AIR PUBLICATION

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Cover 1

(Formerly A.P.2899AG, Vol. 1, Cover 1)

FGRI.26008/1

AND

FGRI.26008/2

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence

FOR USE IN THE
ROYAL AIR FORCE

Prepared by the Procurement Executive, Ministry of Defence

A.L.34,Nov.71

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The reference number of this publication was altered from A.P.2899AG, Vol. 1, Cover 1 to A.P.115C-0200-1 Cover 1 in May, 1967. No general revision of page captions has been undertaken, but the code number appears in place of the earlier A.P. reference and new or amended leaves issued subsequent to these dates.

LIST OF ASSOCIATED PUBLICATIONS

	A.P.
UHF multi-channel transmitter-receiver	2531*J*
*TR*5043, *FGRI*.5439 *and Naval wireless set Type* 86*M*	2528*H*
UHF single-channel transmitter Type T.7355	2531*D* & *E*
VHF ground station aerial systems	2521*A*

CONTENTS

PART 2 SERVICING

Section 1 FRGI.26008/1

PART 1

LEADING PARTICULARS AND GENERAL INFORMATION

LEADING PARTICULARS OF FGRI 26008/1 AND FGRI 26008/2

PURPOSE AND BRIEF DESCRIPTION ... The FGRI 26008/1 and FGRI 26008/2 are modified versions of the Cossor Radar CR 787, a medium range surveillance and approach control radar installation operating on the S (10 cm) band. An installation has two transmitter-receivers, one in use and the other as a standby, the changeover being made by a waveguide switch. Provision is made for local and remote viewing. The FGRI 26008/2 differs from the FGRI 26008/1 in that a different aerial is employed and, to take full advantage of the different aerial, the r.f. amplifier in the receiver uses a parametric amplifier instead of a travelling wave tube (TWT).

Note ...

The differences between FGRI 26008/1 and FGRI 26008/2 are given in Section 3. With the exception of Chapter 1 of Part 1 Sect 1, all references in Parts 1, 2 and 3 are to FGRI 26008/1.

MAIN EQUIPMENT	ITEM	REF NO
Note ... Cossor Ref. No. given in brackets.	T/R assembly radar Type S1/2 (EA 186/9)	10D/23660
	Radar set group Type S1/1 (EA 4952	10D/23666
	Radar set control Type S6/3	10L/16575
	Azimuth range indicator Type S5/1 (D/GA 87991/2)	10Q/16194
	Radar set control Type S6/4 (EA 2960/3)	10L/16582

Transmitter frequency: 2940 Mc/s to 2980 Mc/s

Peak power output: 450 kW nominal

Repetition frequency: 700 pulses per second (nominal)

MAIN EQUIPMENT	ITEM	REF NO
Pulse length	1 microsecond	
Receiver noise figure	7·5 - 8·5 dB (FGRI 26008/1) 4·5 - 5·7 dB (FGRI 26008/2)	
AERIAL SYSTEM	The feed from the transmitter is via a rotating joint to a horn. On the FGRI 26008/1 the output from the horn is reflected from a continuous-surfaced, metallized reflector to produce a cosecant squared vertical pattern. On the FGRI 26008/2 the horn is fin loaded.	
Aerial polarization	In both radars the polarization is normally horizontal. On the FGRI 26008/1 the polarization can be made circular by switching in a quarter wave anti-rain plate. On the FGRI 26008/2 the plane of polarization can be varied from horizontal through elliptical to circular by the movement of a twin distrene vane variable phase shifter.	
Aerial rotation	12 rev/min. Constant for winds up to 45 knots.	
POWER REQUIREMENTS	Approximately 12kVA at 230V, 50 c/s single phase.	

SECTION 1

GENERAL DESCRIPTION AND OPERATING INSTRUCTIONS

Chapter 1

FGRI. 26008/1
and
FGRI. 26008/2

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Introduction

1. The FGRI. 26008/1 and FGRI. 26008/2 are medium range surveillance radar equipments operating in the S (10 cm) band. The FGRI. 26008/2 is a modified FGRI. 26008/1, employing a different aerial system and a different rf amplifier in the receiver. Details of the modifications are given in Sect.3.

2. An FGRI.26008/1 installation comprises two main groups of equipment as can be seen in fig.1. The differences for the FGRI. 26008/2 are shown in Section 3. For either radar the remote site equipment may be located up to 4000 yards from that in the radio equipment and approach control rooms and is a complete installation in itself. The radio equipment and approach control rooms enable the displays and controls to be available at the airfield control centre.

3. Two radar T/R assemblies S1/2 (transmitter-receivers) are provided, one as a main and one for standby purposes. The main elements in a FGRI. 26008/1 installation are listed below, and except for the aerial and a modification to the T/R assemblies, the list can be used also as a reference for the

FGRI. 26008/2. Details of the interconnection cables between the main elements, shown in fig.1, are given in Tables 1 and 2 at the end of this chapter.

Type	Ref.No.
Aerial Type S5/1	10B/20188
Circularizer and actuator assembly Type S1/2	10B/20171
Aerial turning gear cabin Type S5/1	10D/23937
Radar T/R assemblies Type S1/2 (2 off)	10D/23660
Radar set group Type S1/1	10D/23666
Waveguide switch	10B/20178
Pulse generator power supply Type S18/2	10D/23956
Pulse generator power supply Type S18/1	10D/23955
Azimuth range indicator Type S5/1	10Q/16194
Radar set control Type S6/4	10L/16582
Amplifier power supply S30/1	10U/17392
Impedance matching network Type S3/1	10B/20172
Impedance matching network Type S1/1 (2 off)	10D/22781
Fixed attenuator Type S8/1	10L/16591

4. At a p.r.f. of 700 p.p.s. and a pulse length of 1μs the T/R assembly Type S1/2 has a peak power output of 450 kW. The transmitter-receiver in use is connected to the aerial via two ports of a four-port waveguide switch. The same switch applies the output of the standby transmitter-receiver to the electrical dummy load Type S1/1 in the radar set group Type S1/1. The receiver section on the FGRI.26008/1 employs an R.F. amplifier Type S13/1 (microwave pre-amplifier) which incorporates a travelling wave tube (T.W.T.) and this gives a receiver noise figure of about 8dB. On the FGRI. 26008/2 the T.W.T. is replaced by a parametric amplifier (see Section 3) and this gives a receiver noise figure of about 5dB. The effect of permanent echoes is minimized by the incorporation of the moving target indication (m.t.i.) system (para.20), involving the essential complementary elements of stalo, coho, etc.

5. The scanner is supported on a ball race built into the roof of the aerial turning gear cabin Type S5/1 and driven by the scanner drive motor, located in the aerial turning gear cabin, via a system of gears and a hollow tubular drive shaft. The aerial turning gear cabin also contains the circuitry associated with the scanner including that of the magslip and sin/cos potentiometer which provide aerial follow information for the displays.

6. On the FGRI. 26008/1 the r.f. feed to the scanner is via a waveguide and rotating joint combination to the horn radiating element. The output of the horn is reflected from a continuous surface, metal parabolic reflector to produce a cosecant squared vertical pattern with a horizontal beam width of 1·4 degrees. The FGRI. 26008/2 system is described in Section 3.

7. The radiated energy is normally horizontally polarized but it can be made circular by the introduction of a circularizer. This is a quarter wave anti-rain plate, switched in when required, on the FGRI. 26008/1 and a variable phase adjuster in the polarizing section of the boom arm on the FGRI. 26008/2.

8. The speed of rotation of the scanner is 12 rev/min and is maintained constant at this speed for winds up to 45 knots.

9. The radar T/R assemblies Type S1/2 and the scanner are controlled at the remote site from the radar set group Type S1/1 which incorporates a thermal noise generator Type S8/1 for noise figure measurements, the electrical dummy load Type S1/1 which provides a resistive load for the standby transmitter during servicing, and the voltage stabilizer Type S1/1 and voltage regulator Type S2/1 which provide power supplies for the two transmitter-receivers and the remaining units (radar set control Type S6/3 and remote switching control Type S14/1) in the radar set group S1/1.

10. A waveguide assembly Type S7/1 mounted in the waveguide run between the waveguide switch and the scanner provides a measure of the mean power delivered to the scanner.

11. The display system at the remote site comprises one azimuth range indicator Type S5/1 and its pulse generator power supply Type S18/2. The latter incorporates the waveform generation circuits fed from the sin-cos potentiometer supply in the synchros assembly Type S1/1 in the aerial turning gear cabin.

12. This azimuth range indicator provides for p.p.i. presentation of normal radar and m.t.i. information on four ranges 0-10 miles, 0-25 miles, 0-50 miles and 0-100 miles, secondary radar and c.r.d.f. information. A north bearing marker and range markers are also provided. A special circuit arrangement provides for the range markers which are at 1, 5, 10 and 20 nautical miles to have successive degrees of brilliance so that the operator can cause the markers to appear in succession commencing with the 20 mile marker.

13. Provision is also made for video mapping and inter-scan markers, if required.

14. The display system at the local site, which may be up to 4000 yards from the remote site, provides two azimuth range indicators Type S5/1. This, however, requires, in addition to the pulse generator power supply Type S18/1 (identical to pulse generator power supply Type S18/2), an amplifier power supply Type S29/1 which incorporates a synchros signal amplifier Type S23/1 (aerial follower unit) fed from the synchros assembly in the aerial turning

gear cabin. The synchros signal amplifier Type S23/1 is fixed to the top of the amplifier power supply Type S29/1 and the combination represents a rack assembly Type DGA86793.

15. Normal radar, m.t.i. video and pre-pulse information for both sites are provided via the signal splitter boxes (two impedance matching networks Type S1/1 and one fixed attenuator Type S8/1). The outputs for the local site are amplified in the amplifier power supply Type S30/1 (signal booster) to provide for the attenuation due to the long length of line.

16. The impedance matching network Type S3/1 is introduced to provide compensation for the aerial following signals for different lengths of cable between the two sites.

17. Two land line termination units each comprising a six coaxial terminal strip and three telephone type terminal boxes provide connections to the cable joining the two sites.

18. This installation has been designed for operation in conditions of high ambient temperatures (up to 50 deg.C) and high relative humidity. An efficient ventillation system has been incorporated and standby heaters are provided in the main cabinets to prevent condensation which occurs in certain operational areas when the equipment is switched off.

Moving target indication

19. Moving target indication (m.t.i.) is a means of distinguishing between echoes from fixed and moving targets. It is therefore necessary to choose some characteristic of the signals that is different in each instance. The property that is most sensitive to the change in the range of target is the phasing of the received signal relative to that of the transmitted pulse. For all targets, whether fixed or moving, there is a difference betwenn the phase angles unless the total path length to and from the target happens to be a whole number of wavelengths. For a fixed target the phase difference is constant from pulse to pulse, but for a moving target it will vary as a function of the radial component of velocity of the object. A phase-sensitive detector can thus be used to obtain an output that is constant for a permanent echo but varies in amplitude and polarity for a moving target echo. If this output of mixed permanent echo and moving target pulses is passed through two channels, in one of which is introduced a delay equal to the pulse repetition period, and if one of the outputs is inverted, combination of these two will cause cancellation of the permanent echoes, but leave residual moving target signals for presentation on the display.

20. It is not practicable to compare the phases of a transmitted and received pulses directly, firstly because a transmission only lasts for one microsecond, and, secondly, because phase comparison is difficult at radio frequencies. The coho-stalo system is therefore employed.

21. In this system the output of a very stable oscillator (stalo) is mixed with a sample of the transmitted pulse and also, in a separate mixer, with the received signals, converting both to the intermediate frequency of 30 Mc/s. The 30 Mc/s sample of the transmission is used to phase lock a

coherent oscillator (coho) which is switched off after each scan period and switched on again on the arrival of the synchronizing pulse. The coho is thus phase locked to the transmitter pulse for the whole of the scan period and provides a reference with which the phase of the received signal can be compared.

22. The output of the video pulses from the phase sensitive detector modulates a 20 Mc/s carrier before being applied to the delayed and undelayed channels. The delayed channel uses a quartz delay line for conversion of the electrical signals to ultrasonic waves and then reversion to electrical pulses. Effective cancellation of permanent echoes is ensured by balancing the amplitudes of the pulse outputs from the two channels, and by adjusting the delay so that corresponding delayed and undelayed pulses are synchronous at the cancellation point. Amplitude balance is maintained by automatic gain control and synchronism by the system p.r.f. being locked to the delay of the line.

Operating instructions

23. Switch on the power supply to the radar set group Type S1/2. Check the outputs of the voltage stabilizer Type S1/1 and the voltage regulator Type S2/1.

24. Switch on the remote switching control Type S14/1.

25. Ensure that the MASTER/AUX switch on the radar set control Type S6/3 is set to MASTER. Select the required radar T/R assembly Type S1/2 for connection to the aerial. (On switching on, TX1 automatically connected). Set the appropriate STANDBY and RF ON switches to ON.

26. Ensure that the main circuit breaker (CB1) and MT1 switches on the power supply control Type S7/1 of the operational transmitter-receiver are at ON. Check the output of the variable power transformer (variac) is 230V. The STAND BY ON lamp on the radar set control Type S6/3 should light half a minute later.

27. Check all indicator lamps on the power supply Type S41/1 are lit. Check monitor meter indicates 100 divisions in positions 1, 2 and 3, and 100 ± 20 divisions in position 4.

28. Connect monitor meter to the T/R line plug panel. Check meter indicates 100 ± 10 divisions in positions 6 and 7 (crystal current).

29. On FGRI. 26008/1, check O/L trip lamp on RF amplifier Type S13/1 is not lit. Check that helix current is less than 0·5µA and that the collector current is 15µA. On FGRI 26008/2 check O/L trip lamp is not lit, and adjust klystron reflector control knob for maximum meter deflection on control unit EA/276/1.

30. Check that the AGC/MANUAL switch on MTI group Type S1/2 is set to AGC. Check meter indication in meter selector switch position 11 (carrier level) is 65 divisions. Check that the indications for meter selector switch positions 6 and 7 are exactly equal.

31. When the transmitter has been operating for about 5 minutes the e.h.t. should run up to normal value, and the mains supply can be switched on for the aerial turning gear cabin Type S5/1. Operate the AE ON switch on the radar set control Type S6/3.

32. Switch on the azimuth range indicator Type S5/1 at this site. Check that all indicator lamps are lit and the voltages are correct at the pulse generator power supply Type S18/2. Approximately one minute later rotate the BRIGHTNESS control slowly in clockwise direction until the trace is just visible then slightly reduce the brilliance.

Note...

Rotating of the NR/MTI GAIN controls in clockwise direction should now produce signals on the c.r.t.

33. Switch on amplifier power supply Type S30/1 (signal booster) and check that HT lamps are then lit. Check meter indications for selector switch positions 6, 7 and 8 are 100 ± 10 divisions.

34. Switch on mains supply to displays at radio equipment and approach control rooms. Check the supply voltage at the voltage stabilizer Type S3/1 is 230. Check that all indicator lamps on each of the power supplies are lit and that the h.t. leads are correct.

35. Switch on the two azimuth range indicators Type S5/1 in turn and set up as at para.33 et seq.

TABLE 1

Details of remote site cables

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remakrs
1	Cable Min.Elect. No.12A 6145-99-910-0030	Remote switching control Type S14/1	Relay Unit EA 4465		Spare leads to be taped back at TB.3 end
		SK7	TB3		
	Yellow	1	2B	Aerial Start	
	White	2	3B	Aerial Stop	
	Black	3	9B	Rain Suppress On	
	Brown	4	4B	Rain Suppress Off	
	Violet	5	1B	Aerial On Ind.	
	Orange	6	7B	Rain Supp. on Ind.	
	Pink	7	5B	+60V	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
1 cont.	Green	8	8B	Earth	
		9		Spare	
	Red	10	13B	Telephone	
	Blue	11	14B	Telephone	
	Grey	12		Spare	
2	Cable Min.Elect. No.36C 6145-99-910-0046	Remote switching control Type S14/1 SK2	Remote Termination Box 'B'		
	Red	1	1	Tx.1 Standby On	
	Blue	2	2	Tx.1 Standby Off	
	Green	3	3	Tx.1 e.h.t.	
	Yellow	4	4	Tx.1 e.h.t. Off	
	White	5	5	Tx.2 Standby On	
	Black	6	6	Tx.2 Standby Off	
	Brown	7	7	Tx.2 e.h.t.	
	Violet	8	8	Tx.2 e.h.t. Off	
	Orange	9			Orange and Pink leads to be cut back and insulated at both ends.
	Pink	10			
	Grey	11	9	Switched +60V	Box B - Link Terminals 9 and 10
	Red/Blue	12	11	Change p.r.f.	
	Red/Green	13	13	Change p.r.f. Ind.	Box B - Link Terminals 13 and 14
	Red/Yellow	14	15	Select Tx.1 to Aerial	
	Red/White	15	16	Select Tx.2 to Aerial	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
2 cont.	Red/Black	16	17	Tx.1 to Aerial Ind.	Box B - Link Terminals 17 and 18
	Red/Brown Lt. Green	17	19	Earth	Box B - Link Terminals 19 and 20
	Blue/Yellow	18	21	Tx.2 to Aerial Ind.	Box B - Link Terminals 21 and 22
	Violet/Yellow Violet/Black	19	23	Earth	Box B - Link Terminals 23 and 24
	Blue/White	20	25	Tx.2 r.f. On Ind.	Box B - Link Terminals 25 and 26
	Blue/Black	21	27	Tx.2 Standby On Ind.	Box B - Link Terminals 27 and 28
	Blue/Orange	22	29	Tx.1 r.f. On Ind.	Box B - Link Terminals 29 and 30
	Blue/Green	23	31	Tx.1 Standby On Ind.	Box B - Link Terminals 31 and 32
	Blue/Grey Violet/White	24	33	+60V	Box B - Link Terminals 33 to 39
	Green/Yellow	25	40	Rain Suppress on Ind.	Box B - Link Terminals 40 and 41
	Green/White	26	42	Aerial on Ind	Box B - Link Terminals 42 and 43
	Green/Black	27	44	Rain Suppress Off	
	Green/Orange	28	45	Rain Suppress On	
	Brown/Yellow	29	46	Aerial Stop	
	Brown/White	30	47	Aerial Start	
	Green/Grey	31	48	Spare	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Brown/Black	32	49	Telephone	
	Brown/Grey	33	50	Telephone	Box B Terminals 12, 51 and 52 Spare "See Note 3"
2A	Cable Min.Elect. No.36C 6145-99-910-0046	Remote switching control Type S14/1	Radar set control Type S6/4		For RAF Locking and Tangmere Only
		SK2	PL1		
	Red	1	1	Tx.1 Standby On	
	Blue	2	2	Tx.1 Standby Off	
	Green	3	3	Tx.1 e.h.t. On	
	Yellow	4	4	Tx.1 e.h.t. On	
	White	5	5	Tx.2 Standby On	
	Black	6	6	Tx.2 Standby Off	
	Brown	7	7	Tx.2 e.h.t. On	
	Violet	8	8	Tx.2 e.h.t. On	
	Orange	9	9		Orange and Pink leads to be cut back and insulated at both ends.
	Pink	10	10		
	Grey	11	11	Switched +60V	
	Red/Blue	12	12	Change p.r.f.	
	Red/Green	13	13	Change p.r.f. Ind.	
	Red/Yellow	14	14	Select Tx.1 to Aerial	
	Red/White	15	15	Select Tx.2 to Aerial	
	Red/Black	16	16	Tx.1 to Aerial Ind.	
	Red/Brown	17	17	Earth	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Lt. Green				
	Blue/Yellow	18	18	Tx.2 to Aerial Ind	
	Violet/Yellow	19	19	Earth	
	Violet/Black				
	Blue/White	20	20	Tx.2 r.f. On Ind.	
	Blue/Black	21	21	Tx.2 Standby On Ind.	
	Blue/Orange	22	22	Tx.1 r.f. On Ind.	
	Blue/Green	23	23	Tx.1 Standby On Ind.	
	Blue/Grey	24	24	+60V	
	Violet/White				
	Green/Yellow	25	25	Rain Suppress On Ind.	
	Green/White	26	26	Aerial On Ind.	
	Green/Black	27	27	Rain Suppress Off	
	Green/Orange	28	28	Rain Suppress On	
	Brown/Yellow	29	29	Aerial Stop	
	Brown/White	30	30	Aerial Start	
	Green/Grey	31	31	Spare	
	Brown/Black	32	32	Telephone	
	Brown/Grey	33	33	Telephone	
3	Cable Min.Elect. No.12A 6145-99-910-0030	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.1 Roof Plug Panel		
		PL4	SK24		
	Green	1	1	Earth	
		2	2	Not available	Red and Blue leads not connected at either end. Cut back and insulate.
		3	3	Not available	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Yellow	4	4	Trigger stop	
	Light Green	5	5	Spare	
	White	6	6	E.h.t. On	
	Black	7	7	Standby On Ind.	
	Brown	8	8	+200V	
	Violet	9	9	Prepulse Selection	
	Orange	10	10	R.f. Power On Ind.	
	Pink	11	11	E.h.t. Interlocks	
	Grey	12	12	Standby On	
4	Cable Min.Elect. No.12A 6145-99-910-0030	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.2 Roof Plug Panel		
		PL5	SK24		
	Green	1	1	Earth	
		2	2	Not available	Red and Blue leads not connected at either end. Cut back and insulate.
		3	3	Not available	
	Yellow	4	4	Trigger Stop	
	Light Green	5	5	Spare	
	White	6	6	E.h.t. On	
	Black	7	7	Standby On Ind.	
	Brown	8	8	+200V	
	Violet	9	9	Prepulse Selection	
	Orange	10	10	R.f. Power On Ind.	
	Pink	11	11	E.h.t. Interlocks	
	Grey	12	12	Standby On	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
5	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.1 Roof Plug Panel		
		PL15	PL Red	Normal Radar	
6	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.2 Roof Plug Panel		
		PL20	PL Red	Normal Radar	
7	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.1 Roof Plug Panel		
		PL14	PL Black	M.t.i. Video	
8	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.2 Roof Plug Panel		
		PL19	PL Black	M.t.i. Video	
9	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.1 Roof Plug Panel		
		PL13	PL Blue	Prepulse (T/R to remote switching control Type S14/1)	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
10	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.2 Roof Plug Panel		
		PL18	PL Blue	Prepulse (T/R to remote switching control Type S14/1)	
11	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.1 Roof Plug Panel		
		SK16	PL Green/ White	Prepulse (Remote switching control Type S14/1 to T/R)	
12	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Radar T/R assembly Type S1/2 No.2 Roof Plug Panel		
		SK21	PL Green/ White	Prepulse (Remote switching control Type S14/1 to T/R)	
13	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Fixed attenuator Type S8/1		
		SK22	PL1	Normal Radar to fixed attenuator Type S8/1	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
14	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Impedance matching network Type S1/1		
		SK23	PL1	M.t.i. Video to impedance matching network Type S1/1	
15	Cable R.F.UR70 6145-99-910-0298	Remote switching control Type S14/1	Impedance matching network Type S1/1		
		SK24	PL1	Prepulse to impedance matching network Type S1/	
16	Cable R.F.UR70 6145-99-910-0298	Fixed attenuator Type S8/1	Amplifier power supply Type S30/1 Plug Panel		
		SK1	SKB	Normal Radar (Split)	
17	Cable R.F.UR70 6145-99-910-0298	Fixed attenuator Type S8/1	Pulse generator power supply Type S18/2 Plug Panel		
		SK2	SKBB	Normal Radar	
18	Cable R.F.UR70 6145-99-910-0298	Impedance Network Type S1/1	Pulse generator power supply Type S18/2 Plug Panel		
		SK1	SKC	M.t.i. Video	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
19	Cable R.F.UR70 6145-99-910-0298	Impedance matching network Type S1/1	Pulse generator power supply Type S18/2 Plug Panel		
		SK2	SKBC	M.t.i.Video	
20	Cable R.F.UR70 6145-99-910-0298	Impedance matching network Type S1/1	Pulse generator power supply Type S18/2 Plug Panel		
		SK1	SKD	Prepulse	
21	Cable R.F.UR70 6145-99-910-0298	Impedance matching network Type S1/1	Pulse generator power supply Type S18/2 Plug Panel		
		SK2	SKBA	Prepulse	
22	Cable R.F.UR70 6145-99-910-0298	Amplifier power supply Type S30/1	Remote Termination		
		SKE	Plug '1'	M.t.i./Prepulse (20 Mc/s)	
22A	Cable R.F.UR70 6145-99-910-0298	Amplifier power supply Type S30/1	Amplifier power supply Type S29/1 Plug Panel		For RAF Locking and Tangmere only
		SKE	SKH	M.t.i./Prepulse (20 Mc/s)	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
23	Cable R.F.UR70 6145-99-910-0298	Amplifier power supply Type S30/1 Plug panel	Remote Termination		
		SKF	Plug '2'	Normal Radar	
23A	Cable R.F.UR70 6145-99-910-0298	Amplifier power supply Type S30/1 Plug Panel	Pulse generator power supply Type S18/1 Plug Panel		For RAF Locking and Tangmere only
		SKF	SKBB	Normal Radar	
24	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKCD	SKH	Azimuth Marker	
25	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKDE	SKM	M.t.i. and Normal Radar	
26	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKCC	SKN	Brightener Pulse	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
27	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKDD	SKP	Normal Radar	
28	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKDC	SKZ	Range Rings	
29	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Types 18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKCA	SKA	X Integrator	
30	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		
		SKCB	SKB	Y Integrator	
31	Cable Min.Elect. No.18A 6145-99-910-0036	Pulse generator power supply Type S18/2 Plug Panel	Azimuth range indicator Type S5/1 Plug Panel		Pink, Light Green, Red/Green, and Red/Yellow leads not connected at either end. Cut back and insulated.
		SKB	PLA		
	Red	1	1	+500V stab.	
	Blue	2	2	+300V stab.	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Green	3	3	Earth	
	Yellow	4	4	-330V stab.	
	White	5	5	-500V stab.	
		6			
	Black	7	7	+330V to Defl. Amp.	
		8			
	Red/Brown	9	9	-330V to Defl. Amp.	
		10			
	Brown	11	11	+28V	
	Violet	12	12	+28V Switched	
		13			
	Orange	14	14	(ISO Echo On/off)	Not used
		15			
		16	16		
		17	17		
		18			
		19			
	Grey	20	20	(C.r.d.f. Switch)	Not used
	Red/Blue	21	21	(C.r.d.f. Switch)	Not used
		22	22		
		23	23		
	Red/White	24	24	Stab. Mains (L)	
	Red/Black	25	25	Stab. Mains (N)	
					Pins 16 & 17 in 25 way Unitor Socket 'A' are linked.

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
32	Cable Min.Elect. No.12D 6145-99-910-0033	Synchros assembly Type S1/1	Impedance matching network Type S3/1		Avoid running this cable with Power Cables
		PLB	SKA		
	Red	24	24	H.S. Magslip Stator B	
	Braid	21	21	Screen of Red	
	Braid	1	1	Screen of Blue	
	Blue	2	2	Az. Marker Trigger	
	Green	14	14	Earth	
	Yellow	18	18	H.S. Magslip Stator C	
	Braid	15	15	Screen of Yellow	
	White	5	5	Magslip Supply Rotor Y	
	Braid	22	22	Screen of Black	
	Black	23	23	Magslip Supply Rotor X	
	Brown	12	12	L.S. Magslip Stator B	
	Braid	9	9	Screen of Brown	
	Braid	4	4	Screen of White	
	Braid	13	13	Screen of Green	
	Violet	11	11	L.S. Magslip Stator A	
	Braid	10	10	Screen of Violet	
	Pink	6	6	L.S. Magslip Stator C	
	Braid	3	3	Screen of Pink	
	Orange	8	8	L.S. Magslip Stator D	
	Braid	7	7	Screen of Orange	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Lt. Green	17	17	H.S. Magslip Stator A	
	Braid	16	16	Screen of Lt. Green	
	Grey	20	20	H.S. Magslip Stator D	
	Braid	19	19	Screen of Grey	
33	Cable Min.Elect. No.12D 6145-99-910-0033	Impedance matching network Types 3/1	Remote Termination Box 'A'		Avoid running this cable with Power Cables
		PLB			
	Braid	1	13	Screen of Black	
	Black	2	16	Magslip Supply Rotor X	
	Red	3	8	H.S. Magslip Stator B	
	Braid	4	13	Screen of White	
	White	5	14	Magslip Supply Rotor Y	
	Braid	6	5	Screen of Red	
	Braid	7	5	Screen of Lt. Green	
	Lt. Green	8	6	H.S. Magslip Stator A	
	Yellow	9	10	H.S. Magslip Stator C	
	Braid	10	9	Screen of Grey	
	Grey	11	12	H.S. Magslip Stator D	
	Braid	12	9	Screen of Yellow	
	Braid	13	12	Screen of Green	
	Green	14	29	AZ. Marker Trig. Return	
	Brown	15	21	L.S. Magslip Stator B	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Braid	16	24	Screen of Orange	
	Orange	17	25	L.S. Magslip Stator D	
	Braid	18	20	Screen of Brown	
	Braid	19	18	Screen of Violet	
	Violet	20	19	L.S. Magslip Stator A	
	Pink	21	23	L.S. Magslip Stator C	
	Braid	22	26	Screen of Blue	
	Blue	23	27	Az. Marker Trigger	
	Braid	24	22	Screen of Pink	
					Box 'A' Terminal 30 Spare Screen 31 Spare Lead
33A	Cable Min.Elect. No.12D 6145-99-910-0033	Impedance matching network Type S3/1	Amplifier, power supply Type S29/1 Plug Panel		For RAF Locking and Tangmere only
		PLB	SKB		
	Braid	1	9	Screen of Black	
	Black	2	10	Magslip Supply Rotor X	Avoid running this Cable with Power Cables
	Red	3	1	H.S. Magslip Stator B	
	Braid	4	13	Screen of White	
	White	5	8	Magslip Supply Rotor Y	
	Braid	6	2	Screen of Red	
	Braid	7	22	Screen of Lt. Green	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Lt. Green	8	23	H.S. Magslip Stator A	
	Yellow	9	6	H.S. Magslip Stator C	
	Braid	10	24	Screen of Grey	
	Grey	11	25	H.S. Magslip Stator D	
	Braid	12	7	Screen of Yellow	
	Braid	13	*	Screen of Green	
	Green	14	5	Az. Marker Trig. Return	
					*Sc een of Green to be cut back and insulated.
	Brown	15	11	L.S. Magslip Stator B	
	Braid	16	20	Screen of Orange	
	Orange	17	15	L.S. Magslip Stator D	
	Braid	18	12	Screen of Brown	
	Braid	19	19	Screen of Violet	
	Violet	20	14	L.S. Magslip Stator A	
	Pink	21	16	L.S. Magslip Stator C	
	Braid	22	3	Screen of Blue	
	Blue	23	4	Az. Marker Trigger	
	Braid	24	17	Screen of Pink	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
34	Cable Min.Elect. No.7D 6145-99-910-0028	Synchros assembly Type S1/1	Pulse generator power supply Type S18/2 Plug Panel		
		PLA	SKA		
	Blue	1	10	Az. Marker Trigger	Screens of Blue and Yellow Leads to be Cut Back and Insulated.
	Yellow	4	9	Az. Marker Trigger Return	
	Green	3	4	Sin/Cos Pot. Mt. (Cnd.)	
	Braid	2	5	Screen of Green	
	Black	10	16	+Supply Sin/Cos Pot.Mt.	
	Braid	7	17	Screen of Black	
	Brown	11	18	-Supply Sin/Cos Pot.Mt.	
	Red	9	15	Sin/Cos Pot.Mt. (Cos)	
	Braid	12	8	Screen of Red	
	White	6	13	Sin/Cos Pot.Mt. (Sin)	
	Braid	5	14	Screen of White	
	Braid	8	12	Screen of Brown	
35	Equip.Wire Type 3 70/0076 6145-99-910-0231	Radar set group Type S1/1 Distribution Panel	Radar T/R assembly Type S1/2 No.1		Spade Tags Cossor K.S.70956 To be fitted.
	Red	TB2 Pin 1	TB7 Pin 3	Stab Mains (Line)	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
36	Equip.Wire Type 3 70/0076 6145-99-942-4131	Radar set group Type S1/1 Distribution Panel	Radar T/R assembly Type S2/2 No.1		Spade Tags Cossor K.S.70956 To be fitted.
	Black	TB2 Pin 2	TB7 Pin 4	Stab Mains (Neutral)	
37	Equip.Wire Type 3 70/0076 6145-99-942-4133	Radar set group Type S1/1 Distribution Panel	Radar T/R assembly Type S1/2 No.1		Spade Tags Cossor K.S.70956 To be fitted.
	Green	TB2 Pin 3	TB5 Pin 1	Stab Mains (Earth)	
38	Equip.Wire Type 3 70/0076 6145-99-910-0231	Radar set group Type S1/1 Distribution Panel	Radar T/R assembly Type S1/2 No.2		Spade Tags Cossor K.S.70956 To be fitted.
	Red	TB2 Pin 4	TB7 Pin 3	Stab Mains (Line)	
39	Equip.Wire Type 3 70/0076 6145-99-942-4131	Radar set group Type S1/1 Distribution Panel	Radar T/R assembly Type S1/2 No.2		Spade Tags Cossor K.S.70956
	Black	TB2 Pin 5	TB7 Pin 4	Stab Mains (Neutral)	
40	Equip. Wire Type 3 70/0076 6145-99-942-4133	Radar set group Type S1/1 Distribution Panel	Radar T/R assembly Type S1/2 No.2		Spade Tags Cossor K.S.70956
	Green	TB2 Pin 6	TB5 Pin 1	Stab Mains	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
41	Cable 3 Core 110/0076 To BS2004 Table 18	Radar Set group Type S1/1 Distribution Panel	Radar T/R assembly Type S1/2 Plug Panel		
		TB2	PLG		
	Red	7	A	Stab Mains (Line)	
	Black	8	B	Stab Mains (Neutral)	
	Green	9	C	Stab Mains (Earth)	
42	Cable 3 Core 110/0076 To BS2004 Table 18	Radar Set group Type S1/1 Distribution Panel	Amplifier power supply Type S30/1 Plug Panel		
		TB2	PLA		
	Red	10	A	Stab Mains (Line)	
	Black	11	B	Stab Mains (Neutral)	
	Green	12	C	Stab Mains (Earth)	
43	Cable 3 Core 19/044 To BS2004 Table 13	Mains Supply 230V 50c/s	Radar set group Type S1/1 Distribution Panel		
			TB1		
	Red		1	Unstab Mains (Line)	
	Blue		2	Unstab Mains (Neutral)	
	White		3	Unstab Mains (Earth)	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
44	3 Core Cord 110/0076 To BS2004 Table 18	Mains Supply 230V 50c/s	Pulse generator power supply Type S18/2 Plug Panel		
			PLF		
	Red		A	Unstab Mains (Line)	
	Black		B	Unstab Mains (Neutral)	
	Green		C	Unstab Mains (Earth)	
45	3 Core Cord 110/0076 To BS2004 Table 18	Mains Supply 230V 50c/s	Azimuth range indicator Type S5/1 Plug Panel		
			PLB		
	Red		A	Unstab Mains (Line)	
	Black		B	Unstab Mains (Neutral)	
	Green		C	Unstab Mains (Earth)	
46	Cable/Core 19/044 To BS2004 Table 12	Mains Supply 230V 50c/s	Switch panel		
			TB1		
	Red		1A	Unstab Mains (Line)	
47	Cable/Core 19/044 To BS2004 Table 12	Mains Supply 230V 50c/s	Switch panel		
			TB1		
	Blue		3A	Unstab Mains (Neutral)	

TABLE 1 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
48	Cable/Core 19/044 To BS2004 Table 12	Mains Supply 250V 50c/s	Switch panel		
			TB1		
	White		5A	Unstab Mains (Earth)	
49	Cable Min.Elect. 2A	Thermal noise generator Type S8/1	Waveguide assembly Type S7/1		
		PL2			
	Red	A	Terminal A	Input to	
	Blue	B	Terminal B	R.F. Power Meter	

TABLE 2

Details of radio equipment and approach control room cables

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
101	Cable Min.Elect. No.36C 6145-99-910-0046	Remote Termination Box B	Radar set control Type S6/4		Pink & Orange leads to be cut back and insulated at both ends.
			PL1		
	Red	1	1	Tx1 Standby On	
	Blue	2	2	Tx1 Standby Off	
	Green	3	3	Tx1 e.h.t. On	
	Yellow	4	4	Tx1 e.h.t. Off	
	White	5	5	Tx2 Standby On	
	Black	6	6	Tx2 Standby Off	
	Brown	7	7	Tx2 e.h.t.On	
	Violet	8	8	Tx2 e.h.t.Off	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
			9		
			10		
	Grey	9	11	Switched +60V	Box B - Link Terminals 9 and 10
	Red/Blue	11	12	Change p.r.f.	
	Red/Green	13	13	Change p.r.f.Ind.	Box B - Link Terminals 13 and 14
	Red/Yellow	15	14	Select Tx1 to Aerial	
	Red/White	16	15	Select Tx2 to Aerial	
	Red/Black	17	16	Tx1 to Aerial Ind.	Box B - Link Terminals 17 and 18
	Red/Brown Lt. Green	19	17	Earth	Box B - Link Terminals 19 and 20
	Blue/Yellow	21	18	Tx2 to Aerial Ind.	Box B - Link Terminals 21 and 22
	Violet/Yellow Violet/Black	23	19	Earth	Box B - Link Terminals 23 and 24
	Blue/White	25	20	Tx2 r.f. on Ind.	Box B - Link Terminals 25 and 26
	Blue/Black	27	21	Tx2 Standby on Ind.	Box B - Link Terminals 27 and 28
	Blue/Orange	29	22	Tx1 r.f. on Ind.	Box B - Link Terminals 29 and 30
	Blue/Green	31	23	Tx1 Standby on Ind.	Box B - Link Terminals 31 and 32

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Blue/Grey	33	24	+60V	Box B - Link Terminals 33 34,35,36,37, 38 and 39
	Violet/White				
	Green/Yellow	40	25	Rain Suppress on Ind.	Box B - Link Terminals 40 and 41
	Green/White	42	26	Aerial on Ind.	Box B - Link Terminals 42 and 43
	Green/Black	44	27	Rain Suppress Off	
	Green/Orange	45	28	Rain Suppress On	
	Brown/Yellow	46	29	Aerial Stop	
	Brown/White	47	30	Aerial Start	
	Green/Grey	48	31	Spare	
	Brown/Black	49	32	Telephone	
	Brown/Grey	50	33	Telephone	
					Box B terminals 12,51 and 52 spare
102	Cable Min.Elect. No.12D 6145-99-910-0033	Remote Termination Box 'A'	Amplifier Power supply Type 29/1 Plug Panel		
			SK 'B'		
	Red	8	1	H.S. Magslip Stator B	
	Braid	5	2	Screen of Red	
	Braid	26	3	Screen of Blue	
	Blue	27	4	A.z. Marker Trigger	
	Green	29	5	Earth	
	Yellow	10	6	H.S. Magslip Stator C	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Braid	9	7	Screen of Yellow	
	White	14	8	Magslip Supply Rotor Y	
	Braid	13	9	Screen of Black	
	Black	16	10	Magslip Supply Rotor X	
	Brown	21	11	L.S. Magslip Stator B	
	Braid	20	12	Screen of Brown	
	Braid	13	13	Screen of White	
	Violet	19	14	L.S. Magslip Stator A	
	Orange	25	15	L.S. Magslip Stator D	
	Pink	23	16	L.S. Magslip Stator C	
	Braid	22	17	Screen of Pink	
		-	18	Spare	
	Braid	18	19	Screen of Violet	
	Braid	24	20	Screen of Orange	
		-	21	Spare	
	Braid	5	22	Screen of Lt. Green	
	Lt. Green	6	23	H.S. Stator Magslip A	
	Braid	9	24	Screen of Grey	
	Grey	12	25	M.S. Magslip Stator D	Screen of Green to be cut back and insulated. Box A Terminal 30 Spare Screen 31 Spare Lead.

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
103	Cable Min.Elect. No.18A 6145-99-910-0036	Pulse generator power supply Type S18/1 Plug Panel	Azimuth range indicator Type S5/1 No.1 Plug Panel		Pin, Light Green Red/Green and Red/Yellow leads not connected at either end. Cut back and insulate.
		SKB	PLA		
	Red	1	1	+500V Stab.	Pins 16 and 17 in 25 way Unitor Socket 'A' are linked.
	Blue	2	2	+330V Stab.	
	Green	3	3	Earth	
	Yellow	4	4	-330V Stab.	
	White	5	5	-500V Stab.	
		6	6	-	
	Black	7	7	+300V to Defl. Amp.	
		8	8	-	
	Red/Brown	9	9	-300V to Defl. Amp.	
		10	10		
	Brown	11	11	+28V	
	Violet	12	12	+28V Switched	
		13	13	-	
	Orange	14	14	(1SO Echo On/Off)	Not Used
		15	15	-	
		16	16		
		17	17		
		18	18	-	
		19	19	-	
	Grey	20	20	(C.r.d.f. Switch)	Not Used
	Red/Blue	21	21	(C.r.d.f. Switch)	Not Used
		22	22		

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
		23	23		
	Red/White	24	24	Stab.Mains (Line)	
	Red/Black	25	25	Stab.Mains (Neutral)	
104	Cable Min.Elect. No.18A 6145-99-910-0036	Pulse generator power supply Type S18/1 Plug Panel	Azimuth range indicator Type S5/1 No.2 Plug Panel		Pink, Light Green Red/ Green, and Red/Yellow leads are not connected at either end. Cut back and insulate.
		SKC	PLA		
	Red	1	1	+50V Stab.	
	Blue	2	2	+330V Stab.	
	Green	3	3	Earth	
	Yellow	4	4	-330V Stab.	
	White	5	5	-500V Stab.	Pins 16 and 17 in 25 way Unitor Socket 'A' are linked.
		6	6		
	Black	7	7	330V To Defl. Amp.	
		8	8	-	
	Red/Brown	9	9	-330V To Defl. Amp.	
		10	10	-	
	Brown	11	11	+28V	
	Violet	12	12	+28V Switched	
		13	13	-	
	Orange	14	14	(1SO Echo On/Off)	Not Used
		15	15	-	
		16	16		

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
		17	17		
		18	18	-	
		19	19	-	
	Grey	20	20	(C.r.d.f.Switch)	Not Used
	Red/Blue	21	21	(C.r.d.f.Switch)	Not Used
		22	22		
		23	23		
	Red/White	24	24	Stab.Mains (Line)	
	Red/Black	25	25	Stab.Mains (Neutral)	
105	Cable Min.Elect. No.4P 6145-99-910-0017	Amplifier power supply Type S29/1 Plug Panel	Pulse generator power supply Type S18/1 Plug Panel		
		SKL	PLG		
	Red	A	A	Stab. Mains (Line)	
	Black	B	B	Stab. Mains (Neutral)	
	Green	C	C	Earth	
	Yellow	D	D	Unstab.Mains (L) Blower.	
L06	Cable Min.Elect. No.12D 6145-99-910-0033	Amplifier power supply Type S29/1 Plug Panel	Pulse generator power supply Type S18/1 Plug Panel		
		SKA	SKA		
	Red	1	9	AZ.Marker	
	Braid	2	10	Screen of Red	
	Blue	3	2	(North Marker Relay)	Not Used
	Braid	4	-	Screen of Blue	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
	Green	5	1	Spare (1)	
	Yellow	6	3	Spare (2)	Where Braids are not connected to pins they must be sleeved back.
	Braid	7	-	Spare (2) Screen of Yellow	
	White	8	6	Spare (3)	
	Braid	9	-	Spare (3) Screen of White	
	Braid	10	-	Spare (1) Screen of Green	
	Black	11	11	Spare (4)	
	Braid	12	-	Spare (4) Screen of Black	
		13	-	-	
		14	-	-	
	Brown	15	7	Earth	
	Braid	16	5	Screen of Violet	
	Violet	17	4	Sin/Cos Pot.Gnd.	
	Orange	18	16	+Supply Sin/Cos Pot.	
	Braid	19	17	Screen of Orange	
	Pin	20	18	-Supply Sin/Cos Pot.	
	Lt.Green	21	13	Sin/Cos Pot.Cos	
	Braid	22	8	Screen of Lt.Green	
	Gray	23	15	Sin/Cos Pot.Sin	
	Braid	24	14	Screen of Grey	
	Braid	25	12	Screen of Pink	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
107	Cable R.F.UR70 6145-99-910-0298	Remote Termination	Amplifier power supply Type 29/1 Plug Panel		
		Plug '1'	SKH	M.t.i./Prepulse (20Mc/s)	
108	Cable R.F.UR70 6145-99-910-0298	Remote Termination	Pulse generator power supply Type S18/1 Plug Panel		
		Plug '2'	SKBB	Normal Radar	
109	Cable R.F.UR70 6145-99-910-0296	Amplifier power supply Type S29/1 Plug Panel	Pulse generator power supply Type S18/1 Plug Panel		
		SKF	SKBA	Time Base Trigger	
110	Cable R.F.UR70 6145-99-910-0298	Amplifier power supply Type S29/1 Plug Panel	Pulse generator power supply Type S18/1 Plug Panel		
		SKG	SKBC	M.t.i./Prepulse	
111	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel	Azimuth range indicator Type S5/1 No.1 Plug Panel		
		SKCB	SKB	Y Integrator	
112	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel	Azimuth range indicator Type S5/1 No.1 Plug Panel		
		SKCA	SKA	X Integrator	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
113	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKDC	Azimuth range indicator Type S5/1 No.1 Plug Panel SKZ	Range Rings	
114	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKDD	Azimuth range indicator Type S5/1 No.1 Plug Panel SKP	Normal Radar	
115	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKCC	Azimuth range indicator Type S5/1 No.1 Plug Panel SKN	Brightener Pulse	
116	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKDE	Azimuth range indicator Type S5/1 No.1 Plug Panel SKM	M.t.i./Normal Radar	
117	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKCD	Azimuth range indicator Type S5/1 No.1 Plug Panel SKH	Az.Marker Trigger	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
118	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKCF	Azimuth range indicator Type S5/1 No.2 Plug Panel SKA	Y Integrator	
119	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKCE	Azimuth range indicator Type S5/1 No.2 Plug Panel SKA	X Integrator	
120	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKDF	Azimuth range indicator Type S5/1 No.2 Plug Panel SKZ	Range Rings	
121	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKDG	Azimuth range indicator Type S5/1 No.2 Plug Panel SKP	Normal Radar	
122	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel SKCG	Azimuth range indicator Type S5/1 No.2 Plug Panel SKN	Brightener Pulse	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
123	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel	Azimuth range indicator Type S5/1 No.2 Plug Panel		
		SKDH	SKM	M.t.i./Normal Radar	
124	Cable R.F.UR70 6145-99-910-0298	Pulse generator power supply Type S18/1 Plug Panel	Azimuth range indicator Type S5/1 No.2 Plug Panel		
		SKCH	SKH	Az.Marker Trigger	
125	3 Core Cord 110/0076 To BS 2004 Table 18	Mains Supply 230V 50c/s	Amplifier power supply Type S29/1 Plug Panel		
			PLE		
	Red		A	Unstab. Mains (Line)	
	Black		B	Unstab. Mains (Neutral)	
	Green		C	Unstab. Mains (Earth)	
126	3 Core Cord 110/0076 To BS 2004 Table 18	Mains Supply 230V 50c/s	Pulse generator power supply Type Plug Panel		
			PLF		
	Red		A	Unstab. Mains (Line)	
	Black		B	Unstab. Mains (Neutral)	
	Green		C	Unstab.Mains (Earth)	

TABLE 2 (cont.)

Cable No.	Type of cable, Ref.No. and Colour Code	From	To	Function	Remarks
127	3 Core Cord 110/0076 To BS 2004 Table 18	Mains Supply 230V 50c/s	Azimuth range indicator Type S5/1 No.2 Plug Panel		
			PLB		
	Red		A	Unstab. Mains (Line)	
	Black		B	Unstab. Mains (Neutral)	
	Green		C	Unstab. Mains (Earth)	
128	3 Core Cord 110/0076 To BS 2004 Table 18	Mains Supply 230V 50c/s	Azimuth range indicator Type S5/1 No.1 Plug Panel		
			PLB		
	Red		A	Unstab. Mains (Line)	
	Black		B	Unstab. Mains (Neutral)	
	Green		C	Unstab. Mains (Earth)	

TABLE 3

Units of FGRI. 26008/1

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
REMOTE SITE			
Radar set group S1/1	10D/23666	EA4952	Centre control rack
Dummy load electrical S2/1	10S/17180	EA4901	Dummy load

TABLE 3 (cont.)

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
Generator thermal noise S8/1	10S/17181	EA4900	Noise source
Control radar set S6/3	10L/16575	EA2960/2	Remote control unit
Control remote switching S14/1	10L/16583	EA4707	Remote switching unit
Stabilizer voltage S2/1	10D/5840-99-954-2597	KS95485	Servomex AC7
Stabilizer voltage S1/1	10D/5840-99-954-2596	KS95180	Servomex AC2
Waveguide assembly S7/1	10B/20165	EA4843	Power monitor waveguide
Waveguide switch	10B/20178	Decca RL4046/A	Waveguide switch
Radar T/R assembly S1/2	10D/23660	EA186/9	
RF oscillator S4/2	10V/16383	EA337/1	Stalo unit
Oscillator sub-assembly S8/1	10V/16384	EA4685	Stalo
RF amplifier S13/1	10U/17369	EA4104	TWT chassis
Power supply S17/1	10K/21666	EA4230	TWT power supply
Head amplifier S9/1	10U/17365	EA1425	Head amplifier
Trigger pulses generator S6/2	10D/23663	EA877/2	Lock unit
IF amplifier S10/1	10U/17366	EA884	Test amplifier
Radar modulator S1/1	10D/22775	EA163	Modulator
Power supply control S7/1	10L/16570	EA276/1	Transmitter control unit
Signal comparator S2/2	10D/23662	EA686/1	MTI No.1
IF amplifier S7/1	10U/17363	EA375	Limiting amplifier
Signal comparator S3/1	10D/22777	EA1784	P.S.D.
RF oscillator S5/1	10V/16380	EA789	Coho
IF amplifier S6/1	10W/17362	EA361	Locking amplifier
Delay line 60μs	10D/5840-99-944-4322	KA88743	Test delay line

TABLE 3 (cont.)

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
MTI group S1/2	10D/23664	EA685/3	Mti No.2
RF oscillator S3/1	10V/16378	EA599	20 M/s oscillator
Amplifier modulator S4/2	10U/17375	EA1740/1	Line drive modulator
RF amplifier S12/2	10U/17376	EA1741/1	Post line amplifier
RF amplifier S5/1	10U/17361	EA244	Comparison amplifier
Delay line	10D/23624	KU96176/3	Delay line (1425)
Power supply S41/1	10K/22156	EA5160	Transmitter power unit
Power supply S41/2	10K/22157	EA5160/1	MTI power unit
Power supply S21/1	10K/21685	EA159	EHT power unit
Variable attenuator S4/1	10L/16569	EA1862	0-7 dB attenuator
Phase changing network S2/1	10D/23661	EA60	Phase shifter
Valve unit S1/2	10AE/2007	EA48/1	Magnetron box
Transformer, variable power	10K/21668	EA776/1	EHT variac
Generator pulse power supply S18/2	10D/23956	D/GA86788/1	Base unit, local
Pulse generator S14/1	10V/16385	D/GA87994/1	Waveform generator
Sweep generator S20/1	10D/23984	D/GA87989	Waveform generator int.
Electronic marker generator S21/1	10D/23985	D/GA87998/1	Waveform generator video
IF amplifier S11/1 (part of S21/1)	10U/17367	EA1080	Normal i.f. amplifier
Power supply S27/2	10K/22109	D/GA87996/1	Positive power supply
Power supply sub-assembly S56/1	10K/22634	D/GA87993/1	Unstabilized chassis
Voltage stabilizer S5/1	10D/23983	D/GA87997/1	Stabilized chassis

TABLE 3 (cont.)

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
Power supply S26/1	10K/22108	D/GA87992	Negative power supply
Power supply sub-assembly S55/1	10K/22633	D/GA87993	Unstabilized chassis
Voltage stabilizer S4/1	10D/23980	D/GA87997	Stabilized chassis
Switch assembly S5/1 (Part of S4/1)	10F/21117	D/GA87999	Switch unit
Indicator, azimuth range S5/1	10Q/16194	D/GA87991/2	Viewing unit
Sweep generator S15/1	10D/23686	D/GA86756/2	Deflection amplifier
Video amplifier S17/1	10D/17379	D/GA86755	Video amplifier
Control indicator S13/1	10L/16580	D/GA87988/1	Control desk
Amplifier power supply S30/1	10U/17392	D/GA86765	Signal booster rack
Amplifier converter S25/1	10U/17387	D/GA86767	Signal booster
Attenuator variable	10L/16592	B/SA86767/103	Attenuator
Modulator oscillator S3/1	10D/23938	D/GA86767/101	Cable drive modulator
IF amplifier S26/1	10U/17388	C/SA86767/102	30 Mc/s IF amplifier
Power supply S46/1	10K/22611	D/GA86766	Signal booster power supply
Impedance matching network S3/1	10B/20172	GA87949	Cable compensation unit
Impedance matching network S1/1	10D/22781	EA2966/1	Splitter pads
Fixed attenuator S8/1	10L/16591	EA2966/3	Splitter pad (IF)
Synchro assembly S1/1	10K/22613	EA5121	Magslips
Circularizer and actuator assembly S1/2	10D/20188	EA2417/2	Rain plate actuator
Circularizer	10B/20174	EA4250	Rain plate

TABLE 3 (cont.)

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
RADIO EQUIPMENT ROOM			
Amplifier power supply S29/1	10D/17391	D/GA86788/3	Upper base unit
Amplifier synchros signal S23/1	10U/17385	D/GA86763	Aerial follower
R.F. amplifier S24/1	10U/17386	D/GA88774	Post cable amplifier
Voltage stabilizer S3/1	10D/5840-99-107-0275	KA86791	Servomex power supply
Power supply S43/1	10K/22610	D/GA86764	Aerial follower power supply
Generator pulse power supply S18/1	10D/23955	D/GA86788/2	Servobase unit
Pulse generator S14/1	10V/16385	D/GA87994/1	Waveform generator
Sweep generator S20/1	110D/23984	D/GA87989	Waveform generator int.
Electronic marker generator S21/1	10D/23985	D/GA87998/1	Waveform generator video
IF amplifier S11/1 (part of S21/1)	10U/17367	EA1080	Normal i.f. amplifier
Power supply S27/2	10K/22109	D/GA87996/1	Positive power supply
Power supply sub-assembly S56/1	10K/22634	D/GA87993/1	Unstabilized chassis
Voltage stabilizer S5/1	10D/23983	D/GA87997/1	Stabilized chassis
Power supply S26/1	10K/22108	D/GA87992	Negative power supply
Power supply sub-assembly S55/1	10K/22633	D/GA87993	Unstabilized chassis
Voltage stabilizer S4/1	10D/23980	D/GA87997	Stabilized chassis
Switch assembly S5/1 (part of S4/1)	10F/21117	D/GA87999	Switching unit

TABLE 3 (cont.)

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
APPROACH CONTROL ROOM			
Radar set control S6/4	10L/16582	EA2960/3	Auxiliary remote control unit
Indicator, azimuth range S5/1	10Q/16194	D/GA87991/2	Viewing unit
Sweep generator S15/1	10D/23686	D/GA86756/2	Deflection Amplifier
Video amplifier S17/1	10D/17379	D/GA86755	Video amplifier
Control, indicator S13/1	10L/16580	D/GA87988/1	Control desk

TABLE 4

Units of FGRI. 26008/2

These units replace the aerial and RF amplifier of the FGRI. 26008/1

Name and No.	Schedule reference	Manufacturer's Reference	Colloquial Name
AMPLIFIER PARAMETRIC	10U/5820-99-956-0077	FERRANTI VCA/S21	PARAMP
(Replaces RF AMPLIFIER S13/1 of FGRI. 26008/1)			
POWER SUPPLY	10K/5820-99-956-0660	WE40	KLYSTRON PU
SCANNER RADAR	5840-99-953-5052	PLESSEY D5751A	AERIAL
(Replaces SCANNER RADAR TYPE S1/1 of FGRI. 26008/1)			

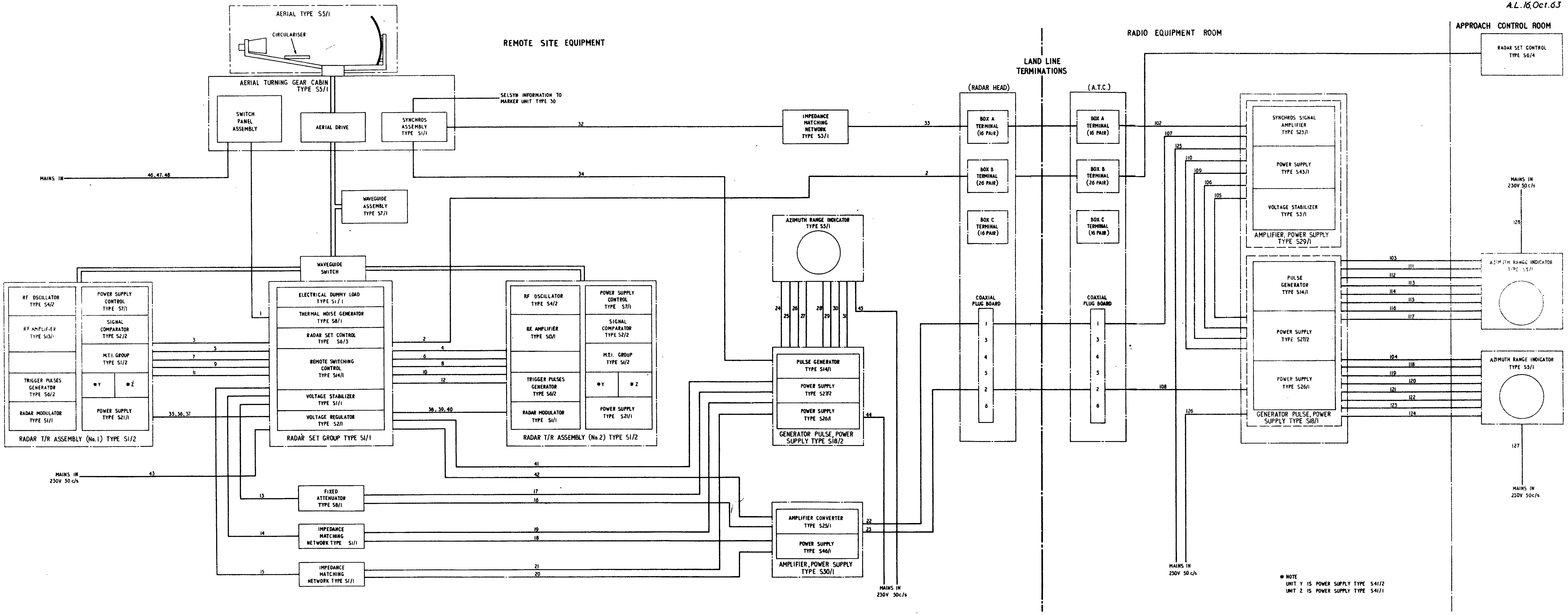

Fig. 1 0125911 D842071 SW 7/61

Interconnection diagram of F.G.R.I. 26008/1

Fig. 1

SECTION 2

FGRI.26008/1

Chapter 1

RADAR T/R ASSEMBLY TYPE S1/2

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Note—*Figures marked with a * are located at the end of the text*

General description

1. The radar T/R assembly Type S1/2 is housed in a cabinet as shown at fig. 1. It has twelve main units (RF oscillator Type S4/2, RF amplifier Type S13/1, TR line assembly, trigger pulses generator Type S6/2, valve unit Type S1/2, radar modulator Type S1/1, power supply control Type S7/1, signal comparator Type S2/2, MTI group Type S1/2, power supply Type S41/1, power supply S41/2 and power supply Type S21/1) which fit into shelves in the main framework of the cabinet. The waveguide run with its associated controls, variable attenuator Type S3/1 (signal splitter) and variable attenuator Type S4/1 (noise figure attenuator), a number of essential complementary items, that is, the main and e.h.t. contactor bank, magnetron and cabinet blower motors, variable power transformer (variac), and the main interconnecting cables, are fixed to the main framework. These can be seen in fig. 2. The noise figure attenuator, signal splitter, power supply Type S17/1, and the variable power transformer are accessible behind the hinged panel between the two columns of units. A tray which fits on the front of the framework is used to provide support for individual units during servicing.

DESCRIPTION OF UNITS

Introduction

2. The majority of the components in this equipment are sign written and hence the remainder are easily identified for servicing. Standard chassis construction is employed with most of the essential controls mounted on the front panels. **Component identification letters vary from unit to unit and for consistency BS reference letters are used in the text.** The references shown on all circuit diagrams are those shown on the manufacturer's drawings.

RF oscillator Type S4/2

3. A feature of the RF oscillator Type 4/2 (fig. 3) is the RF oscillator Type 8/1 (stabilized local oscillator or stalo) which consists of a CV5956 disk seal triode in a concentric line assembly (fig. 4). This assembly is of massive construction to provide good thermal conduction from the anode, and also to ensure mechanical and electrical stability. Mechanical stability is further ensured by having the assembly fitted in an anti-vibration mounting. A special locking lever is fitted to the base in which the stalo cavity is mounted, to enable the anti-vibration mounting to be made firm for transit

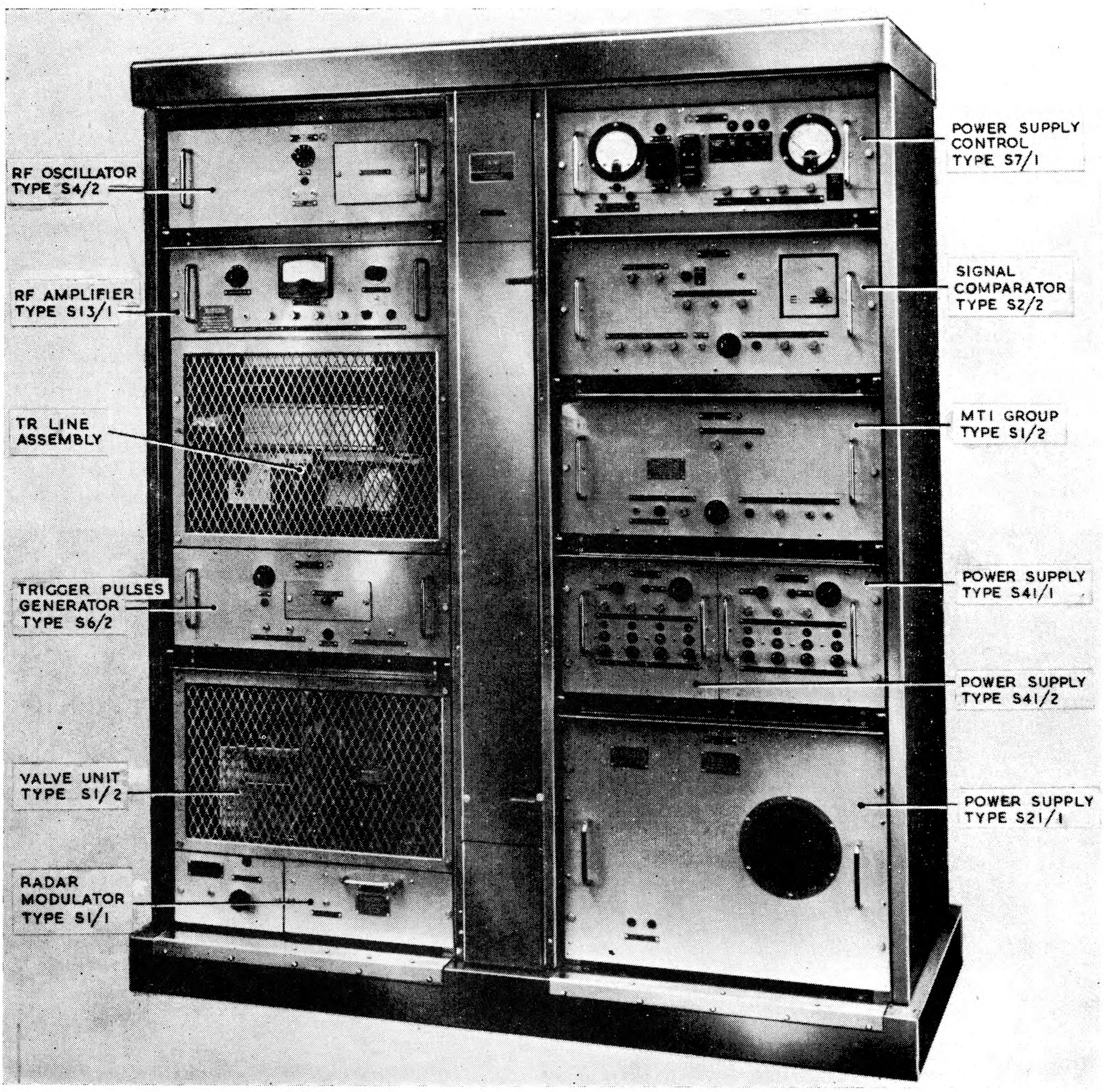

Fig. 1. General view of radar T/R assembly Type S1/2

purposes. A microswitch (SW2) operated by the lever breaks the h.t. to the disk seal triode when set to the locked position. Two preset potentiometers RV1 (HEATER SET) and RV2 (SET HT) are fitted to the stalo support base in a position which is accessible through a small detachable cover fitted to the front panel.

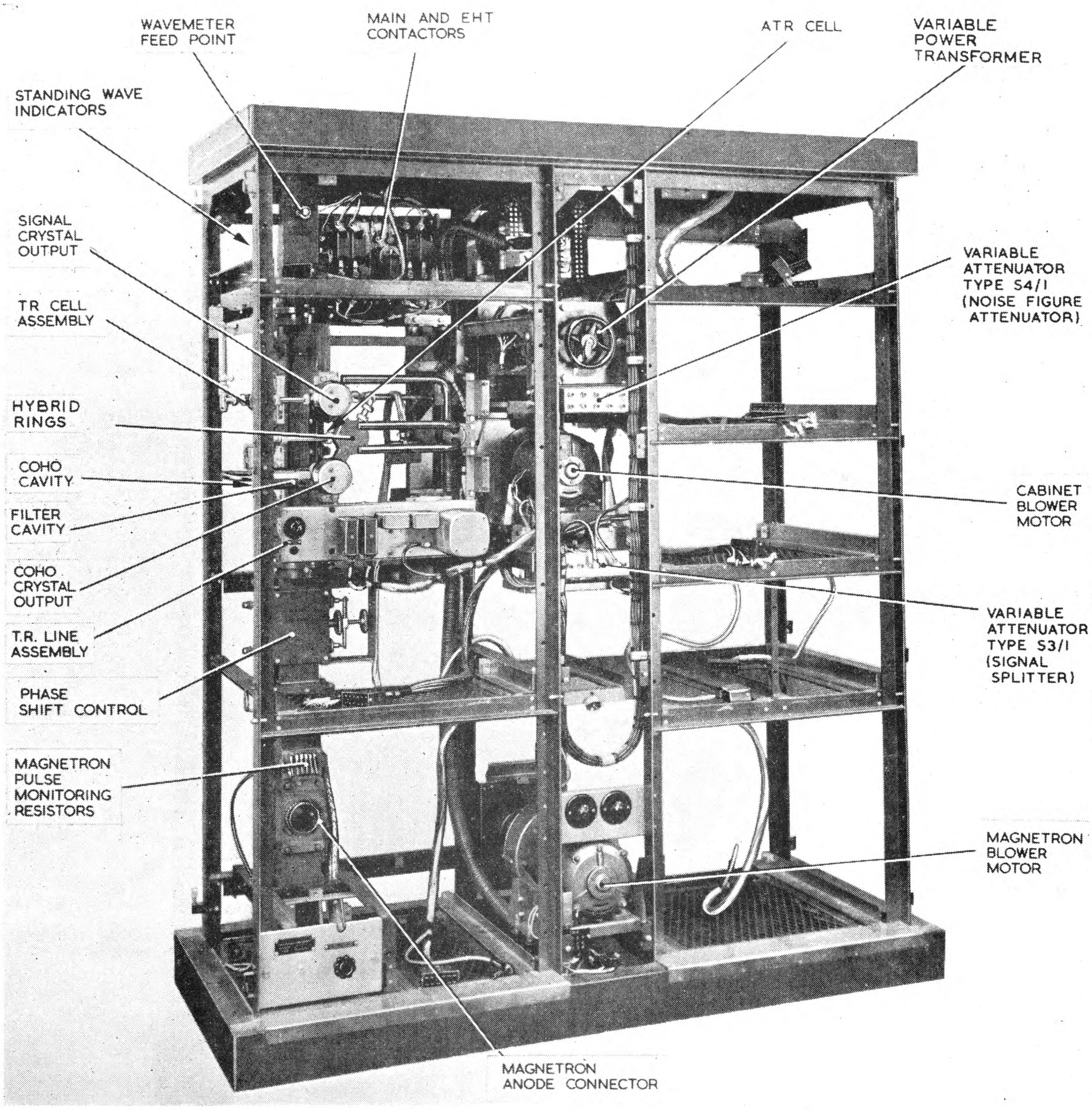

Fig. 2. Internal view of radar T/R assembly Type S1/2 with main units removed

4. A separate view of the stabilized local oscillator unit is shown at fig. 4 in which the coarse and fine tuning controls, temperature compensation adjusting screw, probe locking ring and cathode tuning control can be seen. The temperature compensation is an additional shunt capacitance in the anode-grid line in the form of a U-shaped bi-metallic element. The temperature coefficient with this element in circuit is almost the same as that of the magnetron, that is, 70kc/s per degree Centigrade. Since the same airstream is used to cool the oscillator and the magnetron, any change in the temperature of the airstream has an equal effect on the oscillator and magnetron frequency, and the difference frequency thus remains constant.

5. On the front panel of the RF oscillator Type S4/2 an eleven position selector switch SW1 connects various monitoring points to a METER JACK (JK1). Also two miniature supply sockets are provided there to enable the HT RIPPLE voltage (SKT1) and the HEATER RIPPLE voltage (SKT2) to be checked.

RF amplifier Type S13/1

6. An interior view of the RF amplifier Type S13/1 is shown at fig. 5. The main feature of this

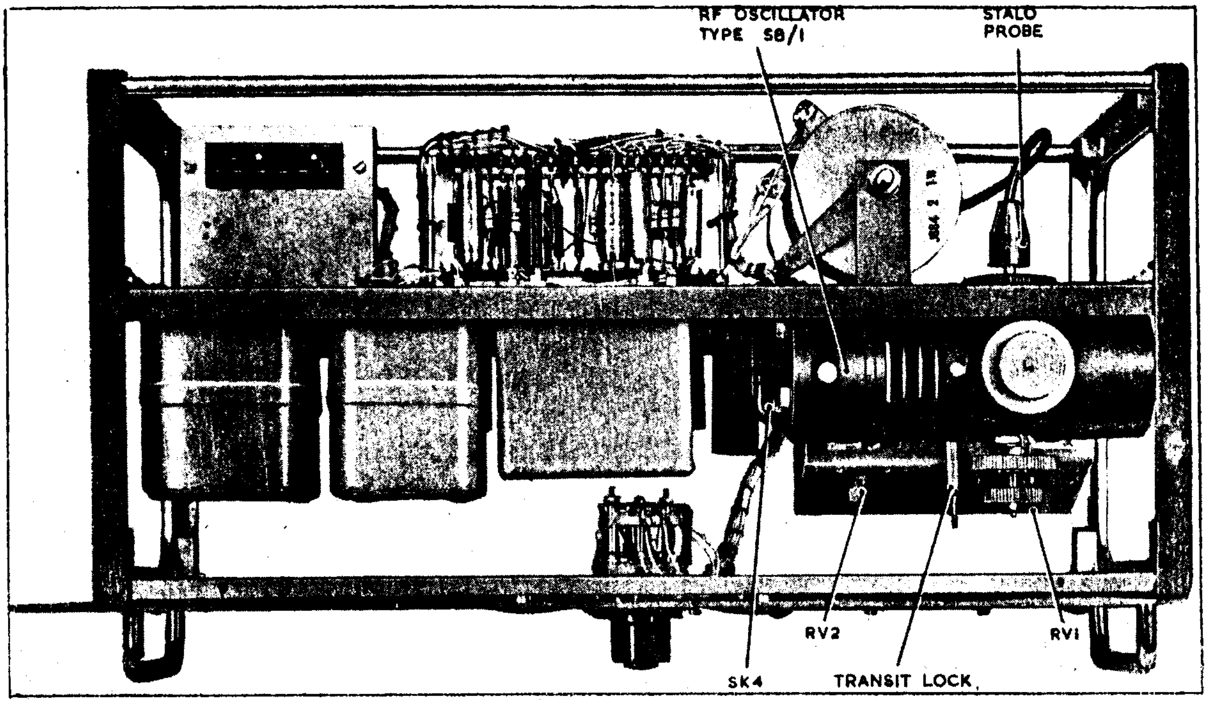

Fig. 3. View of RF oscillator Type S4/2

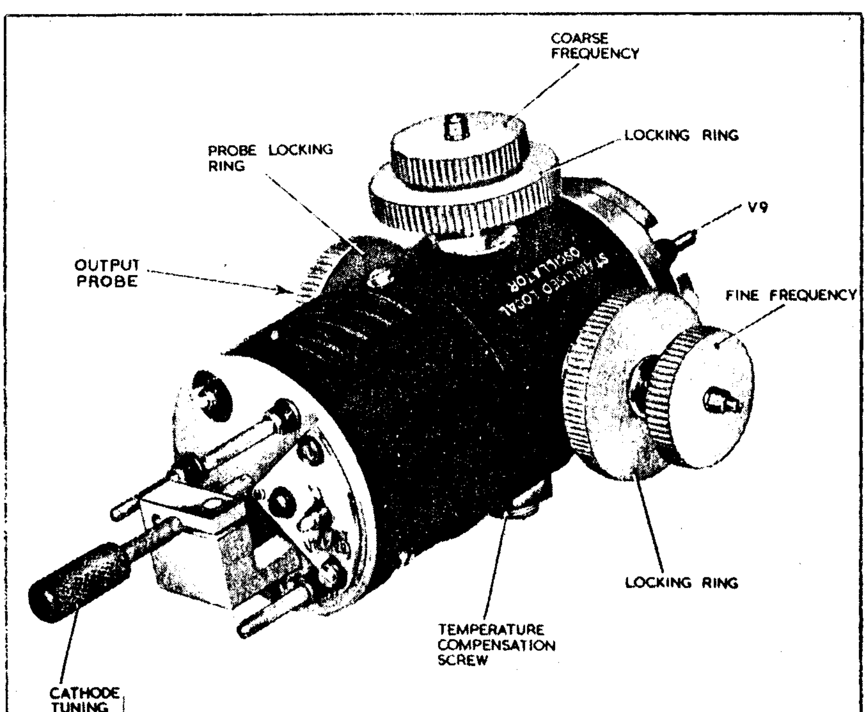

Fig. 4. View of RF oscillator unit Type S8/1

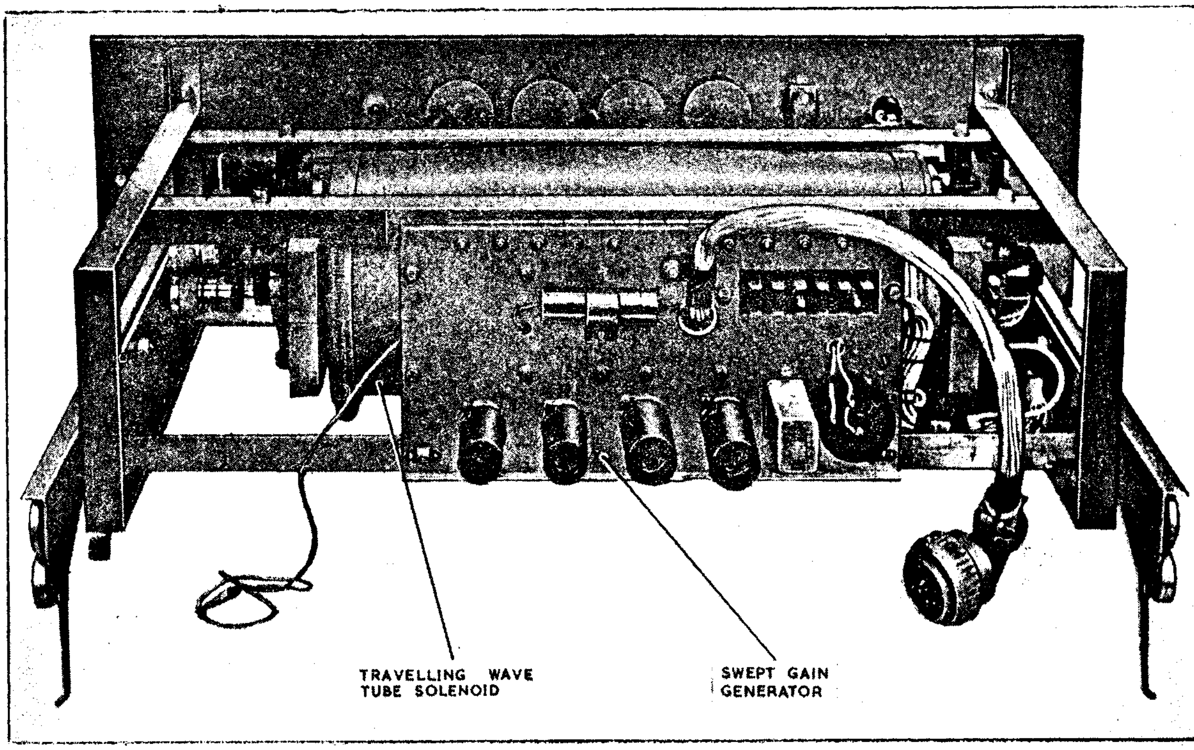

Fig. 5. Internal view of RF amplifier Type S13/1

unit is the travelling wave tube (V4) which is a Marconi Type N1042M. This valve and its associated solenoid are mounted near the centre of the unit.

7. The unit also contains a separately identifiable sub-unit, that is, the swept gain waveform generator built on a hinged chassis which can be seen in fig. 5.

8. On the front panel of the unit are mounted the 0-25μA f.s.d. moving coil meter (M1), its double-bank eleven position METER SWITCH (SW2), the five position SWEPT GAIN LAW selector switch (SW1), the O/L WARNING lamp (ILP1), O/L RESET spring loaded biased switch (SW3), SWEPT GAIN O/P coaxial monitor socket (SKT1) and the four preset potentiometers TWT HELIX (RV5), TWTG4 (RV2), TWTG3 (RV3) and TWTG2 (RV4).

Power supply Type S17/1

9. The power supply Type 17/1 is situated inside the hinged centre panel of the cabinet. It carries the power supply components for the RF amplifier Type 13/1. These include two thermionic half-wave rectifiers (V1 and V2), two thermal delay switches, (V6 and V7) and three gas filled voltage stabilizers (V3-V5). The solenoid supply fuse FS1 (32 S.W.G.) is mounted on the front panel.

Trigger pulses generator Type S6/2

10. This unit is of standard construction and component layout. It has one removable and separately identifiable plug-in sub-assembly, the IF amplifier Type S10/1, which is shown in position in fig. 6. The i.f. amplifier is a general purpose test amplifier connected to PL1 and SKT7 on the front panel by coaxial cables.

11. A meter jack connected to test points in the circuit by the eleven position double-bank selector switch SW1, a single-pole single-throw switch SW2 (TEST AMP. ON OFF), a miniature coaxial plug PL1 (TEST AMP. IN), three miniature coaxial sockets SKT7 (TEST AMP. OUT), SKT4 (SEC. RADAR TRIG. MONITOR) and SKT5 (PRE-PULSE MONITOR) are mounted on the front panel of the unit. Three pre-set potentiometers RV1 (P.R.F.), RV2 (PRE-PULSE DURATION) and RV3 (SR TRIGGER DELAY) are situated on an off-set panel behind the removable cover plate fitted to the front cover.

Radar modulator Type S1/1

12. The radar modulator Type S1/1 components are mounted on a chassis fitted in a rigid framework. A 1μs L-C delay line (DL1) extends from the chassis to the top of the framework and is held in position by four circular section rods. The two valves V1 (thyratron—FX219) and V2 (over swing diode) can be observed through the grid which encloses it in the cabinet (fig. 1). A microswitch (SW1) at the rear of the chassis is a mechanically operated safety interlock in series with the e.h.t. contactor (fig. 2) and opens when the unit is removed from the cabinet.

13. A coaxial plug on the front panel enables the grid drive of V1 to be monitored.

Power supply control Type S7/1

14. The power supply control Type S7/1 distributes the 230V, 50c/s stabilized a.c. mains supply to the radar T/R assembly Type S1/2. The source of this stabilized supply is in the radar set group Type S1/1 (Chap. 2 of this Section). The unit also incorporates interlock and protection arrangements.

15. The chassis on which the internal components, including two thermal delay valves (DLS1 and DLS2), are mounted, is set back from the front panel to make room for a circuit breaker (CB) which projects at the rear of the front panel.

16. The components on the front panel are as listed below:—

(1) A 0-300V, 50c/s moving iron a.c. meter (M1) and associated single-pole two position VARIAC INPUT-OUTPUT (SET 230V) switch SW5.

(2) A 0-1·5mA moving coil meter (M2) which is connected to a 2-way METER CONNECTION plug below the meter to provide a means of making measurements at selected test points. A press button switch (PB1) completes the meter circuit. A 10mA protective fuse FS1 is incorporated.

(3) A 15A ON/OFF circuit breaker (CB).

(4) Two 10A fuses (FS1 and FS2) in the HEATER circuit.

(5) Four neon indicator lamps 1LP1-MAINS, 1LP2 CAB HTRS, 1LP3 RF POWER ON and 1LP4 EHT.

(6) Double-pole single-throw switch SW1 (MTI ON OFF), double-bank single-throw two position switch SW2 (TX CONTROL REMOTE LOCAL), single-pole single-throw switch SW3 (EHT) and single-pole two-position switch SW4 (CAB HTRS. ON OFF).

(7) Four pre-set potentiometers RV1 (COHO GAIN), RV2 (SET GAIN HEAD AMP.), RV3 (SWEPT GAIN AMPLITUDE) and RV4 (TEST AMP. GAIN).

Signal comparator Type S2/2

17. Two main internal chassis are employed in this unit (fig. 7). The one at the rear carries the majority of the general components of the signal comparator Type S2/2 including the pre-set COARSE PRF potentiometer RV12, together with the quartz test delay line (X1). The front chassis carries four removable and separately identifiable sub-assemblies. These are the IF amplifier Type S7/1, the IF amplifier Type S6/1, the signal comparator Type S3/1 and the RF oscillator Type S5/1. The last of these has a control panel which fits into an opening in the front panel of the main unit. Two views showing the component layout in the RF oscillator are given at fig. 8 and 9.

18. The controls and components available on the front panel of the signal comparator Type S2/2 are:—

(1) Eleven pre-set potentiometers RV1 (LOCK BIAS), RV2 (COHO BALANCE), RV3/RV4 ganged (COHO GAIN), RV5 (SIGNAL BALANCE), RV6/RV7 ganged (SIGNAL GAIN), RV8 (FINE REP.), RV9 (COHO GATE WIDTH) RV10 (KNOCK-OFF GATE WIDTH) and RV11 (LIMIT KMP GAIN).

(2) Double-bank eleven position selector switch SW1 with its associated meter jack JK1, and double-pole two-position switch SW2 (NORMAL TEST).

(3) Two coaxial sockets SKT7 (VIDEO OUT) and SKT12 (KNOCKOFF GATE).

(4) Pre-set control for VC1 (COHO TUNE) on the separate coho panel of the RF oscillator Type S5/1.

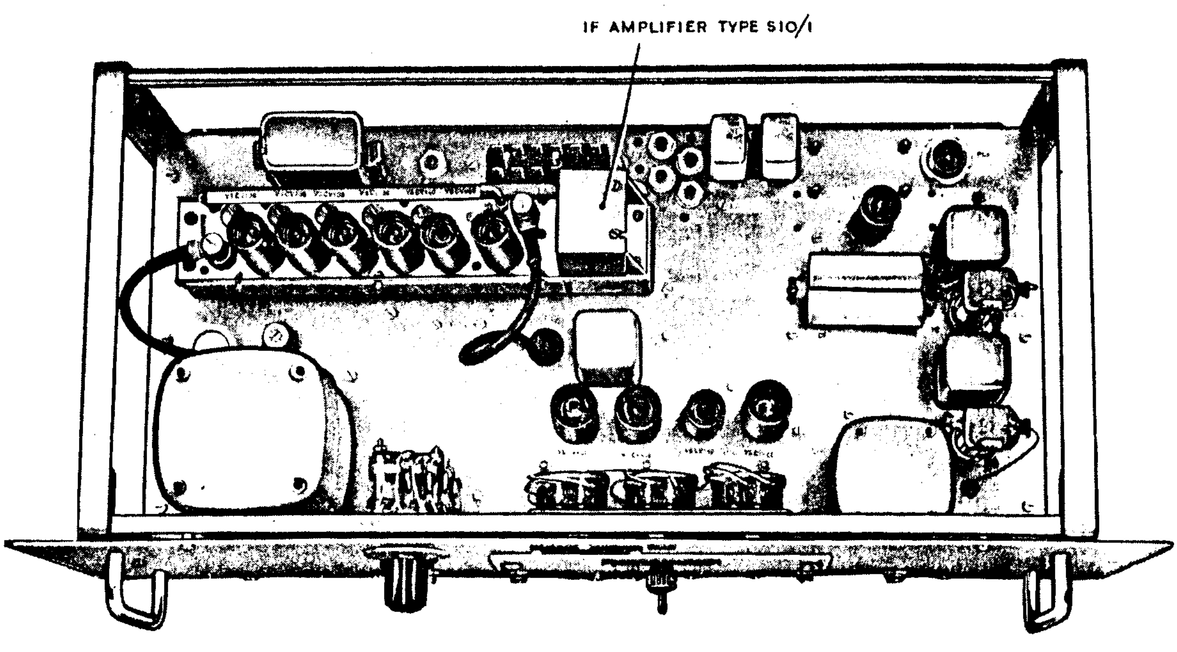

Fig. 6. Internal view of trigger pulses generator Type S6/2

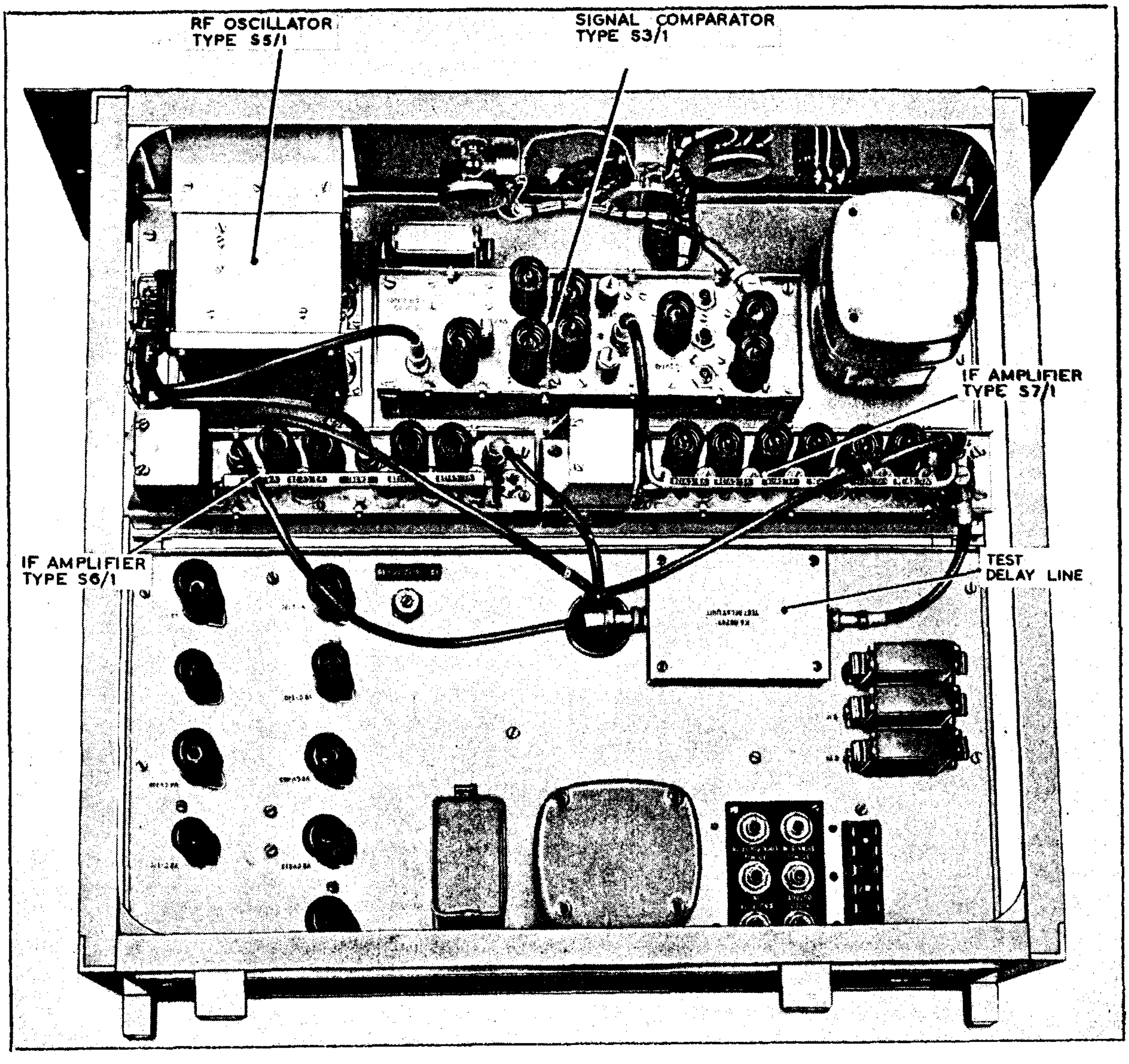

Fig. 7. Internal view of signal comparator Type S2/2

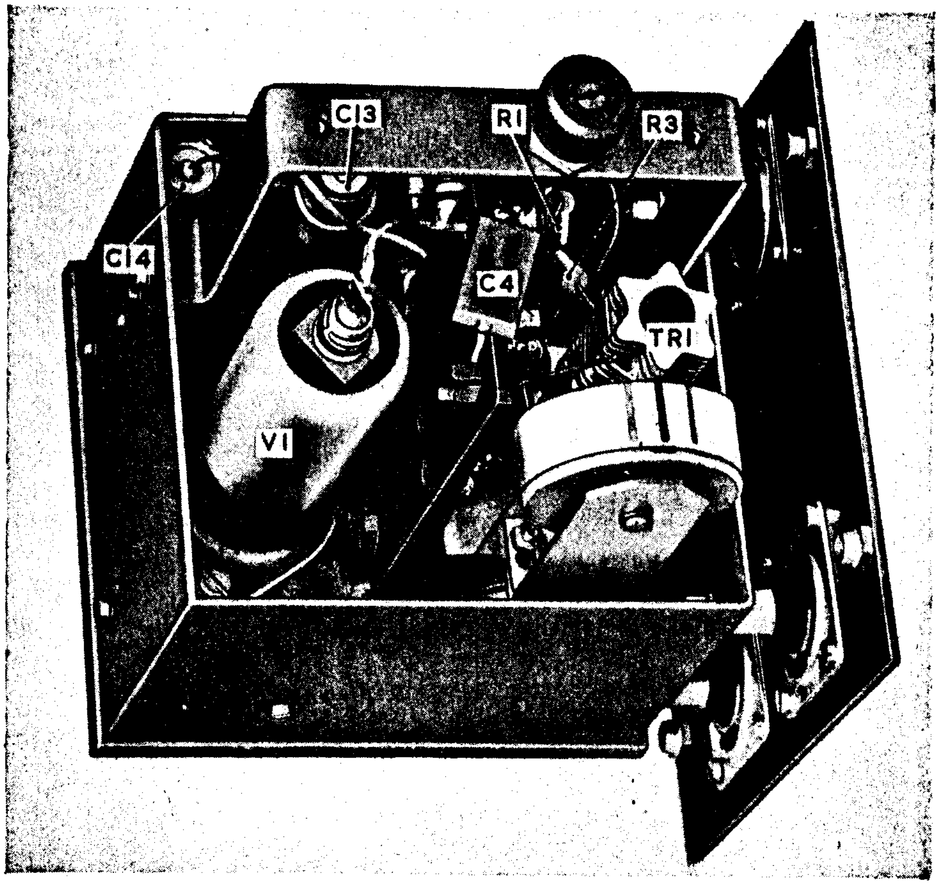

Fig. 8. Top view of RF oscillator Type S5/1 chassis

MTI group Type S1/2

19. This unit has one chassis towards the front panel on which the majority of the general components of the MTI group Type S1/2, together with two removable separately identifiable sub-assemblies, the RF amplifier Type S5/1 and the RF amplifier Type S12/2, are mounted (fig. 10). Also supported in the main framework towards the rear are another two removable and separately identifiable sub-assemblies, the amplifier-modulator Type S4/2 and the RF oscillator Type S3/1, and the quartz delay line housed in a circular metal case.

20. The controls and components mounted on the front panel are:—

(1) Three pre-set potentiometers RV2 (MANUAL GAIN), RV3 (AGC LEVEL) and RV4 (CARRIER LEVEL).

(2) Double-bank eleven position selector switch with its associated meter jack JK1.

(3) Three miniature coaxial sockets SKT5 (DELAY LINE INPUT), SKT10 (KNOCK OFF) and SKT12 (CANCELLED OUT).

(4) One neon indicator lamp ILP1 (ON/OFF) and associated single-pole single-throw switch SW2.

Power supply Type S41/1 and Type S41/2

21. The power supply Type S41/1 and Type S42/2 (fig. 1) are electrically identical, and differ physically only in that the components on the front panel are disposed slightly to the left-hand side of the centre line in the Type 41/1 and to the right-hand side in the Type S41/2 for symmetry when they are fitted in the cabinet (fig. 1). The controls and monitoring points available on the front panel are as follows:—

(1) Three pre-set potentiometers RV1 (+200V), RV2 (+330V) and RV3 (−150V).

(2) Four voltage monitoring points and associated neon indicator lamps MN1-ILP1 (−150V), MN2-ILP2 (+330V), MN3-ILP3 (+200V) and MN4-ILP4 (+470V).

(3) Five fuses FS1 (MAINS 5A), FS2 (500mA) for +200V, FS3 (250mA) for +330V, FS4 (100mA) for −150V and FS5 (60mA) for +470V.

(4) Double-bank eleven position selector switch SW1 and associated meter jack JK1.

Power supply Type S21/1

22. This has a standard e.h.t. power unit component layout. The two diodes V1 and V2 (CV490)

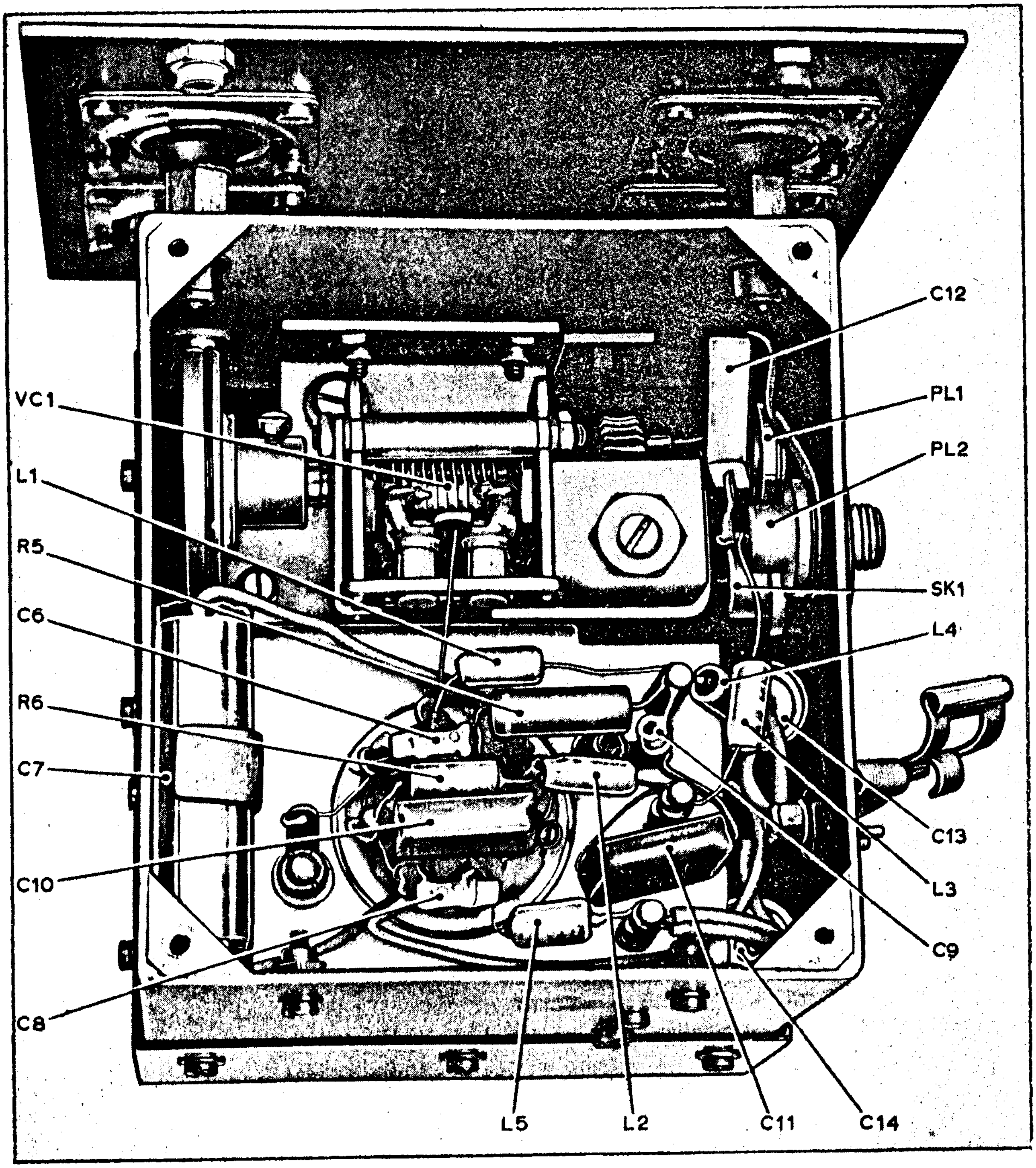

Fig. 9. Underside view of RF oscillator Type S5/1 chassis

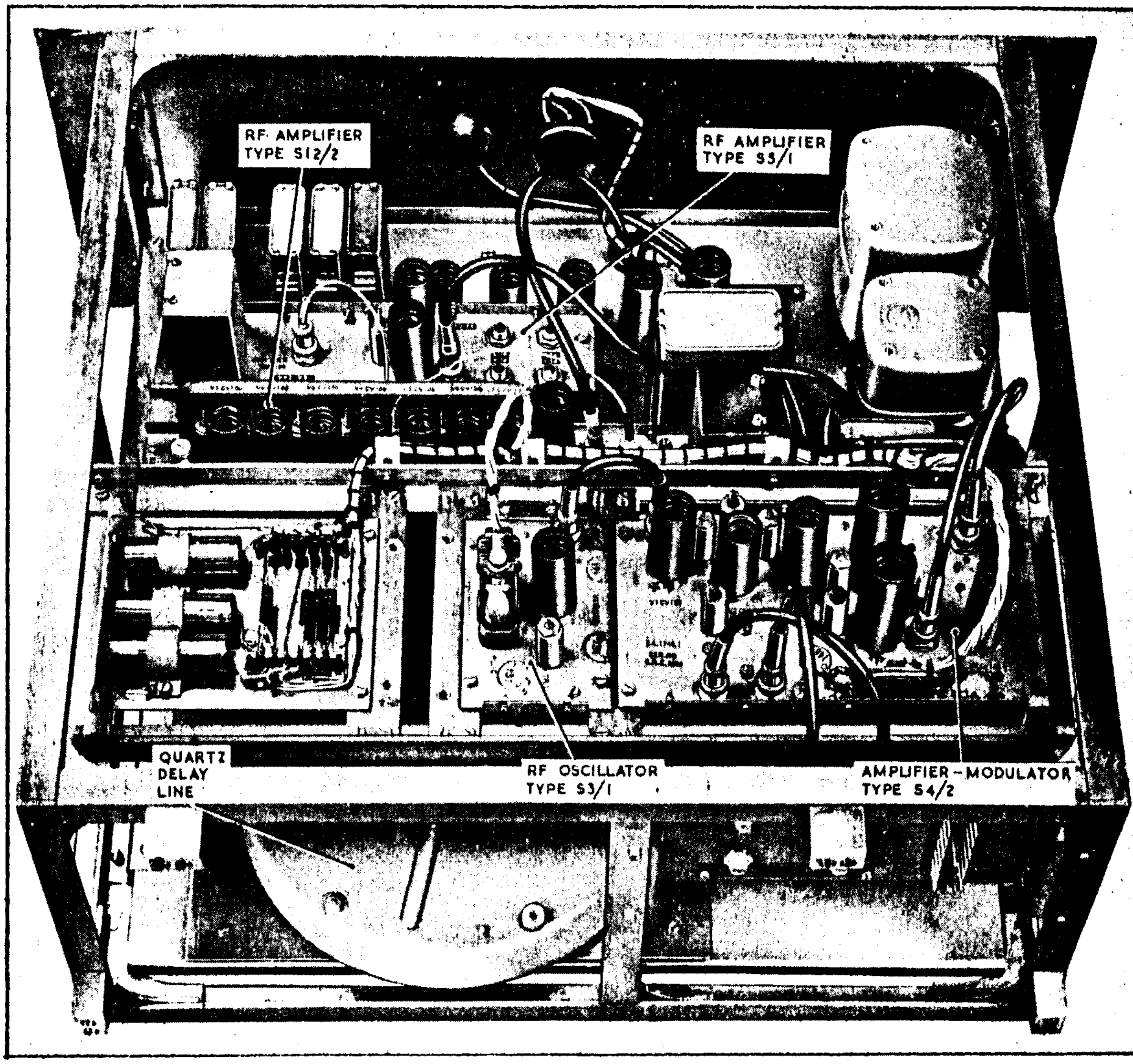

Fig. 10. Internal view of MTI group Type S1/2

can be seen through a circular grille on the front panel (fig. 1). This grille allows air to enter the unit for cooling the valves.

23. A mechanically operated spring-loaded shorting bar is provided and this earths the high potential side of the two smoothing capacitors when the unit has been moved from the cabinet. A safety interlock microswitch SW1, located at the rear of the chassis, is in series with the e.h.t. contactor. It breaks the circuit when the unit is removed from the cabinet.

24. Two monitor jacks JK1 (CURRENT JACK) and JK2 (ZERO VOLTS TRIP SIGNAL) are mounted on the front panel.

Valve unit Type S1/2

25. The valve unit is situated beside the radar modulator Type S1/1. The magnetron is fitted in a case mounted on runners so that it can be moved towards or away from the waveguide to control the amount of coupling to the waveguide. Adjustment is made by means of a lead screw from the underside of the case (fig. 11) which engages with a nut mounted on a block on the cabinet framework between the runners. The hexagonal head on the screw is accessible through a hole in the small panel in the extreme bottom left-hand corner of cabinet and adjustment is made by means of a special key provided.

26. An adjustable plunger, at the termination of the waveguide below the magnetron probe, is used in conjunction with a phase shifter, also mounted in the guide, to match the waveguide to the magnetron. The position of the matching plunger is controlled through a torsional Bowden cable by a knob on the panel below the magnetron unit.

