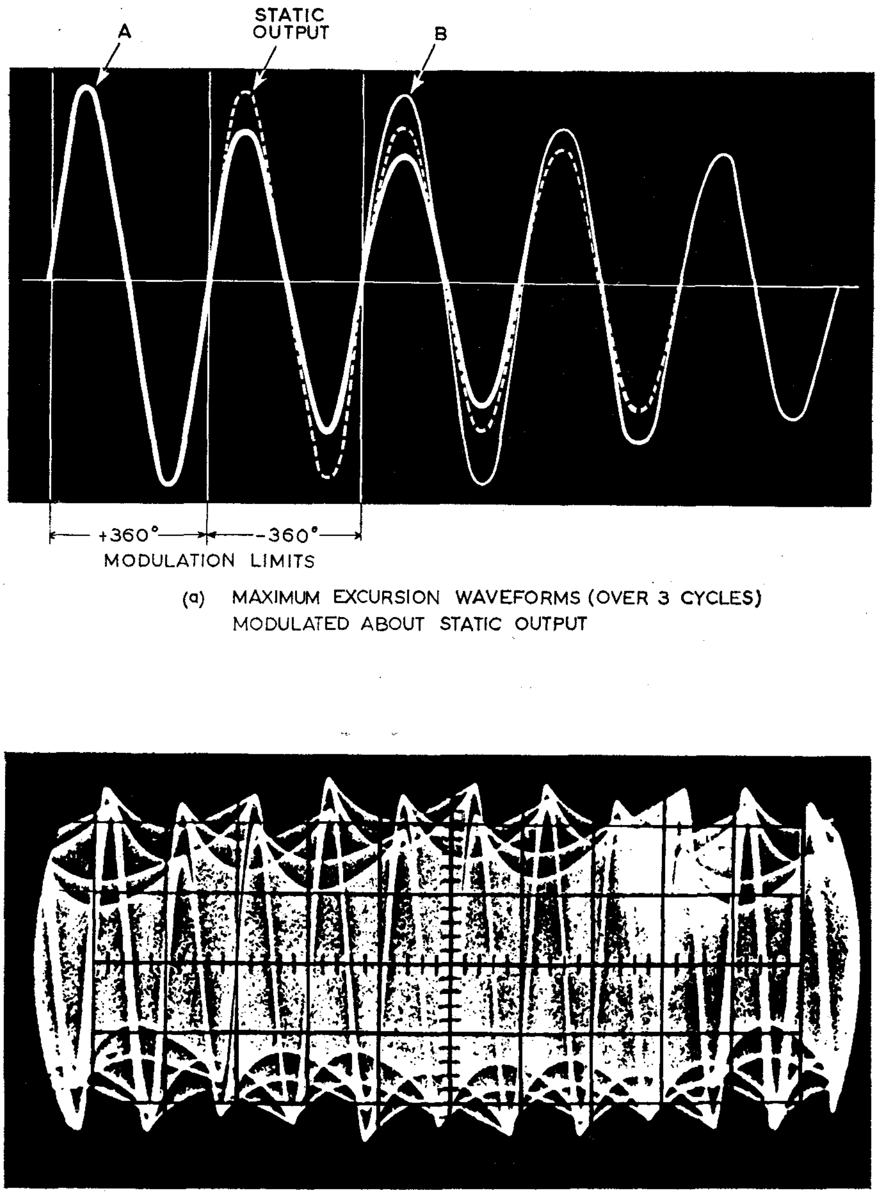


Fig. 7. 130 kc/s final output waveform for ±180° modulation

TABLE 1

Frequencies and typical voltages for re-alignment

Measurement	Connection point	Voltage	Frequency
Osc. output	V3a pin 6 and earth		14·444 kc/s $^{+6}_{-5}$ c/s
L1 tuning	V7 pin 1 and earth	6·0V r.m.s.	—
L2 tuning	V8 pin 1 and earth	4·0V r.m.s.	—
Output of 1st trebler	V8 pin 1 and earth	—	43·333 kc/s
L3 tuning	PL1 and earth (across 68-ohms load)	0·8V r.m.s.	—
Output of 2nd trebler	PL1 and earth (across 68-ohms load)	—	130 kc/s
L.F. oscillator output	—	7·0V r.m.s.	—



(b) WAVEFORM AS SEEN ON OSCILLOSCOPE

Fig. 8. 130 kc/s final output waveform for ±360° modulation

Dismantling instructions

27. There are no complicated mechanical devices or tuning mechanisms, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components (all of which are mounted on the chassis or front panel of the unit) is self-evident. For the location and identification of components refer to component layout diagram fig. 11.

FAULT DIAGNOSIS

Fault finding procedure

28. Before using test apparatus to locate a fault, ensure that all connections are secure (PL1, PL2, JK1) and that all valves are securely seated in their valve bases. For checking the correct operation of the unit, refer to the servicing section of this chapter.

29. In the absence of any signal at all from the unit the obvious starting point, after ensuring that all the fuses are serviceable, is to check the voltages generated within the unit (Tables 2 and 3).

Servicing data

30. To assist in servicing and fault finding of the bearing simulator, tabulated lists of typical voltages are given together with the valve complement and average performance data for the unit.

Supply voltages

31. The supply voltage and the voltages generated within the bearing simulator are given in Table 2. Before commencing voltage measurements, remove the oscillator crystal (XL1) from its holder. The voltages are d.c. and positive, unless stated otherwise, and are taken with the multimeter (MM) or valve voltmeter (VV) as indicated in the table.

TABLE 2

Supply voltages

Circuit	Connection point	Voltage	Meter & Range
Mains supply voltage	PL2/L and PL2/N	200-250V a.c.	MM 1000V a.c.
Transformer outputs	TR1/9 and TR1/6	335V	MM 1000V a.c.
	TR1/11 and TR1/10	6·3V	MM 10V a.c.
H.T. supply for V3, V5-V8	Junct. C16, CH1	275V ± 15V	MM 1000V d.c.
H.T. supply for V1 & V2	Junct. C14, R20	245V ± 15V	MM 1000V d.c.
D.C. bias to ref. input of modulating stages	V5 pin 6 and earth	−2·1V ± 0·5V	VV 10V d.c.
	V6 pin 6 and earth	−2·1V ± 0·5V	VV 10V d.c.
	Junct. R18, R19	−2·1V ± 0·5V	VV 10V d.c.

Oscillator voltage check

32. Replace the crystal (XL1) in its holder and connect the valve voltmeter between XL2 pin 2 and earth. The a.c. voltage at this point should not exceed 1 volt.

Valve voltage checks

33. The voltages for the various pins of the valves are given in Table 3. Before commencing these voltage measurements remove the oscillator crystal (XL1) from its holder. The voltages are d.c. and positive and are taken with the multimeter, which should be set to the ranges designated in the table.