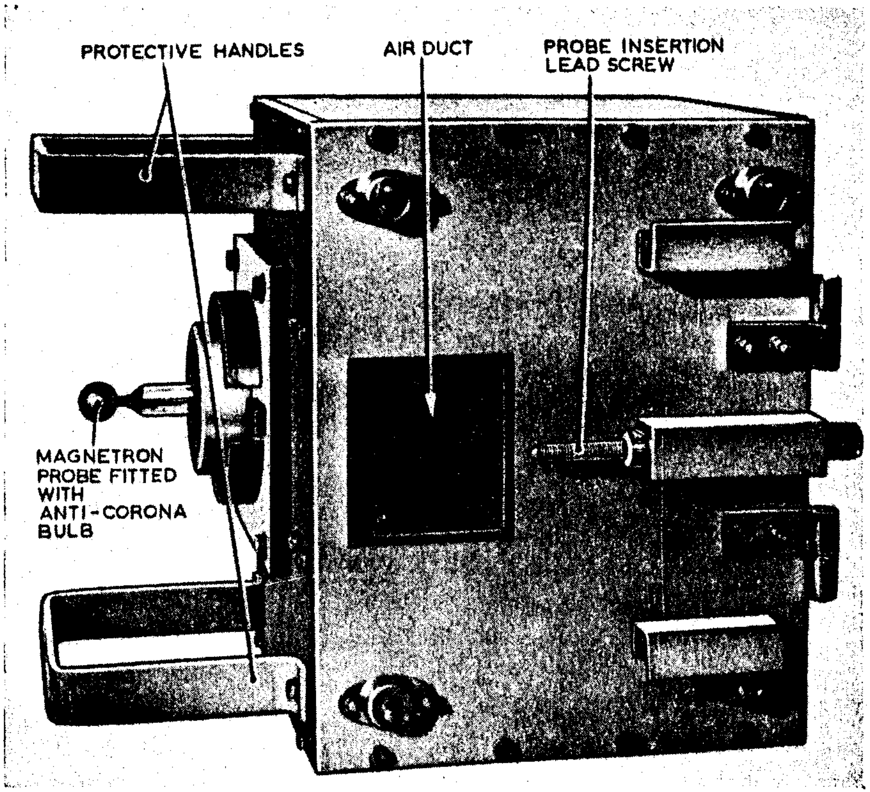

Fig. 11. Underside view of valve unit Type S1/2

27. The magnet is mounted on a hinged panel to facilitate renewal of the magnetron.

Waveguide and associated controls (fig. 2)

28. The waveguide run can be seen in fig. 2. The magnetron anode connector is at the lower end and above this are mounted the group of magnetron pulse monitoring resistors connected via a coaxial cable to the magnetron monitoring plug on the small panel at the extreme lower left-hand corner of the front cabinet. Above the resistors are the phase shifter, variable coho cavity coupled by coaxial cable to the coho crystal via the hybrid ring, ATR cell, pre-TR cell and TR cell, standing-wave indicator and the wave meter feed point.

TR line assembly

29. The TR line assembly consists of a plug panel and two head amplifiers Type S9/1 (one for the signal channel and the other for the coho). The head amplifiers plug directly into the crystal diode elements in the hybrid ring (fig. 2) and the plug panel is just below the head amplifiers. The plug panel carries a number of miscellaneous components including the heater transformer for the head amplifiers, the RF amplifier Type 13/1 and the power supply control Type S7/1, two Jones plugs PL18 and PL19 which receive the 230V 50c/s mains supply for the transformer (T1) and distribute the h.t. supplies to the three units. An eleven-position treble-bank selector switch SW1 connects various measurement points in the circuits to the meter jack JK1 where they can be monitored.

Variable power transformer

30. The variable power transformer (fig. 2) consists of a variac mounted in a rigid framework, a STOP/NORMAL single-pole single-throw switch SW3 on the front panel, a drive motor for the variac, and two limit microswitches SW1 and SW2 at the rear of the unit. The motor is a 17W a.c. induction type and incorporates a step-down gear train which rotates the variac brush arm.

Cooling system and blower motors

31. Two fans of the impeller type are housed in the centre section of the cabinet and mounted on the framework. One of these distributes cooling air to a duct which is an integral part of the side panel of the cabinet. This duct has a series of ports of various sizes located at appropriate positions for cooling each unit on the right-hand side of the equipment. Cooling air for the head amplifiers is obtained through a Flexatex hose.

32. The output of the other fan divides into three airstreams, the largest of which is directed into the valve unit Type S1/2 where it cools the magnetron. The second airstream is applied to the stalo in the RF oscillator Type 4/2 to ensure that it is maintained at the same temperature as the magnetron. A third airstream is directed through an aperture in the waveguide at the output probe of the magnetron to minimize corona discharge from the probe.

33. Each fan is fitted with air filters, the gauzes of which are removable for cleaning.

34. The fan motors are ⅓ h.p. split-phase induction types which rotate at 2800 r.p.m. A 6μF capacitor block which is provided for each motor, is used for power factor correction.

Main and e.h.t. contactors

35. The main and e.h.t. double-pole a.c. operated contactors (30A rating) are mounted on a panel located at the rear of the RF oscillator Type S4/2.

Interconnecting wiring

36. Most of the interconnecting wiring is in the form of polythene covered looms, bound to the framework of the cabinet, and terminated in plugs and sockets for connection to the individual units. The mains supply is introduced through a grommet in the roof of the cabinet and fed from a distribution panel. The necessary external connections to the radar T/R assembly Type S1/2 are made via a 12-way socket and five coaxial plugs and sockets mounted on the roof of the cabinet.

CIRCUIT DESCRIPTION

General

37. The basic units for the transmission and reception functions are the trigger pulses generator Type S6/2, the radar modulator Type S1/1, the valve unit Type S1/2, T/R line assembly and associated centimetric components, RF amplifier Type S13/1, the power supply Type S21/1 and the power supply control Type S7/1. The signal comparator Type S2/2 and M.T.I. group Type S1/2 provide supplementary functions including the removal of permanent echoes, and the remaining items, including the power supply control Type S7/1, provide complementary services required for the operation of the transmitter receiver as a whole. The simplified block diagram at fig. 12 shows how the functions of the units are related and this should be used in conjunction with the transmitter receiver interconnection diagram (fig. 13).

Trigger pulses generator Type S6/2

38. The trigger pulses generator Type S6/2, the circuit of which is shown at fig. 14, produces the following synchronizing pulses which can be seen at fig. 15 and 16:—

(1) The modulator trigger pulse at T_0 (At PL5).

(2) The timebase trigger pulse at T_0—100μs (at SKT1).

(3) The swept gain trigger pulse at T_0—100μs (at SKT2).

(4) The secondary radar trigger pulse at a time within T_0—30μs to T_0 (at SKT4).

(5) The display pulse for the viewing unit at T_0—100μs (at SKT10).

The trigger pulses generator Type S6/2 is normally synchronized with the delay line in the M.T.I. group Type S1/2 at a p.r.f. of approximately 700 p.p.s. In the dual transmitter installation, when the transmitter is working into the dummy load provided with the installation, the trigger pulses generator Type S6/2 is synchronized with the transmitter in use. Provision is also made for the repetition period to be changed momentarily by about 75μs to enable second-time-round echoes to be detected. This is done by means of a switch on either of the radar set control Type S6/3 (Chap. 2 of this Section) which removes the M.T.I. synchronizing pulse and thus allows the trigger pulses generator to run freely at a slightly lower p.r.f.

39. When the transmitter is connected to the aerial, relay RLA is energized and the incoming synchronizing pulse at T_0—100μs from the signal comparator Type S2/2 is applied to the grid of V1A. The triodes V1B and V2A form a-stable multivibrator which produces at the anode of V2A a positive-going pulse, the duration of which is set to 100μs by the PRE PULSE DURATION control RV2. This sets the recovery potential of V2A. A diode limiter V6A stabilizes the amplitude of the negative-going pulse applied to the grid of V2A, and prevents the change of pulse duration which would occur due to changes in the gain of V1.

40. The pulse repetition frequency can be adjusted within the range 525-850 p.p.s. by means of RV1 which determines the positive potential on the grid of V1B and hence the instant in the sequence at which V1B anode current commences to flow. The control is set, with the synchronizing pulse disconnected, to give a pulse repetition period of about 1500μs. When the synchronizing pulse is connected, the repetition period of the multivibrator is reduced to that of the delay circuits in the signal comparator Type S2/2. This is approximately 1400μs.

41. If the SELECT PRF switch on either of the radar control units (Chap. 2 of this Section) is set to CHECK, this will cause relay RLA to become de-energized and contact RLA1 to disconnect the incoming synchronizing pulse. At the same time, the prepulse from the other transmitter is disconnected, by a relay in the radar set control Type S6/3 (Chap. 2 of this Section), from PL9. The multivibrator then runs freely at its own natural p.r.f. of 660 p.p.s. until the relay RLA is again energized. Details of the p.r.f. changing and transmitter change-over switching circuits are given in Chap. 2 of this Section.

Trigger pulse output to the radar modulator

42. The negative-going waveform at the grid of V2A is applied also to the grid of V2B—the prepulse amplifier. This results in a positive-going pre-pulse with an amplitude of 80V at the anode of V2B. The leading and trailing edges are steep because V2B isolates the loading effect of the grid circuit of V3 on the anode circuit of V2A.

43. The positive-going voltage pulse at the anode of V2B is transferred to the grid of V3 which is functioning in a phase splitter circuit. The transformer T1 in the anode circuit of V3 determines the

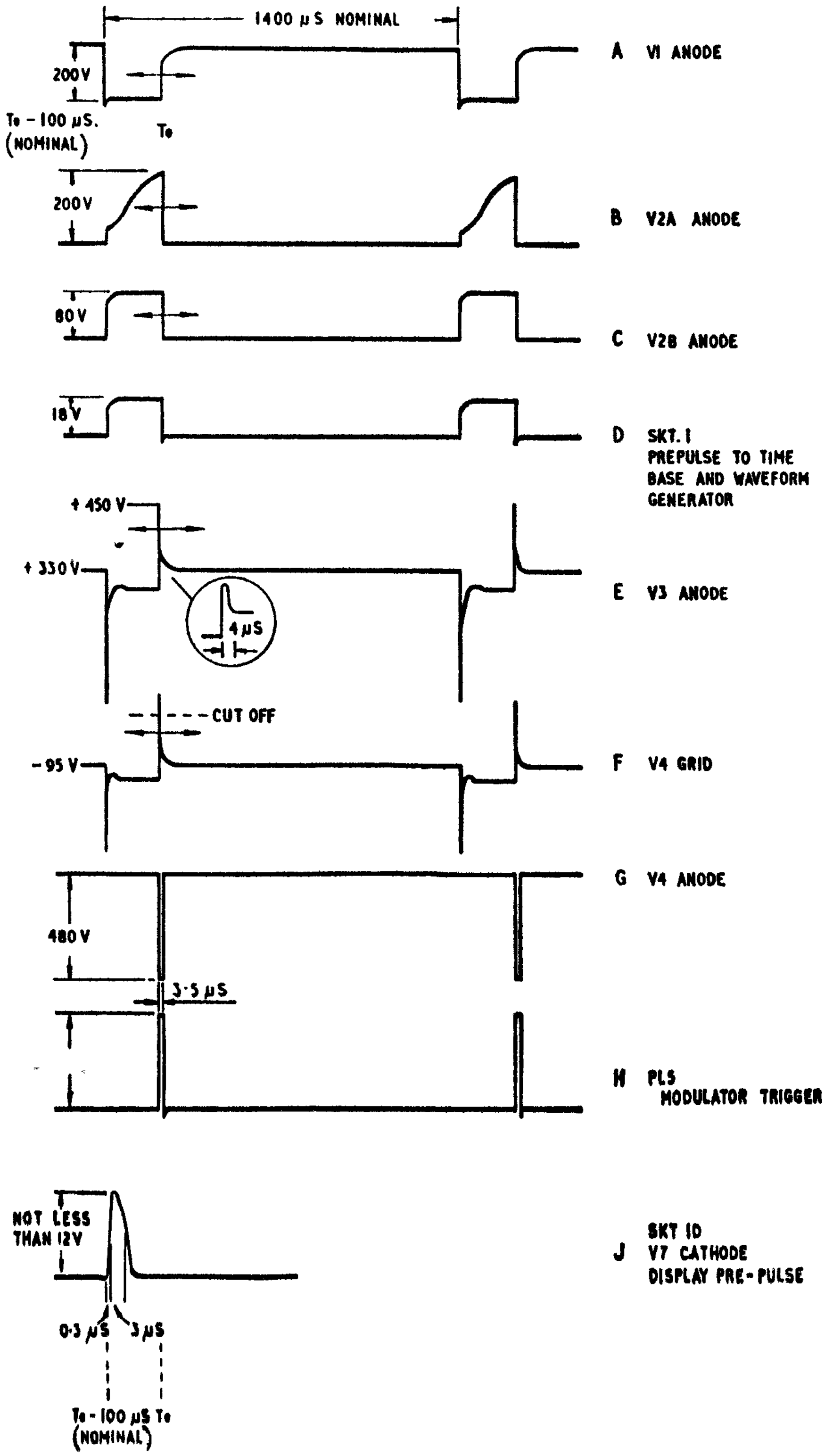

Fig. 15. Trigger pulses generator Type S6/2 waveforms (1)

width of the transmitter trigger pulse by differentiating the anode current pulse. This is due to the fact that the anode current flowing in the primary during the positive input pulse rises to a value very much greater than that required to produce magnetic saturation in the iron core of the transformer. At the end of the pulse at V3 grid, the current in the primary cannot cease immediately but, after an initial step which brings the core out of saturation, the current dies away with the time constant determined by the inductance reflected into the secondary and the grid-to-cathode impedance of the next valve. The grid to cathode impedance of V4 is low because V4 has been driven into grid current by the inverted terminal peak of the secondary pulse. This pulse lasts until all the excess energy stored in the primary inductance has been dissipated. The value of this inductance has been chosen to provide an output pulse of about 4μs duration.

44. The secondary of T1 is connected to the grid of V4. This valve is biased beyond cut-off point by the negative voltage applied to it from the junction of R29 and R30 .The positive pulse from T1 causes V4 to conduct and this results in a negative pulse of 480 volts amplitude being produced at its anode. Transformer T3 in the anode circuit of V4 inverts the pulse and a positive-going pulse of 400 volts amplitude and 3·5μs duration is obtained at the output plug PL5. This voltage pulse is fed to the radar modulator to trigger the modulator thyratron. When the thyratron fires, the initial discharge takes place between anode and grid, and tends to make the grid potential rise towards that of the anode. Then metrosil M1 connected in parallel with the secondary of transformer T3 limits the voltage to which the grid can rise. The unloaded and loaded trigger pulse waveforms are demonstrated at fig. 16.

Pre-pulse trigger voltage to swept gain unit

45. The matching transformer T2 in the cathode circuit of V3 has a step-down ratio of 4: 1, and delivers the positive-going pre-pulse of 23V amplitude and 100μs duration to the output socket SKT2 which is connected to the swept gain unit also via SKT2 connected in parallel with SKT1.

Pre-pulse trigger voltage to timebase unit

46. The timebase trigger voltage is provided by the cathode-follower stage associated with V7. A fraction of the pulse voltage at the anode of V2 is applied to the grid of V7 through the differentiating circuit C16, R54. Only the positive-going voltage pips produce an output from V7 due to negative bias applied to the grid from the junction of R54 and R55. The output is cathode coupled to the timebase circuits of the azimuth range indicators (Section 3 of this Part) and has an amplitude of about 12V. The leading edge of the voltage trip produces the timebase triggering and has a fast rise time, that is, 0·3μs.

Trigger for m.t.i.

47. A synchronizing pulse is fed from the pulse generator circuit in the signal comparator Type S2/2 to PL1. For moving target indication, function relay RLA is energized and the pulse is then applied to the grid of V1A the synchronizing amplifier. This synchronizing pulse occurs at T_0 - 100μs and is positive-going with an amplitude of 20V and 3μs duration. The multivibrator is adjusted to have a free running p.r.f. of 660 p.p.s. and the multivibrator is thus locked to the delay line in the M.T.I. Group Type S1/2 (para. 162 et seq.).

Trigger output for secondary radar

48. Secondary radar equipment may be used with the F.G.R.I.26008/1, and because of transponder delay the secondary equipment must be triggered before T_0 for correct display on the primary radar. The negative-going pulse at the anode of V1 is fed via C13 to the grid of V5B, switching it off. The rate of recovery on the grid of V5B is determined by the time constant of C13 and R46,

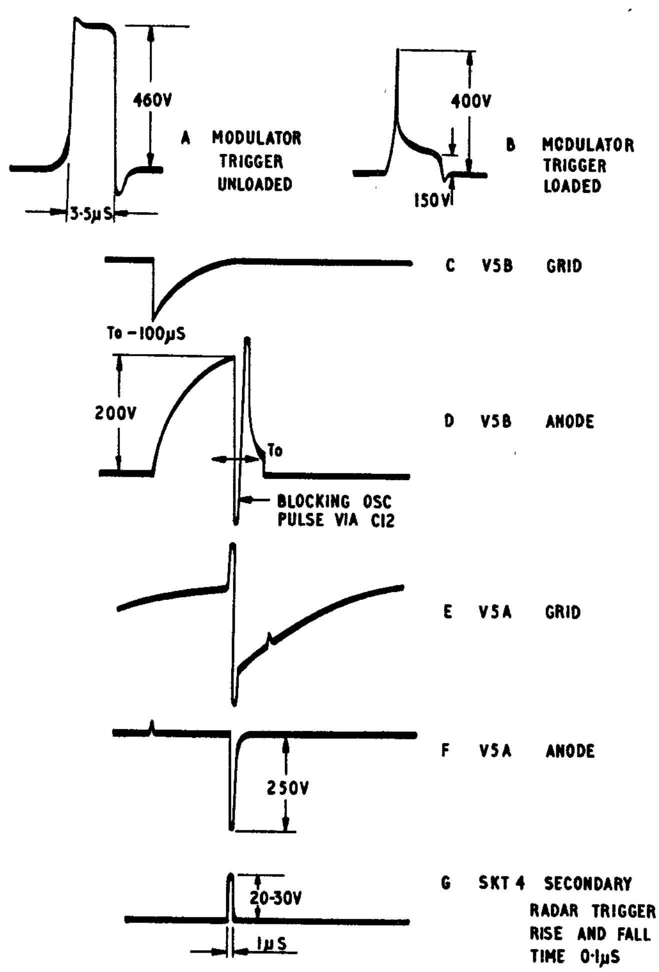

Fig. 16. Trigger pulses generator Type S6/2-waveforms (2)

and the potential towards which the grid is recovering, as determined by the setting of RV3. Thus the trailing edge of the positive-going waveform at the anode of V5B can be adjusted between $T_0 - 30\mu s$ and T_0. This waveform is applied via C12 to the anode of V5A.

49. V5A is connected as a blocking oscillator and is normally biased beyond cut-off by the negative voltage applied from the junction of resistors R41 and R42. The trailing edge of the positive-going voltage waveform at the anode of V5B is applied, via C12, to the anode of V5A. This triggers the valve and normal blocking oscillator action takes place. A third winding on the blocking oscillator transformer, T4, provides a positive output pulse suitable for remote triggering of secondary radar ground equipment, at SK4. This output voltage has an amplitude of between 20V and 30V, a duration of $1\mu s$ and its waveform is shown at fig. 16.

50. Multivibrator jitter which results from hum is minimized by injecting at the grid circuit of V2A a voltage at 50c/s from the heater transformer T5. The amplitude and phase of this voltage are preset by RV4. A number of monitoring points are provided and these are connected via switch SW1 to the meter jack J1.

If amplifier Type S10/1

51. The IF amplifier Type S10/1 (test amplifier) is an entirely independent unit housed for convenience in the trigger pulses generator Type S6/2. It is a piece of test equipment which enables i.f. signal voltages to be amplified to a sufficient level for presentation on an oscilloscope display. The circuit diagram of the IF amplifier is given at fig. 17. The i.f. signal voltages are introduced at PL1 and amplified by a four valve amplifier which consists of two staggered pairs (V1 and V2, and V3 and V4). The control of the grid bias for the first three stages is adjusted by means of the TEST AMP IN control on the power supply control Type S7/1 (para. 104 et seq.). The double diode valve V5, connected as a half-wave rectifier, feeds a cathode-follower output stage associated with V6. An indication of the level of diode current is obtained by applying the p.d. across the ◀variable resistor RV5 (Adjust 3dB) in the generator trigger pulse S6/2▶, in series with the load of V5, R15, to the meter jack via filter, comprising L5, C22 and C24, and PL2/8. The input plug PL1 and output socket SKT1 are connected via two coaxial cables to PL3 (TEST AMP IN) and SKT7 (TEST AMP OUT) respectively on the trigger pulses generator Type 6/2. Power supplies are introduced at PL2 from SKT8 on the trigger pulses generator Type S6/2.◀ RV5 (Adjust 3dB) is used to give 0dB or 3dB of attenuation when noise figure measurements are being taken.▶

Radar modulator Type S1/1

52. The circuit diagram of the radar modulator Type S1/1 is shown at fig. 18. This unit consists basically of an artificial line which is discharged by a hydrogen thyratron to produce a 27kV pulse of $1\mu s$ duration. This pulse is applied to the magnetron. The waveforms associated with this circuit are shown at fig. 19. The e.h.t. voltage for the thyratron is introduced at PL2.

53. The LC delay line is charged via the inductor L1 from the e.h.t. supply. The inductor forms a series resonant circuit with the line capacitance. When the line charges, the inductance, representing the line and the primary of T3, has the effect of slightly modifying the effective value of L1. Initiation of the charging process excites an oscillation in the resonant circuit, and at the end of the cycle of this oscillation the line has been charged to twice e.h.t. voltage.

54. If the trigger pulse from the trigger pulse generator Type S6/2 arrives at the moment when the line is charged to the peak voltage of 12kV, V1 discharges the line in a time determined by the double transit time ($1\mu s$) of the line. The discharge current pulse of 180A through the primary of transformer T3 developes a voltage pulse of 6kV across the primary winding. The transformer T3 which matches the magnetron to the line, has a step up ratio to the two tightly coupled secondary windings of 4·5 to 1, and thus a negative voltage pulse of about 27kV is produced. This is applied to the magnetron cathode.

55. The thyratron must always fire at the instant the line capacitance is charged to maximum voltage if maximum efficiency is to be obtained. The inductance of L1 and the capacitance of the line

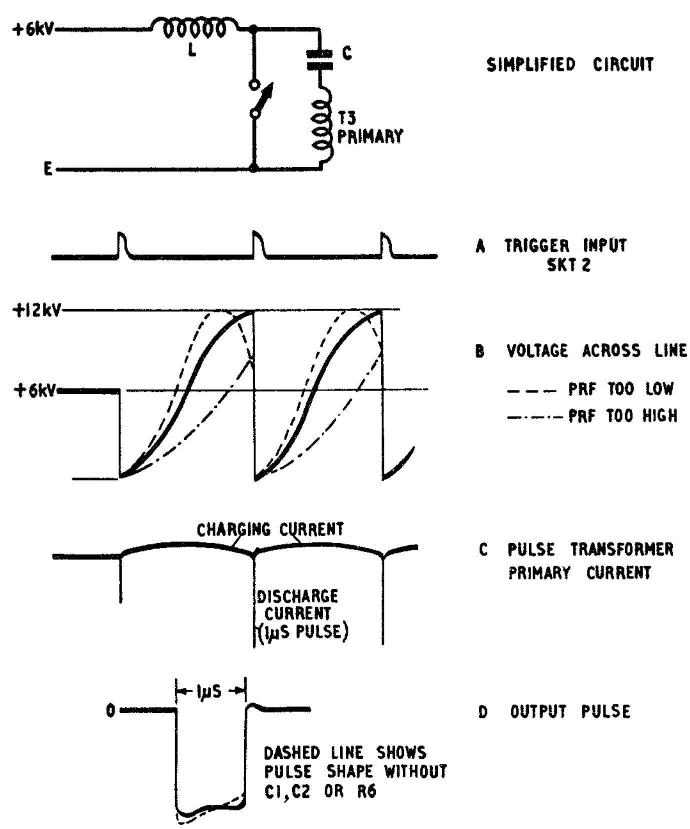

Fig. 19. Radar modulator waveforms

are, therefore, so chosen to resonate at the p.r.f. of the system. If the p.r.f. were too low, the voltage across the line would begin to decrease before the trigger pulse arrived, as shown in fig. 19B. On the other hand if it were too high, the line voltage would not reach its maximum before the trigger pulse arrived.

56. The magnetron may fail to oscillate in the desired mode if the leading edge of the voltage pulse applied to it rises too sharply. For this reason, inductor L2 is inserted in series with the thyratron to limit the initial current surge when the thyratron is fired. In the same way the 100 ohm resistor R2 limits the initial current that can flow into the grid of the thyratron. R2 also serves, with the metrosil across the pulse transformer in the trigger pulses generator Type S6/2, to limit the voltage rise fed back to the transformer.

57. The resistors R1 and R7 form a potential divider from the junction of which the incoming trigger pulse may be monitored at SKT2.

58. The series circuit comprising capacitors C1 and C2, and resistor R6 is connected between the magnetron heater cathode and earth to counteract the tendency of the pulse to droop. The broken line in fig. 19D shows the pulse shape without these components. During the early part of the pulse the heavy current charges the capacitors through R6, thus reducing the initial pulse voltage. Later in the pulse, as the voltage tends to fall below the p.d. across C1 and C2, these capacitors supply current which tends to maintain the voltage. The resultant pulse shape is similar to that shown at fig. 19D.

59. The magnetron heater is fed from the transformer T2 through the two high-voltage windings of transformer T3. The secondary of T2, which presents a high impedance to the pulse, is bypassed by C3 and C5 so that the lower ends of both high-voltage windings are, in effect, tied together and to earth.

60. The microswitch SW1 is a safety interlock, in series with the e.h.t. contactor, and opens as soon as the radar modulator is withdrawn from its normal position in the cabinet.

61. A series of momentary short-circuits which results in high negative potentials being developed at the anode of the thyratron can result from faulty operation of the magnetron. When sparking or mode-jumping occurs a sudden decrease of the resistance of the load is presented to the delay network, and, because the thyratron is a unidirectional switch, a negative charge is left on the line after each pulse. This charge may build up after a number of pulses and can cause breakdown of the delay line, the resonant circuit inductor, or the thyratron.

62. The valve V2 is an overswing diode connected in parallel with the delay line to protect the circuit. When a negative voltage is applied to the cathode of the diode it conducts and energizes relay RLZ. RLZ1 then cuts off the supply to the e.h.t. transformer. The diode also provides protection against open-circuits in the load, which would cause the pulse voltage across the line and the pulse transformer to be almost double the normal working voltage. If the transformer does not break down, this results in a high inverse voltage on the line which is removed by the diode.

Valve unit Type S1/2

63. The 27kV pulse from the modulator is applied to the magnetron and its output, within the frequency range 2940 Mc/s and 2980 Mc/s, is transferred to the waveguide by the magnetron coupling probe, and passes via the centimetric components (para. 64) ▶◀ to the aerial horn. An adjustable plunger at the lower end of the waveguide, below the magnetron probe, is used in conjunction with the phase shifter (para. 64) to match the waveguide to the magnetron. The position of the matching plunger is controlled via a torsional Bowden cable, from the knob on the magnetron unit.

Waveguide run and hybrid ring circuit

64. The waveguide run (fig. 20) transfers the output of the magnetron to the aerial via the waveguide switch. A phase shifter, which consists of a plate of polystyrene placed longitudinally in the waveguide and shaped for broad-band matching purposes, can be moved laterally across the broad dimension of the waveguide to reduce the load reactance presented to the magnetron. Thus, the magnetron can be made to operate into the best load impedance (power factor about 0·9) with resultant freedom from moding and misfiring. When a new magnetron has to be fitted or the magnetron operating conditions have altered, readjustments for optimum working may be necessary. The coho cavity, a tunable high-Q resonator loosely coupled to the waveguide, supplies a sample of the transmitted pulse to a crystal mixer in the hybrid ring via a short length of coaxial cable. Above the coho cavity is an ATR cell coupled to the waveguide by a window. ▶A quarter of a waveguide wavelength further along the line is a pre-TR cell, also coupled to the waveguide by a window.◀ The pre-TR cell branch is in turn coupled to the main TR cell mounted on a tunable resonant cavity. The gap in the resonant cavity is located approximately one quarter of a wavelength from the plane of the pre-TR cell, the precise electrical length of the branch being determined by the reactive component reflected from the resonant cavity.

65. ▶When the equipment is transmitting, the cells are ionized and form very low resistance paths. The ATR cell and associated waveguide stub are so designed that the firing of the cell presents a low impedance at the main waveguide wall and the transmitter output power passes direct to the aerial.◀

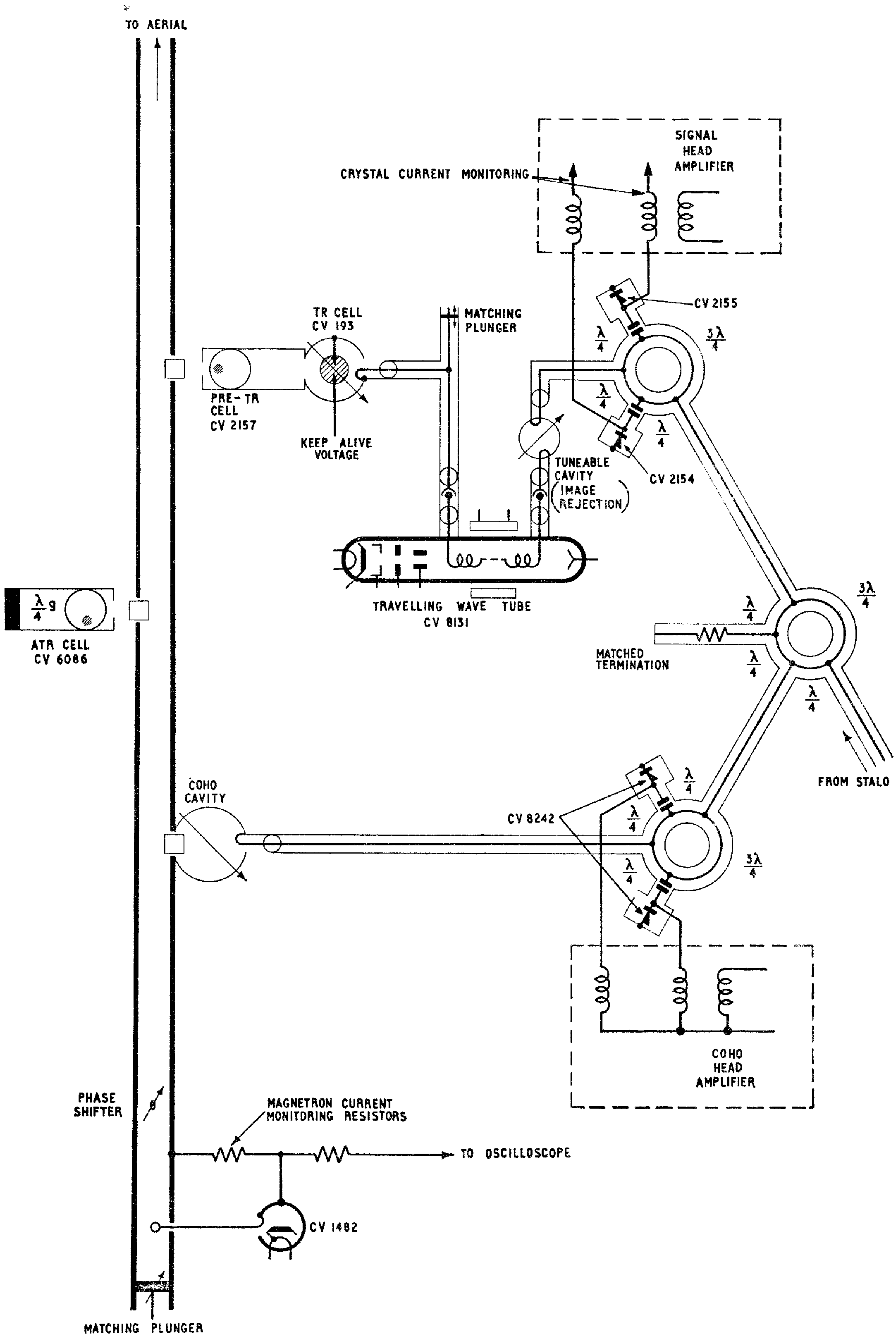

Fig. 20. Waveguide run and hybrid ring circuit

66. The discharge in the pre-TR cell causes the majority of the energy to be reflected back into the main waveguide in phase with the wave advancing towards the aerial. This reflection, whilst not complete, considerably reduces the power applied to the resonate cavity of the TR cell which then provides a second reflecting plane at which the ratio of transmitted to reflected power is approximately 80dB. The use of the pre-TR cell in conjunction with the TR cell provides adequate protection for the RF amplifier Type S13/1 and lengthens the life of the TR cell. Ionization of the TR cell is maintained at a low level between pulses by the keep-alive electrode to which a negative potential of 800V is applied.

67. On reception, the TR cells are quiescent. The pre-TR and TR cells offer a low impedance path to the signals, which are then amplified by RF amplifier Type S13/1. A tunable stub in the coaxial line between the TR cell and the input of the travelling wave tube ensures a good match. The ATR cell in the waveguide is located at a point one quarter of a wavelength from the TR cell branch so that the quarter wave section of the ATR cell, together with the quarter wavelength along the guide, constitute an equivalent half-wave line interposed between the TR cell branch and the waveguide run towards the magnetron. This arrangement presents the high impedance at the TR cell branch when looking towards the magnetron and this minimizes leakage of signals towards the transmitter.

68. ▶The output of the travelling wave tube is applied to one of the hybrid rings via a high-Q tunable cavity, the frequency of which is adjusted to reject the image frequency, that is, magnetron frequency — 60 Mc/s.◀

69. The output of the stabilized local oscillator Type S4/2 is fed to a third coaxial line hybrid ring via an attenuator (incorporated in the coaxial line) and from here it is distributed to the hybrid rings coupled to the coho cavity and the travelling wave tube. The attenuator is included to prevent reactive components being reflected to the stalo. Both the coho cavity and signal hybrid rings have balanced crystal mixers mounted in them. The output of the travelling wave tube is fed to the upper mixer (fig. 20) which has silicon diodes fitted. The stabilized local oscillator or stalo is operated at 30 Mc/s and signals at the resultant intermediate frequency of 30 Mc/s pass to the signal head amplifier Type S9/1 which plugs into the associated crystal mixer.

70. The lower mixer receives the sample of the transmitted pulse via the loosely coupled coho cavity. The loose coupling ensures that only a few milliwatts are applied to the germanium crystals, which convert the pulse to 30 Mc/s. As in the signal channel, the output is applied to the second head amplifier Type S9/1 which is also plugged in to the mixer.

71. The relative positions of the inputs to, and outputs from, the hybrid rings, in terms of waveguide wavelengths, ensure maximum mixed outputs. The matched termination in the hybrid ring connected to the stalo, ensures that the coho input is not connected to the signal channel.

RF amplifier Type S13/1

72. The RF amplifier Type S13/1 is the microwave pre-amplifier unit which receives the r.f. signals from the TR cell, and after amplifying them, passes them on to the signal mixer. The circuit diagram of the R.F. amplifier is shown at fig. 21. The microwave pre-amplifier valve (V4) is a forward travelling wave tube (CV8131), and power amplification takes place by interaction between the electric field due to the r.f. wave travelling in the helical inductor, and that due to the main electron beam. The cathode, first grid and the next three electrodes of the travelling wave tube form a conventional electron gun system. The electron beam which passes along the axis of the helix is sharply focused by a solenoid. The collector at the far end of the tube is maintained at a positive potential of 450V and completes the electron path.

73. Input signals, at magnetron frequency, are fed in at the cathode end of the helix and set up a wave which travels along wire of the helix at about the speed of light. The component of velocity of the wave parallel to the axis of the helix depends on the ratio of the pitch to the circumference of the turns of the helix, and electrode voltages are adjusted so that the velocity of the electron stream is slightly higher than the axial velocity of the r.f. wave.

74. Interaction between the electric fields results in bunching in the electron stream, with a net decrease of the average velocity of the beam. This is accompanied by a transfer of energy from the beam to the r.f. field, and the signal is amplified, the overall gain being about 25dB for a noise figure of about 6dB. The use of this valve thus ensures a considerable reduction in general noise on the display.

75. An attenuator is fitted around the centre of the helix which isolates the input and output sections and thus prevents positive feedback and the production of oscillations.

76. The output from the helix is taken via a coaxial cable to a tunable resonant cavity for image rejection. This is necessary because the travelling wave tube is a broad-band device having a band-width of about 100 Mc/s.

Electrode supplies and controls

77. The cathode and first grid of the travelling wave tube are connected to chassis and positive potentials are applied to all other electrodes and to the helix. The second and third grids are fed from potentiometers RV4 (TWTG2) and RV3

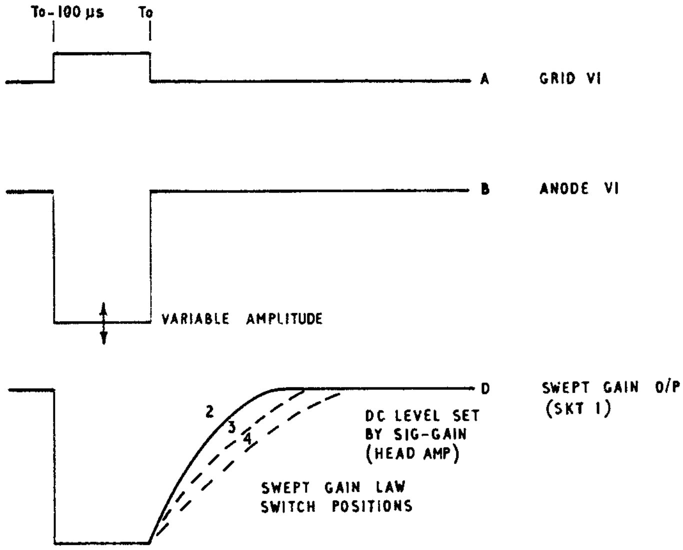

Fig. 22. Swept gain generator waveforms

(TWTG3) in a potential divider chain connected between the positive 150V supply and chassis. The TWTG4 control RV2 is in a potential divider chain connected between the +300V and the +150V supplies. The helix is supplied via R27 from RV5 (TWT HELIX), which is in a potential divider chain connected between the +450V and +300V supplies. An overload trip circuit (para. 79) is connected in parallel with R27. The focusing solenoid is supplied at a fixed potential of −18V and takes a current of 10A.

78. The TWTG2 control RV4 is used to set the beam current and an indication of the level of this current can be obtained by measuring the p.d. across the shunt resistor R30 in the collector lead. The potentials on the third and fourth grids are adjusted to produce an accelerating field of such a value that, acting for a longer time on slow moving electrons and for a shorter time on fast moving electrons, it results in an emergent beam of uniform velocity. The effect of this considerably reduces the beam current noise. The TWT helix control is used to adjust the beam velocity for optimum gain at the frequency of operation.

Overload trip

79. If an appreciable current flows between the electron stream and the helix due, for example, to incorrect focusing, the r.f. attenuator may be burnt out. An overload trip circuit is therefore included in the helix feed to prevent this occurring.

80. The overload trip valve V5 is a double-triode, and its two grids are connected to opposite ends of resistor R27. When no d.c. current is flowing in the helix there is no voltage drop across resistor R27 and both grids are then at the helix potential of about +375V. Both triodes conduct and act as d.c. cathode followers, with their cathodes at the same potential, and relay RLA remains un-energized.

81. When current flows between the helix and beam, the p.d. across R27 causes the grid voltage and cathode voltage of the left-hand triode of V5 to fall. Current now flows in the winding of relay RLA, and if the helix current exceeds 10μA the relay operates. One set of contacts A1, connects the control grid G2 to chassis and cuts off the beam current. The other set of contacts A2, complete the circuit to the O/L warning lamp ILP1. The lamp current flows through R27 and maintains sufficient voltage drop across this resistor to maintain relay RLA energized.

82. When the fault has been cleared the beam current can be restored by momentarily opening the push button overload reset switch SW3 which de-energizes relay RLA.

83. A further protective device in the power supply Type S17/1 (para. 200) disconnects the h.t. supplies in the event of failure of the focusing solenoid supply.

Metering

84. The 25μA movement moving coil meter M1 can be used to measure the p.d.s across resistors at strategic points in the circuit. Selection is by means of switch SW2.

Swept gain generator

85. A separate circuit element, the swept gain generator, is incorporated in the circuit of the RF amplifier Type S13/1. This receives the positive-going $T_0 - 100\mu$s pre-pulse and produces from it a negative-going pulse of variable amplitude and recovery time, which is superimposed on the signal head amplifier. The waveforms for the swept gain generator are shown at fig. 22.

86. The positive-going prepulse is introduced at pole K of PL5 and applied to the series resistors R1 and R2. The attenuated pre-pulse from the junction of R1 and R2 is then applied to the grid of the penode valve V1. During the pulse, the fall in voltage at the anode of V1 causes capacitor C5 to be charged negatively through the diode V2. The amplitude of the pulse applied to the diode, and hence the voltage to which C5 is charged, is determined by the bias on the suppressor grid of V1 which is controlled by the SWEPT GAIN AMPLIFIER control on the power supply control Type S7/1 (para. 104 et seq.).

87. At the end of the pre-pulse, the diode is again cut off and C5 can only discharge through the resistors selected, by the SWEPT GAIN LAW CONTROL switch SW1, from the resistor chain R12, R13 and R14. The SWEPT GAIN LAW CONTROL thus determines the recovery time constant and hence the time for which the reduction of gain is effective. In the first position of the switch the pulse from the V1 is by-passed to earth by C5 providing an OFF position without pre-pulse breakthrough.

88. The swept gain waveform (fig. 22) is superimposed on the signal head amplifier bias, introduced through resistor R11 and passed on to the amplifier V3A of the double-triode V3. The cathode load of V3A is provided by triode V3B. The voltage rise at the anode of V3A is passed to the grid of V3B reducing the impedance of the valve and assisting the fall in potential at the cathode of V3A. The variable bias for the grid of V3A, which sets the d.c. level of the output waveforms, and hence the normal bias level for the head amplifier, is decoupled by capacitor C5. The swept gain output waveform can be monitored at the coaxial socket SKT1.

89. Power supplies for the travelling wave tube circuits are introduced from the power supply Type S17/1 (para. 199) and the connections to the swept gain generator circuit at PL5 are made from SKT5 and the TR line assembly.

TR line assembly

90. The TR line assembly comprises the TR plug panel (fig. 23) and the two head amplifiers Type S9/1 (stalo and coho) the circuit for which is shown at fig. 24.

TR plug panel

91. This provides the heater supplies for the head amplifiers, the power supply control Type S7/1 and the RF amplifier Type S13/1 from T1. In addition it provides a route for various services including h.t. supplies, gain control, and metering facilities provided by SKT1 and SW1 as indicated on the circuit.

Head amplifiers Type S9/1

92. The coho reference pulse, phase locked to the transmitter pulse, and the signal pulse from the crystal mixers in the hybrid rings, are now both at 30Mc/s and can therefore now be amplified by identical units and two head amplifiers Type S9/1 are provided for this purpose. The circuit diagram is shown at fig. 24.

93. The head amplifier Type S9/1 is a high-gain i.f. amplifier designed for operation at 30 Mc/s. It employs five stages of amplification consisting of two staggered broad-band triples, the first being from T1 to T3, and the second from T4 to T6. A low-noise CV408 triode is used in the first stage and is neutralised by VC1 in series with C6.

94. The gain of the amplifier is controlled by varying the bias on the grids of V2, V3 and V4 by means of the COHO GAIN (HEAD AMP.) or the SIG GAIN HEAD AMP preset controls on the power supply control Type S7/1. The maximum gain available in the amplifier is between 50dB and 60dB.

95. In the signal channel the 30Mc/s i.f. signal output is fed to the signal-splitter attenuator (fig. 25), which is mounted on the centre member of the main cabinet. The attenuator provides two outputs, one taken by a 80-ohm cable to the normal radar amplifier in the viewing unit, and the other output is supplied to the M.T.I. group Type S1/2 (moving target indication cancellation unit).

96. Provision is made in the signal head amplifier for measuring the current of each crystal in the signal mixer. Relay RLA or RLB is energized when the meter switch on the TR line plug panel is set to position 6 or 7 respectively.

97. In the signal channel, the gain control voltage is obtained from the swept gain generator in the RF amplifier Type S13/1. Adjustment is by means of the signal gain control which alters the d.c. level of the swept gain waveform. The crystal current of this amplifier is not measured because the mean current output of the crystal is too small to operate the meter.

RF oscillator Type S4/2

Note . . .

When inserting or withdrawing the disk seal triode, a twisting motion must be avoided or the valve seals may be damaged.

98. In the coho-stalo moving target indications system using an intermediate frequency (30 Mc/s), a local oscillator of very great stability is an essential requirement for the production of the coho reference pulse locked to the recurrence frequency of the system. The RF oscillator Type S8/1 unit (fig. 26) fulfils this requirement. It employs a CV5956 disk seal triode in a typical concentric line tuned-anode tuned-grid circuit and the 3000 Mc/s band output is available at SKT3. Fine tuning is by manual adjustment of the anode tuning capacitance, coarse control being by means of an adjustable feedback probe. The

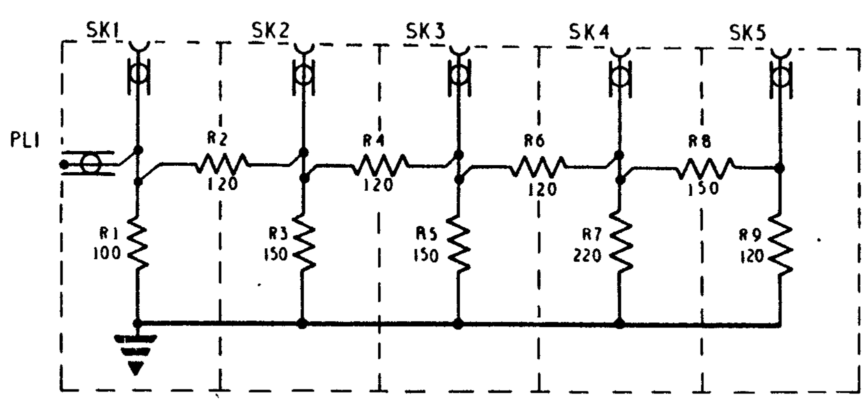

Fig. 25. Variable attenuator Type S3/1 (signal splitter attenuator): circuit

grid circuit is tuned by adjusting the amount of inductance in circuit. The mechanical construction of the associated coaxial line assembly into which the valve is built plays an essential part in achieving this high degree of electrical stability. A special shunt capacitance in the anode-grid line in the form of a U-shaped bi-metal element provides temperature compensation. The temperature coefficient of oscillator frequency is about 70kc/s per deg.C. which is almost the same as that of the magnetron. The air stream cools the oscillator and the magnetron, and therefore any change in ambient temperature has an equal effect on the oscillator and the magnetron, and the difference frequency remains constant.

99. The 200V h.t. and the 6·3V d.c. for the oscillator valve are stabilized. The h.t. supply (fig. 27) is obtained from the circuit associated with valves V1 to 4 inclusive. A potential divider chain consisting of R16, RV2 and R17 is connected across the h.t. supply to the anode of the oscillator valve, and voltage variations at the slider of RV2 are applied to the grid of pentode V1. Valves V1 and V2 are connected as a long-tailed pair. The grid of V2 is maintained at +85V by a voltage regulator valve V3, and the amplifier a.c. voltage developed across R4, 180 deg. out of phase with the voltage applied to V1 grid, is applied to the control grid of pentode valve V4 and controls the conductance of that valve which is a series stabilizer. The loop gain of the system is increased for a.c. by C4 which shunts the upper part of the potential divider chain. A stable and low-ripple h.t. supply of 200V is thus achieved.

100. The heater supply for V9 is derived from a regulator circuit employing a saturable reactor TD1 in the a.c. supply to a bridge rectifier MR1. The rectified output is passed to the heater via the smoothing circuit comprising the choke input filter L1 and R37. The d.c. winding of TD1 forms the anode load of V5, and the heater supply voltage can therefore be adjusted by the SET HEATER control RV1 which determines the grid potential of V5. RV1 is in series with R1 connected between the +200V stabilized supply and chassis.

101. Valves V6, V7 and V8, and their associated circuits provide ripple suppression. The heater of V9, the triode oscillator, forms the cathode load of V6 and V8 shunted by the potential divider chain R19 and R20. The voltage at the junction of R19 and R20 provides the bias supply for V6. The ripple voltage on the heater supply is applied to the cathode of V8 via C11. The grid of V8 is earthed in effect through C8 and its bias provided by the cathode potential of V6 plus the p.d. across resistor R18. The in-phase ripple at the anode of V8 is inverted and amplified by V7, and passed to the grid of V6, a cathode follower. This valve supplies to the oscillator heater a ripple current 180 degrees out of phase with the ripple current from inductor L1. The ripple variation of the heater current is therefore extremely small.

102. The microswitch SW2 in series with the h.t. supply to the anode of V9 is mechanically operated by a lever lock fitted at the rear of the stalo unit. This is used to lock the anti-vibration mounting of V9 when the unit has been transported from one place to another. The microswitch remains open until the lever is set to the unlock position.

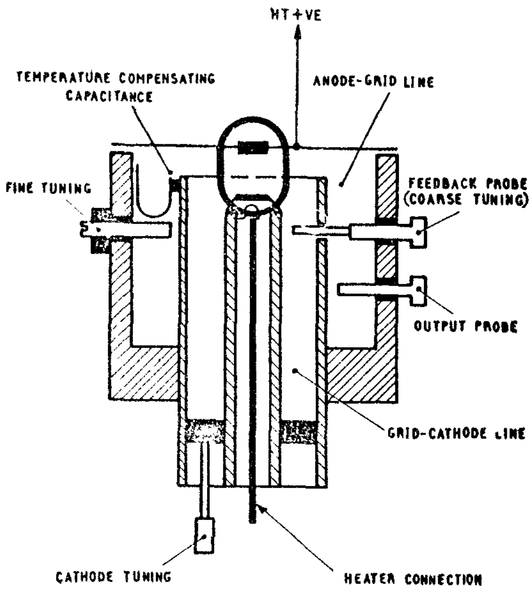

Fig. 26. R.F. oscillator Type S8/1 : circuit

103. Two coaxial monitor sockets are provided, one for the HT RIPPLE voltage (SKT1) and the other for the HEATER RIPPLE voltage (SKT2). Several voltage monitoring points are also provided and these are connected to the meter jack JK1 via the 11-position switch SW1.

Power supply control Type S7/1

104. The circuit diagram of the power supply control Type S7/1 is shown at fig. 28. This unit distributes the 230V 50c/s mains supply to the transmitter and the moving target indication system. Interlock and protection arrangements are incorporated and two meters are provided for monitoring purposes. Gain controls for the signal head amplifier, coho head amplifier, IF amplifier Type S10/1 (test amplifier) and the swept gain generator are in this circuit. A simplified circuit of the switching and delay circuits is given at fig. 29 for reference.

105. The 230V supply is introduced at PL1/9/11 (line) and PL1/10/12 (neutral). It is distributed from here via the two 10A fuses FS1 and FS2 via JK1 and SW4 to the units and to external test gear sockets via SKT4. A further supply is taken to a lamp which illuminates the variac control knob. The a.c. mains supply is also fed direct to a 15A circuit breaker which represents the radar T/R assembly ON/OFF switch. Distribution of power is then made to the following points :—

(1) The variac via SKT2/11/12 and contactor No. 1.

(2) The operating coil of the mains contactor No. 1 via the LOCAL/REMOTE SWITCH at LOCAL or through relay contact H1 at REMOTE and

SKT2/9/10; the operating coil of contactor No.2 via relay contracts B2 and SKT2/5/6.

(3) The variac motor for e.h.t. run-up and run-down via relay contracts B1 and SKT4/7/8.

(4) The magnetron heater circuit, via the thermal delay switch DLS2, and SKT2/7/8.

106. The a.c. output from the variac, which should be set 230V, enters the power supply control unit at PL1/2/3 and is fed out via SKT2/1/2, to the distribution blocks, and to the M.T.I system via switch SW1, and SKT2/3/4.

E.h.t. switching

107. Special precautions have to be taken to ensure that a reduced mains voltage is applied to certain units of the equipment until an adequate warming-up period has been allowed. The motor controlled variac of the variable power transformer (para.203) makes provision for this (fig.29). A second brush on the variac controls the e.h.t. voltage. This brush is rotated by a reversible motor via a step down gear train from zero to the maximum voltage available as set by the first brush, and vice versa, as determined by the preset limit switches on the variable power transformer. The motor is an induction type with two similar stator windings, a starting capacitor being connected between the windings. Each winding may be used either as the main or the starting winding. The direction of rotation is thus determined by the terminal to which the supply is connected.

108. The heater of the thyratron in the modulator takes five minutes to reach its full working temperature. A delay circuit associated with valve V1 is incorporated in the power supply control to initiate the e.h.t. run-up about five minutes after the low voltage power is applied. The system is controlled by the EHT ON/OFF switch SW3 and section B of the TX control, REMOTE/LOCAL switch SW2.

109. When the TX REMOTE/LOCAL switch is set to LOCAL, the coil of contactor No.1 is energized via SK2/9/10, by closing the circuit breaker. When remote switching is required the circuit breaker is left closed with the REMOTE/LOCAL switch set at REMOTE. Contactor No.1 can then be energized by applying -48V to relay RLH, by means of the TX STANDBY SWITCH at the display position. Contactor No.1 switches on the low voltage supplies.

110. When the low voltage supplies come on, the delay control valve V1 is cut off by the -150V applied to its grid via RLA1. Half a minute later the contacts of the thermal delay switch DLS1 close and relay RLA is energized, provided there is an earth return via SKT4/9 in the radar modulator. The half minute delay ensures that C1 which is connected between the +330V and -150V lines becomes fully charged via R11 to 480V before the grid potential of V1 begins to rise from -150V. When anode current begins to flow, the valve acts as a Miller integrator, the rate of anode voltage run down being determined by the time constant of C1 and R13, and the potential at the junction of R14 and R15. The run-down time is approximately five minutes.

111. When the anode run down is terminated by bottoming there is a tendency for most of the cathode current to transfer to the screen grid. With the TX control REMOTE LOCAL switch at LOCAL and the e.h.t. switch at ON, the screen grid current is limited, by R10, to a value that is insufficient to operate relay RLB, and the transmitter remains in the standby condition. The e.h.t. is switched on by short circuiting R10, either by setting the REMOTE/LOCAL switch to LOCAL and the E.H.T. switch to ON or by means of the appropriate TRANSMITTER R.F. power switch at the remote switching control Type S14/1 (Chap.2 of this Section). Any of the TRANSMITTER R.F. POWER switches applies -48V to relay RLF, the contacts of which short circuit R10. Relay contact RLF1 is not taken directly to the +200V line, but via PL3/6 and the safety interlock switches to SKT24/11 on the top of the cabinet. This socket only connects with the display equipment, via junction boxes, and pole 11 of the mating plug is connected to pole 8 which carries +200V for the noise source (chap.2 of this Section). When the noise source is in use there is no connection between poles 8 and 11 of SKT24, and the e.h.t. supply cannot be switched on.

112. When resistor R10 is short circuited, the increase in screen current in V1 energizes relay RLB. Relay contact RLB2 now closes and causes the 230V line voltage to be applied to the coil of contactor No.2 via SKT2/5. Contactor No.2 now completes the circuit between the variac brush and the primary of the e.h.t. transformer. Contact RLB1 applies the 230V neutral to the variac motor via SKT4/8. The motor drives the variac brush gear and runs the e.h.t. voltage up to the value required to give a magnetron current pulse of 35A when it is stopped by the preset limit switch (SW3). The run up may be stopped at any intermediate e.h.t. voltage by means of the STOP/NORMAL switch on the variac panel for testing purposes.

113. The e.h.t. supply may be switched off, either locally or remotely, by removing the short circuit across R10 and thus causing relay RLB to be de-energized; the change-over of contact RLB1 transfers the 230V (N) via SKT4/7 to the winding of the variac motor, which then returns the variac brush to the zero voltage position. A similar action takes place for any e.h.t. fault. If a mains failure occurs the e.h.t. supply is switched off immediately but the variac cannot be run down. When the mains supply fault has been corrected and the voltage applied again the normal delay in the h.t. and e.h.t. switching occurs again and, during the first part of this time, the variac is run down.

Thyratron heater interlock

114. The thyratron heater voltage always has to be applied five minutes before the e.h.t. voltages, and for this purpose PL16/9 on the radar modulator is connected to earth and completes the circuit of relay RLA as described at para.110, thus if the radar modulator is disconnected, breaking the heater supply to the thyratron, relay RLA will be de-energized, causing the e.h.t. to fall to zero. The e.h.t. cannot then be restored until five minutes after the radar modulator has been reconnected.

Magnetron flash-over

115. If magnetron flash-over occurs, the e.h.t. supply is switched off automatically. When the magnetron flashes over or does not fire, a large voltage surge is transferred to the thyratron because of the mismatch of the delay line. This surge causes relay RLA in the radar modulator to operate and contacts RLA1 connect PL3/5 of the power supply control to earth. The relay RLE is energized via contact RLC3 so that contact RLE1 causes V1 to be cut off. Relay RLB is then de-energized, thus opening contact RLB2, and contactor No.2 opens with the consequent removal of the e.h.t. voltage. At the same time contact RLB1 applies power to SKT4/7, and the variac drive motor rotates in the run down direction to zero position in a readiness for the next application of the e.h.t. voltage.

116. When the e.h.t. voltage is removed, the fault conditions no longer exist, PL3/5 is not earthed and relay RLE is de-energized. After the normal delay action of V1, the e.h.t. is applied again. If the fault persists, then the trip action repeats and the sequence continues until the equipment is switched off.

117. Relay contact RLC3 has been interposed between the contact RLA1 of the trip relay in the radar modulator and relay RLE in the power supply control. These contacts prevent premature operation of relay RLE. During the initial state of the e.h.t. run up, the magnetron impedance is higher than normal and is changing rapidly. Thus there is a mismatch between the magnetron and the delay line. The consequent current through the damping diode V2 and relay RLA would cause that relay to operate and, by closing its contacts, would complete the circuit back via PL3/5 to relay RLE in the power supply control.

118. The contact RLC3 is in series with relay RLA and closes only when the magnetron has been run up to half power as described at para.121. Thus relay RLA cannot operate during the period of unstable impedance of the magnetron. If a fault occurs when steady conditions for the magnetron have been established then information is fed back from the radar modulator trip relay, which operates relay RLA, causing the e.h.t. supply to be cut off.

E.h.t. overload

119. The relay RLD is used as a protection against e.h.t. overload. The potential obtained from the sampling resistors, R1 and R2, in the power supply Type S21/1 for the operation of relay RLC is applied via R22 to relay RLD. Due to the voltage drop across R22, the voltage across R1 and R2 must rise to 150 per cent of the full load potential difference to cause relay RLD to energize. When this happens, the contact RLD1 closes and thus relay RLA is de-energized. Contact RLA1 cuts off V1 with consequent removal of the e.h.t.

E.h.t. over-voltage

120. The voltage developed across resistors R16, R19 and RV1, in the low-potential end of the bleeder chain in the power supply type S21/1, is brought into the power supply control at PL3/4 and applied to the grid of V2A. Valve V2B is conducting, its grid being biased to about +110V, and at the normal e.h.t. voltage of 6kV, the grid of V2A is at +80V. An over-voltage of 20 per cent thus causes transfer of current to V2A and relay RLG is energized. Relay contact RLG1 is in parallel with the over-load relay contact RLD1 and operates, as described in para.118, to switch off the e.h.t.

Magnetron heater switching

121. When the magnetron is operating and the magnetron pulse is at about ◀ half-power level, the magnetron heaters are switched off because the heat ▶ generated by electrons returning to the cathode is sufficient to maintain efficient operation. This is done automatically by relay RLC. The voltage developed across resistors R1 and R2 in the power supply Type S21/1 is introduced into the power supply control at PL3/8. The value of these resistors is such that the potential difference across them at about half power output is sufficient to cause relay RLC to operate. Contact RLC1 opens and, by breaking the heater circuit of the thermal delay switch DLS2, opens the DLS2 contacts and the magnetron heater supply is interrupted. Contact RLC2 closes and the RF POWER ON lamp ILP3 lights. The function of the contact RLC3 is given at para.115-118.

Gain controls

122. Potentiometers RV1, RV2, and RV4 control the gains of the coho, signal head amplifier, and the IF amplifier Type S10/1 respectively, while RV3 controls the amplitude of the swept gain waveform provided by the waveform generator in the RF amplifier Type S13/1. The control voltages provided by these potentiometers are as indicated below:

COHO GAIN (HEAD AMP.) -1.5V to -5.5V

SIG. GAIN (HEAD AMP.) -2.5V to -7.5V

TEST AMP. GAIN -1.5V to -5.5V

SWEPT GAIN AMPLITUDE 0V to -203V

The divider networks for the three amplifiers are fed from the -150V line in the power supply control but the SWEPT GAIN AMPLITUDE control supply is obtained from the divider in the RF amplifier Type S13/1, introduced at SKT4/11. The coho head amplifier and the IF amplifier Type S10/1 control voltages are taken directly to these amplifiers, and the swept gain amplitude voltage is used to bias the suppressor grid of the pulse amplifier V1 in the RF amplifier Type S13E1. The signal gain bias is also fed to the RF amplifier Type S13/1 where it sets the d.c. level of the swept gain waveform.

Monitoring meter

123. The monitoring meter M2 is connected to a plug from which a flylead can be connected to other units for measuring currents at selected test points. Current measurements are obtained from the potential differences developed across series monitoring resistors.

124. The meter has a full scale deflection of 1·5mA and has a nominal resistance of 80 ohms, which, with the series resistor R17, gives a total circuit resistance of 510 ohms plus the resistance of the meter fuse FS3. When more accurate readings are required, the push-button switch PB1 is used to short-circuit the meter fuse FS3, the resistance of which has a wide tolerance.

Note . . .

If the meter fuse becomes open circuit when monitoring, no attempt should be made to obtain a reading by operating PB1 because damage may result to the meter.

Signal comparator Type S2/2

125. The signal comparator Type S2/2, the circuit of which is shown at fig. 30, includes pulse generator and the phase comparison circuits. The pulse generator unit provides the trigger waveforms for operating the M.T.I. system. Heater supply transformers are mounted on the chassis but the h.t. supply is brought in from the M.T.I. power supply unit (mounted separately) via a Jones plug at the rear of the unit.

Pulse generator

126. The pulse generator provides trigger pulses and gating waveforms for the M.T.I. system. It maintains a p.r.f. which is accurate and stable from pulse to pulse, and also feeds synchronizing pulses to the trigger pulses generator Type S6/2. A lock-round circuit is used to ensure that the system p.r.f. is governed by the constant of the delay line (X1).

127. Valves V2A and V4A form an astable multi-vibrator, a positive-going rectangular wave being developed at the anode of V2A. The coupling from the anode of V2A to the grid of V4A is via a cathode-follower V2B, which removes the high capacitive loading from the anode of V2A so that a fast positive-going edge is produced.

128. The pulse at the cathode of V2B is rectangular, the positive-going portion being between 80μs and 120μs duration depending on the setting of RV9, the COHO GATE WIDTH control, which sets the recovery time of V2A grid. This pulse is differentiated by C8 and R35. A positive spike of 20V amplitude appears at the cathode of V3 and is taken via C23 to coaxial output sockets SKT10 and SKT11 in parallel. One output (SK10) synchronizes the transmitter trigger pulses generator and the other is fed to the delay line in the M.T.I. group (S1/2 (m.t.i. cancellation unit) via SKT11. The negative spike resulting from the differentiation is removed by V4B.

129. The trigger pulse emerging from the delay line in the M.T.I. group Type S1/2 is known as the knock-off pulse and is used to initiate the succeeding trigger pulse. This is done by re-inserting the trigger pulse from the line via a knock-off amplifier V1 and diode V6A, to the grid of V2A, and arranging that the free-running period of the multi-vibrator, V2A, V4A, is longer than the time delay of the line. For the major portion of the repetition period, V4A is cut off and when the knock-off pulse arrives the grid of V4A has almost completed its recovery. The knock-off pulse switches V2A off and V4A on as required by the next sequence. The potentiometer RV12 is the COARSE PRF control which sets the 'switch on' potential of V4A.

Lock-round circuit

130. The lock-round circuit includes the following:—

(1) main multivibrator V2A and V4A, differentiating circuit C8 R35, cathode follower V3.

(2) the amplifier-modulator Type S4/2, quartz delay line and RF amplifier Type S12/2 in the M.T.I. group Type S1/2.

(3) the gated knock-off amplifier V1 and diode V6A in the signal comparator Type S2/2.

A block schematic diagram of the lock-round circuit is given at fig. 31 and associated waveforms are given at fig. 32.

Gating the knock-off amplifier V1

131. The knock-off amplifier V1 is suppressed between trigger pulses to prevent nearby radar equipment causing spurious triggering of the main multivibrator, V2A and V4A, by direct breakthrough. The amplifier is gated on a few microseconds in advance of T_0 -100μs by the gating monostable stages associated with V5A and V5B.

132. In the quiescent state, V5A is cut off and V5B is passing anode current. At T_0 -100μs the negative-going rectangular wave at the anode of V2B is applied to the differentiating circuit,

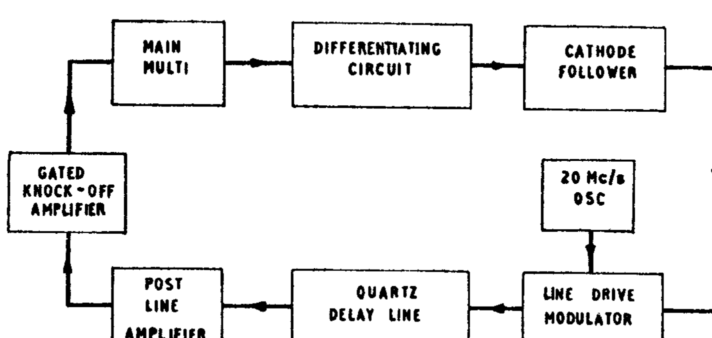

Fig. 31. Block diagram of lock-round system

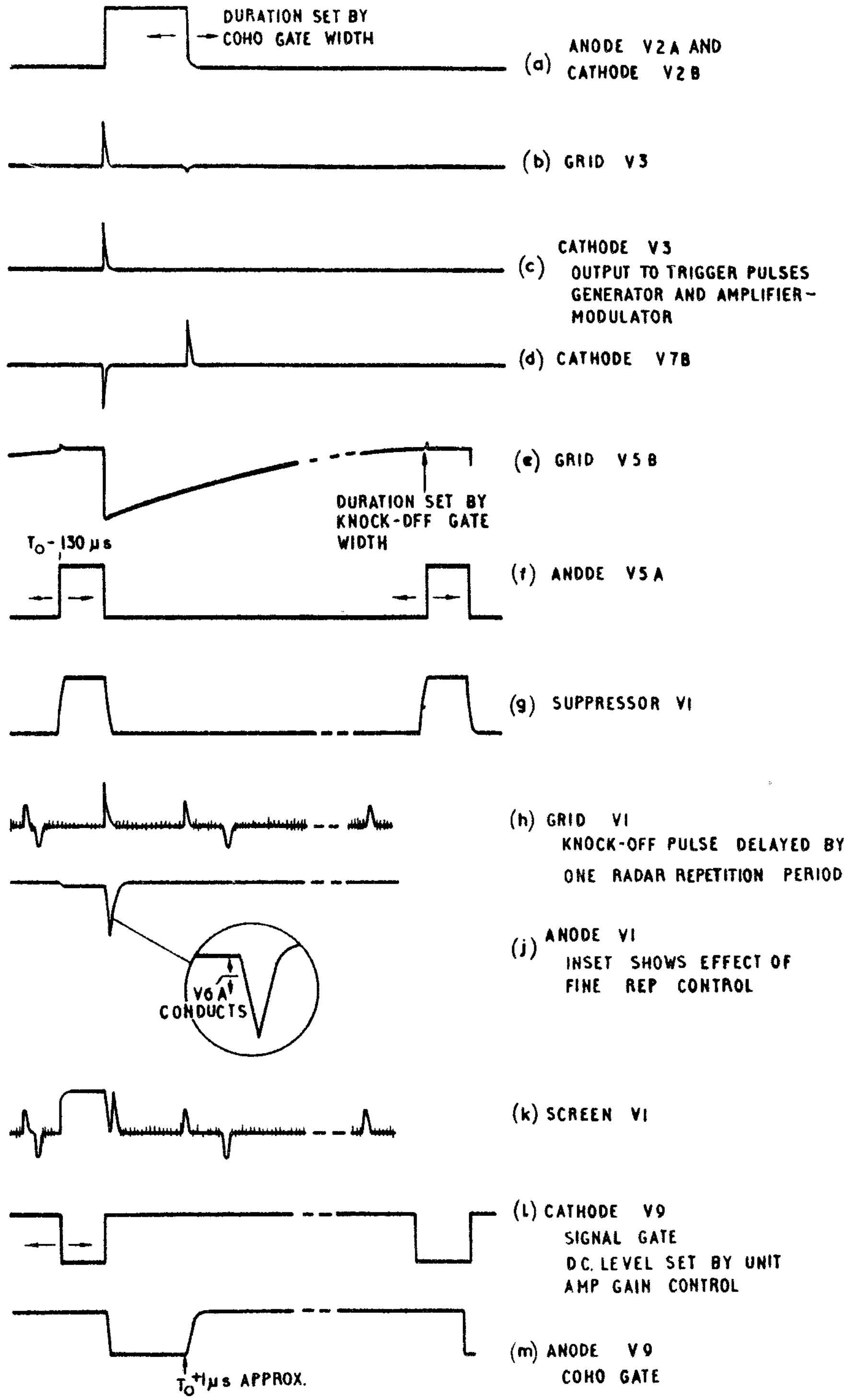

Fig. 32. Pulse generator waveforms

C15 and R51. Only the negative-going spikes across R51 are passed through diode V7B to the grid of V5B, initiating the monstable multivibrator action. The grid of V5B rises exponentially to cut-on point, about 30μs before the next pulse arrives at $T_0 - 100\mu$s. The recovery time of V5B is determined by C13 and R52, and the setting of RV10, THE KNOCK-OFF GATE WIDTH control. The negative excursion is limited by diode V7A, to give improved stability.

133. A negative-going rectangular wave is produced at the anode of V5A, beginning at $T_0 - 100\mu$s and ending about 30μs before the arrival of the next trigger from V2B. The short positive-going portion of this waveform is used to gate the suppressor-grid of V1 in readiness for passing the knock-off pulse.

134. The leading and trailing edges of the waveform at anode V5A are slowed down by partial integration by R58 and C21 as shown in the waveform diagram (fig. 32). This prevents the gate pulse on the suppressor of V1 from cutting off V1 before the knock-off pulse on the control grid is complete. The gate pulse is d.c.-restored by V6B so that the polarity of the input to the suppressor grid of V1 is negative with respect to earth for the whole of the suppression period.

135. Before the arrival of the knock-off pulse at the control grid of V1, the valve is conducting at a low level because of the positive gate pulse on the suppressor grid. The knock-off pulse is thus amplified, and the potential at the anode of V1 falls by about 200V in 0·25μs. Diode V6A has its anode biased by RV8, the FINE REP control. When the potential at the cathode of V6A falls below that at the anode, the remainder of the fall at V1 anode is passed to the grid of V2A as a trigger pulse. Thus a controllable delay of the order of 0·1μs is introduced between the arrival of the knock-off pulse and the next triggering of the multivibrator.

136. A small resistor R65 is inserted in the feed to the screen of V1 for monitoring purposes. The waveform across R65 displays at SKT12 at the relative timing between the knock-off pulse and gate (fig. 32).

Signal gate to limiting amplifier

137. Unless special precautions were taken, the knock-off pulse would arrive at V1 accompanied by noise injected into the delay channel by the receiver circuits. This noise could then cause p.r.f. jitter. This is prevented by suppressing IF amplifier Type S7/1 (fig. 35) during the time the knock-off pulse is due to arrive.

138. The gating waveform is obtained from knock-off gate multivibrator V5A and V5B, and has the same duration as the knock-off gate but is of opposite polarity, the negative portion suppressing IF amplifier Type S7/1 from about $T_0 - 130\mu$s until $T_0 - 100\mu$s. The bias line for IF amplifier Type S7/1 is obtained from cathode-follower V9 in signal comparator Type S2/2 (via full-wave rectifier MR1. The purpose of this diode is to prevent positive bias being applied to the grid bias line of IF amplifier Type S7/1. Because of the delay in rise time introduced by this rectifier in the grid circuits of IF amplifier Type S7/1 the suppression pulse remains for approximately 30μs after $T_0 - 100\mu$s, and thus receiver noise does not accompany the knock-off pulse. The pulse is tapped off the anode load of V5B and passed via C16 to cathode-follower V9. At the grid of V9 it is d.c.-restored by V8B to a level determined by RV11, the LIMIT AMP GAIN control.

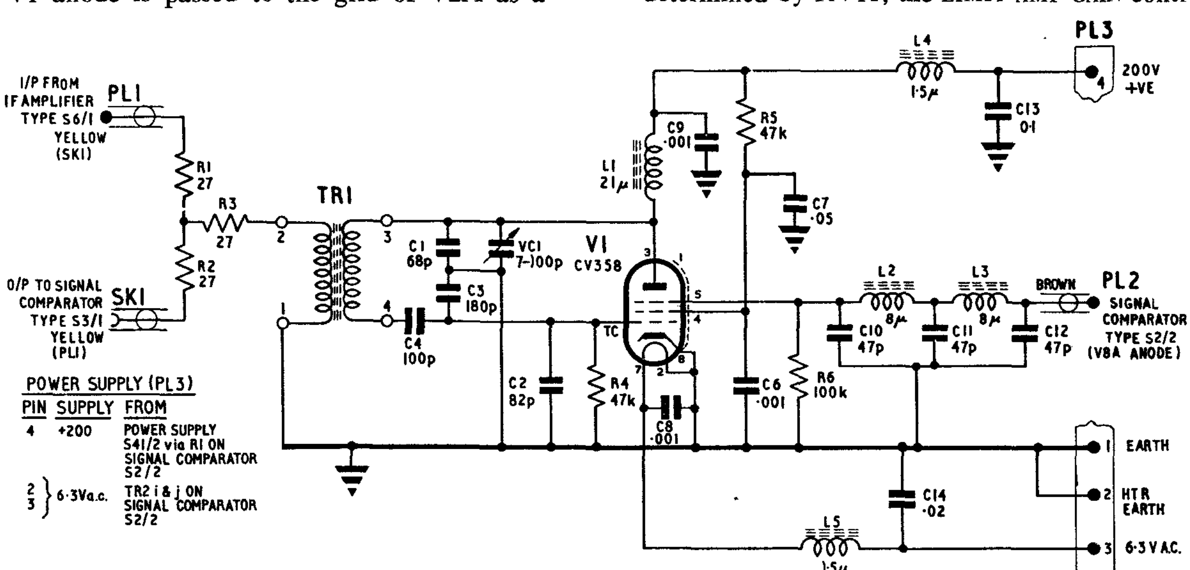

Fig. 33. R.F. oscillator Type S5/1: circuit

Coho gate

139. Part of the waveform generated by the main multivibrator circuit is used to derive the gating waveform which is applied to the suppressor grid of the RF oscillator Type S8/1 (coho) valve (fig. 33). This waveform, the width of which is adjustable by means of RV9 (COHO GATE WIDTH) gates the coho oscillator off at $T_0 - 100\mu s$, and on again approximately 1 μs after T_0. The gate pulse is negative-going and is developed across R41. The operation of the coho oscillator is thus timed by RV9. Diode V8A is a d.c. restorer and returns the suppressor grid of the coho valve to earth at the end of the suppressor gating pulse. Thus the coho can continue to oscillate until the arrival of the next m.t.i. trigger pulse at $T_0 - 100\mu s$.

Phase comparison circuits

140. The phase comparison circuits comprise four sub-units mounted on the mains signal comparator Type S2/2 chassis. These are:—

IF amplifier Type S6/1 (fig. 34).
IF amplifier Type S7/1 (fig. 35).
RF oscillator Type S8/1 (fig. 33).
Signal comparator Type S3/1 (fig. 36).
60μs quartz test delay line.

An analysis is given in Appendix 1 showing that the phase relationship is preserved between the transmitted pulse and the signal received from a target, when that signal is mixed with the output of the stabilized local oscillator operating at a different frequency.

141. With reference to fig. 37, two inputs are received from the signal and coho head amplifiers; one is a sample of the transmitted pulse, and the other contains echo signals, both converted to an i.f. of 30 Mc/s. The sample of the transmitted pulse is used to lock the phase of the coho oscillator which provides the reference oscillation for signal comparator Type S3/1 (phase sensitive detector, fig. 36). Echo signal voltages are amplitude-limited and also passed to signal comparator Type S3/1.

142. At the time of arrival of the sample locking pulse, the coho oscillator is prevented from operating until the gating pulse arrives from the pulse generator. The sample locking pulse now excites the tuned circuit, allowing the oscillation to be built up in phase with the locking pulse and to continue for the repetition period. This phase reference oscillation is passed to signal comparator Type S3/1.

143. There are two reasons for locking the coho oscillator at each transmitter pulse. Firstly, it is necessary to establish a fresh reference phase at each pulse because the magnetron does not perform in exactly the same manner during each pulse. Even if it did, unless the p.r.f. where a whole sub-multiple of the stalo frequency, there would always be a change in the i.f. phase from pulse to pulse. The stalo, to which the sample of the transmitter pulse is referred, is the primary reference of the system. Secondly, relocking the coho oscillator prevents frequency drift in the oscillator becoming cumulative, which would be so with a continuous oscillation source.

IF amplifier Type S7/1 (fig. 35)

144. Signals of constant amplitude must be applied to signal comparator Type S3/1 to ensure that its output varies as a result of phase changes only. IF amplifier Type S7/1 provides the necessary limiting. The input to the grid of V1 is tuned by T6 and the signal developed across the primary of T1 in the anode circuit of V2 is coupled to V3 (V2 may be ignored for the moment). The signal is passed on to further amplifying stages associated with V3, V4, V5 and V6. The screens of all valves are at a higher potential than the anodes. The output is fed from SKT1 to PL3 on signal comparator Type S3/1.

145. The overall gain of the unit is adjusted by RV11, the LIMIT AMP GAIN control in signal comparator Type S2/2 (fig. 30). This control sets the level of the signal gating waveform from the cathode of V9 in the m.t.i. pulse generator section and hence the grid-cathode potential for V3, V4, V5 and V6.

146. Valve V2 is provided to enable an artificial signal derived from the coho locking pulse to be injected in place of normal echo signals. This is useful when the equipment is being set up as it enables the adjustment of the phase comparison circuits to be made independent of aerial position. The amplified locking pulse is brought from IF amplifier Type S6/1 via a 60μs quartz delay line. A NORMAL/TEST switch, SW2, on signal comparator Type S2/2 is used to suppress amplification of echo signals when the test pulse is in use.

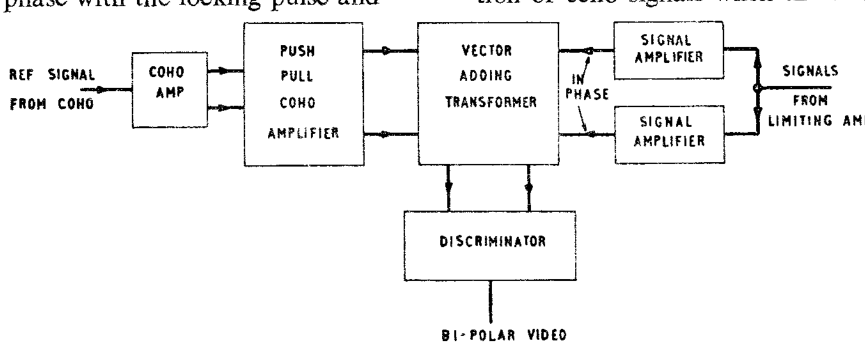

Fig. 37. Block schematic of phase comparison system

The grid of V1 connected to a potential divider chain R12 and R13 on the chassis of the signal comparator Type S2/2. In the NORMAL position of the switch, R12 is shorted out so that the grid of V1 is returned to earth. When the test conditions are required, the short across R12 is removed and a negative bias of 15V is applied to the grid of V1, cutting off the valve current.

IF amplifier Type S6/1

147. The IF amplifier Type S6/1 (fig. 34) receives the 30 Mc/s sample of the transmitted pulse from the coho head amplifier and provides an output which locks the phase of the coho oscillator. The input is taken from SKT1 of the coho head amplifier to PL2 (yellow) on the signal comparator Type S2/2 and then via a link to PL1 of the IF amplifier Type S6/1.

148. The main amplifier comprises V1 and V2, which together have a bandwidth of 4 Mc/s. It provides the locking pulse to the RF oscillator Type S5/1 (coho oscillator) via SKT1. Valves V1, V3 and V4 provide a similar pulse, but of greater amplitude, to the test delay line. The greater amplitude is necessary to compensate for the attenuation in the delay line. Bias to V2 is adjusted by RV1, the LOCK BIAS control in the signal comparator Type S2/2 and this controls the gain of the main amplifier. The output from the anode of V2 is passed from SKT1 to PL1 on the RF oscillator Type S5/1.

149. A second output from V1 is fed from TR1 to the amplifiers, V3 and V4. The output of V4 at SKT2 provides the test output pulse to the 60μs delay line. When the switch SW2 is in the TEST position, pole 6 of the supply socket of the locking amplifier is earthed, removing the —ve 15V bias and allowing V3 to conduct. At the same time V1 of the limiting amplifier is cut off.

RF oscillator Type S5/1

150. The RF oscillator Type S5/1 (fig. 33) consists of the coherent oscillator and associated circuitry. This oscillator is phase-locked by the 30 Mc/s sample of the transmitted pulse and maintains the phase for reference purposes during the remainder of each repetition period.

151. The circuit is a modified Colpitts oscillator, designed to give a highly stable output, and is not critical to valve capacitances. The tuned circuit consists of the secondary of TR1 with a capacitance comprising the series combination of C4, C2 and C3 in parallel, C1 and VC1 in parallel. Tuning is effected by VC1.

152. The input capacitance of the valve is across C2 + C3 and is small compared with the sum of their capacitances. Thus, any change in valve capacitance will have a negligible effect on the tuned circuit. Similarly, the anode-cathode capacitance of the valve is in parallel with C1 and VC1, and is also small by comparison. A low-microphony pentode is used as V1 and the overall frequency stability of the oscillator is one part in 10^6 per degree Centrigrade.

153. The negative-going rectangular wave from the pulse generator SKT4 in the signal comparator Type S2/2 is fed to PL2 on the coho oscillator and is then applied to the suppressor-grid of V1 through the low-pass filter C12, L3, C11, L2, C10. This input prevents the valve oscillating between $T_0 - 100\mu s$ and T_0. The low-pass filter assists in reducing the rise time of the gating waveform and prevents shock-excitation of the oscillator, which would invalidate it as a phase reference.

154. At PL1 (yellow) a 30 Mc/s sample of the transmitted pulse is available at T_0 and sets up a low-level oscillation in the tuned circuit. For correct locking the COHO GATE WIDTH control is set so that the negative-going wave terminates, and the valve is switched on, approximately 1μs after the locking pulse has ended, when there is a decaying oscillation in the tuned circuit. The increasing amplification then causes the oscillation to be built up to a steady value that is maintained until the valve is again switched off at $T_0 - 100\mu s$. If the COHO TUNE and COHO GATE WIDTH controls are set correctly, this sustained oscillation will be in phase with the incoming lock pulse. The build-up of oscillation must be gradual since any sudden change of amplitude brings a change of phase and for this reason the trailing edge of the coho gate pulse is not too steep. The coho output is taken via SKT1 to the signal comparator Type S3/1.

Test delay line

155. The test delay line provides a rapid means of checking the performance of the m.t.i. system and is also a useful aid when the equipment is being set up. It is connected by coaxial leads between SKT2 on the IF amplifier Type S6/1 and PL2 on the IF amplifier Type S7/1. The amplified coho locking pulse is delayed 60 μs and passed by the limiting amplifier to the signal comparator Type S3/1. Amplification of echo signals is suppressed by the NORMAL/TEST switch SW2 in the signal comparator Type S2/2 when the test delay line is in use. This arrangement simulates a permanent echo on the display at a range of 5 miles. Successive reflections in the test delay line result in further attenuated pulses at 10-mile intervals from the first, that is, at 15, 25, 35 miles. The setting-up is best carried out with the first pulse.

Signal comparator Type S3/1

156. The signal comparator Type S3/1 (fig. 36) represents the phase sensitive detector. It compares the phase of the received signals with the coho reference oscillation and provides an output of signal pulses varying in amplitude and polarity in relation to the phase difference. The phase reference oscillation, which is maintained by the coho oscillator, is brought in via PL1 to the grid of V1, a pre-amplifier. In the anode of V1 the load is the primary of T1 and the centre-tapped secondary drives the balanced amplifier stage associated with V2 and V4, the anode loads being

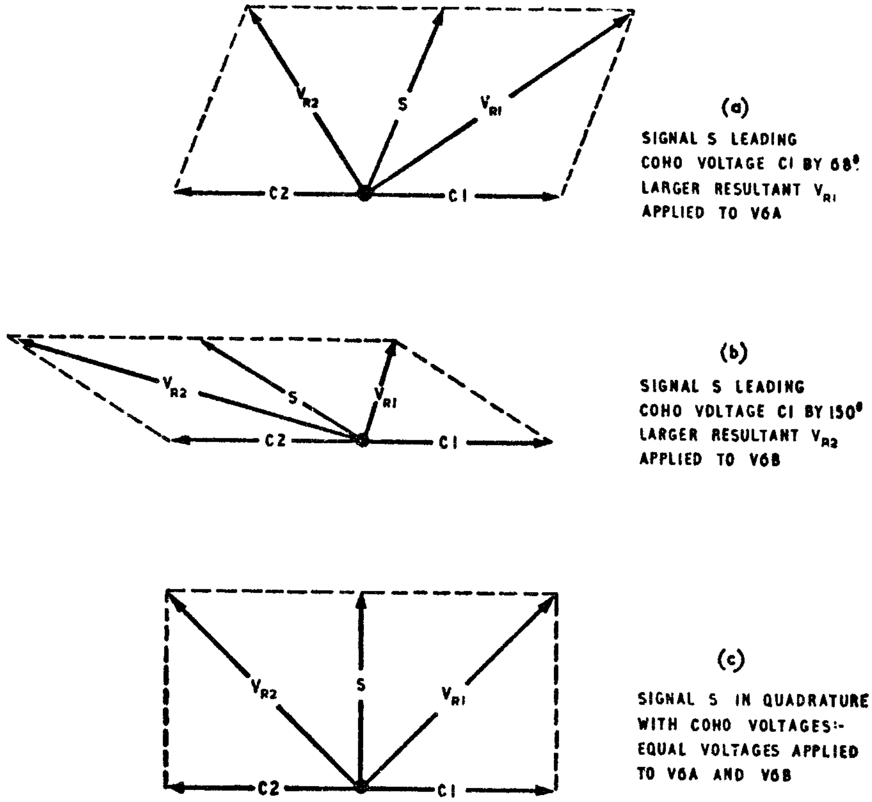

Fig. 38. Detector vector diagrams

T2 and T3 respectively both tuned to 30 Mc/s. The signal input from the IF amplifier Type S7/1 is applied to a similar stage associated with V3 and V5 also operating with T2 and T3 as anode loads and the combination therefore operates as an additive mixer.

157. In this way the primaries of T2 and T3 receive the anti-phase reference signal and the in-phase radar signals. The resultant voltages applied to the anodes of V6A and V6B will depend on the relative phase of the two signals. Three examples are illustrated in fig. 38. At (a) the larger voltage is applied to V6A so that a positive signal will be developed across R16. In (b) the reverse condition is shown, with V6B receiving the larger resultant, producing a negative signal across R16.

158. When the target signal is in quadrature with the reference signal as shown at (c) there will be no output. This does not prevent a moving target indication on the display because the echo from the next transmitted pulse has not the same phase relationship with the reference signal and therefore gives an output from the signal comparator Type S3/1.

159. The conditions for optimum sensitivity are as follows:—

(1) the signal voltages applied to the primaries of T2 and T3 must be equal.

(2) the reference voltages applied to T2 and T3 must be equal.

(3) the signal and reference voltages should be equal.

Thus the gains of V2 and V4 must be equal, and also the gains of V3 and V5 must be equal. The screen grids of V2 and V4 are fed from ganged potentiometers, RV3 and RV4, COHO GAIN, in the signal comparator Type S2/2. The COHO BALANCE control RV2, also in the signal comparator Type S2/2, varies the ratio of the voltages applied to RV3 and RV4 to compensate for any difference in the characteristics of V2 and V4.

160. The signal amplifiers V3 and V5 are fed from a similar circuit, the SIG.BAL. control RV5 feeding ganged potentiometers RV6 and RV7, SIGNAL GAIN. The two pairs of ganged potentiometers are used to equalize the amplitudes of the reference and signal voltages. The video output of the signal comparator Type S3/1 is amplified by V7 and passed to the cathode-follower V8. From SKT4, the output is taken to the amplifier-modulator Type S4/2 in the M.T.I. group Type S1/2.

161. Monitoring points for use when setting up the equipment are provided at SKT1, SKT2, and SKT3. Provision is made for p.d. across resistors at strategic points in the circuit to be measured. These are connected to the meter jack SKT17 by SW1.

M.T.I. group Type S1/2 (*fig.* 39)

162. The M.T.I. group Type S1/2 (m.t.i. cancellation unit) receives the video output of the signal comparator Type S2/2 and compares successive echo signals from the same target, passing a resultant video signal from a cancellation point to the viewing unit. It also receives the trigger output at T_0 $-100\mu s$ from the pulse generator circuit in the signal comparator Type S2/2 and returns the knock-off pulse to that circuit.

163. The unit contains the following sub-assemblies:—

RF oscillator Type S3/1 (fig. 40)
Amplifier-modulator Type S4/2 (fig. 41)
RF amplifier Type S12/2 (fig. 42)
RF amplifier Type S5/1 (fig. 43)
Cancellation circuit and a.g.c. amplifier
Quartz delay line

The unit has its own heater supply transformers, T1 and T2, but the h.t. and bias supplies are obtained from the common m.t.i. power supply (power supply Type S41/2).

164. Video output pulses from V6 in the signal comparator Type S2/2 are fed to the M.T.I. Group Type S1/2 to modulate a 20 Mc/s carrier in the amplifier-modulator Type S4/2. The output of the amplifier-modulator divides to the delayed and undelayed channels and is then applied to the cancellation point.

RF oscillator Type S3/1

165. The oscillator valve V1 operates in a modified Colpitts circuit, which is arranged so that the valve capacitances have little effect on the constants for the resonant circuit. The oscillator is screened from the remainder of the M.T.I. group Type S1/2. The h.t. supply is decoupled by C1 and the heater of V1 is decoupled by the inductor-capacitor network C3, L1 and C4. The output at 20 Mc/s is taken via SKT1 to the amplifier-modulator Type S4/2.

Amplifier-modulator Type S4/2

166. The output of the 20 Mc/s oscillator is amplified by V1. This valve acts as a buffer and its gain is controlled by a bias voltage obtained by adjusting RV4, the CARRIER LEVEL control.

167. In the anode load of V1 is a damped resonant circuit, tuned to 20 Mc/s, and capacitor coupling (C5) is used to the third grid of V2, the signal modulator valve. The first grid of V2 receives two inputs, (1) the signals from SKT4 of the signal comparator Type S3/1 fed to PL3, and (2) the positive-going prepulse at T_0 $-100\mu s$ from SKT10 or SKT11 on the pulse generator. These inputs modulate the 20 Mc/s carrier. The modulated carrier is fed from the secondary of T1 to the amplifier stage associated with V3. A coupling winding on T1 in conjunction with VC1 forms a neutralizing feedback path for V2.

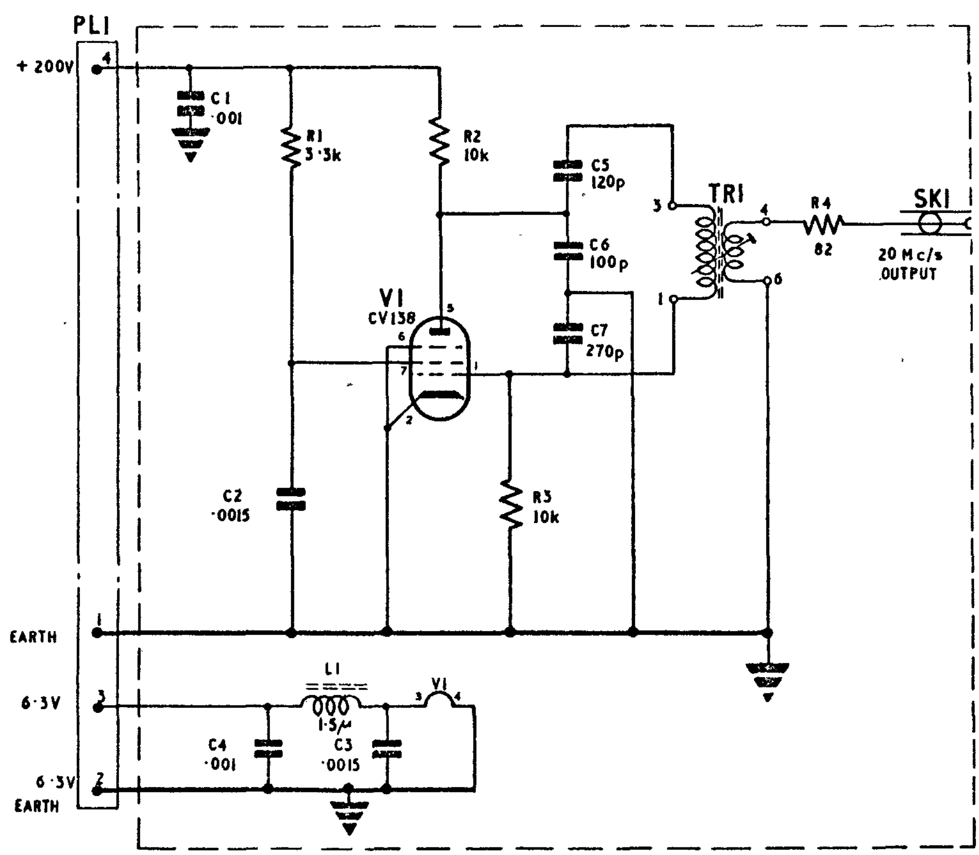

Fig. 40. R.F. oscillator Type S3/1: circuit

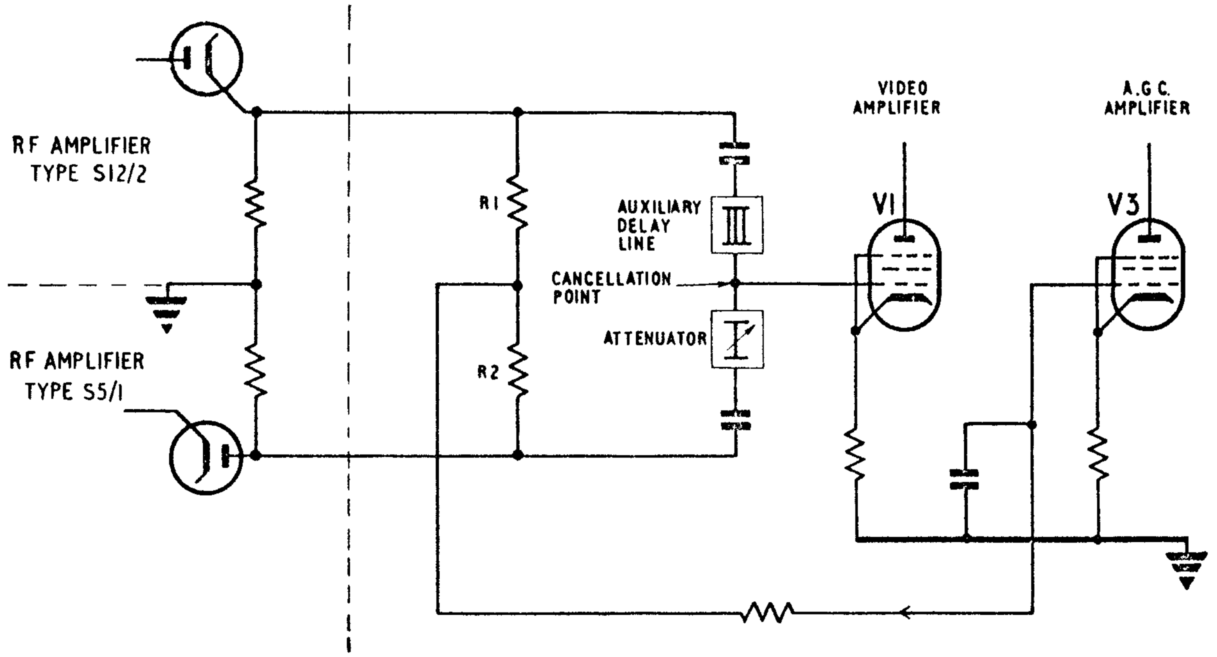

Fig. 44. Simplified cancellation circuit

168. Transformer T2, fed from V3, has a centre-tapped secondary which feeds V4 and V5, a push-pull amplifier stage. The anodes of V4 and V5 feed the output transformer T3, which has two secondary windings giving outputs to the delayed and undelayed channels. Bias for V4 and V5 is provided from a divider network R17, with R57 on the M.T.I. group Type S1/2 chassis, across the −ve 150V supply. The intermediate tuned stages, T1 and T2 are staggered above and below 20 Mc/s to give a wide response from the amplifier.

169. Diode V6 is included, with the filter circuit C24, L6, C25, L7, L8, C27, to provide an oscilloscope monitoring point for the drive input to the delay line. The output across the voltage sampling resistor R21 is used to measure the level of the 20 Mc/s carrier applied to the delay line, when the meter selector switch is in position 11.

170. The amplifier-modulator operates about a mean carrier level. Positive signal pulses increase the carrier amplitude—negative pulses decrease it. It thus has the appearance of a c.w. carrier amplitude modulated alternately by positive and negative pips.

Quartz delay line

171. The delay line used in the operation of the m.t.i. system is a quartz line in the shape of an irregular polygon. A fixed delay is derived from the line and is of 1425μs duration. Connection to the amplifier-modulator and RF amplifier Type S12/2 is made by coaxial cable.

RF amplifier Type S12/2

172. The RF amplifier employs six stages, staggered tuning being used throughout to obtain the necessary bandwidth. The damping resistors R3, R6, R10, R17 and R20 are included to flatten the response of the individual tuned circuits. Valves V2, V3, V4 are controlled by the a.g.c. voltage taken via pole 5 of PL2. Valves V1 to V4 have biasing resistors which are not decoupled. These minimize input impedance changes with changes of a.g.c. voltage.

173. The signal output at the secondary of T6 is fed to one of the diodes of the double-diode V7 the second diode not being in use. This gives a positive-going output. From the diode load, R24, the demodulated signal is passed via L16 and C29 to the grids of V8, a double-triode. This valve is cathode coupled to SKT2 where it provides the knock-off pulse for the main multivibrator circuit in the signal comparator Type S2/2. From SKT9 on the signal comparator Type S2/2 chassis this pulse is fed to PL7 on the pulse generator (fig. 30). A video output at SKT1 on the RF amplifier Type 12/2 feeds a delayed input, via PL9 of the main chassis, to the M.T.I. group Type S1/2 cancellation circuit (para. 176).

RF amplifier Type S5/1

174. This sub-unit consists of V1, operating as an amplifier, followed by a detector V2, one half of double diode. The incoming undelayed signal is taken from SKT1 on the amplifier-modulator to one of the sections of the attenuator network (PL1-5) preceding the grid of V1. The degree of attenuation is determined when setting up the m.t.i. cancellation unit and is chosen to pre-set the level of the output of V2.

175. The tuned circuit T1, damped by R10, is set to 20 Mc/s. From the secondary of T1 an undelayed video output is fed to the cathode of the detector and the rectified negative-going output is taken from SKT1 to the cancellation circuit. The connection, via the filter L8, L9, C17-19, to the PL6/8, is provided for measuring diode current when tuning and setting up the equipment.

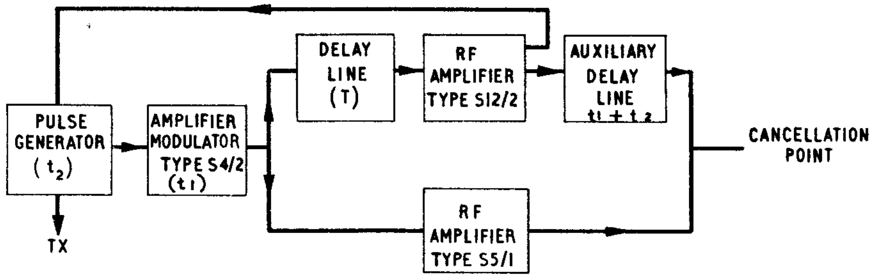

Fig. 45. Delayed and undelayed channels and lock-round circuit block diagram

Cancellation circuit

176. This section of the M.T.I. group Type S1/2 consists of a bridge comparison circuit, a simpified diagram of which is shown at fig. 44. One arm of the bridge consists of the delay line DL1, fed from the RF amplifier Type S12/2 via SKT1, PL9 and C3, and this arm carries the delayed video pulses. Another arm consists of a pre-set resistive attenuator, which carries the undelayed video pulse output, via SKT1, PL10, C4 from the RF amplifier Type S5/1. The other two arms of the bridge comprise R1 and R2, shunted by the equal diode loads in the RF amplifier Type S12/2 and the RF amplifier Type S5/1. The junction of the diode loads is earthed. Although the junction of R1 and R2 is not earthed, it is held at zero potential by the a.g.c. circuits when the system has been balanced.

177. The grid and the cathode of V1 are connected across the junction of the arms of the bridge and earth. Any difference in the two video pulse input levels, results in a signal voltage across the bridge and hence at the grid of V1. Ideally, the two inputs are of equal amplitude for permanent echoes and, being of opposite polarity, cancellation takes place at the grid of V1. However for moving objects, the bridge inputs are unequal and moving target indications are passed to the video amplifier.

178. Cancellation of permanent echoes takes place if the delayed pulse representing a particular object arrives at the cancellation point at precisely the same time as the undelayed pulse from the same object resulting from the next transmitter pulse. The system p.r.f. and the relative timing of delayed and undelayed signals are not determined by the delay of the quartz delay line alone, but are affected by minor delays in various parts of the lock-round circuit. The block schemative diagram of fig. 45 shows the lock-round and cancellation system. The symbols under the unit names denote the delays to be considered. It is convenient for simplicity to consider the T_o $-100\mu s$ output from the pulse generator as a signal passing through both channels since the intervals between these pulses will be the same as those between successive transmitter pulses and between successive echoes following transmitter pulses. These time intervals are shown in fig. 46.

179. A pulse (number 0) from the pulse generator is fed to the amplifier-modulator Type S4/2, but before reaching the delay line (fig. 46B) it undergoes a small delay t_1 and emergies from the RF amplifier Type S12/2 after a further major delay T, as in waveform (fig. 46C). The drive to the delay line is also the undelayed input to the RF amplifier Type S5/1. There is no significant difference between the delays in the RF amplifier Type S12/2 and the RF amplifier Type S5/1. The delayed output from the RF amplifier Type S12/2, fed back to the pulse generator, produces a second pulse (number 1) after a short delay to t_2 in the gated knock-off amplifier. The interval between any two pulses from the pulse generator is thus $t_1 + T + t_2$.

180. The second pulse is again delayed by t_1 before being applied to the RF amplifier Type S5/1. This pulse therefore emergies from the RF amplifier Type S5/1 $t_1 + t_2$ after pulse number 0 emerges from the RF amplifier Type S12/2. The same argument applies to all successive pairs of undelayed and delayed pulses. Before being applied to the cancellation point, the output from

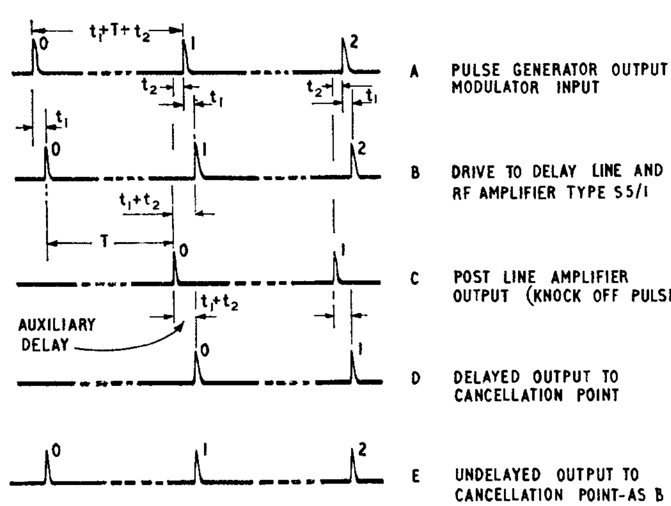

Fig. 46. Delayed and undelayed pulse timing waveforms

the RF amplifier Type S12/2 must, therefore, be delayed by $t_1 + t_2$ (fig. 46 D). This is the function of the auxiliary delay line.

181. The delay t_1 in the amplifier-modulator is approximately 0·25μs and the knock-off circuit delay t_2 is about 0·1μs. The delay required in the auxiliary line is thus about 0·35μs. Exact coincidence of delayed and undelayed signals is brought about by using the FINE REP control (RV8) on the signal comparator Type S2/2. This control varies the knock-off circuit delay t_2.

182. The output from the cancellation bridge, consisting of moving target signals, is fed to the video-signal amplifier V1. This valve feeds its output to the phase splitter V2A. A positive pulse at the grid of this valve produces a positive pulse at the cathode and a negative pulse at the anode, while a negative pulse at the grid produces a pair of pulses having polarities the reverse of those given above. These pulses are applied to the bridge rectifier circuit MR1-MR4, which passes on only positive pulses to the grid of the cathode follower V2B, where they are d.c. restored by the diode MR5. The output is fed via SKT11 to the azimuth range indicator Type S6/4 (Chap. 5 of this Section), and to SKT12 the monitoring point on the front panel.

Automatic gain control

183. The a.g.c. circuit develops the control bias for the RF amplifier Type S12/2. If the output of either the delayed or the undelayed channel changes, due for example, to temperature variations, the mean potential at the junction of R1 and R2 will change also. The polarity of this potential will be dependent upon the channel with the greater output.

184. The a.g.c. circuit is a d.c. amplifier which restores the balance of the output of the two channels for permanent echoes only. It does this by ensuring that the mean carrier levels in the outputs of the RF amplifier Type 12/2 and the RF amplifier Type S5/1 are the same. Currents through R1 and R2 are the d.c. components of the mean c.w. input at 20 Mc/s to the detectors in the two RF amplifiers. Under balanced output conditions, the junction of R1 and R2 is at earth potential. If the gain of the RF amplifier Type S12/2 increases, its mean output also increases and the junction becomes positive. This potential change is applied via R41 to the grid of V3. The resultant amplified negative-going voltage at the anode is passed to the grid of V5, a cathode-follower. The output of V5 is used as the gain control voltage for the RF amplifier Type S12/2.

185. A long time-constant integrator, R41 and C7, is used in the input circuit to V3 and avoids instantaneous gain changes resulting from the pulse component of the voltage applied to R1 and R2. Negative feedback from V5 to V3 takes place through R19 and gives linearity of d.c. control. The clamping diode V4 is included to ensure that the cathode of V5 does not become more positive than −1V w.r.t. earth because it would then take the control grids of the RF amplifier Type S12/2 into the positive-grid region.

186. The standing bias to the RF amplifier Type S12/2 is pre-set by RV3, the A.G.C. LEVEL control. This pre-set control is necessary for balancing the diode current inputs to R1 and R2. When the switch SW2 is moved from AUTO to MANUAL, RV2, the MANUAL GAIN control, adjusts the gain for the RF amplifier S12/2 and is used for servicing.

Power supplies

187. The power supplies for the individual units are provided by four units. These are as follows:—

Power supply Type S41/2 (fig. 47)
Power supply Type S41/1 (fig. 47)
Power supply Type S21/1 (fig. 48)
Power supply Type S17/1 (fig. 49)

Two of these power units, power supply Type S41/1 and power supply Type S41/2 are electrically identical.

Power supplies Type S41/1 and Type S41/2

188. Power supply Type S41/1 provides the power supplies for the transmitter and the power supply Type S41/2 the power for the m.t.i. units. Both units provide the following supplies:—

▸ −150V ◂stabilized, reference and bias voltage
+200V stabilized
+330V Stabilized
+470V unstabilized
−800V TR cell keep alive voltage

189. The +470V unstabilized supply is derived from a bridge rectifier consisting of four silicon diodes MR1-4. This supply is smoothed by the capacitor input filter C10, R5, C11 and R6. The +330V stabilized supply is fed from this line. It is stabilized by the series stabilizer valve V5 in association with V6. The potential divider chain R33, R34, RV2 and R35 connected between the +330V at the output of V5 and the −150V reference line, feeds the grids of the double triode V6. The two sections of the double triode form a two stage d.c. amplifier connected in cascade to produce a high loop gain around the circuit. Any tendency for the output voltage to change because of variations in load or supply voltage is offset by amplified and inverted changes applied to the grid of the series valve V5. If the load current increases for example the output voltage tends to fall because of the high impedance of the transformers in association with the rectifiers. The voltages at the grid of V6A and V6B thus become more negative. An amplified positive change appears at the anode of V6A and the cathode of V6B, the positive rise of the cathode assisting the negative fall at the grid of V6B, the current through V6B is reduced and this results in a much larger positive voltage change at the anode of V6B and the grid of the series valve V5. The impedance of V5 is thus reduced and this enables the valve to pass the increased load current with a smaller anode to cathode voltage available. The high loop gain of the stabilizer circuit results in the change of output voltage being extremely small. The effect of capacitor C15 is to by-pass the upper part of the resistance divider chain and by applying the

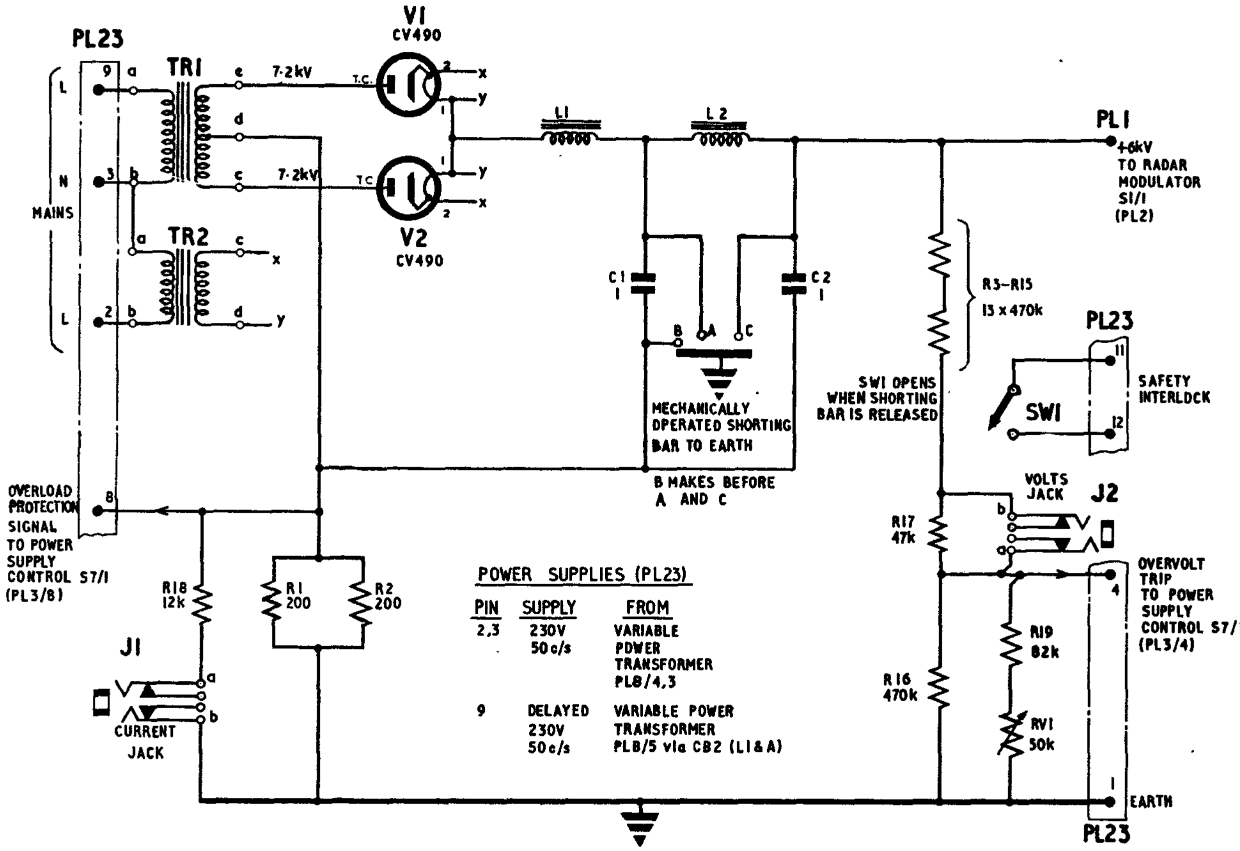

Fig. 48. Power supply Type S21/1 circuit

whole of the ripple voltage present in the output to the grid of V6A increases the a.c. loop gain. The preset RV2 enables the level of the +330V to be set.

190. The +200V supply is stabilized in a similar manner to the +330V line but three valves connected in parallel are used in the series valve circuit because of the increased load current on this circuit. The grids of the d.c. amplifier valves V4A and V4B are fed from the potential divider chain R23, RV1 and R24 with C13 used to by-pass the upper part of the chain to increase the a.c. loop gain. This voltage can be set by means of RV1.

191. The +800V keep-alive voltage for the TR cell in the waveguide run is from the 640V winding on the transformer T1. Rectification is provided by three silicon diodes MR9, MR10 and MR11 in series. Smoothing of this voltage is provided by C8, R3, R4, R2 and C9. The voltage drop across R2 is small because the anode current is low in this instance.

192. A separate transformer, T2, is used to provide the −150V supply. Rectification of the output of the secondary winding is provided by bridge rectifier MR12, MR13, MR14 and MR15. The output is smoothed by capacitor input filter C18 and R16. This supply is stabilized in a similar manner to the + 330V line, and, in addition, a voltage reference valve V9 maintains a stabilized voltage at the cathode of V8A.

193. Monitor points are provided for all the output voltages with the exception of −800V. In addition the voltages at various points in the circuit can be measured at jack JK1. Connections are made to the jack by means of selector switch SW1.

Power supply Type S21/1

194. Power supply Type S21/1 provides the e.h.t. voltage for the transmitter. The two diode valves V1 and V3 form a full-wave rectifier fed by the centre tapped transformer T1. The output is smoothed by the inductor input filter comprising L1, L2, C1 and C2. The voltage supplied to the transmitter is 6kV. A mechanically-operated shorting bar connects the high potential side of the two capacitors to earth to remove the charge. The excessive voltage which would be developed across R1 and R2 by the discharge current from the smoothing capacitors is prevented by contact B which short-circuits the resistors to earth before the mechanically-operated shorting bar operates. A chain of 470K resistors is connected between the e.h.t. voltage and earth to remove the charge from the capacitors when the unit has been switched off.

195. *Over-voltage protection.* If the units were brought into operation by using the variac (para. 203 *et seq.*) with no load on the e.h.t. supply, high e.h.t. voltage would be produced. Protection against these excessive voltages is therefore necessary so that smoothing capacitors of reasonable voltage rating can be used. This is achieved as follows. The p.d. across RV16, R19 and RV1 at the earth end of the e.h.t. bleed chain is applied to a relay in the power supply control via PL23/4. If a rise in e.h.t. voltage occurs, this relay removes the supply from the e.h.t. transformer. The SET O'VOLT TRIP control RV1 sets the voltage at which this trip operates. It is preset so that the trip will operate at 8kV.

196. *Magnetron heater switching and overload protection.* Resistors R1 and R2 connected in parallel in the e.h.t. lead produce a voltage proportional to the load current and hence to the mean magnetron current. This voltage is taken via PL23/8 to the control unit, where it is used for magnetron heater switching and for overload protection.

197. *Safety interlock.* Microswitch SW1 is one of the safety interlock switches in series with the e.h.t. contactor.

198. *Metering.* The p.d. developed across resistors R1 and R2 is taken to current metering jack JK1, and the p.d. across one of the e.h.t. bleed chain resistors, R17, is connected to VOLTS JACK JK2 to represent a measure of the e.h.t. voltage.

Power supply Type S17/1

199. Power supply Type S17/1 provides the power supplies for RF amplifier Type S13/1. These are as follows:—

+545V d.c. unstabilized.
+450V d.c. stabilized.
+300V d.c. stabilized.
+150V d.c. stabilized.

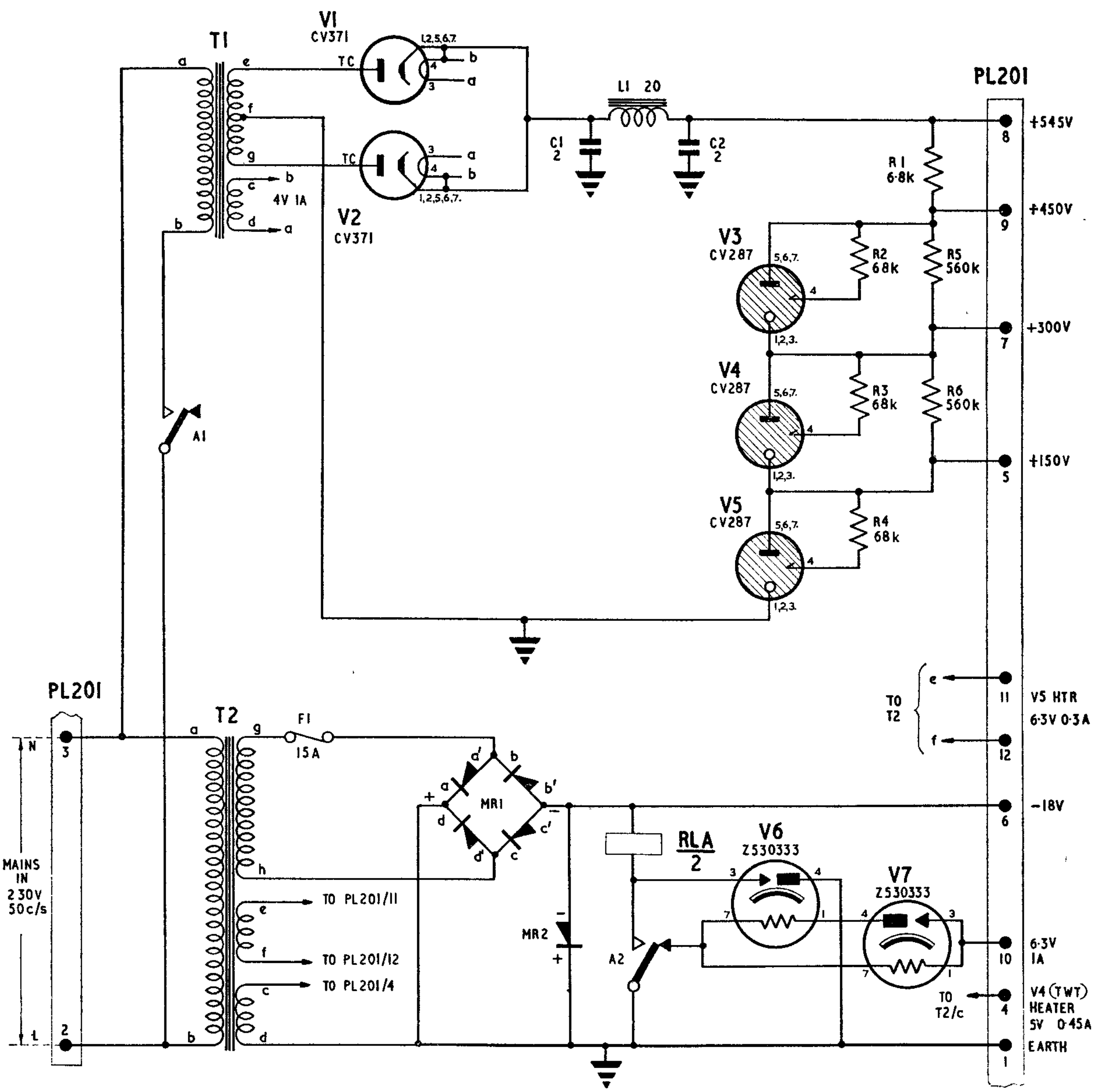

Fig. 49. Power supply Type S17/1: circuit

−18V d.c. for travelling wave tube solenoid.
5V a.c. for travelling wave tube heater.
6·3V a.c. for overload trip valve heater.

Positive d.c. supplies

200. The h.t. d.c. supplies are derived from full-wave rectifier V1 and V2 fed from the h.t. winding on transformer T1 with smoothing provided by capacitor input filter C1, L1 and C2. The unstabilized output is +545V. The +545V is also applied via R1 to the three 150V gas-filled voltage stabilizers in series (V3-V5) to provide stabilized supplies of +450V, +300V and +150V. Resistors R5 and R6, with R1, form a bleeder network across the smoothing filter to ensure that the capacitors are discharged when the unit is switched off and no external loads are connected. The supply to the primary winding of transformer T1 is fed via contact RLA1, which is part of the circuit employed to protect the travelling wave tube from failure of the focusing current.

Travelling wave tube solenoid supply

201. The travelling wave tube solenoid supply is fed from the g-h winding on transformer T2 rectified by bridge rectifier MR1 and provides −18V at about 10A. The additional rectifier-element MR2 across the d.c. terminals of the bridge is a quench diode to protect MR1 from back surges.

Delayed h.t. switching and interlock

202. It is essential that the positive h.t. supplies are not applied to the travelling wave tube until its heater has been switched on for at least one minute. The a.c. supply to transformer T1 is therefore fed through relay contact RLA1. The relay is controlled by two thermal delay switches V6 and V7 in cascade. A 6·3V a.c. supply is provided via RF amplifier Type S13/1, from the heater transformer on the T/R line assembly plug panel. It is applied directly to the heater of V7 and when the contacts of V7 close, the supply is then applied to the heater of V6. The contacts of V6 provide an earth return for relay RLA; contact RLA1 then switches the 230V a.c. to h.t. transformer T1. Contact RLA2 then breaks the supply to the heaters of the delay valves and also provides a direct earth for relay RLA.

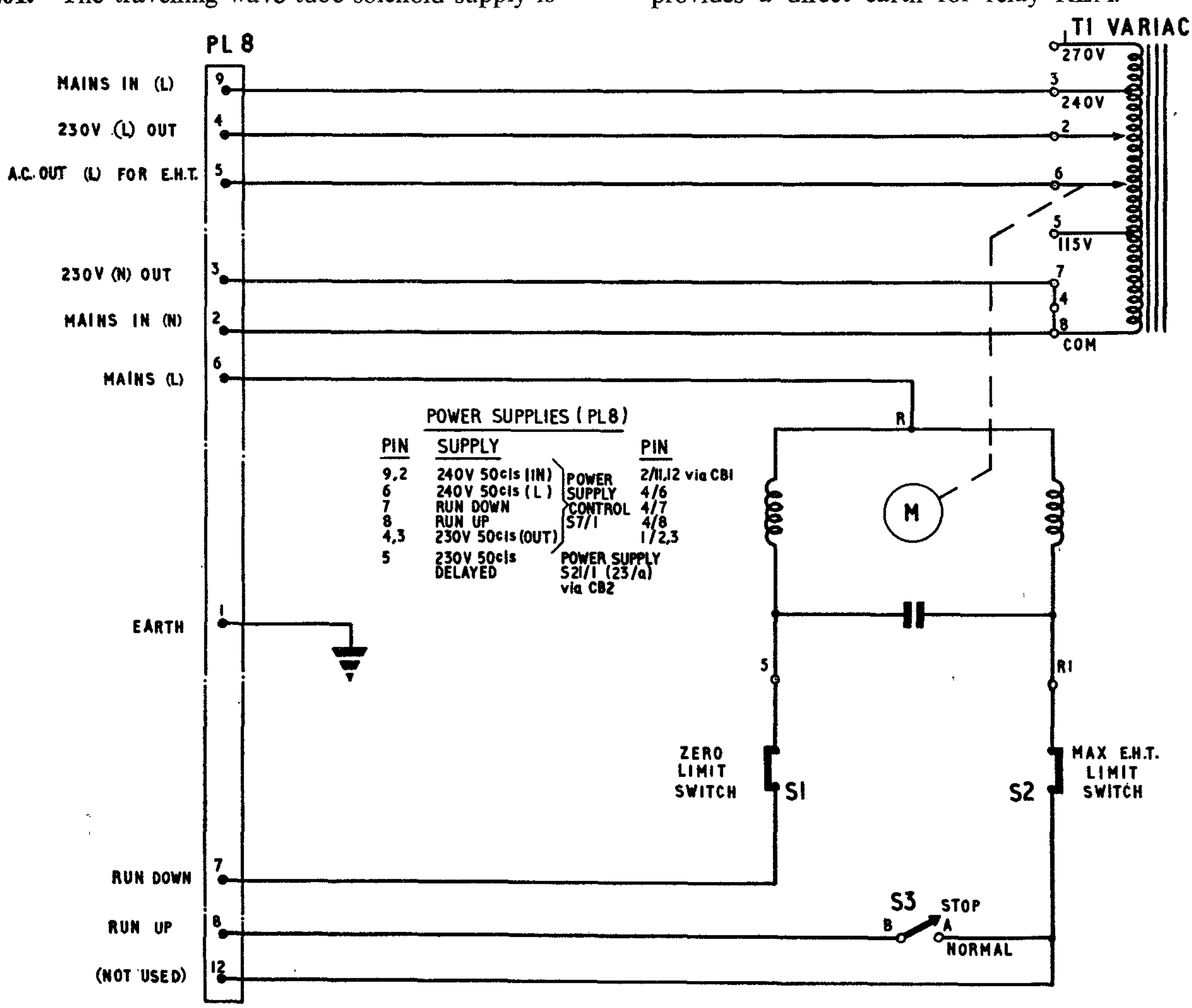

Fig. 50. Variable power transformer circuit

Ancillary equipment

Variable power transformer

203. The circuit diagram for the variable power transformer is shown in fig. 50. It comprises a variac, reversible induction motor and limit switches. The variac incorporates two sets of variable brush-gear. One brush is adjusted manually to provide an a.c. output of 230V. The second brush governs the run-up and run-down of the e.h.t. It is rotated by the motor via a step-down gear train and provides an output from zero to a preset maximum voltage. The drive motor is an induction type with two similar stator windings, a starting capacitor being connected between the windings. Each winding may be used either as the starting or main winding. The direction of rotation is thus determined by the terminal to which the supply is connected by means of relay contact RLB1 in the power supply control. The output is fed to the primary of the e.h.t. transformer. The input and main output voltages of the variac can be measured by meter M1 in the power supply control (para. 107).

204. A STOP/NORMAL switch SW3 is in series with the switched run-up supply from SKT4/8 on the power supply control. This enables the e.h.t. to be run-up to any intermediate voltage for the purpose of setting-up or testing the equipment.

205. Zero limit microswitch SW1 is adjusted during assembly to a position slightly in advance of the zero output voltage position to allow for a small overrun of the motor. This should not require further adjustment. Maximum e.h.t. limit switch SW2 is set to allow the e.h.t. to rise to a value that will give a magnetron current pulse of 35A.

Contactors

206. Two double-pole a.c.-operated contactors (fig. 29) are provided to switch the power supplies for the equipment. One of these is connected in the line and neutral leads to the variac, and functions as the main ON/OFF control. For local operation it is energized by the action of the contact breaker in the power supply control and, for remote operation by a switch on the remote control panel.

WARNING . . .

Servicing sockets, variac indicating lamps and cabinet heaters are still connected to the supply even when the contactor is de-energized.

207. The second contactor is connected as two single-pole switches. One pole is in series with the line supply from the variac to the e.h.t. transformer, and the other pole is in the line supplied to the magnetron blower motor. Thus when the contactor is energized, the supply is applied to the e.h.t. transformer and the magnetron blower motor simultaneously.

Blower motors

208. The two split-phase induction type motors are connected directly to the supply when the equipment is switched on. Capacitors of 6μF are fitted to each motor for both start and run power factor correction.

Variable attenuators Type S3/1 and S4/1

209. The circuit diagrams for variable attenuators Types S3/1 and S4/1 are shown in fig. 25 and 51 respectively. The output of the signal head amplifier has to feed the normal radar amplifier in the viewing unit and also IF amplifier Type S7/1 in the signal comparator Type S2/2. Since IF amplifier Type S7/1 is adjacent to the head amplifier and the remote viewing unit may be up to 4,000 yards away, much more attenuation is required in the feed to IF amplifier Type S7/1. The feed to both amplifiers is therefore taken via the attenuators (fig. 25). This enables the necessary matched signal splitting and the introduction of the appropriate amount of attenuation in each lead to be adjusted to between 0 and 40dB steps. This adjustment is made during installation and should not require to be subsequently adjusted. Further attenuation may be introduced by signal splitters in the transmitter junction box. The other attenuator (fig. 51) is incorporated in the radar T/R assembly for convenience. It is used in noise figure measurements.

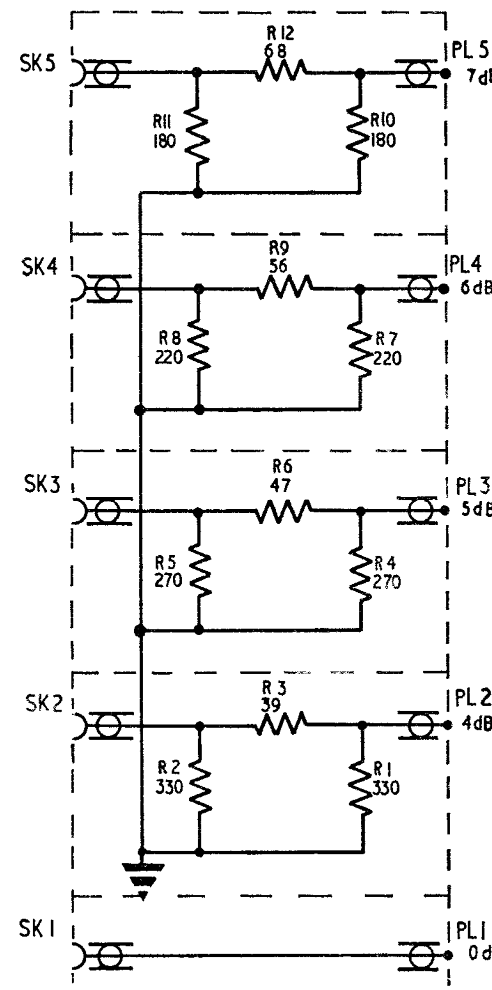

Fig. 51. Variable attenuator Type S4/1 (noise figure attenuator): circuit

Servicing sockets

210. The two three-pole 2A sockets provided for servicing are supplied via fuses FS1 and FS2, in the power supply control direct from the incoming mains supply. The sockets are therefore not affected by the variac and are available for servicing when the main contactor is switched off.

Safety switches

WARNING . . .

No attempt is to be made to by-pass any of the safety switches as this would expose personnel to the possibility of contact with lethal voltages.

211. The power supply Type S21/1 and the radar modulator Type S1/1 have safety switches fitted which cut off the e.h.t. voltages whenever the units are withdrawn from the rack. The grille cover for the radar modulator/valve unit compartment, and the centre panel of the cabinet actuate micro-switches when in position. Unless all these microswitches are actuated the e.h.t. cannot be applied.

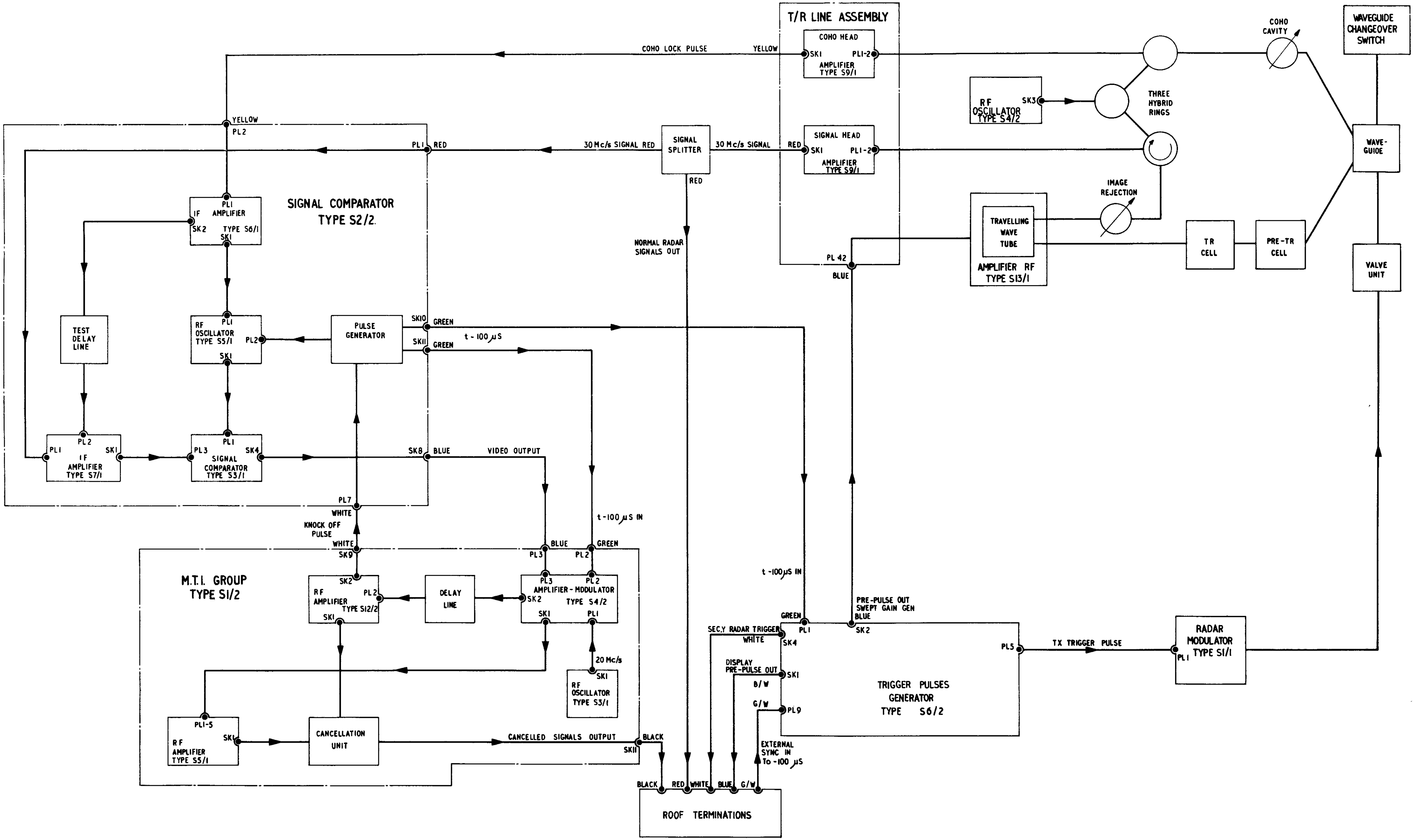

Fig.12 Radar T/R assembly Type S1/2 : block diagram Fig.12

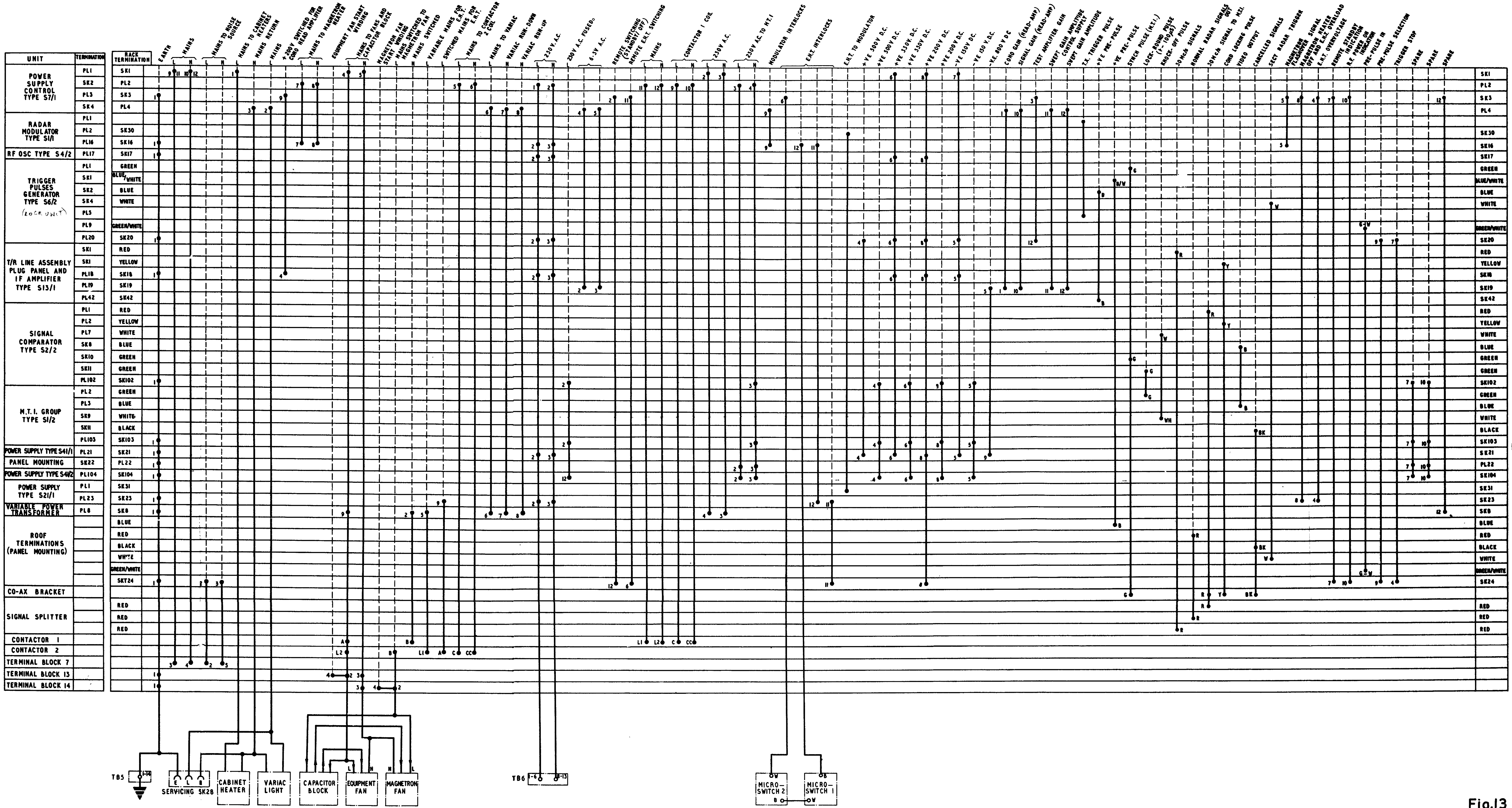

Fig.13

Radar T/R assembly Type S1/2 : interconnection diagram

Fig.13

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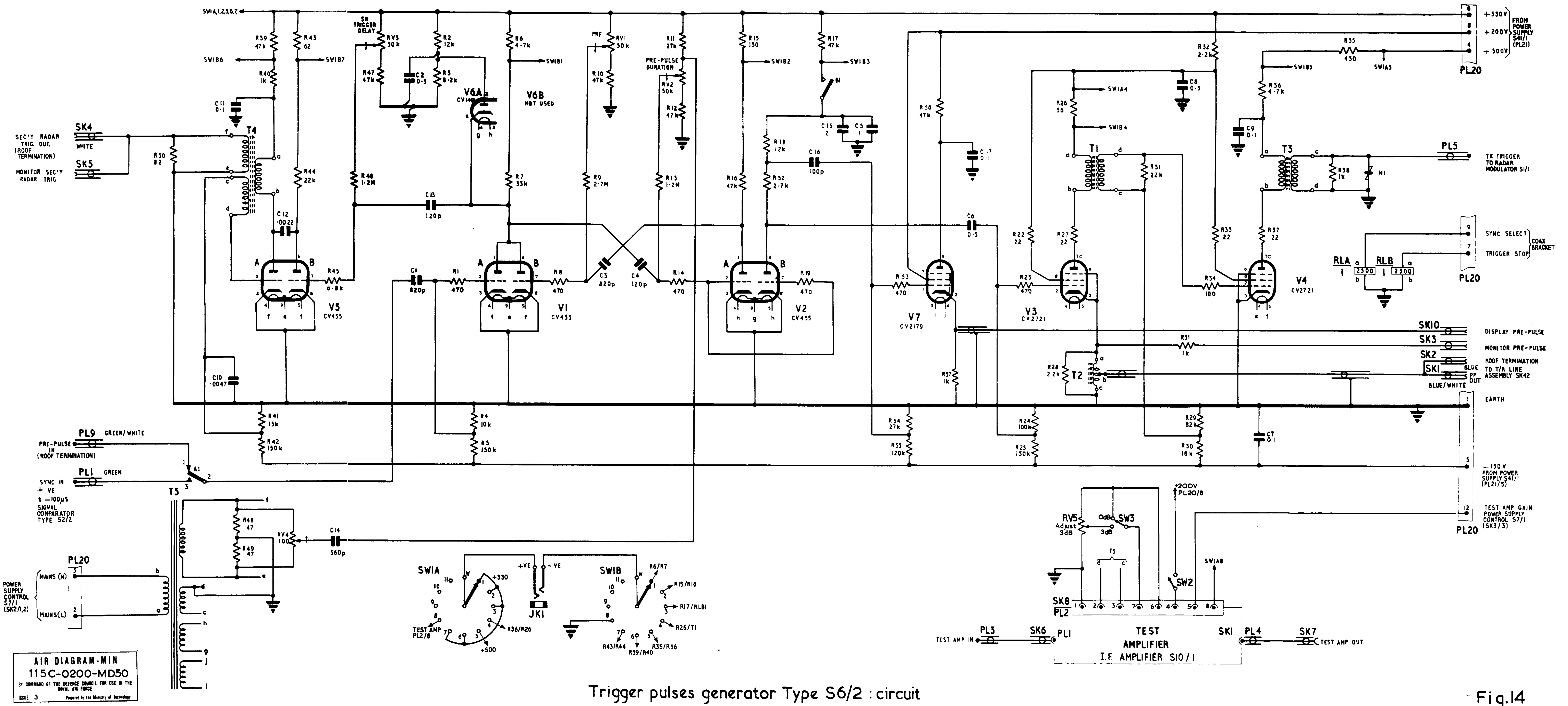

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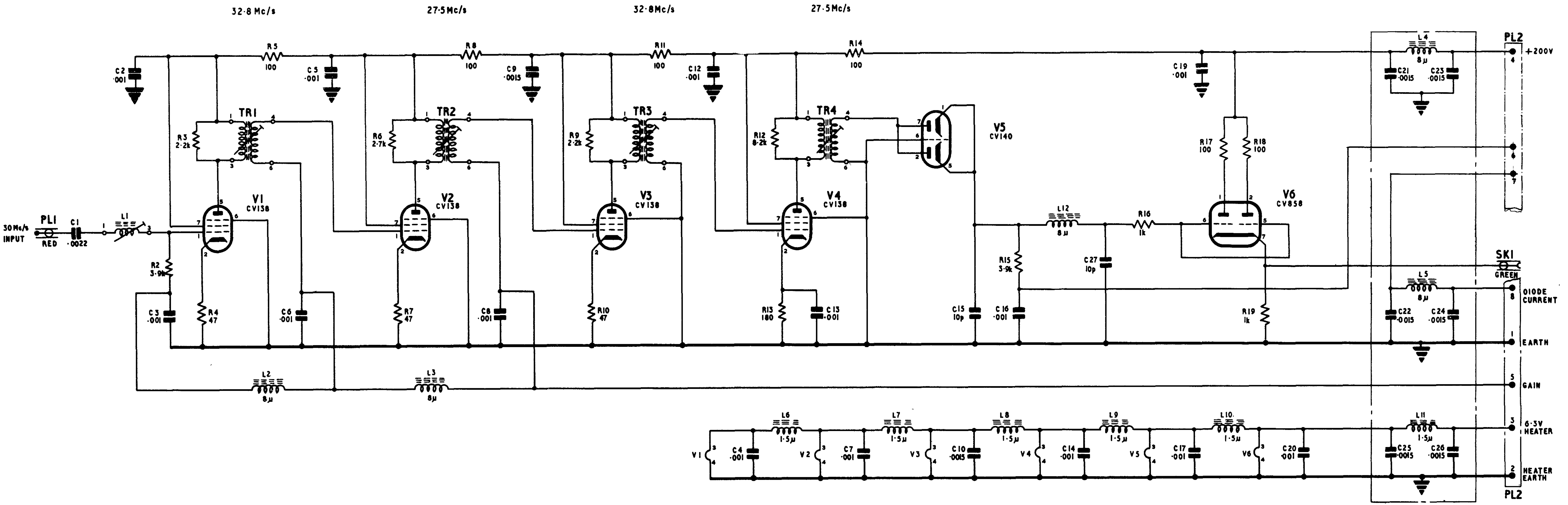
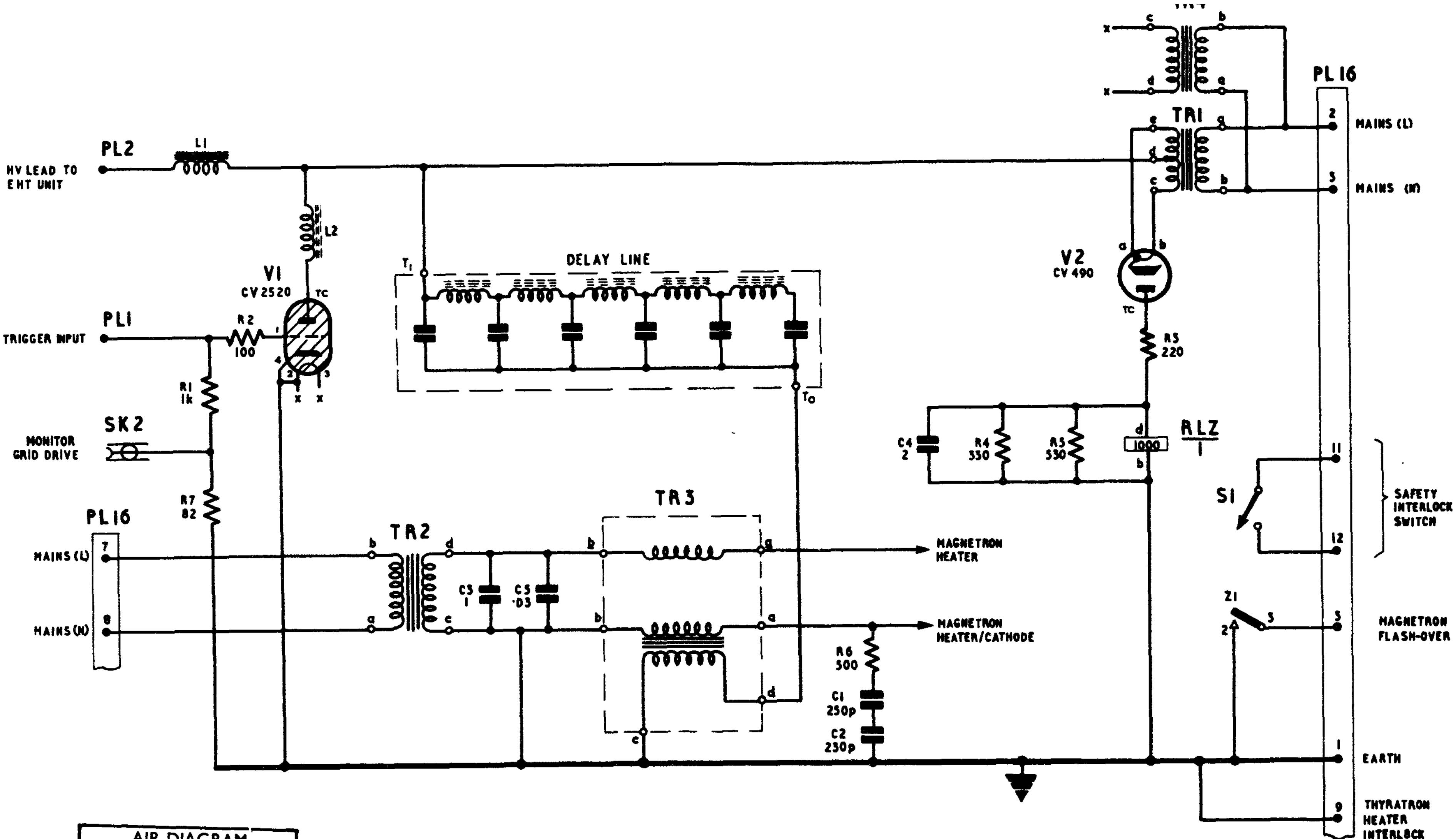
Trigger pulses generator Type S6/2 : circuit

Fig.14



I.F. amplifier Type S10/1 : circuit

Fig.17



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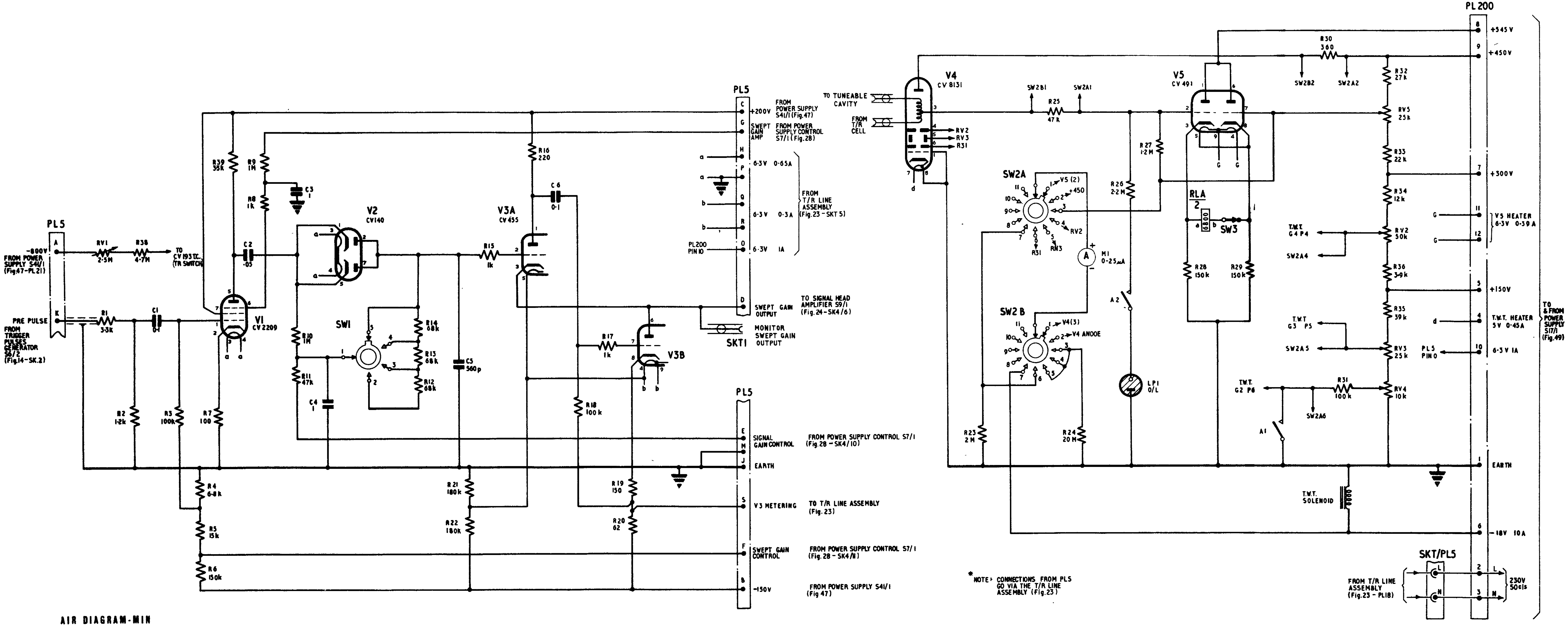
Radar modulator Type S1/1 : circuit

Fig.18



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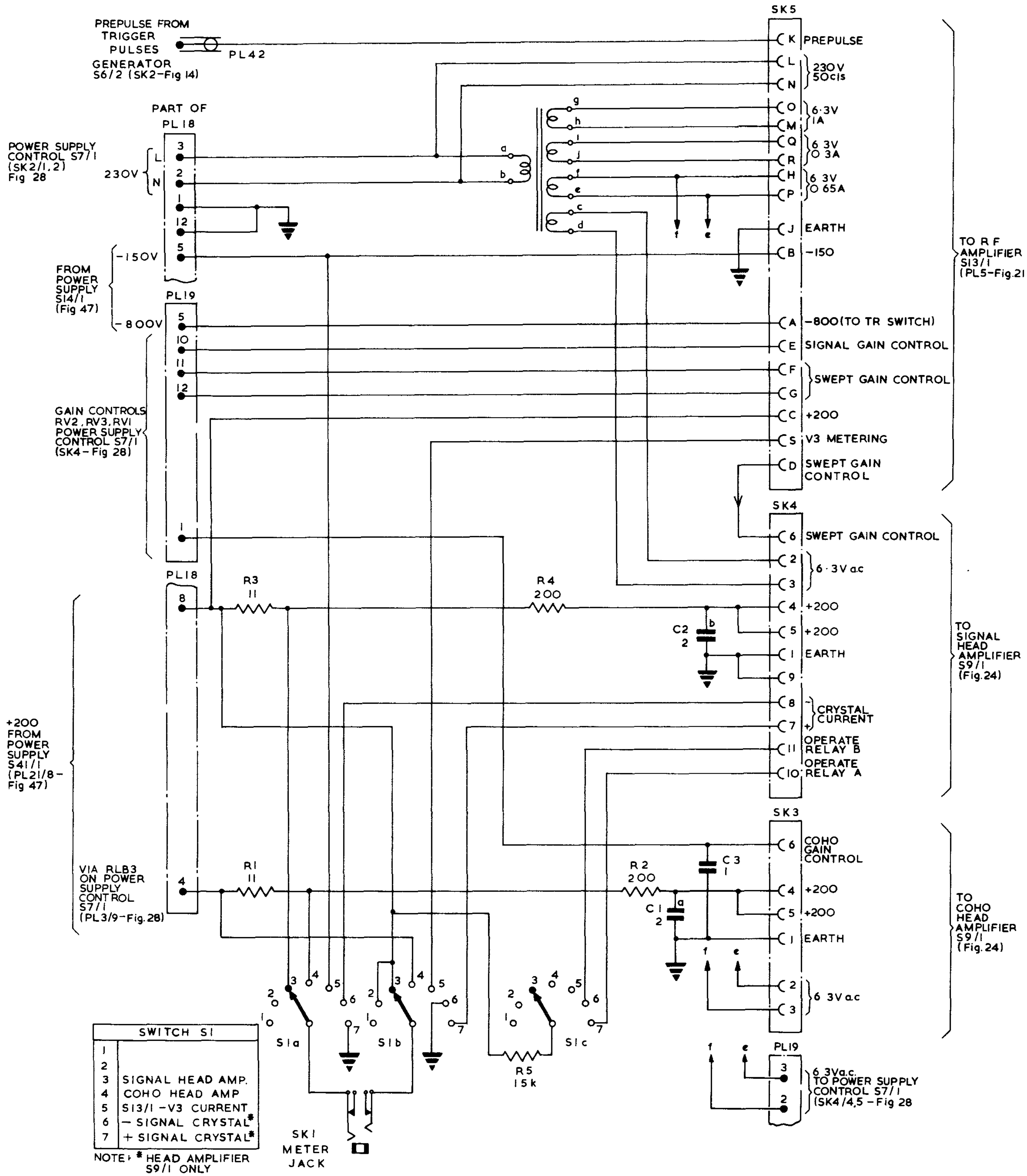
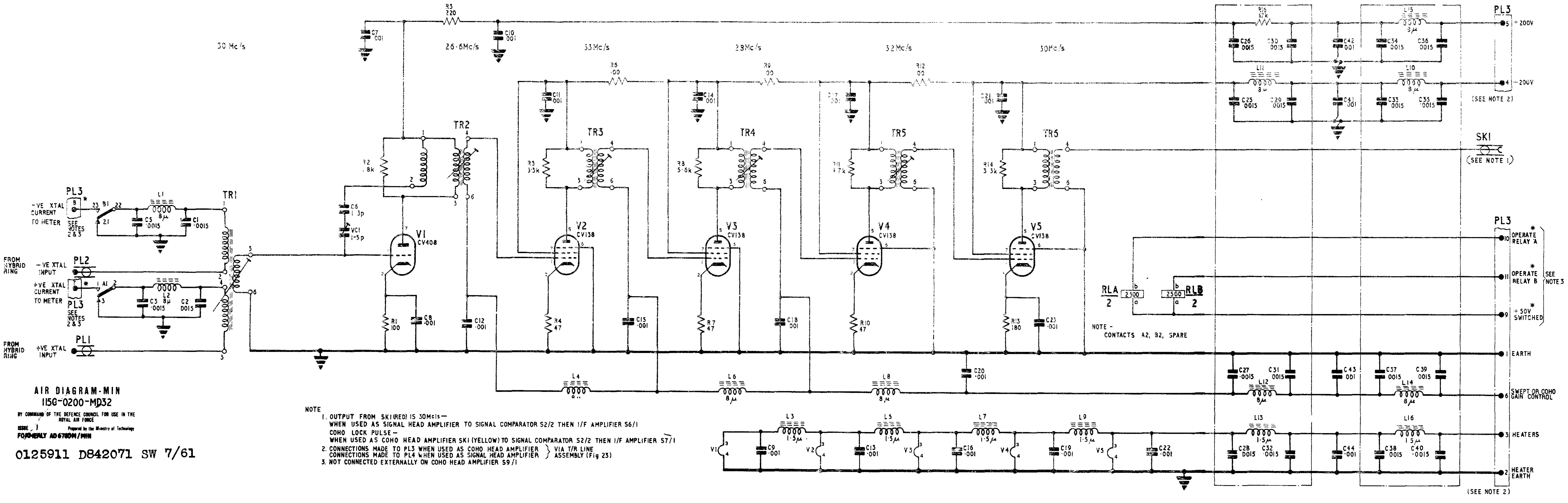
R.F. amplifier Type S13/1 : circuit

Fig.21



T/R line assembly plug panel : circuit.

Fig. 23



NOTE
1. OUTPUT FROM SK1(RED) IS 30Mc/s—
WHEN USED AS SIGNAL HEAD AMPLIFIER TO SIGNAL COMPARATOR S2/2 THEN I/F AMPLIFIER S6/1
COHO LOCK PULSE—
WHEN USED AS COHO HEAD AMPLIFIER SK1 (YELLOW) TO SIGNAL COMPARATOR S2/2 THEN I/F AMPLIFIER S7/1
2. CONNECTIONS MADE TO PL3 WHEN USED AS COHO HEAD AMPLIFIER } VIA T/R LINE
CONNECTIONS MADE TO PL4 WHEN USED AS SIGNAL HEAD AMPLIFIER } ASSEMBLY (Fig 23)
3. NOT CONNECTED EXTERNALLY ON COHO HEAD AMPLIFIER S9/1

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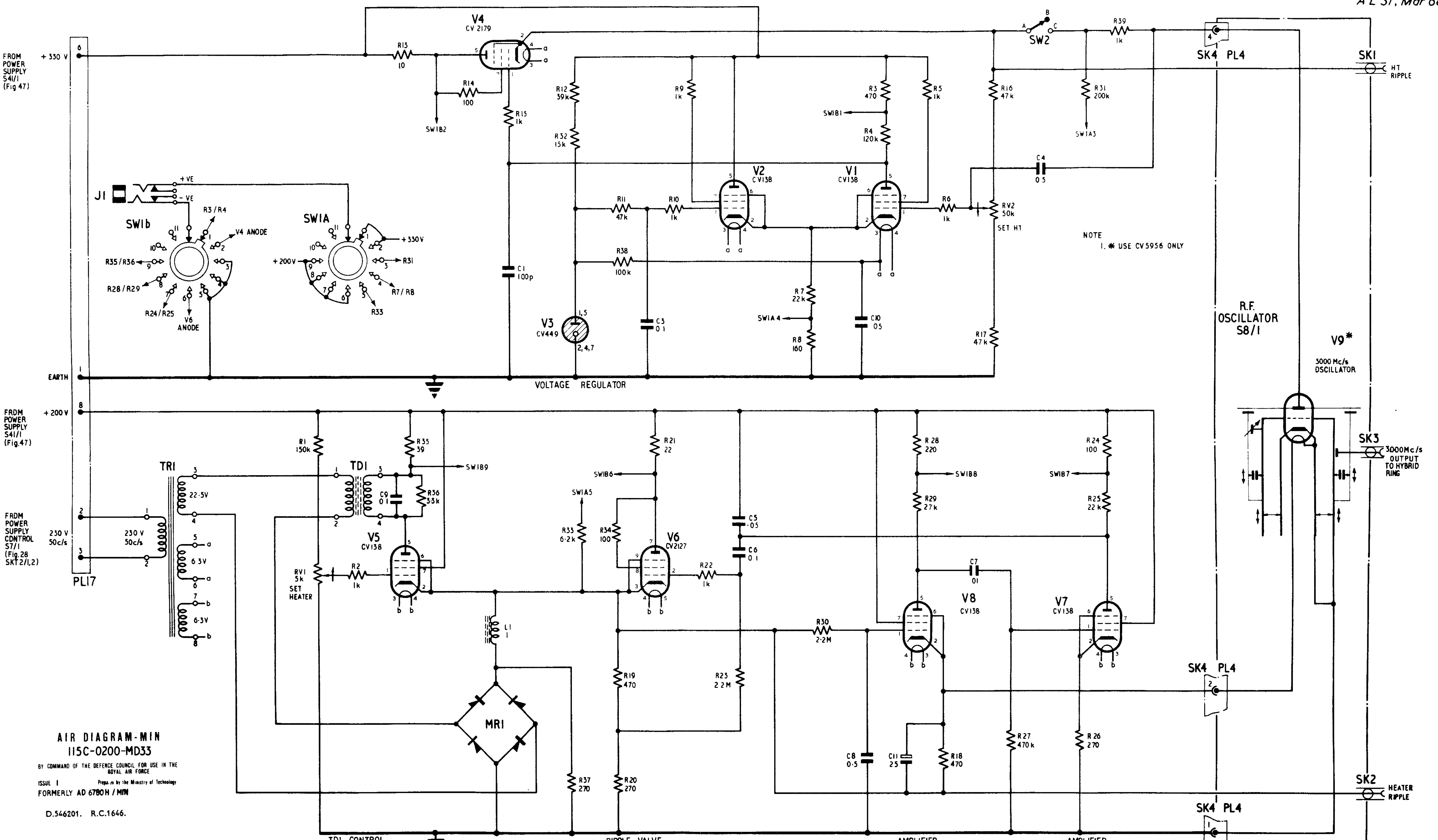
Head amplifier Type S9/1: circuit

Fig.24



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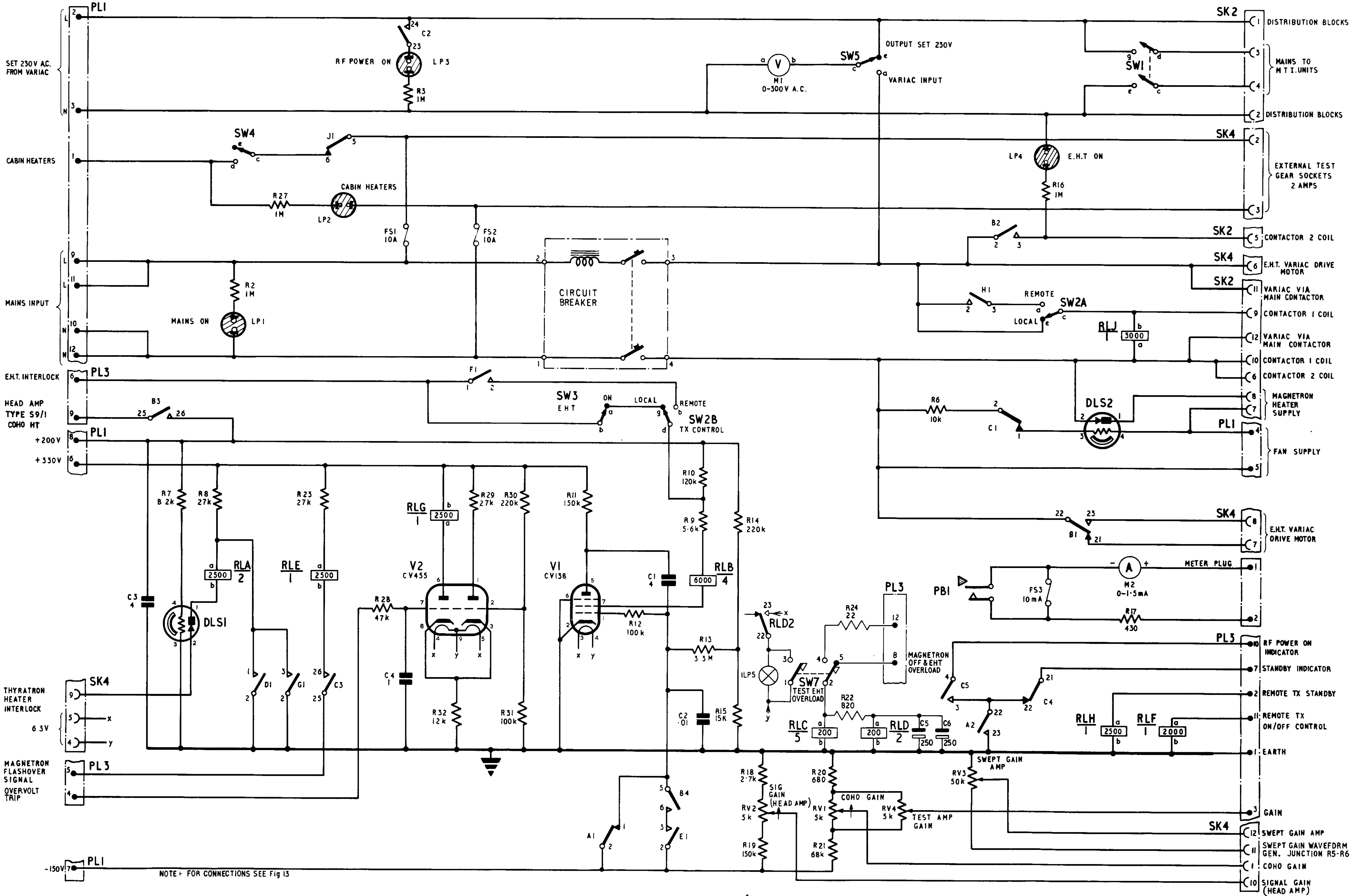
R.F. oscillator type S4/2 : circuit

Fig.27



Power supply control Type S7/1 : circuit

Fig.28

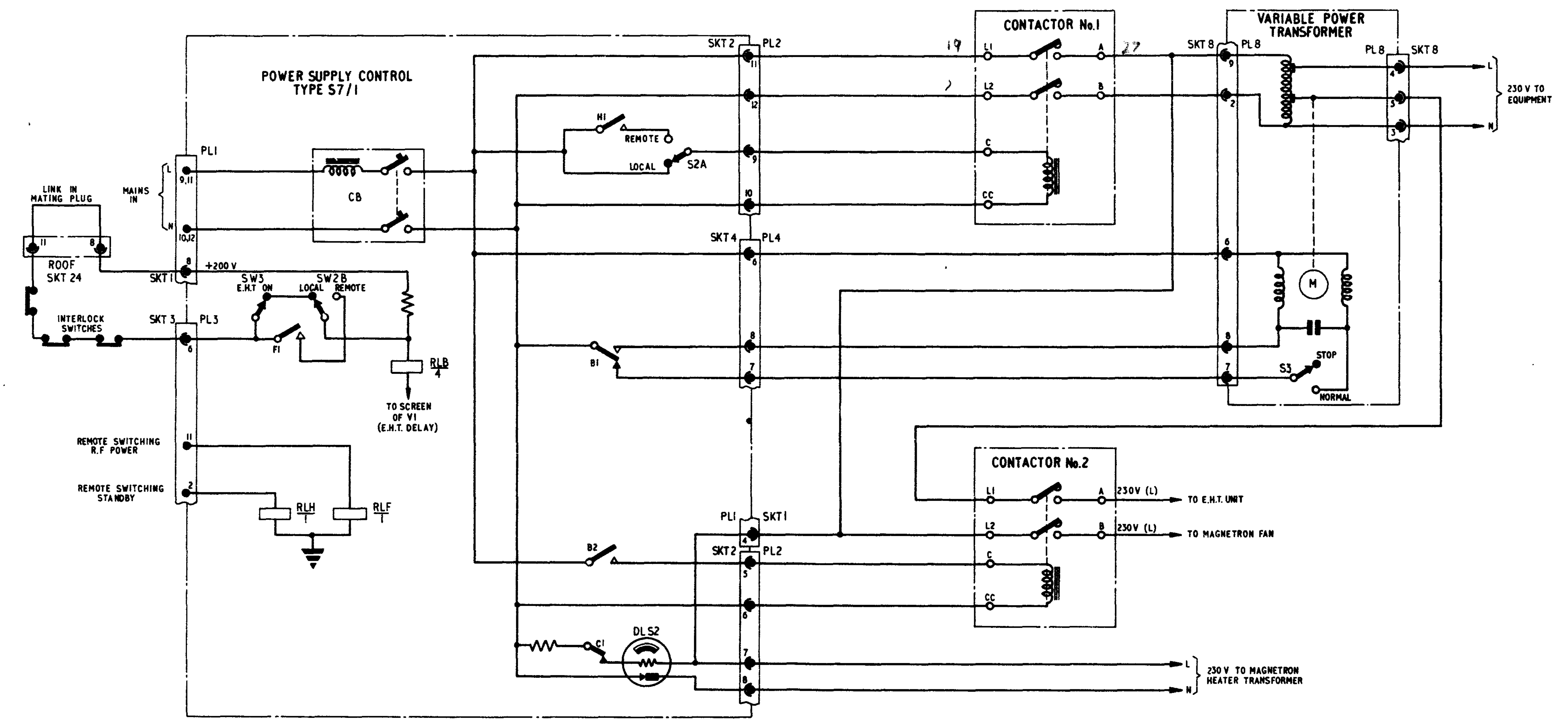


Fig.29 PP9257 306/372659 5/64 C & P Simplified voltage control circuit Fig.29

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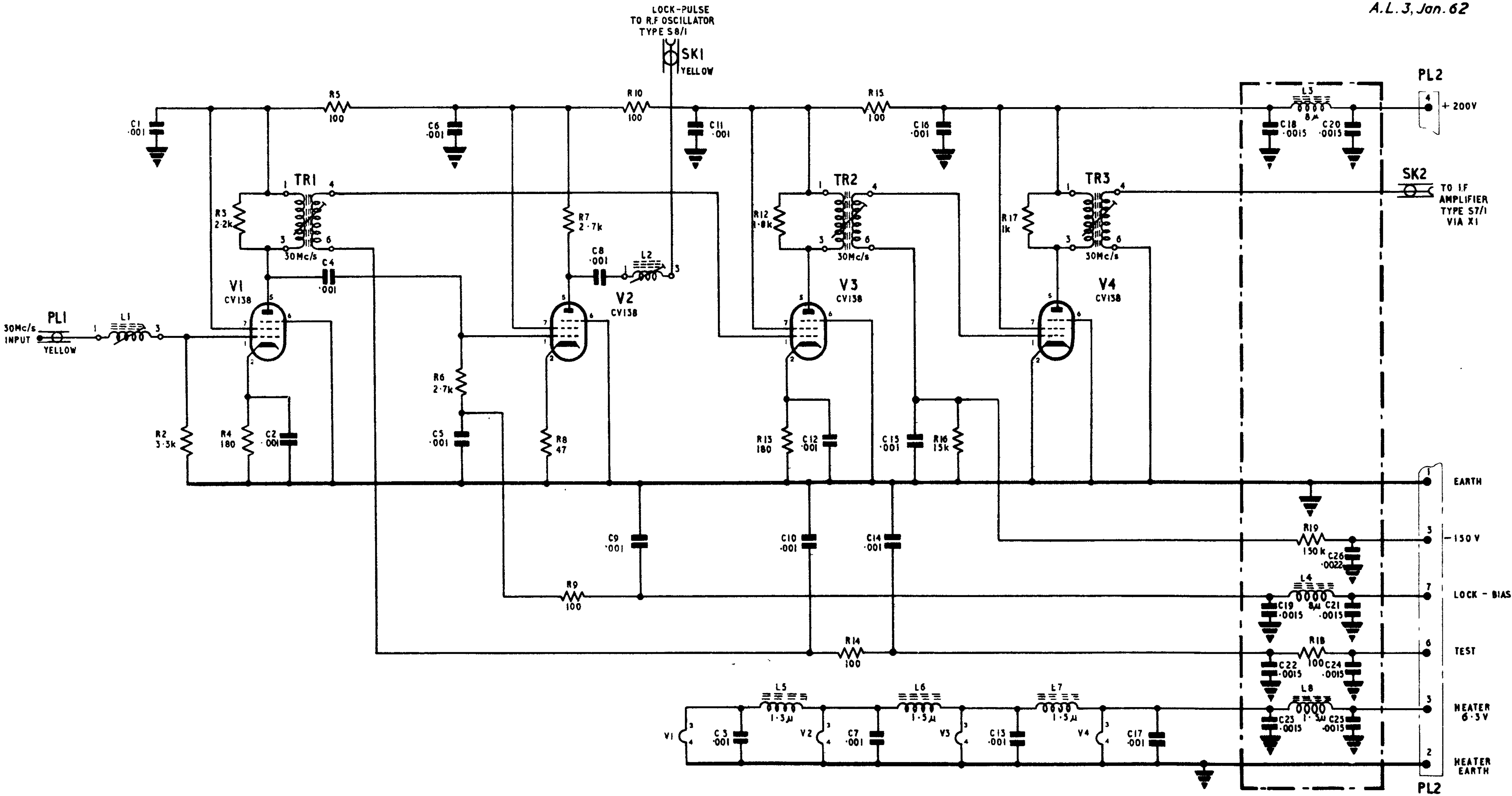
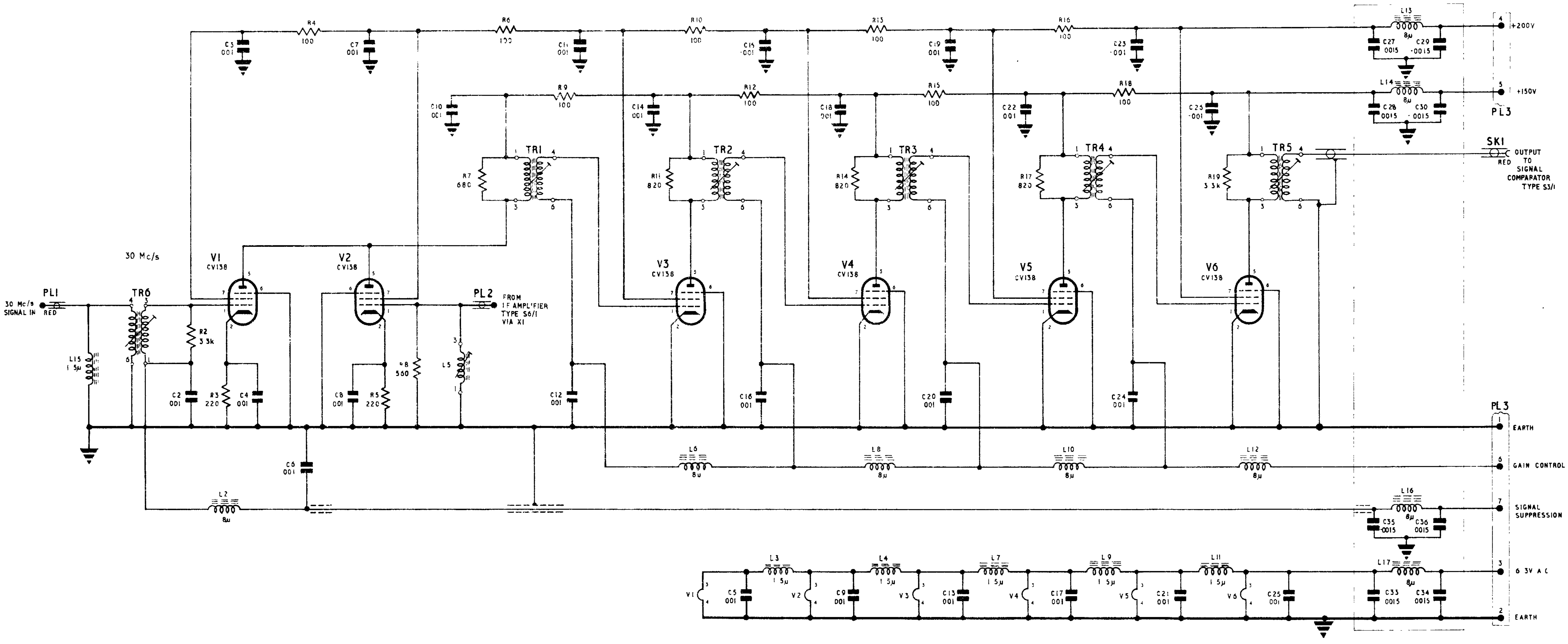
Signal comparator Type S2/2 : circuit

Fig. 30



I.F. amplifier Type S6/1 : circuit

Fig.34



I.F. amplifier Type S7/1 : circuit

Fig. 35

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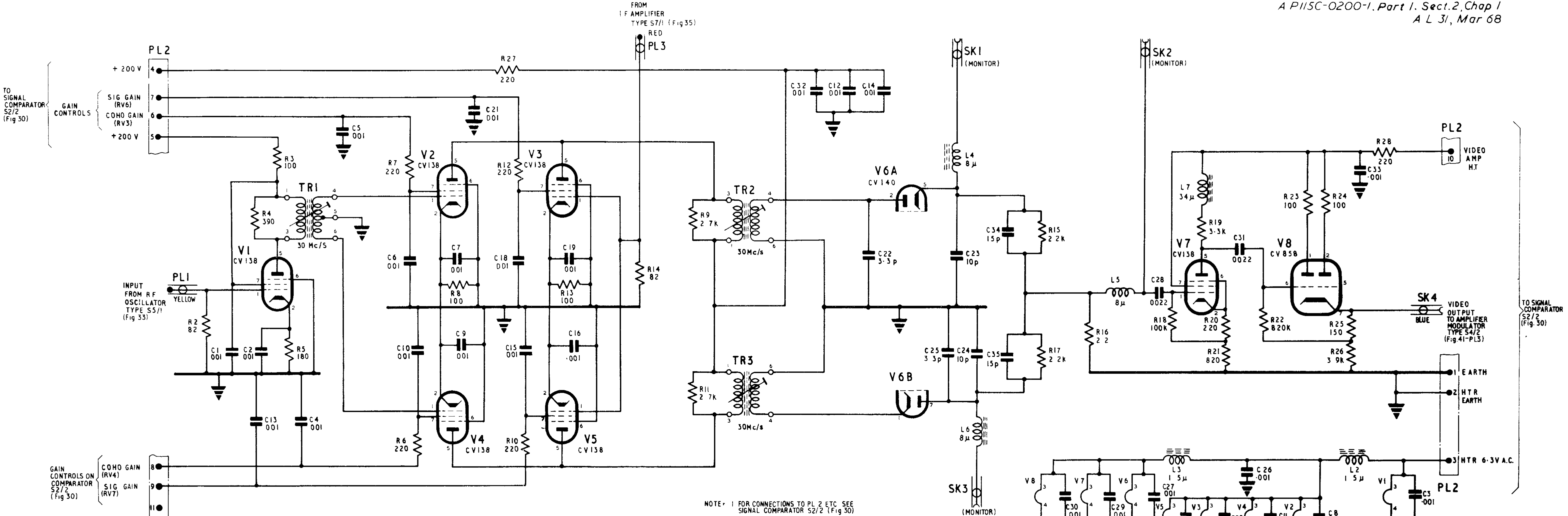

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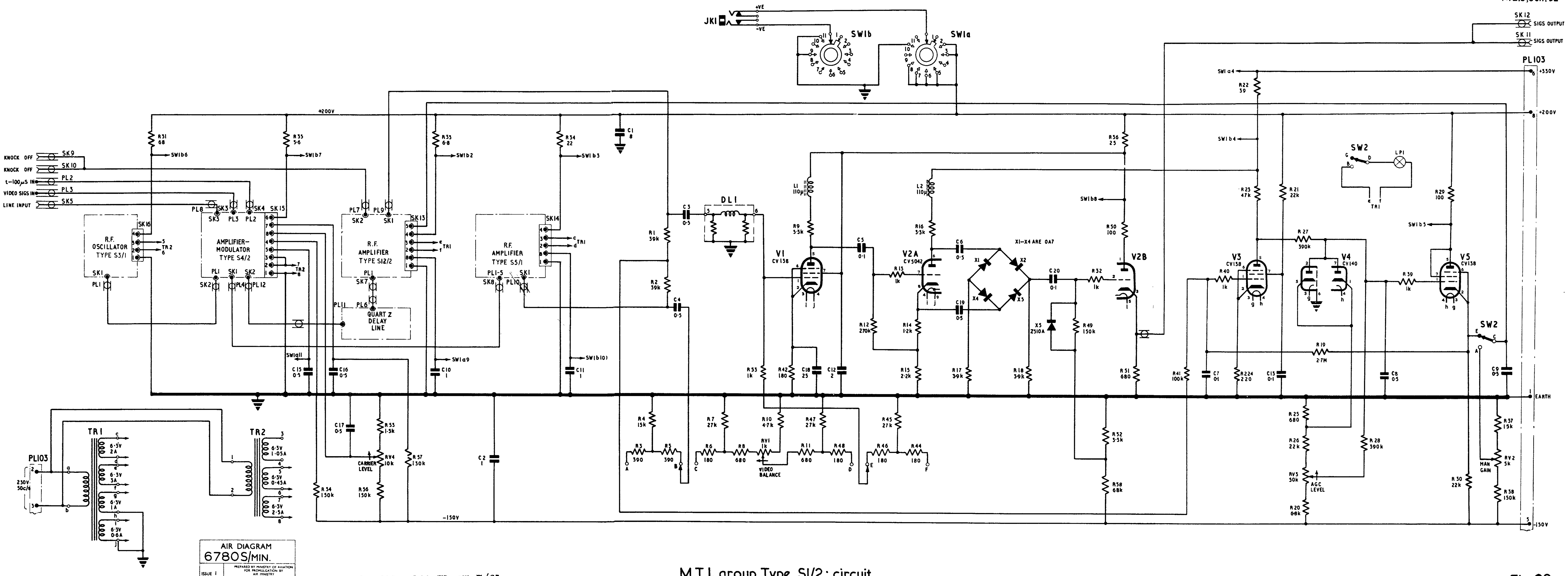
Signal comparator Type S3/1: circuit

Fig.36



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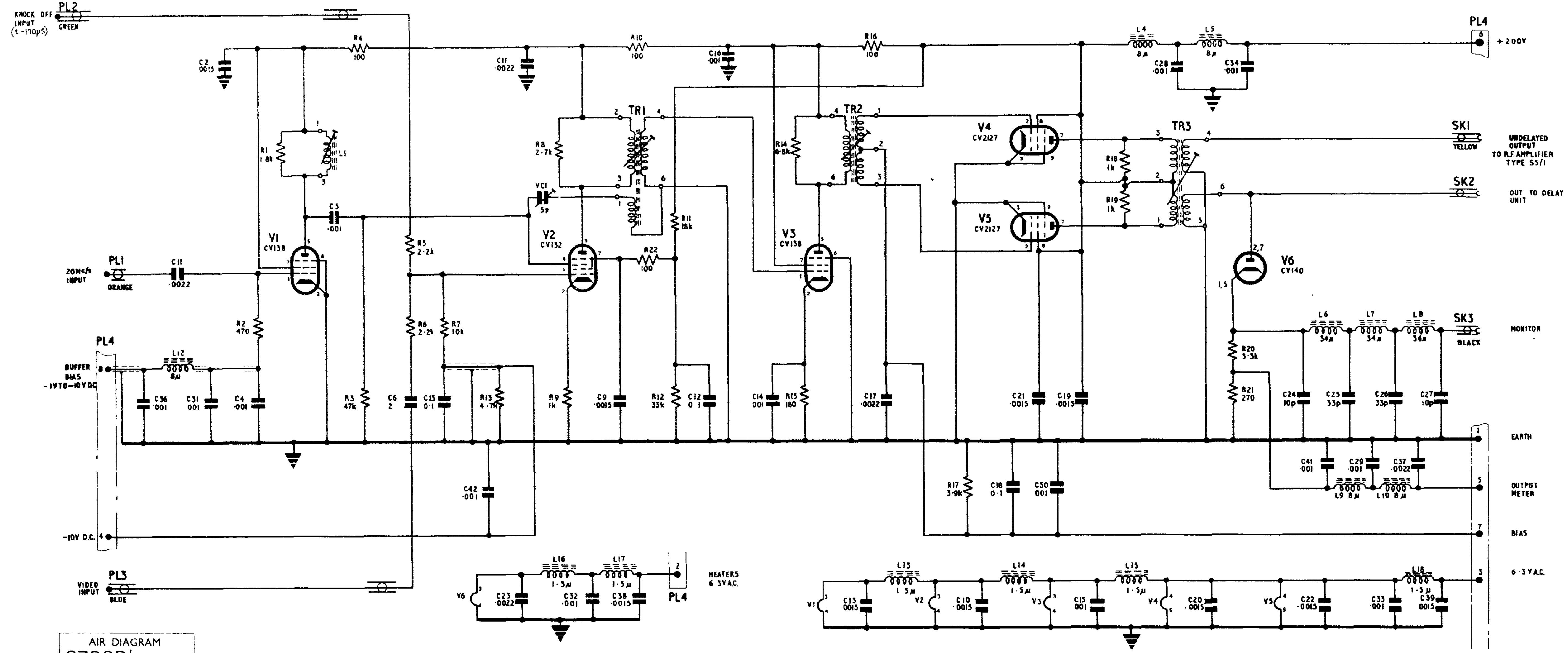
M.T.I. group Type S1/2: circuit

Fig.39



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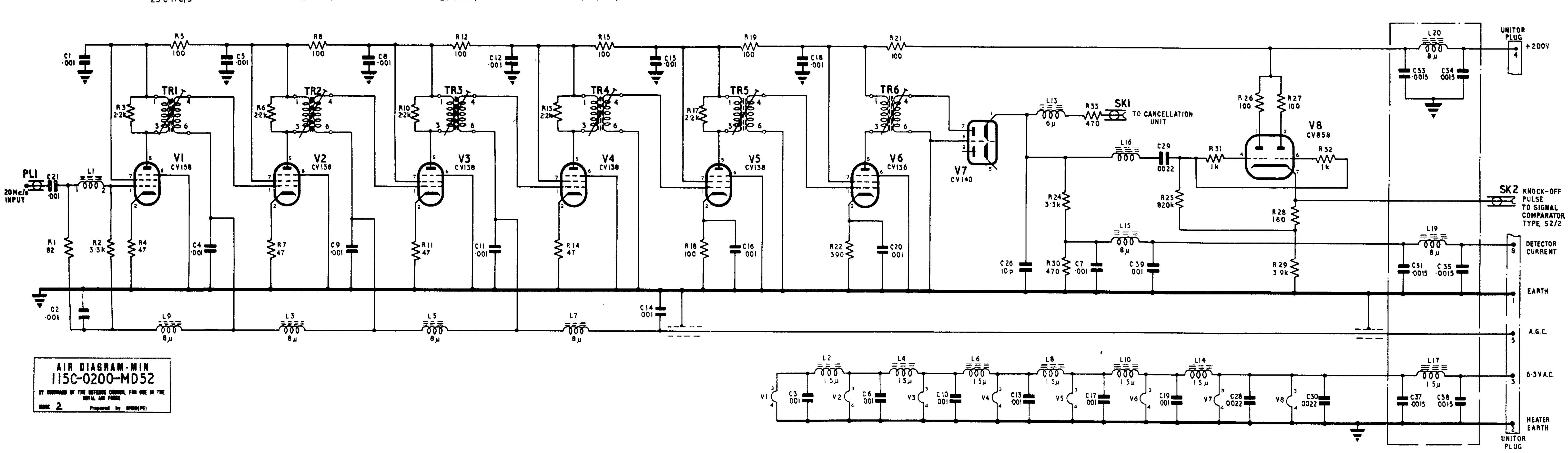
Amplifier-modulator Type S4/2: circuit

Fig.41



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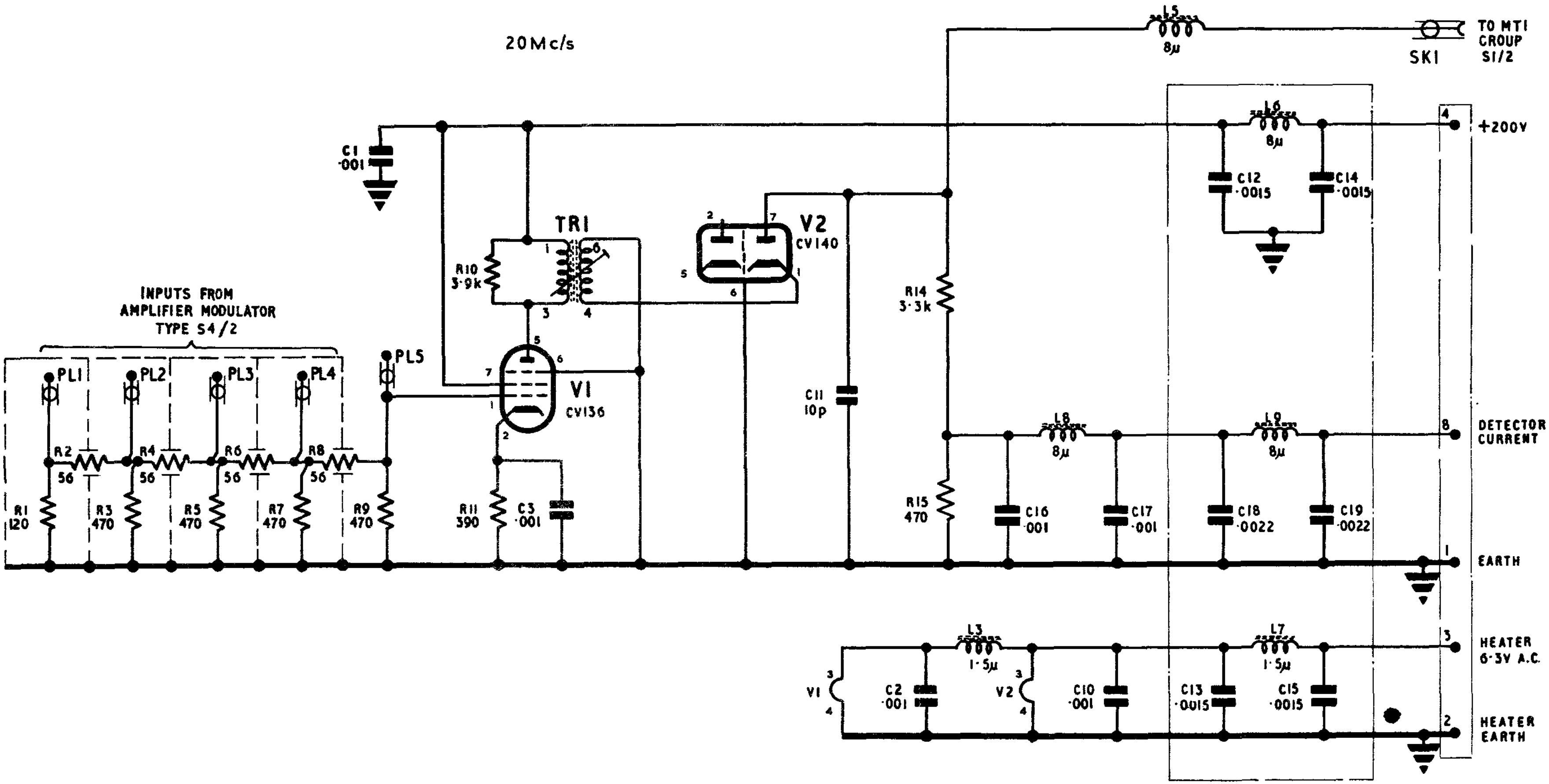
R.F. amplifier Type S12/2 : circuit

Fig.42



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R.F. amplifier Type S5/1: circuit

Fig.43

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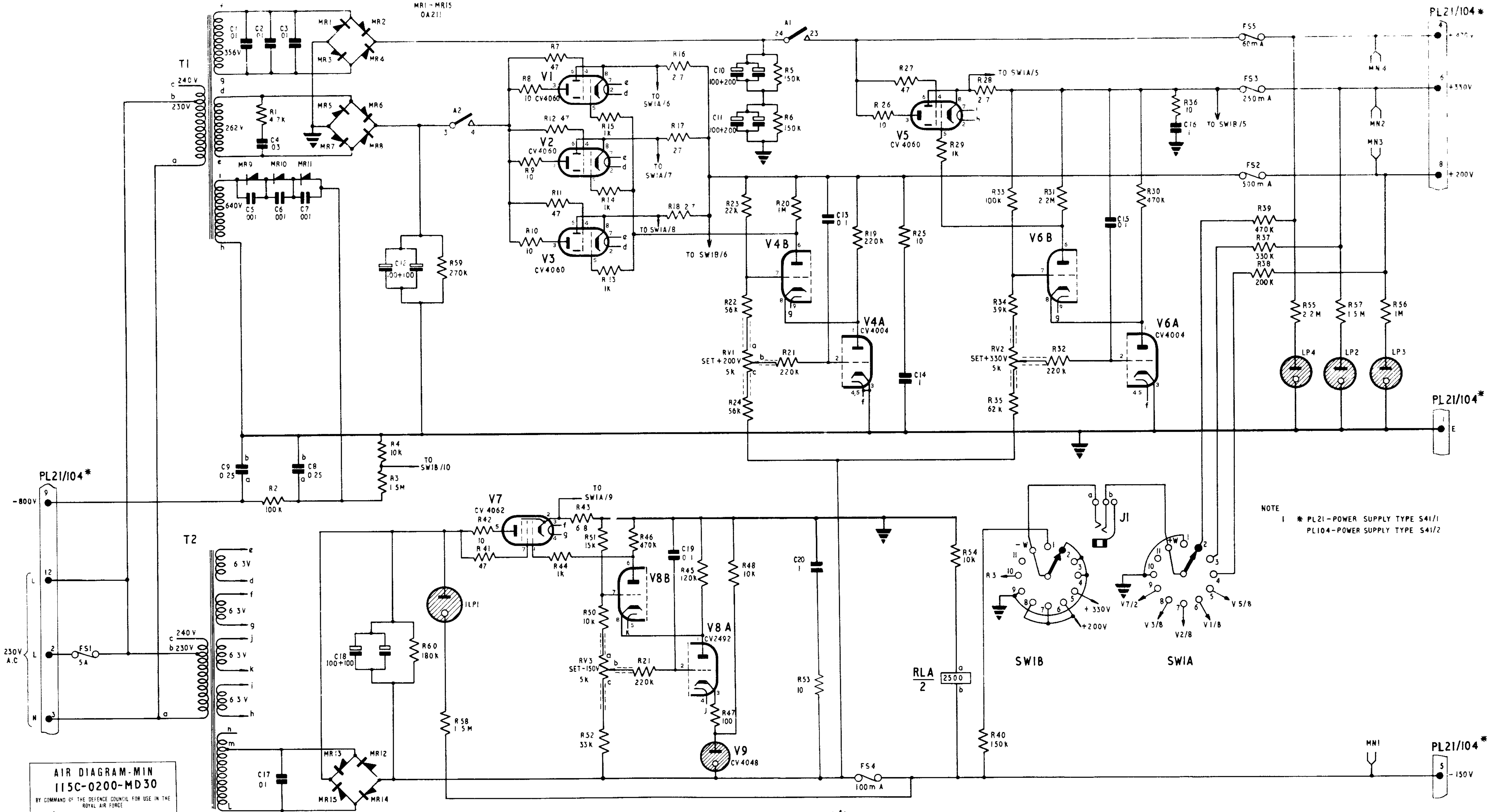

Power supply Type S41/1: circuit

Fig.47

Chapter 2

RADAR SET GROUP TYPE S1/1

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LIST OF ILLUSTRATIONS

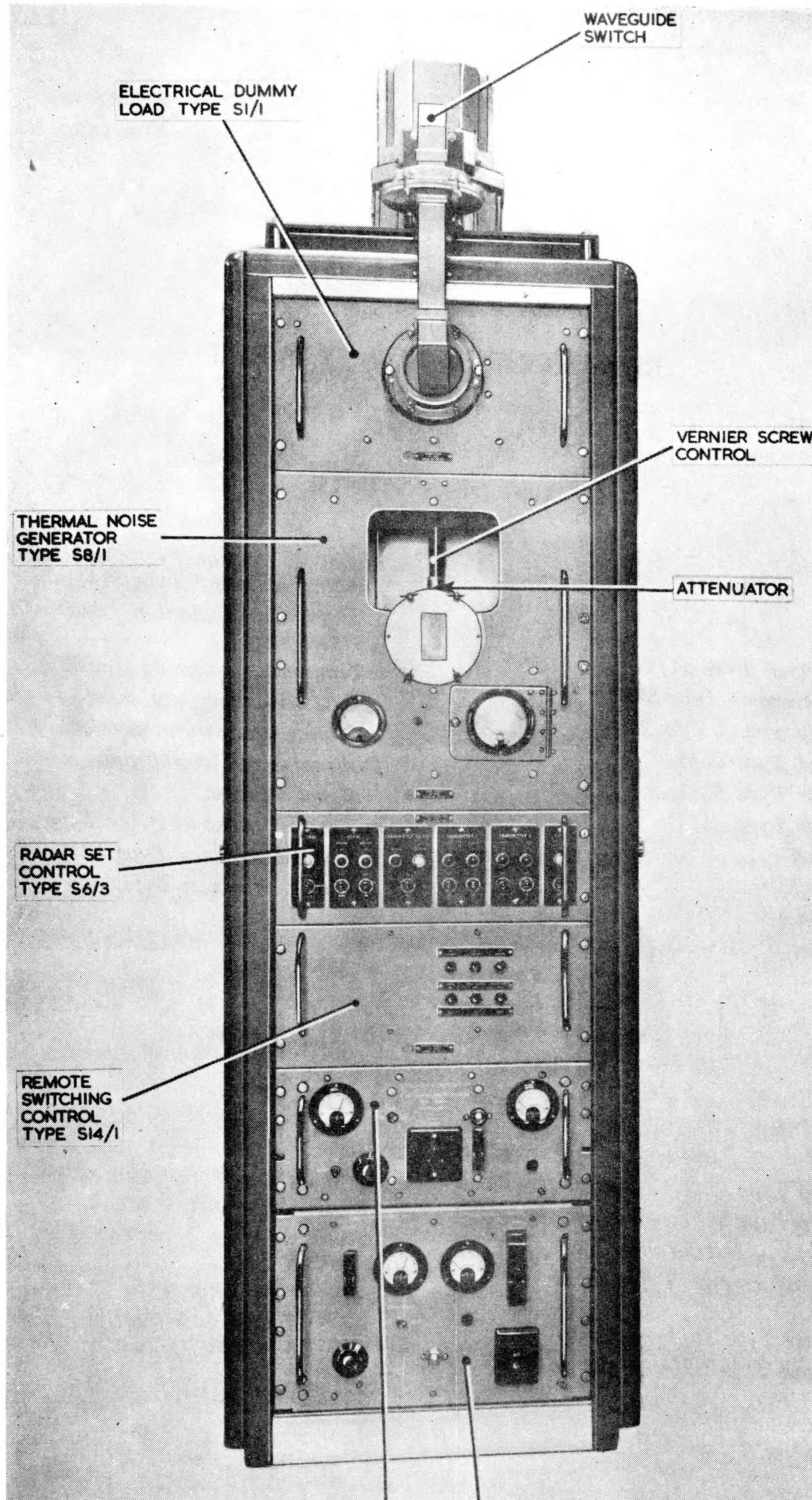


Fig. 1. Radar set group Type S1/1 — general view

Introduction

1. The radar set group Type S1/1 accommodates two items of test equipment, that is, thermal noise generator Type S8/1 and the electrical dummy load Type S1/1, and a radar set control Type S6/3, a remote switching control Type S14/1, a voltage stabilizer Type S1/1 and a voltage regulator Type S2/1. The units are mounted in a cabinet (*fig.* 1) situated between the two radar T/R assemblies Type S1/2 in this dual channel installation. The necessary interonnecting wiring between the units is not, in general, loomed but where it has to travel some distance it is enclosed in polythene sheaths. Access to the interior of the cabinet (*fig.* 2) is obtained through hinged doors, one on each side and one at the rear of the cabinet.

2. A waveguide switch, by means of which one or other of the radar T/R assemblies is coupled to the aerial and the remaining one to the electrical dummy load, is mounted on top of the cabinet (*fig.* 1). It obtains its supplies from the remote switching control Type S14/1.

DESCRIPTION

General

3. Standard construction methods and component mounting are used in these units. The controls required for operation of the installation at the remote site are available on the front panels of the units.

4. The distribution panel located at the bottom of the radar set group Type S1/1 cabinet receives mains supply input. From here it is connected to the voltage stabilizer Type S1/1 and the voltage regulator Type S2/1. The output of these two units is then distributed via the distribution panel to the two radar T/R assemblies, the other units of the radar set group Type S1/1 and the local display circuits. A fuse is connected in each of the line outputs. These are 15A for the radar T/R assemblies and 5A for the others.

Electrical dummy load Type S1/1

5. The electrical dummy load Type S1/1 is a standard construction and comprises a graphite loaded plastic wedge type absorptive element mounted in a length of waveguide on the outside of which are fitted cooling fins. The waveguide is terminated in a flange suitable for connection to the short length of waveguide via which it may be connected to the waveguide switch (*fig.* 1). A push-rod-operated interlock microswitch is mounted behind the waveguide flange and is operated to the closed position by a stud on the flange of the aerial waveguide connection when in position. The purpose of the microswitch is to ensure that the standby transmitter cannot be run up if the dummy load is not in position.

Thermal noise generator Type S8/1

6. The thermal noise generator Type S8/1 is mounted just below the electrical dummy load. It consists essentially of a 15W fluorescent tube mounted through the end of a length of waveguide. This waveguide terminates at a flange on the front panel. A glass strip microwave attenuator can be lowered into the waveguide and the extent of the penetration is measured on the Vernier scale. A calibration chart provided with each equipment enables this to be translated into dB of attenuation.

7. The fluorescent tube (LP1) and associated components are enclosed in an oblong metal case and that part of the tube outside the waveguide is screened by a cylindrical metal tube. The tube current control potentiometer RV1 and the associated meter jack JK1 are mounted on the side of the outer case (*fig.* 2).

8. Two moving coil meters are mounted on the front panel. The one on the left (*fig.* 1) has an 0–1A movement calibrated 0–1kW and is accommodated in this unit for convenience. The meter is connected to a pair of thermocouples mounted in a special section of the waveguide run via a 3-pole Plessey plug (PL2) mounted on the thermal noise generator main framework, and provides an indication proportional to the amount of mean power being transmitted. The other meter has a 0–1·5mA movement and is mounted on a hinged panel which can be swung out to enable it to be seen from the right-hand radar T/R assembly. It is connected to the 2-pole plug PL2 mounted between the meters on the front panel and can be connected from there via a suitable socket to a meter jack JK1 on the thermal noise generator or alternatively any other suitable point on the radar T/R assembly.

9. The vernier control associated with the attenuator is accessible through a large hole in the front panel of the thermal noise generator just above the waveguide flange and illumination is provided by a 15 watt lamp.

10. The waveguide termination of the thermal noise generator is provided with a polythene dust cap which can be transferred to the dummy load waveguide termination when required.

11. Power supplies for the thermal noise generator are provided by the remote switching control Type S14/1 which also carries the control switches for the noise generator.

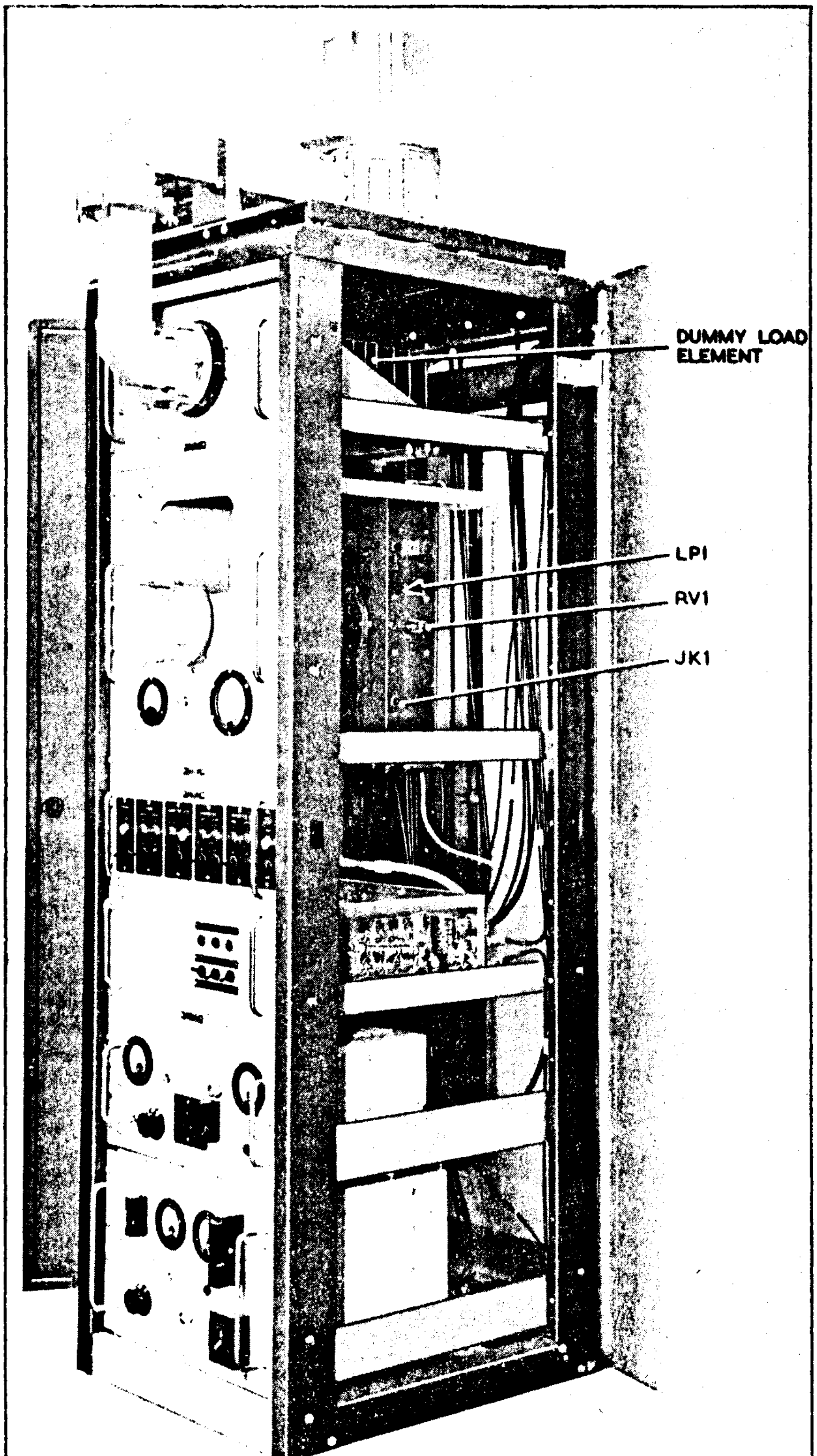


Fig. 2. Radar set group Type S1/1 — interior view

Remote switching control Type S14/1

12. Standard component layout and mounting are employed in the remote switching control Type S14/1. Sixteen hermetically sealed relays are mounted on a vertical chassis along one side of the unit.

13. All the plugs and sockets of this unit are mounted on the rear panel. The destination of each of these is detailed on the circuit diagram given at fig. 4. The front panel of the unit carries the MAINS ON/OFF double-pole single-throw switch SW1, the NOISE SOURCE ON/OFF single-pole single-throw switch SW2 and the NOISE SOURCE RUN START double-pole single-throw switch SW3, the two fuses FS1 (2A), FS2 (500mA) and the 60V ON lamp LP1.

Radar set control Type S6/3

14. The radar set control Type S6/3 provides the main controls for the installation for local operation. The control switches and their associated indicator lamps are mounted on the front panel. These switches (CONTROL, AERIAL, TRANSMITTER SELECT, TRANSMITTER 1, TRANSMITTER 2 and PRF SELECT) are all 3-position centre biassed with the exception of the PRF SELECT and the CONTROL switches which are 2-position biassed and 2-position unbiassed respectively. All the connections to the front panel components are taken out via a 36-pole plug PL1 mounted on an offset panel fitted on four pillars at the rear of the front panel. This in turn is connected via a socket and plug to the remote switching control Type S14/1. The telephone 3-pole plug PL2 and the jack JK1 are mounted on this offset panel.

Voltage regulator Type S2/1

15. The voltage regulator Type S2/1 provides most of the stabilized 230V supply required by this installation at the remote site, that is, about 5A, the remainder being provided by the voltage stabilizer Type S1/1 (*para.* 18).

16. The front panel carries a MAIN ON/OFF double-pole single-throw switch, the fine VOLTAGE CONTROL, the 6·3V 0·3A indicator lamp, a 40A Slydlock fuse, a 10A Slydlock fuse, and a 1A cartridge fuse, the INPUT OUTPUT voltage switch and the two moving iron meters. The left-hand meter (*fig.* 1) is calibrated 0–300V and is used to measure the input or output voltage depending on the position of the INPUT OUTPUT voltage switch. The other meter is calibrated 0–30A and is used to measure the load current of the unit. A COARSE voltage control is mounted in the unit and is accessible for adjustment purposes through a small hole at the rear of the unit.