TABLE 3

Valve voltages

Valve	Pin No.	Voltage	Multimeter range (d.c.)
V1	3	80V ± 8V	250V
V2	1	175V ± 17V	250V
	3	1·5V ± 0·5V	10V
	6	195V ± 20V	250V
	8	43V ± 5V	250V
V3	1	85V ± 8V	250V
	3	0·4V ± 0·2V	10V
	6	70V ± 7V	250V
	8	0·4V ± 0·2V	10V
V5	2	3·4V ± 0·5V	10V
	5	250V ± 25V	1000V
	7	160V ± 15V	250V

TABLE 3—(Contd.)

Valve	Pin No.	Voltage	Multimeter range (d.c.)
V6	2	3·4V ± 0·5V	10V
	5	250V ± 25V	1000V
	7	160V ± 15V	250V
V7	2	1·8V ± 0·5V	10V
	5	250V ± 25V	1000V
	7	200V ± 20V	250V
V8	2	3·3V ± 0·5V	10V
	5	260V ± 25V	1000V
	7	250V ± 25V	1000V

Average performance data

34. The bearing simulator should satisfy the average performance figures given in Table 4 before it is considered as operational.

TABLE 4

Average performance data

Crystal oscillator frequency	14·444 kc/s $^{+6}_{-5}$ c/s
Output frequency	130 kc/s phase modulated at 55·5 c/s
Range of phase modulation	Zero to at least 360°
Output voltage	Not less than 0·4V r.m.s. (The d.f. circuits of the C.A.D.F. equipment can operate with an output voltage as low as 0·25V r.m.s.)

TABLE 4—(Contd.)

Input voltage	10V r.m.s. maximum (reference waveform)
Power supply	200-250V a.c. in 10V steps, 50-60 c/s single-phase
Power consumption	36VA approximately

Valve complement

35. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, which are given in Table 5, may be used if available.

TABLE 5

Valve complement

Valve	'T' range	CV No.	J.S. CAT. No.	Commercial Type	CV No.
V1	6060	4024	5960-99-000-4024	12AT7	455
V2	6057	4004	5960-99-000-4004	12AX7	492
V3	6060	4024	5960-99-000-4024	12AT7	455
V4	5726	4007	5960-99-000-4007	6AL5 (short bulb)	140
V5-V6	—	2209	5960-99-000-2209	6F33	329
V7-V8	6064	4014	5960-99-000-4014	6AM6/8D3	138

Common faults

36. The most obvious fault that is likely to occur is the failure or deterioration of any one of the valves. If either of the modulator valves (V5 or V6) is renewed it is probable that the other modulator valve will have to be renewed also; the two valves in the modulating stage must have exactly similar characteristics. If any of the tuned circuit components are renewed the relevant tuned circuit must be checked for alignment as described in paras. 25 and 26.

OPERATING INSTRUCTIONS

37. Before using the bearing simulator, the operator should be familiar with the normal lining-up procedure of the C.A.D.F. equipment using a signal via the aerial system.

Preliminary checks

38. Carry out the preliminary checks on the C.A.D.F. equipment as follows:—

(1) Switch on the d.f. cabinet and display indicator. The indicator should be allowed at least 30 minutes to warm up, if an accurate calibration check is required.

(2) For a multi-channel installation, ensure that the aerial switching units are switched on.

(3) Connect an oscilloscope between metering point MP1 and earth on the reference signal generator, and check that the observed waveform is a stepped sine wave with no pulses missing.

Checking the d.f. circuits

39. To check the d.f. circuits, carry out the operations on the various units as follows:—

(1) Disconnect the coaxial sockets from PL2 and PL3 of the combining amplifier; this isolates the d.f. circuits from the receivers and aerial system.

(2) Connect the bearing simulator to the mains via cable (33-LRA.343A) and connect the 130 kc/s output cable (33-LRA.74R) between PL1 of the bearing simulator and PL2 of the combining amplifier.

(3) Connect the reference waveform cable (33-LRA.342A) between JK1 of the bearing simulator and metering point MP1 of the reference signal generator.

(4) Switch on the bearing simulator and adjust the TRACE LENGTH control to its approximate mid-position; this should give a bearing trace on the c.r.t. indicator.

(5) Adjust the display unit controls for a well defined focused trace.

(6) Plug the test meter on the d.f. cabinet into the monitoring jack socket (MP8) of the signal comparator (5825-99-943-5894).

(7) Use the phasing control (RV1) and the 180° phase-reversal switch (SW1) of the delay line (5825-99-943-5933) to obtain zero deflection on the d.f. cabinet test meter; this operation checks the phasing of the signal.

(8) At the local control unit, set the LOCAL/REMOTE switch to its LOCAL position and the SIGNAL (CENTRE CHECK) switch to the off position, thereby removing the 50 kc/s d.f. signal of the delay line unit from the signal comparator input.

(9) Adjust the zero balance controls (RV1 and RV2) of the resolver (5825-99-943-5893) to obtain a central spot on the c.r.t. indicator.

(10) Restore the d.f. signal to the signal comparator by operating the SIGNAL (CENTRE CHECK) switch on the local control unit to the ON position.

(11) Adjust the TRACE LENGTH control of the bearing simulator to give a full scale trace length on the c.r.t. indicator.

(12) Disconnect the d.f. cabinet test meter from the monitoring jack socket (MP8) of the signal comparator; connect the oscilloscope on each side of MP8 in turn and check that the integrated sine wave output of the unit is not 'breaking'. If the waveform is breaking, reduce the setting of the TRACE LENGTH control on the bearing simulator until a smooth sine wave is obtained.

40. If the phase excursion of the bearing signal is not correctly centred about the zero of the signal comparator characteristic, or if the phase excursion still exceeds $\pm 180°$ after compression in the delay line unit, then the sine wave from MP8 shows 'breaks'. The 'breaks' appear on the oscilloscope trace as large positive or negative-going spikes that break up the continuity of the sine wave. The TRACE LENGTH control on the bearing simulator adjusts the phase excursion of the simulated bearing signal, and excessive trace length settings will therefore cause breaking of the sine wave.

41. The remaining alignment of the d.f. circuits is carried out as for normal alignment, when a d.f. signal from the aerial system is used. After the d.f. circuits have been tested with the bearing simulator the alignment procedure must be repeated, using an externally radiated signal, before the equipment can be considered as operational.