17. Standard component mounting methods are used in this unit. The variac, associated 2-phase drive motor and gear train are mounted between the front panel and the vertical chassis fixed between the two side panels of the unit. The output brush is fitted at the end of an arm fitted on the main variac drive shaft. A cork faced clutch in the gear train minimizes damage due to mechanical overload. The step down ratio of the gear train between the drive motor and the variac has a ratio of approximately 200 to 1. A 2-stage valve amplifier and associated bridge components are mounted on a separate chassis.

Voltage stabilizer Type S1/1

18. The voltage stabilizer Type S1/1 is similar to the voltage regulator Type S2/1 the main differences being a lower rating of the components and the layout of the front panel.

19. The front panel carries the MAINS ON OFF switch, the fine SET VOLT control, the 6·3 volt 0·3A indicator lamp, the 15A Slydlock fuse, a 3A cartridge fuse, a double-pole single-throw VOLTS IN OUT switch, a 5A mains servicing plug and two moving arm meters. The left-hand meter (*fig.* 1) is calibrated 0–300V and measures the input or stabilized output voltage depending on the position of the VOLTS IN OUT switch and the other meter, calibrated 0–10A, measures the output load current. The COARSE SET VOLTS control is accessible through an opening at the rear of the unit.

Distribution panel

20. The distribution panel is located at the bottom of the radar set group Type S1/1 cabinet. It consists essentially of a terminal strip which provides the necessary mains supply input connections and the output connections to the various units of the installation for local operation. In addition it carries five fuses, one for each line connection.

Waveguide switch

21. The waveguide switch (*fig.* 3), although not part of the radar set group Type S1/1 is mounted on top of the cabinet. It is an electrically operated waveguide switch which connects the output of the radar T/R assembly in use to the aerial and the output of the standby radar T/R assembly to the dummy load in the radar set group Type S1/1.

22. The switch is driven by a reversible a.c. induction type motor via an associated step down gear train. A spring loaded slipping clutch prevents the motor being burnt out in the event of the switch becoming jammed in an intermediate position. A manual control for the switch is also provided to enable the switch to be operated by

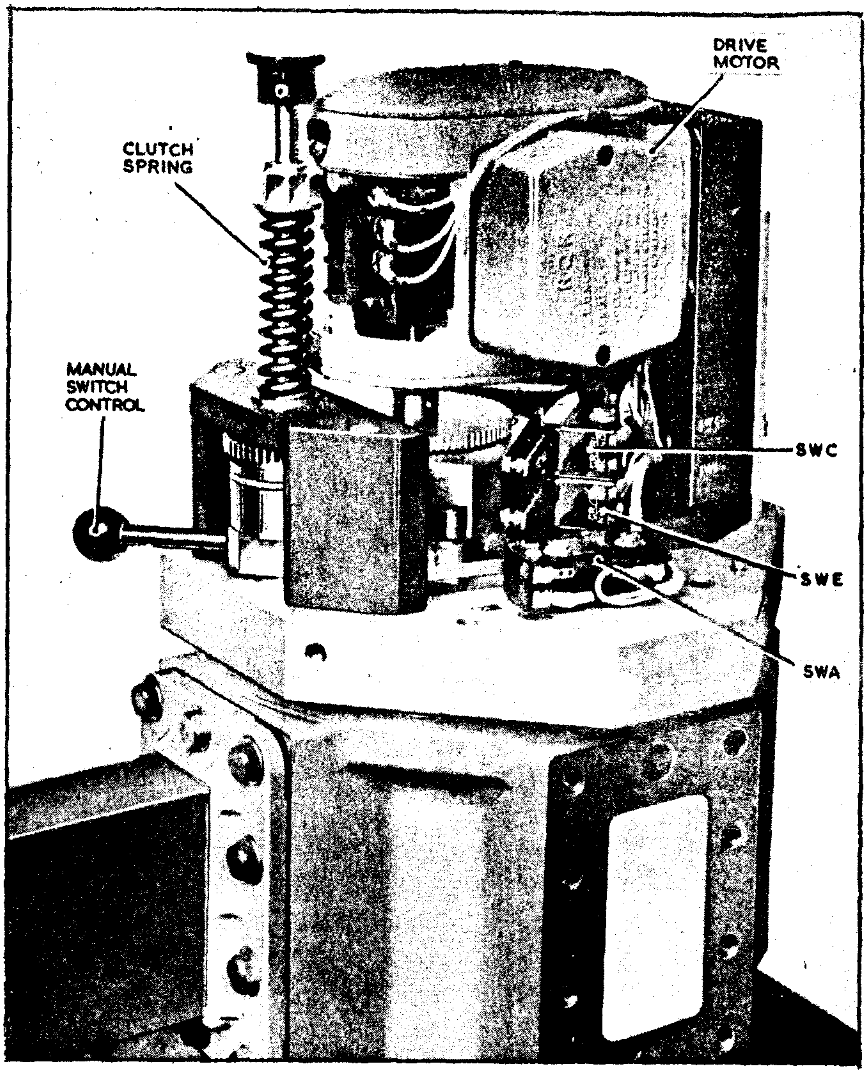


Fig. 3. Waveguide switch — interior view

hand in the event of a motor failure. Six micro-switches are employed with the waveguide switch and three of these can be seen in fig. 3.

CIRCUIT DESCRIPTION

Switching circuits

23. The remote switching control Type S14/1 (*fig*. 4) and the radar set control Type S6/3 (*fig*. 5) control all the aerial, anti-rain plate and transmitter switching for the installation at the remote FGRI.26008/1 site. A switch on the radar set control Type S6/3 enables the control to be passed to the radar set control Type S6/4 (*fig*. 6) and this renders all the remaining switches on the radar set contro Type S6/3 inoperative.

24. The connections from the radar set control in use are routed through the remote switching control Type S14/1 to the radar T/R assemblies Type S1/2, the waveguide switch and the aerial. Relays in the remote switching control Type S14/1 are used to select the radar signal, waveforms and certain power supplies from the appropriate radar T/R assembly and pass them to their appropriate destination. A simplified diagram of the switching circuits is shown at fig. 7. In this the signal selecting circuits and indicator lamps have been omitted from this digram for the sake of clarity. Fuller details of the switching operations within related units in other parts of the installation are given in the appropriate chapters, that is, power supply control Type S7/1 in Chapter 1 of this section, and the aerial and anti-rain plate starters in Chapter 3 of this Section.

Radar set control Type S6/3 and remote switching control Type S14/1

25. The circuits of the radar set control Type S6/3 and the remote switching control Type S14/1 are closely inter-related and will now be considered together.

Transmitter selection and waveguide switching

26. When the CONTROL switch SW5 and TRANSMITTER SELECTOR switch SW7 on the radar set control Type S6/3 are set to MASTER and TX1 respectively, the relay RLQ in the remote switching control Type S14/1 is energized and its contact Q1 is opened. This removes the energizing supply to relay RLR. Contact R3 now connects the a.c. supply (L) to the arm of the microswitch SWA in the waveguide switch circuit (*fig.* 8). If the waveguide switch is already in the position in which the TX1 is connected to the aerial, all the microswitches of the waveguide switch are in the position shown and the mains supply is not connected to the motor of the waveguide switch. If, however, the waveguide switch is in the position where TX2 is connected to the aerial, all the microswitches are in the opposite positions to those shown, and the motor will have driven the waveguide switch to the alternative position. On completion of the changeover the microswitches will revert to the condition shown in fig. 7. It should be noted that if the waveguide switch is not in the position where TX1 is connected to the aerial when the MAINS switch on the remote switching control Type S14/1 is set to ON, the motor will return the waveguide switch to the TX1 position without the TRANSMITTER SELECTOR switch being operated.

27. When the TRANSMITTER SELECT switch is depressed to the TX2 position, the 60V relay energizing supply is applied to relay RLR. Contact R1 now closes, and since RLQ has become de-energized, contact Q1 is also closed so that relay RLR is now energized by connection direct to the +60V supply. It remains energized

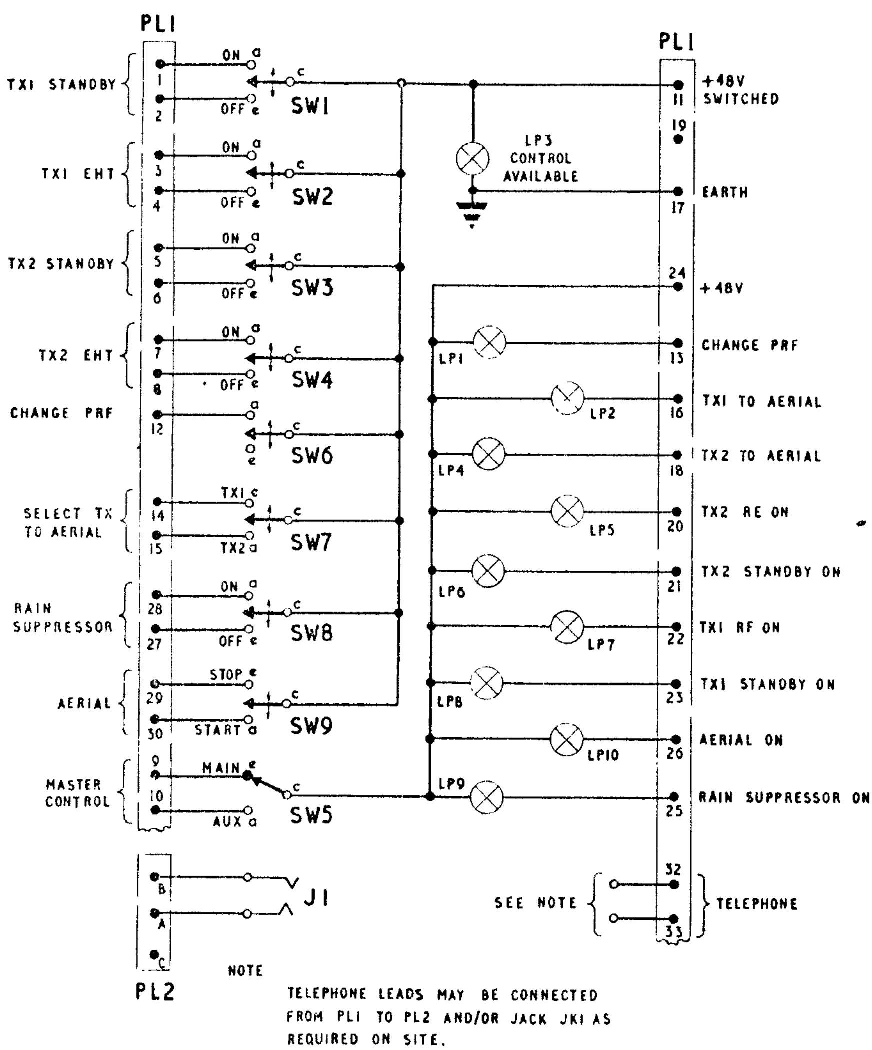


Fig. 5. Radar set control Type S6/3

until TX1 is selected again. At the same time contact R3 now reverts to its original position so that the mains supply is now applied to the other side of the waveguide switch drive motor via SWB. Completion of the changeover operation of the waveguide switch is assured for TX2 by the completion of RLR relay energizing circuit via contacts Q1 and R1, and for TX1 by the opening of contact Q1 which causes relay RLR energizing circuit to be broken. The changeover contact R2 switches on the appropriate CONTROL AVAILABLE lamp (1LP2 or 1LP4) on the radar set control Types S6/3.

Transmitter switching (standby)

28. Either of the radar T/R assemblies can be switched to the standby position, whether it is connected to the aerial or not. Separate switches (SW1 and SW3) on the TRANSMITTER 1 and TRANSMITTER 2 switch panels on the radar set control Types S6/3 control this function. They make and break the energizing circuit for relays RLA and RLE in the remote switching control Types S14/1. Once these relays have been energized they are retained in this condition by the action of their own contacts A1 and E1 and the normally closed contacts B1 and F1. Contacts A2 and E2 control the application of the +60V supply to the relay RLH in the power supplies control Type S7/1 in the radar T/R assemblies. When either of the transmitters STANDBY switches is depressed to OFF, relay RLB or RLF is energized and contact A1 or E1 opens the energizing circuit for relay RLA or RLE as appropriate. The remaining contacts A3 and E3 are used to switch the STANDBY indicator lamps 1LP6 and 1LP8.

E.h.t. switching and interlocks

29. The basic e.h.t. switching circuits are similar in principal to those for the standby condition but various interlocks are inserted to provide for all conditions. The RF power switches

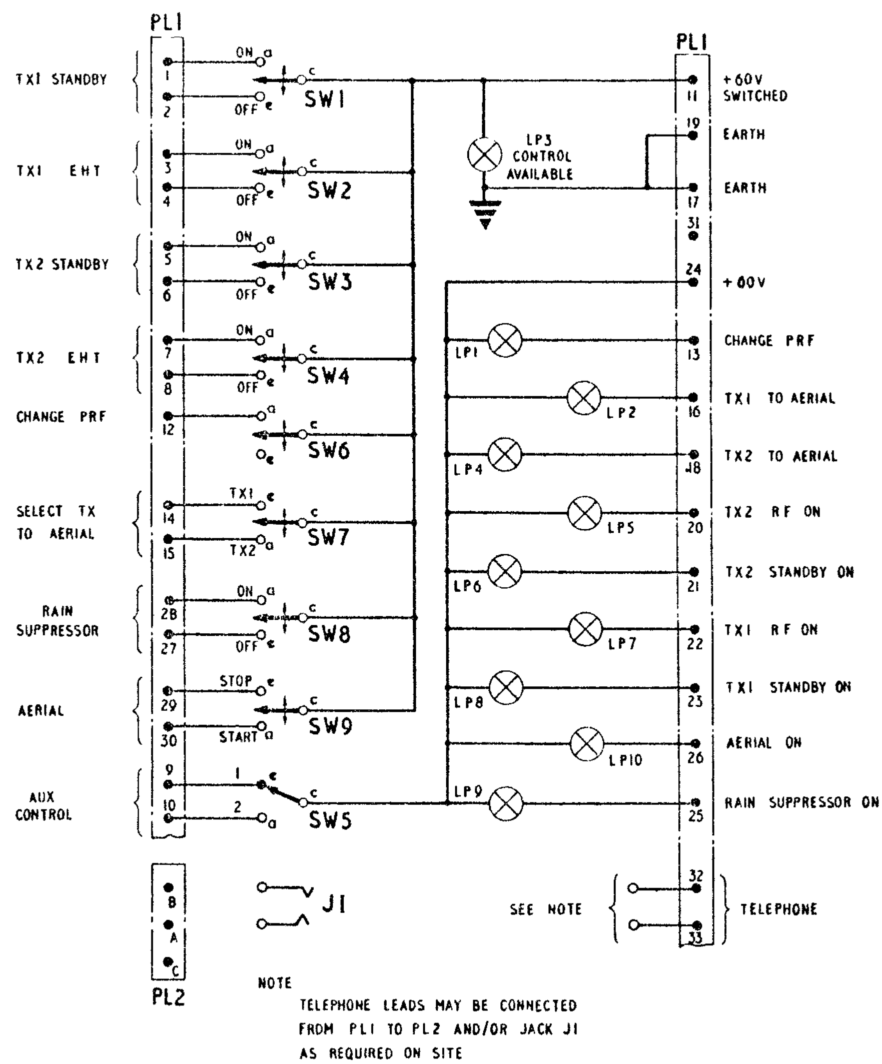


Fig. 6. Radar set control Type S6/4

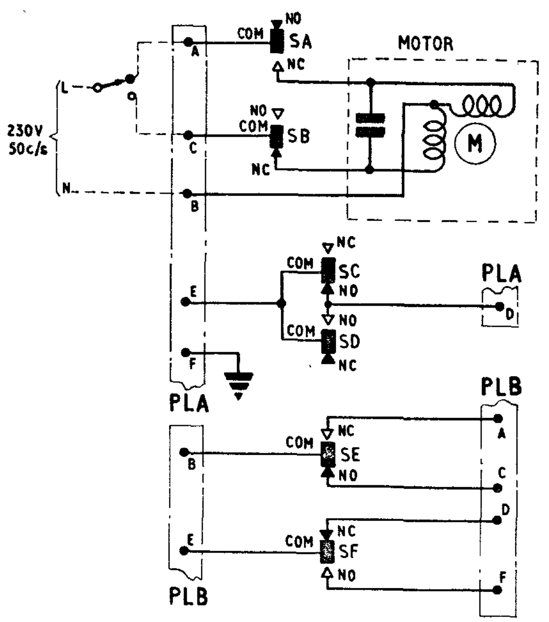


Fig. 8. Waveguide switch — circuit

(SW2 and SW4) adjacent to the STANDBY switches, complete the energizing circuit for relays RLC and RLG, which have similar hold-on arrangements to those for the standby relays. Additional contacts A4 and E4, which are normally open, are inserted in series with the hold-on circuit of these relays to ensure that the e.h.t. relays do not remain energized when the energizing supply to the standby relays is removed. Contacts C2 and G2 apply the +60V relay supply to the relays RLF in the power supply control Type S7/1 (Chapter 1 of this Section). The remaining two contacts C3 and G3 complete the circuit for the RF POWER ON indicator lamps ILP5 and ILP7.

◀**Note . . .**

It may be necessary to connect the thermal noise generator Type S8/1 to the standby radar T/R assembly whilst the operational radar T/R assembly has e.h.t. voltage applied. To avoid high power r.f. radiation damage to the precision attenuator in the thermal noise generator, the 500 mA fuse (FS2) must be removed from its fuseholder on the front panel of the remote switching control Type S14/1.▶

30. It will be seen from fig. 7 that a certain combination of states of relays RLM, RLP and RLS is required for the e.h.t. interlock circuits of the radar T/R assemblies to be completed. The energizing circuit for relay RLP is controlled by the microswitches SWC and SWD in the waveguide switch. When the waveguide switch is in the changing position, both of these switches are in the NC position and relay RLP is therefore not energized. Contacts P1 and P2 remain open until the relay is energized again when the waveguide switch has completed the changeover. The microswitches SWC and SWD also open the energizing circuit for the relays RLB in the trigger pulses generators Type S6/2 of the radar T/R assemblies at the same time as the relay RLP circuit is opened, thereby preventing a trigger pulse being applied to the radar modulator of either radar T/R assembly during the changeover.

31. With the waveguide switch connecting the No. 1 transmitter to the aerial, relay RLM is not energized because microswitch SWF in the waveguide switch is open, breaking the energizing supply. Contact M2 thus completes the e.h.t. interlock circuit for TX1 via contact P1 and the +200V line. When the waveguide switch is in the TX2 position relay RLM is energized. This breaks the e.h.t. interlock circuit for TX1 (unless contact S1 is closed) and completes the circuit for TX2 via M3. The remaining contacts M1 and M4 of relay RLM are used to select the prepulse and secondary radar trigger pulse from the radar T/R assembly in use.

32. The function of the third relay RLS is to ensure that the standby radar T/R assembly can be run up only when it is connected to the electrical dummy load Type S1/1. This relay is controlled by a microswitch mounted behind the waveguide flange of the dummy load, and is energized only when the dummy load is connected to the waveguide switch via the special length of waveguide provided for this purpose. Contacts S1 and S2 then perform the same function as contacts M2 and M3 completing the interlock circuit for the radar T/R assembly which is selected to work into the dummy load. The contact W4, in series with the coil of relay RLS, opens when the p.r.f. of the radar T/R assembly in use is changed (*para.* 37). This prevents RLS from completing the interlock circuit of the standby radar T/R assembly, and prevents the interference that would be caused at the display if both radar T/R assemblies were on but unsynchronized.

33. The coils of relays RLN and RLU are in parallel with that of relay RLM. Their contacts U1 and N2 are used to select normal radar and m.t.i. video signals from the radar T/R assembly in use, and to complete the +200V supply for the thermal noise generator Type S8/1.

Transmitter synchronization

34. When the output of the standby radar T/R assembly is being fed into the electrical dummy load its p.r.f. is synchronized with that of the radar T/R assembly in use to reduce interference to a minimum. This synchronization can only be achieved when the operational radar T/R assembly in use is synchronized with its m.t.i. system, which is the normal practice. If it is assumed that the No. 1 radar T/R assembly is connected to the aerial, relay RLA in its trigger pulses generator Type S6/2 will be energized via the microswitch SWE in the waveguide switch and relay contact T1.

This trigger pulses generator will thus be using the synchronizing pulse from the m.t.i. unit. The corresponding relay RLA in the trigger pulses generator Type S6/2 of the No. 2 radar T/R assembly will not be energized because micro-switch SWF, which is in series with relay contact T2, is open. This trigger pulses generator will thus be using the pre-pulse from the No. 1 radar T/R assembly which comes in via contact T3.

35. When the No. 2 radar T/R assembly is connected to the aerial waveguide switch, micro-switch SWE opens and SWF closes. This causes relay RLA in the No. 1 radar T/R assembly trigger pulses generator to become de-energized and that in the No. 2 radar T/R assembly trigger pulses generator to be energized. The No. 1 radar T/R assembly then receives the pre-pulse from the No. 2 radar T/R assembly via contact T4.

Distinguishing "second time round" echoes

36. Echoes from aircraft at ranges greater than that corresponding to the repetition period of this radar installation may be received under suitable conditions. Such an echo will appear on the display at the range which would end on the time interval between the transmitted pulse following the one which produced the echo and the reception of the echo. A "second time round" echo may be distinguished from a normal echo by temporarily changing the p.r.f. of the equipment. This causes a change in the time interval mentioned above, and a "second time round" echo will therefore change its position on the display while normal echoes will not move.

37. The change of p.r.f. is effected by setting the P.R.F. SELECT switch on the radar set control Type S6/3 to CHECK. This causes relay RLT in the remote switching control Type S14/1 to be energized. Contacts T1 and T2 then open and the relay RLA in the appropriate trigger pulses generator Type S6/2, depending on which of the radar T/R assemblies is in operation. At the same time, the pre-pulse from the standby radar T/R assembly is prevented from taking over because contacts T3 and T4 are now open. The trigger pulses generator of the operating radar T/R assembly then runs freely at the lower p.r.f. The increase of repetition

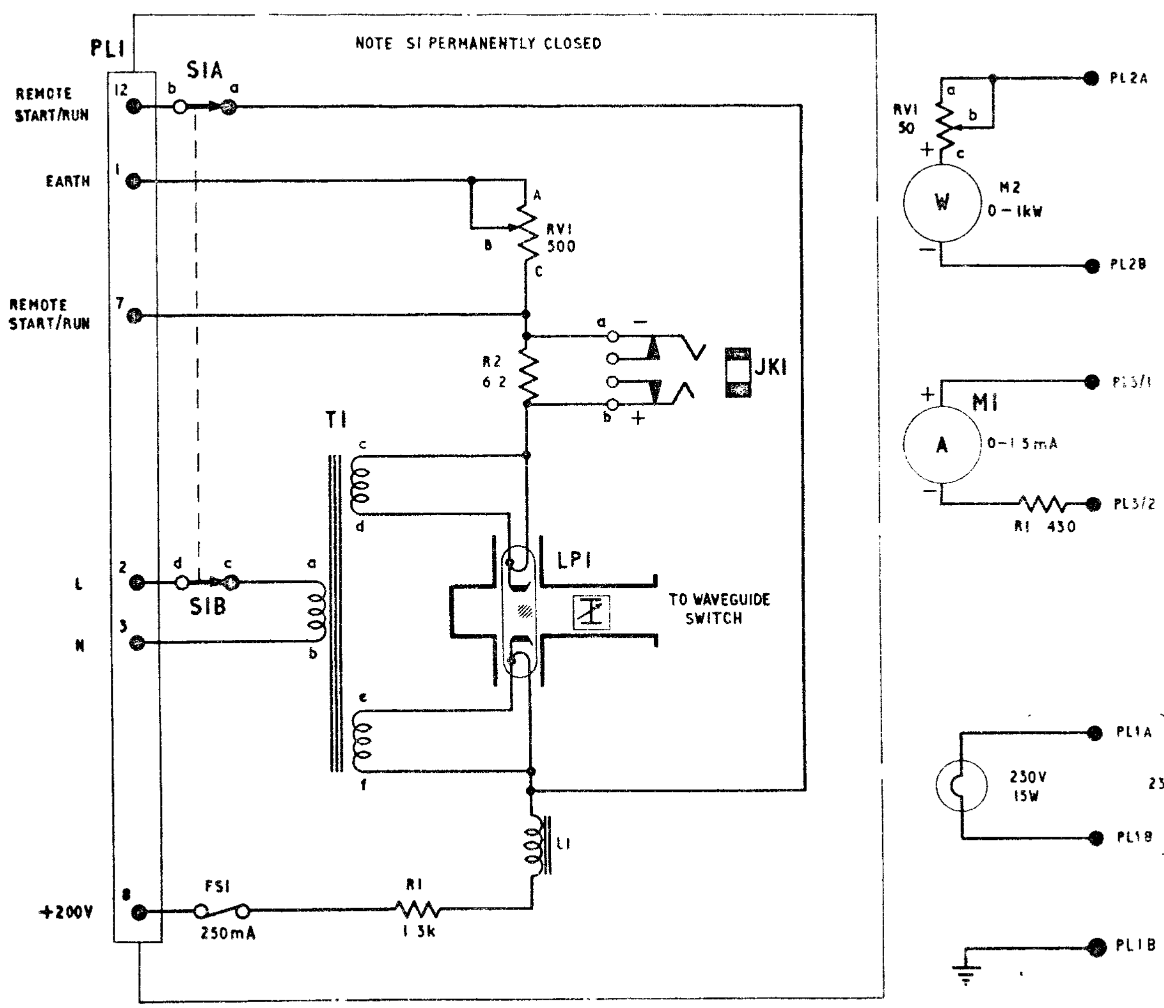


Fig. 9. Thermal noise generator Type S8/1 — circuit

period from that of the m.t.i. delay line is about 75 microseconds, so that a "second time round" echo will jump about six miles on the display.

38. When the operating radar T/R assembly is not locked to its m.t.i. delay line, the m.t.i. system ceases to function. The effects of this are minimized due to the fact that the change of p.r.f. is automatically limited to 15 seconds. The relay RLW is energized simultaneously with relay RLT, and the energizing supply to both these relays is maintained via contacts X1 and W3. Contact W2 controls a transistor delay circuit which feeds relay RLX. The transistor, VT1, normally passes only a small current, its base being more positive than its emitter. The opening of contact W2 allows the base potential to fall at a rate determined by the time constant of R3 and C3, the setting of the potentiometer RV1 and the gain of the transistor, the action being similar to that of a Miller delay valve. When the collector current has risen sufficiently relay RLX becomes energized and as contact X1 opens, the hold-on path for relay RLT and RLW is broken and the system reverts to normal operation.

39. It should be noted that it is not necessary to hold the P.R.F. SELECT switch at CHECK after RLT and RLW are in the hold-on condition, and it is in fact undesirable to do so because as soon as relay RLX is energized, the transistor in the circuit is reset due to contact W2 closing, and relay RLX is again de-energized. If the P.R.F. SELECT switch is maintained in the CHECK position when contact X1 closes again, the whole process will recommence and be repeated until the switch is released.

40. Contact W1 is used to complete the circuit of the CHANGE P.R.F. lamp indicator on the radar set control Type S6/3 when the p.r.f. of the operational radar T/R assembly is unlocked from the m.t.i. system. Contact W4 brakes the interlock system of the standby radar T/R assembly by causing relay RLS to be de-energized (*para.* 32).

Signal selection

41. Change-over relays are used to connect the operating radar T/R assembly to the azimuth and range indicators Type S5/1 and to the secondary radar equipment if this has been installed. The contacts and signals concerned are:—

M1 Secondary radar trigger pulse.
M4 Prepulse to viewing units.
M2 M.t.i. video signals to viewing units.
U1 Normal radar signals to viewing units.

In addition contact M3 connects a matching resistor R9 to the pre-pulse lead of the standby radar T/R assembly, to preserve the shape and width of the pulse applied to the radar modulator. Contact M1 selects the +200V supply for the thermal noise generator from the standby radar T/R assembly.

Thermal noise generator Type S8/1 (fig. 9)

42. The thermal noise generator Type S8/1 provides a source of electrical noise at a standard level for use in making noise figure measurements of the receiver. The noise source is a 15W fluorescent lamp LP1 mounted in a length of waveguide and couples energy to the electric field of the waveguide. This length of waveguide is terminated in a flange, and coupling to the waveguide switch is made by means of a special length of waveguide provided for use during noise figure tests. A high loss glass strip calibrated microwave attenuator in the length of waveguide between the source and the flange is used to determine the level of noise in dB being transmitted to the receiver. There is sufficient level of noise in the appropriate part of the spectrum of the source to provide up to about 16dB of noise at the input to the receiver.

43. Power supplies for the thermal noise generator are provided from the remote switching control Type S14/1 (fig. 4) which also carries the NOISE SOURCE ON OFF and START RUN control switches.

44. The fluorescent tube is of the pre-heating type, with a heater at each end. The heaters are supplied with power from transformer T1 during the heating period only. The d.c. h.t. voltage (+200V) for the tube is supplied via the NOISE SOURCE ON OFF switch in the remote switching control. When this switch is set to ON, the tube is started by means of the START RUN switch. When it is set to START, power is applied to the heater transformer T1 and a virtual short circuit applied to the tube. After about 15 seconds this switch may then be set to RUN. The supply is now disconnected from the heater transformer T1 and the short circuit removed from the tube. The surge voltage produced across inductor L1 causes the tube to strike and the discharge is then maintained by the 200V supply. When the noise generator has to be switched off, this should be done by setting the NOISE SOURCE ON OFF switch to OFF with the START RUN switch left at RUN.

45. The tube current can be measured by connecting the 1·5 milliammeter to the meter jack socket JK1 via the test lead provided. The current level should be 80mA and can be adjusted to this by means of RV1.

46. The method of applying the thermal noise generator to measuring receiver noise figures is given in the setting up and operating instructions in Section 3 of this Part.

47. The 0 to 1 milliammeter M2 is employed to measure a voltage representative of the mean power being delivered to the aerial. This voltage is developed across two thermocouples in series mounted in the waveguide between the waveguide switch and the aerial. The thermocouples, the centre point of which is earthed, are spaced approximately ¼ of a guide wavelength apart to minimize the effect of a shift of the standing wave pattern relative to the thermocouples. The variable resistor RV1 in series with the meter enables the complete monitoring system to be calibrated.

48. The coupling of the thermocouples to a field in the waveguide can be varied by slackening their clamping rings and rotating the thermocouples. The method adopted for setting up the system is to adjust the thermocouples one at a time for maximum output. The remaining thermocouple should have a six ohm resistor connected in parallel with it while this is being done. The mean transmitter power is then measured by, for example, the calorimeter method and RV1 adjusted until the meter M2 indicates the same power. This adjustment is made by the manufacturer and should only need to be repeated if a thermocouple has to be replaced.

Voltage regulator Type S2/1

49. The circuit diagram of the voltage regulator Type S2/1 is shown at fig. 10. This unit provides voltage stabilization for a.c. supplies of any value in the voltage range 200V-250V and frequency range 45-65c/s for any load power factor. The transformer numbers T1 to T4 which appear on the circuit diagram are employed for reference purposes only. They do not appear on the unit.

50. This voltage regulator uses an electro-mechanical control assisted by a two valve amplifier to produce the stable output voltage required. The a.c. output voltage is in fact the input voltage plus or minus the voltage developed across the secondary winding of the buck and boost transformer T4, depending on whether this is in phase or 180° out of phase with the voltage of the supply. This phase relationship is determined by the position of the brush (T) in relation to the tapping Z on the variable transformer.

51. The control action is as follows. The stabilized output is applied to the primary of transformer T1 set for the nominal mains voltage, in this instance 230. The secondary winding PM is applied to the bridge network, normally in a state of balance, in which the dependent variable is a 6·3V 0·3A pilot lamp. If the mains voltage varies the bridge is no longer balanced and a voltage, in phase or 180° out of phase with the supply depending on whether the voltage is a rise or fall, is then applied to the two valve amplifier via the 20: 1 step-up transformer T2.

52. The output of the amplifier is transformer coupled to the stator winding joined to terminals 2 and 5 on the servo motor. The overall phase change produced by the amplifier is arranged to be such that the output voltage is leading or lagging on the input by 90° and, as the motor requires a 90° phase difference between supplies to its two stator windings, a reference voltage direct from the heater winding on the input transformer T1 is applied to the stator winding at terminals 1 and 4. Thus the motor is arranged to drive the variable transformer brush in the appropriate direction to adjust the corrective voltage at the secondary of the buck and boost transformer to neutralise the original change and thus maintain the output voltage within 0·6V of the predetermined level required for the particular application.

53. The stator winding section connected to terminals 3 and 5 is used to provide the amplifier with a feedback voltage the amplitude of which is a function of the speed of the servo motor. This voltage is applied to the grid of the output valve V1A and stabilizes the servo system.

Note . . .

If the feedback system is disconnected the servo motor will hunt at about 1 *to* 2 *c/s. This provides a useful test of sensitivity of the instrument because the sensitivity is such that if the gain of the amplifier falls considerably, the mechanical friction would be sufficient to prevent hunting. The test is made by short circuiting the terminals* 3 *and* 5 *of the servo motor and moving the gear wheel of the motor slightly with the finger. If the system hunts it may be assumed that the sensivity is up to specification.*

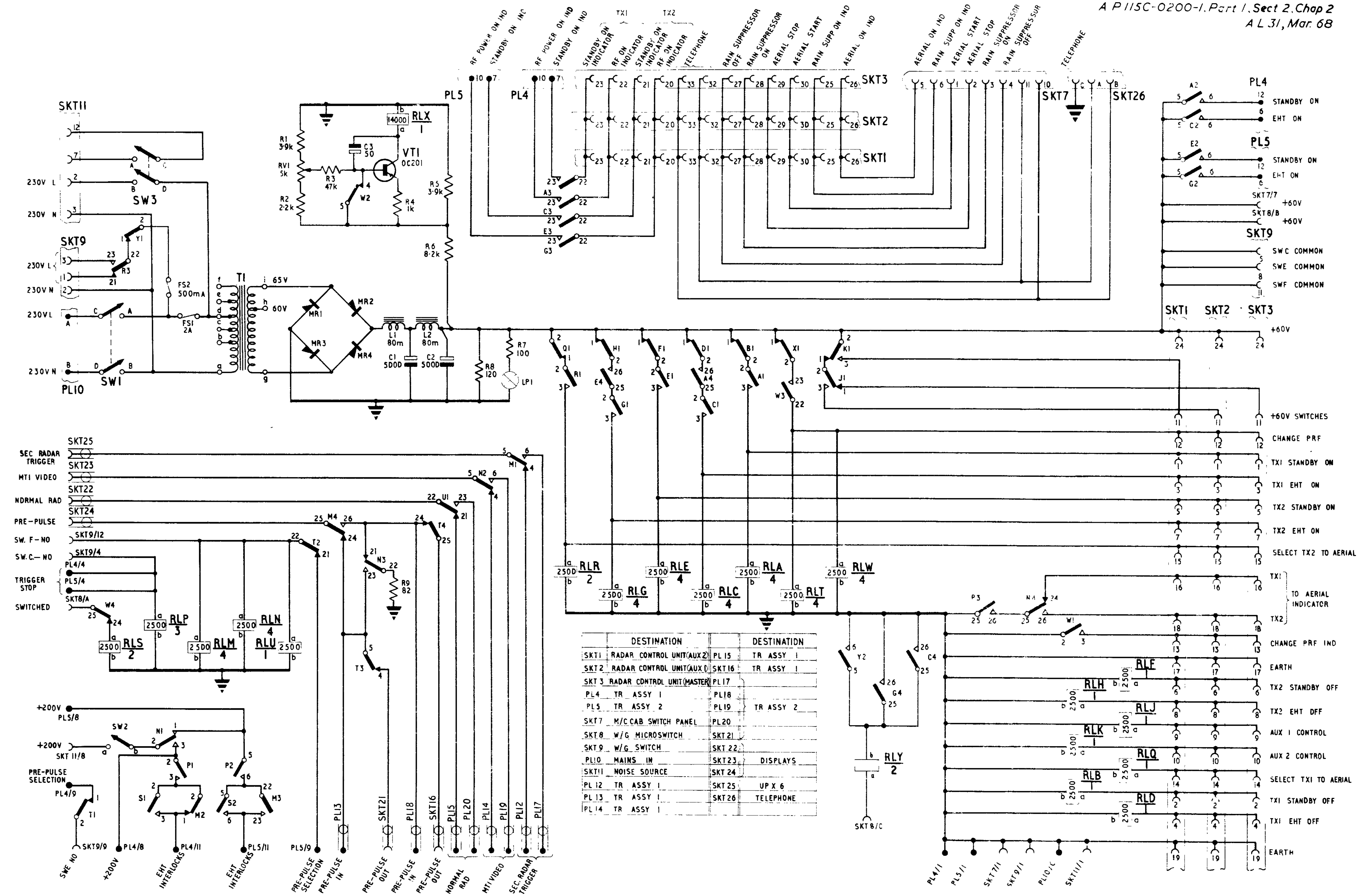
54. The purpose of the RC network in the grid circuit of V1A is to provide a filter for unwanted 3rd harmonic content at the input of the amplifier.

Voltage stabilizer Type S1/1

55. The voltage stabilizer Type S1/1 is very similar to that of the voltage regulator Type S2/1 and the circuit diagram is therefore not given here. Apart from the wattage rating of the transformers and variac the only other differences are those listed below:—

(1) The 40A, 10A, and 1A fuses of the voltage regulator Type S2/1 are respectively 15A, 3A and 1A in the voltage stabilizer Type S1/1.

(2) The resistor R21 has a value of 470 ohms in the voltage regulator Type S2/1 and 220 ohms in the voltage stabilizer Type S1/1.



	DESTINATION		DESTINATION
SKT1	RADAR CONTROL UNIT(AUX2)	PL15	TR ASSY 1
SKT2	RADAR CONTROL UNIT(AUX1)	SKT16	TR ASSY 1
SKT3	RADAR CONTROL UNIT(MASTER)	PL17	
PL4	TR ASSY 1	PL18	
PL5	TR ASSY 2	PL19	TR ASSY 2
SKT7	M/C CAB SWITCH PANEL	PL20	
SKT8	W/G MICROSWITCH	SKT21	
SKT9	W/G SWITCH	SKT22	
PL10	MAINS IN	SKT23	DISPLAYS
SKT11	NOISE SOURCE	SKT24	
PL12	TR ASSY 1	SKT25	UP X 6
PL13	TR ASSY 1	SKT26	TELEPHONE
PL14	TR ASSY 1		

Remote switching control Type S14/1 : circuit

Fig.4

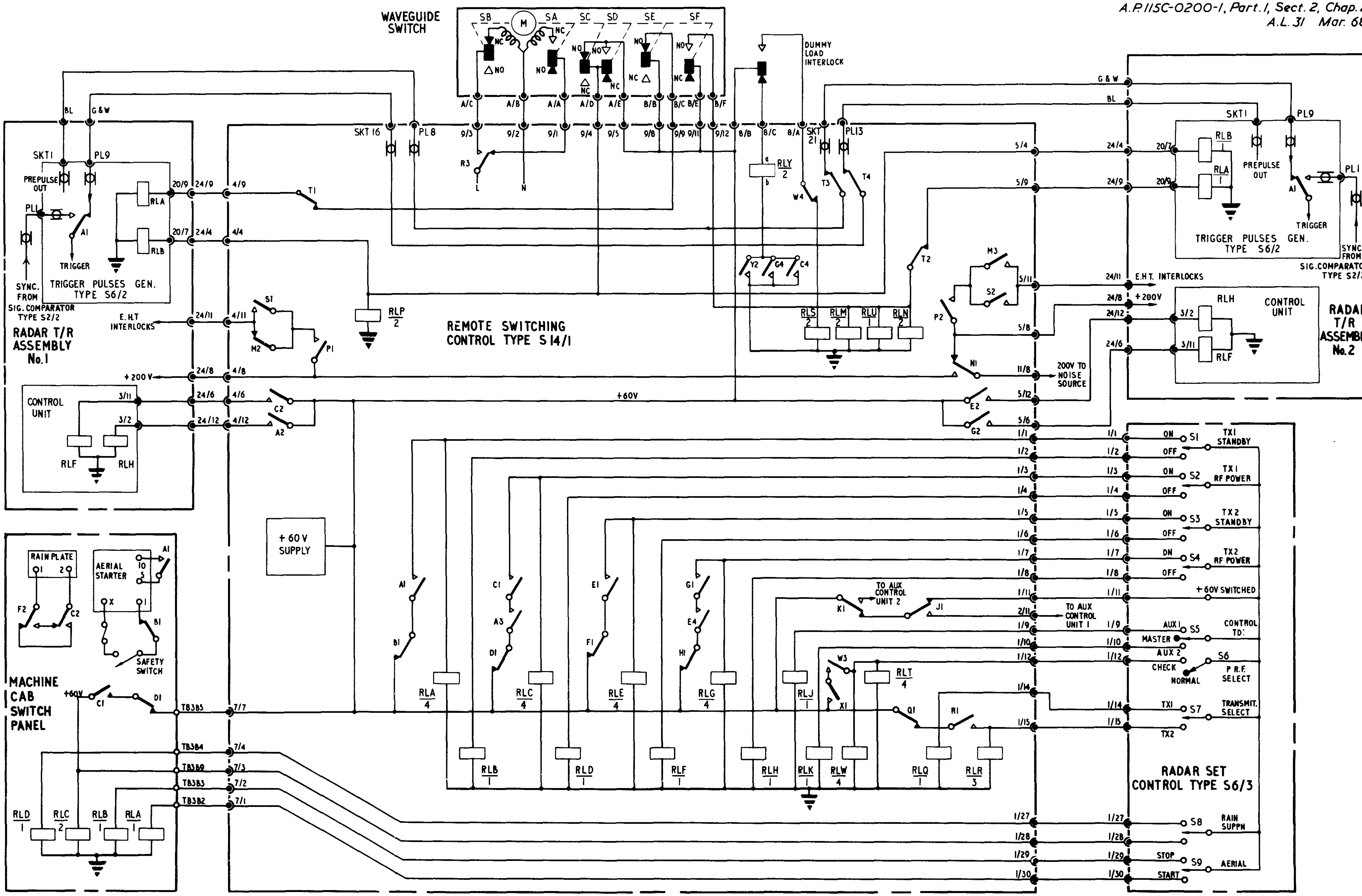
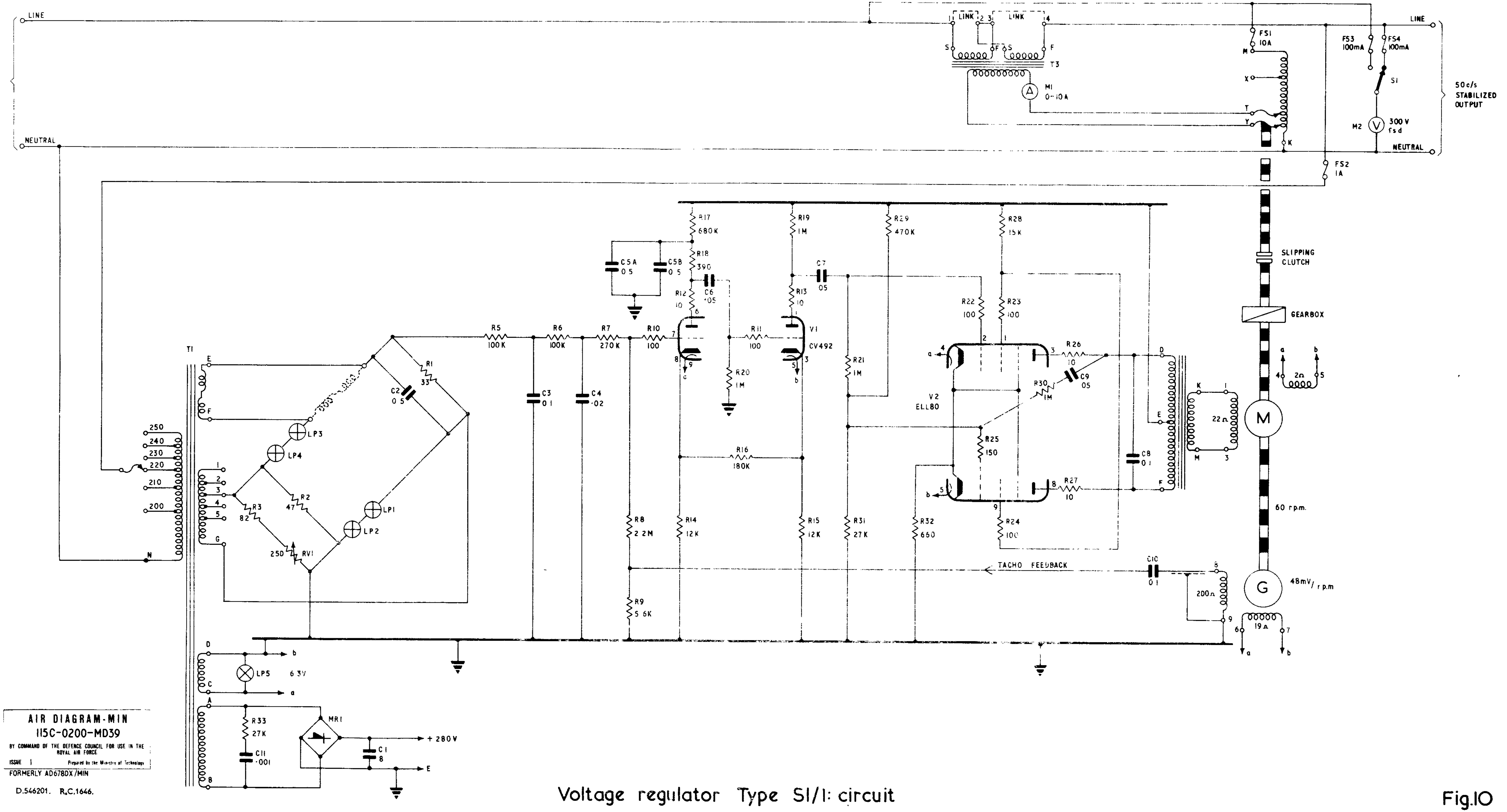


Fig.7

Simplified T/R Switching circuits

Fig.7



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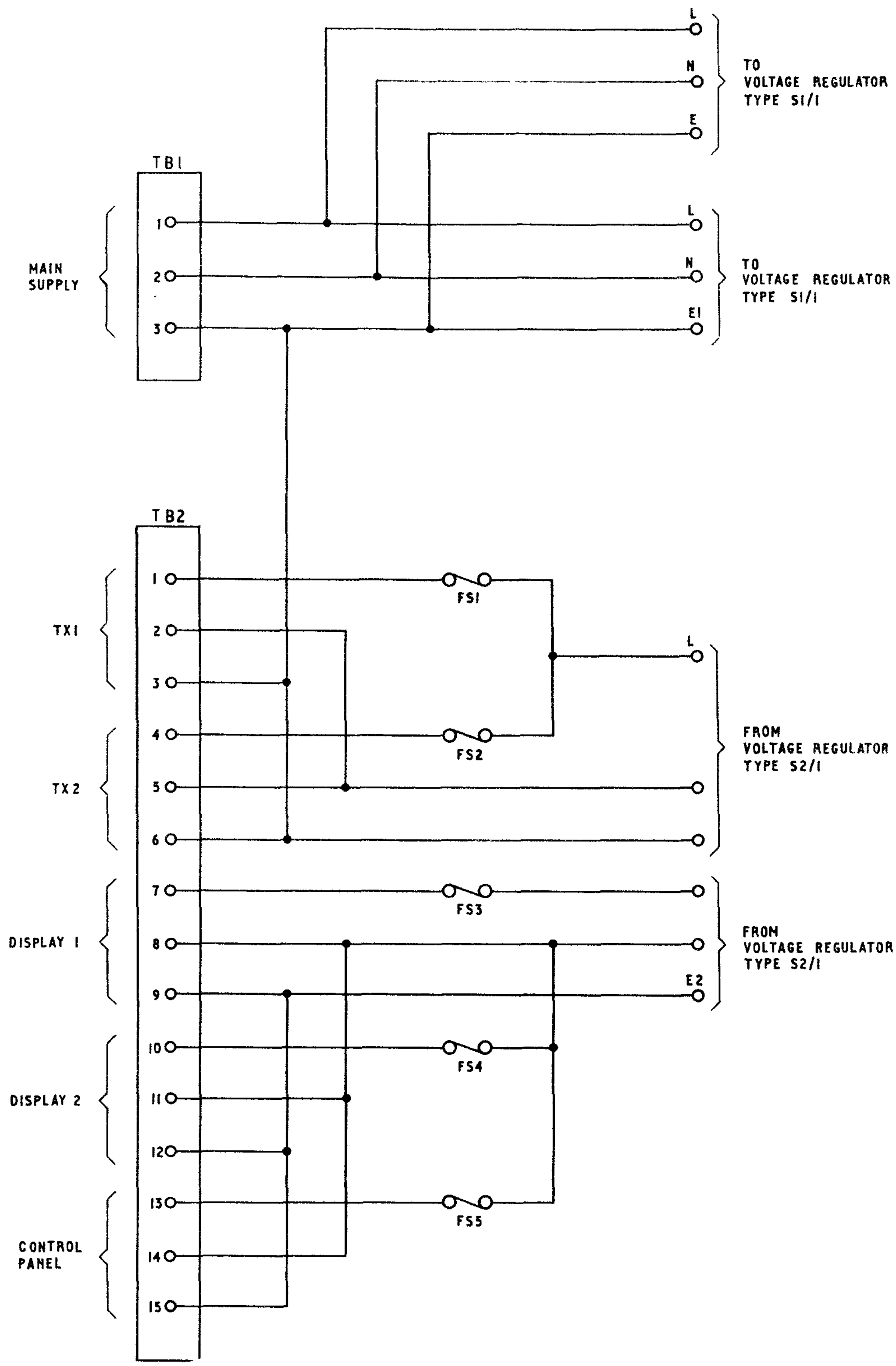
Voltage regulator Type S1/1: circuit

Fig.10



Distribution block (part of radar set group type S1/1)— circuit Fig. 11

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Chapter 3

AERIAL TYPE S5/1 AND AERIAL TURNING GEAR CABIN TYPE S5/1

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The Aerial Type S5/1 (scanner) represents the radiating element of the FGRI.26008/1 and carries circulariser and actuator assembly Type S1/2. The circulariser (anti-rain plate) provides rejection of unwanted signals returned from major masses of moisture-laden atmosphere. The functioning of the circulariser is dealt with in Appendix 1 of this Chapter. The radar scanner is on the roof of the aerial turning gear cabin Type S5/1 which houses the scanner turning gear and associated circuitry.

GENERAL DESCRIPTION

Aerial Type S5/1

2. The Aerial Type S5/1 (scanner) (fig. 1) has a waveguide fed aerial horn located at the focal point of the reflector. The waveguide and aerial horn are supported on a boom of tubular steel and the reflector is mounted on a tubular steel support frame. The complete scanner structure is supported on a ball race at the upper end of the turning shaft on the roof of the turning gear cabin.

3. The horn aerial has a sighting tube attached to it and this is used to align the horn with respect to the reflector during installation. The horn also has a 300W heater fitted to it for de-icing.

4. The reflector is a double-skin metal parabolic sector producing a continuous reflecting surface. It has a horizontal aperture of 16 ft and a vertical aperture of 6 ft. 9 in., and the resulting beam of radiation produced has a cosecant squared pattern with a top angle of 45°. Two aircraft obstruction lights are mounted on the reflector support.

5. ◀The aerial assembly may be tilted through about 4° elevation by adjustment of the tilt adjustment screw at the root of the boom assembly.▶ This adjustment may be made to compensate for minor changes in the disposition of permanent echoes at the site. The adjustment does not affect the focusing of the aerial which is set up carefully during installation.

6. The circulariser and actuator assembly Type S1/2 is also mounted on the boom. The circulariser is a grating type quarter wave plate consisting of an assembly of metal strips and plastic spacers. It can be raised as shown dotted in fig. 1 and thus interposed between the aerial horn and the reflector when rain clutter rejection is required. When not in use it is lowered to the alternative position shown in fig. 1.

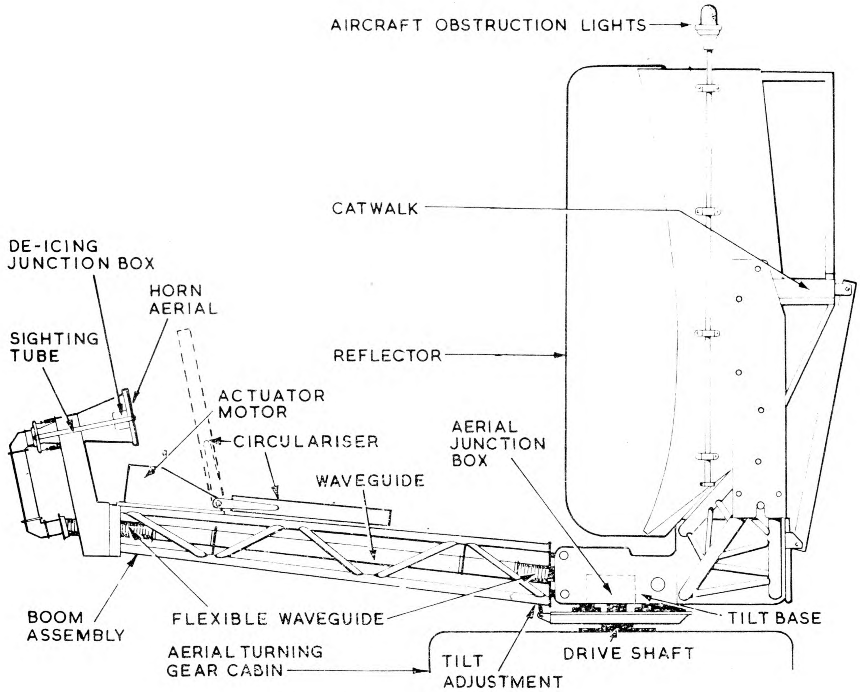


Fig. 1. Aerial Type S5/1

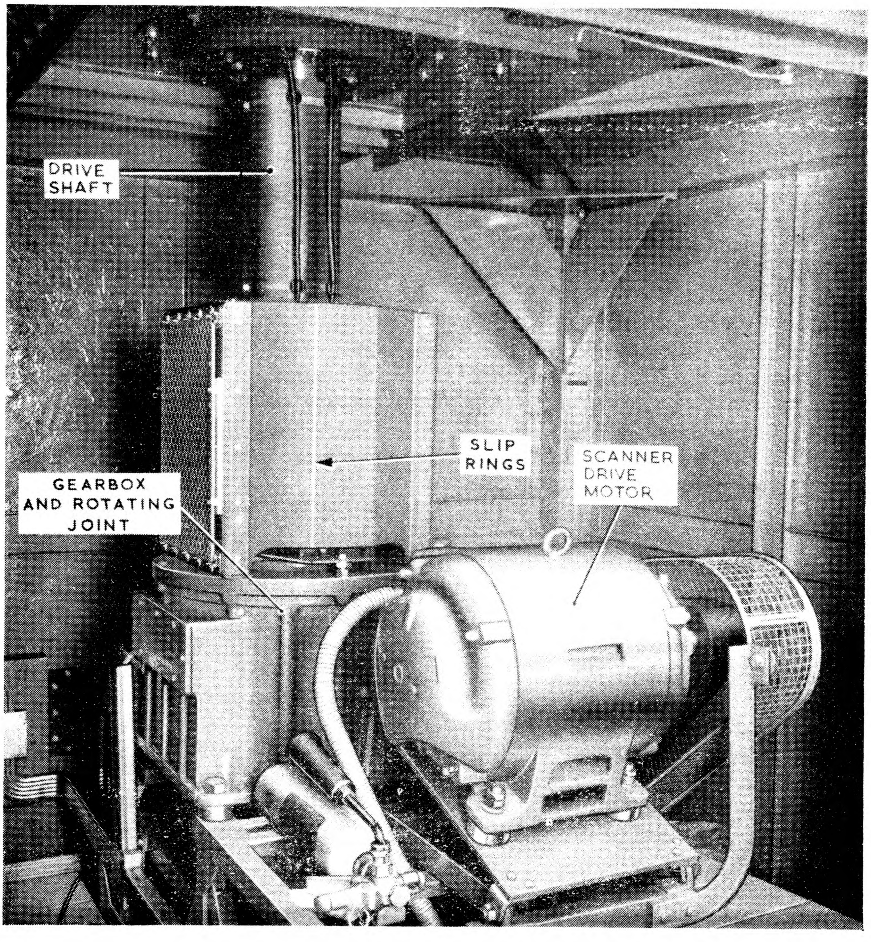


Fig. 2. Interior view of aerial tuning gear cabin showing scanner drive motor

7. The circulariser attitude is controlled by a 0·083 h.p. split phase actuator motor. The speed of this motor is 710 r.p.m. and this drives the shaft which raises and lowers the circulariser element via a 116 : 1 gear train. An electro-magnetic brake is fitted to the end of the motor shaft to stop it rotating immediately the supply is switched off.

8. A gantry is attached to the back of the reflector which facilitates servicing.

Aerial turning gear cabin Type S5/1

9. The aerial turning gear cabin Type S5/1 houses the 5 h.p. 1440 r.p.m. capacitor start–capacitor run split phase scanner drive motor (fig. 2) and associated belt driven gearbox, hollow tubular drive shaft or torque tube which transmits the drive to the scanner. The waveguide and rotating joint which carry the r.f. feed to the aerial are located inside the torque tube. The remaining electrical connections to the scanner are transferred via a set of sliprings at the base of the torque tube. The controls are located on a switch panel (fig. 3) mounted on the cabin wall and include a relay unit, scanner motor starter and associated capacitors, circulariser motor starter, two mains sockets for test equipment, and six circuit breakers. The circuit breakers are all rated at 5A except the earth leakage element, which is rated at 30A.

10. Details of the scanner drive are given in the cut away view given at fig. 4. It comprises a reduction gearbox interposed between the motor pulley and the torque tube. The main shaft (A) is a hollow tube of similar dimensions to the torque tube to which it is bolted. The main shaft is fitted with a bevelled wheel B driven by a pinion C which, in turn, is driven through a spur gear D by a pinion E mounted on the input drive shaft F. The gears A to J drive a shaft S which is coupled to the synchros assembly Type S1/1.

11. The rotating joint employed is of the straight through type and is built integrally with the gearbox. The complete system comprises a rectangular to circular transition bolted to the underside of the gearbox, a 3 in. circular waveguide in which is mounted a trapezoidally-shaped metal bar, and a circular to rectangular transition fixed to the upper rotating rectangular waveguide. This arrangement is demonstrated in the sectional view of the torque tube and rotating joint shown at fig. 5.

12. The circular waveguide is mounted concentrically within the gearbox main shaft and is supported in the latter by a ball bearing at the upper end and plain bearing at the lower end. This waveguide is driven in the same direction as, but at half the speed of, the upper transition and the rectangular guide. These are mounted within the torque tube and rotate at the scanner speed.

13. The joint works on the principle of the optical half-wave plate. The half-wave plate is formed by the metal bar in the circular waveguide and its effect is to make this waveguide effectively ellip-

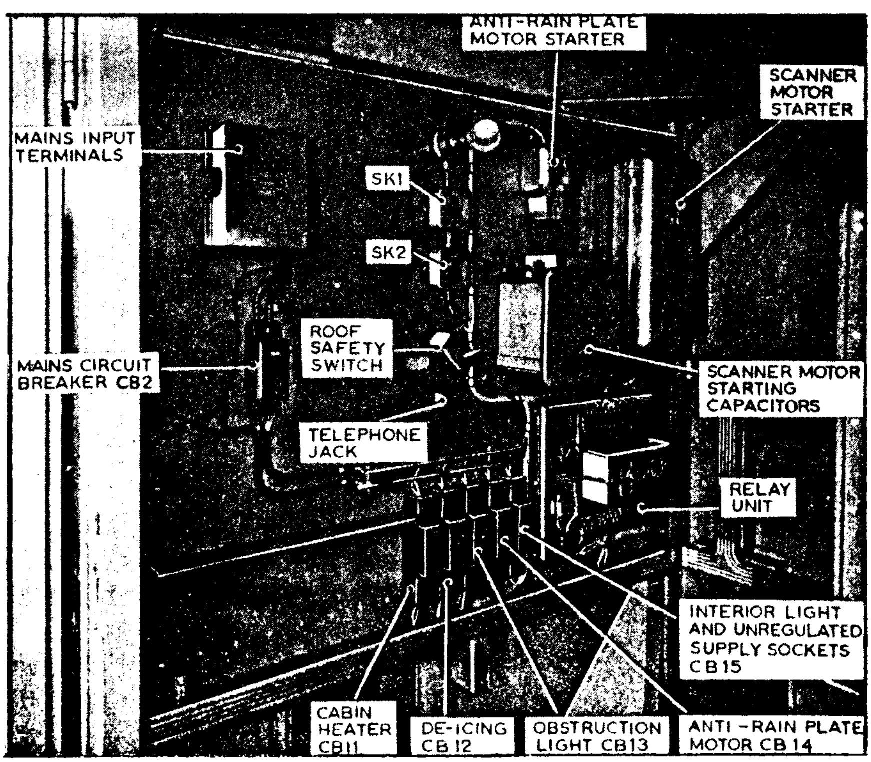


Fig. 3. Interior view of aerial turning gear cabin showing switch panel

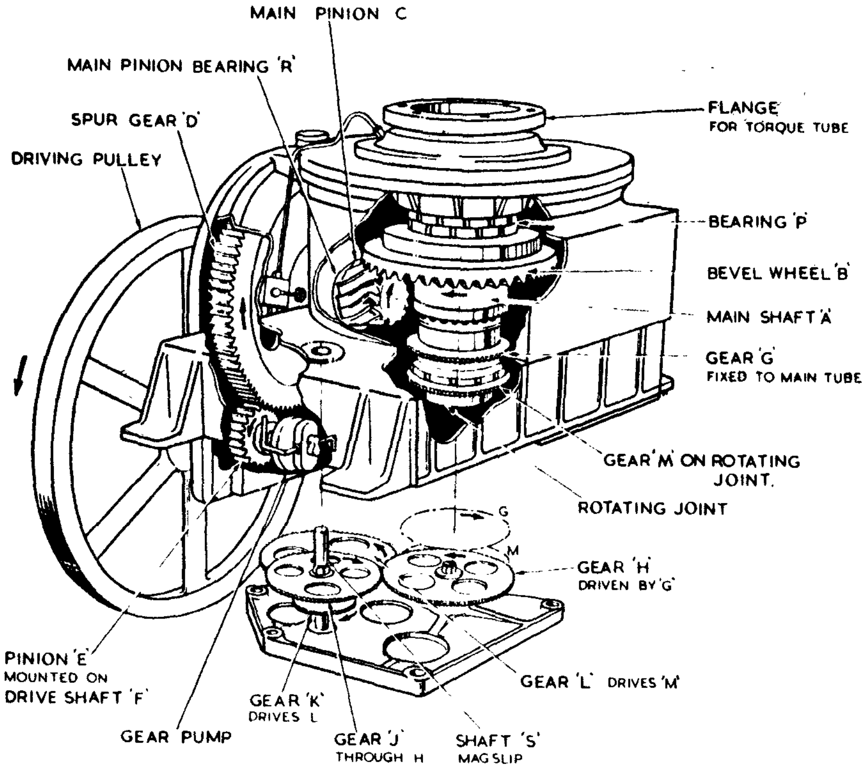


Fig. 4.
Cut away view of scanner drive gearbox

tical. The H_{01} mode in the rectangular waveguide is changed to the H_{11} mode in passing through the rectangular to the circular transition. This mode can be resolved into two components normal to and at right-angles to the plate, with amplitudes dependent on the angular position of the half-wave plate. The two cross-polarized components have different phase velocities, and the guide is so designed that there is a phase slip of 180 deg. between them in the passage through the circular waveguide. If one component is rotated by the action of the plate through an angle α from the direction of polarization of the original wave, the recombination of this component with the phase-reversed cross-polarized component at the output end of the circular guide gives a resultant wave polarized at an angle 2α to the original wave, and the upper rectangular waveguide must be turned through this angle, relative to the fixed guide, to receive the emergent wave.

14. The action outlined in para. 13 is illustrated by the vector diagrams shown at fig. 6. On the left, the input and output waveguides are shown in line with each other. With the metal plates in the circular waveguide in the position shown, the incident wave passes through without modification. On the right the circular waveguide is shown rotated through an angle α producing the components shown by the vectors drawn inside the waveguides. At the output end of the circular guide one component is shown reversed because of the 120 degrees phase slip. Recombination of the other component gives an emergent H_{01} wave which is rotated through an angle 2α.

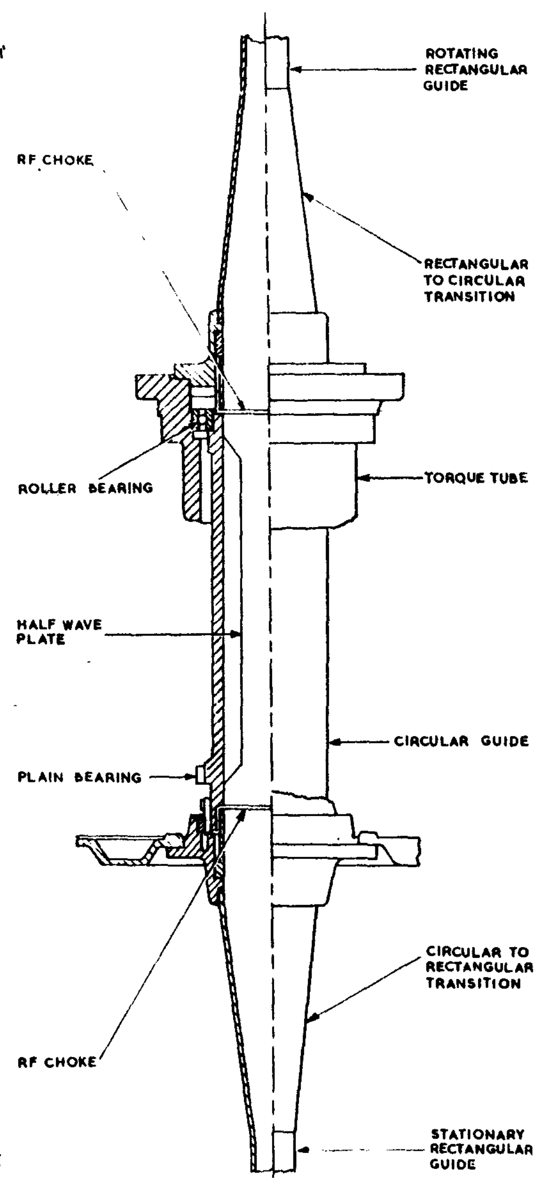


Fig. 5.
Sectional view of torque tube and rotating joint

15. The circular waveguide is driven by a 2 : 1 reduction gear from the gearbox main shaft A. This comprises the gear G, keyed to the main shaft (fig. 4), and intermediate gears H, J, K and L driving the final gear M, which is fitted to the lower end of the circular waveguide. Part of this gear train, G. H and J, is common to the synchros assembly shaft drive. At the shaft carrying J, the drive to the rotating joint is transferred to the smaller gear K, carried on the same shaft as J and rotating at the same speed.

16. A forced-feed pump system of lubrication is provided for the gearbox. This causes a steady flow of oil at the critical bearings. The oil reservoir is provided by the gearbox sump, and gives splash lubrication to the gears. Two glass sights are provided in the gearbox case for inspection of oil levels. The oil pump is of the geared type and delivers oil to the bearings through capillary tubing seen in fig. 7. The points to which the oil is directed are as follows :—

(1) The upper main shaft bearing P as shown in fig. 4.

(2) The main pinion bearings R.

(3) The mesh of the pinion C and bevel wheel B.

The pump is connected to the input drive shaft F (fig. 4) on the side of the spur gear casing remote from the belt pulley.

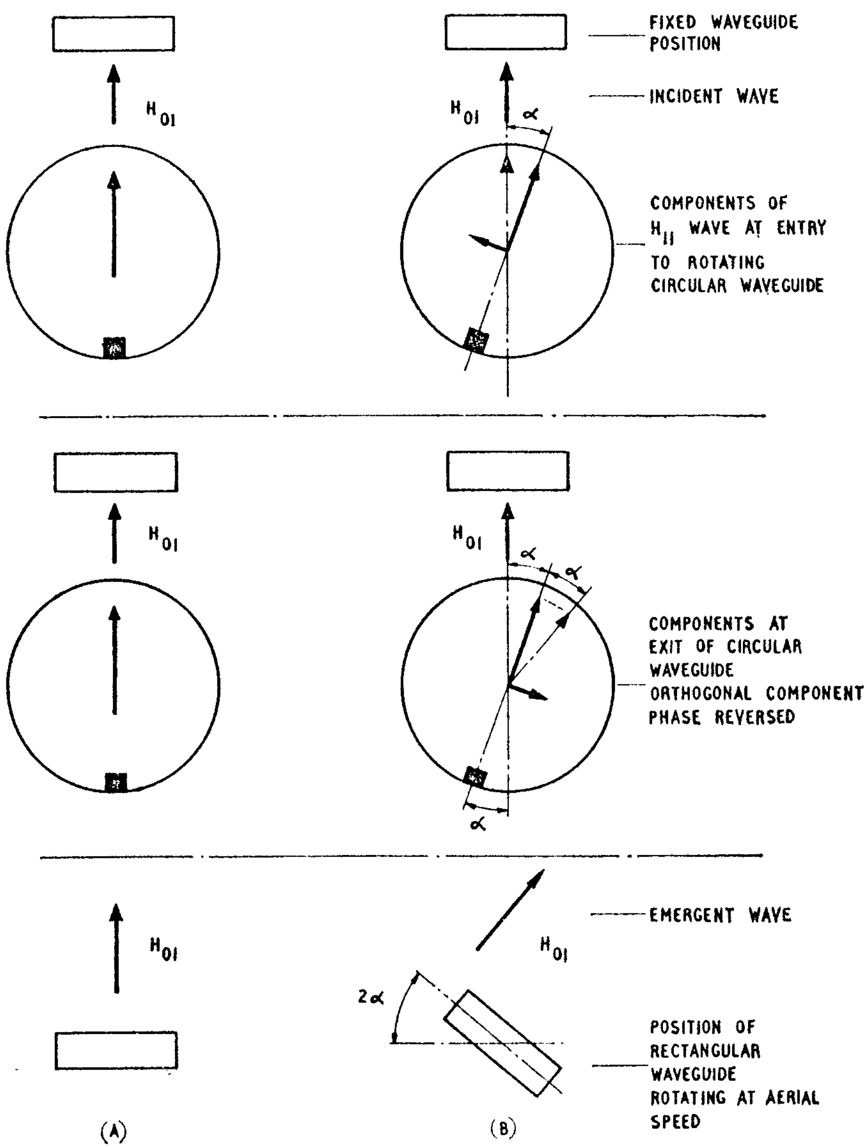


Fig. 6. Operation of rotating joint

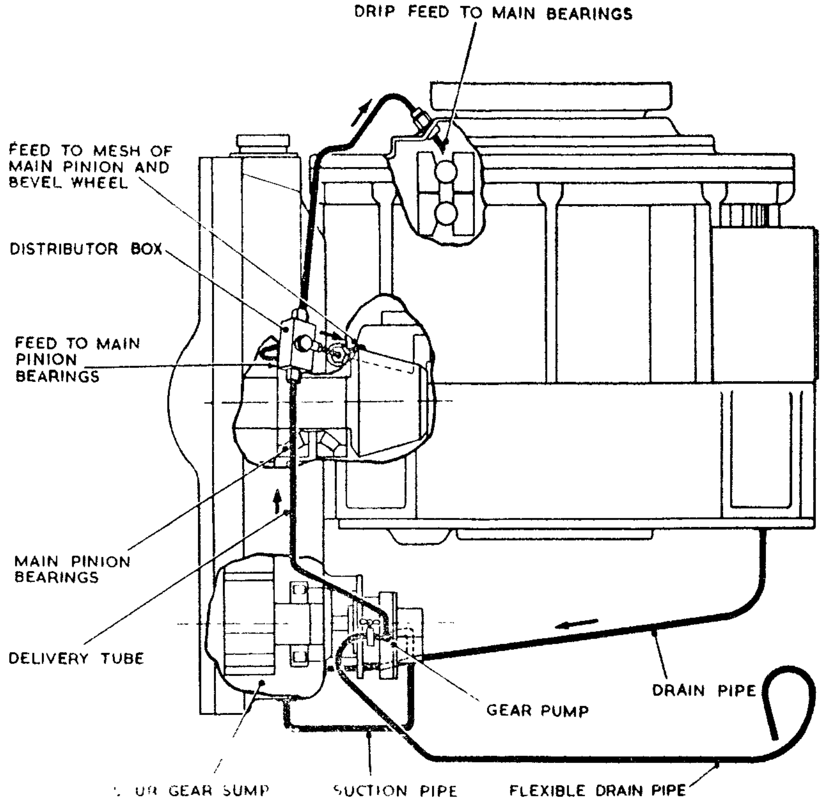


Fig. 7. Scanner gear box lubrication system

17. The aerial turning gear cabin also houses the synchros assembly Type S1/1 or magslip gearbox assembly which incorporates the magslips, sin-cos potentiometer and North marker microswitch. The synchros assembly provides aerial follow information for the displays at the two sites and is driven via gear S in the scanner drive gearbox (fig. 4).

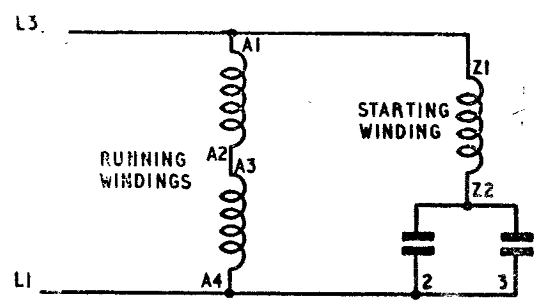
CIRCUIT DESCRIPTION

General

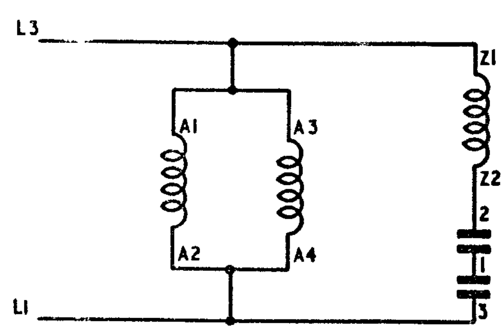
18. The circuit for the aerial turning gear cabin Type S5/1 and the Aerial Type S5/1, without the centimetric circuits, is shown at fig. 8. The unregulated 230V mains supply is introduced via TB1 and the 30A earth lead circuit contact breaker CB2. From here it is routed via 5A circuit breakers CB11 (cabin heater), CB12 (de-icing heater) on the aerial horn, CB13 (scanner obstruction lights), CB14 (anti-rain plate starter) and CB15 (interior lighting and unregulated supply sockets for test equipment).

Scanner drive motor and starter

19. When the START press button switch is closed the mains supply is completed to the start-run contactor and the start contacts close. At the same time the auxiliary contact between 9 and 10 closes, and this causes the main contactor coil to be energized and closes the main contacts. The supply to the scanner drive motor is then completed via



(a) STARTING



(b) RUNNING

Fig. 9. Connections to scanner motor windings

the thermally operated overload circuit breaker. The connections to the motor windings are then as shown at fig. 9a. At the same time the make-before-break switch changes position, bypasses the START switch and thus completes the circuit for the hold-on current to the contactors.

20. The current in the START-RUN contactor coil also passes through the thermal switch via the speed control resistors. After an interval, determined by the amount of resistance in circuit, the thermal switch contact opens and breaks the supply to the START-RUN contactor coil. The START contacts now open and the RUN contacts close. The connections to the motor winding are then as shown at fig. 9b.

Note . . .

The amount of resistance in series with the thermal switch is determined by the position of the link marked FMS *for fast, medium or slow changeover.*

21. If excessive current flows in the overload circuit breaker heaters, the bi-metallic strips are operated as a trip bar operates the overload trip contacts. This de-energizes the main contactor. The setting of the trip mechanism is variable and settings are shown on a chart fixed inside the cover of the starter.

Important Note . . .

The starter is rated for 15 starts per hour and repeated frequent operation without appropriate cooling interval may damage the start-run contactor coil.

22. An oil dashpot is associated with the start-run contactor. This dashpot should be filled with oil to the bottom of the threads.

Circulariser and actuator assembly Type S1/2

23. The motor of the circulariser and actuator assembly is controlled by a starter and remotely operated relays, all of which are located on the aerial turning gear cabin switch panel. The method of controlling the position of the anti-rain plate is demonstrated at fig. 10. This shows the conditions existing when the anti-rain plate is in the down position.

24. When the RAIN SUPPRESSOR switch on either the radar set control Type S6/3 or radar set control

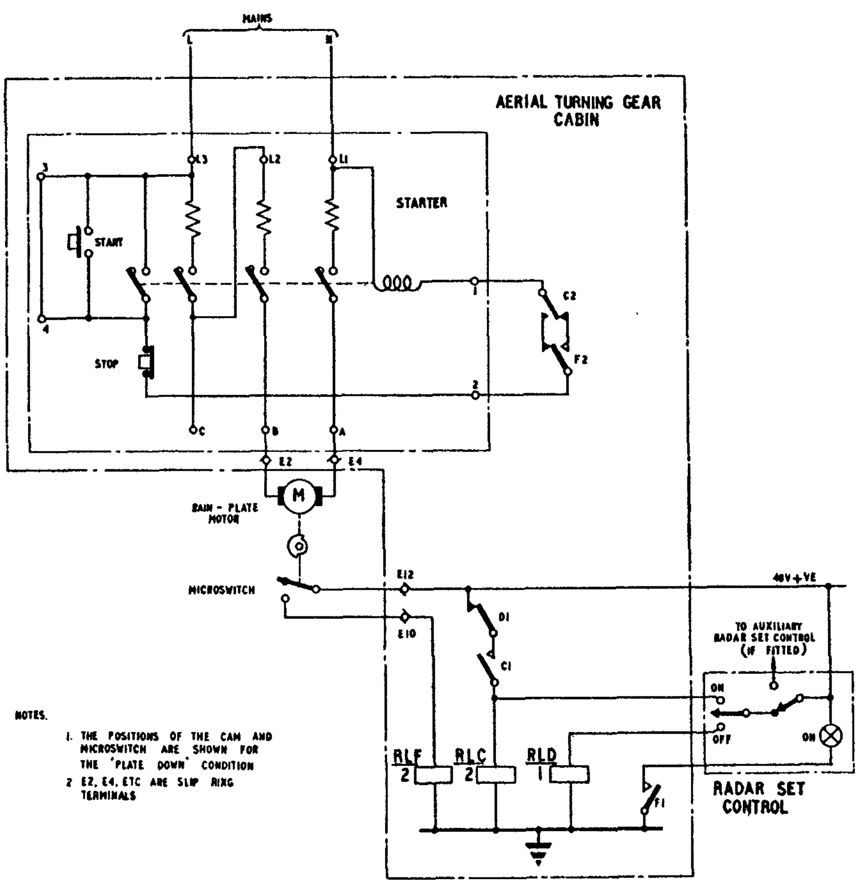


Fig. 10. Simplified anti-rain plate switching circuit

Type S6/4 is set to the ON position, relay RLC is energized and contact C2 completes the circuit of the contactor coil via contact F2. Contact C1 closes and provides a hold-on circuit for relay RLC. The motor turns half a revolution and raises the plate so that it intervenes between the horn aerial and the reflector. The cam then operates the actuator microswitch and causes relay RLF to be energized. Contact F2 breaks the contactor coil circuit. Contact F1 provides an earth connection to complete the circuit for the RAIN PLATE ON indicator lamps on both radar set controls.

25. When the RAIN SUPPRESSOR OFF switch at either of the radar set controls is depressed to the OFF position relay RLD is energized and contact D1 opens. This removes the hold-on supply for relay RLC. The changeover of contact C2 completes the contactor coil circuit and the motor turns another half revolution in the same direction as before. The mechanical linkage reverses and lowers the anti-rain plate. On completion of this operation, the actuator microswitch is opened by the cam and relay RLF is no longer energized. Contact F2 breaks the contactor coil circuit and the system reverts to the initial condition.

26. The electro-magnetic brake fitted to the motor to minimize over-running is spring loaded and normally in the on position. It is in series with the motor and when current is applied to this, the brake solenoid is energized and the brake released.

Synchros assembly Type S1/1

27. The synchros assembly Type S1/1 provides aerial turning information for the local and remote displays by means of a sin/cos potentiometer (to pulse generator Type S14/1 in pulse generator power supply Type S18/2) and two magslips (to synchros signal amplifier Type S23/1 in the rack assembly). The third magslip provided for video map is not used at present. Protection for the potentiometer is provided for the potentiometer windings by two 2mA fuses.

28. The two microswitches SA and SB are operated by a striker on the magslip drive. SA provides North marker information for the displays and SB has been provisioned for auto alignment facilities for the marker unit Type 30 required if video map is introduced.

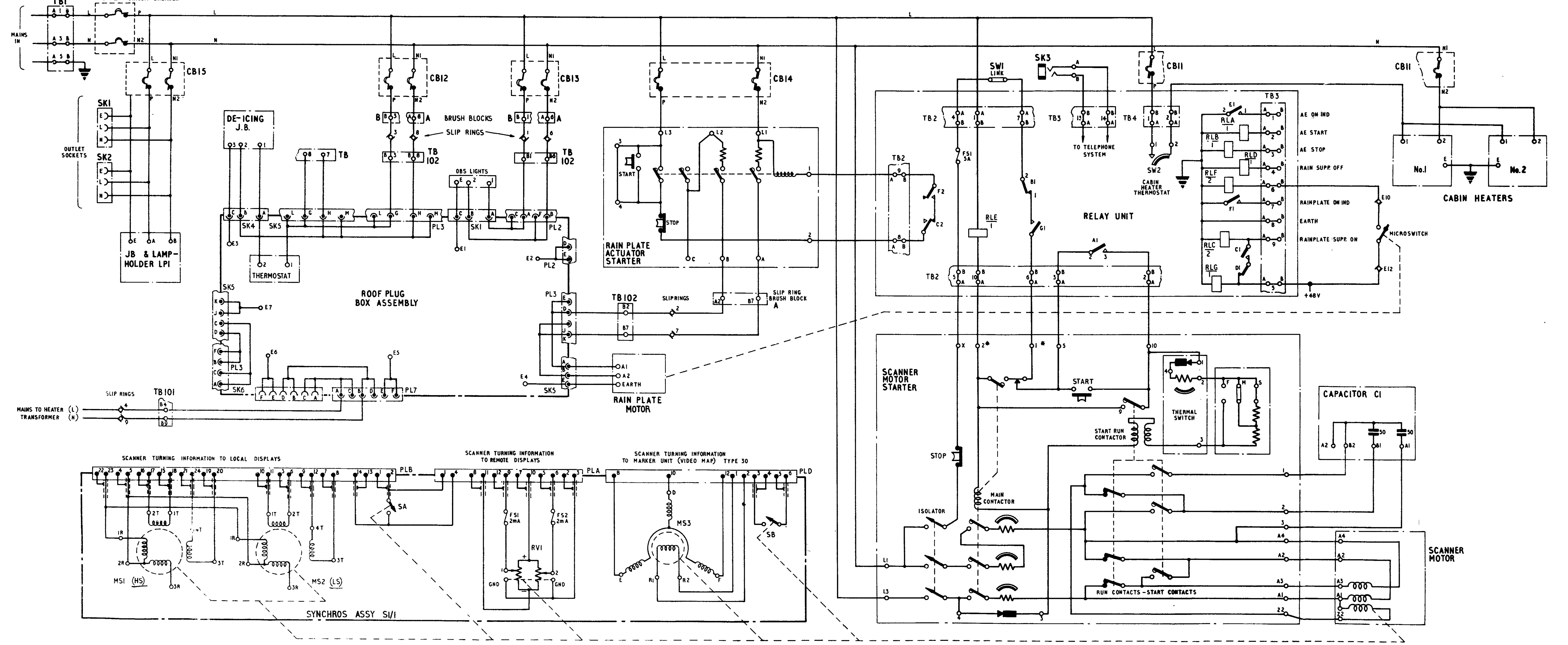


Fig. 8

Aerial turning gear cabin and scanner: interconnections

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Appendix 1

PRINCIPLE OF CIRCULARISER

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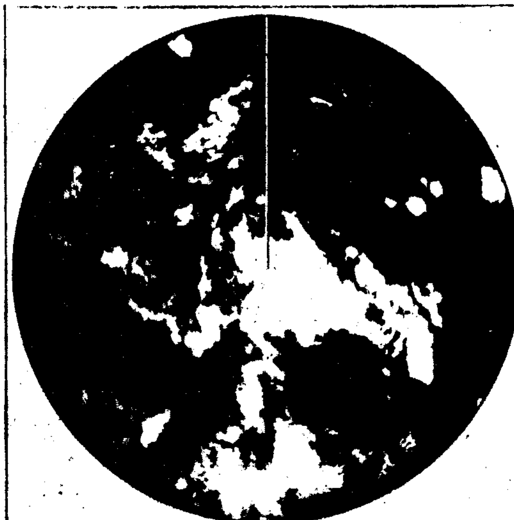
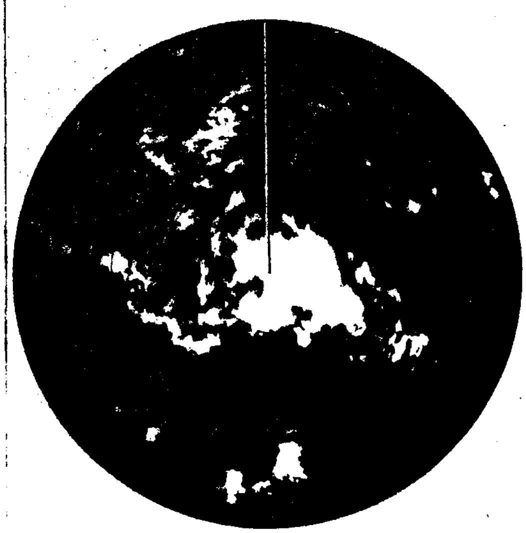
LIST OF ILLUSTRATIONS

Introduction

1. At S-band frequencies strong reflections are received from falling rain and in bad weather large areas of rain clutter on the p.p.i. may obscure the echoes it is desired to see. Discrimination against rain echoes is achieved by converting the horizontally polarized wave radiated by the horn to one that is circularly polarized, that is, one in which the electric vector rotates as the wave advances. This result is obtained by interposing the circulariser (anti-rain plate) between the aerial horn and the reflector. The effect of this is described in the following paragraphs and illustrated at fig. 1.



25M RANGE NORMAL RADAR : MODERATE RAIN



AS ABOVE WITH ANTI-RAIN PLATE IN USE

Fig. 1. Effect of introduction of circulariser (anti-rain plate)

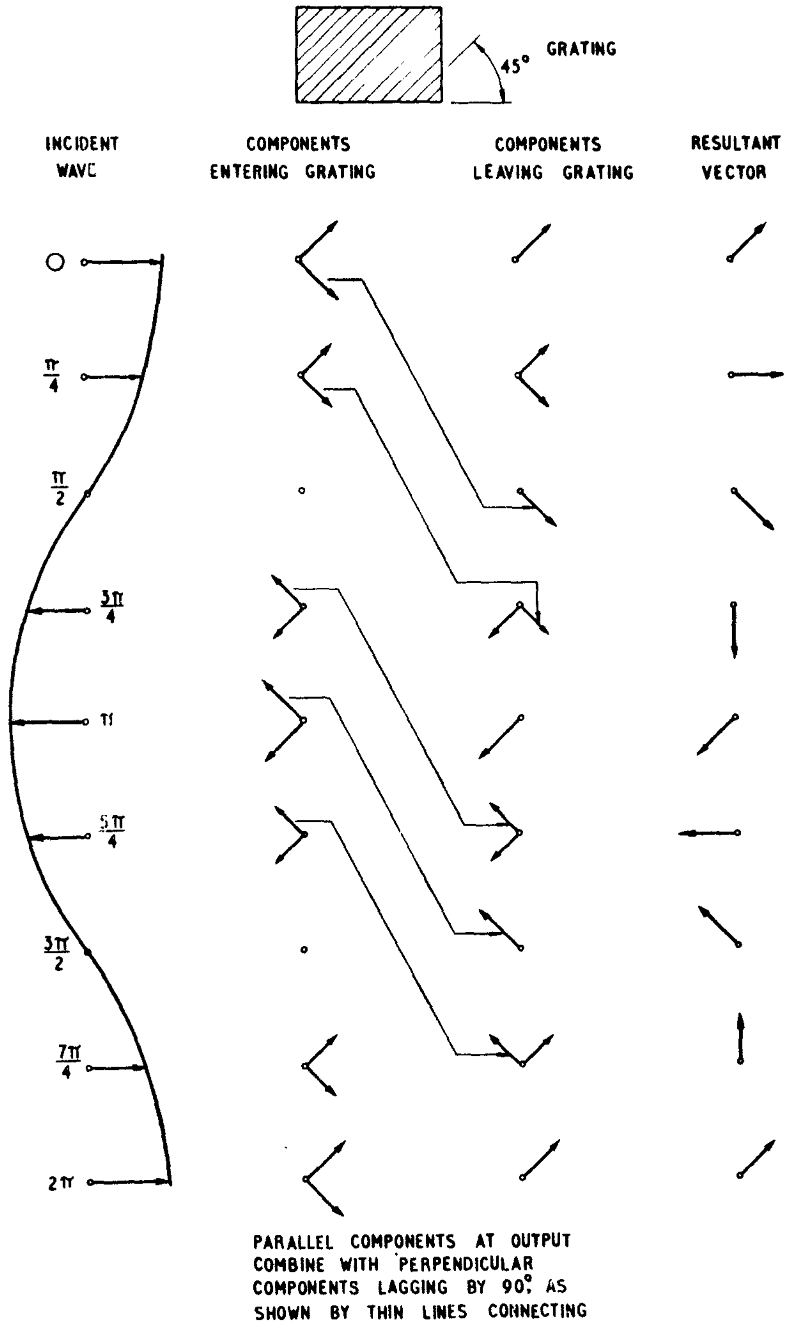


Fig. 2. Production of circularly polarized wave

Production of circularly polarized waves

2. The metal strips forming the grating of the circulariser have their short dimension in the direction of propagation of the wave and their long dimension at an angle of 45 deg to the direction of polarization of the wave emerging from the horn. This wave may be resolved into two components one parallel to the strips and another perpendicular to them. The two components have different phase velocities within the grating and the dimensions of the grating are chosen so that the component at right angles to the strips emerges from the grating with a phase shift of 90 deg. relative to the parallel component. Both components vary sinusoidally in amplitude and thus they combine to form a wave whose electric vector rotates.

3. The vectors in column 1 of fig. 2 show the variations in amplitude and sign of the incident wave at intervals of $\frac{1}{8}$ cycle. The second column shows the components of this wave parallel and perpendicular to the strips. The components at

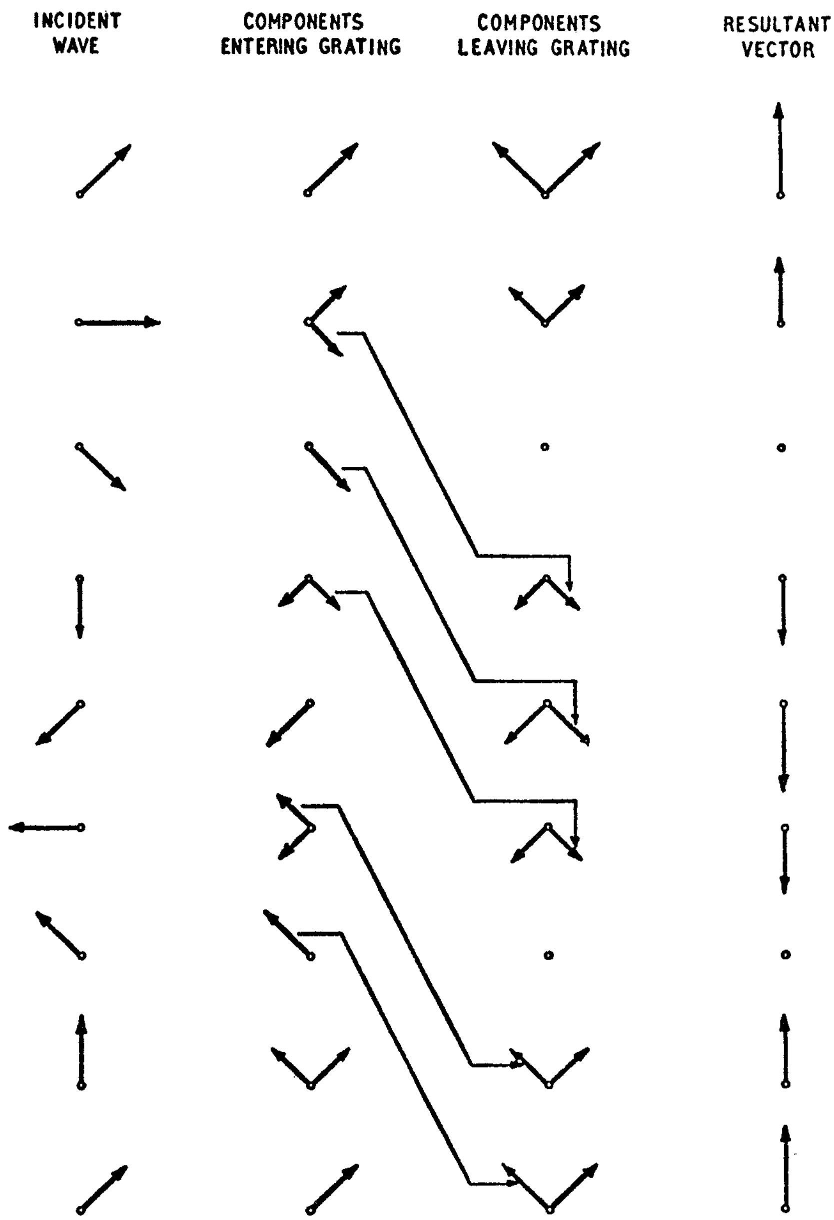


Fig. 3. Conversion of circularly polarization rain echo to vertical polarization

the exit of the grating are shown in column 3. Here the parallel components are in the same phase as those shown in column 2 and the components at right angles lags by 90 deg. The last column shows the re-combination of these components into a wave whose electric vector rotates and at the same time maintains a constant amplitude.

Reflection by rain drops

4. Due to the fact that raindrops are approximately spherical in shape and present a symmetrical aspect to an incident wave they therefore reflect waves polarised in any direction equally. There is a 180 deg. phase reversal on reflection and a reflected circularly polarised wave will appear, if seen from source, to be rotating in the same direction as the transmitted wave.

5. The manner in which a wave reflected from a raindrop is affected during its return passage through the grating is illustrated at fig. 3. The first column shows the electric vector of the circularly polarised incident wave at ⅛ cycle intervals during one complete cycle. In the second column

this vector is resolved into components parallel and perpendicular to the metal strips. The parallel components are shown in column 3 emerging from the grating in the same phase as at the input, while the component at right angles is retarded by 90 deg. The right-hand column shows the result of combining these two components. The resultant is now vertically polarised

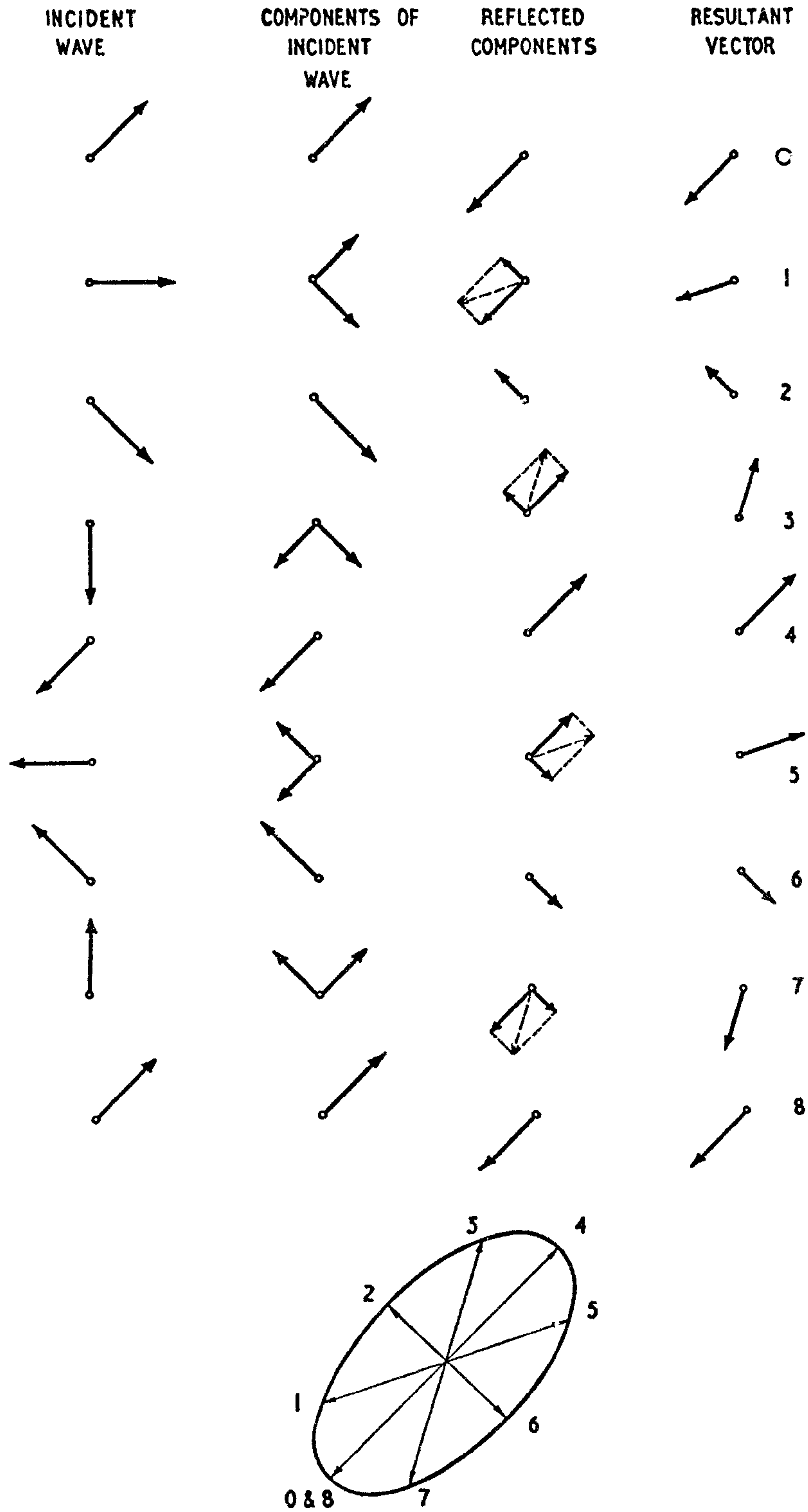


Fig. 4. Elliptical polarization resulting from unequal reflection of the components of a circularly polarized wave

and varies sinusoidally in amplitude. The vertically polarised wave is not accepted by the waveguide and thus no signal is passed to the receiver.

Reflection by an aircraft

6. An aircraft is an irregular structure and therefore nearly always reflects most efficiently waves of one particular polarisation. It will therefore reflect the components of a circularly polarised wave unequally and the reflected wave will be elliptical, that is, its electric vector will rotate and also vary in amplitude. The first two columns of fig. 4 show a circularly polarised wave and its components. These vectors are a repetition of those shown in columns 3 and 4 of fig. 2. If it is assumed that a particular aircraft reflects most effectively waves polarised in the direction shown at the top of columns 1 and 2 in fig. 4, then the third column shows the components reflected unequally, with a phase reversal, and the last column the reflected components re-combined, producing an electric vector which rotates and varies in amplitude. An object which favours any other direction of polarisation will reflect a wave of a similar nature but the axis of the ellipse described by the rotating vector will lie in different directions. The eccentricity of the ellipse depends on the relative efficiency of reflection for different polarisations.

Reception of a wave reflected from an aircraft

7. It can be seen from fig. 3 that vertically polarised wave emerges from the grating after reflection from rain because, at each of the instances selected, the component parallel to the strips combines at the output with a cross component of the same amplitude. When the returning wave is elliptically polarised, these com-

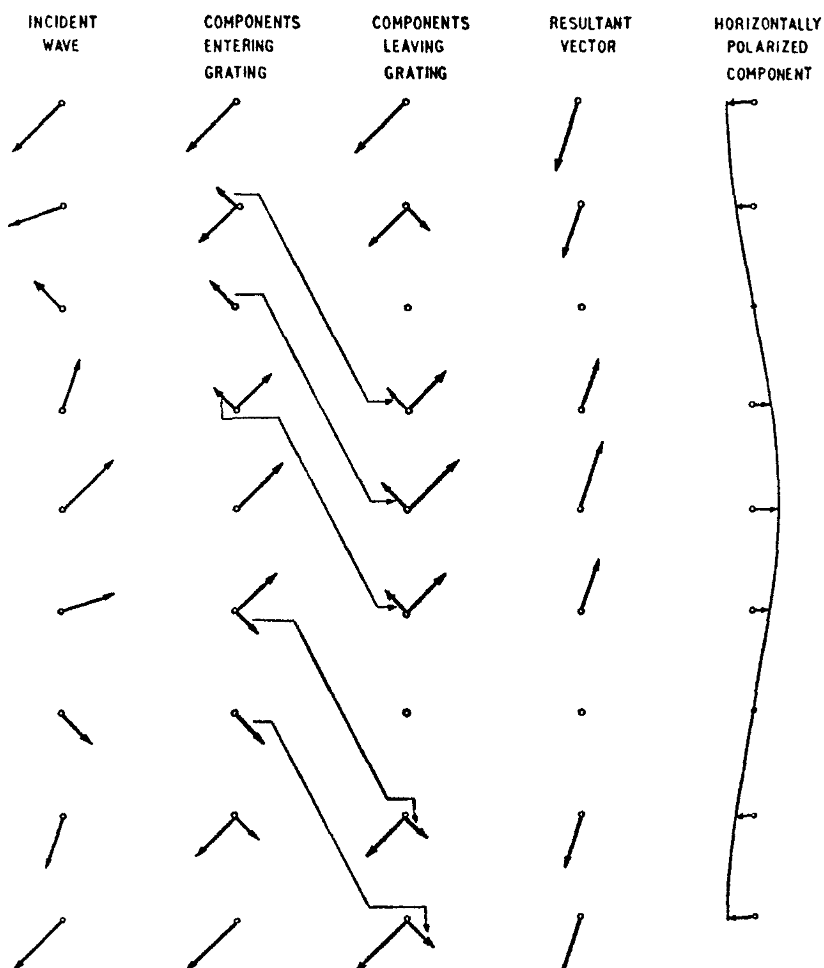


Fig. 5. Conversion of elliptical polarization to linear polarization

ponents are no longer equal and they are thus asymmetrical with respect to both the vertical and horizontal axis. This is illustrated in fig. 5 where the vectors and components of the incident wave are repetitions of those shown at fig. 4. As before, the components parallel to the strips are shown (column 3) in the same phase as at the input, and the cross components, now of small maximum amplitude, are shown lagging by 90 deg. It will be seen from column 4 that the resultant wave is linearly polarised in a direction inclined to the vertical. There is therefore an alternating horizontal component that is accepted by the waveguide and passed to the receiver.

Conclusion

8. It will be seen from the above that, ideally, no signal is passed to the receiver due to rain echoes. In practice, reductions of the order of 25dB in rain echoes are achieved, for a reduction of only 3 to 4dB in the level of the wanted signals. An overall discrimination aginst rain echoes exceeding 20dB may thus be obtained.

Chapter 4

AZIMUTH RANGE INDICATOR TYPE S5/1

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LIST OF ILLUSTRATIONS

Introduction

1. The azimuth range indicator Type S5/1 is the display unit used in FGRI.26008/1 and three are provided, one for use at the remote site and the other two at the approach control room. The associated waveform generation circuits are located in the pulse generator power supply Type S18/2 (remote site) and the pulse generator power supply Type S18/1 (radio equipment and approach control rooms).