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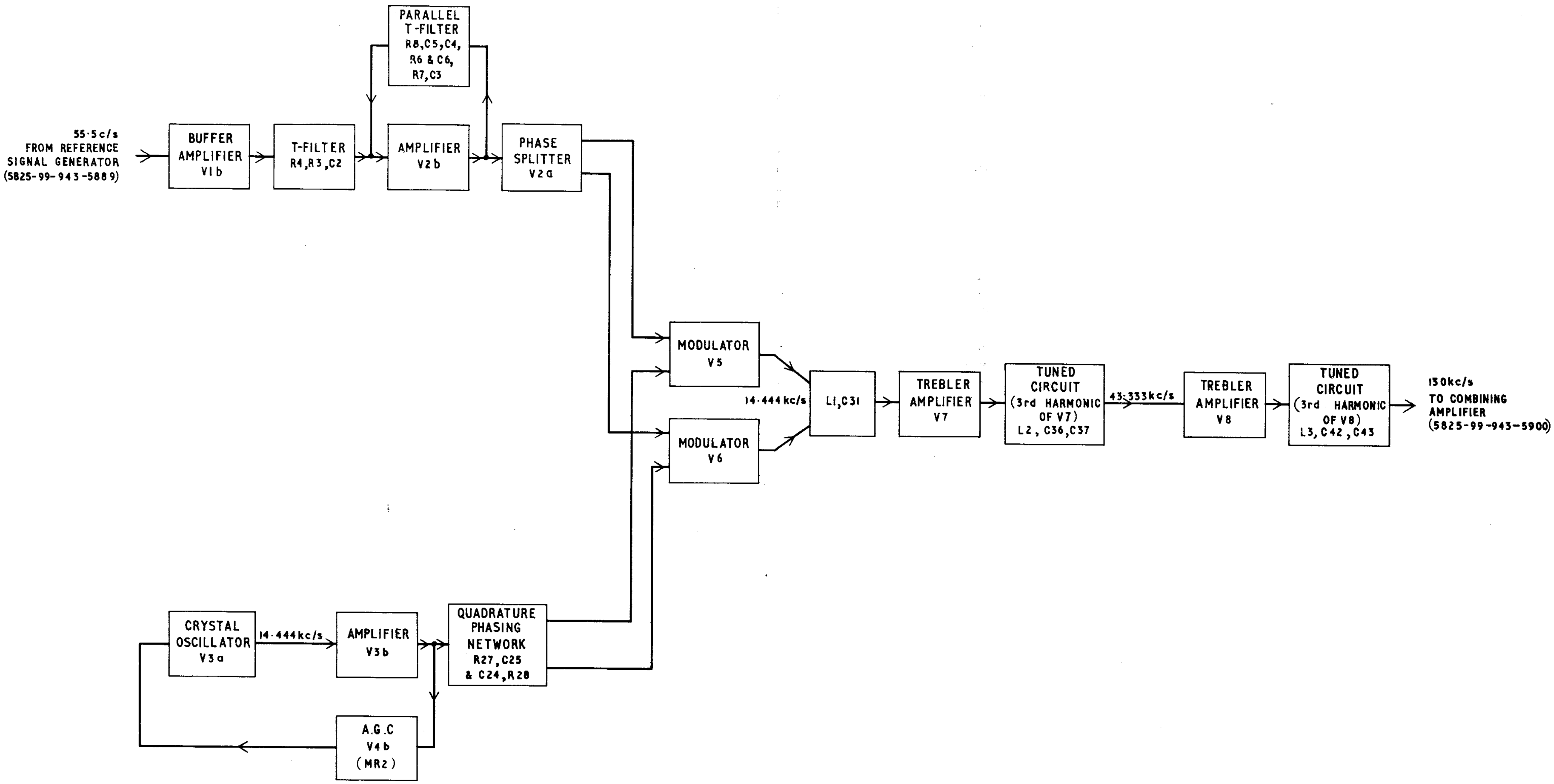

Fig.9 Bearing Simulator 6625-99-946-5431: block diagram Fig.9

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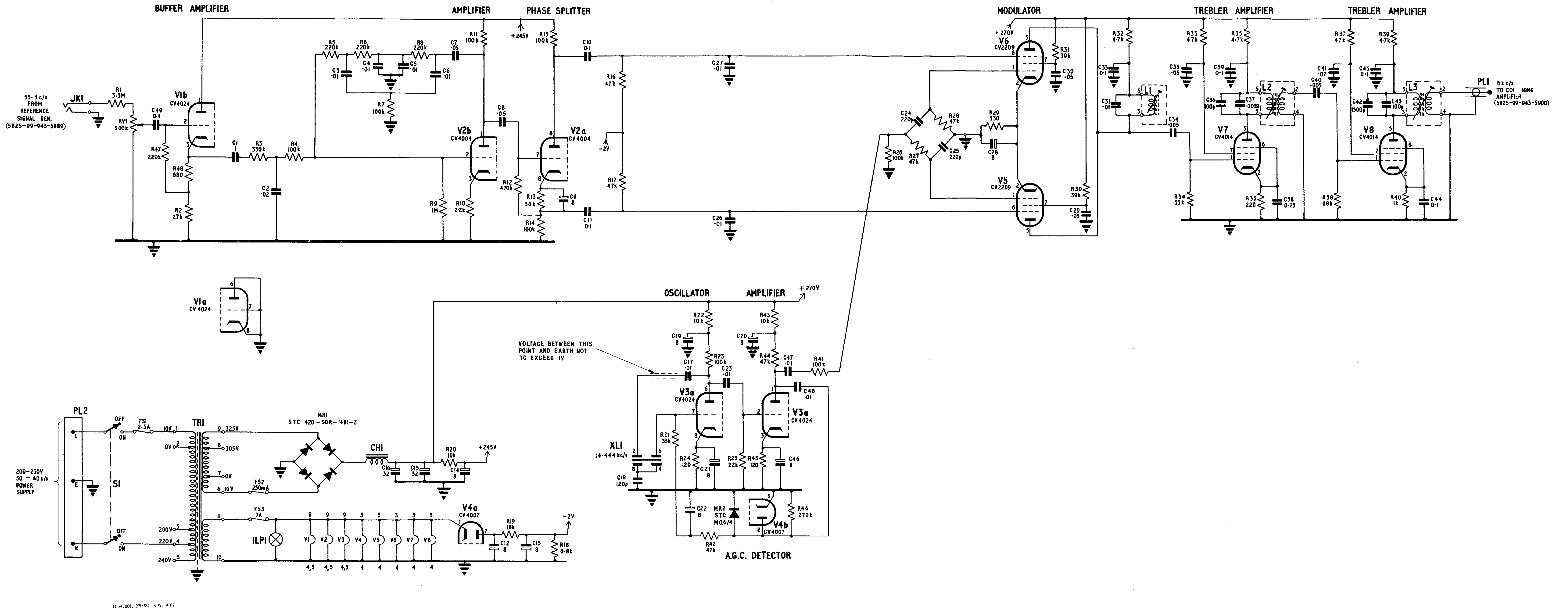

Fig.10

Bearing simulator 6625-99-946-5431: circuit

Fig.10

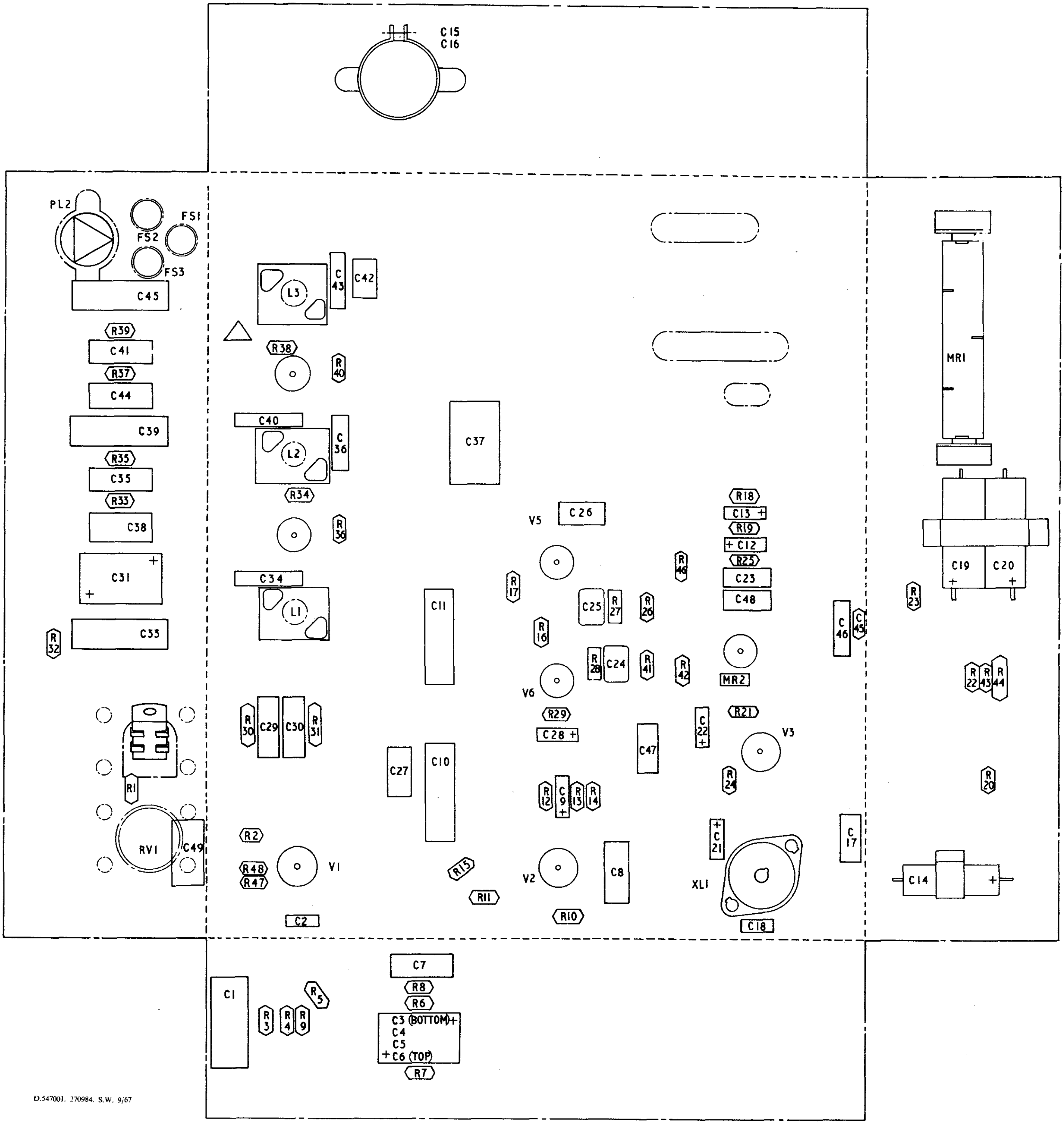

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Fig. 11 Bearing Simulator 6625-99-5431 : component layout Fig. 11

Chapter 2

◀D.C. CALIBRATOR (6625-99-933-2618)▶

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UNIT DESCRIPTION

Introduction

1. The d.c. calibrator is a general purpose, portable test instrument which simulates d.f. bearing information in the form of four co-ordinate d.c. voltages. These voltages correspond to the north, south, east and west output potentials obtained from the resolver (5825-99-943-5893) or the two types of bearing display amplifier (5825-99-933-5890 or 5825-99-933-0812) in the d.f. equipment of C.A.D.F., when a live signal is being received.

2. When these simulated voltages are applied to the d.f. indicator (5825-99-943-5935), they produce a bearing trace which can be rotated through 360° in $22\frac{1}{2}^\circ$ steps by means of a control on the d.c. calibrator. In this way, the alignment of the trace on the c.r.t. indicator can be tested without using a live signal via the d.f. units. The instrument is also used for testing the bearing display amplifier and the circuits associated with the triangulation equipment. The output voltages are produced at three levels: ±100V balanced about +200V, ±50V balanced about a nominal zero or earth potential, and a ±4V balanced about +6V.

Construction

3. Basically, the instrument comprises a case containing a shallow mild steel chassis bolted to a front panel. The front panel is secured to the case by 18 countersunk screws. The case is mounted on four rubber feet and has ventilation louvres in the sides and rear. A lifting handle is fitted on each side of the case. A front view of the instrument is shown in fig. 1.