General description

2. The azimuth range indicator consists of a normal c.r.t. type housing with the c.r.t. fitted through the centre. The deflection coil, pre-centering and focus coils on the neck of the tube are fitted to the base of the casing and the remaining components are mounted on the

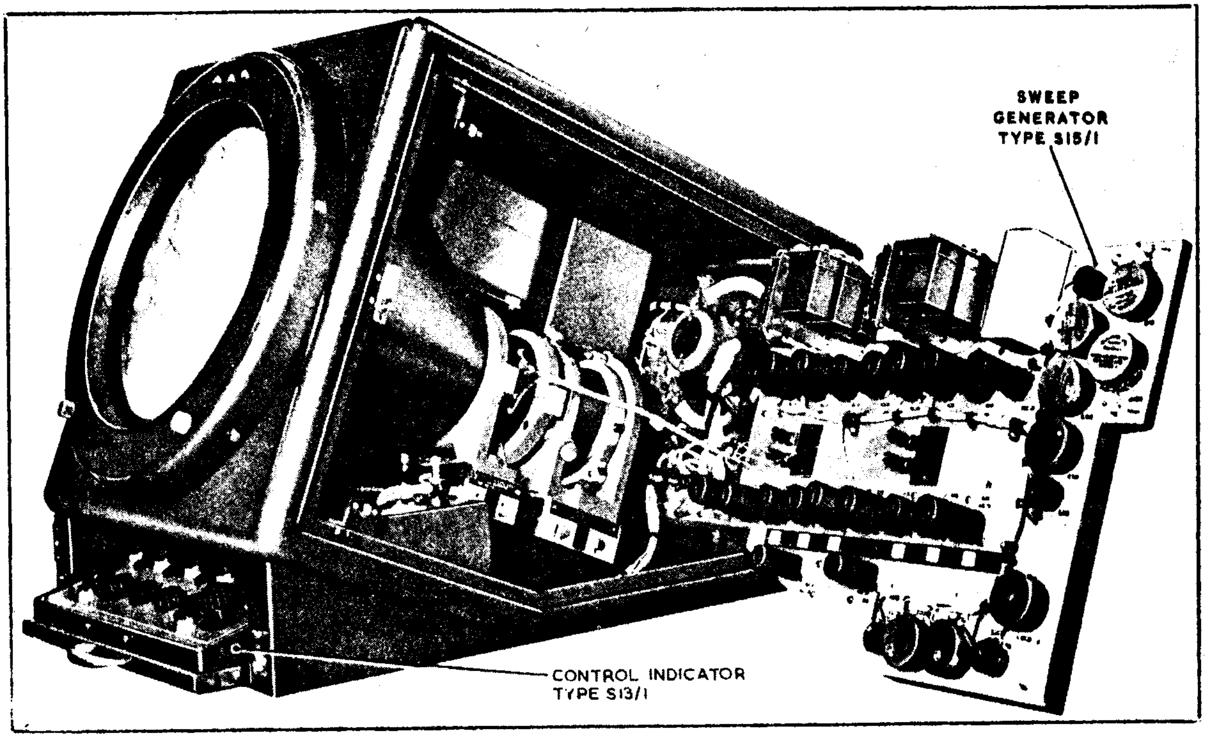


Fig. 1. Internal view of Azimuth range indicator showing sweep generator Type S15/1

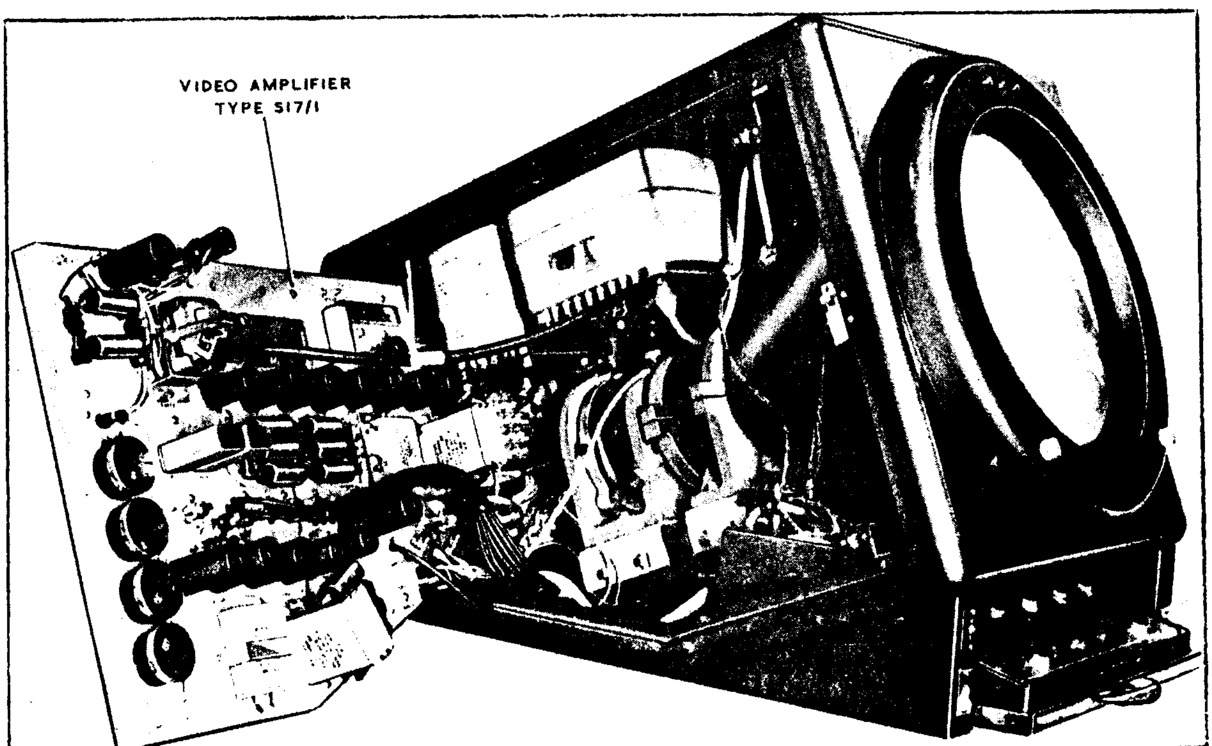


Fig. 2. Internal view of Azimuth range indicator showing Video amplifier Type 517/1

base and the roof of the casing. Two main sub-assemblies, the video amplifier Type S17/1 and the sweep generator Type S15/1 (fig. 1 and 2) are on hinged chassis to provide maximum accessibility for servicing. They are normally protected by the removeable side panels. Two safety micro-switches are fitted to the casing in such a position that they are operated when the side panels are opened and thus disconnect the power supplies from the unit.

3. The rear panel of the unit (fig. 3) has 24 coaxial sockets, three 5A sockets, and a blower unit and associated grille mounted on it. Eight of the coaxial sockets are not used in this application. One of the 5A sockets is for connection to the unstabilized mains supply and the other to make this supply available for test equipment.

4. The extractor fan driven by the blower motor is mounted behind the grille. It draws air through the polythene filter in the control indicator recess.

5. Two 30W anti-condensation heaters are fitted below the c.r.t. They are automatically connected to mains supply when the equipment is switched off to simulate the heat normally produced by the components.

6. The operating controls for the azimuth range indicator are all mounted on a third sub-assembly, the control indicator Type S13/1, which is housed in a recess in the front of the unit. The control indicator is coupled to the azimuth range indicator via flexible leads terminated in a plug and a socket. This enables the control indicator unit to be withdrawn when adjustments have to be made. The function of these controls as detailed in table 1.

7. The sweep generator Type S15/1 carries the circuit for X and Y deflection and the video amplifier Type S17/1 those circuits associated with video mixing, brightener mixer and the e.h.t. circuits. Power supplies for these are obtained through one of the switching units in the voltage stabilizer Type S4/1 in the appropriate pulse generator power supply.

8. The sweep generator Type S15/1 and the video amplifier Type S17/1 chassis have a number of preset potentiometers required during setting-up only and in addition, the sweep generator is provided with a number of monitoring points.

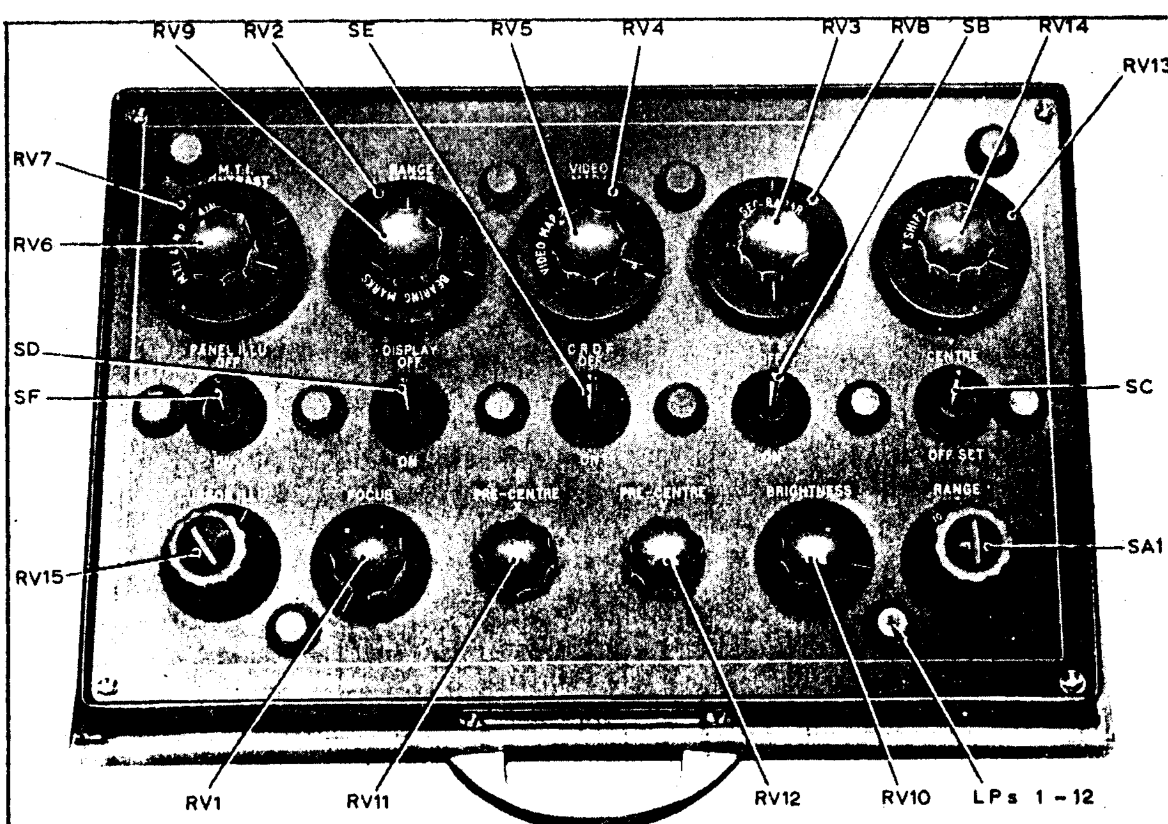


Fig. 3. Control indicator Type S13/1

TABLE 1

Function of controls on control indicator Type S13/1

Circuit reference	*Function*	*Remarks*
SA1	RANGE SWITCH	4 position rotary switch.
SB	Toggle switch	When set to ON, relays in the video amplifier Type S17/1 are energized from the +330V supply. Two of the input circuits to the video amplifier then present a short time constant (S.T.C.) to the input pulse and so reduce clutter.
SC	CENTRE/OFFSET	Toggle switch. This brings into operation the X and Y OFFSET controls.
SD	DISPLAY ON/OFF	Toggle switch. This initiates the switching sequence which provides stabilized mains and h.t. supplies to the azimuth range indicator.
SE	C.R.D.F.	Toggle switch. This brings into operation the C.R.D.F. control RV8.
SF	PANEL ILLUM. ON/OFF	Toggle switch. This is used to complete the 28V ac. circuit from P2 to the 12 panel lights.
RV1	FOCUS	This control adjusts the correct potential of the focussing valve V16 on the video amplifier chassis and thus controls the current through the c.r.t. focussing coil.
RV2	RANGE RINGS	Adjustment of this control enables range rings to be displayed. It is not used in this application.
RV3	SECONDARY RADAR	This controls the secondary radar display.
RV4	VIDEO MAP 1	This control is provided for the first video map display. It is not used in this application.
RV5	VIDEO MAP 2	This control is provided for the second video map display. It is not used in this application.
RV6	M.T.I./N.R. GAIN	This controls the mixed m.t.i. and normal radar signals display.
RV7	M.T.I. CONTRAST	This control enables permanent echoes to be displayed as a background to moving targets.
RV8	C.R.D.F.	This controls the c.r.d.f. display It is not used in this application.
RV9	BEARING MARKS	This controls the north marker display.
RV10	BRIGHTNESS	This controls the general brightness level of the display.
RV11	PRE-CENTRE X	This control varies the current through the X pre-centering coil.
RV12	PRE-CENTRE Y	This control varies the Y pre-centering coil current.
RV13	X SHIFT	
RV14	Y SHIFT	
RV15	CURSOR ILLUM.	This control adjusts the illumination level of the nine lamps surrounding the cursor.

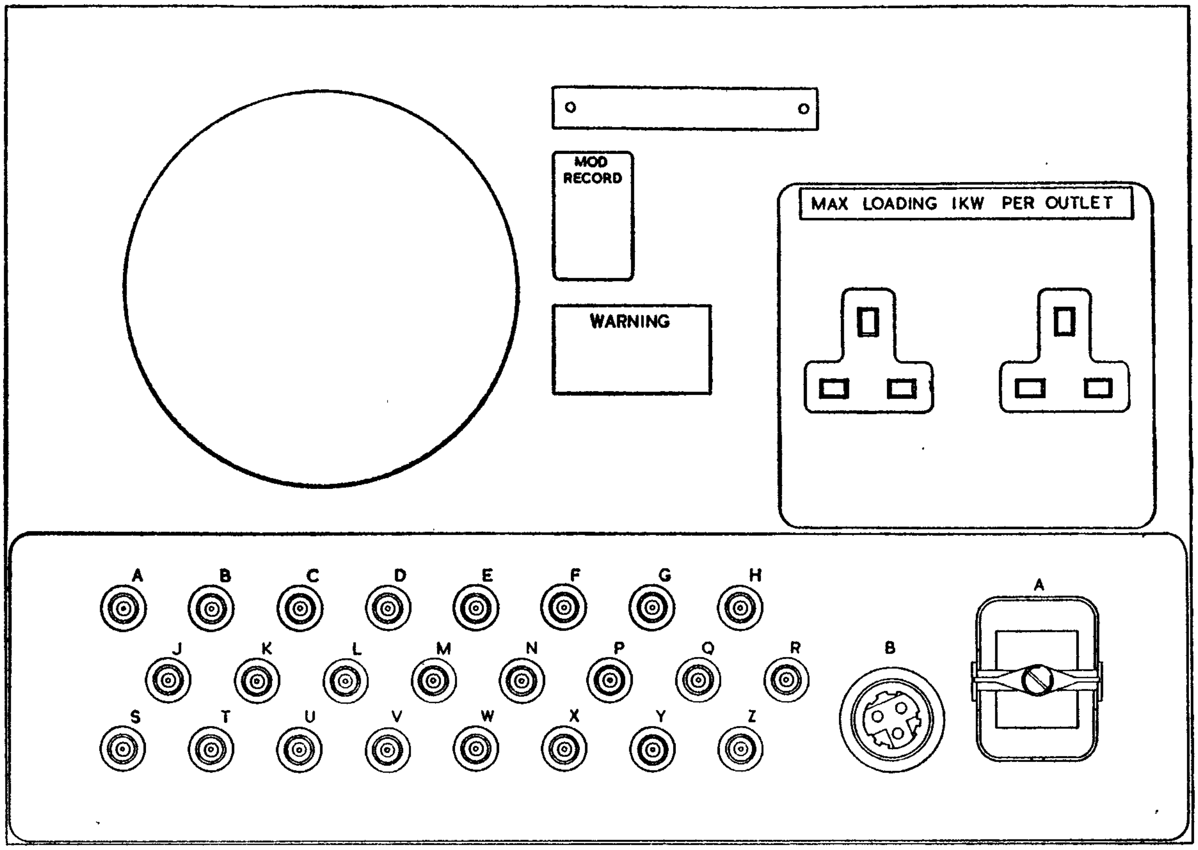


Fig. 4. Rear Panel of Azimuth Range Indicator Type S5/1

CIRCUIT DESCRIPTION

General

9. The overall circuit diagram of the azimuth range indicator is given at fig. 5 and the detailed circuits of the three sub-assemblies, that is, the sweep generator Type S15/1, the video amplifier Type S17/1 and the control indicator Type S13/1 are given at fig. 6, 7, and 8 respectively.

10. The sweep generator Type S15/1 provides conversion of the sawtooth input voltages from the integrators to sweep current for the deflection coils. D.c. coupling is employed and the use of high gain amplifiers plus a large amount of negative feedback, ensures good frequency response and an accurate coil-current representation of the input waveform. Provision is made for offsetting the display to allow more detailed observation of a selected area. The circuits of the X and Y channel amplifiers are identical. The video amplifier Type S17/1 can accept up to five positive-going brightener input signals and supplies a positive output to the grid of the c.r.t. It can also handle up to six positive-going video signals and supply a negative output to c.r.t. cathode. It comprises a video mixer, brightener mixer, focus pre-centre circuit and an e.h.t. oscillator regulator circuit. The third of the sub-assemblies, the control indicator Type S13/1, carries all the main operational controls.

Important Note . . .

> **The X PRE-CENTRE control (RV11) and Y PRE-CENTRE control (RV12) must not under any circumstances be used to centre the origin of the trace.**

Sweep generator Type S15/1

11. The sweep generator Type S15/1 comprises two identical deflection amplifiers which convert the X and Y sawtooth input voltages from the pulse generator power supply Type S18/2 into drive currents for the deflection coils of the c.r.t. (fig. 5). Each of these deflection amplifiers is in turn divided into two separate amplifiers known as the main amplifier and the slave amplifier.

12. Valve V1 to V4 form the main X amplifier. V1 and V2A are voltage amplifiers and V2B operates as a limiter. V3 and V4 are voltage/current converters and supply current to the deflection coil in one sense. Valves V5 to V8 form the slave X amplifier with V7 and V8B as voltage amplifiers and V8A as a limiter. V5 and V6 perform the same function as V3 and V4 and supply current to the deflection coil in the opposite sense to the main X amplifier.

13. V3 and V4 in parallel are connected in series with the parallel connected V5 and V6 and the combination connected between the −330V and +330V supplies. One end of the X deflection coil is connected to the junction of the cathodes and anodes of this valve combination (BSKTF); the other end is connected via the current sampling resistors R28 and RV3 to chassis.

14. Up to six separate inputs may be fed into the amplifier and resistively mixed at the grid of V1. When all these signals are at zero two conditions exist:

(1) The total standing current through V3, V4 and V5, V6 is 15mA.

(2) The current in the X deflection coil is zero.

How these conditions are obtained is more clearly understood with some knowledge of the functioning of the amplifier and is therefore given after the amplifier description.

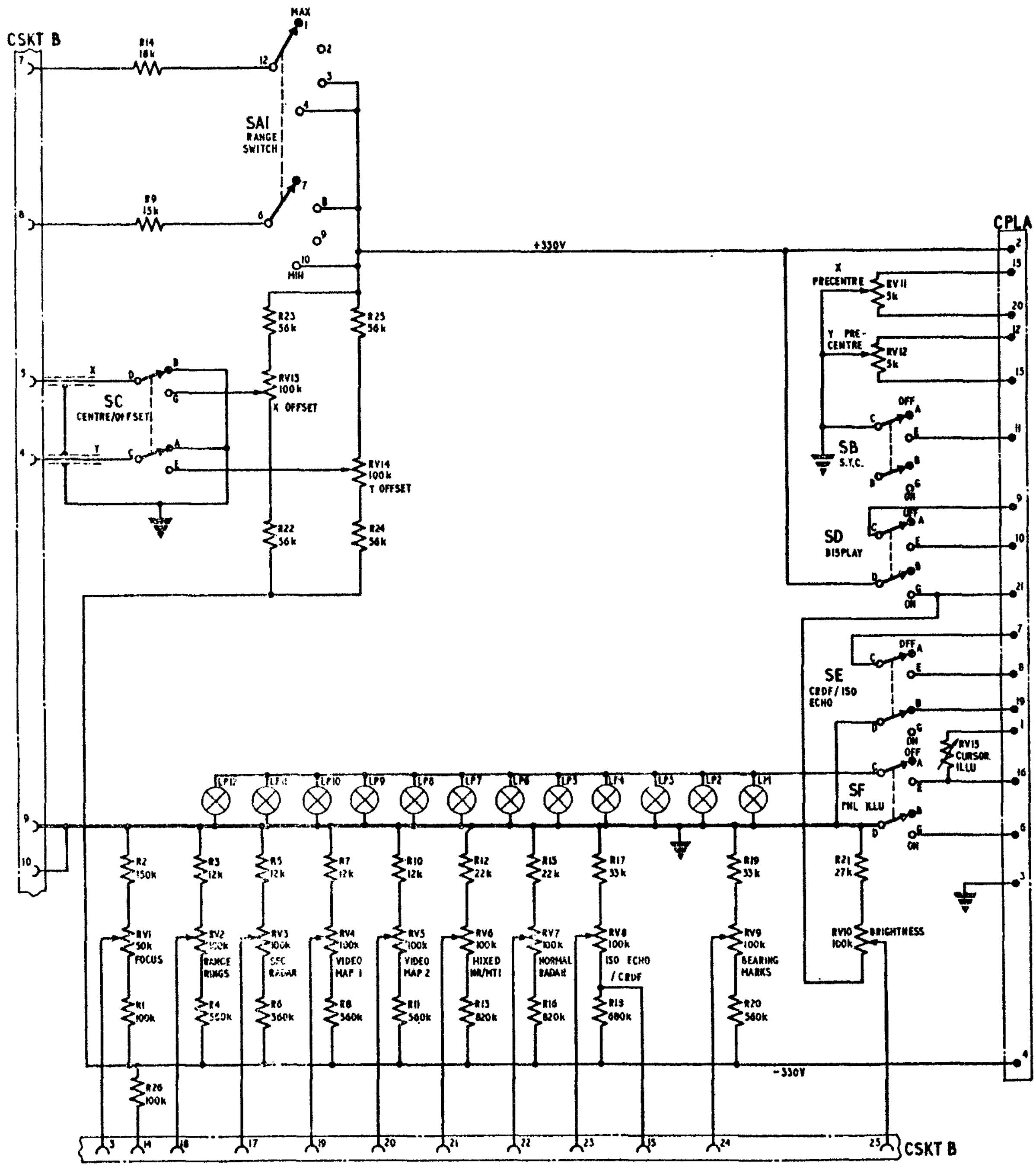


Fig. 8. Control Indicator Type S13/1—Circuit

15. Sawtooth voltages are fed into pole 19 of BPLA from the appropriate pulse generator power supply. These voltages are of constant duration but change in peak amplitude and sign. The value of peak amplitude and the sign of these have a direct relationship with the instantaneous bearing of the aerial. A maximum peak amplitude of 144V ± 6V is required to produce the peak coil current (80mA) for a full radius of deflection of 130mm.

16. These sawtooth voltages are fed to the grid of V1 via one of two paths involving R50, R72, R73 and links a and b or a and c. These alternative arrangements cater for peak amplitude tolerance of the input waveform.

17. A positive-going sawtooth input at the grid of V1 produces an inverted version at V1 anode, which is coupled via R5 to the grid of V2A. The resulting positive-going sawtooth voltage at V2A anode is fed via R9 and the parallel combination of R10 and R11 to the grids of V3 and V4. This causes an increase in the total anode current and therefore an increase in coil current. A sample of this coil current is taken as the resulting negative-going sawtooth voltage developed across R28 and RV3 and this is fed via R32 and R33 to the grid of V8B. The positive-going waveform at the anode of V8B is coupled to the grid of V7 via R34 and the resulting negative signal at V7 anode is fed to the grid of V5 and V6. This causes a decrease in the cathode current of these valves which is sampled by R23 in their anode circuits. This sample is used for current negative feedback within the slave amplifier via R24 to the grid of V8B. The gain of the slave amplifier is controlled by the ratio of R24 to R32 + R33 which is approximately unity, and since the resistance of R23 is approximately equal to that of the resistance of R28 + RV3 the first 15mA of scan current in the coil is due to V5 and V6 being driven to cut-off. During this period therefore, V3 and V4 can be considered as a constant current source of 15mA and, initially this current passes through V5 and V6. As the sawtooth input to the amplifier increases from zero the current is diverted from V5 and V6 to the deflection coil.

18. The current in V3 and V4 changes by a very small amount and provides sufficient input to operate the slave amplifier. As V5 and V6 are now unable to contribute any more coil current V3 and V4 take over to maintain the rate of change of coil current until the end of the sawtooth when they are providing the full 80mA for the coil (fig. 9A). This current is prevented from rising above this value, as would happen if the azimuth range indicator was switched to a shorter range, by the action of V2B. The cathode of this valve is connected to the junction of the coil and R28, and during the negative-going excursion of the coil current will reach a potential nearly equal to that existing on its grid as controlled by the MAIN AMP. LIMIT potentiometer RV2. At this point V2B conducts heavily and since its anode is connected to the junction of R9, R10 and R11 prevents any further signal increase at the grids of V3 and V4.

19. A negative-going sawtooth voltage at the grid of V1 will alternatively produce a negative-going signal at the grids of V3 and V4 which will tend to cut these valves off. The positive-going sample sawtooth voltage across R28 and RV3 is, however, fed to the slave amplifier and results in a positive signal at the grids of V5 and V6. The current in these valves now increases with the input to provide the first 65mA of scan current to the deflection coil. At this point the current in V5 and V6 is 80mA and is prevented from rising any further by the action of V8A which is connected as a diode limiter. The anode of this valve samples the input to the slave amplifier at the junction of R32 and R33. The cathode of V8A is referred to a potential controlled by the SLAVE AMP. LIMIT potentiometer RV4. As the positive-going sawtooth voltage at the anode approaches the preset potential at its cathode, V8A will conduct and prevent any further drive to the slave amplifier. Under these conditions V5 and V6 can be considered as being a constant current source of 80mA, 65mA of which is flowing into the coil and the remaining 15mA passing through V3 and V4. As the sawtooth input to the main amplifier increases still further V3 and V4 are driven towards cut-off, the 15mA being diverted into the deflection coil. This gives a total of 80mA deflection coil current at the end of the sawtooth (fig. 9B).

20. Current negative feedback is provided by feeding voltage at junction of coil and R28 to V1 grid. The amount of feedback, which is controlled by RV3 (GAIN), is switched by contacts on RLA and RLB as a means of changing the displayed range. On maximum range only R48 is in the feedback loop. On other ranges the gain of the amplifier is the ratio between the feedback arm and the input arm. Thus on the second range R47 is in series with R48, and since they are of equal value the gain is increased by a factor of 2. Thus for the same rate of change of input signal the rate of change of coil current will be increased by this factor of 2.

21. Capacitor C10 in the input circuit to V1 provides compensation for some of the non-linearity at the start of the trace. Trimmers C11 to C15 are provided to minimize phase shift within the amplifier at high frequencies. C1 to C4 across the feedback resistors also provide high frequency compensation and of these C1 and C2 are low hysteresis types to prevent distortion of the origin. A small percentage of voltage negative feedback is taken from the junction of R26 and R27, and fed via R49 and C5 to the grid of V1 to provide a measure of stability.

22. Since the slave amplifier current is reduced by 15mA to supply the coil for the first part of a positive-going input waveform it must have a standing current of 15mA. The SLAVE CURRENT ADJUST potentiometer RV5 sets this condition by adjusting the bias on the grid of V8B and consequently the potential difference across R23. When this current has been set it is necessary to ensure that all of it flows through valves V3 and V4 and none through the deflection coils. This is achieved by adjustment of the set ZERO potentiometer RV1 which sets the d.c. conditions for the main amplifier.

23. Potentiometer RV3 permits adjustment of the gain of the amplifier to its nominal value. Variations in gain of the amplfier due to component tolerances can thus be eliminated.

24. The two diodes V9A and V9B in series prevent the positive overswing voltage of the coil from exceeding 330V. Diode action of the grid/cathode of V5 and V6 limits the negative overswing.

25. A d.c. voltage can be introduced at pole 21 of BPLA and applied to the grid of V1 via R55. This is used to produce a standing current in the deflection coil which displaces or offsets the origin of the trace on the c.r.t.

26. The displacement of the radar and c.r.d.f. aerials can be simulated by the application of a d.c. voltage gated into the amplifier at pole 23 of BPLA and applied via R57 to the grid of V1 during the period that the c.r.d.f. trace is being displayed.

27. If the inter-trace markers are required, the

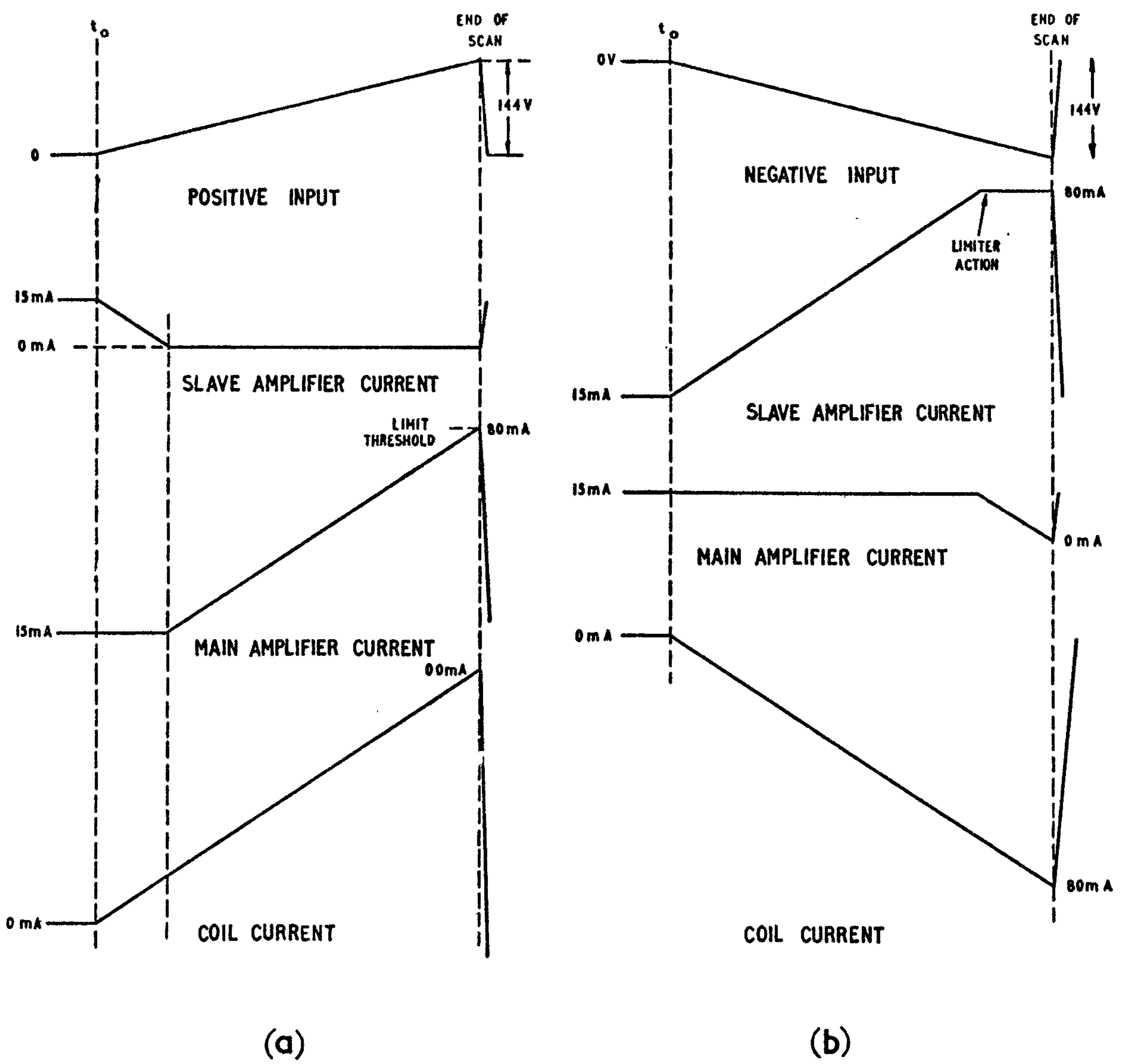


Fig. 9. Current distribution in sweep generator on maximum range

character voltages may be introduced at pole 11 of BPLA and fed to the grid of V1 via the resistance chain R51 to R54. These resistors are selected by the contacts of relays RLA and RLB by the operation of the RANGE switch to ensure constant amplitude of the characters on all ranges. Positional information of these characters would be fed into the amplifier via pole 19 of BPLA between successive sawtooth voltages. A reference shift voltage may be applied via pole 22 of BPLA via R56 to the grid of V1 to minimize hysteresis effects in the deflection coil.

28. Due to misalignment of the tube gun and current in the pre-centre coils the trace origin may not be at the geometric centre of the tube when all inputs to the deflection amplifier are at zero. This is overcome by introducing another voltage into the amplifier from the RE-CENTRE potentiometer RV6 which controls the sign and the mean of the voltage at the grid of V1. The voltage is applied via resistors R61 to R67 as selected by the contacts of relays RLA and RLE operated by the RANGE switch to ensure equal correction of the centering on all ranges.

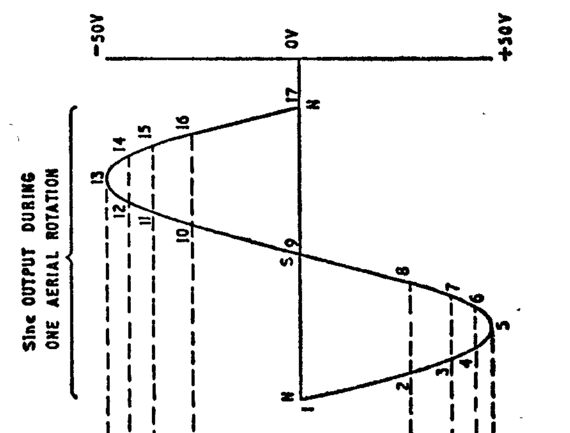
29. The method by which the outputs of the X channel and Y channel deflection currents are used to produce a radial timebase are demonstrated at fig. 10.

30. Three test points are provided for monitoring. These are as follows:

TP1 voltage across the deflection coil

TP2 current through the deflection coil

TP3 slave output current as represented by the potential difference across R23.



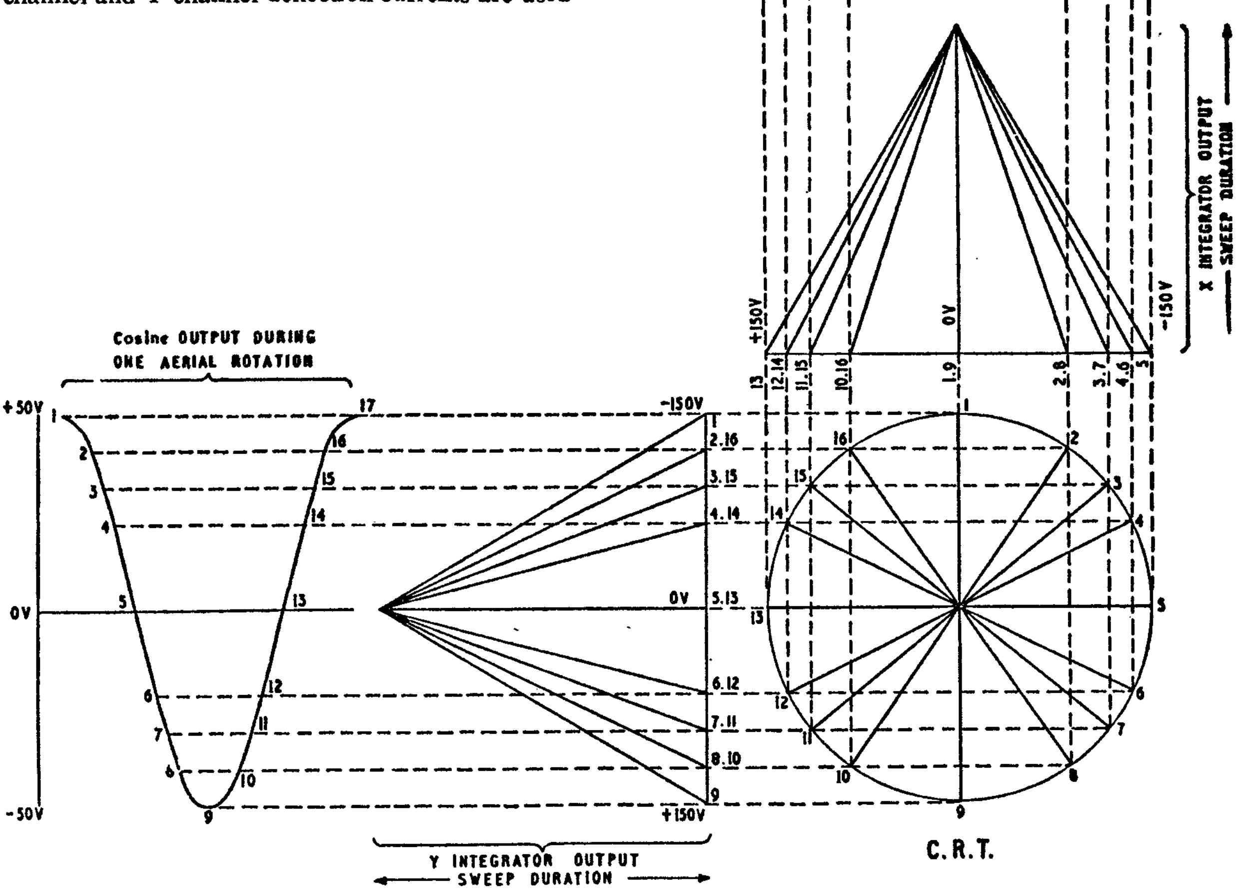


Fig. 10. Production of Radial Time Base

Video amplifier Type S17/1

31. The video amplifier Type S17/1 circuit (fig. 7) performs four distinct functions. These are video signal mixing and amplification, brightener waveform mixing, provision of e.h.t. for the voltage doubler circuit (V10 and V11) on the main chassis of the azimuth range indicator (fig. 5), and the supply of focus coil current.

Video mixer

32. The video mixer circuits (V1, V2 and V3) will accept up to six positive-going video input signals and, after amplification, supply a negative output to the cathode of the c.r.t. The three valves employed are double triodes and the no signal potential on their grids are controlled independently by the appropriate potentiometers on the control indicator Type S13/1.

33. All six input sockets are d.c. coupled to the grid of their respective triode amplifier through CR networks. These CR networks provide a high input impedance together with h.f. compensation. The grid connections to the controls on the control indicator are de-coupled to earth also by CR networks. Table 2 shows the signals dealt with by each channel and the socket, valve and control associated with each circuit. At time of issue of this chapter the video map and secondary radar are not being used.

34. When it is necessary to reduce clutter on the signals on the V3 channels the input circuits can be switched through short time constant circuits by operation of relay RLA and RLB. These are controlled by the STC switch SB on the control indicator. Relays RLA and RLB are energized from +330V line when this switch is at ON and the input voltages are then differentiated by C5 R7 and C15 R42. The diodes V7A and V7B clip the negative excursions of the differentiated waveforms.

35. The function of V17 is to provide a +70V stabilized h.t. supply for V1, V2 and V3 and also for the corresponding circuits in the brightener mixer. V17B operates as a series valve which is controlled by the output from V17A, the shunt valve. H.t. for the stabilizer is obtained from the +330V supply.

36. A common anode load is used for the three valves and is represented by R23 in series with L1 the latter element providing h.f. compensation. The negative signal output is transferred through C11 and R28 to the grid of V4. This valve has zero bias and is passing saturation current. The input voltage is thus restored negatively by the action of the grid. The amplified output from this stage is applied via R68 to the grid of the output valve V5, h.f. compensation being provided by C16.

37. V5 is almost cut off by the negative potential, approximately −5V, obtained from the cathode of V6B. V6B is normally conducting and draws current through R105 which forms part of the potential divider R105 and R106 connected between the −330V supply and chassis. V6A, connected as a diode, restores the input positively. The screen of V5 is connected directly to the +330V line to obtain a large output swing. The negative pulses at the anode are supplied to the cathode of the c.r.t. via SKTT. RV2 and C14 are included to provide compensation for h.f. losses caused by the inter-unit cabling.

38. The diode MR1 operates as a limiter to restrict the output to a level within the 10V to 30V grid base of the c.r.t. MR1 is connected between the anode of V5 and the junction of R15 and R93 in the potential divider chain R15, R93, V12A and R94 and R95 in parallel. The setting of RV1 (VIDEO LIMIT) determines the voltage drop across V12A and hence the reference voltage of MR1. If the anode voltage of V5 tends to fall below this level, MR1 conducts and limits the negative-going pulse by applying negative feedback to the grid of V5.

TABLE 2

INPUT CHANNELS

Socket	*Channel*	*Valve*	*Control indicator potentiometer*
ASKTZ	Range rings	V1A	RV2
ASKTY	Secondary radar	V1B	RV3
ASKTQ	Video Map 1	V2A	RV4
ASKTR	Video Map 2	V2B	RV5
ASKTP	Normal radar	V3B/V7A	RV7
ASKTM	M.t.i. and normal radar	V3A/V7B	RV6

Brightener mixer

39. The brightener mixer accepts up to five positive-going brightener waveforms and provides a positive output to the grid of the c.r.t. and each channel is controlled independently from the control indicator. Valves V12B, V13 and V14 provide amplification for each of the five channels but in this application only two of these are used. These are the north marker introduced at SKTH and the main scan introduced at SKTN. Amplification for these is provided by V14A and V14B respectively the other three triodes V12B, V13A and V13B are biased beyond cut off via the 1·8 megohms resistors to the −330V line and therefore remain cut off. The amplified outputs of V14A and V14B are applied to the voltage amplifier V15 and produce pulses of about 40V for application to the c.r.t. grid. V15 is normally conducting at saturation and restores the input negatively. The screen potential of V15 is preset by RV4 (BRIGHTENER LEVEL) to compensate for variations in the characteristics of different c.r.ts. The anode is connected through R86 and APLA pole 17 to the potentiometer RV10 (BRIGHTNESS) on the control indicator. This controls the c.r.t. grid voltage about the level set by RV4 and provides normal brightness control.

Video mixer c.r.t. protection circuits

40. If a sudden heavy load is applied to the power supplies, for example, another azimuth range indicator unit is switched on, this could cause excessive brightening of the c.r.t. in the azimuth range indicator already being supplied from these sources. This brightening effect is minimized by three protective circuits in the video amplifier Type S17/1.

41. A momentary decrease of the −330V supply would cause a temporary drop in the +70V supply. This would have the same effect as signals at the anodes of the diode mixers and cause brightening signals to be applied to the grid and the cathode of the c.r.t. The long time constant of R109 and C44 in the grid circuit of V17A largely overcomes this effect. MR2 in the grid circuit of V15 also assists in this. Under normal signal conditions MR2 presents a low impedance path to earth due to R110 being connected to the −330V supply; a sudden decrease in this voltage transmitted via C46 biases off MR2 which now becomes a high impedance and allows the transient voltage to oppose the negative-going change at the grid of V15 caused by the drop in the +70V supply.

42. Negative-going transients on the +330V supply would be fed to the grid of V5 via R68 and C13, and this in itself would cause an unwanted signal to be applied to the c.r.t. cathode. The potential at the grid of V5 and of C13 is prevented from changing due to the restorer action of V6B; this results in a change of charge on C13. The trailing edge of the transient would therefore act as a positive-going signal to the grid of V5 and appear as a negative signal at the cathode of the c.r.t. The duration of this signal would depend upon C13 re-charging through R104. The bias for V5 is, however, obtained via V6B, which acts as a cathode follower, and overcomes this defect. Any negative-going transient of the +330V supply is a.c. coupled to the grid of V6B via C47 which causes a similar change at its cathode: since this is connected by R104 to C13, both plates of this capacitor will experience the same transient. Thus no change of charge will take place and no undesired signal will be fed to the c.r.t. grid. MR3 d.c. restores the grid of V6B and prevents excessive brightening of the c.r.t. as C47 charges and its potential rises to +330V when the azimuth range indicator supplies are switched on.

43. Two sets of conditions can arise when one of the azimuth range indicators is switched off. These are as follows:

(1) Unwanted brightening of the c.r.t. may occur when the azimuth range indicator is switched off by means of the switch provided because:

(a) The e.h.t. circuit has a time constant in excess of 0·6s.

(b) When the +330V is removed the grid and cathode of the c.r.t. are effectively shorted together due to the d.c. coupling to the electrodes. One pair of contacts on the ON/OFF switch is across C17 and in the OFF condition these contacts are open. During the delay between switching off and the +330V supply being removed, C17 will charge up and will bias off the c.r.t. via R89 and R85. When the +330V supply is removed, C17, which is effectively coupled between the cathode and the grid of the c.r.t. via the anode loads of V5 and V15, provide a differential between these two electrodes during the decay of the e.h.t. and minimizes the c.r.t. brightening.

(2) If the EMERGENCY switch is used to switch off the display the normal protective circuits will not operate and the c.r.t. screen may be damaged. This is prevented by the action of MR4 and C12. Under working conditions the forward resistance of MR4 is negligible and C12 in association with R37 provides decoupling. When the system is switched off and the +330V supply is removed, MR4 will be biased off due to the charge on C12.

This in turn maintains the differential between the grid and cathode of the c.r.t. during the decay of the e.h.t.

Focus valve

44. V16 is a d.c. power amplifier which controls the current through the focus coil. This coil is connected between sockets ASKTU and ASKTS. The latter is returned to the +330V supply. The grid potential of V16 is provided from RV1 (FOCUS) on the control indicator and is used to vary the amount of current passing through the focussing coil. Current negative feedback is provided by the cathode resistor R91.

E.H.T. power supply

45. *General.* E.h.t. supply comprises a regulated oscillator circuit operating about 40 kc/s which produces 15kV at 100μA. A voltage doubler is used to minimize the peak inverse voltage imposed on the rectifiers and the coil.

46. *E.h.t. oscillator and regulator circuit.* The oscillator valve V9 is connected as a Hartley circuit and uses the primary of T1 (fig. 5) The secondary circuit of T1 provides the e.h.t. voltage. Fluctuations in the output voltage of the oscillator are prevented by the use of V8 which regulates the voltage of the grid of V9. V8A, connected as a diode, rectifies the voltage from secondary winding (AB) of T1 and charges the reservoir capacitor C18 in proportion to the output voltage. V8B is connected as a d.c. amplifier and is coupled to the grid of V9 so that an increase of the output is counteracted by an increase in bias, which reduces the output of the oscillator to normal. The grid of V8B is referred to a potential determined by the setting of RV3 (SET E.H.T.). This control causes the regulator output level to be varied and this in turn alters the amplitude of oscillation and so adjusts the level of the e.h.t.

47. *Operation of voltage doubler.* The output voltage at the e.h.t. secondary of T1 is applied to the voltage doubler circuit, which comprises rectifiers V10 and V11, and reservoir capacitors C23 and C24. During one half cycle C24 is charged through V10 and attains the secondary voltage. In the same way capacitor C23 is charged during the next half cycle through V11. As capacitors C23 and C24 are in series the voltage developed across the combination is twice that of the secondary voltage and is 15kV. This is applied to the final anode of the c.r.t. through the CR filter comprising C23, R62 and C1.

48. *Pre-centering system.* Any mis-alignment of the electron gun would cause distortion of the scan and produce bearing errors. This is avoided by directing the electron beam through the centre of the deflection coils by the fields of a pair of pre-centering coils L2. These are supplied with d.c. and the direction of the current is determined by potentiometers RV11 (X PRE-CENTRE) and RV12 (Y PRE-CENTRE) in the control indicator.

Important Note . . .

These pre-centering controls must not be used to centre the origin of the trace under any circumstances.

Control indicator Type S13/1

49. The control indicator carries all the operational controls and switches associated with the azimuth range indicator and the circuit diagram of this unit is shown at fig. 8. The functions of these controls and switches is given at Table 1 in this chapter.

Auxiliary circuits

General

50. A number of auxiliary circuits are associated with the azimuth range indicator and can be seen on the circuit diagram at fig. 5. They are concerned with the cooling system, anti-condensation heaters and interlocks.

Cooling system

51. The motor associated with the extractor fan in the cooling system is supplied from the unstabilized mains plug DPLB through the contacts of relay RLA. This relay is energized from the 28V d.c. supply when the azimuth range indicator is switched on.

Anti-condensation heaters

52. Two 30W anti-condensation heaters are supplied from the unstabilized mains supply via the contacts of RLA when the equipment is switched off, that is, when the relay is de-energized.

Interlocks

53. The microswitches SA and SB are wired in series with the 28V line to the DISPLAY ON/OFF switch and are operated by the removal of either side panel. When necessary, they can be rendered inoperative for servicing purposes.

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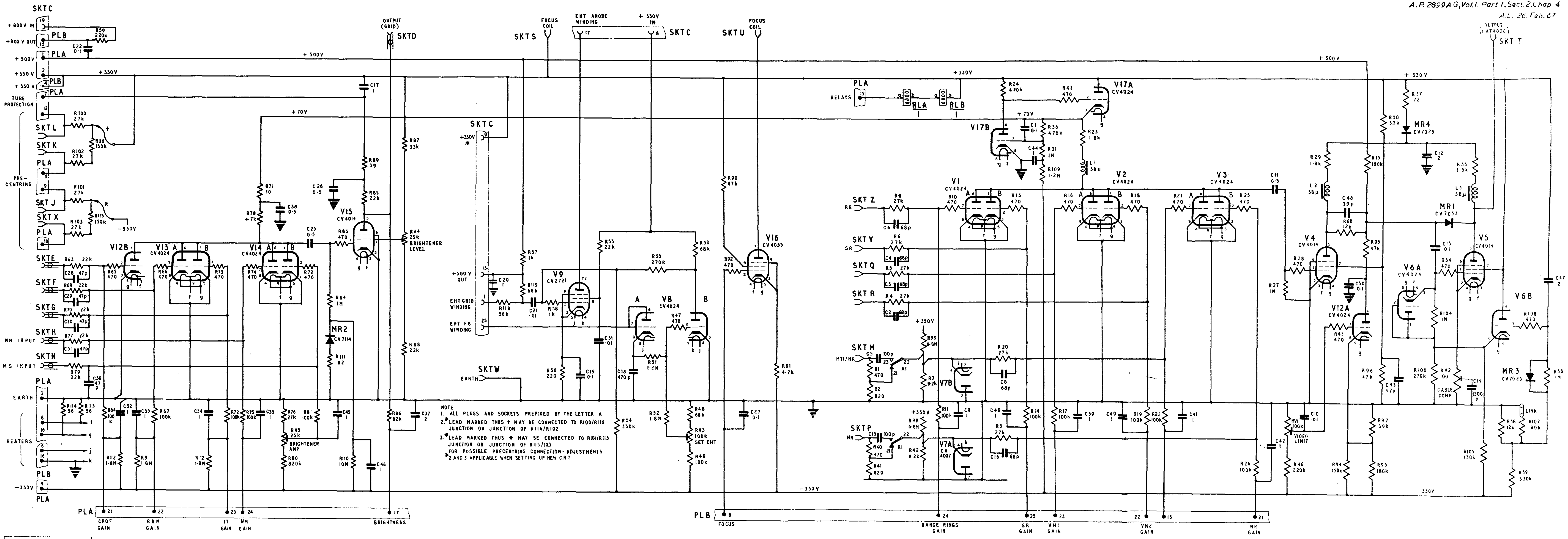
Sweep generator Type S15/1: circuit

Fig. 6



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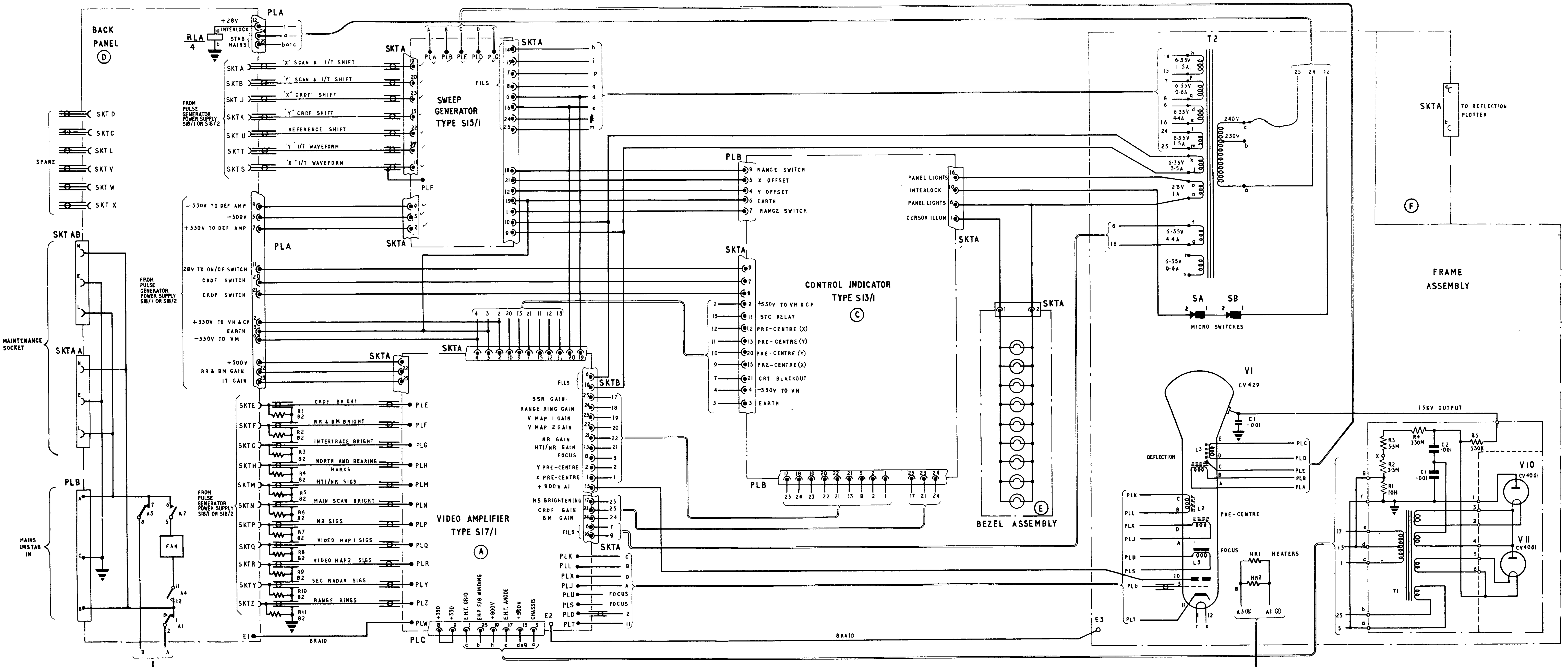
Video amplifier Type S17/1: circuit

Fig.7



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Azimuth range indicator Type S5/1: circuit

Fig.5

Chapter 5

PULSE GENERATOR POWER SUPPLY TYPE 18/2

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Introduction

1. The pulse generator power supply Type S18/2 provides the stabilized power supplies, waveform generation and signal mixing circuits for the azimuth range indicator Type S5/1 at the remote site.

2. A general view of the pulse generator power supply is given at fig. 1 showing the associated azimuth range indicator in position. The pulse generator power supply comprises a cabinet and the three units contained in it. The units are the pulse generator Type S14/1, the power supply Type S27/2 and the power supply Type S26/1, and these are supported on runners along the inner walls of the cabinet.

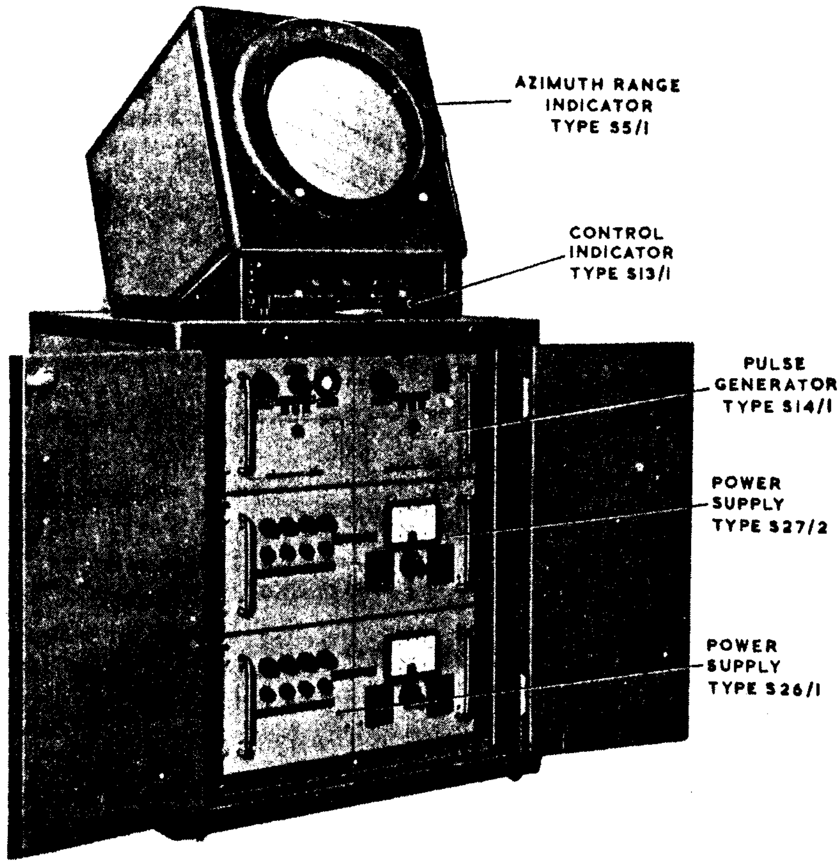


Fig. 1. Pulse generator power supply Type S18/2 showing azimuth indicator Type S5/1 in position

3. The cabinet, which has doors to protect the units when access to controls is not required, has all the inter-unit wiring loomed and cleated to the side and rear wall of the cabinet, a 30W anti-condensation heater in the base; two relays RLA and RLB, a capacitor start 1/50 h.p. 2800 r.p.m. motor with fan and associated nylon mesh filter are mounted on the rear wall. The fan forces the air stream through a duct at the bottom of the cabinet and up the left-hand side of the cabinet to provide cooling for the units. External connections for the pulse generator power supply are made via a plug panel at the top of the rear wall. There are three sets of fourteen coaxial sockets, two 25-pole and one 18-pole unitor sockets, a 3-pole and 4-pole Plessey plug and two 3-pole mains sockets for test equipment.

4. In addition to these there are on the left-hand front pillar of the cabinet, a service lamp switch, which controls a servicing lamp on the roof of the cabinet, an EMERGENCY OFF switch and two indicator lamps, one for STAB MAINS ON and the other for UNSTAB MAINS ON. On the opposite front pillar there are three safety microswitches SC, SD and SE.

5. The pulse generator Type S14/1 has two major sub-assemblies strapped together and these are the electronic marker generator Type S21/1 and the sweep generator Type S20/1. These are shown in the general view at fig. 2. The operating controls and monitor points for both the electronic marker generator and the sweep generator are mounted on the front panel. Preset potentiometers required for servicing are located behind hinged flaps on the front panels, and also on the chassis of the units. The points selected by the 11-position selector switches are detailed on the inner face of the hinged flaps.

6. A one inch c.r.t. is provided on the front panel of the electronic marker generator Type S21/1 for monitoring purposes.

7. The electronic marker generator Type S21/1 has a removeable and separately identifiable unit mounted in it, the i.f. amplifier Type S11/1, which provides signals to the video amplifier Type S17/1 in the azimuth range indicator. The i.f. amplifier can be seen in fig. 3.

8. The power supply Type S26/1 which provides negative power supplies also comprises two chassis, the power supply sub-assembly Type S55/1 and the voltage stabilizer Type S4/1, and these are shown separated at fig. 4. The power supply sub-assembly Type S55/1 provides the unstabilized supplies which are then stabilized by the voltage stabilizer Type S4/1.

9. The voltage stabilizer Type S4/1 also has three

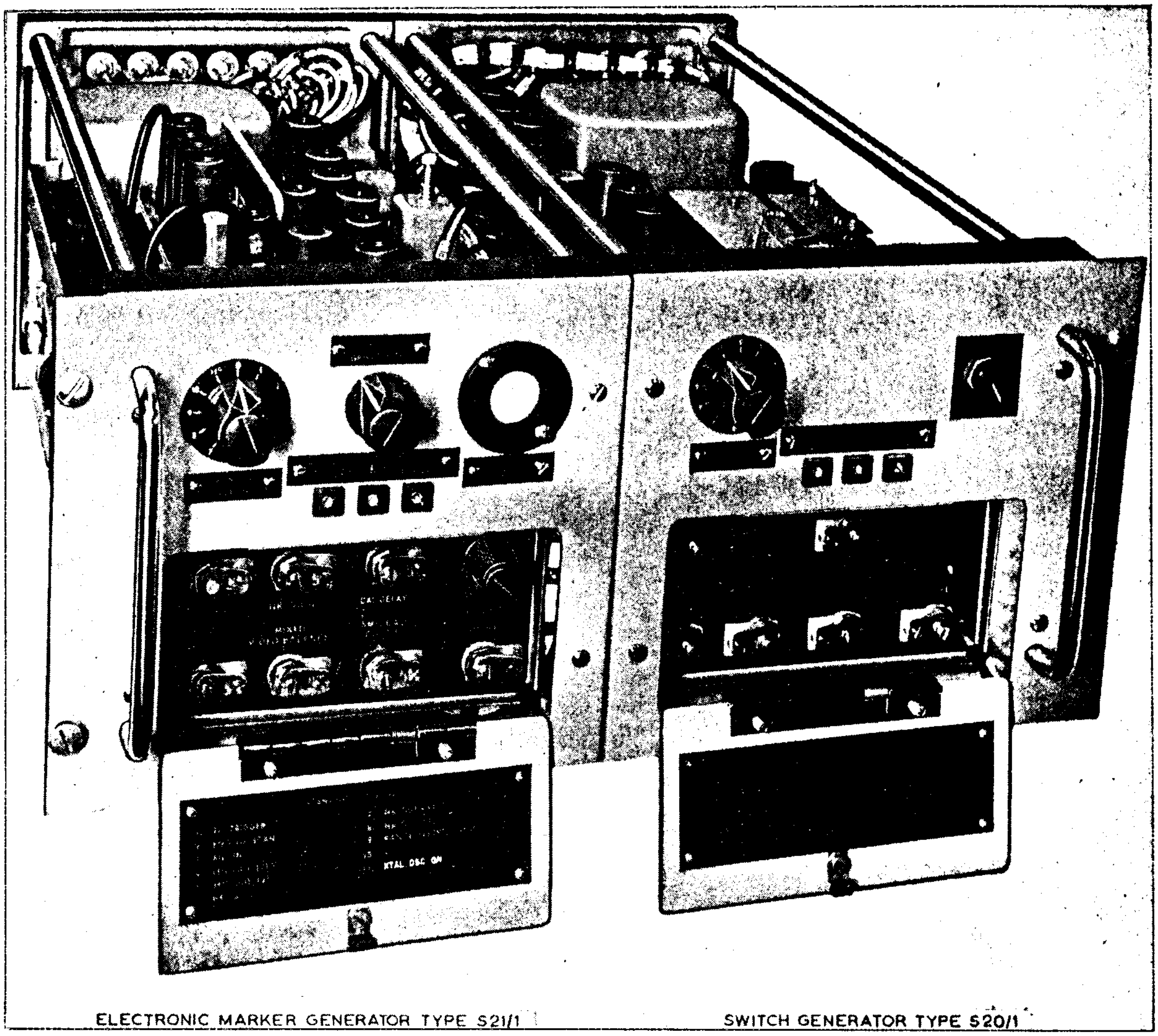


Fig. 2. General view of pulse generator Type S14/1

identical switch assemblies Type S5/1 which are plugged into sockets SKTA, B and C (fig. 4). Each of these is used to switch power through to one of the pulse generators Type S14/1 or to one of the azimuth range indicators Type S5/1, in the sequence required for correct operation.

10. The power supply Type S27/2 is similar in construction to the power supply Type S26/1 but provides positive power supplies. It has two chassis, the power supply sub-assembly Type S56/1 (unstabilized) and the voltage stabilizer Type S5/1 (stabilized).

11. External connections to the pulse generator Type S14/1 and the two power supply units are made via plug panels on the rear of the units.

CIRCUIT DESCRIPTION

General

12. The pulse generator power supply Type S18/2 has four main circuit sub-divisions. These are the pulse generator Type S14/1, power supply Type S27/2, the power supply Type S26/1 and the circuit of the pulse generator power supply cabinet when these three units have been removed.

Cabinet of pulse generator power supply Type S18/2

13. The circuit of the cabinet of the pulse generator power supply Type S18/2 is given at fig. 5. The unstabilized mains is brought in through plug PLF and from here is distributed to the two servicing sockets SKTD and SKTE. An unstabilized mains supply is brought from the radar set group Type S1/1 and introduced at plug PLG. When the unstabilized mains supply is switched on, it is applied to the anti-condensation heater HR1 and the UNSTAB MAINS ON lamp LP2. The SERVICE lamp LP3 can be switched on by means of switch SWB. If the three units are in position in the cabinet the three micro-switches SWC, SWD and SWE will be closed and

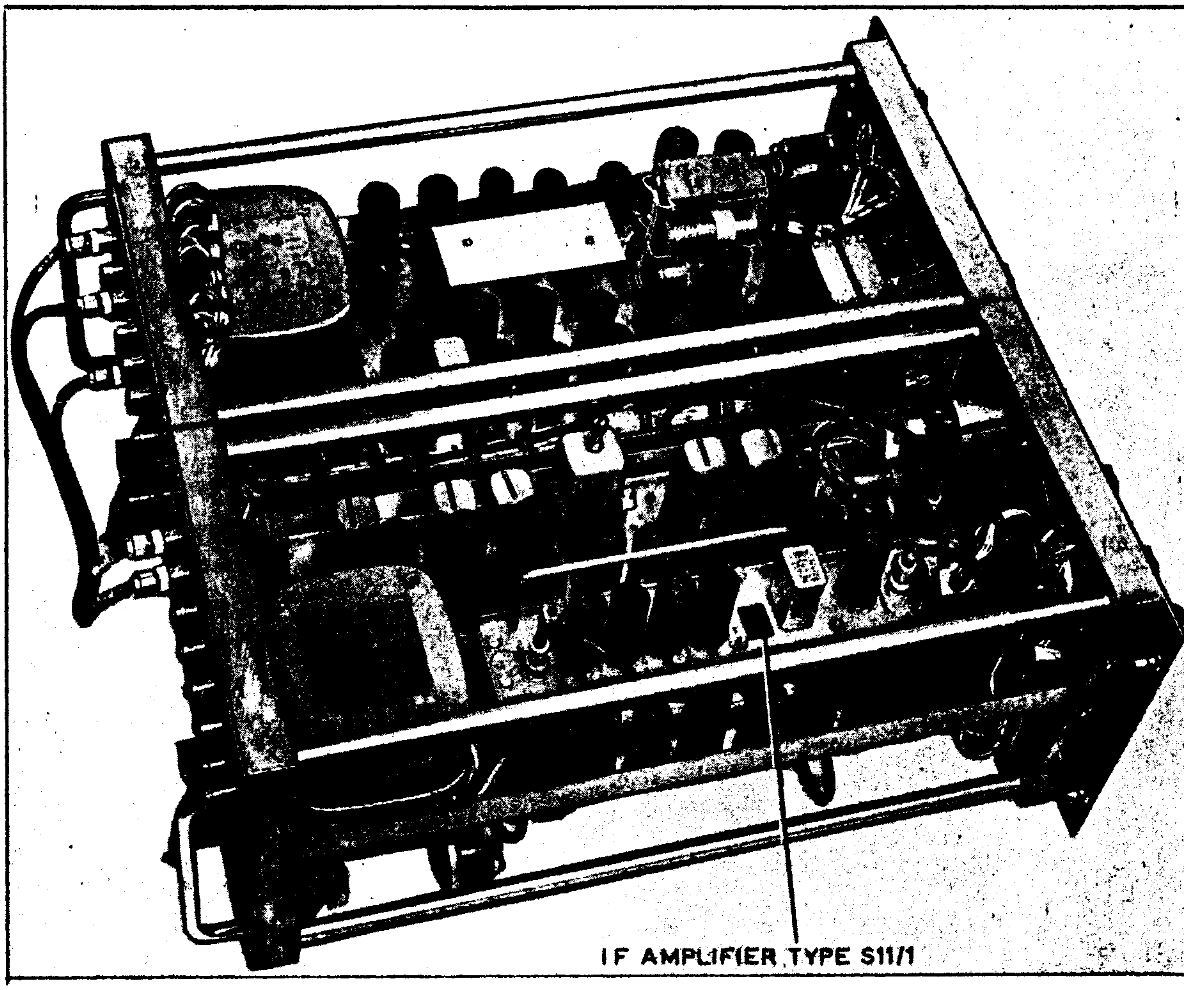


Fig. 3. Interior view of pulse generator Type S14/1

the mains will be applied to relay $\frac{\text{RLA.}}{2}$ Contacts RLA1 and RLA2 will close and apply this supply to the STAB MAINS ON lamp LP1 and relay $\frac{\text{RLB.}}{1}$ Contact RLB1 now changes over and applies the unstabilized supply to the blower motor BL1 instead of to the anti-condensation heater. If any of the three units are removed the appropriate microswitch will remove the supply from $\frac{\text{RLA.}}{2}$ Contacts RLA1 and RLA2 will open and remove the supply from relay $\frac{\text{RLB}}{1}$ and the other units as detailed in fig. 5.

Pulse generator power supply Type S14/1

14. The circuit of the pulse generator Type S14/1 sub-divides into two main elements. These are the electronic marker generator Type S21/1 and the sweep generator Type S20/1. The circuit diagrams of these are given at fig. 6 and 7 respectively. The electronic marker generator Type S21/1 has a sub-assembly, the i.f. amplifier Type S11/1 (normal radar amplifier), and the circuit of this is given at fig. 8. The electronic marker generator and the sweep generator are to some degree inter-dependent for certain functions and these are detailed at Table 1 below.

TABLE 1

Interconnections between electronic marker generator and sweep generator

Electronic sweep generator	Function	Sweep generator
SKTA	Negative trigger	SKTA
SKTC	End of scan trigger	SKTC
SKTX	NR/MTI gate	SKTX
SKTD	CAL gate	Flying lead

Electronic marker generator Type S21/1

15. The electronic marker generator contains the circuitry associated with the range marker generator, the m.t.i./normal radar gate, and the i.f. amplifier Type S11/1 (normal radar amplifier). Trigger pulses required by circuits in the sweep generator are also provided. A monitor c.r.t. is incorporated for calibration purposes.

16. The electronic marker generator is designed to accept either positive-going or negative-going trigger pulses but in this application the incoming pulses are positive-going and occur at T_o-100µs. These are introduced at SKTW, developed across RV43 (TRIGGER SENSITIVITY) and taken through link AB, in the positive position, to switch SWA. It is then applied via transformer T8 to the grid of V50. This valve amplifies the trigger pulse before it is applied to the phantastron delay circuit associated with valves V43 and V44. The delay thus introduced is necessary because the trigger pulse is 100µs in advance of T_o. V43 now delivers a negative-going pulse to the anode of V51B and transformer T9 causes a positive-going pulse to the applied to the grid and cuts this valve on. The resulting output from the cathode is a positive-going pulse of 25V amplitude and 4µs wide. This is for use in the video map equipment, when used, and is available at SKTY. The negative-going pulse at the anode of V51B is required for use on the sweep generator Type S20/1, and is made available at SKTA.

17. An internal trigger pulse is provided for test purposes by an astable multivibrator formed by V49A and B. This may be switched into circuit by SWA and its output applied from the cathode end of R387 to the primary of transformer T8. The p.r.f. of the pulses is variable over the range 300 Hz to 700 Hz and determined by the setting of RV32. In this application it is normally set to 700 Hz.

Range calibration generator

18. The range calibrator generator provides range marker rings on the p.p.i. display at one, five, ten and twenty mile intervals. The operation of the circuit is initiated by the Hartley type calibration oscillator V26. A positive-going calibration gating pulse is introduced from the sweep generator chassis at SKTD and this is amplified and inverted by V51A. Diode V25B d.c. restores the output voltage negatively before it is applied to the suppressor V26. This allows the oscillator to operate for the duration of the sweep gate. RV31 (CAL DELAY) in conjunction with C84 enables the leading edge of this waveform to be varied when required.

19. In the absence of a gating pulse anode current is flowing through V26 but no oscillations are being produced because the anode circuit does not permit feedback to the grid in the correct phase. When the gate pulse arrives, however, the anode current is cut off and the circuit oscillates with V26 operating as a triode with the screen serving as the anode. The frequency can be adjusted between 80 KHz and 89 KHz by means of the tuning slug T1. The oscillatory output of V26 is applied to the grid of V27A which is biased to produce a square wave output. The differentiated output is used to trigger the one mile blocking oscillator stage V27B. The output of V27B is in turn used to trigger a divide by five phantastron stage formed by V28 and V29, the division ratio being controlled by RV25 (5M CAL COUNT). This in turn triggers the second blocking oscillator stage associated with V30 which produces the five mile markers. A cathode coupled output from V30B is used to trigger a divide-by-two blocking oscillator stage associated with V31A which provides the ten mile markers. V31A is in turn cathode coupled to V31B another divide-by-two stage which produces the twenty mile markers. The outputs of all the marker generators are applied to the grids of the calibration marker mixer stage associated with V33. The outputs of V33A and V33B are cathode coupled via sockets SKTAB and SKTP to the video amplifier Type S17/1.

20. The amplitude of the one mile markers cannot be varied but that of the five, ten and twenty mile markers can be adjusted by means of RV36 (5M CAL. AMP), RV37 (10M CAL. AMP) and RV38 (20M CAL. AMP) respectively. These enable the brilliance of the range marker rings displayed on the p.p.i. to be graduated. A typical level for the one mile marker is 1V and the corresponding levels to which the five, ten and twenty mile markets should ◀ be adjusted are 1.3V, 1.6V and 2.0V respectively measured at output sockets SKT.P and SKT.A.B. Typical values for levels measured on left hand monitor waveform SKT with monitor waveform switch SC to position 9 are 0.15V to 0.50V for 1 mile markers. ▶

21. Since the start of the 150V sawtooth timebase voltage generated in the sweep generator is delayed 2 or 3 μs relative to the trigger provided at SKTA, RV31 has to be adjusted to provide a similar delay. This ensures that the calibration oscillator commences to operate at the same time as the sweep.

Calibration check oscillator

22. In position 11 of the NORM TEST switch SC, the crystal controlled oscillator stage associated with V47A may be used for checking the frequency of the calibration oscillator. The sine wave output voltages of both stages are applied to the deflection plates of the miniature monitor c.r.t. and thus when both oscillators are operating at the same frequency, a single Lissajous figure is produced. As a result of the fact that the calibration oscillator is gated, however, it is necessary to ensure that both outputs are maintained in the correct phase relationship so that a steady figure is displayed. A sample of the crystal oscillator output is therefore taken through rectifier MR6 to the internal trigger multivibrator to obtain synchronisation.

M.T.I./normal radar gate

23. Facilities are provided for accepting m.t.i. signals from the i.f. amplifier Type S11/1, and producing a composite display which obtains the maximum advantage from each type of signal. During the initial part of the trace, m.t.i. signals are displayed to avoid clutter around the centre of the screen caused by nearby permanent echoes. Then at a point along the trace beyond which these are no longer troublesome, normal radar signals are displayed. The switching action is initiated by a sweep waveform input from the sweep generator and the point at which the changeover occurs can be controlled to suit the operator's requirements.

24. The incoming m.t.i. signals are introduced at SKTQ and applied to the two stage compensated video amplifier formed by V36 and V42, gain being controlled by RV27 (MTI GAIN). The output is applied to the grid of V39B, the m.t.i. gate. Signals from the i.f. amplifier Type S11/1 are applied to the grid of V39A which serves as the normal radar gate. The symmetry of this gating stage is controlled by RV29 (MIXED VIDEO BALANCE). V39A and V39B are cathode coupled to the double diode isolating valve V40. The signal in the anode is then

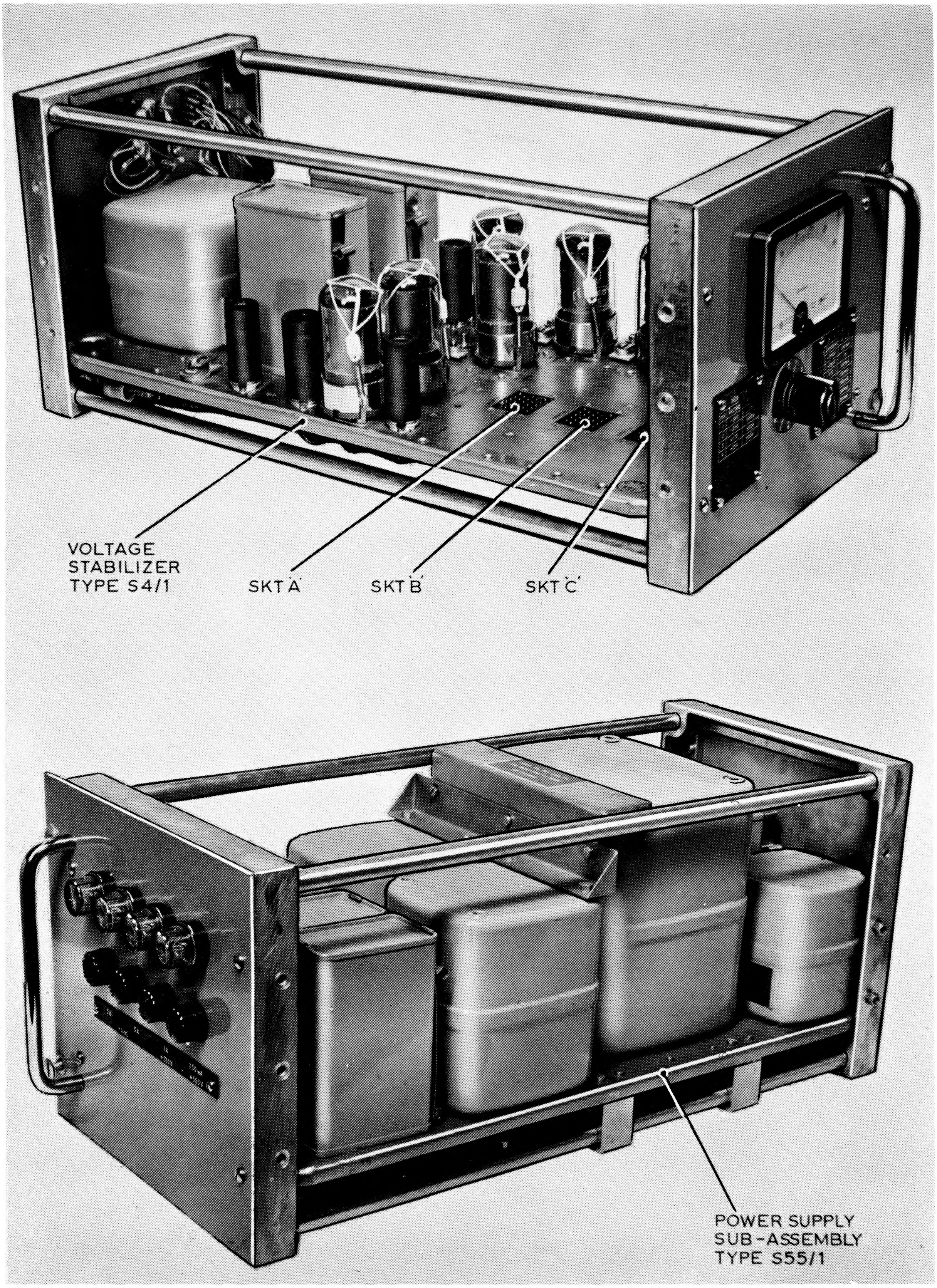


Fig.4. General view of two sub-assemblies of power supply Type S26/1 with switch assemblies Type S5/1 removed.

transferred to the twin cathode follower stage V45. The m.t.i./normal radar outputs are then available at the two cathodes of V45 and made available externally at sockets SKTS and SKTT.

25. The gates are controlled by the action of valve V41 as follows. A negative-going sweep waveform is introduced from the sweep generator at socket SKTX and applied to the grid of V34A in the monostable stage associated with V34. V34B is at this stage biassed beyond cut off by the potential applied from the slider of potentiometer RV28 (MTI RANGE) but as the input increases negatively, a point is reached when the changeover takes place and a negative-going pulse is obtained from the anode of V34B.

26. The negative-going pulse at the anode of V34B is applied to the bistable stage associated with V35. At the commencement of the sweep, V35A is conducting. When the negative-going pulse is applied to the grid of V35A the state of this circuit is reversed and a positive-going pulse at the anode of V35A is applied to the grid of V41A. The state of this stage is now reversed so that the normal radar gate valve V39A is made to conduct and the m.t.i. gate is closed. The output of V39A is now applied through the isolating diode V40A to the grids of the cathode follower stages V45A and V45B, so that the normal radar signals appear at the output for the latter portion of the trace. The point along the sweep when the changeover occurs may be adjusted by means of RV28.

27. Since V35 is a bistable stage, it must be triggered to return it to its original state in readiness for the next sweep. A negative-going end of scan trigger pulse is therefore introduced from the sweep generator Type S20/1 for this purpose and is applied via SKTC to the grid of V35B.

Normal radar output

28. Provision is also made for two normal radar outputs to be made available. The input to V39A is also applied to the grid of the twin cathode follower stage V46 and the output at the cathode coupled to sockets SKTR and SKTU for this purpose.

Monitoring

29. A number of points in the circuit can be monitored by means of the oscilloscope. The points are selected by means of switch SWC and the waveforms to be observed are as follows:—

Position 1	T_0 trigger
Position 2	end of scan trigger
Position 3	m.t.i. input
Position 4	m.t.i. output (1)
Position 5	m.t.i. output (2)
Position 6	normal radar input
Position 7	normal radar output (1)
Position 8	normal radar output (2)
Position 9	range monitors.

I.F. amplifier Type S11/1

30. The circuit of the i.f. amplifier Type S11/1 is given at fig. 8. Normal radar signals at the intermediate frequency of 30 Mc/s are introduced from the head amplifier Type S9/1 in the appropriate radar T/R assembly and fed in at SKTG. These signals are amplified by four broad banded stages and then detected by X1. From there they are applied to the grids of V5A and V5B, which are connected in parallel as a cathode follower stage. The output is taken to SKTF from which it is applied to PLF on the electronic marker generator chassis. The maximum gain provided by the amplifier is 85 dB and control of this is provided by the potentiometer RV26 (NR GAIN) in the electronic marker generator (fig. 6).

31. A 200V stabilized h.t. supply is provided by the series stabilizer valve V37 in conjunction with V47B on the electronic marker generator chassis.

32. This i.f. amplifier has been designed to operate with a number of equipments and relay RLA is not required in this application and remains unenergised. For the same reason the junctions between R14 and R24, and R17 and R20 are connected to chassis in the electronic marker generator.

Sweep generator Type S20/1

General

33. The circuit of the sweep generator Type S20/1 (fig. 7) includes the main range gate generator, the X and Y integrators, the north marker generator and the brightener generator. In addition other trigger outputs are provided so that monitoring facilities can be used to check all parts of the circuit.

Main range gate generator

34. The main range gate generator is a phantastron circuit embracing V1, V2 and MR2. A negative-going trigger pulse from the T_0 generator is introduced at SKTA and applied to V1 via V2A to initiate the rundown. V2A is used to prevent back coupling from V1 anode. The point at which the anode voltage bottoms represents the end of the gate and this is adjusted by means of RV1 (TIMEBASE DURATION) to correspond to the maximum scan time required by the installation.

35. The positive-going square wave at the suppressor of V1 is applied to the phase splitter V3A. The negative-going output at the anode is used to cut off V4, the driver for the two main gate phase splitters V5 and V6. These two valves are normally cut off but are switched on by the output from V4 which is d.c. coupled to the grids. Inverted square waves are obtained from the cathode and anode of each valve, the V5 output being used to gate the Y integrator and V6 for the X circuit. The negative-going pulse at the anode of V3A is also applied to the grid of V3B via the differentiating circuit comprising C5 and R20. This produces positive-going and negative-going end of scan voltages taken to SKTZ and SKTC for use on auxiliary equipment, as required.

Main scan brightness

36. A further application of the negative-going pulse at the anode of V3A is made to the grids of V7A and V7B after being d.c. restored by MR1. This pulse cuts off the valves during the range gate and produces positive-going pulses at their anodes which are used as main scan brightener waveforms fed out via SKTB and SKTL, and taken to the brightener mixer circuits in the video amplifier.

Input to integrators

37. The inputs to the X and Y integrators are derived from sine/cosine potentiometers. In the case of the remote site equipment this is derived from the synchros assembly Type S1/1 in the aerial turning gear cabinet and in the synchros signal amplifier Type S23/1 in the case of the radio equipment room part of the installation. In each instance voltages proportional to the sine and cosine of the scanner bearing are produced. D.c. voltages of equal amplitude, but of opposite polarity, are applied across the track of the potentiometer. The two wipers are spaced 90 degrees apart and aligned so that when the scanner is at position corresponding to 0 degrees, the wiper producing the sine output is at 0 volts and the wiper producing the cosine output at +50V d.c. (maximum). As the aerial rotates the voltages will vary between 0 and ±50 d.c. but will be 90 degrees out of phase. These voltages are then fed to the integrator circuits to produce sawtooth voltages. These are then fed via the sweep generator Type S15/1 in the azimuth range indicator to the c.r.t. deflection coils so that a rotating radial trace is displayed with an angular position corresponding to that of the scanner bearing.

X and Y integrators

38. The Y integrator, which uses valves V8 to V14, and the X integrator, which uses valves V16 to V21, are identical circuits. The former is concerned with the cosine input from the sine/cosine potentiometer, and the latter with the sine input. As the operation of the circuits is the same only that of the X integrator is given here.

39. V15 is the main integrator valve and C33 the integrating capacitor. Between traces, the clamping diodes V16A and V16B and V17A and V17B are conducting and thus short circuit C33. The d.c. sine input is applied through a matching resistance network to the grid of V15 and to one plate of C33. This voltage varies in polarity and amplitude as the aerial rotates but can have no effect upon the grid voltage while the clamp circuit is operating.

40. At T_0, when the range gate begins, the diodes are cut off by the output from V6 which consists of a positive-going pulse at the cathode of V17, and a negative-going pulse at the anode of V16. The integrating action now commences and the charging current for C33 is determined by the instantaneous level of the sine voltage and therefore the rate of change of voltage at V15 anode. This anode voltage varies positively or negatively about a mean level of 220V, according to the polarity of the sine input, and appears as a sawtooth waveform with a maximum amplitude of 150V. At the end of the gate, the diodes conduct and discharge C33. This produces the flyback.

41. The output from the anode of V15 is d.c. coupled to the grid of the cathode follower valve V18A which enables the starting level of the sawtooth waveform to be changed from +240V to 0V without varying the amplitude of the sawtooth, by virtue of the effect of the constant current triode V19A in its cathode circuit. A similar waveform is also obtained at the anode of V19A but the sitting level is approximately 0V. This output is fed to the grid of V18B. V18B is in turn cathode coupled to the second plate of capacitor C33 and so completes a feedback loop. V19B is also a constant current triode stage which represents a high dynamic load for the cathode follower V18B and this improves linearity. Resistor R59 is included between the cathodes of V18A and V19A to provide a measure of current negative feedback.

42. The output from V18B cathode, which is the true integrator output, is applied to the line drive stage V20. This is a cathode follower output stage which employs V21 as a load to improve linearity. The output is taken from SKTE and SKTF to the X channel of the sweep generator Type S15/1 in the azimuth range indicator.

Integrator preset controls

43. The operation of the X integrator controls is the same as that of their counterparts in the Y integrator. Switch SWC is used to disconnect the input and connect the grid of V15 to chassis. RV16 (SLOPE) may then be adjusted so that, with zero input, the current through C33 is set to zero and, therefore, the rate of change of the integrator is zero. RV18 (RIPPLE) is a humdinger control which allows the ripple to be reduced to a minimum. It is held at a positive potential to prevent emission occurring from the heater to cathode which would produce noise. RV20 (ZERO LEVEL) is set so that the output from V20 varies about zero.

44. The variable capacitor C31 connected between the anode and cathode of V17 is used to balance out any stray capacitance which could introduce steps on the gate waveform. C11 is employed to equalize the edges of the gate output waveform from V6 and thus minimise spikes. Since stray capacitance has a greater effect on the higher impedance anode circuit, extra capacitance is added to the cathode circuit to create the balance.

Production of north marker

45. The north marker circuit obtains its input from a microswitch in the synchros assembly Type S1/1 in the aerial turning gear cabin. It is adjusted to close when the aerial is facing north. V22 is normally held cut off at the suppressor as well as at the control grid. When the microswitch closes, R177 is short circuited and the grid voltage raised to 0V. This has no effect on the anode current, however, since the valve is still cut off at the suppressor. At T_0 the positive-going range gate from the screen or V4 lifts the bias on the suppressor of V22. Thus during the gate the north marker will appear as a negative-going pulse at the anode of V22. This is applied to the monostable multivibrator formed by V24A and V24B, the natural period of which is much longer than the equivalent of the maximum range of the equipment. The pulse cuts off V24B and the changeover produces a positive-going pulse at the cathode of V24A. This represents the north marker output and it is applied to the brightener mixer via SKTK.

46. The negative end of scan trigger pulse from the anode of V3B is applied via C44 and the d.c.

restorer V23B to the grid of V24A to drive the monostable multivibrator back to its stable condition. The trailing edge of the anode waveform at V24B is fed to the grid of V22 to cut this valve off as a precaution in case the microswitch is still closed. Without this, the pulse at V22 grid could continue until the next range gate period at the suppressor of V22. The effect of V23A is to d.c. restore this waveform negatively.

Note . . .

10 degree markers can also be fed in to V22 but this facility is not used in this application.

M.t.i. range gate output

47. The sawtooth voltage at the anode of V1 is fed out via SKTX to the electronic marker generator where it is used to switch over the mixed video output from the m.t.i. to normal radar at a time determined by the m.t.i. range control RV28.

Range ring gating pulse output

48. The positive-going pulse at the cathode of V3A is coincident with the range gate. This is used as a gating pulse for the range ring circuit and is fed out via PLD.

Video map gating pulse output

49. A fraction of the positive-going pulse at the screen of V4 is made available at SKTN. It is intended as a gating pulse for associated video map circuitry, when used.

Monitoring

50. Monitoring facilities are provided in this unit and the relevant points in the circuit are connected to switch SWB. With an oscilloscope connected to TP1, a main waveform may be observed at each position of the switch. TP3 is connected to SKTA at which the T_0 pulse is received and this may be used as a synchronising pulse for the oscilloscope. TP2 is an earth point.

Power supply Type S27/2

General

51. The power supply Type S27/2, which provides the positive power supplies for the pulse generator power supply Type S18/1, derives its primary supply from the stabilised mains. The power supply Type S27/2 has two major circuit sub-divisions, that is, the power supply sub-assembly Type S56/1 (fig. 9) and the voltage stabilizer Type S5/1 (fig. 10). The voltage stabilizer Type S5/1 has a small additional circuit for the sine/cosine potentiometer and this is given at fig. 11. The reason for the use of the voltage stabilizer in this instance is to ensure that the outputs are suitable for the d.c. coupled circuits used in the pulse generator power supply Type S18/1.

Power supply sub-assembly Type S56/1

52. The power supply sub-assembly Type S56/1 uses conventional bridge rectifiers and LC filters, and produces three unstabilized outputs. These are +650V, +470V and −160V, and they carry fuses FS7 (250mA), FS6 (1A) and FS5 (0·5A) respectively.

53. The relay $\frac{RLA}{2}$ is energized from a circuit in the voltage stabiliser Type S5/1 until the stabilised +330V reaches the correct level. Contacts RLA1 and RLA2 therefore remain open initially and thus the charging current in C3 is limited by R19, and that in C5 by R20.

Voltage stabilizer Type S5/1

54. The voltage stabilizer Type S5/1 provides the +500V and +330V supplies. It also uses the −160V from the power supply sub-assembly Type S56/1 as an internal reference voltage for test purposes.

55. *Stabilized +500V supply.* The +650V input from the unstabilized supply is introduced at PLA7 and 15. V5 and V10 are series stabilizers which are controlled by V4 in the conventional manner. The anode voltage of V4 is obtained from the unstabilised +650V supply decoupled by C4 and R18. The setting of RV5 determines the output voltage level.

56. *Stabilized +330V supply.* The +330V input from the unstabilized supply is introduced on PLA8 and PLA15. V6, V7, V8 and V9 operate as series stabilizers controlled by V1 and V2, the ripple feedback being applied to the grid of V1. The output voltage level in this instance is determined by the setting of RV4.

57. The supply which energizes the relay $\frac{RLA}{2}$ in the power supply sub-assembly Type S56/1 is taken from the +330V stabilized output through the limiting resistor R60.

58. *Internal reference voltage circuit.* The grids of V1, V2A and V4 are normally returned to the stabilized −500V line introduced at PLA5. The unit has to be tested independently of this negative supply, however, and for this purpose an internal reference voltage is provided. This is obtained from the −160V input from the unstabilized chassis, which is stabilized at −85V by the circuit associated with V3. When switch SWB is set to TEST, the grids of V1, V2A and V4 are returned to the reference voltage by two alternative resistive networks, the values of which are chosen so that normal conditions are simulated.

59. *Monitoring.* Monitoring facilities are provided by the meter M1 in conjunction with switch SWA. The following table shows the functions checked at each position of the switch.

TABLE 2

Voltage stabilizer Type S5/1 monitoring points

Position	Function	Meter f.s.d.
1	−500V supply	500V
2	−85V reference voltage	100V
3	+300V supply voltage	500V
4	+500V supply voltage	500V
5	+330V line current	1A
6	+500V line current	200mA
7	V3 anode current	10mA
8	V6 anode current	500mA
9	V7 anode current	500mA
10	V8 anode current	500mA
11	V9 anode current	500mA

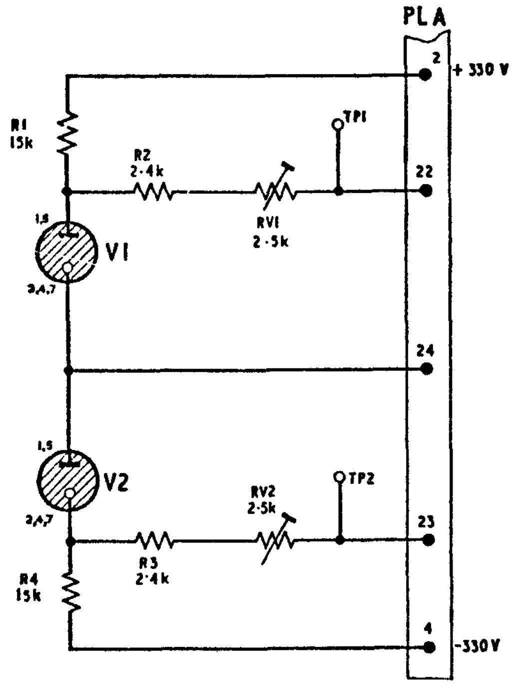


Fig. 11. Sin/cos potentiometer supply: circuit

60. *Sine/cosine potentiometer supply.* The circuit of the sin/cos potentiometer supply is shown at fig. 11. A +330 and a −330 stabilized voltage supply is provided from the voltage stabilizer Type S5/1 and the voltage stabilizer Type S4/1 respectively, and applied to the voltage stabilizer valves V1 and V2 respectively. The resulting +50V, −50V and 0V are applied via PLA22, 23 and 24 respectively to the sin/cos potentiometer.

Power supply Type S26/1

61. The power supply Type S26/1 which provides the negative power supplies for the pulse generator supply Type S18/1 also derives its primary supply from the stabilized mains. The power supply Type S26/1 has two major circuit sub-divisions, that is, the power supply sub-assembly Type S55/1 (fig. 12) and the voltage stabilizer Type S4/1 (fig. 13).

Power supply sub-assembly Type S55/1

62. The power sub-assembly Type S55/1 is very similar to the power supply sub-assembly Type S56/1 (paras. 52 and 53). The supplies provided in this instance are −500V, −330V, +140V, +150V and +330V. It should be noted that the −500V and the +150V outputs are derived from a 650V circuit, and the −330V and the +140V outputs are obtained from a 470V circuit.

Voltage stabilizer Type S4/1

63. There are four main circuits included in the voltage stabilizer Type S4/1. Two of these provide the −330V and the −500V supplies; one is an internal reference voltage circuit and the last is the 24V d.c. supply for relay operation.

64. *Stabilized* −330V *supply.* The unstabilized voltage for this is brought in on PLA13 (+140V) and PLA22 (−330V). Valves V3, V5, V6 and V7 operate as a series stabilizer stage which is controlled by the circuits of V1 and V2. The screens of these series stabilizer valves are held at a steady potential of +170V provided by the internal reference circuit associated with V9. The grid of V1 is returned to the slider of RV3, which is preset to obtain the required output level.

65. Ripple voltage on the negative 330V line affects the cathode potential of V1 and the amplified ripple voltage at the anode of V1 is then applied to the grid of V2A. Due to the fact that R14 is a common cathode load for V2A and V2B the ripple is applied to the grid of V2B so that the anode voltage is in the correct phase to control the grids of the series stabilizer valves. RV1, RV2 and RV4 are used to adjust the current through valves V3, V6 and V7 to be the same as that through V5. The meter M1 is switched across each of the 1 ohm anode resistors in turn to check that this correct.

66. An output is taken from the −330V line through R35 to supply relay $\frac{RLA}{2}$ on the power supply sub-assembly Type S55/1. This limits the charging current through C3 and C5 in that unit until the −330V stabilized line has reached its normal level.

67. *Stabilized* −500V *supply.* The unstabilized voltage is introduced on PLA12 (+150V) and PLA23 (−550V). The screen of the series stabilizer valve V8 is held steady at +75V by the voltage stabilizer V10 and is controlled at the grid by V4. The anode voltage of V4 is obtained from the +330V stabilised input on PLA2. Voltage stabilizer V12 is employed to hold the cathode of V4 at a potential of −415V. The input voltage to the control circuit is obtained from the junction of R63 and R64, which form part of the potential divider chain across the output.

68. *Internal reference voltage circuit.* The +330V output from the voltage stabilizer Type S5/1 is normally used to provide the h.t. for the control circuit of V1 and V2, but to allow the negative supplies to be checked independently, an internal reference voltage is provided by the circuit associated with V9. Under normal conditions, the anode voltage of V9 is obtained from the stabilized +330V input introduced on PLA2 and the +170V reference voltage at the cathode of V9 is used as the screen supply for the four series stabilizer valves. When switch SWB is set to TEST, however, the unstabilized +330V input from the power supply sub-assembly Type S55/1 is used to provide the anode voltage for V9. The +170V reference voltage is also switched to V1 and V2, to replace the stabilized +330V, and R15 is switched into circuit to provide compensation for the lower h.t. by bringing the bias level back to normal.

69. 28V *d.c. supply.* A 28V winding on the heater transformer T1 is connected to the bridge rectifier, MR1 to 4, via the 2A fuse FS1. The 28V d.c. output is then used as the supply for the relays.

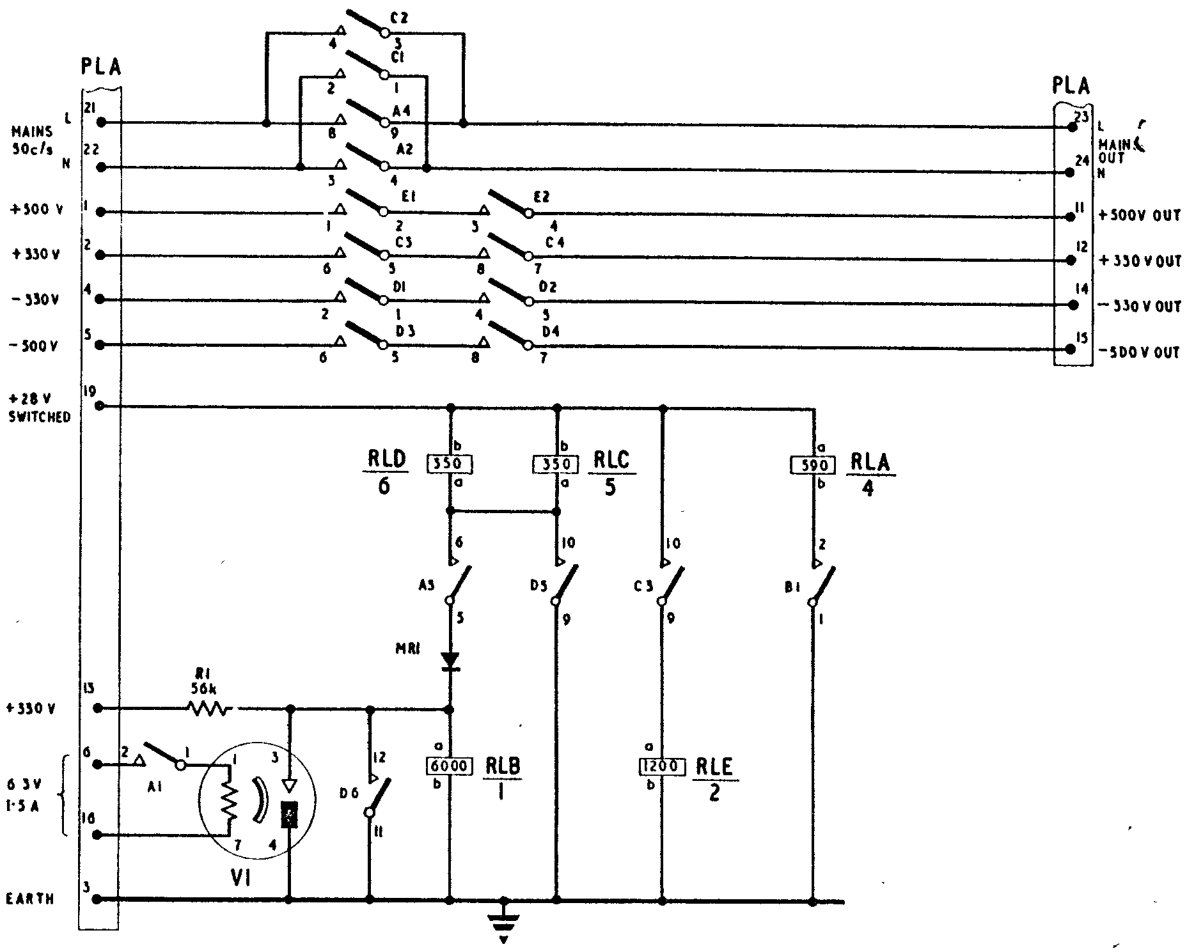


Fig. 14. Switch assembly Type S5/1: circuit

70. *Monitoring.* The meter M1 can be switched to the various voltage and current monitoring points in the circuit, and these are indicated in Table 3 shown below.

TABLE 3
Voltage stabilizer Type S4/1 monitoring points

Position	Function	f.s.d.
1	−500V supply voltage	500V
2	−300V supply voltage	500V
3	+170V reference voltage	500V
4	+330V supply voltage	500V
5	−500V line current	100mA
6	−300V line current	1A
7	V9 anode current	100mA
8	V5 anode current	500mA
9	V6 anode current	500mA
10	V7 anode current	500mA
11	V3 anode current	500mA

Switch assembly Type S5/1

71. *General.* Provision is made for three switch assemblies Type S5/1 (fig. 14) to be used with the voltage stabilizer Type S4/1. Each of these is used to switch stabilized mains and d.c. voltages through to one of the pulse generators Type S14/1 or one of the azimuth range indicators, in the correct sequence. It can be switched on at any time after the installation has been switched on by closing the ON OFF switch on the control indicator of the associated azimuth range indicator. This completes the +28V line. The action is then initiated by completion of the 28V d.c. relay supply from the appropriate voltage stabilizer Type S4/1. This action is automatic, due to a permanent link, for a switching unit controlling the supplies to a pulse generator Type S14/1. The DISPLAY ON/OFF switch completes the 28V supply for a switch assembly which controls supplies to an azimuth range indicator.

72. *Operation.* When the equipment has been switched on, the +330V reference voltage line is introduced via PLA-13. Relay RLB is then energized and contact RLB1 completes the earth return for relay RLA. This is the standby condition for the switch assembly. When the +28V circuit is completed to PLA19, relay RLA is energized and contact RLA1 completes the 6·3V a.c. supply from transformer T1 in the voltage stabilizer Type S4/1 to the heater of the thermal delay switch V1. Contacts RLA2 and RLA4 switch the stabilized mains through to the controlled unit. Contact RLA3 connects one side of relay RLD through MR1 to V1. Relay RLD cannot yet be energized since the voltage at the V1 end of MR1 is more positive than the +28V line at PLA19 and current cannot flow in the reverse direction through MR1. About 70 seconds later the contacts of V1 close thus completing the circuit which energizes relays RLC and RLD.