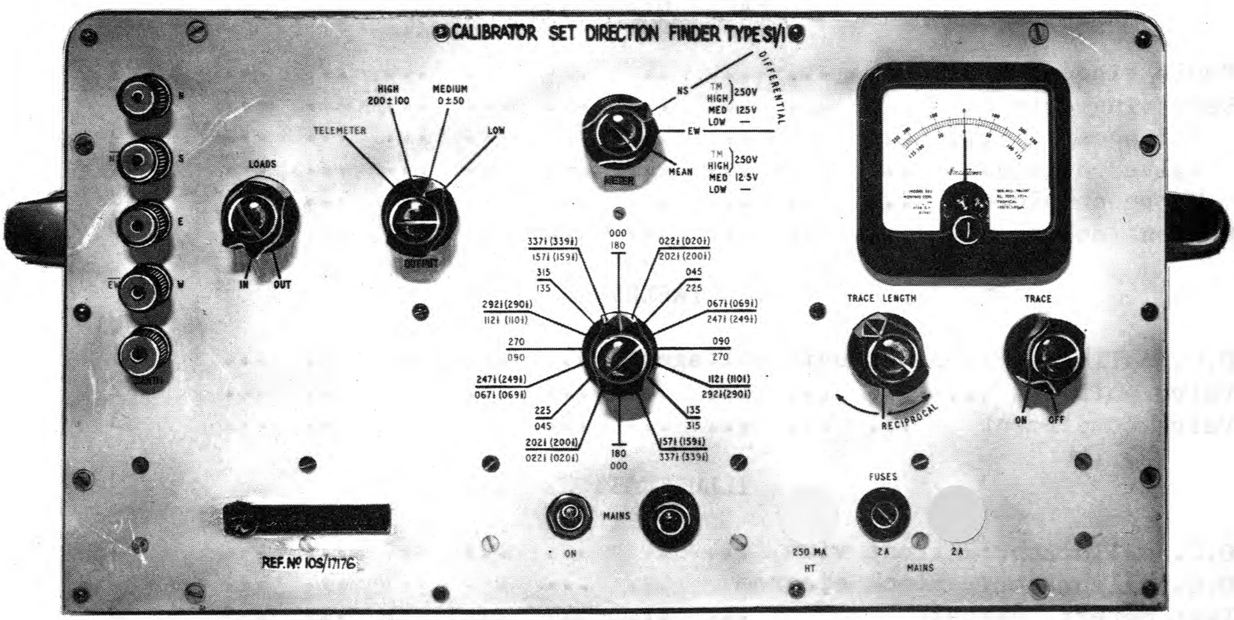


Fig. 1 D.C. calibrator: front view

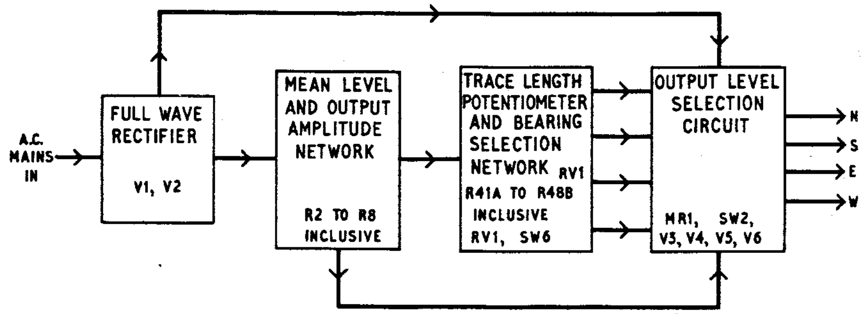


Fig. 2 D.C. calibrator: block diagram

Dimensions, weight and connecting cables

4. The weight and overall dimensions of the d.c. calibrator are as follows:

(1) Weight: 31 lb (14 kg)

(2) Height: 9¾ in. (24.7 cm)

(3) Width: 20⅝ in. (52.4 cm)

(4) Depth: 10⅜ in. (26.35 cm)

5. The connecting cables supplied with the instrument are as follows:

(1) Cable (S.T.C. code 33-LRA.8V): for testing the d.f. indicator.

(2) Cable (S.T.C. code 33-LRA.30F): for testing the C.A.D.F. bearing display amplifiers.

Brief electrical description (fig. 2)

6. The mains input voltage is applied to a full-wave rectifier, which produces a d.c. output voltage of approximately 500V. This voltage is applied to a mean level and output amplitude network, parts of which can be earthed or shorted out to obtain different voltages. Each of these voltages is used to produce one of the balanced output voltages about a mean reference level. The output from the network is applied to a trace length potentiometer and bearing selection network, comprising a double ganged potentiometer in parallel with a potential divider. The voltage from the mean level and output amplitude network is connected across both tracks of the potentiometer. The sliders of the potentiometer are mechanically offset, so that a polarity change is obtained in the voltage across the sliders when the potentiometer is rotated through the mid position.

7. The voltage applied across the potentiometer (RV1, the TRACE LENGTH control) determines the maximum amplitude of output voltage. Voltages obtained from the sliders are applied to the potential divider from which the bearing voltage is derived. At successive points in this potential divider, voltages are obtained which simulate the north, south, east and west voltages. By pairing these voltages (north/south and east/west) at the output of the d.c. calibrator, balanced voltages are obtained. The positions of the bearing selection switch (SW6) determine the amplitude of the pairs of co-ordinate voltage outputs, which follow a sine and cosine law. Each position of the switch represents an increment of $22\frac{1}{2}^{\circ}$ on the simulated bearing.

8. The four outputs from the trace length potentiometer and bearing selection circuit are connected to an output level selection circuit containing four cathode followers. Each cathode follower has an attenuator network which, in conjunction with the mean level and output amplitude network, is switched by the OUTPUT switch (SW2). The switch selects the level of the bearing co-ordinate voltage outputs from the unit. Output levels can be monitored on the front panel meter M1.

Circuit description (fig. 4)

Full wave rectifier

9. The input mains voltage is connected to PL1, which is mounted on the right hand side of the instrument. Both sides of the mains input voltage are protected by fuses (FS2, FS3) and then switched by the MAINS switch (SW1). The mains is then applied to the MAINS lamp LP1 and the primaries of TR1 and TR2. Primary taps on both transformers can be set to accept an input voltage from 200V to 250V in steps of 10V, but are normally set to 230V. The secondary windings on TR1 provide an h.t. voltage of 400V–0–400V and a 6·3V valve heater voltage. The h.t. winding of TR1 is connected to full wave rectifier valves V1 and V2, which feed a choke-capacitive smoothing circuit comprising C1, L1 and C2. A d.c. voltage of approximately 500V is developed across C2 and applied via fuse FS1 to the mean level and output amplitude network, and to the anodes of the four cathode followers.

Mean level and output amplitude network

10. The network comprises R2 to R8 and the potential derived from the network is applied across the double track of RV1. The balanced voltages that are obtained from the four cathode followers are derived from the potential taken from the wipers of RV1. Switch wafers SW2a and SW2j are part of the four-position OUTPUT switch and provide two distinct voltage levels to RV1. In the TELEMETER and HIGH positions of the switch, R3 is shorted out and the negative side of the h.t. line is earthed. With R3 shorted out, an increased potential is applied across RV1, and the balanced voltage between the two sliders is a maximum of ±100V. Earthing of the h.t. negative line refers this balanced voltage to +200V. In the MEDIUM and LOW positions of the switch, the short-circuit across R3 is removed and the earth connection is switched from h.t. negative line to the junction of R4 and R6. In this condition, the voltage applied to RV1 is decreased and the balanced voltage between the two sliders is a maximum of ±50V referred to earth.

Trace length potentiometer and bearing selection network

11. This network comprises RV1, the double ganged TRACE LENGTH control and the potential divider network containing R41a to R48b. By mechanically offsetting the two sliders of RV1, the voltage across the sliders changes polarity on rotating the control through the mid position.

Note . . .

This change of polarity is used to rapidly obtain the reciprocal of any bearing selected by the bearing selection switch. The RECIPROCAL *sector of the* TRACE LENGTH *control is indicated on the front panel by a red arrow, and the other sector is indicated by a black arrow. The colour of the arrow corresponds to the red and black bearings indicated around the* 16 *position bearing selection switch (SW*6).

The balanced voltage between the sliders of RV1 is applied to the resistor network, R41a to R48b, and to the four wafers of the 16-position switch SW6. Intermediate tapping points on the resistor network are selected by the switch. The interconnections between the switch wafers and the network and the values of the resistors in the network are such that balanced voltages are obtained across the two pairs of the switch wipers. These voltages are proportional to the sine and cosine of the bearing angle selected by the switch. For example with SW6 in position 1 and SW2 set to HIGH (as shown in fig. 4), the balanced voltage obtained across the wipers of wafers 'g' and 'e' is the maximum voltage from the network, balanced about a mean of +200V; the voltage at 'g' is positive with respect to that at 'e', when the TRACE LENGTH control is in the black sector. The potential on the wipers of both 'a' and 'c', however, is the mean of +200V, i.e. a balanced voltage of ±0V. In position 2 of SW6, the polarity of wiper 'g' with respect to 'e' remains the same, but the amplitude of the balanced voltage across them is decreased. For wipers 'a' and 'c' a voltage balanced about a mean of +200V is obtained and 'c' is positive with respect to 'a'. With successive positions of SW6, the balanced voltage across wipers 'g' and 'e' decreases, reaches zero (position 5) and then increases, but with 'g' negative with respect to 'e'. Similarly, the balanced voltage across wipers 'c' and 'a' increases and reaches a maximum at position 5. Thus for any position of the switch, the two balanced voltages obtained are '90° out-of-phase' with each other.

12. When the d.c. calibrator is supplying simulated bearing voltages to the display unit, the effect of rotating the TRACE LENGTH control from the black to the red sector is that the length of trace reduces from maximum, through zero to the maximum length of trace at the reciprocal bearing. Each position of switch SW6 produces a voltage increment that corresponds to a bearing change of $22\frac{1}{2}°$. Voltages at wipers 'g', 'e', 'c' and 'a' are the north, south, east and west bearing co-ordinate voltages respectively.

Note . . .

At the octantal settings of the bearing selection switch, two alternative markings are given. For c.r.t. indicators with a linear scale, the true octantal bearings of $22\frac{1}{2}°$, $67\frac{1}{2}°$ *etc. are to be used. The alternative bearings shown in brackets* ($20\frac{1}{2}°$, $69\frac{1}{2}°$ *etc.) are applicable to indicators with a non-linear scale.*

Output level selection circuit

13. The voltage from each wiper is fed to a separate cathode follower via SW4, the TRACE switch. Each valve has a separate heater supply from secondary windings on TR2. With the TRACE switch in the OFF position, the grids of the cathode followers are connected to the mean potential at the junction of R6, R7. Each cathode follower has a fixed load resistor (R15, R16, R17, R18 for V3, V4, V5 and V6, respectively), which can be disconnected by the LOADS switch (SW3) when suitable cathode loads exist on the equipment under test.

14. The amplitudes of the north, south, east and west voltages obtained from the cathode followers are determined by a combination of the mean level and output amplitude network and by four identical resistive attenuator networks in the cathode circuit of each valve; e.g. in V3 cathode circuit, the potential divider comprises R19 and R24. In the HIGH and MEDIUM positions of the OUTPUT switch SW2, the amplitudes of the balanced output voltages are determined by the mean level and output amplitude network only; the final outputs of the unit are taken directly from the cathode of each valve, and are not attenuated by the resistive networks associated with SW2e and SW2g.

15. In the LOW position of the switch, the basic circuit conditions for medium outputs are retained, but the amplitude of the output voltages is further decreased by the cathode-circuit attenuators. Each attenuator network is returned to a stabilized voltage of +6V, which is derived from a Zener diode (MR1) that determines the mean level for the LOW output voltages. The amplitude of the balanced voltage output is decreased to ±4V. Thus, output voltages of 6V ±4V for the N-S and E-W pairs are obtained.

16. In the TELEMETER position of the switch, a set of triangulation co-ordinate voltages are obtained from the high voltage output; these correspond to triangulation outputs of N,$\overline{NS}$ via R28, R30, R31, and E,$\overline{EW}$ outputs via R29, R32, R33.

Monitoring of the output voltages

17. The front panel meter, M1 is a centre zero meter with a scale calibrated for two voltage ranges, 250V–0–250V and 125V–0–125V. In conjunction with switching by SW2 and the front panel METER switch SW5, the meter can be set to read the mean potentials and north/south and east/west differential voltages for the three output levels of HIGH, MEDIUM and TELEMETER. Direct reading for the low output level is not provided, but the meter does indicate the voltages before attenuation.

SERVICING

Test apparatus

18. The following items of test equipment are required for full servicing.

(1) Two Multimeters Type 9980 or Type 12889.

(2) Variac.

(3) B.S. grade 1 voltmeter, f.s.d., 400V a.c., 10V a.c. (moving coil preferred and connected with a spring return switch as shown in fig. 3).

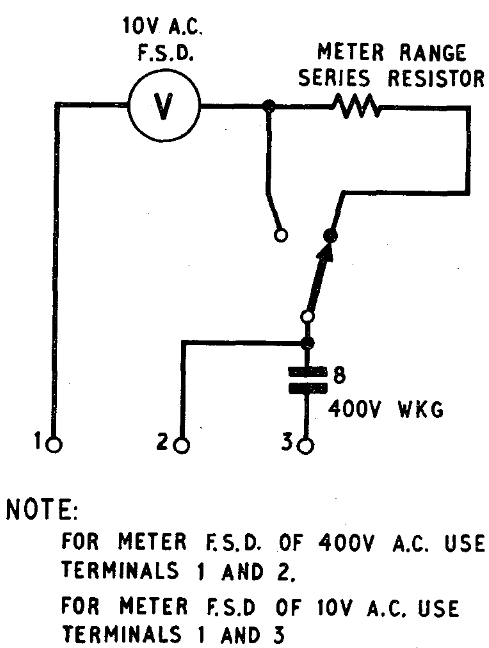


Fig. 3. Test meter: circuit

(4) Load resistors:
(a) 25 kilohm 10W
(b) 10 kilohm 20W
(c) 6 kilohm 40W

(5) Indicator, azimuth 5825–99–943–5935 (d.f. indicator).

Note . . .
Two multimeters are required, one being used for current measurements and the other for voltage measurements. In the test instructions they are referred to as the voltage multimeter and the current multimeter, respectively.

Tests for serviceability

19. Preliminary serviceability checks should be made by first checking the mains input voltage and the condition of the various fuses.

Removal of chassis

20. The chassis can be withdrawn from the case by unscrewing the 18 countersunk screws round the edge of the front panel and sliding the chassis from the case.

Test procedure

21. Rigorous testing of the unit would necessitate an accuracy test on all outputs, employing all the relevant items of equipment. However, it is considered adequate to fully test only the medium output with the aid of the d.f. indicator. For the other outputs, a limited voltage level test, using the multimeter is sufficient. In the following tests it is assumed that the display unit is a correctly-aligned known working unit; all tests are made with the display unit switched to the QTE condition.

22. The test procedure is as follows:—

(1) Ensure that the correct lamp, fuses and valves are in the unit.

(2) Connect the mains supply via the variac to the mains input plug PL1 on the d.c. calibrator, and connect the specified 400V a.c. voltmeter across the output of the variac. Set the MAINS switch to ON and ensure that the MAINS indicator lamp lights. Ensure that the mains input voltage is 230V (if necessary adjust the variac). Maintain the setting of the variac throughout the test procedure. Set the MAINS switch to the off position and disconnect the 400V a.c. voltmeter.

(3) On the d.c. calibrator, set the front panel controls as follows:

(a) OUTPUT switch to MEDIUM
(b) LOADS switch to IN
(c) TRACE switch to OFF
(d) TRACE LENGTH control fully clockwise.

(4) Remove the 250 mA H.T. fuse (FS1) from the d.c. calibrator and connect the following voltmeters across C2:

(a) 10V a.c. voltmeter (terminals 1 and 3, fig. 3).
(b) Voltage multimeter, switched to the 1000V d.c. range.