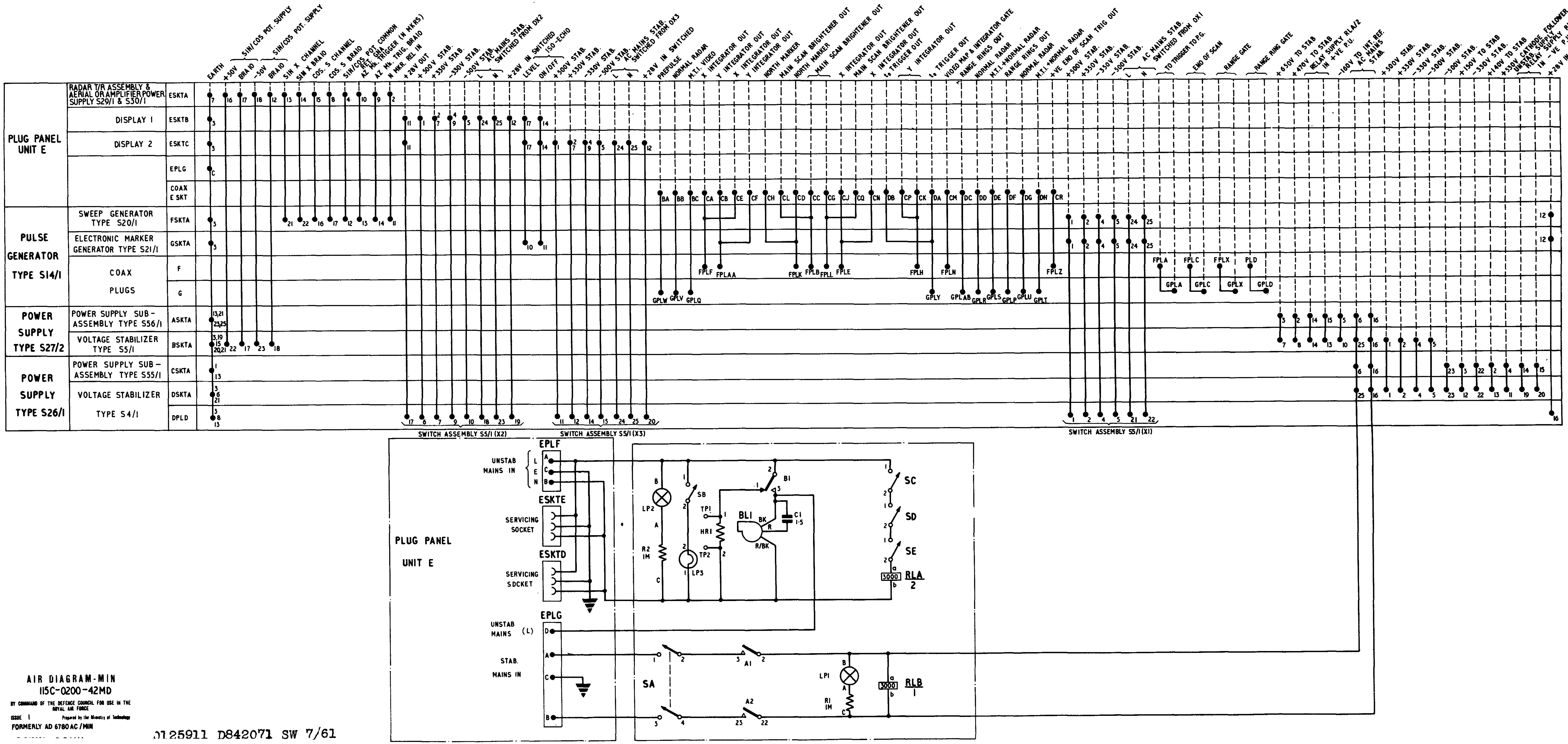
73. Contacts RLD1 and RLD2 (in series) and contacts RLD3 and RLD4 (in series) switch the −330V and the −550V supplies, respectively. Contacts RLC3 and RLC4 (in series) switch the +330V supply to the controlled unit. Contact RLC5 completes the circuit which energizes relay RLE and then contacts RLE1 and RLE2 (in series) switch the +550V supply to the controlled unit. This completes the switching on sequence.

74. When the contacts of V1 close a further switching sequence is initiated as a safety measure. As relay RLB is in parallael with V1 contacts, RLB will be de-energized and contact RLB1 will open. This in turn will cause relay RLA to become de-energized. Contact RLA1 now opens and V1 commences to cool. Contacts RLA2 and RLA4 are also opened but contacts RLC1 and RLC2, which are in parallel with them, are already closed and maintain the mains supply circuit. Contact RLA3 is opened, but as contact RLD5 is already closed relays RLC and RLD remain energized. Thus all supply circuits are maintained. V1 contacts will finally open again but contact RLD6 maintains the short circuit across relay RLB.

75. If the unit is switched off and then on again during the cooling period of V1 the relays RLC, RLD and RLE will become de-energized but, since the hold-on contact RLD5 is opened, these relays cannot become re-energized. When V1 has cooled, its contacts will open and allow relay RLB to become energized. The complete switching cycle will then be repeated. The complete switching cycle is also repeated if the unit is switched off and on again after the contacts of V1 have opened.

Note . . .

The above switching sequence ensures that the valve heaters of the unit being controlled have an adequate warming up time and also that the supplies to the unit are always connected in the correct sequence.



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Pulse generator power supply Type S18/2, cabinet: circuit and interconnections

Fig.5

Electronic marker generator Type S21/1 : circuit

Fig. 6

Fig.7

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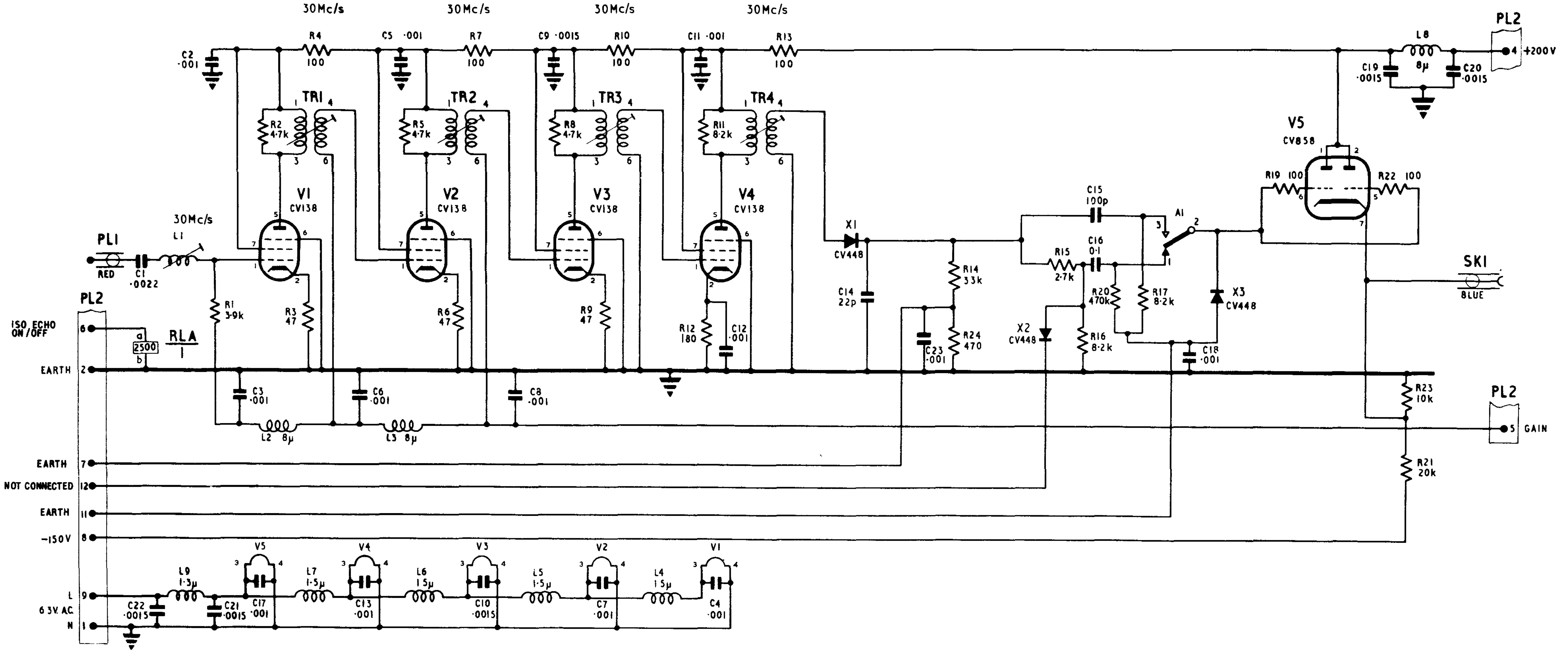
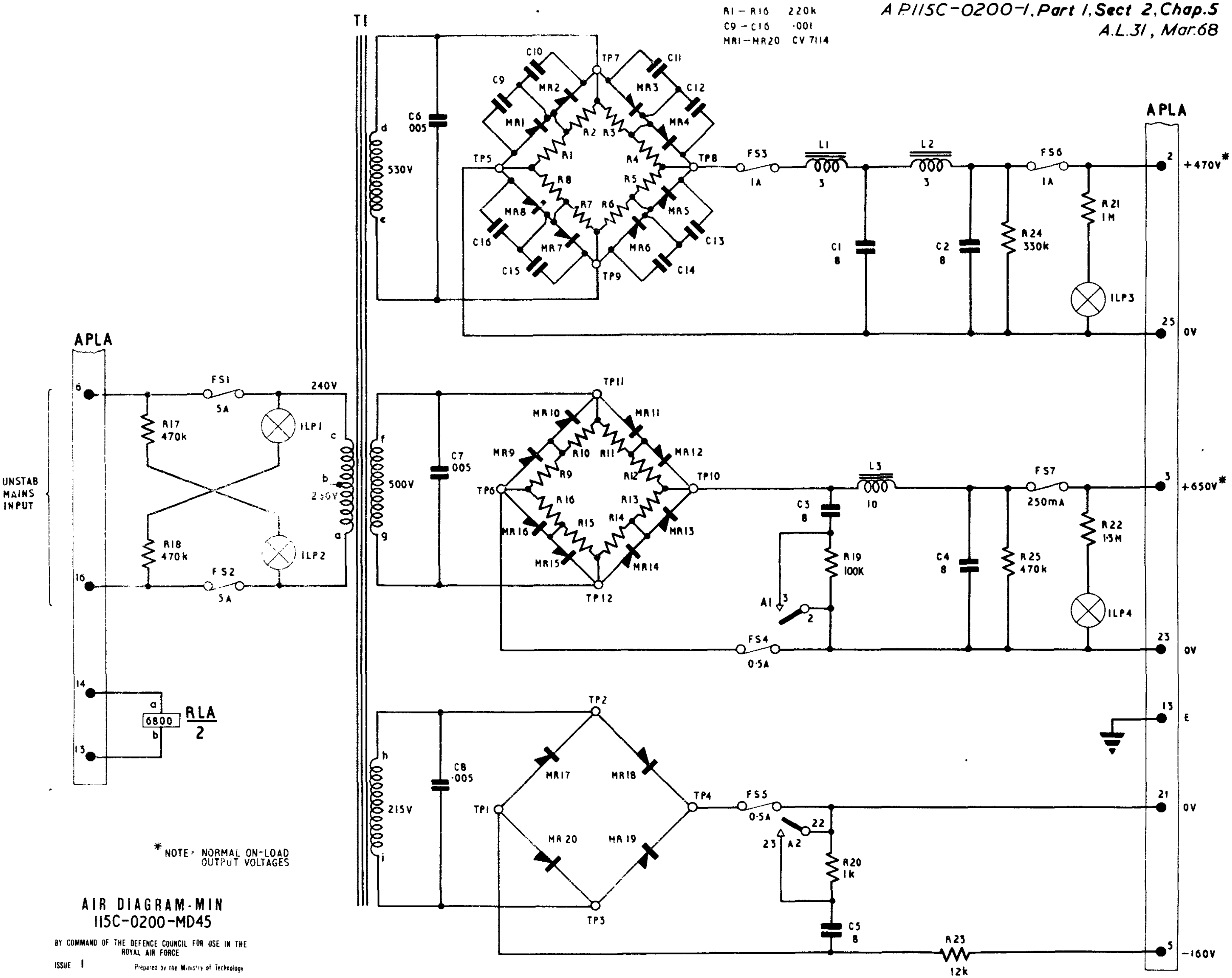
Sweep generator Type S20/1 : circuit



I.F. amplifier Type S11/1 : circuit

Fig.8



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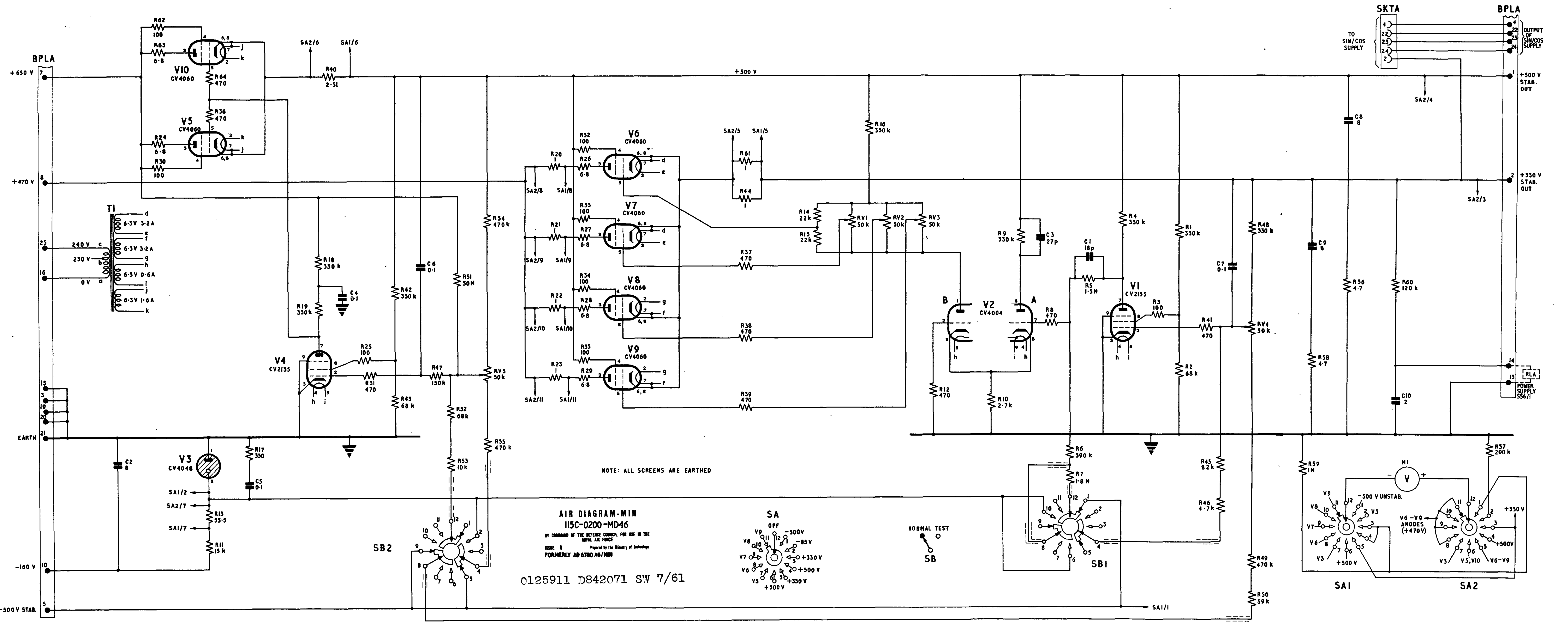
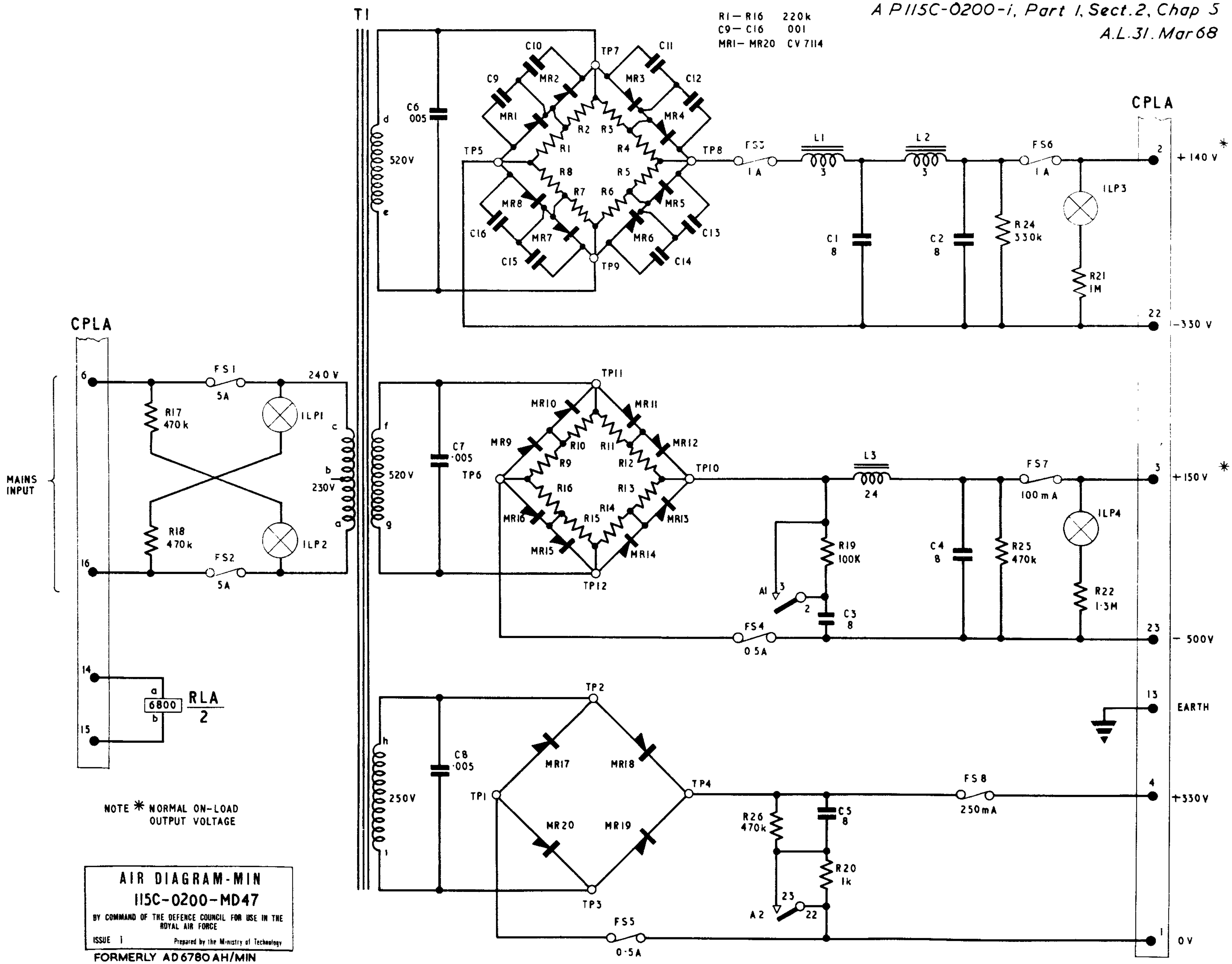
Power supply sub-assembly Type S56/1 : circuit

Fig.9



Voltage stabilizer Type S5/1 : circuit

Fig.10



NOTE * NORMAL ON-LOAD OUTPUT VOLTAGE

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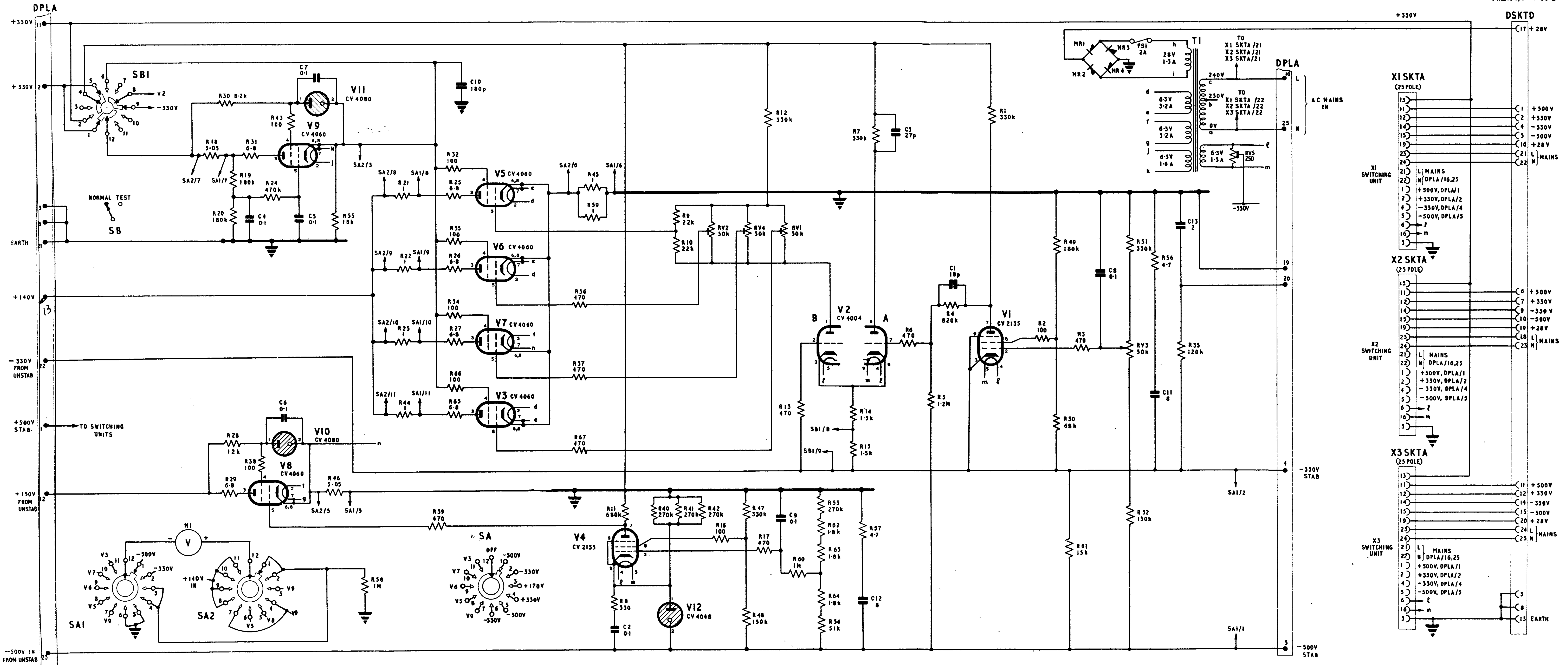
Power supply sub-assembly, Type S55/1 : circuit

Fig.12



Voltage stabilizer Type S4/1: circuit

Fig. 13

AIR DIAGRAM
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Chapter 6

RACK ASSEMBLY IN RADIO EQUIPMENT ROOM

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LIST OF ILLUSTRATIONS

Introduction

1. The rack assembly (fig. 1) in the radio equipment room comprises a pulse generator power supply Type S18/1, which is almost identical with the pulse generator power supply Type S18/2 described in Chapter 5 in this Section, and an amplifier power supply Type S29/1 mounted on top of it. The main difference between the pulse generator power supply Type S18/1 and Type S18/2 is that the forced air cooling supply in the pulse generator power supply Type S8/1 is coupled to the cooling duct in the amplifier power supply Type S29/1.

2. The amplifier power supply Type S29/1 provides the sin/cos output in sychronism with the aerial as required for the pulse generator power supply Type S18/1, equivalent to that provided by the synchros assembly Type S1/1 (in the aerial turning gear cabin Type S5/1) for the remote site displays. This method is essential because of the excessive volts drop which would be produced by transmitting the output of the sin/cos potentiometers at the aerial turning gear cabin over the 4,000 yard line.

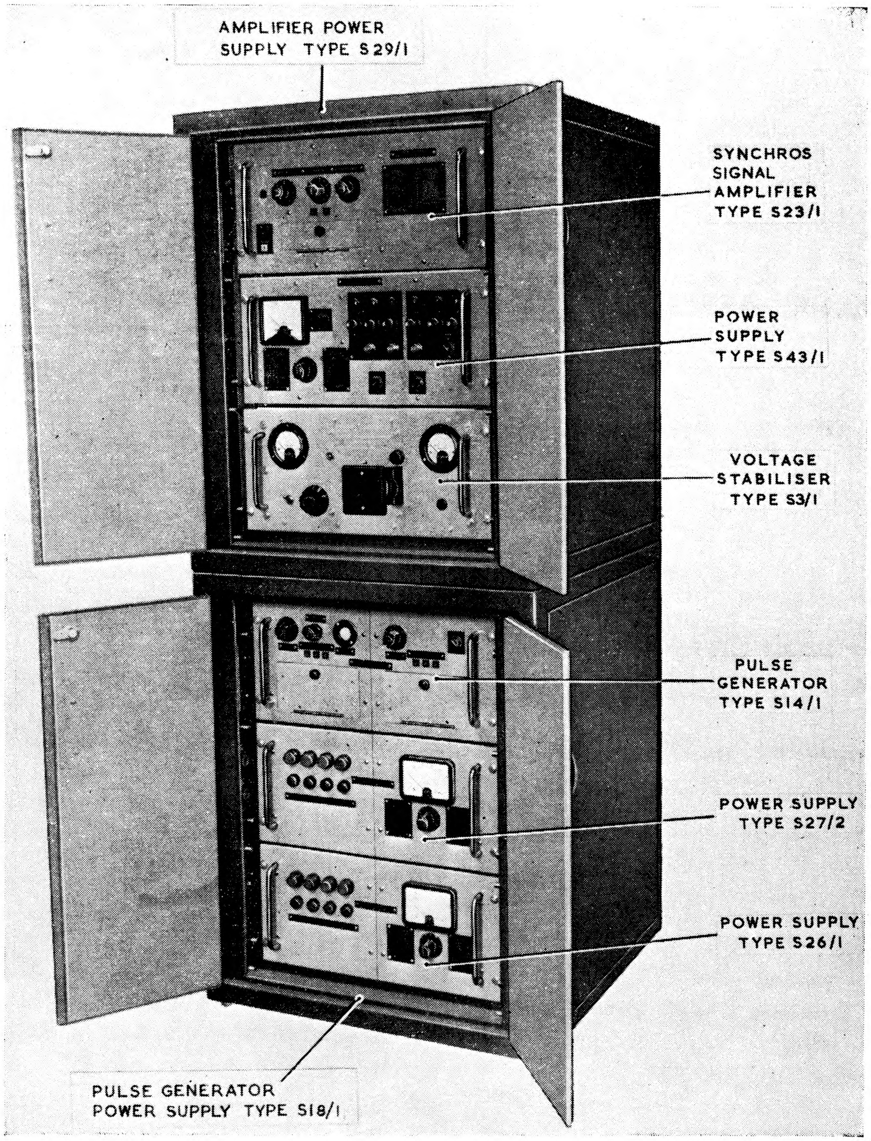

Fig. 1. Rack assembly — general view

Amplifier power supply Type S29/1

3. The amplifier power supply has three units — synchros signal amplifier Type S23/1, power supply Type S43/1 and the voltage stabilizer Type S3/1 and these can be seen in position in fig. 1. The voltage stabilizer Type S3/1 is identical to the voltage stabilizer Type S1/1 in the radar set group Type S1/1 described in Chapter 2 of this Section and provides the stabilized 230V a.c. supply for the rack assembly. The power supply Type S43/1 provides the necessary h.t. supplies for the synchros signal amplifier Type S23/1 and a.c. supply for the magslip in the synchros assembly Type S1/1. All the warning lamps, preset potentiometers, fuses, on/off switches, meter and associated selector switch are all mounted on the front panel of the unit. The synchros signal amplifier Type S23/1 contains the two aerial follower magslip resolvers and associated sin/cos potentiometer which transmit the information received from the aerial magslips in the synchros assembly in the aerial turning gear cabin into the drive required to feed the pulse generator Type S14/1. It also has a separately identifiable sub-assembly, the r.f. amplifier Type S24/1 (fig. 2) which provides amplification for the pre-pulse and m.t.i. video signals to compensate for the attenuation of the signals over the long inter-site transmission lines. The operating controls and monitor points are immediately available on the front panel and a number of presets required for setting up are located behind a hinged flap.

CIRCUIT DESCRIPTION

General

4. Amplifier power supply Type S29/1 has four main circuit sub-divisions. These are: synchros signal amplifier Type S23/1 (fig. 3), power supply Type S43/1 (fig. 5), voltage stabilizer Type S3/1, and the circuit for the cabinet of amplifier power supply Type S29/1 (fig. 6). The circuit of r.f. amplifier Type S24/1, which is a sub-assembly of synchros signal amplifier Type S23/1, is given in fig. 4. For the circuit of voltage stabilizer Type S3/1 reference should be made to fig. 10 and para. 55 in Chap. 2 of this Section.

Synchros signal amplifier Type S23/1

5. The two magslip resolvers (MSR1 — high speed and MSR2 — low speed) are fed from MS1 and MS2, in aerial turning gear cabin Type S5/1, which provide the error signals for the amplifier. This in turn provides the corrector supplies for the servo motor which causes the magslip resolvers and the associated sin/cos potentiometer to be reset accordingly. The sin/cos potentiometer output is now fed into pulse generator Type S14/1, as in the remote site displays, and this in turn causes the radial scan of the p.p.i. display to follow the aerial scan correctly.

6. In addition to the normal follow condition mentioned in para. 5, three other conditions required during setting-up and adjustment are provided and can be selected by switch SA. These are dealt with in para. 19 to 23.

7. The principle of the follow system is demonstrated in fig. 7. The aerial (transmitter) magslip (T_R) is shown driven by the aerial with the rotor

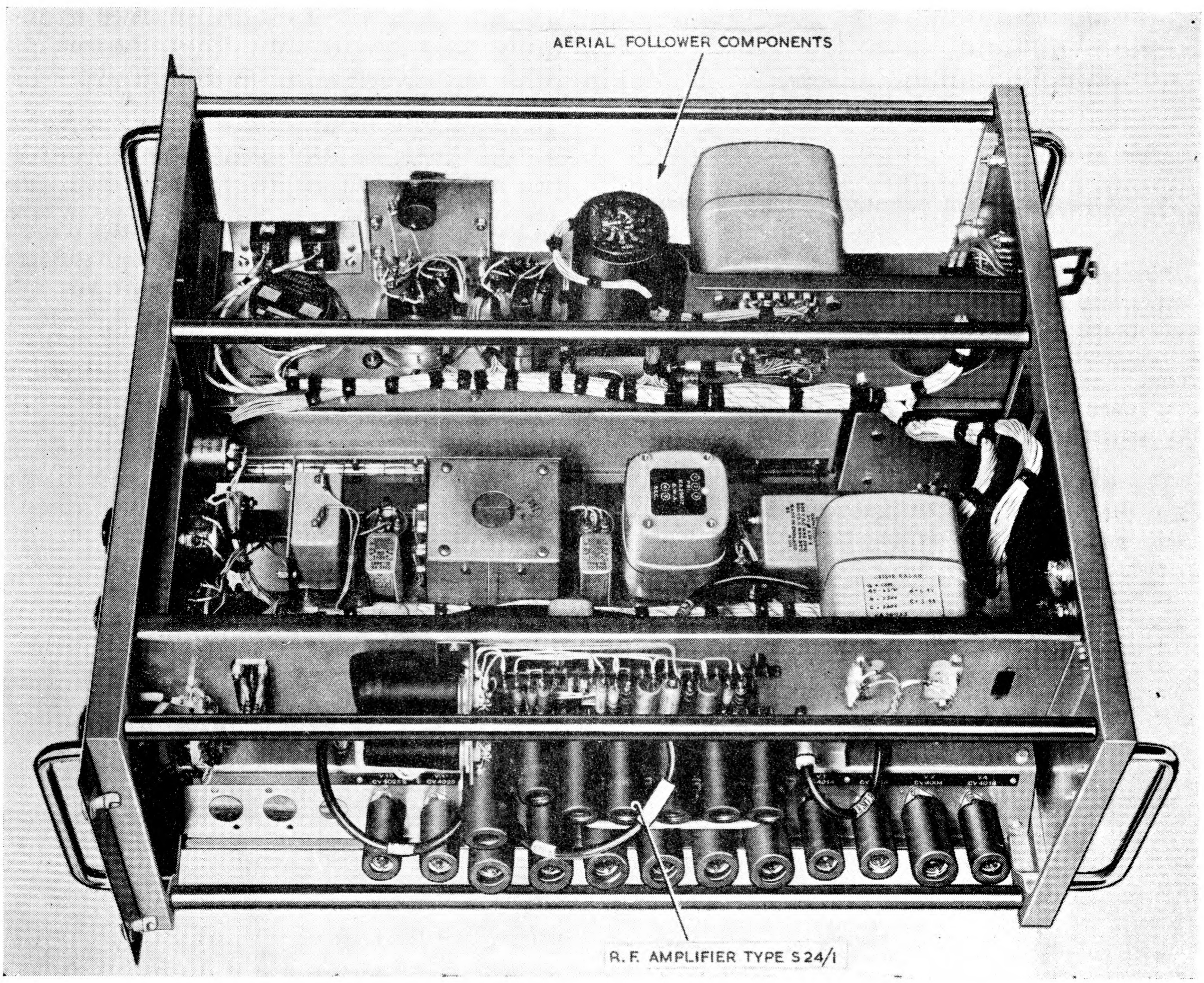

Fig. 2. Interior view of synchros signal amplifier Type S23/1—circuit

fed from the a.c. supply. The phase and amplitude of the e.m.f. induced in stators T_{S1} and T_{S2} as the aerial rotates is a function of the angle Θ and these stators feed those at the receiver magslip, R_{S1} and R_{S2}. The phase and amplitude of the voltage induced in rotor R_R is a function of angle $(\Theta-\phi)$ and represents the error in the angular position of R_R w.r.t. T_R. If this voltage is amplified it can be fed to the motor of tacho-generator (fig. 3) causing it to turn the receiver magslip in a direction to offset the error.

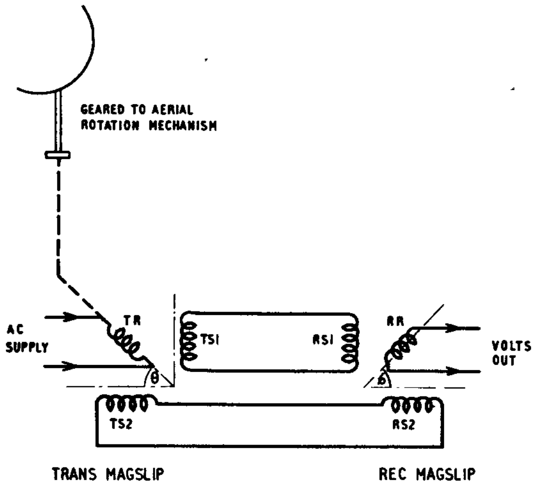

Fig. 7. Arrangement of magslips in basic system

8. The basic system described in para. 7 serves to underline the principles involved but has the disadvantage of fairly large follower errors and the practical system employs duplicate synchro systems, one for low speed (LS) which rotates at the scanner speed and the other the high speed (HS) geared to it in the ratio of 36:1.

9. The block diagram shown in fig. 8 demonstrates the principle of the practical aerial follow system and shows the arrangement of the high and low speed synchros with the amplifier providing the correct drive to the motor. In the circuit diagram (fig. 3) MSR1 is the high speed receiver synchro and MSR2 the low speed synchro. These are coupled via a gear train to the driving motor and the sin/cos potentiometer. In the normal position of switch (SA) the inputs from the synchros assembly at the aerial turning gear cabin are applied to MSR1 and MSR2, and the voltages at the rotors of these synchros appear at SC1/1 and SC1/2 respectively.

10. When an error signal has been established the output of the low speed synchro is used to reduce this to less than 3 degrees and then the output of the high speed synchro is employed to complete the correction. This procedure is necessary because the high speed output could be incorrect by an integral number of its revolution, since its position of minimum output can correspond to 72 different aerial positions. The changeover from low speed to high speed is done automatically.

11. A proportion of the error signal output from the low speed magslip is applied to the grid of amplifier valve V1, the anode of which feeds an anode bend detector valve V3A. The output of V3A is d.c.-coupled to the grid of the control valve V4 in such a way that when the signal amplitude falls to the correct level as determined by the setting of RV1 (HIGH SPEED TAKEOVER), the anode current of V4 rises and high speed takeover relay RL1 is energized. This arrangement for the control of the changeover takes no account of the possibility of 180 deg. ambiguity in the phase of the output from the low speed resolver. If the rotor of MSR2 is in a position 180° ± 3° from the true position, the output as presented to the control circuit, V1, V3A and V4, will be the same as for the true position ± 3°. This ambiguity is overcome by connecting the output from a second rotor winding of MSR2, 90° displaced from the first, in series with a supply of 2·5V from the secondary terminals 9 and 10 of transformer T1.

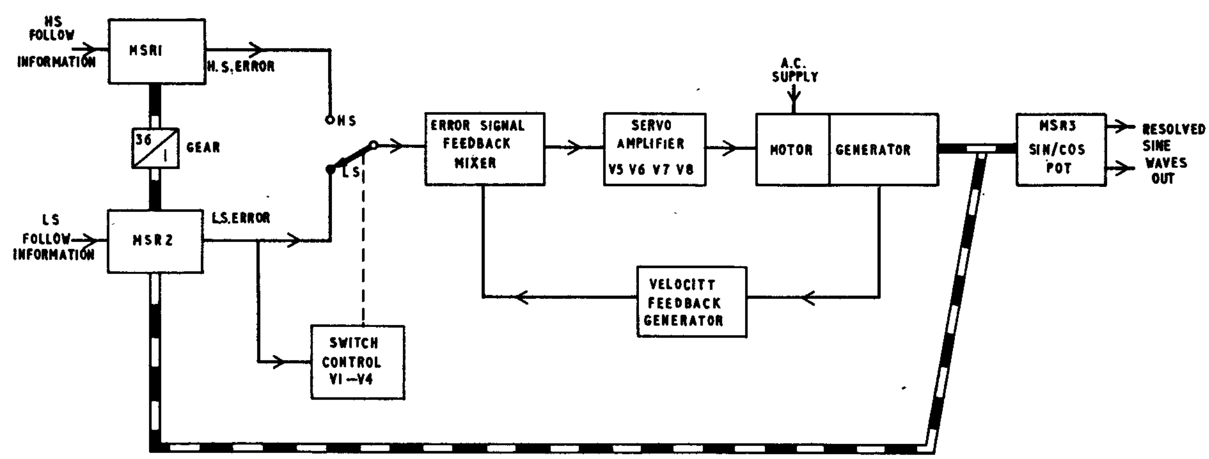

Fig. 8 Principle of practical aerial follow system

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12. The phase of the output from the second rotor is retarded by C3 and C35, and that of the supply from T1 advanced by the presence of C4. This method of shifting the phase of both sources in opposite directions minimizes errors which might arise through change in frequency of supply. In addition the fraction of the auxiliary supply voltage is adjusted by the AMBIGUITY PHASING control RV7 so that when the resolver position is correct the two voltages cancel. When the rotor is displaced by 180°, however, the two outputs are added and the resultant is fed to the grid of V2. The anode of V2 is in turn coupled to the grid of V3B and the anode load of this is common with that of V3A. The output of V3 is d.c. coupled to V4 which is as held at the cut off and prevents the changeover to high speed working, even though the error voltage input to V1 has dropped to the changeover level.

13. The error input selected by RL1/2 is fed to the phase correcting network, the function of which is to compensate for phase shift introduced by the synchros and associated feed resistors. When the network is correctly adjusted by means of the ERROR SIGNAL PHASE control RV6, the error signal is in phase with the voltage at pin 16 of transformer T1. The voltage is then advanced approximately 90° by C10 and C16 and thus the voltages applied to the two windings of the motor are in quadrature and maximum torque results. Another reason for restoring the phase of the error signal to that of the main supply is to satisfy the conditions required in the feedback system which is described in para. 15 et seq.

14. The output of the phase correcting network is taken to the grid of V13A. The output of this valve is coupled to the grid of V5B the first valve of the error amplifier circuit. The anode of V5B is d.c. coupled to the grid of V2A which provides a split-phase drive for V6A and V6B. These in turn drive the output stage which consists of two double triodes V7 and V8 operating in push pull. The output of these valves is fed to the driving motor from the secondary of transformer T2. A degree of negative feedback is applied to the cathode of V5B derived from the secondary of the output transformer.

15. Since the servo system comprises a closed loop of high gain, it is liable to oscillate at a frequency which is determined mainly by the mechanical inertia of the system. The oscillatory condition would be initiated if the system were subjected to some changes, and feedback is necessary to prevent this. The feedback system employed has been designed to respond only to transients because if the full feedback were to be applied at all times the high gain of the system could be destroyed. This condition is achieved by obtaining a feedback voltage proportional to the angular velocity of the servo motor, and comparing this voltage with an inverted version of the same voltage which has delayed amplitude variations only. In the state of steady rotation, these two voltages cancel; a stabilizing feedback voltage is obtained only when the speed varies.

16. The generator portion of the tacho-generator is excited from a 50V secondary winding of transformer T1. The amplitude and phase of the output of this generator are proportional to the angular velocity and the direction of rotation respectively. The output is attenuated by R131, R115 and potentiometer RV4 (TACHO-FEEDBACK) and applied to the grid of V13B via R118. This is the velocity feedback voltage and its level is controlled by RV4. Capacitor C38 and potentiometer RV8 (TACHO-PHASE) provide phase correction.

17. The generator output is also applied to the phase sensitive bridge rectifier, V10 and V11 (fig. 9). A voltage, 25V–0–25V, from the secondary of T1 polarizes the rectifier. The output from the generator unbalances the bridge and produces push pull outputs across R72 and R74, which drive the grids of the balanced modulator valve V12. A 50 c/s signal voltage is injected into the cathode circuit of V12 and, if the grids of this valve are at equal potentials as determined by the correct setting of RV2 (MOD. BAL), there would be no output from the secondary of transformer T3 in the anode circuit. The output of the phase sensitive rectifier unbalances the modulator and produces an output in the secondary of transformer T3. A portion of this is selected by potentiometer RV5 (DELAYED VELOCITY FEEDBACK) and applied to the grid of V13B, in anti-phase to the velocity feedback voltage mentioned already. Thus, these two voltages can be made to cancel in the state of steady rotation, by equalising the amplitudes and phases. The RC networks in series with the grids of V12 cause a delay in the arrival of the application of the output of the phase sensitive rectifier to the grids of V12 but the direct velocity feedback at V13B grid changes immediately. The result is that during a change of velocity, the two voltages arriving at V13B grid do not cancel and a net feedback voltage is available.

18. The net velocity feedback voltage at V13B grid is amplified by this valve and, with relay RL2 in the unenergised condition, the amplified version is passed to the grid of V13A, where it is subtracted from the error voltage delivered by the phase correcting network. The amplified difference voltage is developed across R124 in the anode circuit of V13A and passed to the servo amplifier.

19. The foregoing description has dealt with the condition for normal follow operation. When switch S.A. is set to position 1, SA5/1 connects the input of the servo amplifier, via the phase correcting network, to the slider of RV3 (FREE RUN SPEED), which forms part of a phase shift network across a 6·3V supply from transformer T1. This provides the required error signal to maintain running of the system independent of the aerial position information. In this condition the velocity feedback system is rendered inoperative because relay RL2, which changes over the contacts in the anode circuit of V13 is now energised via SA6/1. This opens the feedback loop. At the same time the gain of V13A is reduced by R137 being connected in parallel with R123 and thus increasing the feedback from the anode to the grid. It should be noted that although the normal anode current of V2 passes through the relay it is insufficient to energise it.

20. The switch contact SA6/1 also reduces the anode voltage of V2 to zero and no ambiguity signals are passed to the detector V3B so that V4 is held on. There is no input to MSR2 and thus minimum error signal is applied to V1 and RL1 remains continuously energised. As the 180° ambiguity circuit is not operative and with RL1 continuously energised, the artificial error signal from RV3 remains connected to the input terminal of the phase correcting network.

21. The two remaining operational conditions selected by the switch SA are required during setting up. These are for the rotors to be set to 0° (position 3) and 270° (position 4). The incoming information from the aerial synchros is disconnected and the required static supplies to MSR1 and MSR2 provided as an alternative. These supplies are obtained from the 70V winding of T1 and are applied, via R64, and switch sections SA1, SA2 and SA3 to the appropriate stator windings. In position 3 (0°), the supply is connected to terminal 1S of the low speed MSR2, the other stator of which is disconnected. This arrangement is reversed for position 4 (270°). In both positions the supply is applied to terminal 1S only of MSR1. These conditions are the same as those existing at the instance when a rotating aerial passes through the 0° and 270° position.

22. In the 0° and 270° positions, one phase shift capacitor, C35 is removed from the ambiguity resolving circuit since a smaller phase shift is required in these static conditions because the stator voltages are obtained locally. In addition, the junction of R58 and R1 is taken via R59 to earth and thus places a 2: 1 attenuator across the auxiliary rotor output. This is done as more output is obtained from the rotor under local supply conditions than is available when the synchro is fed from the aerial.

Lock pulse separator

23. M.t.i. video and lock pulse (pre-pulse) are introduced at BPLQ and applied to the double diode (V17) input stage to the lock pulse separator. This applies a positive-going trigger via transformer T5, to the trigger amplifier valve V18. This in turn applies a positive-going pulse to the grid of V19 via transformer T6. This valve operates as a blocking oscillator and produces a large amplitude positive-going output pulse taken out via BSKTN to the display circuits.

Monitoring points

24. A number of monitoring points in the circuit are provided and these are connected to monitor point BSKTJ for application to an oscilloscope. In addition a number of voltage monitoring points are provided for application to an external meter in the power supply Type S43/1.

◀ **Note . . .**

Motor, control NSN 6105-99-933-1479 *will be superseded by motor control NSN* 6105-99-954-2484. *Terminal connections for the two motors are not identical; therefore reference should be made to fig.* 10 *when replacing this component.* ▶

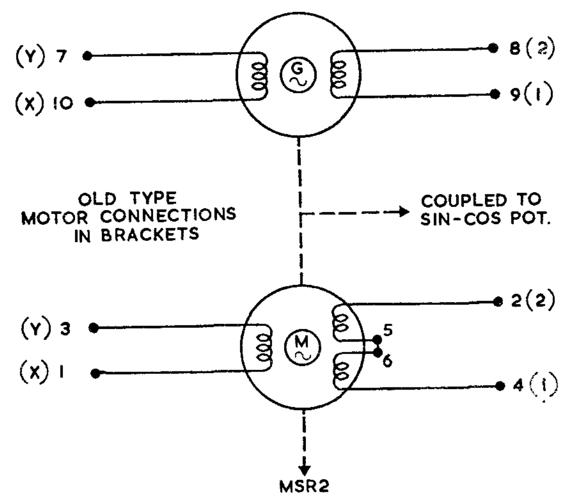


Fig. 10. Terminal connections for motor control (N.S.N. 6105-99-954-2484)

R.f. amplifier Type S24/1

25. The R.F. amplifier Type S24/1 (fig. 4) provides amplification of the m.t.i. video and prepulse signal modulated 20 Mc/s carrier, required by the radio equipment room displays. The unit provides five high gain broad band stages of amplification and the output of these is applied to a diode detector which feeds a cathode follower output stage associated with V7.

Power supply Type S43/1

26. The circuit diagram for the power supply Type S43/1 is given at fig. 5. The unit provides all the h.t. supplies for the synchros signal amplifier Type S23/1 and the r.f. amplifier Type S24/1. The 230V a.c. stabilized supply from the voltage stabilizer Type S3/1 is introduced at APLA6 and 16 via a 5A fuze in each lead and the MAINS ON OFF switch SC to the three mains transformers T1, T2 and T3. T1 provides the circuit for the positive stabilized supplies, T2 the negative stabilized supplies and T3 provides 13·3V for the magslips in the aerial turning gear cabin.

27. The 336V secondary of T2 feeds a bridge rectifier and the smoothed d.c. output is applied to the series stabilizer valve V7 controlled by V8A and V8B with the reference voltage being provided by V9. The −330V output voltage is taken to a PLA5 via relay contact RLB1 which is controlled as follows. On switching on, 6·3V is applied to the heater of the thermal delay valve V10 and when this has reached its operating temperature the thermal delay contact closes and, if the STANDBY switch SD is closed, the energising circuit for relays RLA and RLB is completed. Relay contact RLA1 changes over and completes the hold on circuit for these relays short circuiting the contact of V10. Relay contact RLB1 then completes the output circuit for the −330V. At the same time contact RLA2 completes the energising circuit for relay RLC1 and contact RLC1 closes. Thus when the +330V ON OFF switch SE is closed the mains is applied to transformer T1. This has a 336V secondary and a 262V secondary both of which feed conventional stabilizing circuits producing +470V, +330V and +220V. If at any time the standby switch SD

+200V

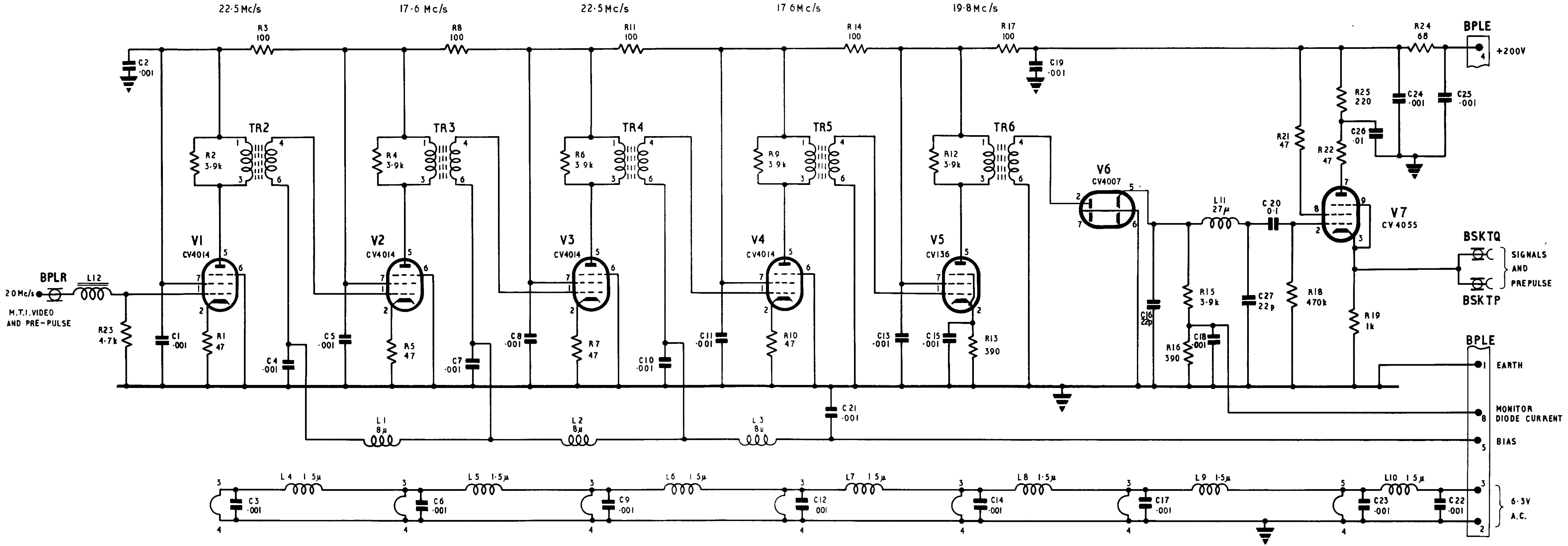
is opened the switching on sequence associated with the thermal delay valve V10 has to be repeated before the negative and positive h.t. supplies are switched on again. A number of monitoring points are connected to the meter M1 via switch SA in the internal position. This meter can also be applied to the monitor points in the synchros signal amplifier by setting it to the external.

Amplifier power supply Type S29/1 cabinet

28. The circuit and interconnection diagram for the cabinet of the amplifier power supply Type S29/1 is given at fig. 6. The unstabilized mains is introduced from ATB3 and, if the three units are in position, microswitches SC, SD and SE are closed so that relay RLA is energised. Thus when the MAINS ON OFF switch SA is closed relay contacts RLA1 and RLA2 complete the circuit by which the stabilized 230V output from the voltage stabilizer is applied to the synchros signal amplifier and the power supply in this cabinet, and also out via ASKTL to the pulse generator power supply Type S18/1 units. Relay RLB is also energised when the stabilized output is being delivered from the voltage stabilizer and changes over relay contact RLB1 so that the heater is out of circuit while the equipment is operating.

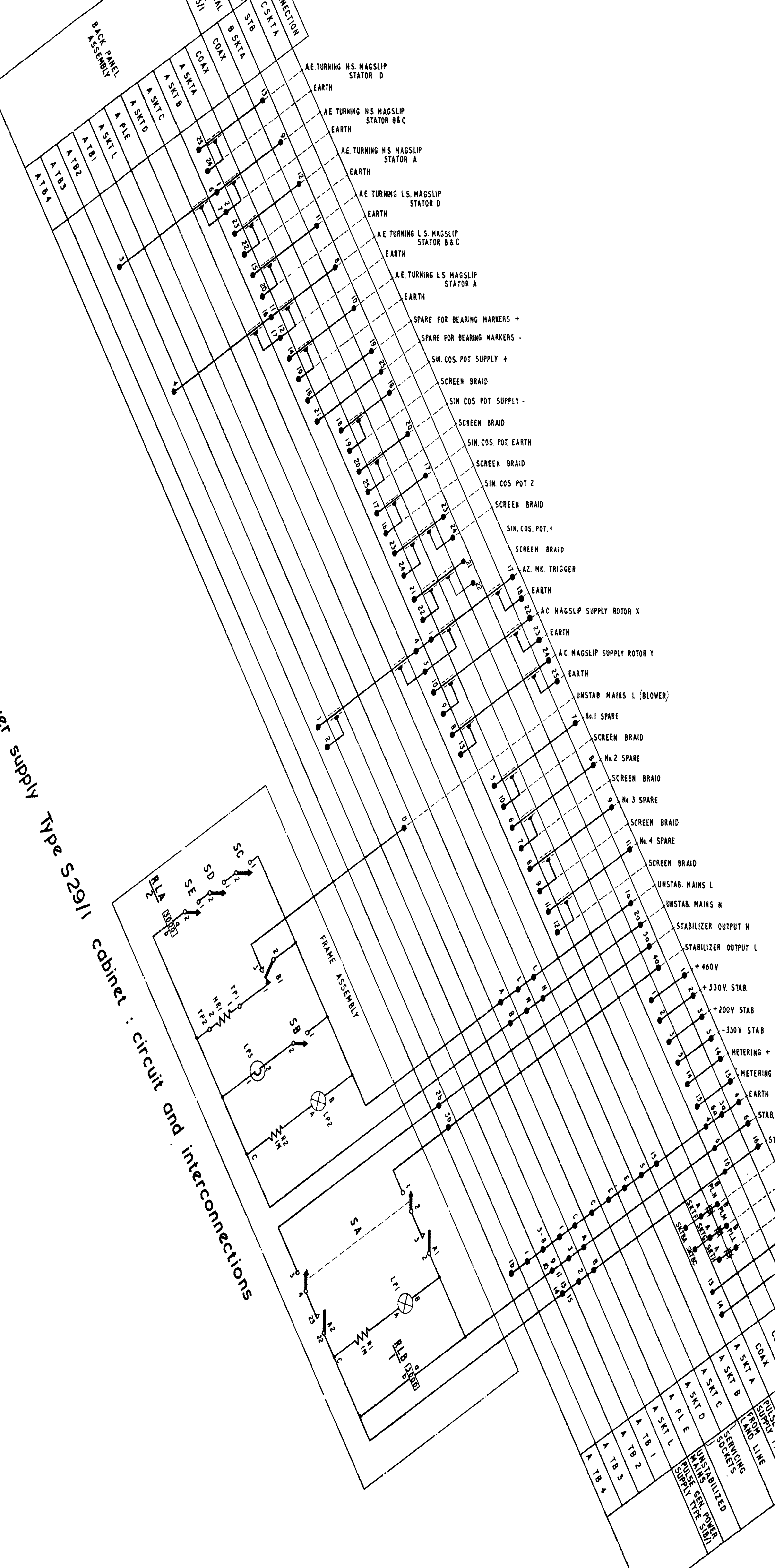
Synchros signal amplifier Type S23/1 : circuit

Fig.3



R.F. amplifier Type S24/1 : circuit

Fig. 4



...er supply Type S29/1 cabinet : circuit and interconnections

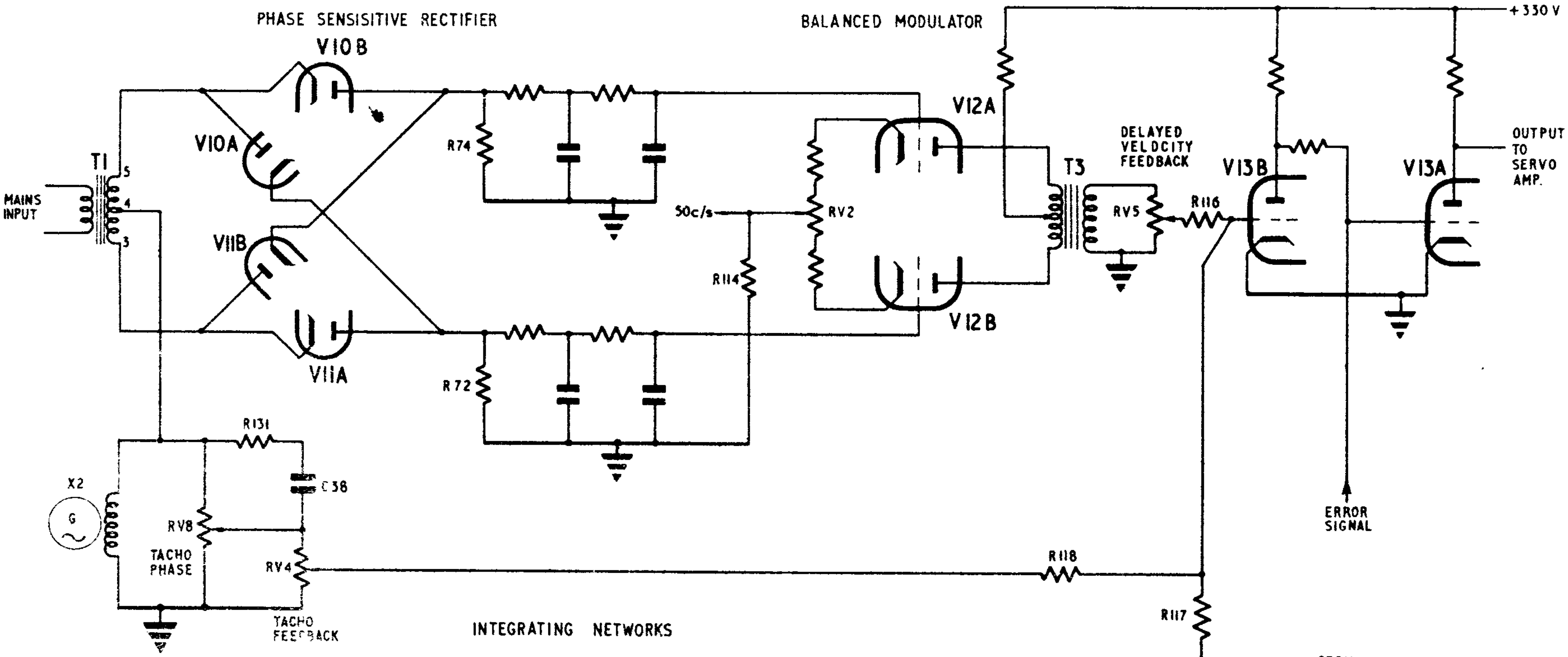


Fig. 9 Simplified velocity feedback circuit Fig. 9

Chapter 7

AMPLIFIER POWER SUPPLY TYPE S30/1

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LIST OF ILLUSTRATIONS

Introduction

1. The amplifier power supply Type S30/1 (fig. 1) comprises a cabinet and two units—the amplifier converter Type S25/1 and power supply Type S46/1. The purpose of the amplifier converter is to provide amplification for the normal radar signals and to produce a 20 Mc/s carrier modulated with the pre-pulse and m.t.i. video signals. The power supply Type S46/1 provides stabilized supplies for the amplifier converter. These are +330V, +200V and −150V h.t. and 230V 50 c/s a.c. It also supplies the amplifier power supply cabinet heater when the unit is switched off. In addition, it provides metering facilities for the modulator oscillator as well as its own internal supplies.

2. The controls, indicator lamps, fuses and monitoring points are mounted on the front panel of the units. The meter for the two units is mounted on the power supply Type S46/1 front panel, and the associated selector switches are on the front panels of the individual units.

3. The amplifier converter has four separately identifiable sub-assemblies, and two of these, the i.f. amplifier Type S26/1 and the modulator oscillator Type S3/1 can be seen in the interior view of the unit shown in fig. 2. The other two are 10 dB step attenuators located underneath the chassis.

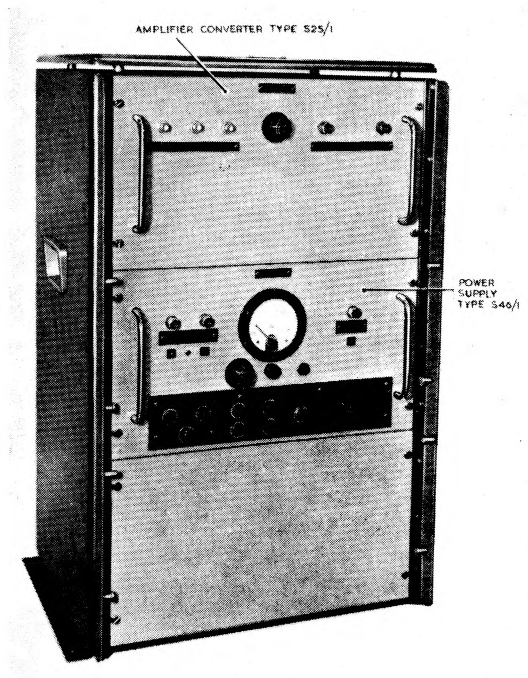


Fig. 1. Amplifier power supply Type S30/1—general view

Circuit description

Amplifier converter Type S25/1

4. The circuit of the amplifier converter Type S25/1 is given at fig. 3 and should be used in conjunction with fig. 4 (modulator oscillator Type S3/1) and fig. 5 (i.f. amplifier Type S26/1).

5. The m.t.i. video signal from the remote switching control Type S14/1 via one of the two impedance matching networks Type S1/1 is introduced at SKTC and applied to the grid of V1, and the pre-pulse signal, introduced via the second impedance matching network Type S1/1 and SKTD, is applied to V2 grid. The fact that V1 is cathode coupled to V2 produces the required positive-going m.t.i. video signal and the negative-going pre-pulse output at V2 anode. These signals are cathode coupled by V3A to SKTM in the modulator oscillator Type S3/1 (fig. 3). The second triode of V3, V3B, represents a compensatory cathode load for V3A.

Modulator oscillator Type S3/1

6. The purpose of the modulator oscillator is to provide a 20 Mc/s carrier, modulated by the m.t.i. video and pre-pulse signals, for onward transmission over the long line to the local site.

7. The input signal is mixed in the stage associated with the hexode valve V6 with the output of the oscillator V1. The double triode V1 is connected in a Butler type crystal oscillator circuit and the output is transferred via a flatly tuned buffer stage (V2) and an r.f. amplifier (V3) to the suppressor grid of V6.

8. The diode V4A provides a d.c. voltage proportional to the oscillator output level for application to the meter. The silicon junction diode V5 provides an a.g.c. voltage, the level of which can be pre-set by means of RV2, for application to the grid of V2. RV2 is located on the amplifier-converter Type S25/1 chassis.

9. The output of V6 is amplified by the flatly tuned stage (V7) followed by a push-pull stage (V8 and V9). The output of this is taken out via SKTN and attenuator A in the amplifier converter. The setting of the attenuator is adjusted to suit the length of line between sites. Double diode V10 provides a voltage proportional to the output level for application to the meter, and a rectified version of the envelope at the junction of R41 and R42 for monitoring at SKTQ.

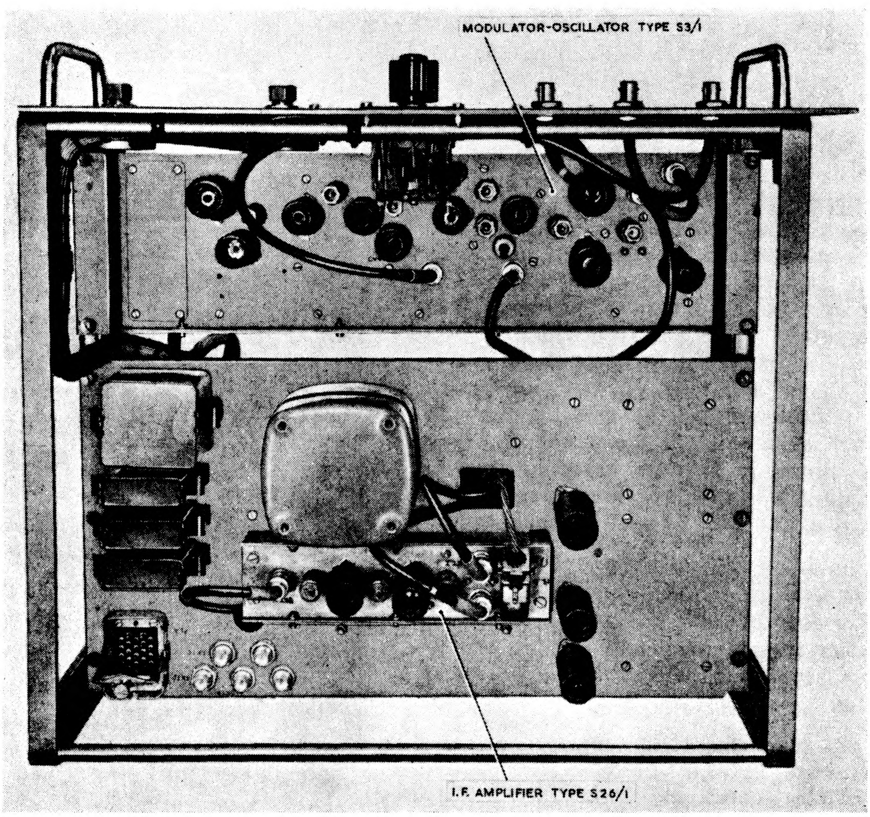


Fig. 2. Internal view of amplifier converter Type S25/1

10. Adequate filtering precautions are taken on the heater and h.t. lines to prevent leakage of the r.f. voltage to external circuits.

I.F. amplifier Type S26/1

11. The i.f. amplifier Type S26/1 provides two broad band stages of amplification for the 30 Mc/s normal radar signal from the remote switching control Type S14/1 via the fixed attenuator Type S8/1. The second stage valve has a resistive anode load and the output is taken via a tuned acceptor circuit (L2 C10) to SKTJ from which it is then fed out via the other line length correcting attenuator (B). A fraction of the output of the second stage is diverted via V3 and associated filter circuit to SKTK for monitoring purposes.

Power supply Type S46/1

12. The circuit for the power supply Type S56/1 is shown at fig. 6. It provides all the power supplies for the amplifier power supply Type S30/1. These are +330V, +200V and −150V stabilized h.t. and stabilized 230V 50 c/s for the amplifier converter. The 230V supply is also fed to the amplifier power supply Type S30/1 cabinet heater.

13. The circuits use conventional series stabilizer valves and control circuits. Relay RLA provides a protective circuit which prevents the positive supplies being switched on until the −150V supply is available.

14. The three position switch S3 enables the power supply to be switched on for normal operation, off, and, in the third position, connects the cabinet heater to the 230V supply.

15. The meter, which has a 10 mA protective fuse fitted, can be used to measure the various power supply outputs or the voltages at the test points in the amplifier converter circuit.

Cabinet interconnections

16. The interconnections for the cabinet of the amplifier power supply Type S30/1 are given at fig. 7.

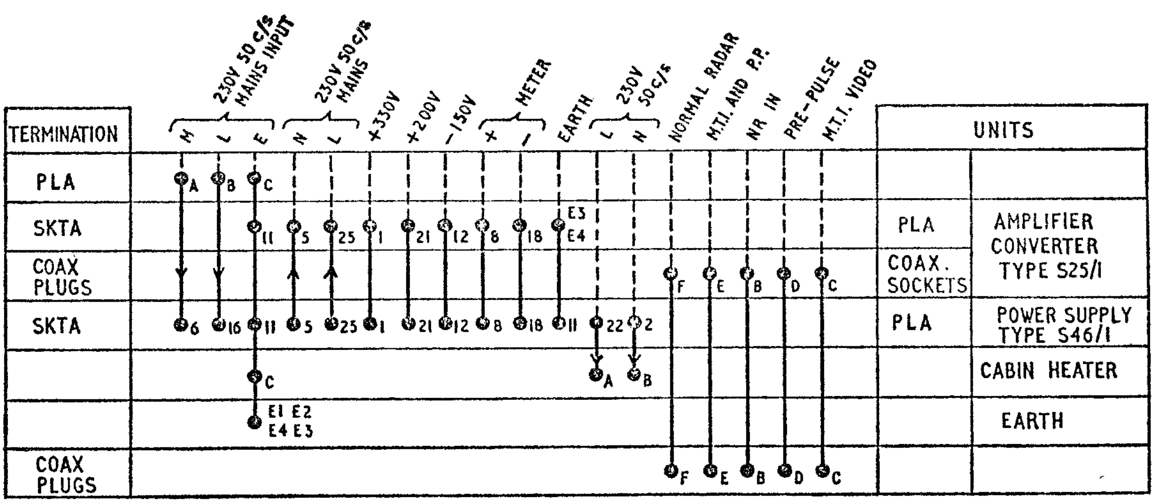
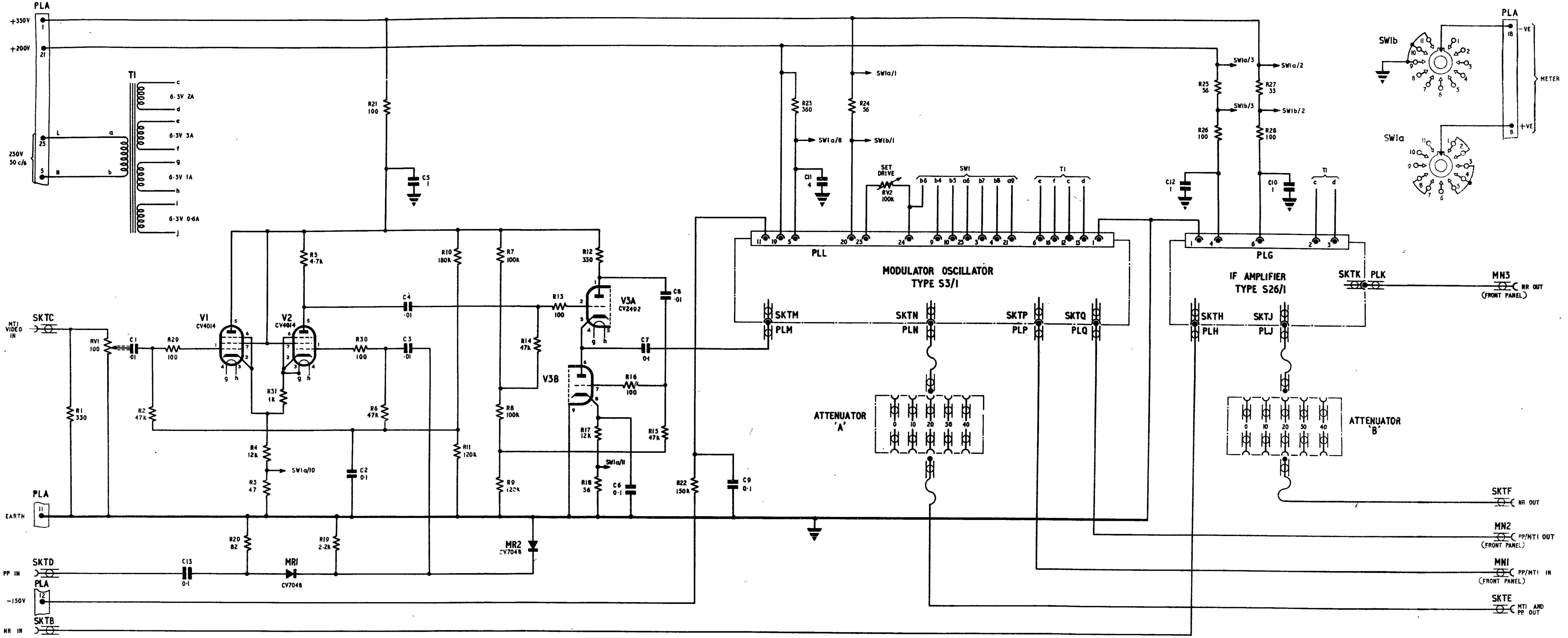


Fig. 7. Amplifier power supply Type S30/1 interconnection diagram

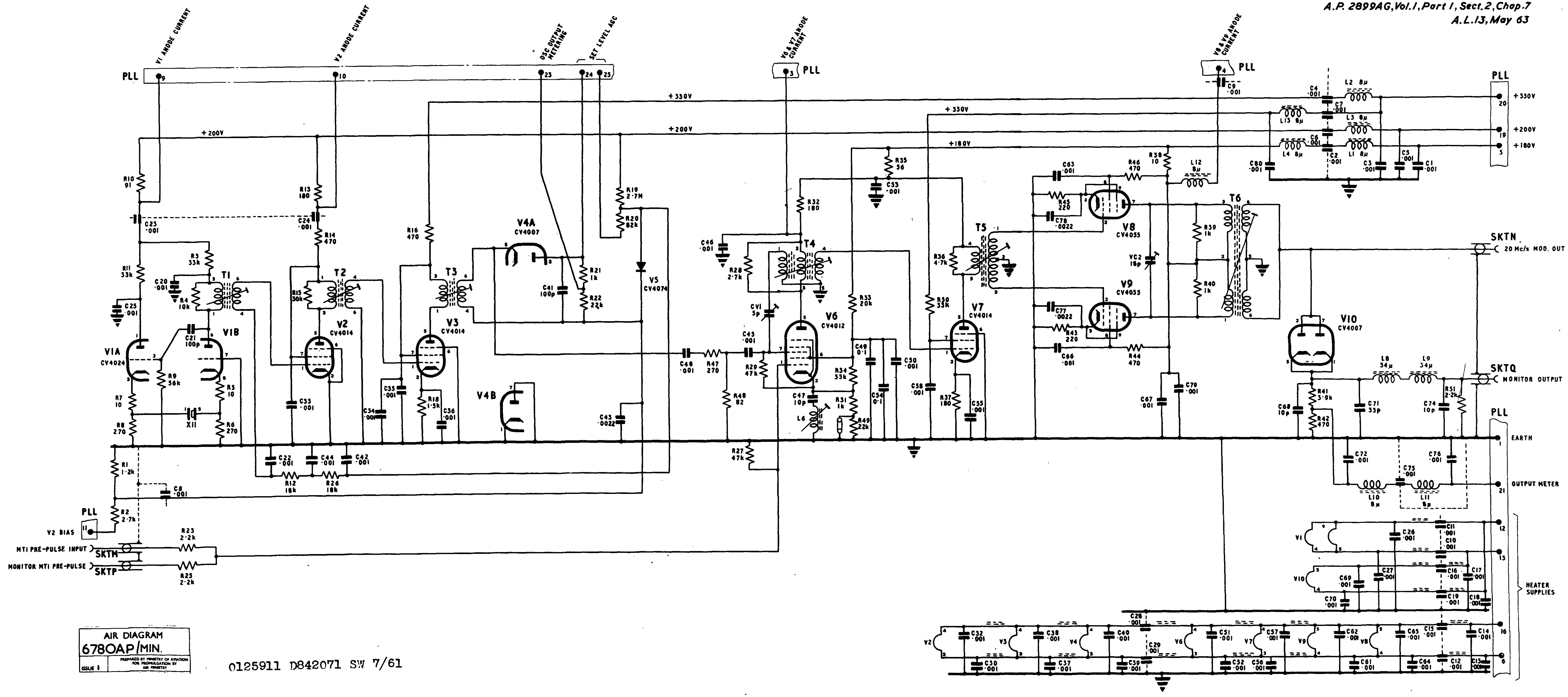


AIR DIAGRAM
6780AS/MIN.
ISSUE 1 PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY

0125911 D842071 SW 7/61

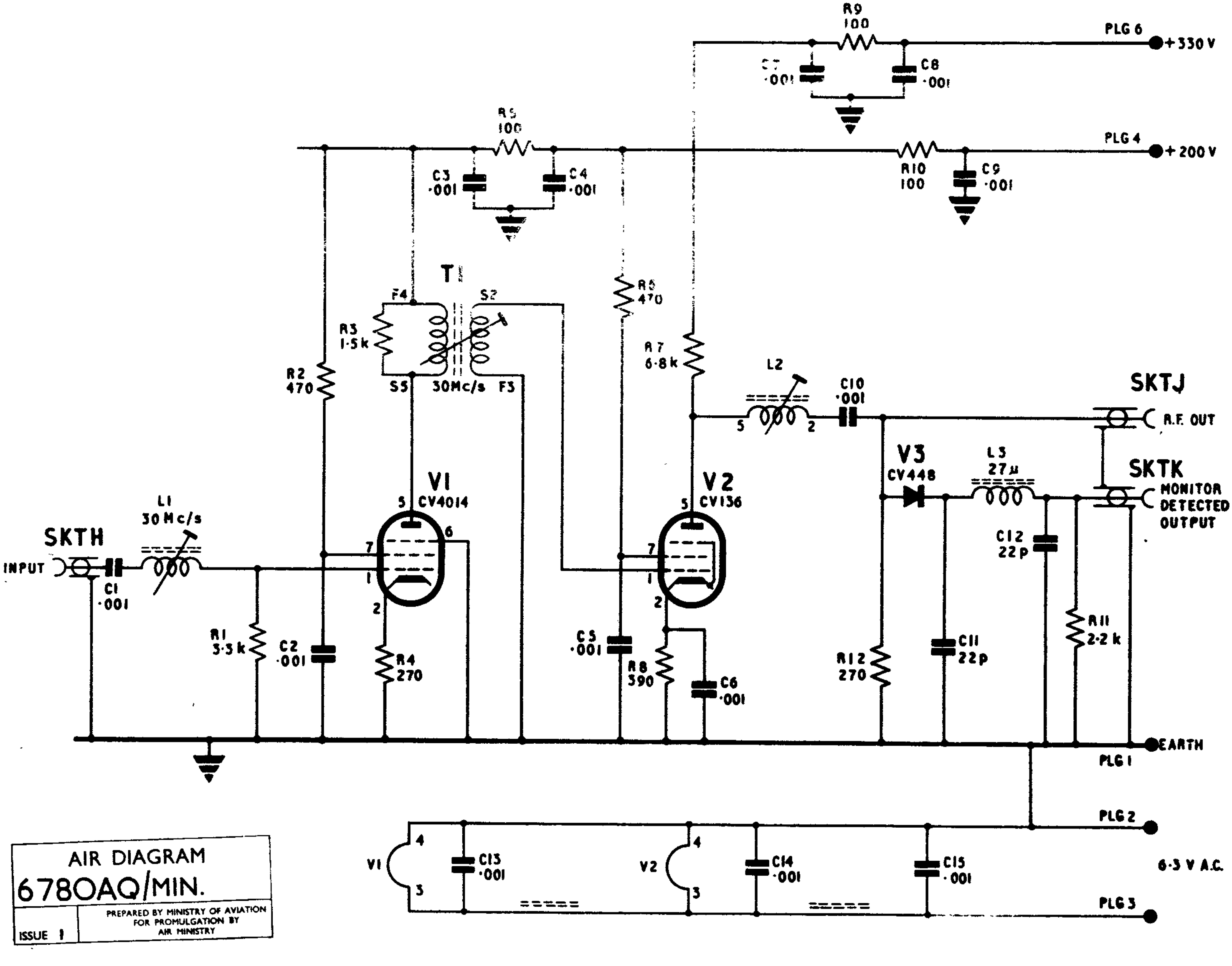
Amplifier-converter Type S25/1 : circuit

Fig.3



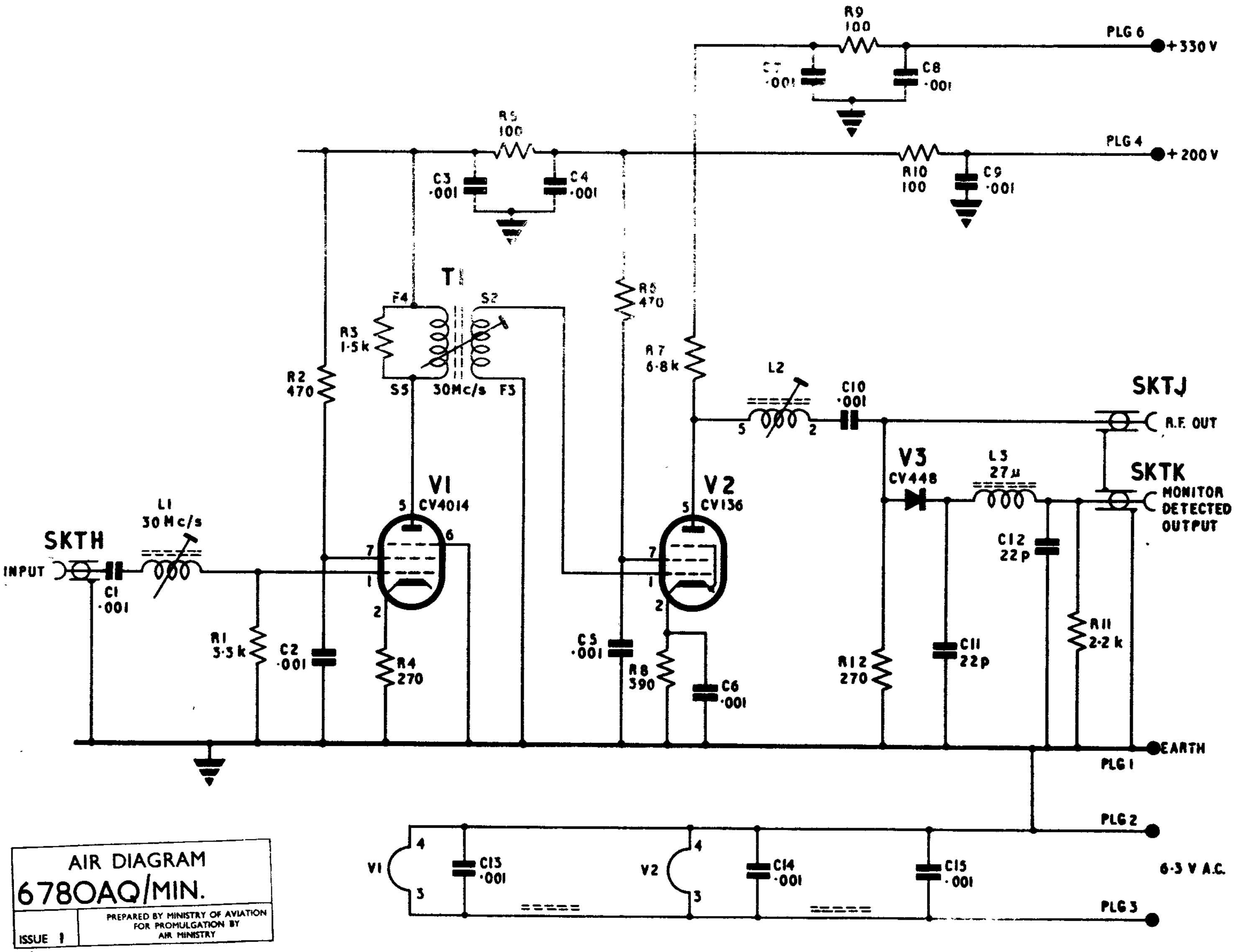
Modulator oscillator Type S3/1 : circuit

Fig.4



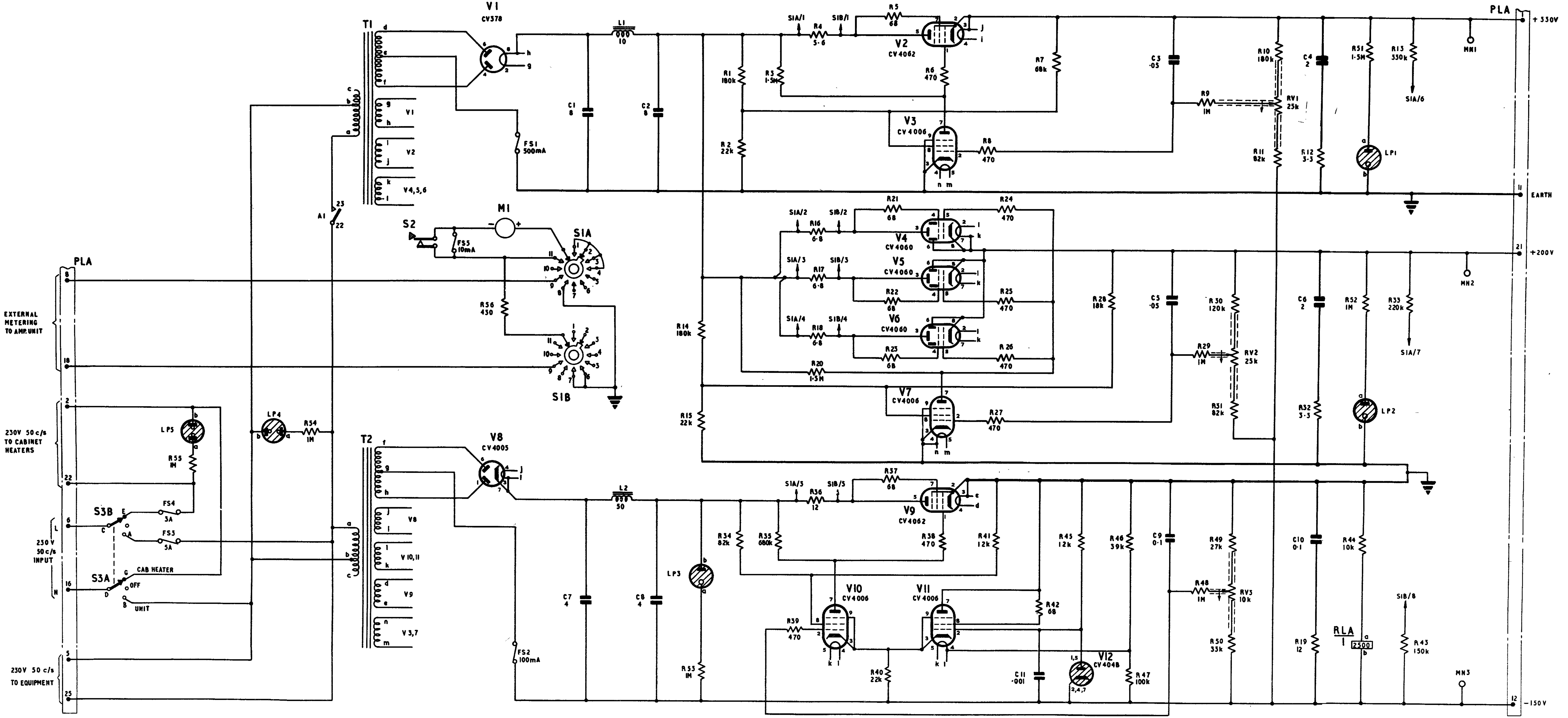
I.F. amplifier Type S26/1 :circuit

Fig.5



I.F. amplifier Type S26/1 : circuit

Fig. 5



AIR DIAGRAM
6780AR/MIN.
ISSUE 1
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0125911 D842071 SW 7/61

Power supply Type S46/1 : circuit

Fig.6

Chapter 8

ANCILLARY EQUIPMENT

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LIST OF ILLUSTRATIONS

Description

1. The main purpose of this chapter is to provide the circuits for four ancillary items of equipment used in the FGR1. 26008/1. These are an impedance matching network Type S3/1 (fig. 1), a fixed attenuator Type S8/1 and two impedance matching networks Type S1/1 (fig. 2).

2. The impedance matching networks Type S1/1 provide signal splitting of pre-pulse and the m.t.i. video signals from the remote switching control equally between the amplifier converter Type S25/1 in the amplifier power supply Type S30/1 and the pulse generator Type S14/1 in the pulse generator power supply Type S18/2 (Sect. 1. Chap. 1, fig. 1). The fixed attenuator Type S8/1 provides

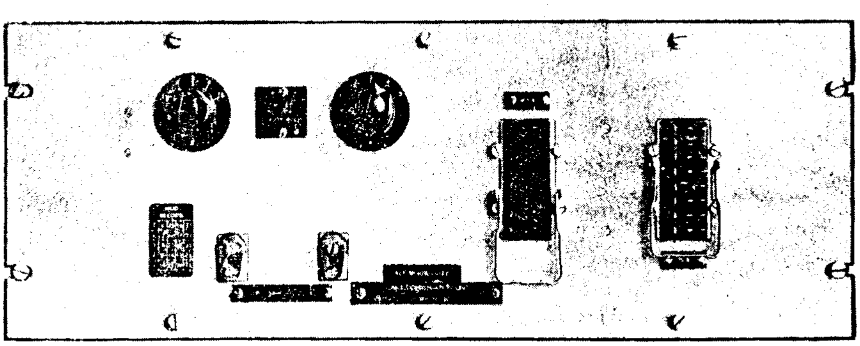

Fig. 1. View of impedance matching network Type S3/1

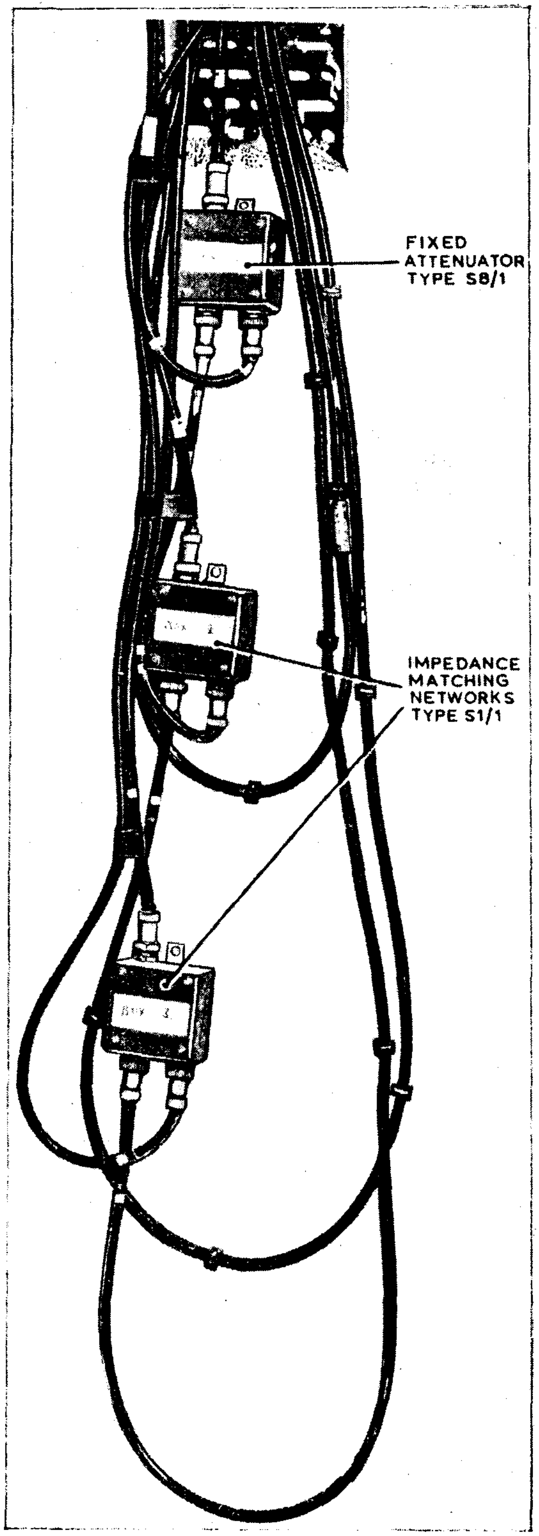

Fig. 2. View of fixed attenuator and impedance matching networks Type 51/1

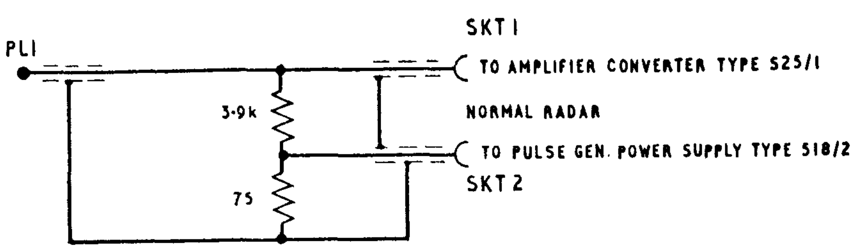

Fig. 3. Fixed attenuator Type S8/1: circuit

signal splitting for the normal radar signal from the remote switching control. An attenuated output matched to 75 ohms is provided for the display at the remote site where the radar T/R assemblies are situated and an unattenuated output is passed to the amplifier converter in the amplifier power supply Type S30/1 where it is amplified before being passed to the displays at the radio equipment room. The impedance matching network Type S3/1 provides for impedance matching between the synchros assembly Type S1/1 in the aerial turning gear cabin Type S5/1 and the synchros signal amplifier Type S23/1 in the amplifier power supply Type S29/1 and enables the voltage levels to be adjusted to a predetermined point to suit the length of land line used at each location.

3. The circuits for these units are shown at fig. 3 (fixed attenuator Type S8/1), fig. 4 (impedance matching network Type S1/1) and fig. 5 (impedance matching network Type S3/1).

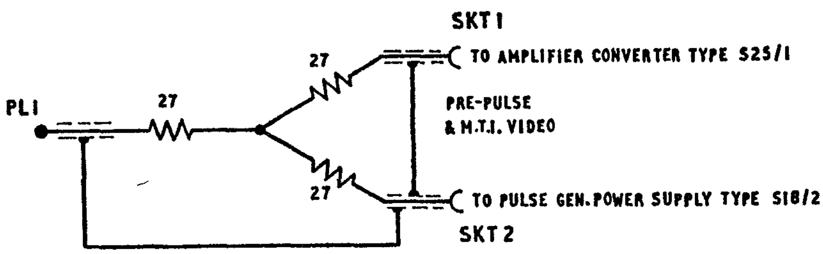

Fig. 4. Impedance matching network Type S1/1 : circuit

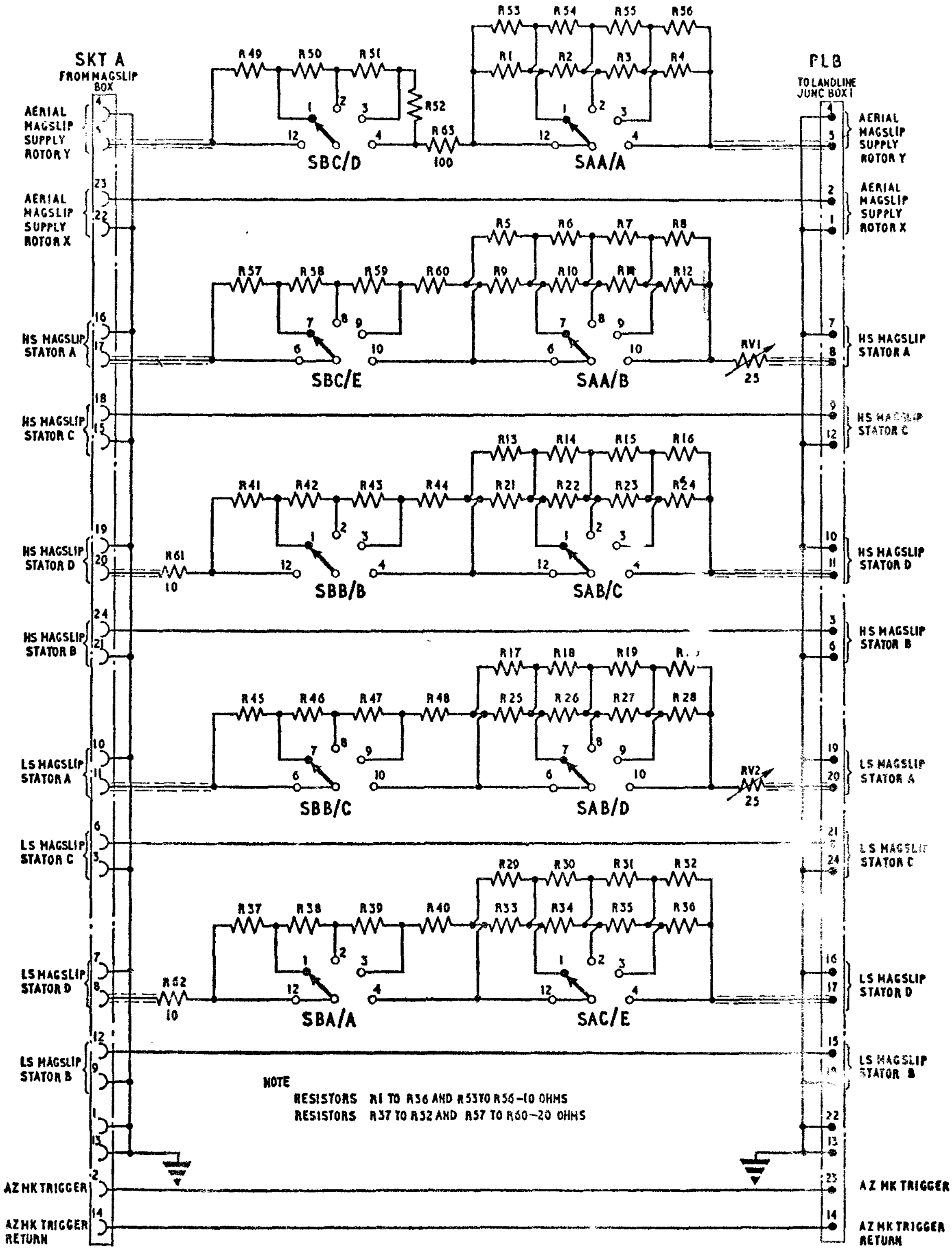

Fig. 5. Impedance matching network Type S3/1 : circuit

Chapter 4

UHF/VHF R/T INSTALLATION IN RVT.515 MK. 2—GENERAL DESCRIPTION

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LIST OF ILLUSTRATIONS

Introduction

1. The purpose of this chapter is to describe the u.h.f./v.h.f. radio telephone installation in the radio vehicle Type 515 Mk. 2. The R/T equipment installed provides transmit and receive communication facilities in the u.h.f. band 225 Mc/s to 399·9 Mc/s and in the v.h.f. band 100 Mc/s to 225 Mc/s.

2. The Mk. 2 vehicle supersedes the Mk. 1 version, and differs mainly in the repositioning of the u.h.f./v.h.f. R/T installation and in a changed mains wiring and switching arrangement. Differences between the marks also occur in some of the mechanical equipment fitted, namely the radar aerial reflector assemblies, the outriggers, steady jacks and derricks.

Power requirements

3. Power supplies at 230 volts, 50 c/s, single phase, are required for the various items of equipment in the radio vehicle, as follows:—

(1) Radar aerial turning gear 5 KVA (max.).
(2) Radar transmitter-receiver 3 KVA (approx.).
(3) Radar display unit (1 KVA each) 2 KVA (approx.).
(4) VHF/UHF R/T equipment 1 KVA (approx.).
(5) Air conditioning unit 1·7 KVA (approx.).
(6) Heater 2 KVA (approx.).

Weight distribution

4. The all-up weights of two models of the RVT. 515 Mk. 2 with the R/T installations fitted are as follows:—

(1) Vehicle 12.A.W.64 6 tons 6 cwt.
(2) Vehicle 12.A.W.65 6 tons 8 cwt.

The aerial reflector assembly accounts for an additional weight of 1382 lbs.

GENERAL DESCRIPTION

5. The vehicle comprises two cabins mounted on a 5-ton four-wheeled Carrimore trailer chassis. The smaller cabin, known as the machine cabin, at the forward end, houses the radar aerial turning gear, mains input panel, voltage regulator and switch gear. The main cabin, known as the radar cabin, contains the radar transmitter-receiver and display consoles, an air conditioner unit, and the u.h.f. and v.h.f. R/T installations. An illustration of the complete installation is given in fig. 1, and an interconnecting diagram for the u.h.f./v.h.f. units appears in fig. 8.

6. The main items of equipment forming the R/T installation are as follows:—

(1) A 'main' and a 'standby' u.h.f. transmitter-receiver Type TR5/ARC.52, complete with associated control units Type C1607/ARC.52, interconnecting boxes, power supply units (AC) and mounting trays. One aerial system Type AJE is provided.
(2) A 'main' and a 'standby' v.h.f. transmitter-receiver TR.1588A, complete with associated control units Type 374, junction boxes Type 17A and rectifier units Type 5. One aerial system Type 220A is provided.
(3) A 230V mains and aerial changeover unit.

UHF/VHF R/T cabinet

7. The u.h.f./v.h.f. R/T installation is, in the main, contained in this one cabinet which is located in the radar cabin at the rear nearside (fig. 3). The cabinet is shockproof mounted and contains sliding trays on which are fitted the u.h.f. transmitter-receivers with their associated power units, and the v.h.f. transmitter-receivers. Com-

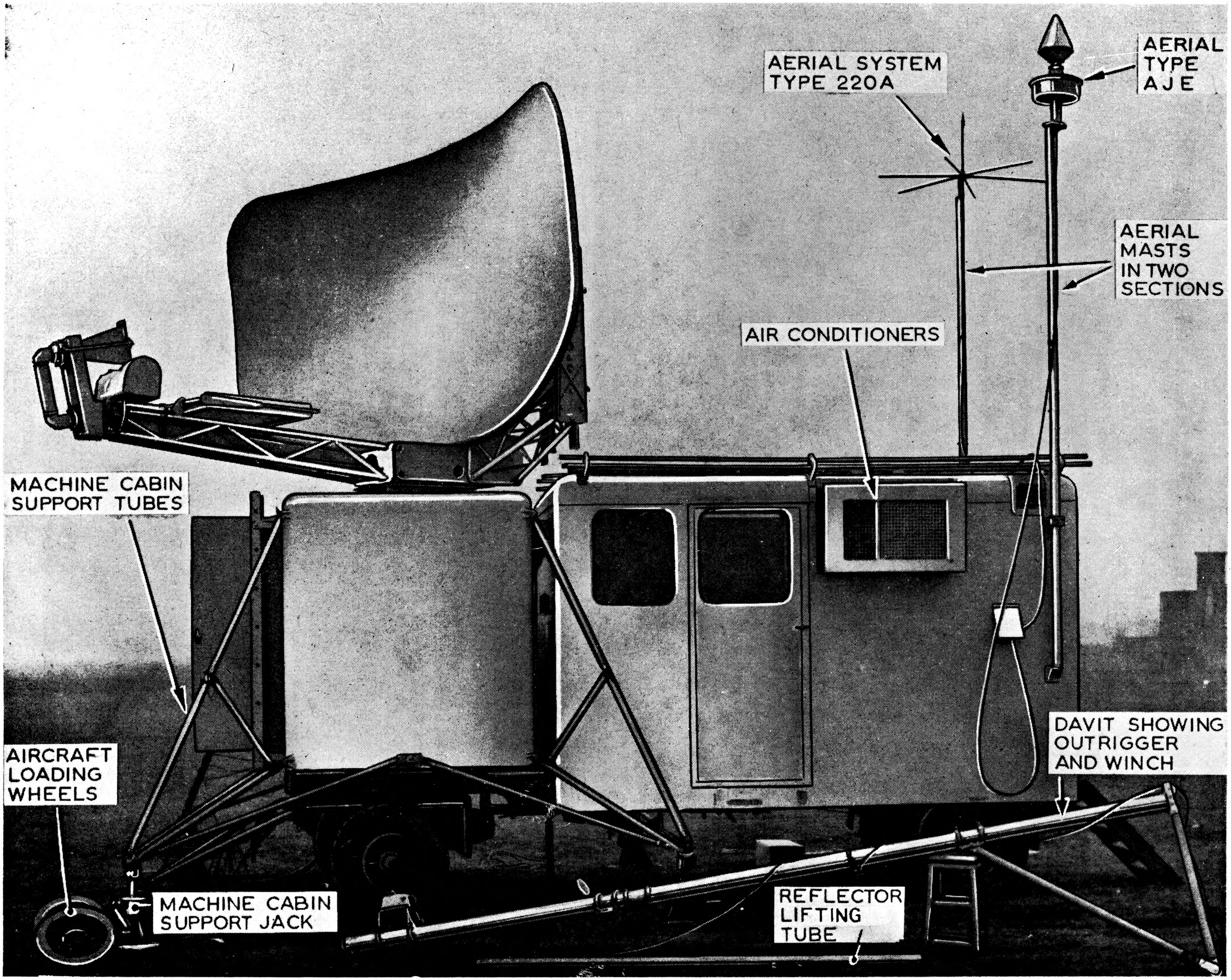


Fig. 1. Radio vehicle Type 515 Mk. 2

pared with the Mk. I version of the installation, an improved u.h.f. layout has been achieved by inverting the u.h.f. connecting boxes and securing them to the cabinet immediately beneath their associated power units. The 230-volt mains and aerial changeover unit is secured to the cabinet on the right-hand side of the top u.h.f. interconnecting box. Both the u.h.f. and the v.h.f. 'main' transmitter-receivers are mounted above their respective 'standby' transmitter-receivers. The u.h.f. rectifier units are not contained in this cabinet but, as can be seen in fig. 3, are mounted beneath the spares cabinet.