(5) On the d.c. calibrator, set the MAINS switch to ON and ensure that the indication of the voltage multimeter is within $^{+10\%}_{-5\%}$ of 590V. If the indication of the 10V a.c. voltmeter is not more than 10V when a steady deflection is obtained, actuate the spring return switch. With the spring return switch actuated, ensure that the indication of the meter is not more than 1V. Set the MAINS switch to the off position.

(6) Repeat test instruction (5), but with the following load resistors connected in series with the current multimeter in turn. The multimeter should be switched to the 100 mA d.c. range and connected across C2. Check that the results obtained are within the specified limits.

Load resistor	25 kilohm	10 kilohm	6 kilohm
Load current (approximately)	20 mA	40 mA	80 mA
Voltage	560V $^{+10\%}_{-5\%}$	540V $^{+10\%}_{-5\%}$	500V $^{+10\%}_{-5\%}$
Ripple	2V	3V	4V

Note . . .

If the d.c. is less than 480*V for a load current of* 40 *mA, repeat all the previous test procedure and following tests with the h.t. secondary winding of TR*1 *set to the* 440*V taps.*

(7) Replace the 250 mA H.T. fuse (FS1) and set the MAINS switch to ON. Using the voltage multimeter switched to the 10V d.c. range, ensure that the voltage across MR1 is 6·8V ±10%. Set the MAINS switch to the off position.

(8) Connect the N, S, E, W terminals of the d.c. calibrator to PL1 pins A, B, C, D respectively of the d.f. indicator, using cable (S.T.C. code 33–LRA.8V). Switch on the d.f. indicator, setting its TRACE LENGTH control to the mid position. After a suitable warming-up period, set the MAINS switch of the d.c. calibrator to ON and the calibrator TRACE LENGTH control fully clockwise. Ensure that a full scale trace is displayed on the screen of the indicator c.r.t.

(9) On the d.c. calibrator, progressively set the bearing selection switch to successive bearing positions, and ensure that the bearing of the trace on the c.r.t. rotates in the same direction as the selected bearings. Ensure that when the calibrator TRACE LENGTH control is rotated counter-clockwise to the RECIPROCAL sector, the trace length reduces to zero and then increases to a maximum trace at the reciprocal bearing.

(10) Set the calibrator TRACE switch to OFF, then centre the spot on the display unit c.r.t. in the normal way. Set the TRACE switch to ON, and adjust the calibrator TRACE LENGTH control for a full scale trace. Set the bearing selection switch to each one of the 16 positions in turn, and ensure that the error is not greater than $\frac{3}{4}°$ at any position.

Note . . .

On octantal bearings ensure that the calibrations observed are the ones relevant to the type of c.r.t. scale. (Calibrations in brackets at the octantal points appertain to indicators with a non-linear scale.)

(11) Switch off the indicator and the d.c. calibrator, and remove the connecting cable.

Note . . .

The remainder of the test procedure is concerned with checking the output levels indicated by the front panel meter. It is not possible to test the TELEMETER *output without a complete telemeter test chain; it is sufficient to verify that the front panel meter reading is the same in the* TELEMETER *and* HIGH *positions of the* OUTPUT *switch.*

(12) On the d.c. calibrator, connect the voltage multimeter between the N and EARTH terminals and set the controls as follows:

(a) MAINS switch to ON

(b) TRACE LENGTH control fully clockwise

(c) METER switch to NS

(d) Bearing selection switch to 000 (black).

(e) TRACE switch to ON

Set the OUTPUT switch to the HIGH, MEDIUM and LOW positions in turn, and note the readings of the front panel meter and the voltage multimeter. Then set the TRACE switch to OFF and ensure that the results obtained are as follows:

Note . . .

The voltage multimeter must be switched to the d.c. voltage range compatible with the test figures.

TRACE switch position	OUTPUT switch position HIGH	MEDIUM	LOW
ON	Note front panel meter reading (a)	Note front panel meter reading (c)	
ON	Note multimeter reading (b)	Note multimeter reading (d)	Note multimeter reading (e)
OFF	Front panel meter reading to be ±10V with respect to (a)	Front panel meter reading to be ±5V with respect to (c)	
OFF	Multimeter reading to be 200V ±10V and 100V +8V —5V with respect to (b)	Multimeter reading to be 0 ±10V and 50V +10V —5V with respect to (d)	Multimeter reading to be 6V ±0·5V and 5V ±1V with respect to (e)

Note . . .

The front panel meter reading has no direct significance in the LOW *position of the* OUTPUT *switch.*

(13) On the d.c. calibrator, set the controls as follows:

(a) METER switch to MEAN

(b) TRACE switch to OFF

(c) OUTPUT switch to HIGH

Ensure that the reading of the front panel meter is within ±10V of the voltage multimeter reading.

(14) On the d.c. calibrator, set the OUTPUT switch in turn to MEDIUM and LOW and ensure that the reading of the front panel meter is within ±5V of the multimeter reading.

(15) Repeat (12) but with the multimeter connected between E and EARTH terminals, and the METER switch to EW.

(16) Switch off the d.c. calibrator and disconnect the test apparatus.

Dismantling instructions

23. There are no complicated mechanical devices on the unit, hence the only dismantling likely to be involved during servicing concerns components for replacement. The method of removing components is self-evident. For the location and identification of components refer to the component layout diagram fig. 5.

FAULT DIAGNOSIS

Fault finding procedure

24. Before using test apparatus, ensure that plug and socket connections are secure and that valves are securely seated in their bases. For checking the correct operation of the d.c. calibrator, refer to the servicing section of this chapter. In the absence of any output from the unit, the obvious starting point is to check the mains input voltage.

Servicing data

25. To assist in fault finding on the d.c. calibrator, typical voltages are given together with the valve complement of the unit.

Voltages

26. The mains input voltage together with the power unit voltages are given in Table 1. The d.c. output test voltages obtained from this unit are determined by the individual settings of the various controls. For complete details, reference should be made to the test procedure.

TABLE 1

D.C. calibrator: power unit voltages

Circuit	Connection point	Voltage
Mains supply	PL1	230V a.c.
Rectifier input	Top cap of V1 to junction of C1,C2	400V a.c.
Rectifier input	Top cap of V2 to junction of C1,C2	400V a.c.
Rectifier output	Across C2	500V d.c.

Valve voltages

27. Voltages at various pins of the valves should be measured with a multimeter. The readings should approximate to those given in Table 2. All voltages are d.c., positive with respect to earth, and should be measured with the OUTPUT switch in the TELEMETER or HIGH position.

TABLE 2

Valve Voltages

Valve	Pin No. 1	2	3	4	5	6	7	8	9
V1			500V						
V2			500V						
V3					500V	500V	500V		
V4					500V	500V	500V		
V5					500V	500V	500V		
V6					500V	500V	500V		

Valve complement

28. When replacing valves it is recommended that the 'T' range is used; the commercial types with similar characteristics, given in Table 3 may be used if available.

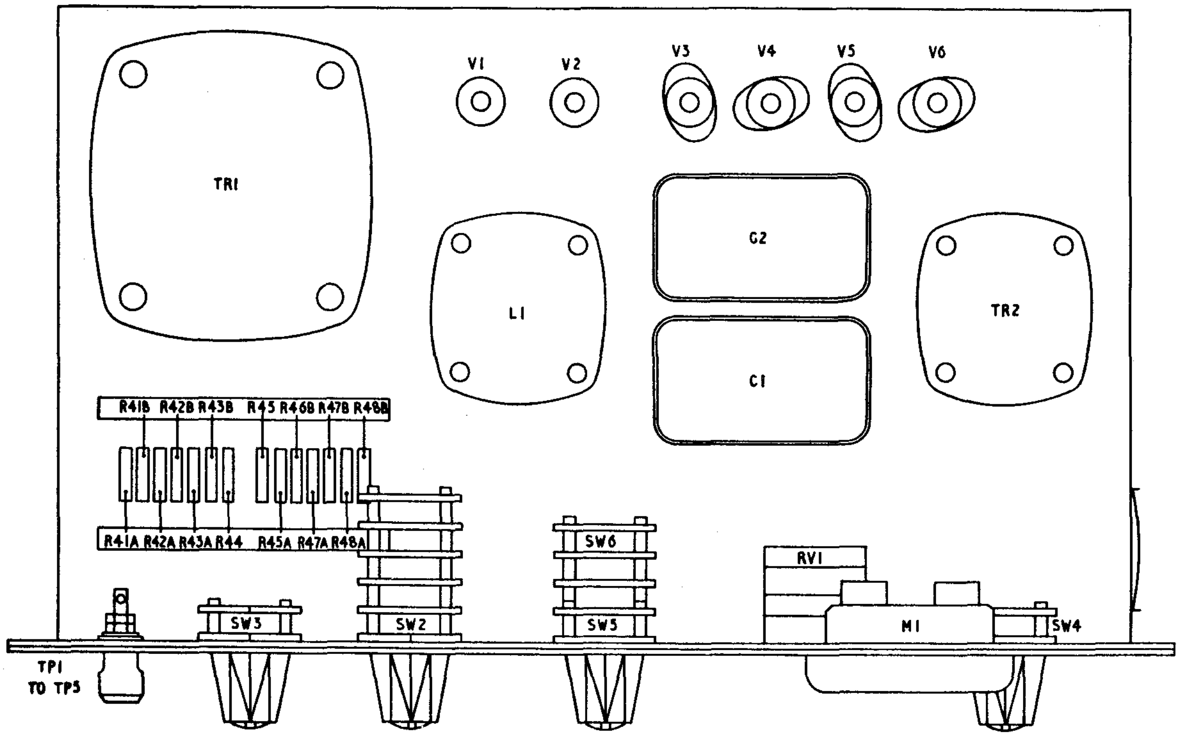
TABLE 3

Valve complement

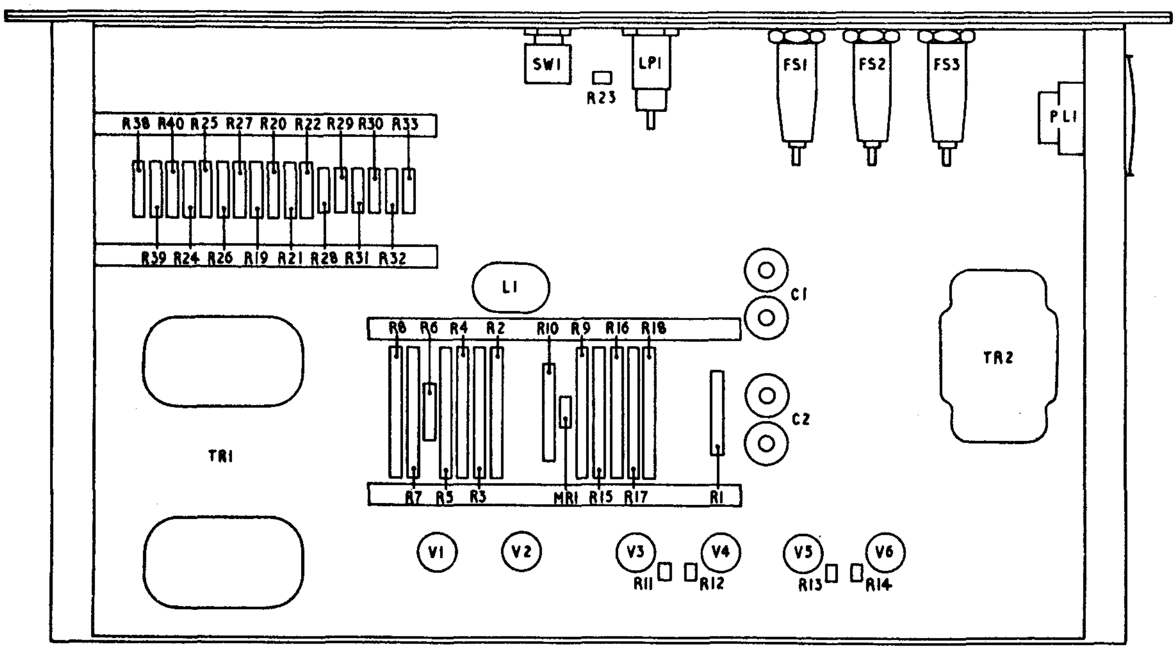
Valve	'T' range	CV No.	J.S. CAT. No.	Commercial Type	CV No.
V1, 2	6443	4044	5960-99-000-4044	R18	2235
V3-V6	6064	4014	5960-99-000-4014	6AM6/8D3	138

Common faults

29. The faults most likely to occur in the unit are failure of fuses, deterioration of any one of the valves, or rotary switch contacts developing high resistance. Before renewing a fuse or valve, always check the directly associated components for faults.



FRONT VIEW



REAR VIEW

Fig. 4. ◀ Calibrator, d.c. 6625-99-933-2618: ▶ component layout

S6 *BEARING*

CONTACT	BEARING	CONTACT	BEARING
1	000 180	9	180 000
2	022½ (020½) 202½ (200½)	10	202½ (200½) 022½ (020½)
3	045 225	11	225 045
4	067½ (069½) 247½ (249½)	12	247½ (249½) 067½ (069½)
5	090 270	13	270 090
6	112½ (110½) 292½ (290½)	14	292½ (290½) 112½ (110½)
7	135 315	15a, c, e, g	315 135
8	157½ (159½) 337½ (339½)	15b, d, f, h	337½ (339½) 157½ (159½)

S5 METER

CONTACT	FUNCTION		
1, 5, 9	N S	TM } 250V HIGH } 250V MED 125V LOW –	DIFFERENTIAL
2, 6, 10	E W		
3, 7, 11	MEAN	TM } 250V HIGH } 250V MED 12·5V LOW –	

S2 OUTPUT

CONTACT	FUNCTION
2, 8	TELEMETER
3, 9	HIGH 200 ± 100
4, 10	MEDIUM 0 ± 50
5, 11	LOW

Fig. 5 Calibrator, d.c. 6625-99-937-2618: circuit Fig. 5