Spares cabinet

8. This cabinet is positioned alongside the R/T cabinet and is provided with sliding doors and shelves. It contains five pull-out drawers which may be secured with a bar and padlock. The top of the cabinet provides a working surface and forms a bench on which is stowed the Cossor Model 1042A oscilloscope.

R/T control unit assembly

9. The u.h.f. and v.h.f. R/T control units are mounted together with microphone/telephone sockets as one complete assembly and positioned on the control desk between the radar display consoles at the forward end of the radar cabin. The control unit assembly is shown in fig. 4.

Electrical equipment

Mains input panel

10. The panel is located on the offside of the

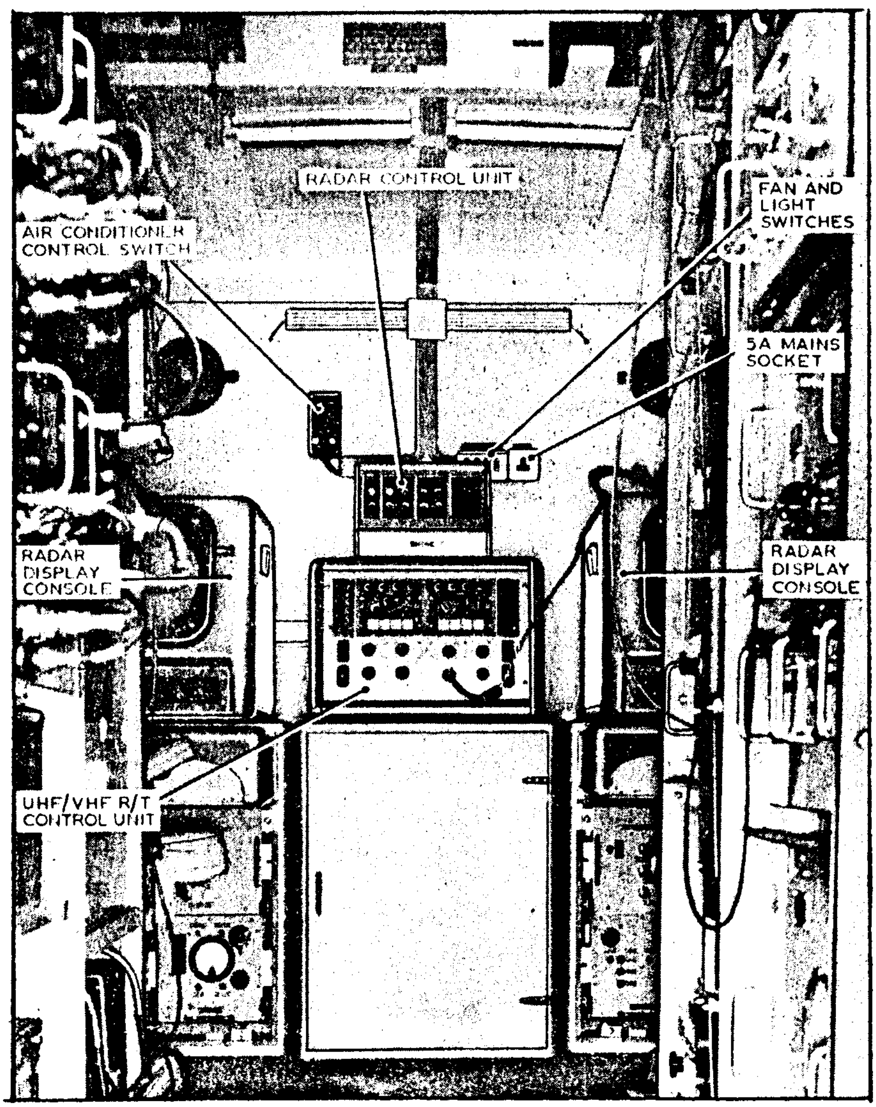


Fig. 2. General view of radar cabin interior

machine cabin and contains a 4-pole, 60A power, lighting and accessories plug for the connection of the external mains supply. The panel includes facilities for a separate input to the storage heater, by way of a 3-pole 5A plug. Also fitted to the panel is a main earth terminal and an insulated earth terminal for connecting to the safety earth system. Other terminations fitted to the input panel and provided for the radar equipment are shown in fig. 5.

Mains distribution

11. The switch gear and circuit breakers associated with the distribution of power supplies in the vehicle are mounted on the offside wall of the machine cabin (*fig.* 6). Two earth-leakage circuit breakers are fitted and are located immediately below the mains distribution panel; one of the circuit breakers (CB1) protects the regulated mains circuits, the other (CB2) protects the unregulated mains circuits.

Earth-leakage circuit breaker operation

12. These circuit-breakers are the Crabtree, 60A DP, Type E60 which operate on the following principle. If an earth fault occurs which produces a potential difference between chassis and earth, the earth leakage current energizes a coil which in turn attracts a small armature. This action causes the leg of the armature to move a trigger pin which is attached to, and hence rotates, a half-shaft. As the half-shaft turns, it allows the operating toggle mechanism to collapse and the contacts immediately spring open under the influence of strong contact return springs. As the

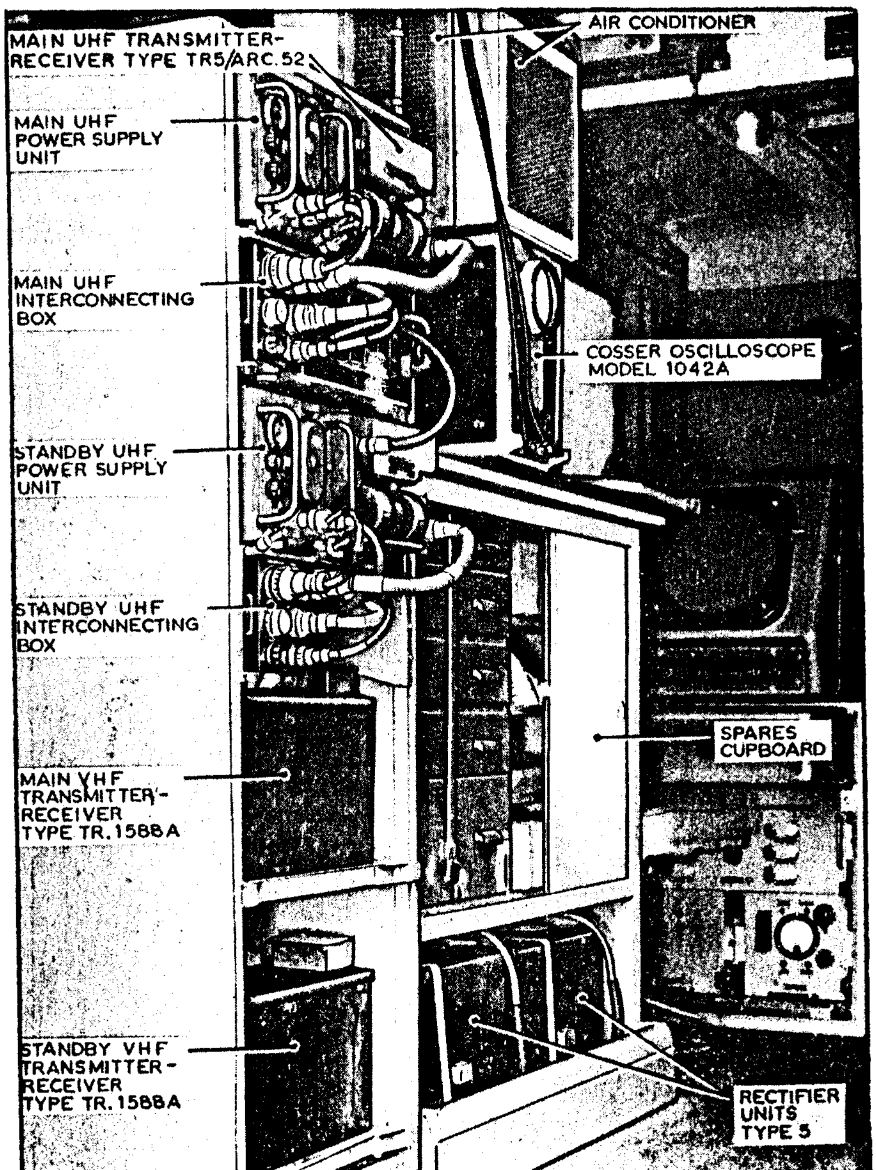


Fig. 3. UHF/VHF R/T installation and ancillary equipment

toggle mechanism is positively linked to the moving contacts, it is impossible for the operating handle to assume the OFF position unless the contacts are open. A manual ON/OFF switch is provided on the front of the unit, but as the switch handle is linked to the trip mechanism, the circuit-breaker cannot be held in the ON position under fault conditions. A test button is incorporated for testing the tripping mechanism and the continuity of the earth conductor between the circuit-breaker and earth.

13. On pressing the test button, the mains 'live' supply is connected via a dropping resistor through the trip coil to earth, thus simulating an earth leakage current through the trip coil and causing the circuit breaker to open. Failure to trip indicates excessive earth electrode resistance or a broken earth lead. Immediately the test button is released, the 'live' supply is disconnected and the trip coil is reconnected between the chassis and earth.

14. Regular checks using the test button should be made to ensure the correct functioning of the circuit breaker. The leakage coil is protected by a spark gap against possible damage by lightning.

Note . . .

Where mobile generators are used, the neutral poles of which are not normally earthed, operation of the test button will not trip the mechanism. This is due to the lack of a return path to complete the circuit from line via resistor and test button to earth, and earth to neutral. If public supply mains are used (where the neutral is normally earthed) the test will trip the mechanism.

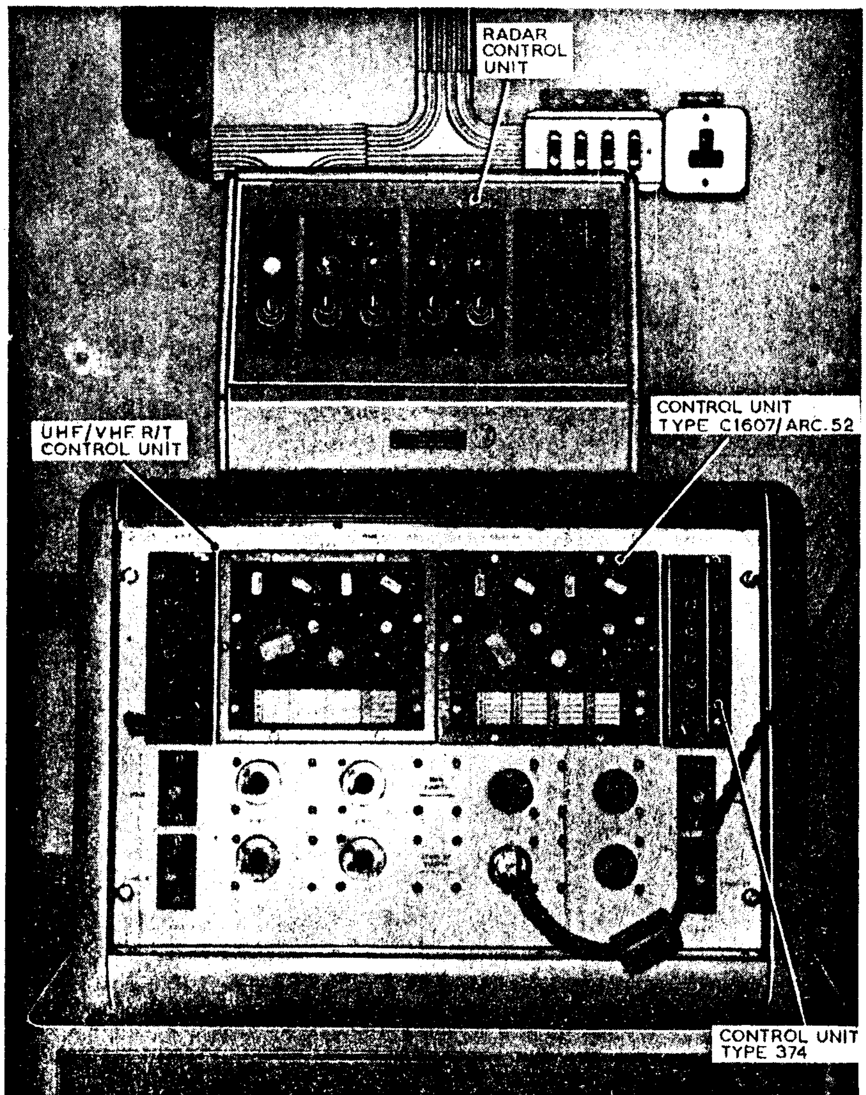


Fig. 4. UHF/VHF R/T control unit assembly

Power distribution circuits

15. A bank of circuit breakers is mounted below the earth-leakage circuit breakers in the machine cabin, and is shown in fig. 6. The circuit breakers are provided for the various services as follows: —

(1) CB3 5A. Remote control relay box and regulated mains socket.

(2) CB4 15A. Communications equipment.

(3) CB6 15A. Radar TX.1

(4) CB7 5A. Radar display 1.

(5) CB8 5A. Radar display 2

(6) CB9 15A. Radar (main) cabin air conditioner.

(7) CB10 5A. Radar (main) cabin lights and fans.

(8) CB13 5A. Obstruction lights.

(9) CB14 5A. Rainplate motor.

(10) CB15 5A. Machine cabin, lights and unregulated mains socket.

Power sockets, fans and lights

16. Fan and light switches are positioned on the forward wall of the radar cabin, and alongside these is mounted a 5A outlet socket for the unregulated mains supply (*fig.* 2). Three sockets marked VHF/UHF MAINS, REG. MAINS 5A and AIR CONDITIONER are located above the u.h.f./v.h.f. R/T cabinet. Two switched, 3-pole sockets marked VHF STANDBY and VHF MAIN respectively, are mounted above the spares cupboard.

17. The main lighting for the radar cabin consists of two fluorescent lamps, with diffusers, fitted to the ceiling above the radar display units. Spare fluorescent tubes are secured adjacent to these

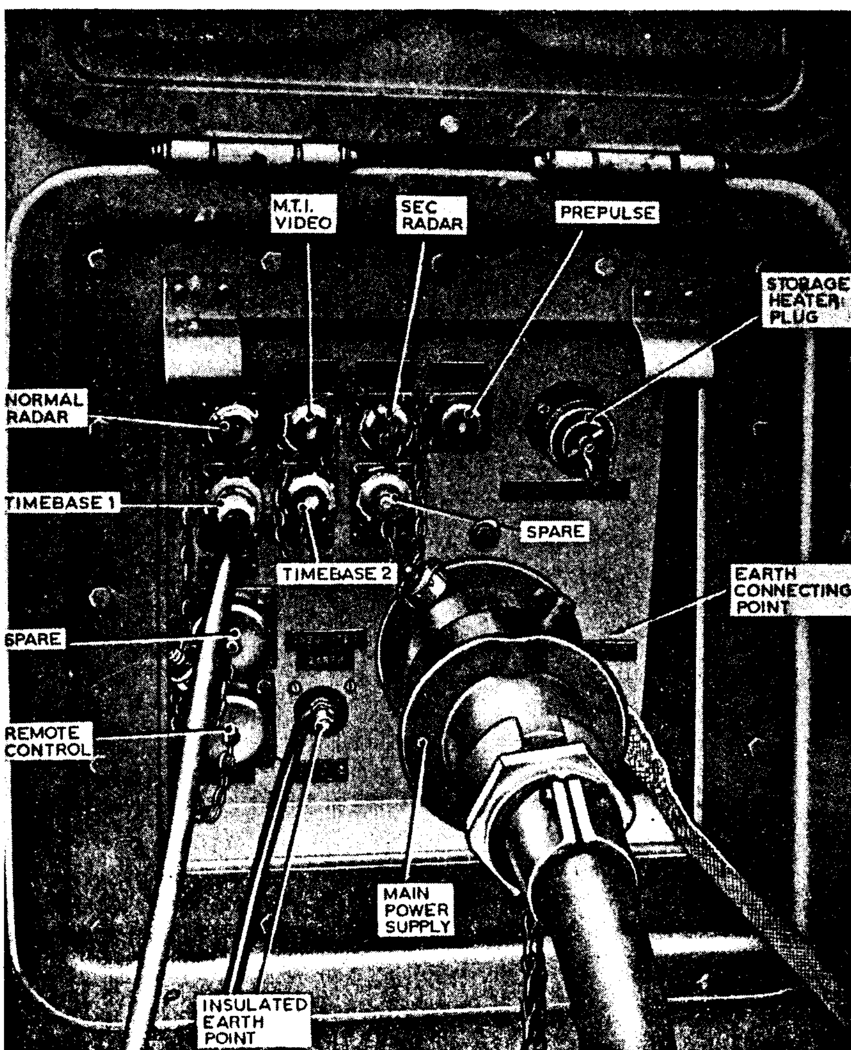


Fig. 5. Mains input panel

lighting fittings. A third fluorescent lamp is fitted to the rear of the radar cabin.

Voltage stabilizer

18. A voltage stabilizer Type 16189 (Ref. No. 10D/22340) is positioned on the floor of the machine cabin adjacent to the nearside wall. The stabilizer is used to control the supply voltage for the radar transmitter and receiver equipment.

Earthing arrangement

19. Two earthing points are provided on the vehicle chassis, and an earth rod Type 5 is used for each connection. The stowed position in the vehicle for both earth rods is on the nearside wall of the machine cabin.

(1) *Main earth*. The connection for this earthing point is between the earth rod driven into the ground and the main EARTH terminal located on the mains input panel.

(2) *Safety earth*. The connection for this earthing point is between the earth rod driven into the ground and the INSULATED EARTH terminal located on the mains input panel. This connection is made with an insulated lead.

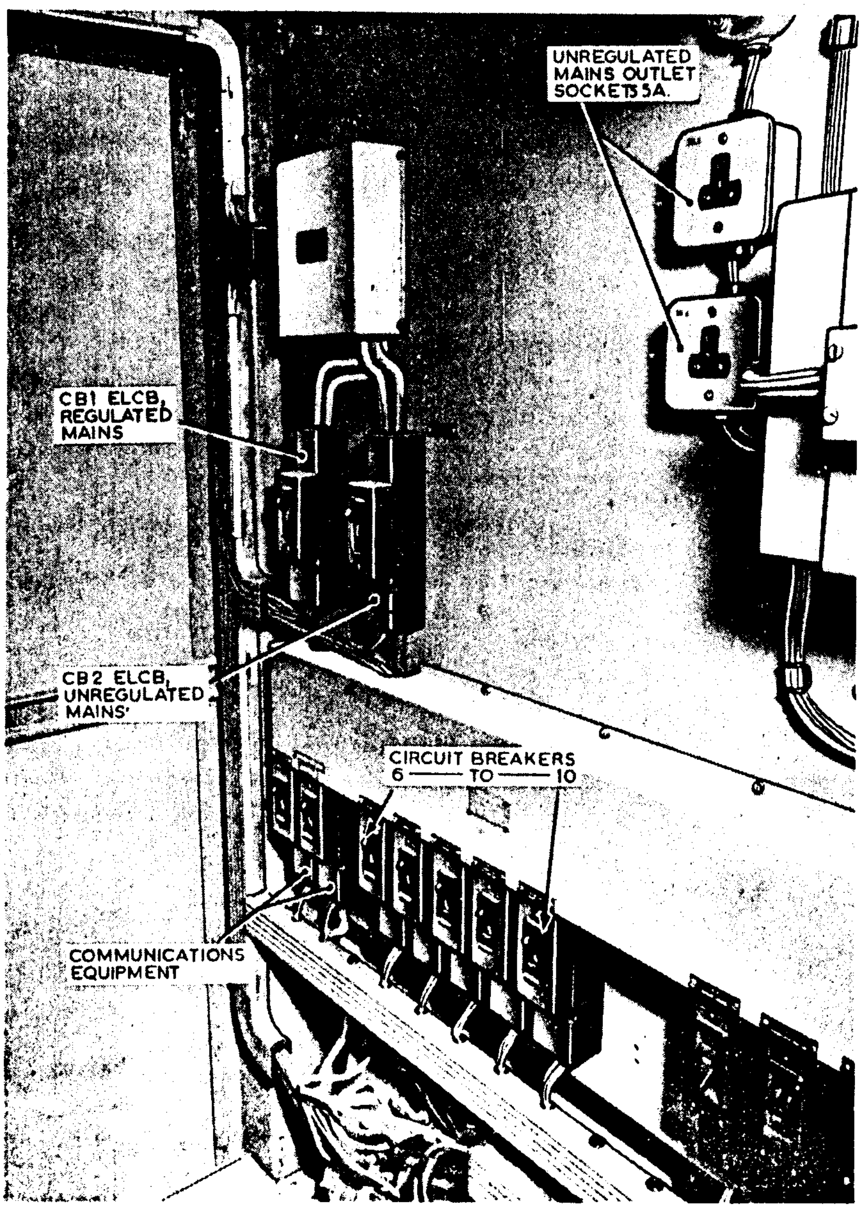


Fig. 6. Circuit breakers and mains sockets in machine cabin

The procedure for installing the earth rods is given in Sect. 3, Chap. 5.

230V mains and aerial changeover unit

20. This unit is mounted below the main v.h.f. R/T transmitter-receiver and is shown in position in Sect. 3, Chap. 5, fig. 2. The unit is provided with four Crabtree D.P. 5A circuit breakers Type F60 for switching the 230-volt mains to the u.h.f. and v.h.f. R/T main and standby equipment. Four sockets are provided on the unit; two are for connection of the v.h.f. aerial input to the main or standby equipment and the other two provide similar facilities for the u.h.f. main and standby equipments. A coaxial connector is fitted to the unit; this connector may be connected to either the main or standby u.h.f. transmitter-receivers, and is shown connected to the standby u.h.f. set in fig. 3.

Note . . .

A standby equipment is not to be used unless a breakdown of the main equipment occurs. No equipment should be switched on and run up with the aerial (or dummy load) disconnected.

Aerial systems

Masts

21. Two masts are provided with the installation, one for the u.h.f. and one for the v.h.f. aerials. Each mast is in two sections and, when the vehicle is in transit, the sections are stowed on the floor in the centre of the radar cabin; two lower and two upper masts brackets are stowed immediately forward of the spares cupboard. When in use, the masts are affixed to the sides of the vehicle by means of the brackets which fit into wedge plates secured to the exterior walls (*fig.* 1). They do not require guying or any additional support.

Aerials

22. An aerial Type AJE and an aerial system Type 220A, brief details of which are given in the following sub-paragraphs, are supplied for u.h.f. and v.h.f. respectively. The external aerial connectors terminate on the vehicle aerial input panel located on the nearside of the radar cabin (*fig.* 1).

(1) Aerial Type AJE is suitable for use on any frequency in the range of 225Mc/s to 399·9 Mc/s. Its main features are:

(a) Omni-directional in the horizontal plane.

(b) Good impedance matching into a coaxial feeder without need for matching or balancing.

(c) Light weight.

The aerial is described in A.P.2531D and E, Vol. 1, Part 1, Sect. 4, Chap. 1.

(2) Aerial system 220A is a quarter-wave omni-directional type designed to operate over the frequency range of 100 Mc/s to 155 Mc/s. The length of the radiating element is adjustable to allow the aerial to be tuned in 1 Mc/s steps to the frequency in use. The aerial is described in A.P.2521A, Vol. 1, Chap. 7.

Spares

23. As a u.h.f. and a v.h.f. R/T transmitter-receiver installation is fitted as standby spare equipment, the minimum amount of additional component spares is provided. This spares equipment is listed in table 1.

TABLE 1

UHF/VHF R/T installation — component spares

Ref. No.	*Item*	*Qty.*
10CV/525	Valves, electronic Type CV.525	4
10CV/664	Valves, electronic Type CV.664	2
10CV/665	Valves, electronic Type CV.665	4
10CV/694	Valves, electronic Type CV.694	4
10CV/788	Valves, electronic Type CV.788	2
10CV/2213	Valves, electronic Type CV.2213	3
10H/21708	Resistors Type 15605	2
110K/711	Transformers	2
10H/0590108	Fuse links	5
10H/0590110	Fuse links	5
10H/0590111	Fuse links	5
10H/0590112	Fuse links	5

Test equipment

24. The items of test equipment required for testing and servicing the u.h.f. and v.h.f. equipments is as follows : —

Pumps, pressurizing (Ref. No. 4G/5435).
Gauges, pressure (Ref. No. 4G/2595).
Test set IE-36 (Ref. No. 110S/156).
Test meter (Ref. No. 110S/53).
Test set UHF (Ref. No. 10S/9434149).
Headset Type 9 (Ref. No. 10AH/14).
Microphone assembly Type 48 (Ref. No. 10A/14381).

UHF transmitter-receiver equipment

Transmitter-receiver Type TR5/ARC.52

25. This unit is a pressurized multi-channel u.h.f. R/T equipment operating over the frequency range of 225 Mc/s to 399·9 Mc/s. The frequency is crystal controlled and sufficient crystals are incorporated in each equipment to provide 1750 frequency channels, of which 18 channels, plus a guard frequency, can be preset. The required channel may be selected by an automatic frequency selector mechanism in the equipment, operated by a single rotary switch on the control unit. Alternatively, four manually operated controls permit the equipment to be set to any one of the 1750 channels required. The guard channel consists of an additional fixed-tuned receiver operating over the frequency range of 238 Mc/s to 248 Mc/s, and can be switched into operation as and when required. The transmitter-receivers used in this installation have been converted for carbon microphone operation; any replacement equipments must be similarly converted before use.

Control unit Type C.1607/ARC.52

26. Remote control facilities for the function, channel selection and manual frequency selection, and volume control for the transmitter-receiver are provided by this unit. Two control units are mounted in the control unit assembly; the controls on the front panel of each unit are as follows : —

(1) The function switch has four positions to permit the selection of one of the following services : —

(a) OFF. In this position the power supply ON/OFF relay in the transmitter-receiver is not energized.

(b) T/R. In this position the power supply ON/OFF relay is energized and the equipment is switched on for operation.

(c) T/R + G. In this position the guard receiver is available in addition to the transmitter-receiver.

(d) ADF. In this position the transmitter-receiver is switched for automatic direction finding. It is not used with this installation.

(2) The channel selector (CHAN) switch has 20 positions, those numbered 1 to 18 providing facilities for selecting the required preset frequency channel and the remaining two positions being annotated M and G.

(a) M position is used to switch the selection of the frequency to manual control.

(b) G position is normally set up to the guard frequency and thus enables the main transmitter-receiver to be used on the guard frequency independent of the guard receiver.

(3) The manual control incorporates four controls, each of which has associated with it a series of numbers appearing in an aperture adjacent to the appropriate control. The four controls are manipulated to set the numbers to correspond with the required channel frequency, thus enabling any one of the 1750 channels to be selected as required.

(4) The volume control (VOL) is used to adjust the level of the audio signal in the telephones.

(5) Access to the control for setting-up the preset frequency channels is obtained by releasing the panel at the bottom of the front panel. The panel includes an ivorine tablet upon which the frequencies of the channel may be marked.

(6) Two lamps are arranged on the front panel to provide diffused illumination of the controls.

Interconnecting box

27. The interconnecting box is used for the termination of various cables and connectors. They are : —

(1) A 30-core cable from the strip connection, which in turn is wired to the control unit.

(2) A 6-core cable from the microphone/telephone and the "press to transmit" terminal blocks.

(3) A 42-core connector carrying the power, control and microphone/telephone supplies to the transmitter-receiver.

(4) A 2-core connector from the power unit.

The u.h.f. test set may be connected to the interconnecting box by using the 12-core connector provided.

Power supply unit (AC)

28. The power supply unit operates from an a.c. supply of 100-125 volts, or 200-250 volts at 45 to 65 c/s. The unit provides a nominal 27·5 volts d.c. at up to 15 amps output, and consists of a step-down transformer (T1) with two primary windings and a centre-tapped secondary winding feeding a full-wave silicon diode rectifier circuit. The inclusion of a saturable reactor (X1) with its two reactance windings connected in the input supply circuit, and its voltage and current windings connected in the d.c. output circuit, provides a degree of stabilization with changes of output current and unit temperature. A shorting link enables the d.c. output to be connected with either the positive or negative pole earthed. A circuit diagram of the unit is shown in fig. 7. The components mounted on the front panel are as follows: —

(1) A voltmeter, calibrated 15 to 30 volts.

(2) Two 5A fuses.

(3) DC OUTPUT ON indicator lamp.

(4) Supply ON/OFF switch.

(5) AC input supply plug.

(6) DC output socket

(7) AC input supply tapping switches located beneath a hinged cover.

29. Details of the u.h.f. equipment (except the power unit) are contained in A.P.2531J, Vol. 1.

VHF transmitter-receiver equipment

Transmitter-receiver Type TR.1588A

30. This is a four-channel v.h.f. R/T equipment operating over the frequency range of 100 to 156 Mc/s. The four preset frequency channels are crystal controlled and are selected by means of push-buttons on a control unit Type 374. In this installation, two control units are incorporated in the control unit assembly. Individual sets of crystals are used in the transmitter and in the receiver.

Rectifier unit Type 5

31. The unit has input facilities for 105V, 115V, 125V, 210V, 230V or 250V a.c. and provides outputs of 300V d.c. for h.t. negative, 150V d.c. for grid bias, and 13V d.c. for the valve heaters in the transmitter-receiver TR.1588A.

32. Full details of the transmitter-receiver Type TR.1588A, the associated junction box Type 17A, and the rectifier unit Type 5, are given in A.P. 2528H, Vol. 1 (2nd Edn.), Part 1.

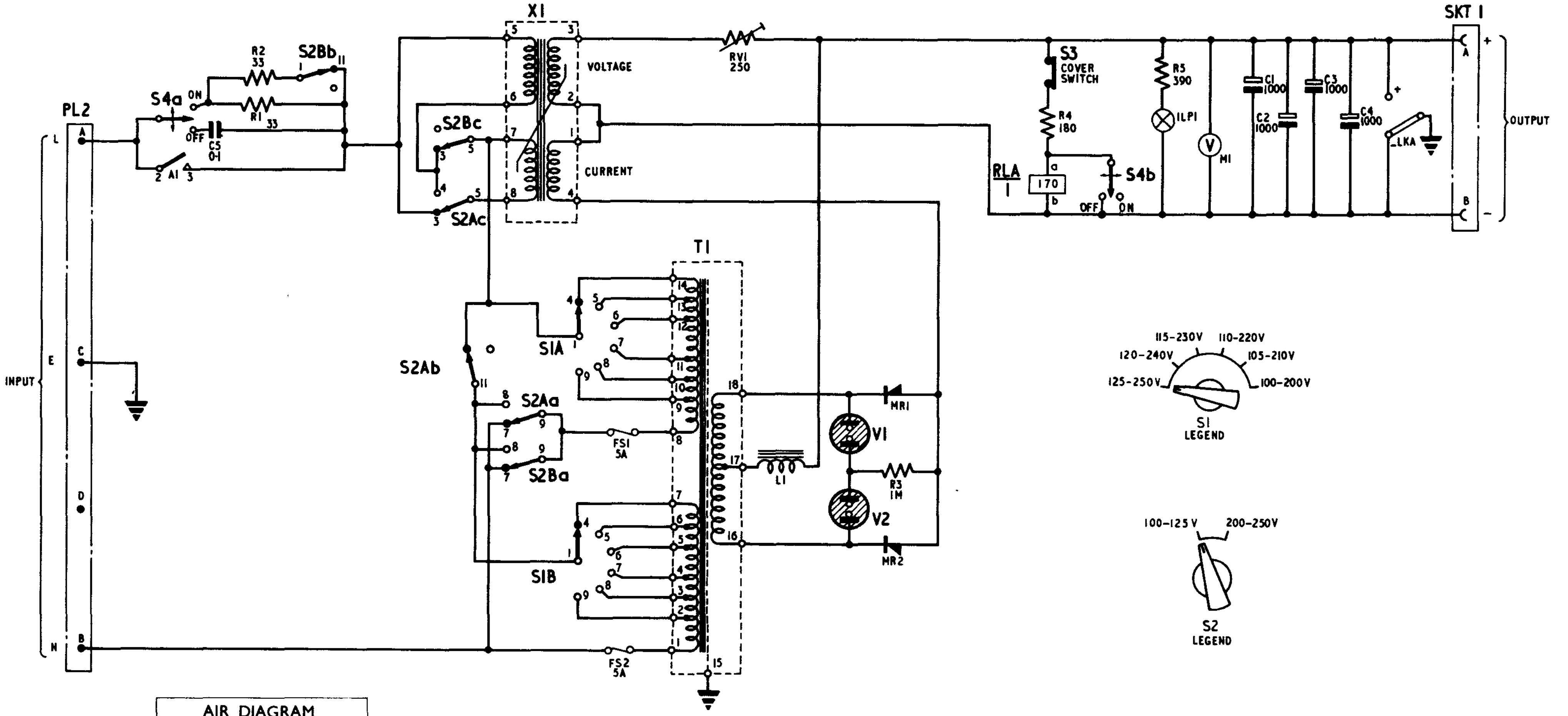
Fire extinguishers

33. Two CO_2 type fire extinguishers are provided with the installation. One is fitted inside the machine cabin on the offside door, the other is located in the radar cabin on the nearside rear door.

Air conditioner unit

34. An air conditioner unit Type 52 is installed in the radar cabin. It is fitted above the spares cupboard and is supported by runners which pass freely along rails secured to the roof of the vehicle. This arrangement enables the air conditioner to be moved outboard into its working position when required. The air conditioner unit is shown in position in the radar cabin in fig. 3, and an external view of the unit appears in fig. 1.

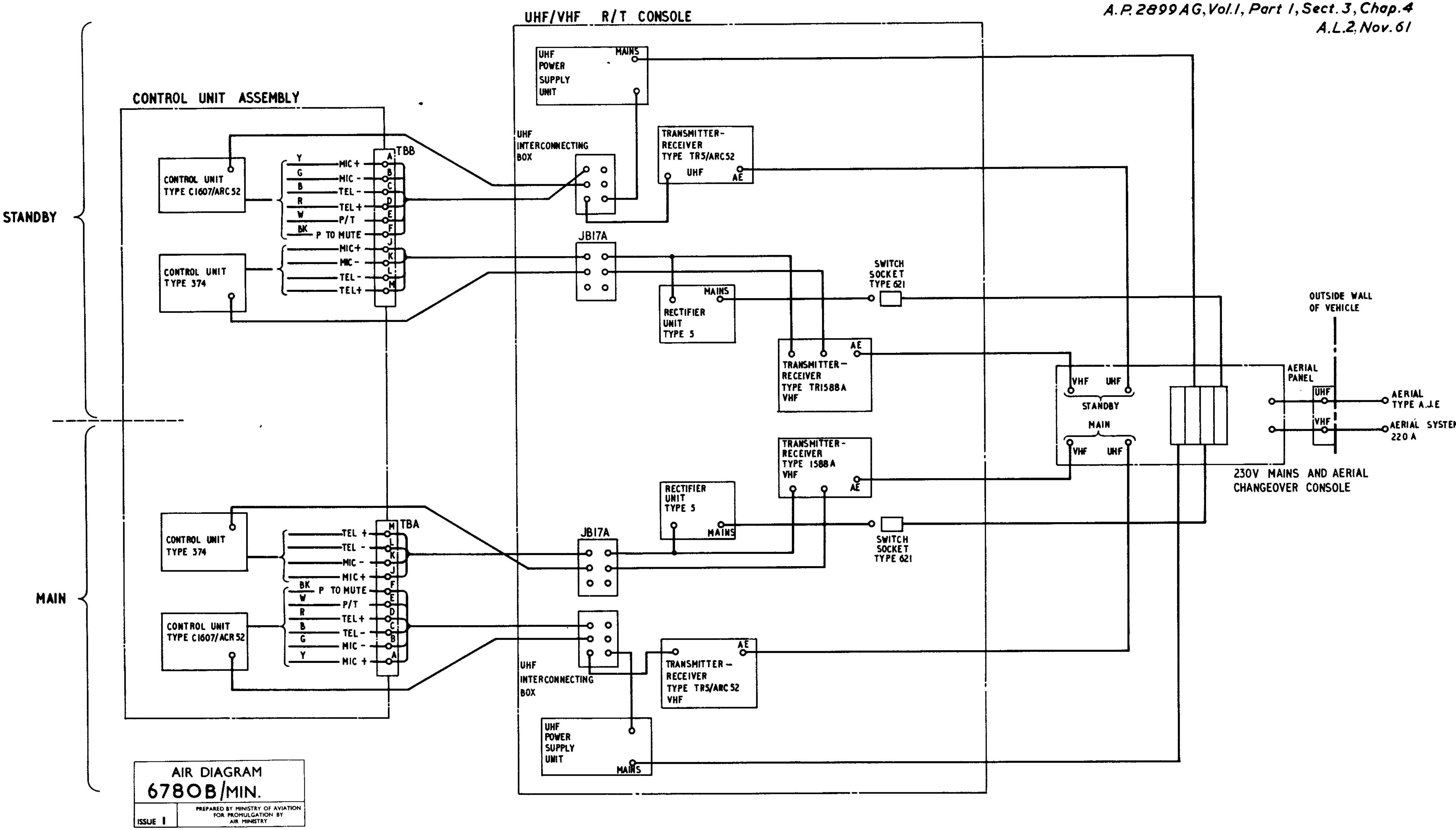
35. To put the air conditioner unit into its working position it is necessary to unscrew four turnscrews, coloured red. The unit is then pushed to the stop position and locked by tightening the two outboard screws. A control switch for the air conditioner unit is positioned on the forward wall of the radar cabin.



AIR DIAGRAM	
6780A/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY

U.H.F. power supply unit (a.c.) : circuit

Fig.7



Radio vehicle Type 515 Mk 2- UHF/VHF R/T equipment interconnections

Fig. 8

Chapter 5

UHF/VHF R/T INSTALLATION IN RVT.515 Mk. 2 —

SETTING UP AND OPERATING

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This chapter gives the setting-up and operating instructions for the u.h.f. and v.h.f. radio telephone equipments installed in the radio vehicle Type 515 Mk. 2. The sequence of operations as set out should be carefully followed to ensure the correct working of the R/T installation, and also to avoid serious damage to the equipment.

2. The setting-up procedures described in this chapter are based on the underlying assumption that the vehicle has been newly installed and connected, and that the R/T aerial systems are to be assembled and erected.

Erecting the aerials

3. A general view of the radar cabin interior showing the stowage positions of certain items of aerial equipment is given in fig. 1. Each aerial mast is in two sections and stowed on the floor of the cabin; the two lower and two upper mast brackets are stowed on the floor forward of the spares cupboard.

4. When in operation, the aerial masts are affixed to the sides of the vehicle, being held in position by brackets which fit into wedge plates secured to the exterior walls of the vehicle. A view of the aerials fitted to the vehicle is given in fig 1 of Chap. 4, Sect. 3.

5. To erect and assemble the aerials, first remove the upper and lower mast brackets from their stowages in the radar cabin and fit them into their mast mounting plates on the exterior walls at the rear of the vehicle.

6. Remove the mast sections and the aerials Type AJE and Type 220A from their stowages in the cabin. Assemble each mast with its appropriate aerial and external aerial connector. Fit the completed aerial systems to the mast brackets on each side of the vehicle, and plug the connector into the appropriate socket on the aerial input panel.

Vehicle earth connections

7. If the vehicle has been newly installed, it will be advisable to make a check of the vehicle earth connections before attempting to carry out the setting-up procedure for the R/T equipment. These connections are dealt with in the following paragraph. A view of the machine cabin interior showing the transit stowage positions of various items of equipment, including the earth rods, appears in fig. 4.

8. The vehicle earthing connections should be checked as follows : —

(1) *Safety earth.* Check that the earth rod has been driven into the ground to its full extent and that it is connected to the insulated

earth terminal on the mains input panel by means of the insulated lead provided. The earth rod should be positioned at least three feet away from the vehicle with a minimum separation of six feet from the main earth rod when this is driven into the ground.

Note . . .

The safety earth is associated solely with the vehicle's earth-leakage circuit breaker and under no circumstances should it be connected to, or used, as the main earth. The safety earth terminal must be connected before the main earth is connected, or before power is applied to the vehicle installation.

(2) *Main earth.* Check that this earth rod has been driven into the ground to its full extent and that it has been connected to the main earth terminal on the mains input panel. The main earth rod should be positioned in the ground not less than three feet from the vehicle, and as stated in sub-para. (1) should be separated by a distance of at least six feet from the safety earth rod position.

(3) Thoroughly moisten the soil around the earth rods to ensure good electrical contact (and periodically water this area of ground if necessary). Check that the earth terminals, earth leads and earth rods are physically clean and that the vehicle earth circuit is of low electrical resistance.

Switching on procedure

9. Check that the power supply is connected to the vehicle mains input panel. In the machine cabin close the two MAINS earth-leakage circuit breakers (CB1 and CB2) and the AIR CONDITIONER circuit breaker (CB9). If the mains circuit breaker CB2 does not trip, thereby indicating no fault conditions on that circuit, circuit breaker CB4 and the circuit breakers for the u.h.f. and v.h.f. main R/T equipments, at the 230-volt mains and aerial changeover unit, should be made in turn. If the mains circuit breaker CB2 trips, this would indicate an earth fault on the vehicle wiring or R/T equipment which must be rectified before proceeding further. The location of the circuit breakers in the machine cabin is shown in

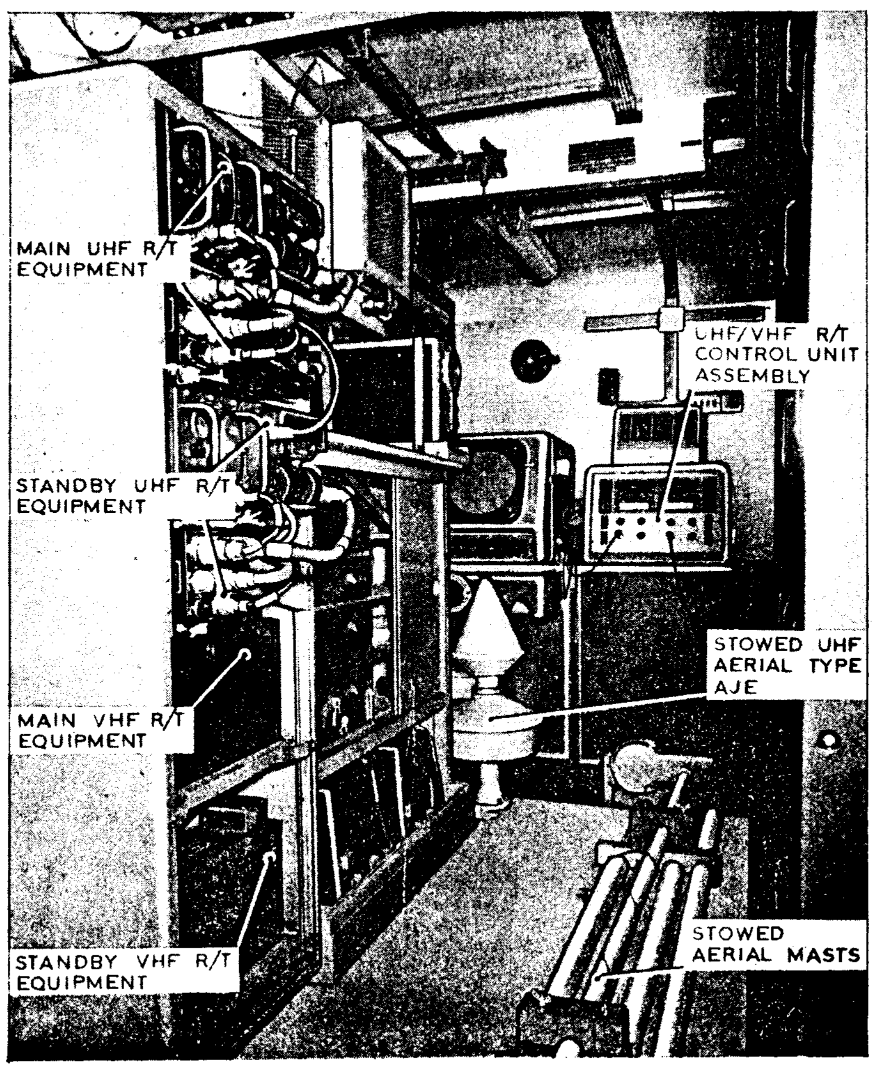


Fig. 1. Radar cabin interior — looking forward

fig. 3. A more detailed view of the communication equipment switch gear appears in fig. 6 of Sect. 3, Chap. 4.

Setting-up the u.h.f. equipment

10. The following paragraphs describe the method of frequency selection, and also a seri s of functional tests which should be made initially and periodically in order to establish that each u.h.f. equipment is in satisfactory working order. A view of the equipment mounted in the R/T cabinet in the radar cabin is given in fig. 2.

Frequency selection

11. The transmitter-receiver TR5/ARC.52, in conjunction with the control unit C1607/ARC.52, can be set up for manual selection of the required frequency or for automatic selection of one of 18 preset frequency channels. In addition, the preselector system includes a guard frequency channel. The method for setting-up any given frequency in the band 225 Mc/s to 399·9 Mc/s is as follows :—

(1) *Manual selection.* Set the channel selector switch CHAN to position M on the control unit, and adjust the four manual frequency dials on the top of the control unit to show the desired frequency. Reading from left to right the dials indicate hundreds, tens, units and tenths.

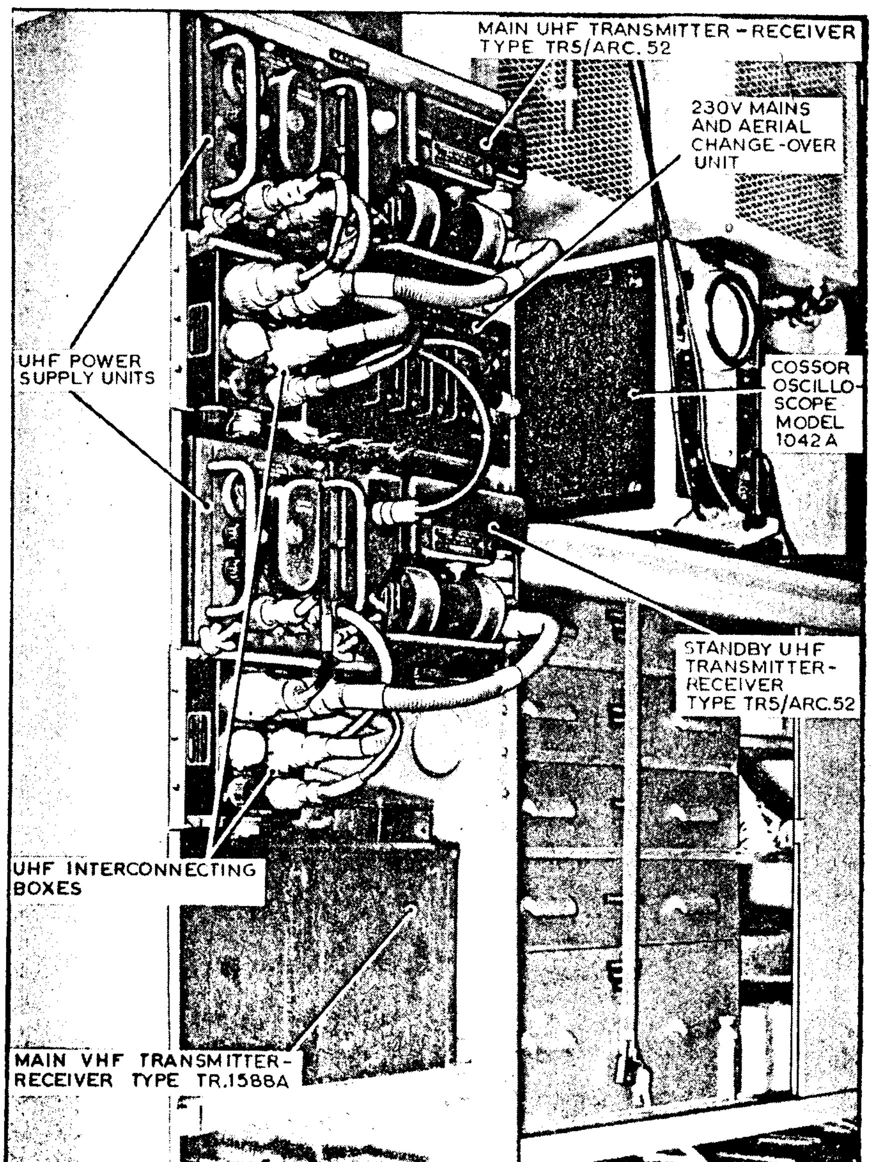


Fig 2. UHF/VHF R/T equipment

(2) *Preset channel selection*. Remove the cover plate from the bottom of the panel. Assuming that channel 7 is to be set up to a frequency of 351·5 Mc/s, rotate the channel selector CHAN switch on the control unit until channel 7 appears in the aperture opposite the arrow pointing to PRESET CHAN. Remove the presetting tool from its stowage and set up the actuators in sequence commencing from the left-hand side of the control unit as follows : —

(a) Hundreds Mc/s; digit 3, first group. Set the first actuator over digit 3.

(b) Tens Mc/s; digit 5, second group. Set the second actuator over the arrow pointing to the upper row which includes the digit 5. Set the third actuator over the arrow pointing to digit 5.

(c) Units Mc/s; digit 1, third group. Set the fourth actuator over the arrow pointing to the lower row which includes the digit 1. Set the fifth actuator over digit 1.

(d) Tenths Mc/s; digit 5, fourth group. Set the sixth actuator over the arrow pointing to the upper row containing the digit 5. Set the seventh actuator over the digit 5.

(e) The frequency for each channel as it is set up should be recorded on the front of the cover plate.

(f) The remaining channels may be set up to the required frequency by the setting of the channel selector switch so that the required channel number appears in the PRESET CHAN position, and then repeating the operations detailed in sub-para (a) to (e).

(g) Channel G (guard frequency) is normally set to 243·0 Mc/s.

(h) After all channels are set up, replace the presetting tool in its stowage and refit the cover.

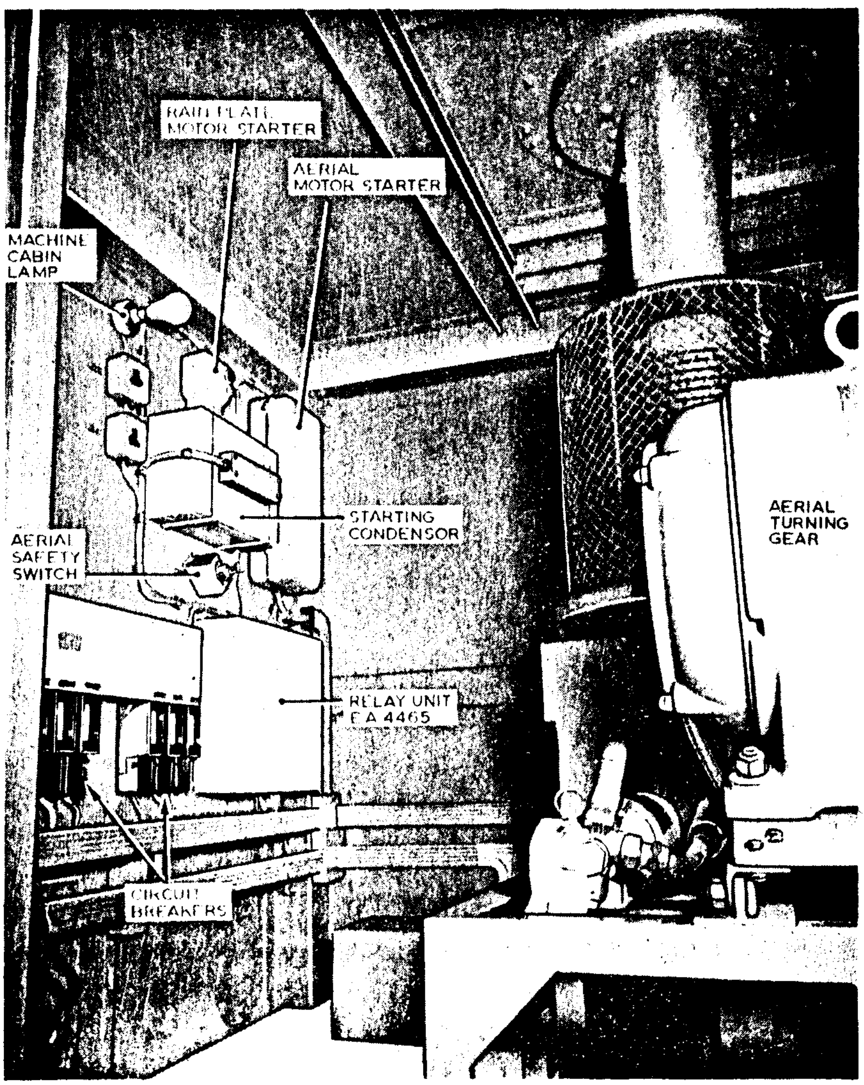


Fig. 3. Switch gear and aerial turning gear in machine cabin

Setting-up the test set UHF

12. Make the following connections between the u.h.f. equipment under test and the test set UHF (*Ref. No.* 10S/9433488) part of test set UHF (*Ref. No.* 10S/9434149).

(1) Unscrew the captive cover of the test socket on the interconnecting box and insert the 12-pole plug of the test set connector (part of test set UHF, 10S/9434149).

(2) Disconnect the aerial connector from the transmitter-receiver and plug it into the large coaxial socket on the test set.

Note . . .

The aerial must not be connected to the test set under conditions of "radio silence".

(3) Connect the RADIO socket of the test set to the aerial socket of the transmitter-receiver under test by means of the coaxial connector colour coded red (part of test set UHF, 10S/9434149).

Tests

13. After switching on the power unit (AC) and ensuring that all plugs and sockets are mating securely, carry out the following tests : —

(1) *Power supply*

(a) Connect the coaxial link, which is provided in the test set, between the sockets marked SIG GEN and RX on the test set.

(b) Set the junction switch on the control unit C1607/ARC52 to the position marked T/R+G.

(c) Set the supply switch on the test set to ON.

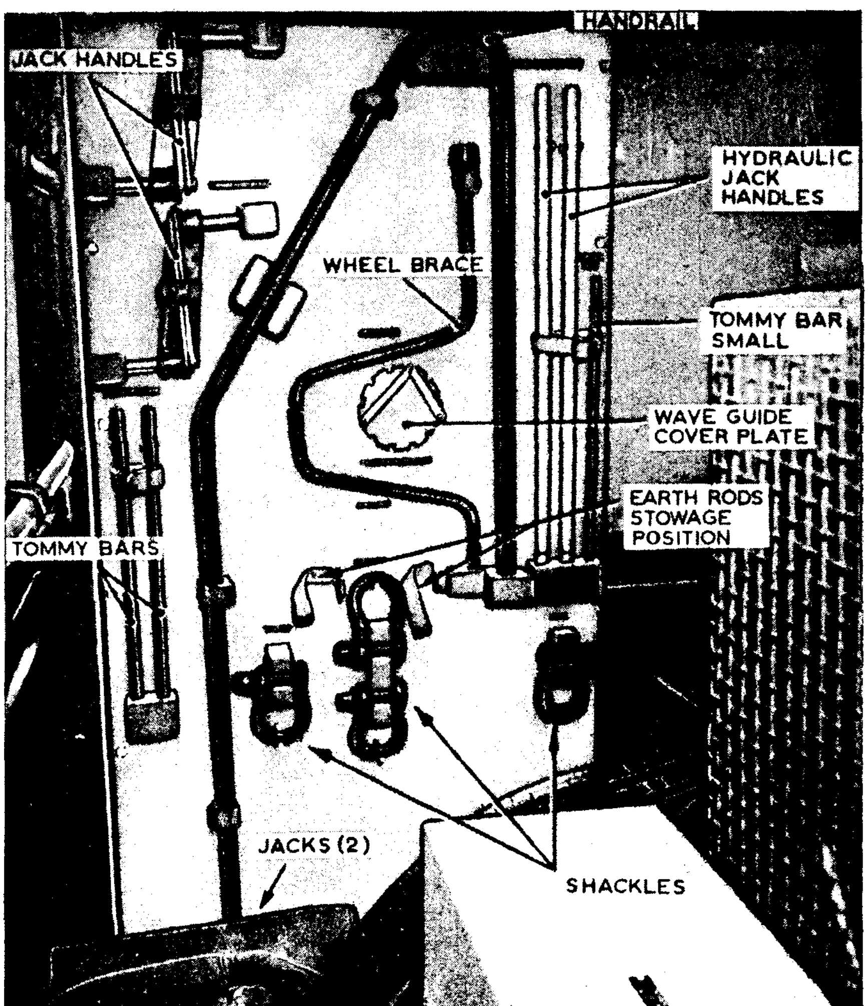


Fig. 4. Machine cabin stowage positions — nearside wall

(d) Set the meter switch on the test set to position 1 DC and measure the d.c. input supply (27·5V d.c. nominal). The meter should read within the blue zone on the scale, indicating that the supply is between the limits of 25V and 29V d.c.

(e) Should the reading obtained be outside the limits quoted, check that the tapping switches on the power unit (AC) have been adjusted correctly to the incoming mains voltage and that *all* connections between the power unit, interconnecting box and the test set are secure.

(2) *Receiver sensitivity*

(a) Re-adjust the junction switch on the control unit to position T/R and set the channel selector switch to channel 1.

(b) Connect the coaxial link of the test set between NOISE GEN and the RX sockets and set the meter switch to position 4 RX SENS.

(c) Adjust the NOISE CONTROL on the test set to give a meter reading at A.

(d) Depress the NOISE GEN switch and ensure that the meter reading exceeds B.

(e) Repeat the procedure detailed in sub-sub paras. (a) to (d) for channels 2 to 18 inclusive, and in addition, for channel G. In every case the meter reading should exceed point B on the scale. If the readings are low on some channels, misalignment of tuned circuits are indicated, and the transmitter-receiver should be changed for a serviceable one.

(3) *Transmitter power output*

(a) Remove the coaxial link from the NOISE GEN and RX sockets on test set and connect it between the LOAD and TX sockets.

(b) Set the test set meter switch to position 5 R.F. POWER.

(c) On the control unit, select channel 1.

(d) After a short pause, press the TALK ON/OFF switch on the test set and the meter reading should be in excess of scale point B.

(e) Repeat the operations as given in sub-sub-para. (d) for channels 2 to 18 inclusive, and on guard channel G, and in every case the meter readings should be in excess of scale point B. If some readings are less than B, there is a misalignment of the transmitter tuned circuits and the transmitter-receiver should be replaced.

(4) *Modulation depth*

(a) On the control unit, select guard channel G.

(b) Set the test meter switch to position 6 DC CAL.

(c) Depress the TALK switch on the test set and adjust the DC CAL. control for full-scale deflection on the meter.

(d) With the TALK switch still depressed, set the meter switch to position 7% MOD. The meter reading should exceed B. If the meter reading is below B, replace the transmitter-receiver.

(5) *Reflection coefficient of aerials and cables.* This test must not be implemented during conditions of "radio silence".

(a) Set the channel selector switch on the control unit to any little-used preset channel, other than the guard channel.

(b) On the test set, remove the coaxial link from the LOAD and TX sockets and connect it between the AERIAL socket (small) and the TX socket.

(c) Set the test meter switch to position 5 R.F. POWER.

(d) Listen out before transmitting, set the meter switch to position 6DC CAL and then depress the TALK switch; adjust the DC CAL control for full-scale deflection on the meter.

(e) Keeping the TALK switch depressed, reset the test meter switch to position 8 REFL. COEFF. The meter reading must not exceed scale point B. Should the reading exceed scale point B, check that the complete aerial system, its terminations and general mechanical condition are satisfactory.

(6) Repeat the tests quoted at sub-para. (1) to (5) for the remaining u.h.f. equipment and, when each equipment has been tested, remove the test set connections and restore each equipment to its normal condition, ensuring that all plugs and sockets are correctly and securely mated.

(7) Test the case pressure of each transmitter-receiver to ensure that it is not less than 3 lbs per square inch. If it is below this figure, the pressure should be raised to 4 or 5 lbs per sq. inch using the pressurizing pump (*Ref. No.* 4G/5435). On completion, ensure that the cap of the Schrader valve is screwed back in position.

Operating the u.h.f. equipment

14. In the following instructions for operating the u.h.f. R/T equipment, it is assumed that the setting-up and test procedures described in para. 11, 12 and 13 have been carried out. Proceed as follows: —

(1) *Main transmitter-receiver.* To operate the equipment on any one of the 18 preset channels, proceed as follows: —

(a) Connect the aerial connector to the appropriate socket on the aerial changeover console for the transmitter-receiver being operated.

(b) Switch on the MAINS, and the UHF SUPPLY circuit breaker at the 230V mains and the aerial changeover console.

(c) Check the supply tapping switches under the hinged cover on the power unit (AC) for correct setting to the incoming mains supply voltage. When replacing the hinged cover, ensure that the cover retaining screw is firmly tightened, as this screw actuates a micro-switch which isolates the mains supply whilst adjustments are made to the tapping switches.

(d) Raise the spring-loaded, centre-biased supply ON/OFF switch on the power unit panel to the ON position, and hold in this position until the red DC OUTPUT ON lamp lights and the meter indicates the d.c. output voltage.

(e) Set the function switch on the associated control unit Type C1607/ARC52 to the T/R position and allow 30 seconds for the valves in the transmitter-receiver to warm up.

(f) Set the channel selector switch CHAN to the required channel.

(g) Adjust the volume control VOL to approximately the centre of its travel. After the first received signal is heard on the loud-speaker, the volume control may have to be re-adjusted to the required level of sound.

(h) Transmission is effected on the same channel by operating the appropriate press-to-talk switch on the control unit assembly.

(2) *Guard receiver.* To bring the guard receiver into operation, set the function switch on the control unit to the T/R+G position. The channel selector switch CHAN should be set to any channel other than G. Thus, watch can be maintained on both the guard frequency and also on the frequency at which the main transmitter-receiver is being operated. The level of the audio output of the guard receiver relative to that of the main receiver is preset by an internal control, while the level of the audio signals in the loudspeaker is adjustable by the VOL control on the control unit.

(3) *Main receiver on guard frequency.* Should it be necessary to operate the main receiver at the guard frequency, or transmit and receive at this frequency, the function switch should be set to T/R and the channel switch to G. The guard receiver output is cut off and the equipment should be operated as described in sub-para. (1) (g) and (h).

(4) *Manual adjustment of frequencies.* To operate the equipment on manually adjusted frequencies, proceed as follows: —

(a) Rotate the channel selector control CHAN to the M position.

(b) Set the function switch to the desired type of operation, T/R or T/R+G.

(c) Adjust each of the four manual frequency dials at the top of the control unit front panel to show the desired frequency.

(d) Operate the equipment as detailed in sub-para (1) (g) and (h).

For more detailed instructions for operating the u.h.f. equipment, reference should be made to A.P.2531J, Vol. 1.

Setting-up and operating the v.h.f. equipment

Transmitter-receiver Type TR.1588A (tuning)

15. The procedure for tuning the TR.1588A equipment, making use of the back-tune facilities, is as follows: —

(1) Determine the crystal(s) for use in the transmitter by dividing the desired output frequency by eighteen.

(2) Determine the crystals(s) for use in the receiver from the formula

$$f = \frac{fr - 12}{h} \times 1000$$

where f is the crystal fundamental frequency in kc/s, fr is the frequency in Mc/s to which the receiver is to be tuned, and h is the receiver crystal harmonic as determined by the following data: —

Frequency in Mc/s (fr)	*Receiver crystal harmonic (h)*
100 – 108	11
108 – 116	12
116 – 124	13
124 – 132	14
132 – 140	15
140 – 148	16
148 – 156	17
156	18

(3) Insert the crystals for the four frequencies in the appropriate transmitter and receiver

crystal sockets. Connect the test meter (*Ref. No.* 110S/53) to the transmitter meter plug (which is adjacent to the meter switch). Connect the aerial socket on the aerial changeover console to the dummy aerial of test set IE-36 (*Ref. No.* 110S/156).

(4) Switch on the VHF SUPPLY circuit breaker on the 230V mains and aerial changeover console. Switch on the rectifier unit Type 5 after ensuring that the voltage selector switch is set to the incoming mains voltage, and allow five minutes for warming-up.

(5) Operate the key switch on the appropriate control unit Type 374 to the transmit position. Switch on the transmitter-receiver by pressing the button on the control unit for the channel preceding the channel to be tuned (in this instance channel D as channel A is to be tuned).

(6) Release the tuning mechanism by pressing the channel release button once (on top of the receiver adjacent to controls marked AUDIO and RELAY).

(7) Loosen the four transmitter tuning control locknuts (turn the locknut bar on wheel counter-clockwise). Press button A on the control unit.

(8) Set the meter switch to position 1, then adjust the oscillator anode tuning control (the control nearest to the switch) for maximum meter indication.

(9) Turn the meter switch to position 2 and adjust the anode tuning control of the first frequency trebler (second tuning control) for maximum meter indication.

Note . . .
To avoid tuning to undesired harmonics, ensure that the tuning controls mentioned in operations (8) and (9) indicate approximately the desired output frequency on the tuning calibration plate.

(10) To avoid overloading the receiver when using the back-tune facility, completely de-tune the remaining transmitter stages so that there is no drive to the output stage.

(11) Holding each tuning control in turn, tighten the locknuts sufficiently to exert a slight pressure on the cams. Check that the tuning of stages one and two are still correct by rocking the controls.

(12) Select channel B, loosen the locknuts and set the meter switch to position 1.

(13) Adjust the channel B controls as in operations (10) to (11).

(14) Adjust the remaining channels C and D by the same method, ensuring that on completion, the tuning control locknuts are correctly tightened.

16. To tune the receiver, return the transmit key switch on the appropriate control unit to its normal position. Transfer the meter socket (if used) of the testmeter (*Ref. No.* 110S/53) to the receiver meter plug and set the AUDIO and RELAY controls fully clockwise. Set the back-tune switch adjacent to the ratchet meter to ON (toggle upwards) and then proceed as follows : —

(1) Press the control unit button for the channel preceding the one to be tuned. In this instance as channel A is to be tuned, select channel D.

(2) Press the channel-release button once. Loosen the tuning control locknuts.

(3) Select channel A.

(4) Set both tuning controls to the desired frequency of channel A as indicated on the tuning control calibration plate. This is important, as an error of more than 3 Mc/s may mean that the receiver is tuned approximately 8 Mc/s from the operating frequency.

(5) Starting from the extreme clockwise position, turn the channel A oscillator anode inductor tuning screw in the counter-clockwise direction until a dip is indicated on the meter. Turn the screw clockwise until the meter reading increases sharply.

(6) Turn the screw in the opposite direction until the meter indication dips. Set the screw to a position three-quarters of a turn beyond the point at which the signal re-appeared. If the signal is decreased appreciably by this extra rotation, continue turning in a counter-clockwise direction until a second peak is obtained. If the second peak gives a greater signal strength, leave the screw in this position. If the signal strength is less, return the screw to the first position.

(7) Adjust the receiver tuning controls for maximum dip on the meter.

Note . . .
To sharpen the tuning slightly, de-tune the transmitter whilst setting-up the receiver.

(8) Tighten the tuning control locknuts sufficiently to exert a slight pressure on the cams, ensuring that in so doing, the adjustments are not altered.

(9) Select channel B and loosen the tuning controls locknuts.

(10) Tune channel B by the methods used for channel A.

(11) Tune the remaining channels C and D in a similar manner.

(12) Press the channel-release button once and, to release the tuning mechanism, tighten both control locknuts by hand, then press the button again to re-engage the mechanism.

(13) Set the back-tune switch to OFF and transfer the plug of the testmeter to the transmitter meter socket. Set the transmit key switch on the control desk to the transmit position.

17. Now proceed finally to tune the transmitter as follows:—

(1) Press channel D button on the control unit and then release the tuning mechanism by pressing the channel release button.

(2) Loosen the four transmitter tuning control locknuts slightly and press button A on the control unit.

(3) Repeat the procedure detailed in para. 15 (8) and (9) for adjusting the first and second tuning controls. (It is assumed that these will have had to be disturbed whilst tuning the receiver).

(4) Turn the meter switch to position 3 and adjust the anode tuning control of the second trebler stage (third tuning control) for maximum indication, then, leaving the switch at position 3, immediately adjust the power amplifier anode control (fourth tuning control) for minimum meter reading. Record this reading.

(5) Holding each, tuning control in turn tighten the locknuts sufficiently to exert a slight pressure on the cams. Ensure that the meter readings do not alter during this operation.

(6) Select channel B and loosen the locknuts.

(7) Set the meter switch to position 1.

(8) Adjust the four channel B controls as in sub-para. (3) to (5).

(9) Tune the two remaining channels C and D. Record the final meter readings.

(10) The highest recorded final reading should be not less than 0·6 or greater than 0·63. If the readings are not within these limits select the channel in question, adjust the aerial inductor coupling control (adjacent to the fourth control) then re-tune the fourth control. Repeat this operation until a reading between 0·6 and 0·63 is obtained.

Note . . .

Two types of aerial coupling control have been fitted; in one the coupling is decreased by turning clockwise and increased by turning counter clockwise, and in the second the adjusting-knob serves as a locknut to secure the inductor in position. To adjust the latter type, unscrew the knob slightly and push it towards the tuning controls to increase the coupling, or away from them to decrease it. After adjustment, tighten the knob securely.

(11) If the aerial coupling has been adjusted, re-tune the remaining three channels (tuning controls 3 and 4 only) in the original sequence, i.e. A.B.C.D., B.C.D.A., C.D.A.B. or D.A.B.C. depending on which channel gave the highest recorded reading. With the meter switch in position 3, check that the highest recorded reading is still within the limits quoted in sub-para. (10).

(12) Remove the test set (*Ref. No.* 110S/53) from the aerial socket on the aerial changeover console and replace it with the aerial connector (internal).

18. Repeat the tuning instructions given at para. 15 to 17 for the remaining transmitter-receiver. Detailed tuning and operating instructions for the equipment are contained in A.P.2528H, Vol. 1 (2nd Edn.).

Section 3

FGRI.26008/2

LIST OF CHAPTERS

Note - A list of contents appears at the beginning of each chapter

Chapter 1

INTRODUCTION

CONTENTS

ILLUSTRATIONS

General

1. All FGRI.26008/1 type radars have been modified to FGRI.26008/2. Apart from these modifications, described below, the description and instructions for the FGRI.26008/1 given in this manual apply also to the FGRI.26008/2.

2. To effect the change from FGRI.26008/1 to FGRI.26008/2, the aerial, both receiver r.f. amplifiers, and the T/R cells are replaced. The new components give a better noise figure. A co-axial limiter, connected between the mixer and the image filter, is added.

Aerial

3. The reflector, horn, boom (including circularizer), and waveguide are replaced by assembly AR-1 Fig.1. The centre section of the torque tube is modified by the addition of an adaptor plate and casting. The replacement circular polarizer can be controlled from the remote site or from the approach room. A meter in the approach room indicates the degree of polarization in arbitrary units. New cables are secured to existing cableforms.

R.F. Amplifier

4. The original amplifier in each T/R assembly is replaced by a parametric amplifier. Associated with the parametric amplifier, on the same assembly, is a klystron oscillator to provide the pump energy. A Microwave power unit, type WE40, provides power to the klystron.

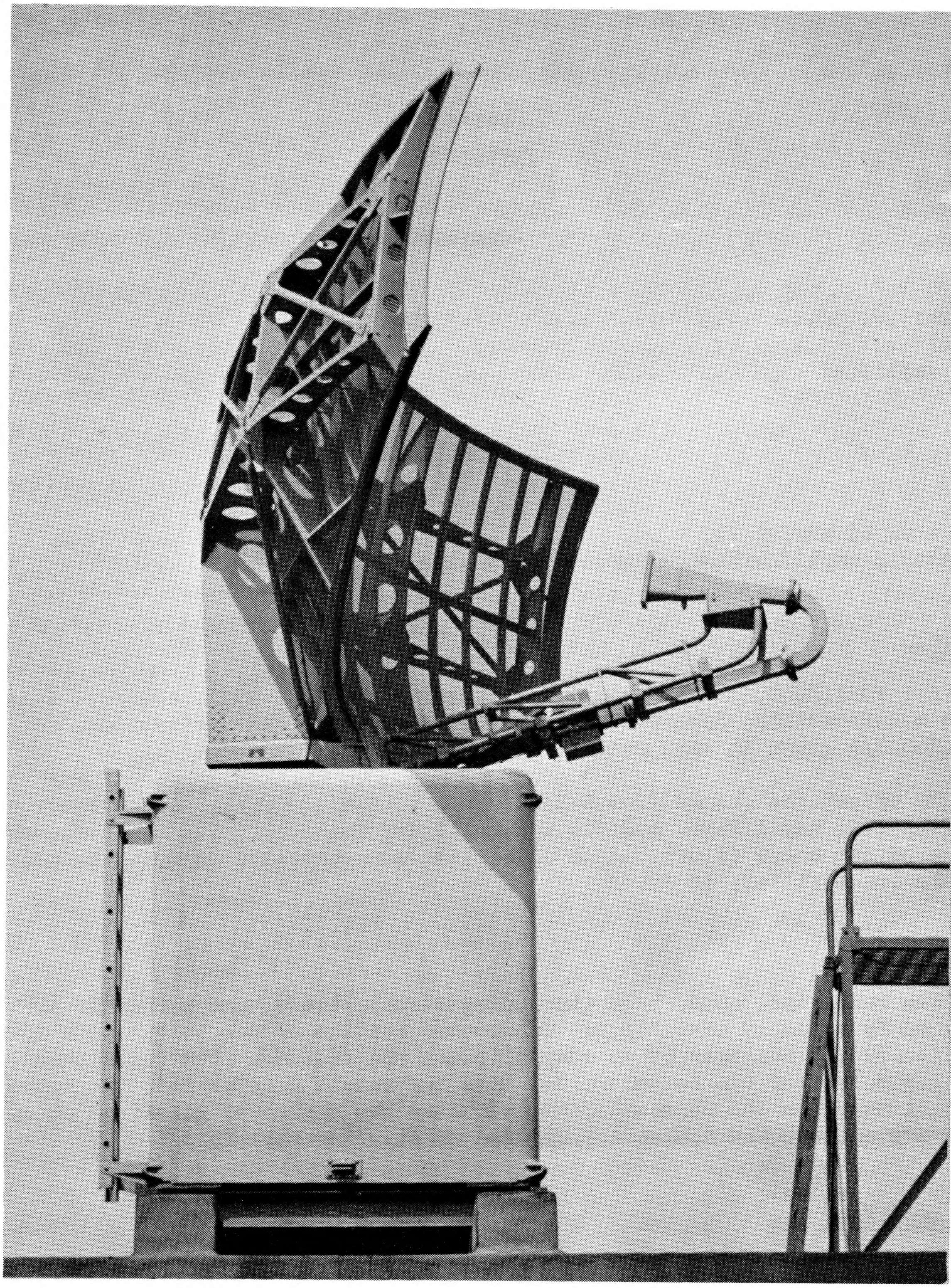
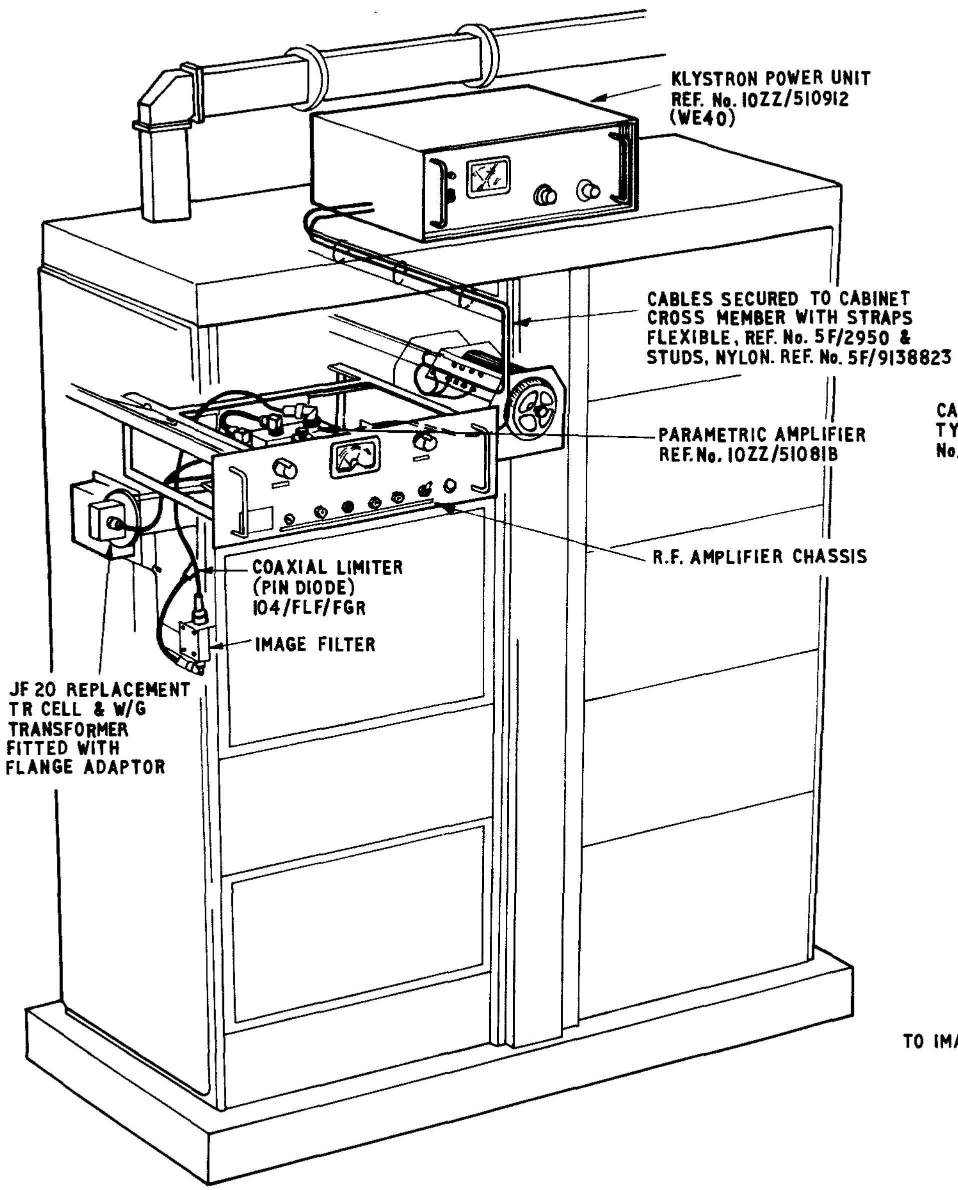
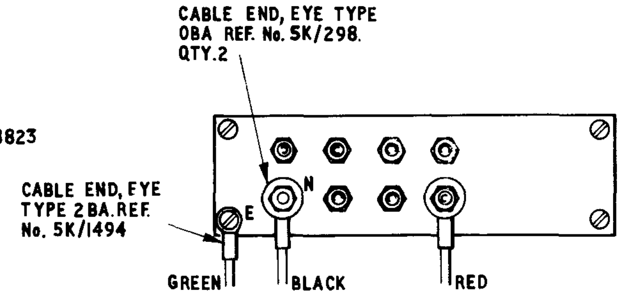
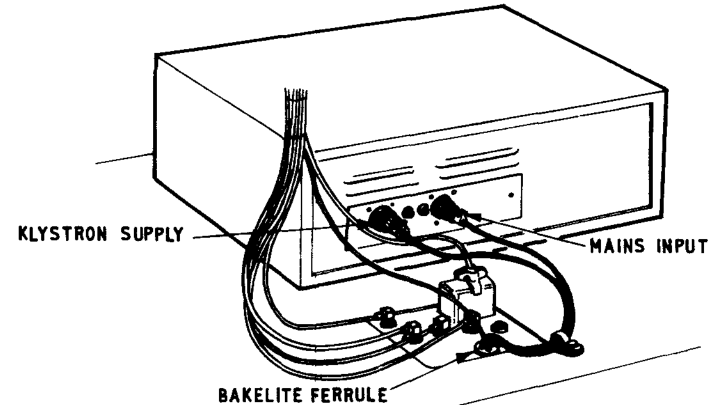


Fig.1 Side view of aerial

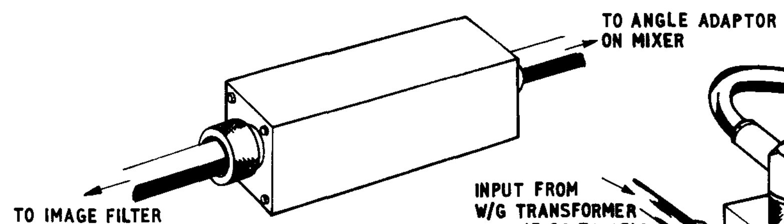




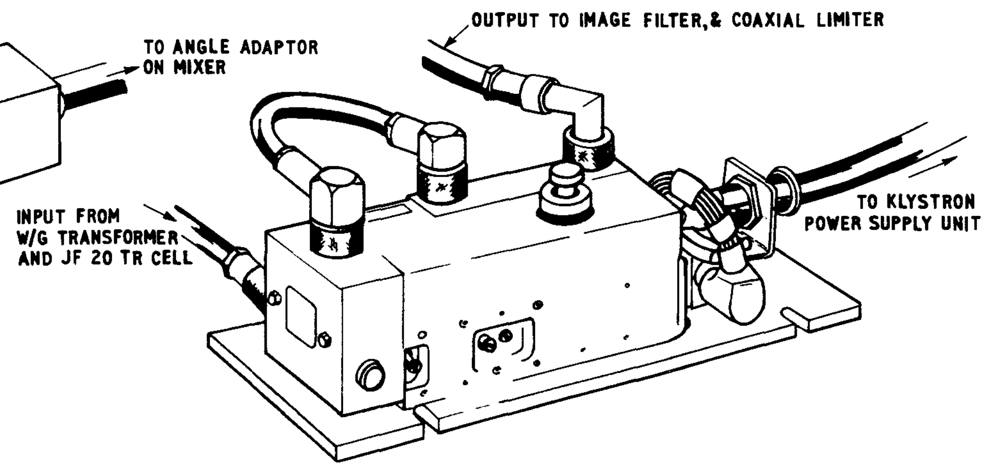
DETAILS OF KLYSTRON POWER SUPPLY UNIT
A.C. CONNECTIONS TO VARIAC ASSEMBLY TERMINAL PANEL



ROUTING OF CABLES FROM KLYSTRON
POWER SUPPLY UNIT TO CABINET INTERIOR



COAXIAL LIMITER



PARAMETRIC AMPLIFIER VCA|521

View of parametric amplifier and ancillaries.

Fig. 2.

Chapter 2

DESCRIPTION

CONTENTS

ILLUSTRATIONS

Aerial AR-1

1. The new aerial system is a horn fed double curvature reflector with the horn and r.f. feed supported on the boom arm. The circular polarizer is an integral part of the r.f. feed.

2. Normal polarization is linear. When precipitation is present the plane of polarization of the transmitted and received energy can be varied continuously from linear through elliptical to circular by the movement of a twin distrene vane variable phase shifter in the polarizer section of the boom arm. The operator is able to select the most suitable polarization from a switch on the polarization panel assembly in the approach room. The switch is connected to the circular polarizer relay unit in radar set control unit S6/3. There is a duplicate switch in unit S6/4.

3. A 240V a.c. motor in the circularizer drives cams through geared couplings. The cams operate the twin distrene vane. Limit switches prevent over-running and a potentiometer, mechanically coupled to the vane mechanism, determines the current to the meter in the approach room. The meter indicates the physical position of the vanes and therefore the degree of polarization. The circuit changes are shown in Figs.2, 3 and 4.

4. Concise Details

Polarization	Variable from linear through elliptical to circular.

The figures below refer to linear polarization

Gain	31 dB relative to isotropic radiator.
Horizontal aperture	16 ft (4.88m)
Horizontal beamwidth	1.5° to half power points
Vertical aperture	6.5 ft (1.98m)
Horizontal sidelobes	-21dB relative to maximum aerial gain within $\pm$ 5°, -24dB outside $\pm$ 5°
Rotation rate	12 rpm clockwise

The aerial is designed to operate under the following conditions:

Ambient temperature	-40°C to $+55^{\circ}$C
Relative humidity	0% to 100%

Maximum wind speeds:

Stationary	120 knots
Turning	70 knots

Parametric amplifier VCA/521

5. Before this amplifier is described a brief description of the principles of a simple parametric amplifier is given.

6. A parametric amplifier is essentially a tuned circuit, resonant at signal frequency, in which one of the parameters, usually the capacitance, is changed at the peak of each voltage cycle of the signal to be amplified. Energy taken from a source (known as the pump) outside of the circuit and used to change the capacitance, in fact to reduce it, is transferred to the tuned circuit with the result that the signal is amplified. In a simple circuit like this the switching of the capacitance occurs at twice the applied signal frequency and has a strict phase relationship to it. This type of amplifier is known as a degenerate parametric amplifier.

7. As the required phase relationship between the applied signal and the pump frequency is impossible at microwave frequencies, the practical amplifier contains three tuned circuits, two varactor diodes, and a klystron r.f. generator (the pump). The input signal mixes with the pump frequency in the varactor diodes to produce power at the idler frequency. The action of the mixer ensures that the voltage in the idler circuit is always in the correct phase for amplification so that the energy in the idler combines with the energy in the pump to produce amplified signal power.

8. It is necessary to separate the input signal from the amplified output signal. This function is performed by a circulator. The circulator is a ferrite device with three ports (or terminals). Power entering at the first terminal emerges at the second, power entering at the second emerges at the third, and power entering the third emerges at the first. The device effectively guides a signal round in one direction only, and in the parametric amplifier the input signal enters port 1 to appear at port 2. Any mismatch at port 2 produces a reflected signal which then absorbed by a resistive load connected to port 3, so that the circulator behaves as an isolator.

9. The gain of the amplifier, determined by the pump power incident on the varactor diodes, is adjusted by a waveguide attenuator situated between the klystron pump and the diode block. The attenuator is normally preset.

10. The amplifier is non-degenerate because the circulator ensures that in the event of a klystron or klystron power supply failure the signal will fail safe and the noise figure will revert to that of the original system with only slight degradation.

11. Concise details

Physical data

Nominal dimensions (complete amplifier excluding pump power supply and input isolator).

8 in x 3 in x 3 in

Weight 5½ lbs

Amplifier coaxial RF input	50 ohms female
Isolator coaxial RF input	50 ohms male
Amplifier coaxial RF output	50 ohms female
Klystron power connection	6 pin Bulgin type P427

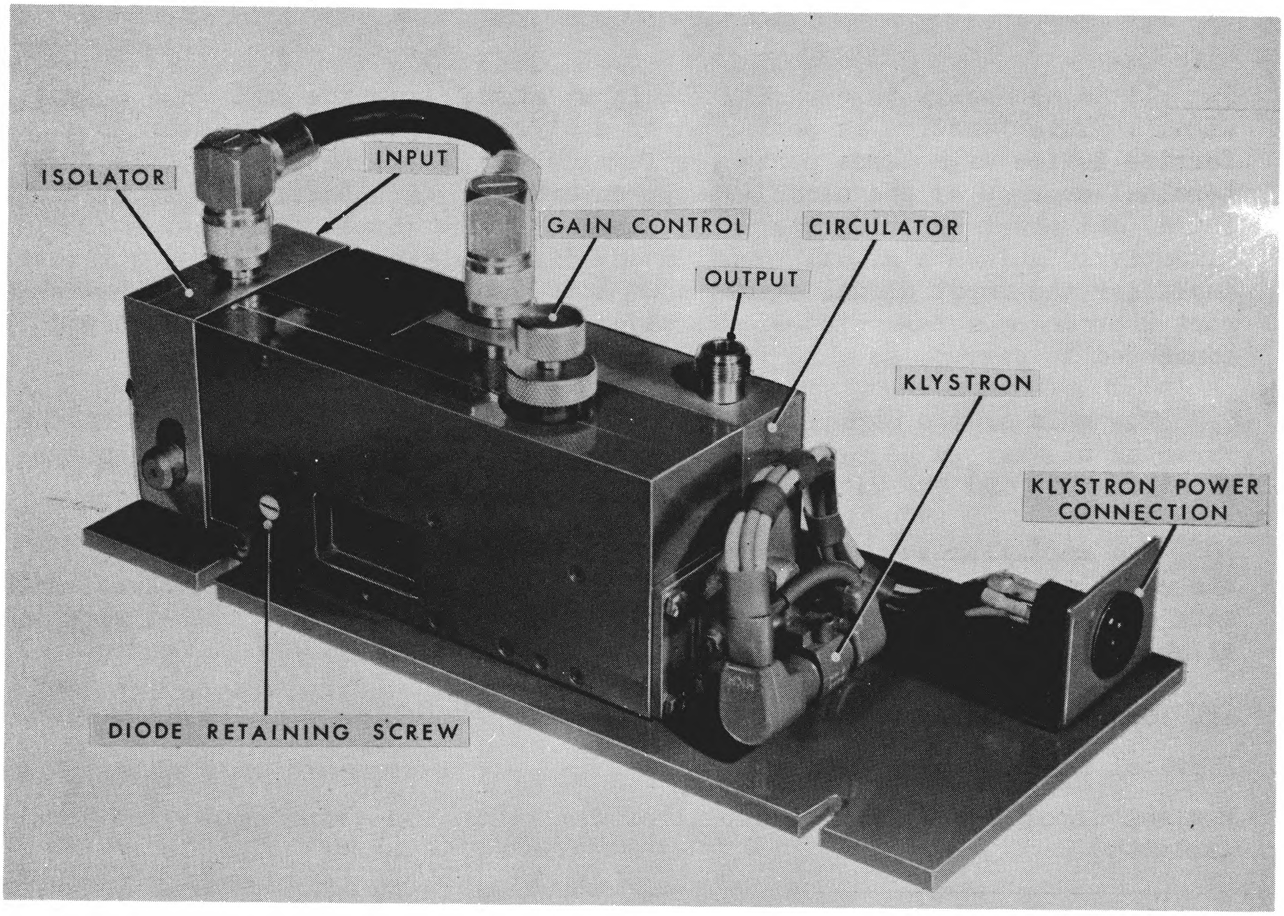


Fig. 1 Parametric amplifier

Electrical data

Ratings (At 25°C ambient temperature unless otherwise stated)

Maximum input signal (CW)	200 mW
Maximum spike leakage (1 usec pulses)	10 ergs
Storage temperature range	-10°C to +55°C
Operating temperature range	35°C to 45°C
Characteristics (at 25°C ambient temperature)	
Frequency	2960 Mc/s setting accuracy ± 5 Mc/s
Bandwidth	60 Mc/s ± 20 Mc/s
Gain	20 dB ± 2 dB
Noise Figure	less than 3.7 dB
Change in gain with temperature over range 35°C to 45°C	less than 3.5 dB
Short Term Phase Stability	less than 2.5°

Operating conditions

Pump Frequency	9.0 to 9.6 Gc/s
Average pump power	5 mW
Pump klystron	SZ52
Varactor Diodes (matched pair)	ZC25BP
Pump klystron supplies	resonator - earth cathode -300 V Heater 5.2 to 5.6 V at 1.5A reflector 100-200 V

Klystron power unit VA201B (WE40)

12. The above voltages are supplied by the klystron power unit. The klystron resonator is connected to earth. The cathode is 300V negative with respect to the resonator, and the reflector is between 100V and 200V negative to the cathode. In the following description all voltages are with respect to the cathode

13. Constant voltage transformer T1 supplies two full wave rectifying circuits. D3 and D4 supply stabilizing tubes V3 and V4 to produce 293V d.c. The voltage for the klystron reflector is taken from the slider of VR201. The voltage is variable from -85 to -202V.

14. D1 and D2, via a series regulator, supply the resonator. R11, VR1, R14, and R12 are in series between earth (resonator) and the stabilized -293V line. V2B and V2A form a cascode amplifier whose output controls series regulator V1. VR1 is set to give the resonator voltage required between pins A and B on the output panel.

15. Meter M201 is connected to a three position switch. Position 1 shows the resonator volts. Position 2 shows the resonator current, Position 3 shows reflector volts.

16. The heater winding of T1 is connected through R207 and R208, and this gives 5.5V across the klystron heater. The low voltage prolongs the life of the heater.

17. Concise details

Resonator voltage (w.r.t. cathode)	+230V to +330V, preset by rear control
Resonator current	50mA maximum
Stability factor	200:1
Ripple	5mV peak to peak
Reflector voltage (w.r.t. cathode)	-100V to -200V (10 turn control)

Stability factor	250:1
Ripple	2mV peak to peak
Heater voltage	6.3V r.m.s. off load 5.5V at heater
Heater current	2.5A maximum
Stability factor	15:1
Mains voltage	Transformer tapped at 200V, 215V, 230V, and 245V
Mains frequency	50Hz

T/R Cell and Waveguide to Co-axial Transformer

18. The Type CV193 TR cell, originally fitted, is narrow band with a high insertion loss. The replacement TR cell, Type JF 20, is wide band with low insertion loss. It carries the transformer, waveguide to co-axial, to accommodate the co-axial input connector to the parametric amplifier.

Coaxial limiter

19. An S-Band coaxial limiter, Type 109SKS, is inserted between the waveguide transformer and the input to the parametric amplifier in order to reduce the spike leakage from the TR cells to a safe level for the varactor diodes.

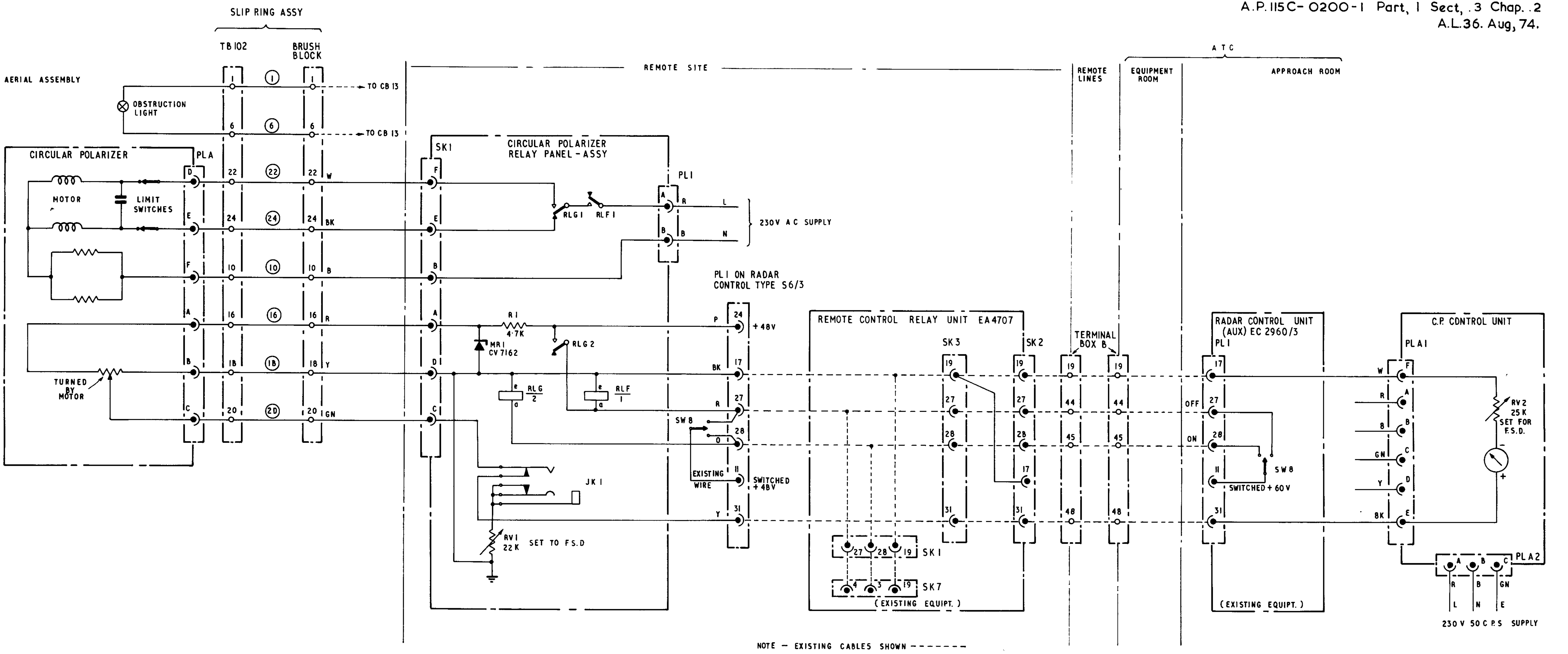
Concise details

20. Series 100 SLS limiter

Type 109SLS with Type N connectors

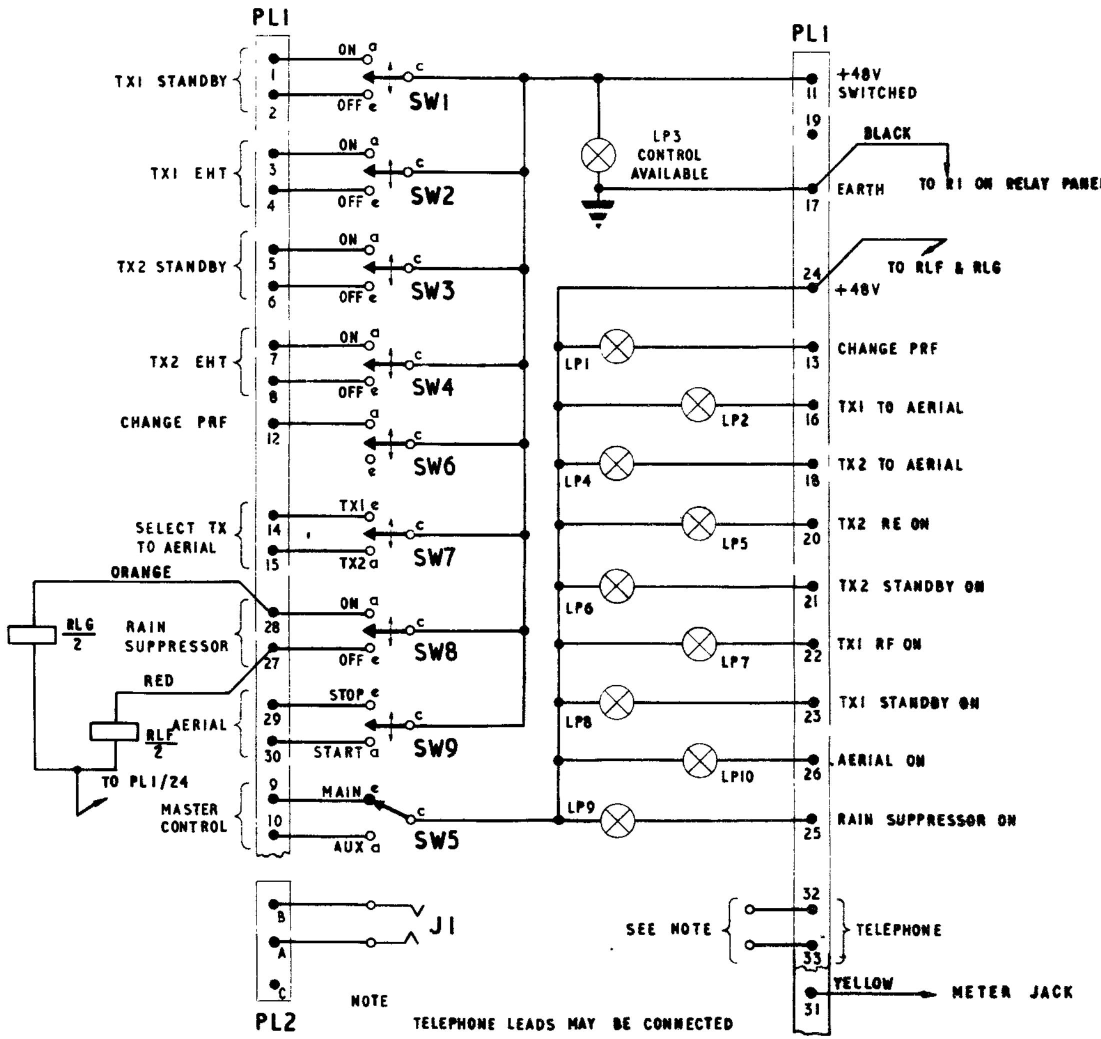
Frequency range	2.7 - 3.1 Gc/s
Insertion loss (max)	0.6dB
VSWR (max)	1.4
Limiting (of spike from JF20 TR cell) (min)	1.3dB

Insertion loss and VSWR are measured with very low power incident signal.



Circular polarizer- connections

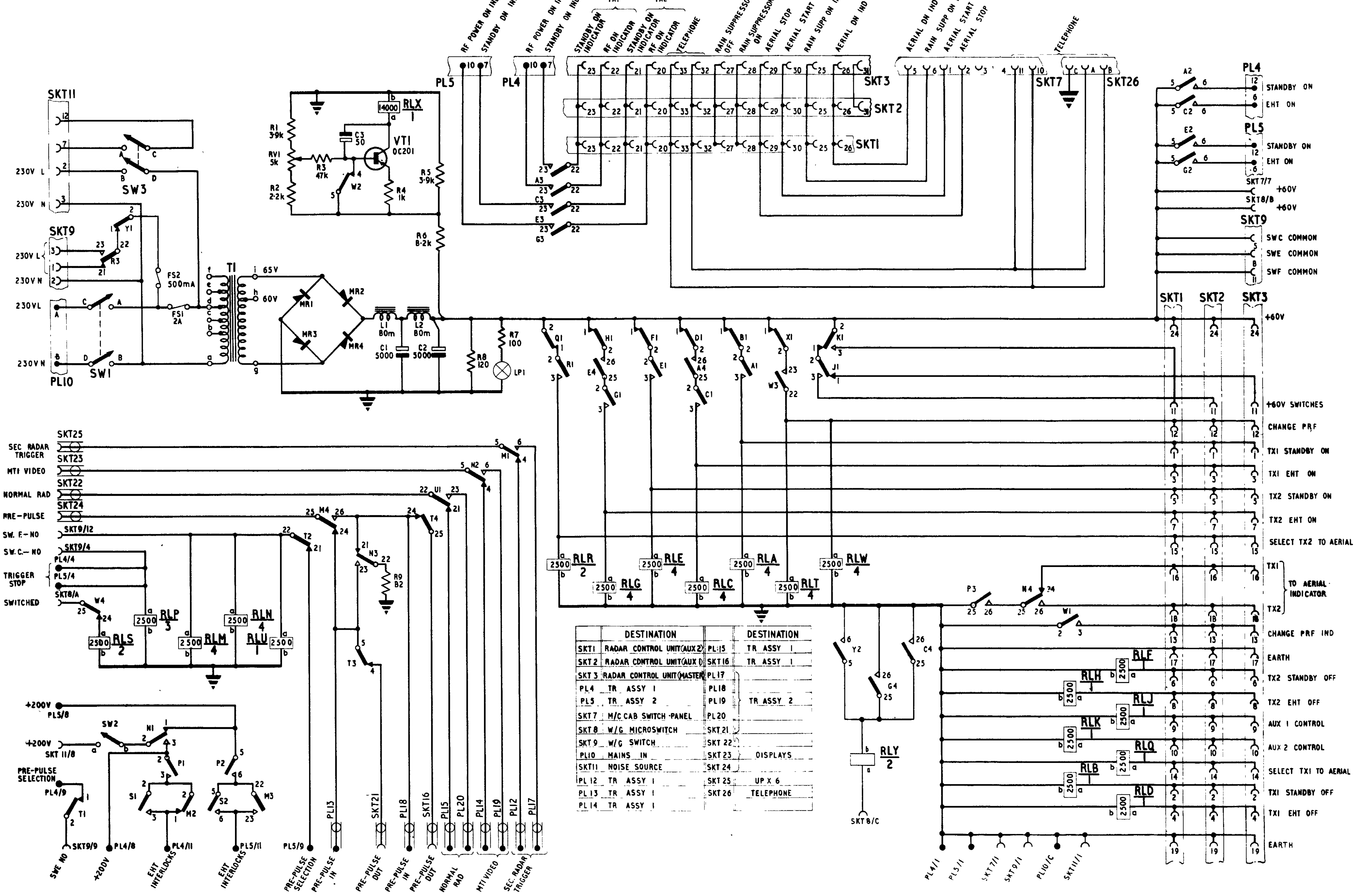
Fig. 2



NOTE

TELEPHONE LEADS MAY BE CONNECTED FROM PL1 TO PL2 AND/OR JACK JK1 AS REQUIRED ON SITE.

Radar set control Type S6/3 - modified for FGR1. 26008/2 (see fig 5, vol 1, part 1, sect. 2, chap. 2) Fig. 3.



	DESTINATION		DESTINATION
SKT1	RADAR CONTROL UNIT(AUX 2)	PL15	TR ASSY 1
SKT2	RADAR CONTROL UNIT(AUX 1)	SKT16	TR ASSY 1
SKT3	RADAR CONTROL UNIT(MASTER)	PL17	
PL4	TR ASSY 1	PL18	
PL5	TR ASSY 2	PL19	TR ASSY 2
SKT7	M/C CAB SWITCH -PANEL	PL20	
SKT8	W/G MICROSWITCH	SKT21	
SKT9	W/G SWITCH	SKT 22	
PL10	MAINS IN	SKT23	DISPLAYS
SKT11	NOISE SOURCE	SKT 24	
PL 12	TR ASSY 1	SKT 25	UP X 6
PL 13	TR ASSY 1	SKT 26	TELEPHONE
PL 14	TR ASSY 1		

Fig.4

Remote switching control Type S14/1: circuit modified for FRG1. 26008/2 (see fig.4, Part 1, Sect. 2)

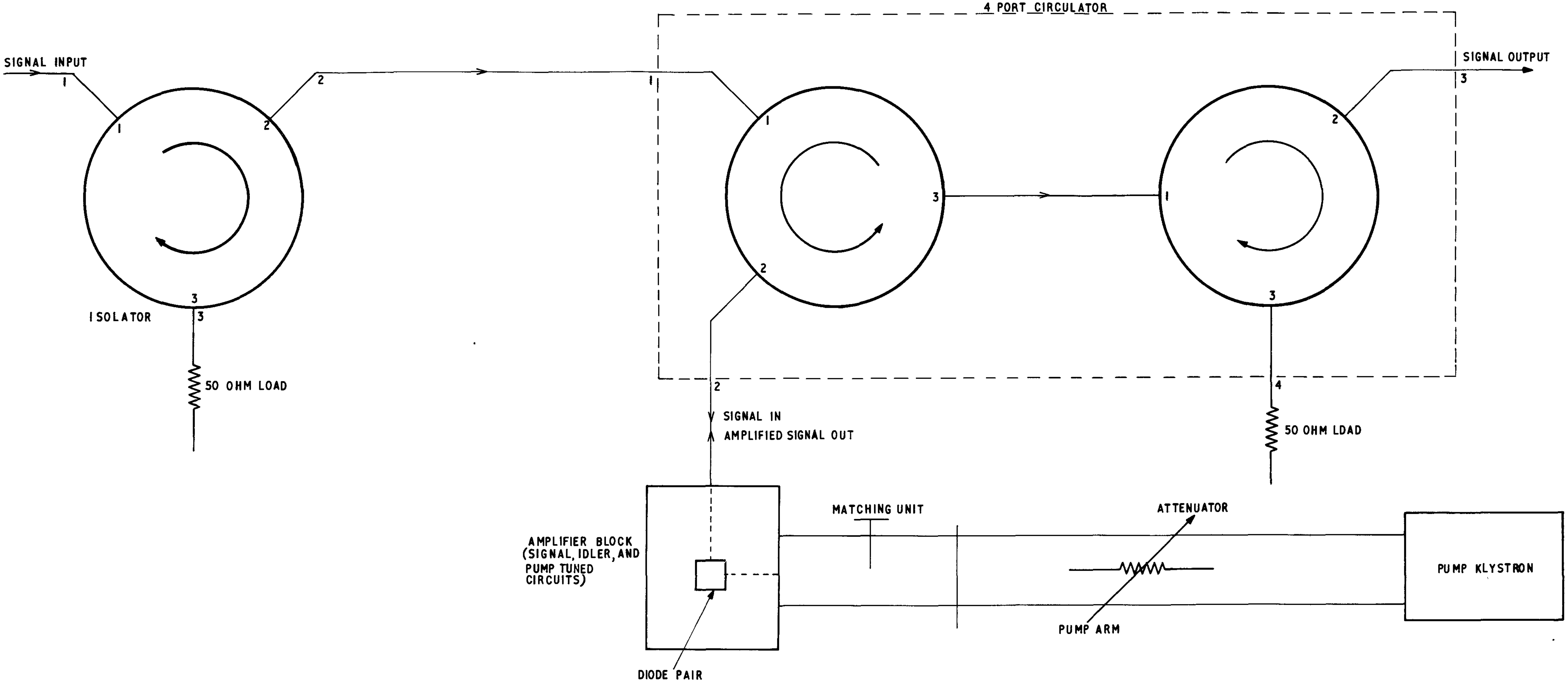
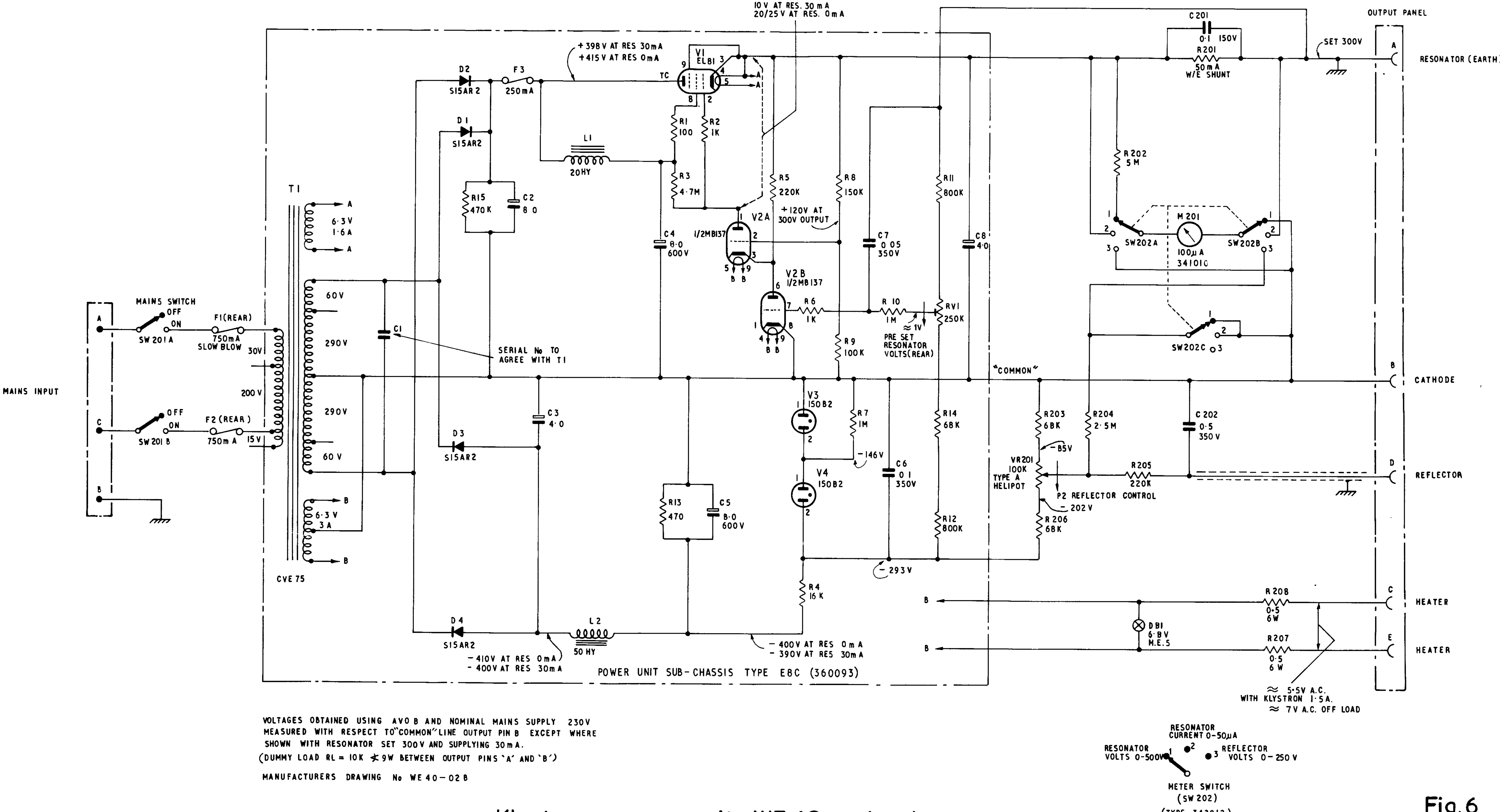


Fig. 5

Parametric amplifier—flow diagram



VOLTAGES OBTAINED USING AVO 8 AND NOMINAL MAINS SUPPLY 230V MEASURED WITH RESPECT TO "COMMON" LINE OUTPUT PIN B EXCEPT WHERE SHOWN WITH RESONATOR SET 300V AND SUPPLYING 30 mA.
(DUMMY LOAD RL = 10K ✱ 9W BETWEEN OUTPUT PINS 'A' AND 'B')

MANUFACTURERS DRAWING No WE 40-02 B

Fig. 6

Klystron power unit WE40 - circuit

Chapter 3

OPERATION

Polarization Indicator

Note the two positions giving minimum return from precipitation and maximum return from targets in the clear. Select one position or the other as circumstances require. If the precipitation echoes do not disappear on selecting the usual setting for circular polarization some slight re-adjustment of the polarization control may give an improvement. Similarly, if the interference from other radars is causing trouble, trial and error adjustment of the polarization control may give some improvement.

Chapter 4

MAINTENANCE

LIST OF CONTENTS

Optimising parametric amplifier performance

1. Switch on the klystron power unit after the parametric amplifier has been installed and check the voltages.

2. Set the swept gain law control to OFF on preamp unit, then remove the short section of waveguide connecting the dummy load unit (S2/1) to the waveguide switch before fitting a long section of waveguide between the waveguide switch and the noise source.

3. Connect the signal head amplifier output at splitter pad via the 0-3dB switch on the generator trig. pulse to the 'test amp in' plug on the lock unit 877/2. Set the test amp switch on the lock unit to ON.

4. Connect the monitor meter wander lead E672 between the meter plug on the front panel of the noise source RA 4900 and the jack on the noise source unit mounted within the rack behind the front panel.

5. Set the noise source ON/OFF switch to ON and the START/RUN switch to START. Wait at least 15 seconds, then reset the START/RUN switch to RUN.

6. Observe the milliameter reading on the noise source and adjust the set current control on the noise source unit EA1363/1 to obtain a meter reading of 100 (i.e. 1mA).

7. Set the START/RUN switch to START on remote control unit EA4704 then disconnect the monitoring meter wander lead (E672) from the noise source and connect it between the meter jack on the transmitter lock unit EA 877/2 and the meter plug on the front panel of the control unit EA276/1. On transmitter lock unit EA877/2 set the meter switch to position 8.

8. Set the RF attenuator (KV96199) to maximum attenuation. Adjust the test amp gain control (RV4) to give a reading of about 30 on the monitoring meter of control unit FA 276/1.

9. Set the START/RUN switch to RUN on remote control unit EA4707, then adjust the r.f. attenuator to minimum attenuation necessary to give some small increase on the monitoring meter deflection.

10. Tune the filter cavity, if still fitted, for maximum output. There are two points at which the output will peak; ensure the cavity is tuned for the larger peak by temporarily setting the START/RUN switch to START. The output should decrease appreciably, but if the wrong peak is chosen the decrease will be small.

Overall Noise Figure Check

11. Adjust the test amp gain control on the control unit EA276/a whilst observing the monitoring meter reading. Check the amplifier is not limiting by increasing the gain to obtain a meter reading between 90 and 100, then set the control to give a reading between 60 and 70. Repeat the check adjusting the sig. gain (head amp) control and note the meter reading at the final setting; this is the reference level for the noise figure check.

12. Switch to 30dB position on LOCK UNIT. Set the START/RUN switch to RUN and decrease the RF attenuation until the monitoring meter indicates the reference level observed in para.10. Reset the START/RUN switch to START.

13. Convert the setting of the micrometer scale on the RF attenuator to decibels using the chart supplied with the instrument. Subtract this figure from the rated output of the noise source as indicated on calibration chart or calibration label to obtain the receiver noise figure. This should not exceed 5.7dB.

14. Repeat para.11 to 13 (inclusive) to obtain three values for noise figure. Average these three results to provide a value which is to be recorded in the servicing log book.

15. Set the noise source ON/OFF switch on the remote control unit to OFF. Remove the long section of waveguide. Refit the short section of waveguide between the dummy load and the waveguide switch.

16. Set the test amp switch to OFF on the transmitter lock unit EA877/2. Move lead from splitter pad to TEST AMP IN.

Checking the Operation of the Circular Polarizer

17. Ensure that the power supplies to the aerial rotation motor are OFF and return to the cabin roof to remove the lower cover plate of the circular polarizer which is located on the aerial boom arm.

18. Use a field telephone or land line between the transmitter building and the ATC equipment room to co-ordinate the following checks.

19. Press the polarization control switch (located in the ATC room) to the right and ensure that:-

(a) The meter type 2005 (also in ATC room) deflects to the right in sympathy.

(b) The circular polarizer vanes on the aerial boom arm move towards the centre of the waveguide.

20. Press the polarization control switch to the left and ensure that:-

(a) The meter type 2005 deflects to the left in sympathy.

(b) The circular polarizer vanes move away from the centre of the waveguide.

21. Check the vanes of the circular polarizer are fully out when the meter in the control room indicates zero.

22. Replace the circular polarizer cover plate.

VSWR Check (Transmitter Room)

23. Ensure that the magnetron power supplies are isolated then break the waveguide run between the transmitter cabinet and the waveguide switch by removing a short waveguide section.

24. Use apparatus from a waveguide test rig Type 12242 (or similar) to measure the VSWR of the aerial system. Measurements should be taken at three frequencies, 2940, 2960 and 2980 MHz. At each frequency the aerial should be rotated in 30 degree steps between 0 and 360 degrees (i.e. twelve positions in azimuth bearing). The VSWR in all these positions should not fall below 0.8.

25. If the results of the tests do not fulfil the specification, adjust the circular polarizer vanes to the mid position, then tune the three tuning slugs, normally situated in the waveguide switch under th gearbox in the aerial cabin, for optimum VSWR at the centre frequency of 2960 MHz.

26. Repeat the tests.

27. Remove the VSWR test equipment from the waveguide run, and replace the waveguide section.

Obstruction Light

28. Ensure that the obstruction lamp on the top of the aerial reflector is operational.

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PART 2

SERVICING

SECTION 1

FGRI.26008/1

Chapter 1

SETTING UP PROCEDURE

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Aerial Type S5/1

1. ◀The geometric arrangement of the major aerial components is shown in fig. 1. *It is important to note that* accurate measurement of the given dimensions can *only* be made by using the special alignment jig in accordance with the instructions given in Vol. 6, Part 4, Sect. 4, Chap. 1, para. 36 to 38 of this publication.

2. A rough check on the geometric alignment can be made by means of the sighting tube mounted on the aerial horn. Look through the sighting tube and check that the black cross painted on the reflector is centred on the cross wires in the tube. If any misalignment is revealed it must be reported to the appropriate third line servicing unit.

Note . . .

The aerial performance could be seriously impaired if any adjustment is attempted by unqualified personnel.

Aerial axis tilt angle

3. The main aerial axis is an imaginary line joining the centre of the horn face and the pole of the reflector (F and B in fig. 1). Provision is made in the tilt base (fig. 3) for the whole aerial assembly and hence the main aerial axis, to be tilted through approximately ±2° elevation. The aerial is tilted about the pivot shaft by moving the position of the two nuts on the swivel bolt, and may be clamped in the desired position by tightening the tilt lock nuts.

4. The angle of tilt is indicated on the cursor inside the tilt base and, within the prescribed limits, will be chosen to give optimum aerial performance for each individual site. It is selected with reference to the desired radar cover and the results of the flight calibration tests carried out when the radar unit is set up. The aerial is then set to the required tilt and the angle recorded for future reference. The cursor indication should, therefore, be periodically checked to

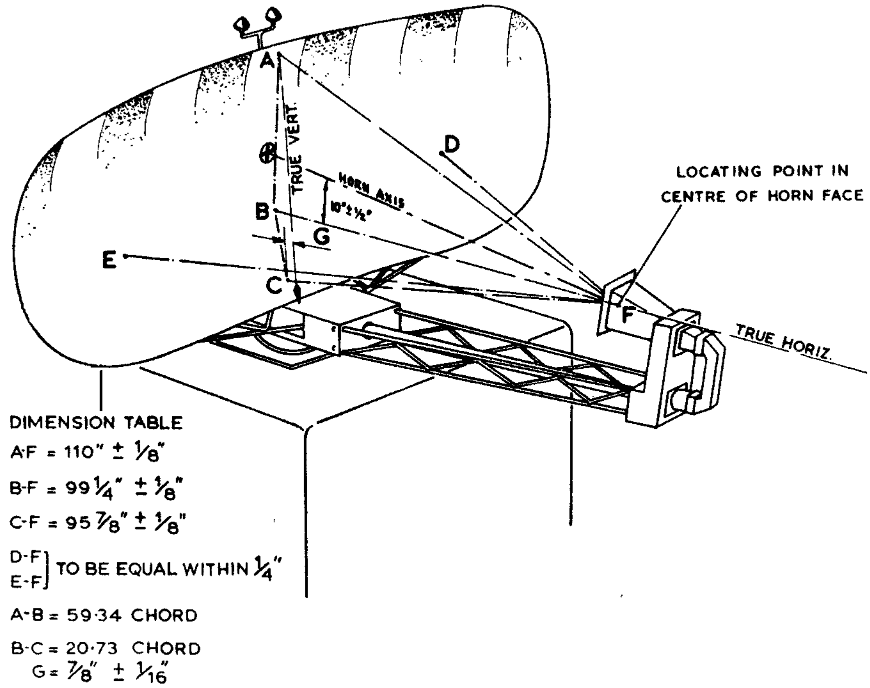

Fig. 1. Aerial geometry

ensure that it complies with the recorded tilt angle. ▶

Radar T/R assembly Type S1/2

Note . . .

The aerial does not require to be rotating during the setting up of the radar T/R assembly Type S1/2 unless it is stated otherwise.

Low voltage power supplies

5. Set the following switches on the power supply control Type S7/1 to the positions stated:—

Circuit breaker to OFF.

LOCAL/REMOTE to LOCAL.

E.H.T. to OFF.

M.T.I. to ON.

VARIAC to OUTPUT.

Open the centre panel of the transmitter-receiver cabinet and rotate the variac handwheel to the extreme counter-clockwise setting.

6. Ensure that the MAINS ON indicator lamp is lit and set the circuit breaker to ON. Contactor No. 1 should operate and the No. 1 fan should start. Adjust the variac for an indication of 230V on the right-hand meter on the power supply control Type S7/1. Allow at least 15 minutes for warming up before proceeding further.

7. Connect the meter socket on the power supply control to the meter jack on the power supply Type S41/1 by means of the lead provided. Set the metering switch on the power unit to position 1 and adjust the appropriate control until an indication of –150V is obtained on an accurately calibrated meter connected to the –150V socket. The left-hand meter indicates approximately 100 divisions (–150V).

8. Check the low voltage power supply at sockets on the front panel of the power supply Type S41/1 by means of an accurately calibrated voltmeter. Set the voltages to +330V and +200V.

Note . . .

While these adjustments are being made the test meter indications should be compared with those on the meter on the power supply control. The PRESS TO READ METER *push button switch should be used for maximum accuracy. In each instance the correct indication is 100 divisions. Any discrepancy between the testmeter indications and those on the built-in meter should be recorded so that the latter may be used for subsequent checks.*

9. Make similar checks to those detailed in para. 8 for the power supply Type S41/2.

System trigger circuits

10. Remove the connection to the SYNCH. IN plug on the trigger pulses generator Type S6/2. Disconnect the knock-off pulse white coaxial lead from PL7 on the signal comparator Type S2/2. Connect the lead from the meter socket on the

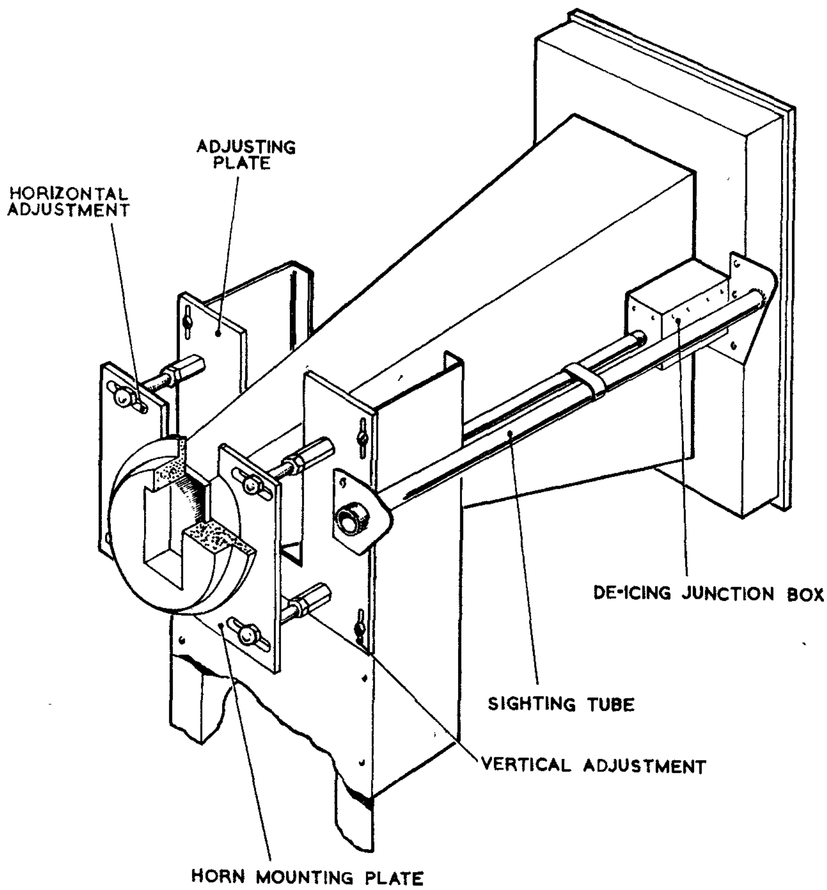

Fig. 2. Angular adjustment of horn

power supply control Type S7/1 to the metering socket on the M.T.I. group Type S1/2. Rotate the meter switch on this unit to position 11 and adjust the CARRIER LEVEL control to obtain a meter indication of 65 divisions. Connect the trigger terminal of the oscilloscope to the SYNCH. pulse connector. Rotate the switch to position 9.

11. Set the A.G.C. MANUAL switch on the M.T.I. group Type S1/2 to MANUAL and check that the indicator lamp is lit. Rotate the meter switch to position 9, and connect the oscilloscope to the CAN. OUT socket on the M.T.I. group Type S1/2, terminated in 80 ohms if the transmitter-receiver is not connected into a system. Disconnect the lead from SK1 (yellow) in the R.F. amplifier Type S5/1 and terminate the lead in a 3·9 kilohm resistor to earth. Adjust the MANUAL GAIN control until the pulse output level is 1·5V. Note the meter indication. Remove the 3·9 kilohm resistor and reconnect SK1.

12. Rotate the meter switch to position 10 and adjust the input attenuator tap on the R.F. amplifier Type S5/1 until the meter indication is as near as possible to that observed at para. 11.

13. Set the A.G.C. MANUAL switch to A.G.C. and rotate the meter switch to positions 9 and 10 alternately, adjusting the A.G.C. LEVEL control until identical meter indications are obtained for both positions of the switch. Transfer the input lead of the oscilloscope to the PREPULSE socket on the trigger pulses generator Type S6/2. Remove the trigger lead from the sync. pulse connector and adjust the oscilloscope controls to display the positive-going pre-pulse at a convenient position on the c.r.t. Adjust the PREPULSE DURATION control on the trigger pulses generator Type S6/2 for a pulse width of 100 microseconds.

14. Adjust the oscilloscope controls to display two pre-pulses and adjust the P.R.F. control on the trigger pulses generator Type S6/2 until the interval between the trailing edges of the two pulses is about 1500 microseconds.

15. Reconnect the sync. pulse lead to the connector from which it was removed and rotate the KNOCK-OFF GATE WIDTH control on the signal comparator Type S2/2 to the extreme counter-clockwise setting. Adjust the COARSE P.R.F. control (RV12) in the signal comparator until the interval

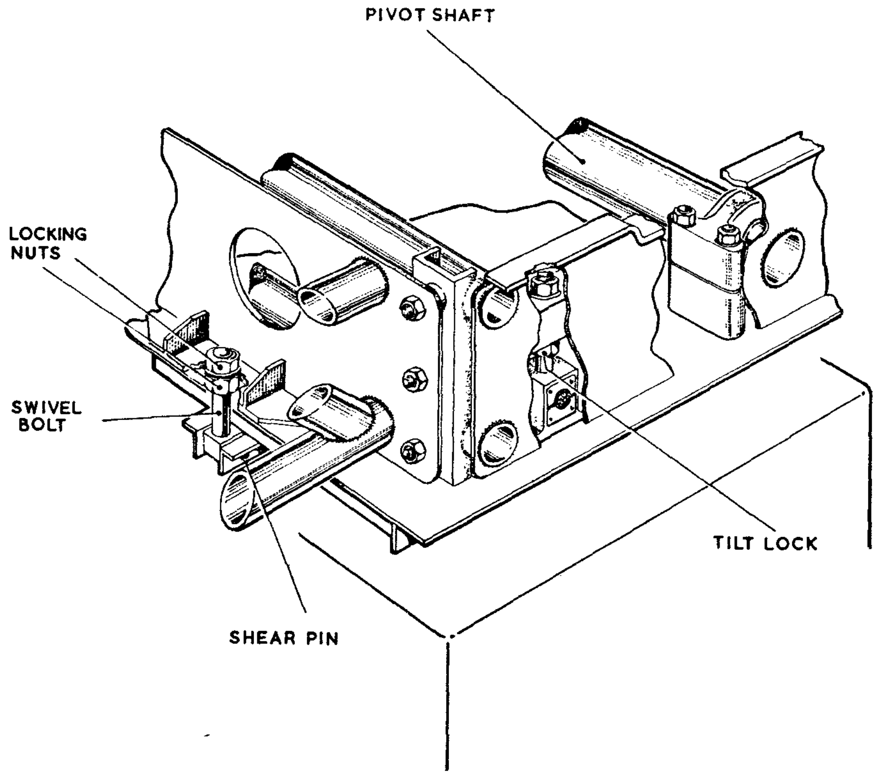

Fig. 3. Aerial tilt adjustment

between the trailing edges of two consecutive pre-pulses is about 1450 microseconds. Remove the sync. lead temporarily and check that the repetition period is now about 1500 microseconds. Reconnect the lead and check that the repetition period suddenly decreases to 1450 microseconds.

16. Reconnect the knock-off pulse lead to PL7 on the signal comparator Type S2/2 and check that the repetition period decreases even further to 1425 microseconds. This indicates that the p.r.f. is now locked to the period of the m.t.i. delay line.

17. Transfer the oscilloscope lead to the KNOCK-OFF GATE socket on the signal comparator Type S2/2. Adjust the KNOCK-OFF GATE WIDTH control until the positive-going pulse is between 30 microseconds and 50 microseconds wide. Check that the knock-off pulse appears as a dip just before the end of the positive pulse.

18. Connect the oscilloscope input to the MONITOR TRIGGER socket on the radar modulator Type S1/1 and check the presence of the transmitter triggering pulses.

Interlocks and e.h.t.

WARNING . . .

> **The following operations, which involve making the safety interlock system temporarily ineffective and working in the vicinity of lethal voltages, should only be performed when there are at least two persons present. All high voltages should be discharged with the earthing stick before work is started and after each operation during which the e.h.t. is applied.**

19. Set the E.H.T. switch on the power supply control Type S7/1 to ON. Ensure that the E.H.T. indicator lamp glows, the No. 2 contactor operates and the magnetron cooling fan is running.

20. Check that partial removal of the centre panel causes the e.h.t. contactor to trip and the magnetron fan to stop. Complete the removal of the centre panel and fix the microswitch to the closed position so that the e.h.t. is restored.

21. Withdraw the power supply Type S21/1 partly and check that this again causes the e.h.t. contactor to trip. Set the E.H.T. switch on the power supply control Type S7/1 to OFF. Withdraw the power supply Type S21/1 about 6 inches to gain access to the microswitch and the high voltage lead at the rear of the unit. Fix the microswitch in the closed position, and disconnect the high voltage lead. Connect the electrostatic voltmeter between the e.h.t. output (PL31) and earth. Remove the short circuit from capacitors C1 and C2 by tying back the shorting bar.

22. Release the swinging arm on the right of the variable power transformer (variac) and set the maximum e.h.t. limit switch (SW2) to extreme clockwise setting.

23. Set the STOP/NORMAL switch on the variable power transformer to STOP and set the SET O'VOLT TRIP control (RV1), on the group board at the left-hand side of the power supply Type S21/1 to the extreme clockwise setting. Set the E.H.T. switch on the power suply control Type S7/1 to ON. Set the STOP/NORMAL switch to NORMAL. Observe the electrostatic voltmeter indication and, as this approaches 8kV, set switch to STOP. Ensure that when the variac motor stops, the e.h.t. voltage is 8kV.

Note . . .
The e.h.t cannot be run up unless the interlock circuit is completed. A part of this circuit is the link between pins 8 and 11 of the Jones plug on the cable which connects SKT24 on the plug panel on the roof of the cabinet to the remote switching control Type S14/1 in the radar set group Type S1/2.

24. Adjust RV1 slowly until the e.h.t contactor trips and the variac motor runs down. Allow 5 minutes for the e.h.t. delay to reset and again run up the e.h.t. by means of the STOP/NORMAL switch. Check that the e.h.t. again trips as 8kV is approached. Repeat the check several times to ensure consistent operation of the over-voltage trip. If necessary, reset RV1 to ensure that 8kV is not exceeded.

25. Set the E.H.T. switch on the power supply control Type S7/1 to OFF. Discharge the capacitor in the power supply Type S21/1. Restore the microswitch and release the shorting bar. Disconnect the electrostatic voltmeter and reconnect the high voltage lead. Fit the power supply Type S21/1 in place again.

26. Leave the centre panel microswitch fixed to the closed position and set the E.H.T. switch to ON. Check that partial removal of the grille over the modulator/magnetron compartment trips the e.h.t. contactor. Restore the e.h.t. and check that partial withdrawal of the radar modulator Type S1/1 also trips the e.h.t. contactor.

Setting up the magnetron

27. Remove the left-hand side panel of the cabinet to gain access to the waveguide components. Connect the mutimeter, set to the low ohms range, between the split metal segments surrounding the magnetron probe on the back of the magnetron box and the spring finger assembly on the waveguide. Insert the special key provided through the hole in the magnetron matching control panel and turn the probe insertion lead screw below the magnetron box in a counter-clockwise direction until the voltmeter indicates an open circuit. Turn the screw clockwise until the metal segments just make contact with the spring fingers, causing the multimeter to read zero ohms. This is the minimum probe insertion position. Disconnect the multimeter.

28. Remove the two crystals from the signal mixer and store them in a position where they will not be damaged by the strong r.f. fields.

29. Transfer the oscilloscope lead to the MAGNETRON OFF socket just below the magnetron. Reset the oscilloscope voltage range to 120V.

30. Set the E.H.T. switch on the power supply control Type S7/1 to ON. Ensure that the E.H.T. indicator lamp glows, the No. 2 contactor operates and the magnetron cooling fan is running.

Note . . .
The amplitude of the display pulse, in volts, can be measured on the oscilloscope using the graticule and the volt scale control. The magnetron current can then be calculated from the value of the monitoring resistor which is engraved on a black plate mounted above the MAGNETRON PULSE *socket. The value of this resistor is approximately 3 ohms.*

31. Run the e.h.t. up by means of the STOP/NORMAL switch until the amplitude of the pulse displayed on the oscilloscope corresponds to a magnetron current of 20A, that is, about 60V. Check that the R.F. ON indicator lamp on the power supply control Type S7/1 is lit, indicating that the relay RLC has operated. This disconnects the magnetron heater supply and connects the overswing safety circuit.

32. Operate the STOP/NORMAL switch and allow the run up to continue until the amplitude of the displayed pulse corresponds to a magnetron current of 35A.

33. Observe the voltage-standing-wave-ratio indicator and note the power output indicated by the mean level of the glow of the neon tubes. Rotate the probe insertion lead screw on the magnetron box in a clockwise direction until the rate of increase of power commences to fall off.

34. Adjust the MAGNETRON MATCHING PLUNGER and the probe insertion alternately to obtain maximum power output. Adjust the phase shifter for the best standing-wave-ratio as indicated by maximum mean level of the glow in the neon tubes of the voltage-standing-wave-ratio indicator,, with minimum difference in their levels.

35. Repeat the adjustments detailed in para. 34 until optimum power output is reached and then recheck the amplitude of the magnetron current pulse. Adjust the e.h.t. if necessary by means of the STOP/NORMAL switch. When optimum power and the best voltage-standing-wave-ratio has been achieved, rotate the plunger adjustment control 18 turns in a clockwise direction.

36. Rotate the swinging arm on the right of the variable power transformer slowly counter-clockwise until the maximum limit e.h.t. microswitch operates. Lock the arm in this position and set the E.H.T. switch to OFF.

37. Allow the variable power transformer to run down to zero and then reset the E.H.T. switch to ON and set the STOP/NORMAL switch to NORMAL. Check that the amplitude of the displayed pulse reaches the equivalent of 35A before the variac motor stops.

38. Connect a test set Type 288 or a similar wavemeter to the socket on the waveguide above the R.F. amplifier Type S13/1. Adjust the tuning of the wavemeter for maximum indication. Then by slowly detuning the wavemeter on either side of the maximum, check that the magnetron spectrum is symmetrical. There should be one well defined main lobe about the maximum point. This lobe should have a width between points giving 50% of the maximum deflection of not more than 2 Mc/s. The peak deflections for the main lobes should not exceed 20% of the main lobe maximum. If the required results are not achived, readjust the matching plunger, phase shifter and probe insertion as already described in para. 34 and 35.

Note . . .
The shape of the current pulse displayed on the oscilloscope should be observed while the above adjustments are being made. For this purpose the coaxial lead to the oscilloscope should be terminated by an 82 ohms resistor which must not, however, be connected, when the amplitude of the current pulse is being measured. Ensure that the final settings give a pulse with a sharp clear top, completely free from blurring. A well balanced spectrum, although desirable for good m.t.i. performance, is less important than freedom from mode jumping. This is indicated by blurring of the pulse.

Preliminary stalo tuning

39. Transfer the monitor meter wander lead to the METER JACK on the R.F. oscillator Type S4/2. Set the meter switch to position 5 and connect the multimeter, set to the 10V d.c. range, between the HEATER RIPPLE socket and earth. Adjust the HEATER SET control to obtain a multimeter reading of 6·3V. The indication on the monitor meter should now indicate 100 divisions. Record the actual indication for spot calibration of the monitor meter.

40. Set the meter switch to position 3. Select a suitable d.c. range on the multimeter and connect it between the h.t. ripple socket and earth. Adjust the H.T. SET control to obtain a multimeter reading of 200V. The monitor meter should now indicate 100 divisions. Record the actual indication for calibration of the monitor meter. Disconnect the multimeter.

41. Lock the oscillator assembly in the transit condition temporarily. Check that this disconnects the h.t. supply and reduces the reading on the monitor meter to zero.

42. Disconnect the output probe from the R.F. oscillator Type S8/1 and insert the T piece. Tune the wavemeter to 30 Mc/s below that obtained at para. 38. Connect the wavemeter via an attenuator to one outlet of the T piece and the mixer to the other. Fit the signal mixer crystals in position. Release the transit lock on the oscillator assembly to restore the h.t. supply.

43. Turn the fine tuning control counter-clockwise to the full extent of its travel. Adjust the coarse tuning control until a deflection is obtained on the wavemaster. Adjust the attenuator for a convenient indication on the wavemeter, if necessary. Adust the cathode tuning plunger and the output probe for maximum output, maintaining the frequency at 30 Mc/s below the magnetron frequency by means of the tuning control.

Note . . .
If the indication of crystal 1 current on the monitoring meter is above 100 divisions with the H.T. SET *control at the maximum counter-clockwise position, the output coupling should be reduced. An indication of 100 divisions (50mA) is the maximum permissible for position 2 of the metering switch (oscillator anode current).*

44. Adjust the fine tuning control until the frequency commences to decrease. Turn the control a further three turns in the same direction. Re-adjust the frequency to 30 Mc/s below the magnetron frequency by means of the coarse tuning control. Lock the tuning controls.

Note . . .
The fine tuning control need not be tightened up at present but care should be taken to ensure the control is not moved, by making the locking device hand tight.

45. Ensure that the fine tuning control alters the frequency approximately 5 Mc/s on either side of the desired frequency. Reset the course tuning control to obtain this range of adjustment, if necessary.

46. Disconnect the wavemeter and mixer from the T piece and disconnect the T piece from the R.F. oscillator Type S8/1. Fit the output probe in position. Adjust the H.T. SET control for a reading of 100 divisions (1mA crystal current) at position 6 of the TR line assembly plug panel switch. Check that the indication in position 7 of the switch is 100±15 divisions. Lock the output probe.

Tuning the coho channel

47. Set the E.H.T. switch on the power supply control Type S7/1 to ON. Connect the oscilloscope to the VIDEO OUT socket on the signal comparator Type S2/2. Short circuit socket SKT3 to chassis on the signal comparator Type S3/1. Remove the signal input lead from plug PL3 and connect the coho input lead to PL1 on the signal comparator Type S3/1. Set the NORMAL/TEST switch to NORMAL.

48. Rotate the COHO GAIN control on the power supply control Type S7/1 to its fully counter-clockwise position. Set the COHO tuning control on the R.F. oscillator Type S8/1 until the black line on the drum coincides with the line engraved on the cover of the unit. A rectangular waveform should be observed at the VIDEO OUT socket. Check that the amplitude of this waveform changes when the COHO GAIN control on the signal comparator Type S2/2 is rotated. Set the control to give an amplitude of 1·0V.

49. Adjust the oscilloscope controls to display the region around the trailing edge of the negative going pulse. For this purpose, the oscilloscope should be triggered from the SEC. RADAR TRIG. socket on the trigger pulses generator Type S6/2, and the S.R. TRIGGER DELAY control used to position the waveform on the c.r.t. trace.

50. Rotate the COHO GATE WIDTH control to the extreme clockwise setting and set the lock bias control at about its mid-position. Rotate the COHO GAIN control on the power supply control Type S7/1 until some noise is visible. Adjust the sensitivity of the oscilloscope to about 0·5V. per centimetre. Adjust the tuning of the COHO cavity until a locking pulse appears. Vary the fine tuning control on the R.F. oscillator unit Type S8/1 very slightly to ensure the stalo is set for optimum frequency as indicated by maximum amplitude of the locking pulse. Tighten the locking device on the fine tuning control of the r.f. oscillator unit Type S8/1.

51. Vary the tuning slugs on the coho cavity and adjust the locking pulse for maximum amplitude, reducing the gain of the coho head amplifier Type S9/1, if necessary, to prevent limiting. Adjust the LOCK BIAS control for a pulse amplitude between 1V and 2V. Tighten the lock nuts on the cavity tuning slugs.

Note . . .

Extreme care is necessary both in adjusting the tuning slug and tightening the lock nuts of the coho cavity. Very small movements of the slugs causes large variations in output and a deterioration of the waveform.

52. Remove the h.t. from the r.f. oscillator unit Type S8/1 by means of the LOCK FOR TRANSIT lever switch, and check that the pulse disappears. Restore the stalo h.t. supply.

53. Adjust the COHO GAIN (head amplifier Type S9/1)and LOCK BIAS controls until the pulse has an amplitude of 1·5V and is just being limited.

54. Set the E.H.T. switch to OFF. Disconnect the coho input lead from PL1 and connect the signal input lead to PL3 on the signal comparator Type S3/1. Set the NORMAL/TEST switch to NORMAL.

Receiver adjustments and measurement of noise figure.

55. Connect the multimeter on the appropriate current range in series with the TR cell (positive side) and its connecting lead (negative side). Adjust RV1 on the R.F. amplifier Type S13/1 until a reading of 125±25μA is obtained. Disconnect the multimeter and reconnect the lead to the T.R. cell.

56. Remove the section of waveguide connecting the electrical dummy load Type S1/1 to the waveguide switch on top of the radar set group Type S1/1. Fit the special section of waveguide supplied between the waveguide switch outlet and the waveguide outlet on the thermal noise generator Type S8/1.

57. Rotate the meter switch on the R.F. amplifier Type S13/1 to position 1 (helix current) and check that the indication does not exceed 0·5A. Turn the meter switch to position 2 and adjust the TWTG 2 control for a meter indication of 15μA. Check the indication for switch position 1 again. It should not exceed 0·5μA.

58. If the conditions specified in para. 57 are not met, the travelling wave tube must be focused. Dosconnect the input and output leads from the travelling wave tube and remove the "keep-alive" lead from the TR cell. Withdraw the R.F. amplifier Type S13/1 on its runner and centralize the travelling wave tube by means of the three adjusting screws at the end of the focusing magnet. Set the meter switch to position 1, and adjust the TWTG2 control for an indication of 5μA. Loosen the locking ring on the travelling wave tube base housing and carefully position the base in the housing to reduce the meter indication to a minimum. Tighten the locking ring carefully, and ensure that the meter indication is maintained at a minimum. Rotate the meter switch to position 2, and adjust the TWTG2 control to obtain a meter indication of 15μA. Reset the meter switch to position 1 and adjust the three adjusting screws for minimum indication. Repeat the adjustments until the correct indications are obtained for positions 1 and 2 of the switch.

59. Fit the R.F. amplifier Type S13/1 into its normal position and connect the input and output leads. Reconnect the "keep alive" lead to the TR cell.

60. Connect the socket SKT1 of the signal head amplifier Type S9/1 to PL1 on the signal splitter and connect the noise figure attenuator (4 db sockets) between the 0 dB output socket of the signal splitter and the TEST AMP socket on the trigger pulses generator Type S6/2. Set the TEST AMP switch on the trigger pulses generator Type S6/2 to ON.

61. Set the START/RUN switch on the remote switching control Type S14/1 to START and set the NOISE SOURCE ON/OFF switch on the same unit to ON, and wait at least 15 seconds before proceeding.

Note . . .

When it is found necessary to switch off the thermal noise generator Type S8/1 the START/RUN *switch should be set to* START. *Once the* NOISE SOURCE ON/OFF *switch has been set to the* ON *position it should remain in this position until all noise figures have been taken.*

62. Connect the monitor meter lead between the jack on the thermal noise generator and the meter plug on the front panel. Set the START/RUN switch to RUN and adjust the SET CURRENT control for a meter indication of 100 divisions (1mA) on the right-hand meter on the thermal noise generator. Reset the START/RUN switch to START. Disconnect the monitor meter lead from the meter plug on the thermal noise generator.

63. Transfer the meter lead to the jack on the trigger pulses generator Type S6/2, rotate the meter switch on this unit to position 8 and measure the I.F. amplifier Type S10/1 diode current. Set the SWEPT GAIN LAW control on the R.F. amplifier Type S13/1 to OFF.

64. Connect the oscilloscope to the TEST AMP. OUT socket on the trigger pulses generator Type S6/2. Set the attenuator on the thermal noise generator for maximum attenuation. Adjust the TEST AMP. GAIN and SIGNAL GAIN controls for a meter indication of about 30 divisions. Check that an indication of 60 divisions can be attained. This signifies that no limiting is taking place.

65. Set the START/RUN switch to RUN and adjust the attenuator on the thermal noise generator for minimum attenuation. Tune the TR cell and adjust the TR cell stub alternatively, for maximum output, and adjust the attenuator on the thermal noise generator, as required, to maintain a convenient meter indication. Lock the tuning screws, taking care that the settings for maximum output are not disturbed.

66. Tune the filter cavity for maximum output.

Note . . .

Two unequal peaks will be observed. The filter should be tuned to the greater of these. The correctness of tuning may be checked by switching the START/RUN *switch to* START. *The output should decrease considerably, but if the wrong peak has been chosen the decrease will be small.*

67. Adjust the TWT HELIX control on the R.F. amplifier Type S13/1 for maximum output.

68. Set the START/RUN switch to START and the attenuator on the thermal noise generator for maximum attenuation. Adjust the TWTG3 and TWTG4 controls alternately for minimum output.

69. Observe the meter indication of the I.F. amplifier Type S10/1 output and the noise displayed on the oscilloscope. Adjust the TEST AMP. GAIN control for a meter indication between 30 and 40 divisions. Check that no limiting is taking place by ensuring that the output can be increased to give a meter deflection between 60 and 70 divisions. Reset the control and repeat this check, using the SIGNAL GAIN control. Reset the gain controls for an indication between 30 and 40 divisions and note the precise indication for reference.

70. Adjust the setting of the noise figure attenuator by moving the leads to the 7dB plug. Set the START/RUN switch to RUN, and decrease the attenuation at the thermal noise generator until the reference output is again obtained. Convert the setting of the micrometer scale of the thermal noise generator attenuator to decibels, using the chart supplied with the equipment. Subtract this attenuation from the rated noise source output (15·8dB) to obtain the receiver noise figure. This should not exceed 8·5dB.

71. Set the NOISE SOURCE ON/OFF switch to OFF Remove the section of waveguide which connects the thermal noise generator to the waveguide switch. Reconnect the electrical dummy load to the waveguide switch by the appropriate waveguide section. Set the TEST AMP. switch to OFF and remove the coaxial leads from the amplifier sockets and from the noise figure attenuator.

Adjustment of the phase comparison circuits

72. Set the E.H.T. switch at the power supply control Type S7/1 to ON. Remove the signal input lead from plug PL3 and connect the coho input lead to PL1 on the signal comparator Type S3/1.

73. Rotate the LIMIT AMP. GAIN control on the signal comparator Type S2/2 counter-clockwise to the full extent of its travel. Adjust the oscilloscope controls, and, if necessary, the COHO GATE WIDTH control, to display the step in the trace. Check that its amplitude is still 1·0V. Remove the short circuit from SKT3 on the signal comparator Type S3/1 and adjust the COHO BALANCE control on the signal comparator Type S2/2 until the step disappears. Adjust the COHO GAIN control, with SKT3 short circuited, and the COHO BALANCE control, with the short circuit removed, until the required conditions are both met. Lock both controls.

74. Fit the short circuit to socket SKT3. Adjust the COHO GATE WIDTH control until the locking pulse appears a little to the left of the step in the trace. Adjust the LOCK BIAS control and, if necessary, the COHO GAIN control on the head amplifier Type S9/1 until the amplitude of the pulse is 0·5V greater than that of the step.

75. Connect the test delay line between the TEST PULSE OUT socket on the I.F. amplifier Type S6/1 and plug PL2 (orange) on the I.F. amplifier Type S7/1. Use the special connector supplied for this purpose. Set the NORMAL/TEST switch to TEST.

Note . . .

The test delay line delivers to the I.F. amplifier Type S7/1 a pulse which simulates a permanent echo from a range of 5 miles. Reflections in the line cause further pulses to appear at 15 miles range, etc. All tests in the following paragraphs should therefore be performed using the first test pulse, except when otherwise stated.

76. Connect the signal input lead to the signal comparator Type S3/1 and rotate the LIMIT AMP. GAIN control clockwise to the full extent of its travel. At the same time ensure that the amplifier is not overloaded. Evidence of overloading is provided by a reduction in the rate of increase of output followed by a decrease of output as the control is advanced.

77. Remove the coho input lead from PL1 on the signal comparator Type S3/1 and repeat the operations given in para. 78 and 79 until the specified conditions are achieved without further adjustment being necessary.

78. Short circuit the socket SKT1 on the signal comparator Type S3/1 to earth. Adjust the SIGNAL GAIN control on the signal comparator Type S2/2 until the amplitude of the signal pulse being observed is equal to that of the step obtained at para. 73. Make sure that the I.F. amplifier Type S7/1 is just limiting the pulse. Check that there is enough reserve gain in the I.F. amplifier Type S7/1 to limit at least the second test pulse.

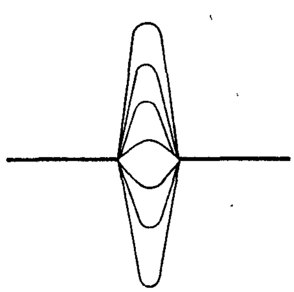

Fig. 4. Output of phase sensitive detector

79. Remove the short circuit from socket SKT3, and adjust the SIGNAL BALANCE control until the amplitude of the displayed pulse is a minimum.

80. Lock both controls, remove the short circuit from socket SKT1 and fit the coho input lead to PL1.

81. Remove the locking pulse input from PL1 on the R.F. oscillator Type S5/1, and rotate the COHO GATE WIDTH control counter-clockwise to the full extent of its travel. This ensures that the coho is unlocked. Make sure that the test pulse is being limited and check that the characteristics of the pulse are similar to those shown at fig. 4.

82. Adjust the COHO TUNE control very carefully until the lacing shown in fig. 4 is predominantly horizontal.

83. Fit the locking pulse input lead and adjust the COHO GATE WIDTH control until the pulse loses its characteristic lacing and its shape is as simple as possible.

84. Check that slight adjustment of the COHO TUNE control causes both edges of the pulse to change sign together. This indicates that the coho is correctly tuned.

85. Check that the best setting of the COHO TUNE control as determined in para. 84 is between the limits marked on the dial seen through the window $\pm 0{\cdot}5$ Mc/s. If it is outside these limits, a fine adjustment of the stalo frequency should be made.

86. Set the E.H.T. switch on the power supply control Type S7/1 to OFF. Remove the test delay line from the TEST PULSE OUT socket and PL2 on the I.F. amplifier Type S7/1, and set the NORMAL/TEST switch to NORMAL.

87. Repeat the operations detailed in para. 5 to 86 for the other radar T/R assembly Type S1/2.

P.R.F. selection and transmitter changeover time

88. Switch No. 1 radar T/R assembly Type S1/2 to the aerial and then run up both transmitters on full power, and switch on both m.t.i. systems. Monitor the prepulse on No. 1 transmitter-receiver and measure the pulse repetition time, that is, the delay time of the delay line.

89. Set the P.R.F. switch to CHECK; the CHECK lamp should then be lit, the pulse repetition time increased to 1500 microseconds and No. 2 transmitter-receiver run down to the standby condition. These conditions should continue for approximately 15 seconds when the indicator lamp will go out. The pulse repetition time will decrease to that measured at para. 88 and transmitter No. 2 will run up to full power.

90. Monitor the pre-pulse on No. 2 transmitter. This should be the same as that measured at para. 88. Remove the pre-pulse IN socket (SKT9 green/white) on the trigger pulses generator Type S6/2. The pulse repetition time should now increase to 1500 microseconds. Reconnect socket SKT9.

91. Set the AE switch to TX2; both transmitters should now return to the standby condition for approximately 5 seconds. The e.h.t. contactors in both transmitters will then become energized again and they will both return to the full power condition.

Note . . .

The variacs in both transmitters will run down while the contactors are not energized but will return to their normal levels approximately 10 seconds after the transmitter selection switch is operated.

92. Repeat the pulse repetition time measurement for the transmitter No. 2 as detailed at para. 88.

93. Set the P.R.F. selector switch to CHECK. The pulse repetition time measured at para. 92 should now increase to 1500 microseconds and transmitter No. 1 go to the standby condition. These conditions will continue to exist for approximately 15 seconds when the pulse repetition time will decrease to that measured at para. 92 and transmitter No. 1 will run up to full power.

94. Monitor the prepulse on the No. 1 transmitter; this should be as measured at para. 92. Remove SKT9 from the trigger pulses generator Type S6/2 and check that the pulse repetition time increases to 1500 microseconds. Connect SKT9 again.

95. Trigger the oscilloscope from the secondary radar trigger socket on the trigger pulses generator Type S6/2 of the No. 2 transmitter, and observe the magnetron current pulse of the No. 2 transmitter on one beam of the oscilloscope. Observe the magnetron pulse of the No. 1 transmitter on the second beam of the oscilloscope. Adjust the PREPULSE DURATION control on the trigger pulses generator of the No. 1 transmitter until the two magnetron current pulses are coincident.

Pulse generator power supply Type S18/2

Power supply Type S26/1

96. Withdraw the power supply Type S26/1 and set the microswitch to the SERVICE position. Set the EMERGENCY switch on the pulse generator power supply Type S18/2 to ON. Switch on the voltage stabilizer Type S1/1 and check that the four indicator lamps of power supplies Type S26/1 and Type S27/2 are lit. Allow a delay of at least 70 seconds for thermal switch operation before proceeding.

97. The power supply Type S26/1 must be loaded correctly for this part of the procedure. The following controls on the azimuth range indicator Type S5/1 should be set as shown to obtain this condition:—

(1) Turn the BRIGHTNESS control to its extreme counter-clockwise setting.

(2) Set the DISPLAY ON/OFF switch on each display to ON and allow at least 70 seconds to elapse.

(3) Set the RANGE switch to 100M and the X SHIFT and Y SHIFT controls to the centre of their travel.

(4) Set the CENTRE/OFFSET switch to OFFSET and adjust the BRIGHTNESS control as necessary. Offset the origin of the trace to the bottom left-hand corner (225°) on the c.r.t. by means of the X SHIFT and Y SHIFT controls.

Note . . .

This instruction applies to all displays controlled by the power unit which is being set up.

(5) Set the BRIGHTNESS control to its extreme counter-clockwise setting. Set the TEST/NORMAL switch located on the right-hand panel of the pulse generator Type S14/1 to the TEST position.

98. Set the METER switch located on the front panel of the unit to position 1. The meter should indicate 500V ± 10V. If this indication is not obtained connect lead No. 166 to one of the following positions:—

TSG 13	TSG 10
TSH 10	TSG 12

When the required indication is obtained, re-solder lead No. 166.

99. Set the METER switch to position 2 and check that the meter indicates 330V. If it does not, unlock and adjust RV3. Lock RV3, ensuring that the indication is maintained at 330V.

100. Set up the currents indicated at METER switch positions 9 to 11 inclusive to be identical to that indicated at position 8 in the following manner. As the current for switch position 8 may be affected by the adjustments at the other positions, reference should be made to position 8 at each step.

(1) Note meter indication at METER switch position 8.

(2) Set METER switch to position 9, unlock and adjust RV2 until the meter indication is identical with that obtained at position 8. Alternate switch between positions 8 and 9, and adjust RV2 until the indications are identical.

(3) Set METER switch to position 10, unlock

and adjust RV4, until the meter indication is identical to that obtained in positions 8 and 9. Alternate switch between positions 8, 9 and 10 and adjust the appropriate potentiometer, to ensure indications are identical at each position.

(4) Set METER switch to position 11, unlock and adjust RV1, until the indication is identical to that previously obtained at the other switch positions. Alternate METER switch between the positions 8 to 11 inclusive and adjust the appropriate potentiometer, to ensure that indications are identical at each position.

(5) Lock potentiometers RV2, RV4 and RV1. Set METER switch to positions 8 to 11 in turn, and check that at each position the current indications are identical.

101. Switch off the azimuth range indicators Type S5/1. Slide the power supply Type S26/1 into position in the pulse generator power supply Type S18/2.

Power supply Type S27/2

102. Fit the service tray and withdraw the power supply Type S27/2. Load the power supply Type S27/2 as described in paras. 96 and 97, for the power supply Type S26/1. The origin of the trace should be offset to the top right-hand, or 045°, position.

103. Set the METER switch to position 1. The meter should then indicate 500V. If indication is incorrect, unlock and adjust RV5 to obtain this indication. Relock RV5.

104. Set the METER switch to position 3. The meter should then indicate 330V. If indication is incorrect, unlock and adjust RV4 to obtain this indication. Relock RV4.

105. Set up the currents indicated at meter switch positions 9 to 11, to be identical to that indicated at position 8 as follows. As the current for switch position 8 may be affected by the adjustments at the other positions, reference should be made to position 8 at each step.

(1) Note meter indication at METER switch position 8.

(2) Set METER switch to position 9, unlock and adjust RV1 until the meter indication is identical with that obtained at position 8. Alternate switch between positions 8 and 9, and adjust RV1 to ensure indications are identical at each position.

(3) Set METER switch to position 10, unlock and adjust RV2 until the meter indication is identical to that obtained in positions 8 and 9. Alternate switch between positions 8, 9 and 10, and adjust the appropriate potentiometer, as necessary, to ensure indications are identical at each position.

(4) Set METER switch to position 11, unlock and adjust RV3, as necessary, until the indication is identical to that obtained at switch positions 8, 9 and 10. Alternate METER switch between the positions 8 to 11 inclusive, and adjust the appropriate potentiometer, as necessary, to ensure that indications are identical at each position.

(5) Lock potentiometers RV1, RV2 and RV3. Set METER switch to positions 8 to 11 in turn, and check that at each position the current indications remain identical.

106. *Sin/cos potentiometer supply.* The setting-up procedure should have been completed up to this point before proceeding with a check of the 51V supplies for the sin/cosine potentiometer as follows:—

(1) Connect the mulitmeter set to the 100v D.C. range between TP1 (+ve) and the frame. The meter should indicate 51V. If the indication is incorrect unlock RV1 on the mounting bracket assembly, and adjust, as necessary, to obtain this indication. Relock RV1. Connect the mulitmeter between TP2 (−ve) and the frame. The meter should indicate 51V. If the indication is incorrect unlock RV2 on the bracket mounting assembly and adjust it to obtain this indication, then relock RV2.

107. Switch off all azimuth range indicators, Type S5/1 and slide power supply Type S27/2 into position in the pulse generator power supply Type S18/2. Remove the service tray.

108. Make a routine check of the power supplies Type S26/1 and Type S27/2 voltages and record for future reference.

Pulse generator Type S14/1

109. Fit service tray into position, withdraw the pulse generator Type S14/1 onto the service tray and turn so that the left-hand side is uppermost. Set interlock switch to the service position and allow at least 70 seconds to elapse.

110. *Trigger.* Set the controls and switches as follows:—

(1) Set the TRIGGER SELECTOR switch SA to NORMAL.

(2) Unlock and set the TRIGGER SENSITIVITY

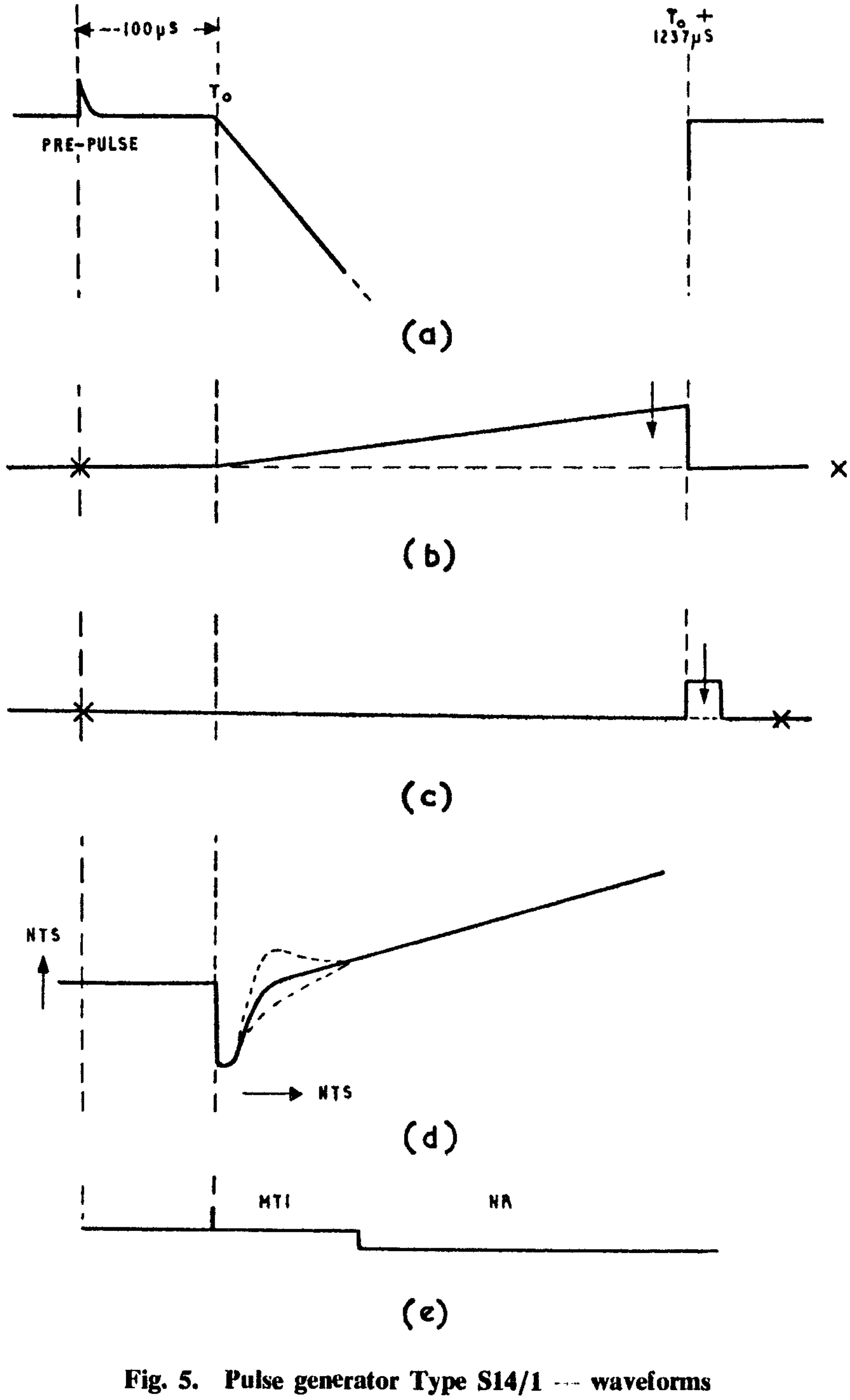

Fig. 5. Pulse generator Type S14/1 — waveforms

control (RV34) located at rear of unit to extreme counter-clockwise setting.

(3) Set the MONITOR WAVEFORM switch SC to position 0.

(4) Adjust the C.R.T. BRIGHTNESS control (RV33) until a spot appears on the MONITOR c.r.t.

(5) Rotate the TRIGGER SENSITIVITY control until a trace appears on the MONITOR c.r.t. Rotate the control a few degrees further in the same direction. Lock RV34.

111. *Prepulse delay.* Proceed as follows:—

(1) Set TEST/NORMAL switch to NORMAL.

(2) Connect the TRIGGER INPUT socket of the oscilloscope to the SCOPE TRIGGER socket. Connect an oscilloscope input lead to each of the MONITOR WAVEFORM sockets. Set the oscilloscope control to ALTERNATE mode. Con-

nect EARTH on oscilloscope to unit chassis. Switch on oscilloscope.

(3) Set the left-hand MONITOR WAVEFORM switch to position 7 to display the n.r. output and the right-hand MONITOR WAVEFORM switch to position 5.

(4) Stop the aerial and secure it at the 0^{o} position.

(5) Adjust the oscilloscope timebase controls until the transmitter pulse is shown in detail. Set the gain of the oscilloscope amplifier so that the start of the sawtooth waveform can be clearly observed.

(6) The start of both transmitter and sawtooth pulses must be coincident. If this is not so, unlock and adjust the TRIG. DELAY control RV35 to obtain this condition, then relock the control.

112. Test p.r.f. adjustment. Proceed as follows:

(1) Connect the trigger input of the oscilloscope to the SCOPE TRIGGER socket. Connect an input of the oscilloscope to the left-hand MONITOR WAVEFORM socket.

(2) Set the left-hand MONITOR WAVEFORM switch SC to position 1, and adjust oscilloscope controls so that at least three of the monitored pulses are displayed. Note the time interval between successive pulses.

(3) Set the TRIGGER SELECTOR switch SA to TEST. Unlock and adjust the TEST PRF control RV32 until the time interval between displayed pulses is the same as previously noted, then relock the control.

113. Range ring oscillator. The procedure given in para.112 must be completed before proceeding as follows:

(1) Set the left-hand MONITOR WAVEFORM switch SC to position 11. A single loop Lissajous figure should then appear on the MONITOR c.r.t. If this is not so, unlock and adjust the tuning slug for T1 to obtain this result. Lock the tuning slug. The figure on the MONITOR c.r.t. should remain unaltered.

(2) Turn the c.r.t. BRIGHTNESS control to extreme counter-clockwise setting and set the TRIGGER SELECTOR switch SA to NORMAL.

114. Range marker delay

(1) Set the left-hand MONITOR WAVEFORM switch to position 9 and adjust the oscilloscope gain controls so that range markers at a convenient amplitude are displayed.

(2) Connect the other input lead from the oscilloscope to tag B7 on the left-hand MONITOR WAVEFORM switch and adjust oscilloscope controls so that both inputs are displayed. The second trace is the normal radar signal.

(3) Adjust the oscilloscope controls to display the leading edge of the transmitter pulse. Check that the first 1 mile range marker occurs at 12.37 microseconds after the leading edge of the transmitter pulse, ignoring any range marker which occurs within 3 microseconds of this pulse. If this is not so, unlock and adjust the CAL. DELAY control RV31 to obtain this condition, then relock the control.

(4) Disconnect the oscilloscope lead from tag B7.

115. The 5 mile count. Adjust the oscilloscope controls so that it will display about 20 one mile markers of a convenient amplitude. Check that each successive 5th marker is of greater amplitude than the others. If the first 4th mile marker or successive 4th or 6th mile markers are of greater amplitude, unlock and adjust the 5ML CAL. COUNT control RV25 until only the 5 mile markers are of greater amplitude. It will be found that this control will produce the desired result over a wide angle of rotation and, when this angle has been determined, the control should be set to the midposition of this range and locked.

116. Range Marks Amplitude. The range markers are set to specific relative amplitudes so that the rings appear on the display in the correct order when the RANGE MARKS control is rotated in a clockwise direction. The necessary adjustments required for this are as follows:

(1) With the oscilloscope connected as required in the proceeding checks, note the amplitude of the 1 mile markers. This should be ◀ between 0.15V and 0.5V. ▶

(2) Check the amplitude of the 5 mile markers. This should be 1.3 times the amplitude of the 1 mile markers. If this is not so, unlock and adjust the 5 MILE CAL. AMP. control RV36 at rear, to obtain this condition and then relock the control.

(3) Check the amplitude of the 10 mile markers. This should be 1.6 times the amplitude of the 1 mile markers. If this is not so, unlock and adjust the 10 MILE CAL. AMP. control RV37 to obtain this condition and then relock the control.

(4) Check the amplitude of the 20 mile markers. This should be 2 times the amplitude of the 1 mile markers. If this is not so, unlock and adjust the 20 MILE CAL. AMP. control RV38 to obtain this condition and then relock the control.

117. Timebase Duration. For convenience the unit may now be laid flat on the service tray before proceeding as follows:

(1) Adjust the oscilloscope controls to display one complete group of range markers plus the first one or two of the next group.

(2) Unlock the TIMEBASE DURATION control RV1 and adjust it until there are five 20 mile markers in each group.

(3) Advance the control still further until the next 1 mile marker just appears and then relock the control.

118. Normal Radar Gain. Proceed as follows:

(1) With the oscilloscope still connected as in the preceeding check, set the left-hand MONITOR WAVEFORM switch to position 7. Adjust the oscilloscope controls so that permanent echoes are displayed.

(2) Unlock and adjust the N.R. GAIN control RV26 for a signal amplitude not greater than 2V. Relock the control.

119. M.t.i. control. Proceed as follows:

(1) With the oscilloscope still connected as in the preceeding check, set the left-hand MONITOR WAVEFORM switch to position 4. Set the timebase duration of the oscilloscope to 1 ms. approx.

(2) Check that change-over from m.t.i. to normal radar does not produce a step in the base line of the displayed waveform. If a step is produced, unlock and adjust the MIXED VIDEO BALANCE control RV29 to remove the step, then relock the control.

(3) Check that the mean amplitude of the noise during the m.t.i. period equals that of the noise during the normal radar period. If this is not so, unlock and adjust the MTI GAIN control RV27 until this condition is achieved. Relock the control. Remove all test connections.

NOTE...
The MTI RANGE control can be set as required to suit the local terrain conditions and the operator's requirements. The control should be adjusted initially so that all the permanent echoes are removed.

120. Integrators. All controls referred to in para.120 to 123 are on the right-hand side of the pulse generator or Type S14/1 chassis. Set the TEST/NORMAL switch SC to TEST.

121. Proceed to adjust the Y integrator as follows:

(1) Set the MONITOR WAVEFORM switch to position 5.

(2) Connect the appropriate position on the oscilloscope to the SCOPE TRIGGER socket and set the oscilloscope control for

(a) D.C. IN

(b) MODE A

(c) Oscilloscope duration for one repetition period of the system

(d) Maximum sensitivity.

(3) Short circuit the input terminals to the oscilloscope and adjust the vertical position of the trace to a convenient reference level.

122. Remove the short circuit on the oscilloscope input and connect this to the MONITOR WAVEFORM socket. The trace should remain a straight line, ignoring spikes, sitting at the reference level. If this is not so, proceed as follows:

(1) Remove any sawtooth voltage by unlocking the Y CHANNEL SLOPE control RV6 and adjusting for zero slope. Lock the control.

(2) Remove any shift of the baseline, that is, the interval between sawtooth periods, by unlocking the Y ZERO LEVEL control RV10 and adjusting it until the baseline is again at the reference level, then relock the control.

(3) Remove any residual sawtooth voltage ripple by unlocking the Y RIPPLE control RV8 and adjusting it for minimum ripple, then relock the control.

NOTE...

Due to the sensitivity of the above controls always recheck after locking.

(4) Remove any step in the waveform by adjusting the Y BALANCE capacitor C21.

(5) Adjust the Y SPIKE capacitor C8 for minimum spike amplitude, together with maximum sharpness of curve at start of scan time. See Fig.5.

123. Set up the oscilloscope as stipulated in the Y integrator para.121 (2). Set the MONITOR WAVEFORM switch to position 7. Remove the short circuit on the oscilloscope input to the MONITOR WAVEFORM socket. The trace should remain a

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straight line, ignoring spikes, sitting at the reference level. If this is not so, proceed as follows:—

(1) Remove any sawtooth voltages by unlocking the X CHANNEL SLOPE control RV16 and adjusting for zero slope. Relock the control.

(2) Remove any shift of the baseline, that is, the interval between each sawtooth, by unlocking the X ZERO LEVEL control RV20 and adjusting it until the baseline is again at the reference level, then relock the control.

(3) Remove any residual sawtooth voltage ripple by unlocking the X RIPPLE control RV18 and adjusting it for minimum ripple, then relock the control.

Note . . .

Due to the sensitivity of the above controls always recheck after locking.

(4) Remove any step in the waveform by adjusting the X BALANCE capacitor C31.

(5) Adjust the X SPIKE capacitor C11 for minimum spike amplitude together with maximum rate of change of curve at start of scan time. See fig. 5 (d).

124. After completion of the setting-up procedure proceed as follows:—

(1) Remove connections to the oscilloscope.

(2) Return TEST/NORMAL switch to NORMAL.

(3) Slide the pulse generator, Type S14/1 back into its position in the pulse generator power supply, Type S18/2 and remove the service tray.

Rack assembly

Note . . .

The setting up procedure for the rack assembly is the same as for the pulse generator power supply Type S18/2 except for the synchros signal amplifier Type S23/1 and this is dealt with as follows.

Amplifier Type S23/1

125. The synchros signal amplifier Type S23/1 is set up to provide a stationary trace at 0° and 270° before it is despatched by the manufacturer. The high speed and low speed magslips in the synchros assembly Type S1/1 in the aerial turning gear cabin Type S5/1 must therefore be aligned correctly with respect to the synchros signal amplifier Type S23/1. The magslips in the synchros signal amplifier Type S23/1 must not under any circumstances be repositioned to secure alignment. Two persons are required, one at the aerial turning gear cabin and the other at the radio equipment room, to carry out these operations.

Note . . .

The scanner must not be rotating while these operations are being performed.

126. Withdraw the synchros signal amplifier Type S23/1 on to its service tray. Remove valve V3. This ensures that when the equipment is switched on, the unit will only operate on the low speed system. Set the RUN/FOL selector switch to FOL. Rotate the TACHO FEEDBACK control RV4 in a clockwise direction to the full extent of its travel.

127. Set the MAINS ON/OFF switch on the voltage stabilizer Type S3/1 in the rack assembly to ON. Set the VOLTS IN/OUT switch to IN, and observe the voltmeter, on the left-hand side of the front panel. Rotate the SET VOLTS control for 230V. Set the VOLTS IN/OUT switch to OUT.

128. Set the MAINS ON/OFF switch on the power supply Type S43/1 to ON. Allow a period of 1 minute for the valves contained in the unit to warm up. The mains indicator lamps should light. Set the ON/OFF switches, switching the d.c. voltages, to ON. All the indicator lamps should then light. Set the INTERNAL/EXTERNAL switch on the meter to INTERNAL. Rotate the meter switch to position 1, 2, 3 and 4 in turn. The indicated voltages should be 470V, 330V, 200V and —330V respectively.

129. If the aerial follower system is found to be stable, set the selector switch RUN/FOL. to RUN and back again to FOL. This will ensure a state of instability. Rotate the TACHO FEEDBACK control in a clockwise direction until stability is achieved.

Note . . .

Stability can be ascertained by rotating the spindle of the low speed magslip MSR1 manually for one third of a revolution. When released the spindle should not oscillate more than twice.

130. *Balancing the stators of the HS and LS Magslips.* Set the MAINS ON/OFF switch to OFF. Remove the cover of the impedence matching network Type S3/1 at the remote site. Break the connection between SKA–20 and TS1–A1 and measure the resistance between these two points by means of a resistance bridge. Adjust this resistance to be as near as possible to 345 ohms by means of switch A and B on the impedance matching network Type S3/1. Note the exact value of this resistance and then make the connections again at SKA–20 and TS1–A1.

131. Set the HS BALANCE control to its mid-position and then break the connection between SKA-17 and TS1–A2. Measure the resistance between these two points and adjust by means of the HS BALANCE control until the reading is the same as that obtained at para. 130. Reconnect SKA–17 and TS1–A2.

132. Break the connection between SKA-8 and TS1–A13 and measure the resistance between these two points. Note the exact value and then reconnect.

133. Set the LS BALANCE control to its mid-position. Break the connection between SKA–11 and TS1–A12 and adjust the LS BALANCE control until the resistance between these two points is the same as that obtained at para. 132. Fit the cover to the impedance matching network Type S3/1.

134. Set the scanner to point true North and secure it in this position. This can be done most accurately by sighting along the back of the reflector and setting in the east-west direction. Clamp the flywheel on the side of the scanner gearbox — a convenient method is to place a wedge between the bottom of the wheel and the floor of the cabin.

135. Unclamp the magslip drive shaft from the scanner gearbox and rotate the magslip box until both alignment slots are adjacent to their respective bushes. Pin the magslip.

136. Set the MAINS ON/OFF switch on the voltage stabilizer Type S3/1 to ON. Remove valve V4 from the synchros signal amplifier Type S23/1 and the +470V fuse from the power supply Type S43/1. Set the RUN/FOL. switch to FOL.

137. Rotate the LS control until maximum error signal is obtained for position 2 of the monitor switch. This should be 6·5V ±0·3V. If this is not so, adjust the taps on transformer T3 in the power supply Type S43/1.

138. Connect one input terminal of the oscilloscope to terminal C of filter box in the synchros signal amplifier Type S23/1 and the other to transformer TR1 pin 16. Rotate the geartrain in the synchros signal amplifier until both traces are approximately the same amplitude and in the same sense. Adjust the ERROR SIGNAL PHASE control until the two signals are exactly in phase.

139. Rotate the LS and HS controls to 0° in the synchros signal amplifier. Connect the oscilloscope to the monitor sockets and switch to position 2. If the LS error is not minimum, which can be checked by a small movement of the LS control, adjust the body of the LS magslip, MS2 in the synchros assembly Type S1/1 until a minimum is reached. Lock the LS magslip.

140. Set the monitor switch to position 1. If the HS error is not a minimum as checked by a small movement of the HS control, adjust the body of the HS magslip MS1 until a minimum is reached. Lock the HS magslip.

141. Fit the +70V fuse in the power supply Type S43/1 and set the RUN/FOLLOW switch to 0°. Both the LS and HS controls should rotate to the 0° position. Check for the 270 deg. position. Set the switch to RUN and adjust the speed to 12 rev/min with the FREE RUN SPEED control. Lock the FREE RUN SPEED control.

142. Set the DELAY VEL. FEEDBACK control to the full extent of its travel in a clockwise direction. Connect the oscilloscope to the MIXED FEEDBACK socket. Adjust the DELAYED VEL. FEEDBACK control and the TACHO PHASE control until the 50 c/s component of the waveform displayed on the oscilloscope has been removed. The correct setting of these controls results in the waveform being less than 70mV peak-to-peak. Lock the TACHO PHASE control.

143. *Check of positional error.* Connect the osscilloscope to the monitor socket M1 and set switch SA to position 0°. Check that the displayed waveform is modulated when the rotor of MSR1 is rotated through 360°. Two positions of maximum and two of minimum should be displayed as the rotor turns through the 360°. The minimum amplitude should be displayed at 0° and 5°, and the maximum points at 2·5° and 7·5°.

144. Set switch SA to position 270°. The same results as those outlined in para 143 should again be observed. Disconnect the oscilloscope.

145. Connect the oscilloscope to the monitor socket M2. Set switch SA to 0°. Rotate the rotor of MSR2 and observe where the position of minimum amplitude occurs. Observe the position of dial on the sin-cos potentiometer. Continue to rotate the rotor of MSR2, and note the position of the dial on the sin-cos potentiometer for maximum amplitude.

146. Set switch SA to 270° and repeat the rotation of the rotor of MSR2. Observe the dial on the sin-cos potentiometer and the waveform on the oscilloscope and note that the points of minimum amplitude obtained at para. 145 are now positions of maximum amplitude. In the same way, positions of maximum amplitude should now be positions of minimum amplitude. Disconnect the oscilloscope and return switch SA to 0°.

147. Connect the oscilloscope to M1. The 50 c/s component in the output at M1 should be a minimum. This can be ascertained by rotating the high speed magslip dial through a few degrees. Now connect the oscilloscope to M2. The 50 c/s component should be less than 20/mV peak-to-peak at this socket.

148. *Sectoring circuits.* Switch off the d.c supplies. Set switch SA to FOL. Rotate RV7 in a counter-clockwise direction to the full extent of its travel. Remove valve V6 and switch on the d.c. supply.

149. Turn the gear train to locate the position between 0° and 180° on the LS dial at which relay RL1 operates. Adjust RV7 to bring this point to approximately 65°.

150. Measure the anode current of valve V4. Adjust RV7 until the relay can be operated by rotating the dial approximately 1·5° reducing the anode current of V4 from about 13mA to zero. Set this point to 65° by adjustment of RV7. Lock RV7.

Note . . .

The anode current of V4 is measured by using the shunt in the anode circuit. The procedure to be adopted is as follows: Set switch to position 2 and connect the multimeter to BPLA pole 14 (+ve) and pole 15 (−ve). Record the voltage across R24 as indicated on the multimeter, and, calculate the anode current as follows: —

$$I = \frac{V}{R24}$$

151. Set switch SA to FOL and RV1 fully clockwise. Fit valve V6 in the unit and turn the gear train against its torque so that the HS dial and LS dial indicate 3°. Adjust RV1 until a change of torque indicates that RL1 has operated.

152. With the aerial rotating, adjust the TACHO PHASE control for minimum error signal (HS potentiometer).

Azimuth range indicator, Type S5/1

WARNING . . .

Lethal voltages are present in the e.h.t section of the azimuth range indicator. Care must be taken not to touch accidentally those points at which high voltages are present.

153. The following settings are to be made before attempting any part of the following procedure: —

(1) Set the X OFFSET and Y OFFSET controls to their mid-positions and set all the remaining dual concentric controls to the extreme counter-clockwise setting.

(2) Set the CURSOR ILLU and BRIGHTNESS controls to the extreme counter-clockwise setting.

(3) Set the FOCUS control to mid-position.

(4) Set all the toggle switches to the OFF position and the CENTRE/OFFSET SWITCH to CENTRE.

(5) Set the RANGE switch to the 10M position.

The 15kV supply

154. Remove the left-hand side panel of the power supply Type S43/1 and set the interlock switch to the SERVICE position. Undo the two fasteners and swing out the unit on its hinges. Connect an 18kV electrostatic voltmeter between the high voltage socket on the e.h.t. transformer after removing the original connection plug.

Important note . . .

If the e.h.t. exceeds 15kV the rectifiers V10 and V11 may be seriously damaged; it is therefore essential to adjust the SET EHT control carefully in order to avoid overshoot.

155. Set the display ON/OFF switch to ON. Allow at least 70 seconds delay and then check that the meter indicates 15kV. If the indication is incorrect, unlock and adjust the SET EHT control RV3, located in the video amplifier Type S17/1, to obtain this indication. Relock the control.

156. Set the display ON/OFF switch to OFF and allow sufficient time for the e.h.t. to bleed away before removing the connections to the electrostatic voltmeter. Replace the original connection to the high voltage socket on the e.h.t. transformer.

Coil assembly adjustments

157. *General.* This procedure is required ONLY if any of the following conditions occur: —

(1) Setting up a new unit.

(2) When the coil assembly has been disturbed.

(3) When the c.r.t. has been disturbed, removed or changed.

158. *Focus coil.* For an accurate and consistent picture, with uniform quality all over, it is essential that the focus coil exerts no deflectional effect on the spot, that is, the focused spot, in the absence of deflector coil currents, coincides with unfocused spot. This state occurs when the focusing field coincides exactly with the beam axes of the c.r.t. To achieve this the focus coil mounting has been designed to have two distinct movements:

(1) Tilt about the axis of the c.r.t. using the three knurled screws on the coil casting.

(2) Transverse shift using the eccentric screw at the top rear of the coil casting.

159. To prepare for this part of the procedure, remove both side panels, undo the two fasteners on the video amplifier Type S17/1 and the sweep generator Type S15/1, and swing each unit away from the frame. Set the two interlock switches to the SERVICE position.

160. Proceed to adjust the controls as follows:—

(1) Disconnect the pre-centre, deflection and focus coils.

(2) Remove V16 from the video amplifier, Type S17/1.

(3) Connect the focus coil between the Y COIL CURRENT and the Y COIL VOLTAGE sockets on the sweep generator Type S15/1.

(4) Connect a 330 ohm 3 watt, wirewound resistor between the X COIL CURRENT and the X COIL VOLTAGE sockets on the sweep generator Type S15/1.

(5) Disconnect the Y scan input to DSKTB and connect in its place the output from a 5 c/s sine wave oscillator. Disconnect the X scan input to DSKTA and connect DSKTA to the chassis.

(6) Set the RANGE switch to the 10M position.

(7) Slacken off the two bolts which secure the focus coil casting to the gantry then adjust the casting position so that the distance between the front face of the focus coil housing, and the rear face of the deflection coil is 4·5 mm when the deflection coil is hard up against the flare of the c.r.t. Make this measurement at both sides of the coil to ensure axial alignment. Tighten the two securing bolts.

(8) Undo the three knurled screws until they no longer protrude through the inner face of the casting, and the focus coil housing is resting on its casting. Slacken off the following: —

(a) the locknut on the eccentric bolt

(b) the two bolts securing the gimbal casting to the main casting

(c) the three bolts retaining the rear tube clamp.

161. Make the following control adjustments:—

(1) Set the output of the sine wave oscillator to zero. Set the BRIGHTNESS control to the external counter-clockwise setting.

(2) Set the DISPLAY ON/OFF switch to ON and allow at least 70 seconds to elapse.

(3 Turn the BRIGHTNESS control very slowly clockwise until the de-focused spot just appears on the c.r.t. Do not increase the brightness any more than is necessary, to avoid c.r.t. screen burns.

(4) Increase the output of the sinewave oscillator until a shape appears, similar to those shown in fig. 6.

(5) Unlock and adjust the Y RE-CENTRE control RV106 located in the generator sweep Type S15/1 to obtain a sharp and equal focus of the two tips Y and Z of the shape. It may be necessary to adjust the Y RE-CENTRE control each time the output of the oscillator is changed, to prevent the sweep generator limiting thereby causing a bright spot which could burn the c.r.t. screen. Relock the control when no further adjustment is required.

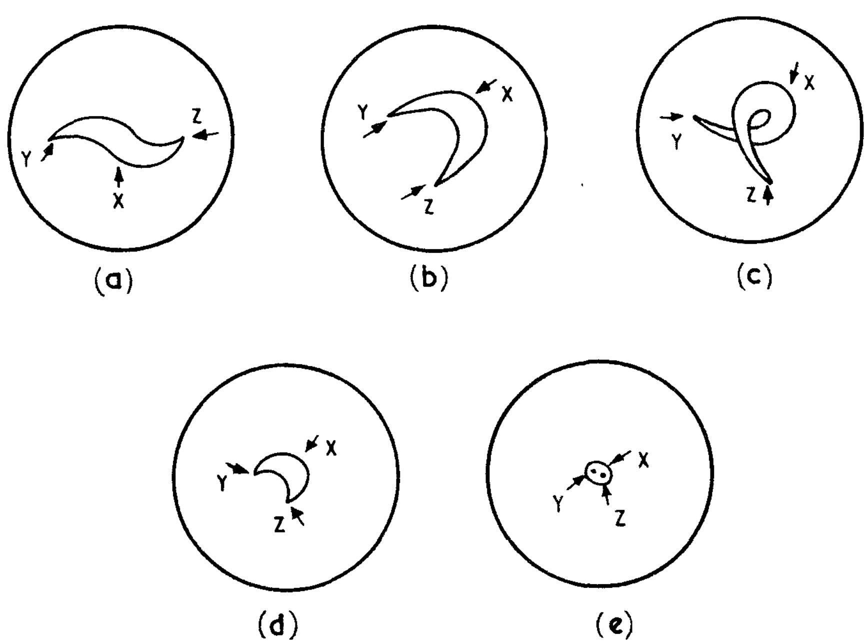


Fig. 6. C.r.t. focuses obtained during focus adjustment

(6) Adjust the eccentric screw at the top rear end of casting to bring the two tips of the shape as close together as possible (fig. 6d). To achieve this condition it may be necessary to adjust the position of the c.r.t. Manipulation of the two eccentric screws, associated with the c.r.t. will enable the tube clamps near the face of the c.r.t. to be lowered. The deflection coil clamp should be slackened to allow for this c.r.t. movement.

(7) Adjust the two lower knurled screws on the coil casting until the two tips of the displayed shape coalesce within the unfocused spot. Ideally, these two tips should unite to form one focused spot in the centre of the unfocused spot but it is acceptable if the points Y and Z are within 2mm of each other and the centre of X, as in fig. 6e. To achieve this desired focus it may be necessary to repeat the relevant instructions contained in the sub-paras. (6) and (7).

162. On completion of each of the following instructions ensure that the focusing conditions remain unchanged. Any change should be eliminated by repeating the relevant instructions contained in sub-paras. (6) and (7) in para. 133.

(1) Tighten the top clamp at the front of the c.r.t.

(2) Tighten the two bottom clamps.

(3) Tighten the three bolts retaining the rear tube clamp.

(4) Tighten the bolts securing the gimbal casting to the main casting.

(5) Tighten the locknut on the eccentric bolt at the top rear of the focus coil casting.

(6) Tighten the knurled screw on the top of the casting.

163. To ensure that the focus controls are correctly adjusted proceed as follows:—

(1) Turn the BRIGHTNESS control to the extreme counter-clockwise setting.

(2) Set the display ON/OFF switch to OFF.

(3) Disconnect the sine wave oscillator and connect DSKTB to the chassis.

(4) Disconnect the focus coil from the Y COIL CURRENT and Y COIL VOLTAGE sockets on the sweep generator. Connect in its place a 330 ohm, 3 watt wirewound resistor.

(5) Reconnect the focus coil to ASKTU and ASKTS and refit V16 in the video amplifier.

(6) Set the display ON/OFF switch to ON and allow at least 70 seconds before turning the BRIGHTNESS control until a spot again appears on the c.r.t.

(7) Check that adjustment of the FOCUS control will ensure optimum focus of the spot being obtained.

164. *Pre-centering coil adjustment.* To set up the pre-centering controls proceed as follows:—

(1) Unlock and rotate the cursor until the five parallel lines are vertical. This occurs when the upper tip of the centre line is symmetrical with respect to the three screws at the top of the casting. Relock the cursor. Unlock and rotate the bearing scale to bring the 0° and 180° marks in line with the centre cursor line, with 0° uppermost. Relock the bearing scale.

(2) Reconnect the pre-centering coils to ASKTSL, K, J and X on video amplifier Type S17/1. Unscrew and remove the covers over the X PRECENTRE and Y PRECENTRE controls RV11 and RV12, and adjust these until the spot on the c.r.t. is at the intersection of the major axis lines on the cursor. To achieve this, it may be necessary to change the connections to either, or both, R115 and R166 in the video amplifier Type S17/1.

165. To ensure the correct setting of the precentering controls:—

(1) Slacken off the two Allen screws on the clamp and adjust the position of the precentre coil so that its rear face is 3 mm from the front face of the focus coil.

(2) Oscillate the Y PRECENTRE control through its full range of travel and observe the angle of direction in which the spot moves. Rotate the precentre coil until the movement of the spot coincides with the centre vertical axis line on the cursor. During this procedure, maintain the gap of 3 mm between the precentre coil and the focus coil.

(3) Tighten the two Allen head screws.

(4) Reset the spot to the intersection of the major axis lines on the cursor by means of both PRECENTRE controls, as necessary.

166. *Deflection coils.* Connect the deflection coils to the control radar set (Ref. No. 10L/5840-99-970-1155) as shown in fig. 7.

167. Make the following control adjustments on the control radar set.

(1) Set the SPOT/SCAN switch to SPOT

(2) Adjust the X SHIFT AMP and Y SHIFT AMP controls to position the spot on the c.r.t. to the intersection of the axes. To achieve this it may be necessary to operate either, or both, of the X and Y current reverse switches.

(3) Set the bearing switch to position 1.

(4) Set the SPOT/SCAN switch to SCAN.

(5) Slacken the two Allen screws securing the deflection coil and then rotate the coil until the trace lies as nearly parallel to the centre vertical cursor-line as is possible. Re-tighten the Allen screws.

(6) Set the trace length at 260 mm by adjustment of the Y SWEEP AMP control on the test set.

168. Due to a number of factors the trace may be curved. This curvature can be reduced to a minimum by the following procedures: —

(1) Unlock and adjust the X PRECENTRE control so that when only the centre of the trace is moved the curvature is reduced.

(2) Move the trace by about 5 mm.

(3) Reset the trace to be under the centre cursor line by adjustment of the X SHIFT AMP. control on the test set.

(4) Recheck the trace for any curvature and repeat these adjustments until the minimum curvature condition is achieved.

(5) Relock the X PRECENTRE control.

Note . . .

Any deviation must be not greater than 0·5 mm and the sum of the maximum deviation either side of the line be not greater than 0·5 mm.

(6) Set the BEARING switch to position 3 and check that the trace is between 90° and 270°, approximately. Set the trace length to 260 mm by adjustment of the X SWEEP AMP control on the test set.

(7) Unlock and rotate the cursor until the trace lies as nearly parallel to the centre cursor line as is possible and then relock the cursor.

(8) The trace may again be curved. If this is so, unlock and adjust the Y PRECENTRE control so that, if only the centre of the trace is moved the curvature would be reduced.

(9) Move the trace by about 5 mm.

(10) Reset the trace to be under the centre cursor line by adjustment of the Y SHIFT AMP control on the test set.

(11) Recheck the trace for any curvature and repeat these adjustments until the minimum curvature condition is achieved.

(12) Relock the Y PRECENTRE control.

Note . . .

Any deviation must be not greater than 0·5 mm and the sum of the maximum deviation either side of the line be not greater than 0·5 mm.

169. *Bearing accuracy.* To determine the bearing accuracy proceed as follows: —

(1) Set the BEARING switch to position 1 and, if necessary, re-adjust the deflection coil until the appropriate trace end lies exactly at 0°. Note the bearing at the other end of the trace, by means of the cursor, for accuracy.

(2) Set the BEARING switch to position 2 and note the bearings at either end of the trace. These should be, ideally, 45° and 225°.

(3) Set the BEARING switch to position 3 and note the bearings at either end of the trace. These should be, ideally, 90° and 270°.

(4) Set the BEARING switch to position 4 and note the bearings at either end of the trace. These should be, ideally, 135° and 315°.

(5) From the bearing figures, so noted, determine the greatest positive error and the greatest negative error from the stipulated ideal. The sum of these two errors, ignoring their signs, must not be greater than 1°.

Example: If maximum positive error was 0·3° and maximum negative error was 0·6° then the sum of the errors would be 0·9°.

(6) Set the display ON/OFF to OFF.

(7) Remove the 330 ohm resistors from the generator sweep Type S15/1.

(8) Disconnect the coils from the bearing test set and reconnect them to the sweep generator Type S15/1.

Sweep generator Type S15/1

170. To set up the two deflection amplifiers proceed as follows: —

(1) Set the BRIGHTNESS control to extreme counter-clockwise setting.

(2) Disconnect the inputs to DSKTA and B and connect these two sockets to chassis.

(3) Remove the right-hand side panel of azimuth range indicator, Type S5/1 and set the interlock switch to the service position.

(4) Connect TP.4 and TP.104 to chassis.

(5) Set the display ON/OFF switch to ON and allow 20 minutes warming-up period.

171. *X amplifier set zero.* To set up the zero adjustment on the X deflection amplifier proceed as follows: —

(1) Connect the multimeter set to the 100v D.C range between the chassis and TP2 on the sweep generator.

(2) Set the RANGE switch to the 10M position. The multimeter should show zero indication when the meter ranges are successively reduced to the lowest available on the meter. If this is not so, unlock and adjust the X SET ZERO control RV1 to achieve this condition.

(3) Relock the control and remove the connections to the multimeter.

172. *X amplifier slave current.* To set the X deflection amplifier slave current proceed as follows: —

(1) Connect the multimeter, set to the 100v D.C range, across R23, with the positive connection to the +330V end.

(2) When the RANGE switch is at the 10 M position the multimeter should indicate 7·2V, when the appropriate range is selected. If this is not so, unlock and adjust the X SLAVE CURRENT ADJUST control RV5 to obtain this condition. Relock the control and remove the connections to the mulitmeter.

173. *Y amplifier set zero.* To set up the zero adjustment on the Y deflection amplifier proceed as follows: —

(1) Connect the mulitmeter, set to the 100 v D.C range, between the chassis and TP102 on the sweep generator.

(2) With the RANGE switch at the 10 M position the multimeter should show zero indication, the ranges being successively reduced to the lowest available on the meter. If zero indication is not achieved, unlock and adjust the Y SET ZERO control RV101 to achieve this condition.

(3) Relock the control and remove the connections to the meter.

174. *Y amplifier slave current.* To set up the Y deflection amplifier slave current proceed as follows: —

(1) Connect the multimeter, set to the 100 v D.C range, across R123, the positive connection to the +330 V end.

(2) When the RANGE switch is at the 10 M position the multimeter should indicate 7·2 V, when the appropriate meter range is selected. If zero indication is not achieved, unlock and adjust the Y SLAVE CURRENT ADJUST control RV105 to achieve this condition. Relock the control and remove the connections to the multimeter.

175. To ensure that the set zero controls are correctly adjusted proceed as follows: —

(1) Repeat the set zero procedure, paras. 143 and 145.

(2) Remove the chassis connections from TP.4, and TP.104.

176. *Re-centering.* To set up the re-centering circuits proceed as follows: —

(1) Set the RANGE switch to the 100 M position.

(2) Turn the BRIGHTNESS control in a clockwise direction until the spot is just visible.

(3) Set the spot to the intersection of the axis by adjustment of the X RECENTRE and Y RECENTRE controls.

(4) Set the RANGE switch to each of the other three positions in turn and note any displacement of the spot. Re-adjust the RECENTRE controls, as necessary, to balance any displacement about the intersection of the axes. The maximum displacement between any two range positions must not be greater than 1 mm.

177. *Limiters.* To set up the limiting controls adjust as follows: —

(1) Set the RANGE switch to the 50 M position and the CENTRE/OFFSET switch to OFFSET, then set the spot to the intersection of the axes by means of the X SHIFT and Y SHIFT controls.

(2) Set the Y SHIFT control to the extreme clockwise setting.

(3) Unlock and adjust the Y MAIN AMP LIMIT control RV102 until the spot just disappears off the display at 180°, then relock the control.

(4) Set the Y SHIFT CONTROL to the extreme clockwise setting.

(5) Unlock and adjust the Y SLAVE AMP LIMIT control RV104 until the spot just disappears off the display face at 0°, then relock the control.

(6) Set the spot to the intersection of the axes by means of the X SHIFT and Y SHIFT controls.

(7) Set the X SHIFT CONTROL to the extreme counter-clockwise setting.

(8) Unlock and adjust the X MAIN AMP LIMIT control RV2 until the spot just disappears off the display face, at 270°, then relock the control.

(9) Set the X SHIFT CONTROL to the extreme clockwise setting.

(10) Unlock and adjust the X SLAVE AMP LIMIT control RV4 until the spot just disappears off the display face, at 90°, relock the control.

(11) Set the spot to the intersection of the axes by means of the X SHIFT and Y SHIFT controls.

(12) Set the CENTRE/OFFSET switch to CENTRE.

178. *Gain adjustment.* To adjust the gain controls proceed as follows: —

(1) Remove the shorting links on DSKTSA and B.

(2) Check that the X and Y scan outputs are correctly set up as stipulated in the relevant section of this procedure.

(3) Reconnect the X and Y scan outputs to DSKTSA and B, respectively.

(4) Set the aerial to 0° and adjust the BRIGHTNESS control until the trace is just visible. The trace should have its extremity at 0° with the origin at the intersection of the axes.

(5) Adjust the Y CHANNEL GAIN control RV103 to give a trace length of 130 mm.

(6) Set the aerial to 90°. The trace should now have its extremity at 90°.

(7) Adjust the X CHANNEL GAIN control RV3 to give a trace length of 130 mm.

179. *Short range linearity.* To set up the RANGE RING control proceed as follows: —

(1) Set the RANGE switch to the 10 M position.

(2) Set the aerial to 0° and turn the RANGE RING control, in a clockwise direction, until the 1 mile markers are visible on the c.r.t.

(3) Adjust C110 in sweep generator, Type S15/1 until the spacing between the 1st and 2nd 1 mile markers is equal to the spacing between the 4th and 5th 1 mile markers.

(4) Set the aerial rotating and adjust C10 in sweep generator, Type S15/1 until the 1 mile ring is circular.

Video amplifier Type S17/1

180. To set up the video mixer amplitude level proceed as follows: —

(1) Set the display ON/OFF switch to ON and allow at least 70 seconds for warming up.

(2) Connect the TRIGGER input of the oscilloscope to ASKTN and the input to ASKTD. The waveform examined must have an amplitude of 40V. If this is not so, unlock and adjust the BRIGHTENER AMP control RV5 to achieve this condition and then relock the control.

181. To set up the video mixer brightness level proceed as follows: —

(1) Set the BRIGHTNESS control to the extreme counter-clockwise setting. Unlock the BRIGHTENER LEVEL control RV4 and set it to the extreme counter-clockwise setting. Connect the multimeter, set to the 500 V D.C range between the chassis (−ve) and ASKTD. Set all signal controls to the extreme counter-clockwise settings.

(2) Turn the BRIGHTNESS control slowly in a clockwise direction to the extreme of its travel. Ensure that there is no visible trace on the c.r.t. Observe the indication shown by the multimeter and turn the BRIGHTNESS control in a counter-clockwise direction until this indication is reduced by 10V. Remove the connections to the multimeter.

(3) Turn the BRIGHTENER LEVEL control RV4 in a clockwise direction until the trace is just visible on the c.r.t. and then lock the control.

(4) Turn the BRIGHTNESS control to the extreme counter-clockwise setting and set the display ON/OFF switch to OFF. Remove all connections to the oscilloscope.

182. *Video limiter.* To set up the video limiter proceed as follows: —

(1) Set the aerial rotating.

(2) Set the BRIGHTNESS control and all signal controls to the extreme counter-clockwise setting.

(3) Set the RANGE switch to the 100 M position.

(4) Unlock and set the VIDEO LIMIT control RV1 to the extreme clockwise setting.

(5) Connect the TRIGGER input of the oscilloscope to ASKTN and the input of the oscilloscope to ASKTT.

(6) Set the display ON/OFF switch to ON and allow at least 70 seconds for warming up.

183. Adjust the video limit controls as follows:—

(1) Turn the BRIGHTNESS control in a clockwise direction until the trace is just visible on the c.r.t.

(2) Turn the RANGE MARKS control in a clockwise direction until the 20 mile markers are bright enough just to become defocused.

(3) Turn the VIDEO LIMIT control in a counter-clockwise direction until the 20 mile markers just start to decrease in amplitude, as observed on the oscilloscope, then lock the control.

184. *Cable compensation—initial setting up of installation ONLY.* Set the oscilloscope controls to display the first 1 mile marker in detail. Unlock and adjust the CABLE COMPENSATION control RV2 in video amplifier Type S17/1 to obtain the optmum undistorted waveshape with the minimum overshoot, then relock the control. Turn the BRIGHTNESS control to the extreme counter-clockwise setting. Set the display ON/OFF switch to OFF and remove all connections to the oscilloscope.

Sine/cosine potentiometer adjustment

185. To set up the SINE/COSINE potentiometer proceed as follows:—

(1) Stop aerial rotation. Lock, or hold steady, the aerial at a known bearing. Set the BRIGHTNESS control to the extreme counter-clockwise setting.

(2) Set the display ON/OFF switch to ON and allow at least 70 seconds before turning the BRIGHTNESS control in a clockwise direction until the trace is just visible on the c.r.t.

(3) Orientate the bearing scale with 0° at the topmost position. The trace should then indicate the set bearing angle of the aerial. If this is not so, loosen the Allen screws which lock the sine/cosine potentiometer in its mounting and rotate the body of the potentiometer to achieve this desired condition. Tighten up the Allen screws, ensuring that the bearing indication still remains correct.

(4) Set the BRIGHTNESS control to the extreme counter-clockwise setting and the display ON/OFF switch to OFF.

Amplifier power supply Type S30/1

Power supply Type S46/1

186. Set switch S3 on the power supply, Type S46/1 to ON. Connect the multimeter between terminals A and B of transformer T1 and measure the voltage. This should be 230V.

187. Allow two minutes from the time of switching on for the unit to warm up. Measure the voltages at the following points by means of the multimeter set to the appropriate d.c. range:

PLA pin 1 +ve 330V

PLA pin 21 +ve 200V

PLA pin 12 −ve 150V

188. Adjust the SET MT1/PP RATIO control RV1 and the SET 20 MC/S DRIVE control RV2 to their mid-positions approximately. Connect the multimeter on the d.c. milliampere range to PLA pole 18 (negative) and PLA8 (positive). Set switch SW1 to positions 3, 4, 7, 8, 10 and 11 in turn. The indications obtained on the multimeter should be 1mA ± 0·2mA.

189. Set switch SW1 to position 6. Set the multimeter to a lower range, if necessary, and observe the meter indication. This should be 0·3mA ± 0·06mA.

190. Set switch SW1 to position 9. With the multimeter on the same range the indication should now be 0·2mA ± 0·04mA.

191. Set switch SW1 to position 5. The indication obtained should be 0·55mA ± 0·11mA. Disconnect the multimeter.

Amplifier convertor Type S25/1

192. *Modulation.* Connect the oscilloscope to the terminating resistor of M.T.I./PP OUT *socket* and observe the modulated carrier. Check that the carrier is free from noise and clearly modulated by the negative pre-pulse and positive m.t.i. video signals. The modulation depth of the pre-pulse should be approximately 100 per cent at its leading edge. Ensure that there is no spurious modulation or similar effects.

193. Adjust SET 20 MC/S DRIVE control RV2 for 3V peak carrier and observe that the carrier is sinusoidal. Adjust SET M.T.I./PP RATIO control RV1 until the ratio of prepulse to m.t.i. video is 6:1.

Note . . .

The prepulse modulating the carrier is of fixed amplitude. When setting RV1 for the ratio required the amplitude of the m.t.i. video only will be adjustable.

194. Set the power meter switch to position 9 and rotate the meter switch SW1 on the amplifier power supply. The following indications should be obtained on the power supply meter: —

SW1 position 3, 4, 7, 8, 10, 11	1·0mA ± 0·2mA
SW1 position 6	0·3mA ± 0·06mA
SW1 position 5	0·55mA ± 0·11mA
SW1 position 9	0·2mA ± 0·04mA

Set switch S3 on the power supply to the centre (OFF) position. Fit the amplifier convertor back into position in the amplifier power supply Type S30/1.

Waveforms

195. Seventy representative waveforms for FGRI.26008/1 are shown at fig. 7 and details of these are given in the following list. References to units are made by abbreviations, e.g. Trig. P.G. S6/2 for trigger pulses generator Type S6/2.

Waveform	Unit	Monitoring point
1	Trig. P.G. S6/2	V1 anode.
2	Trig. P.G. S6/2	V2A anode.
3	Trig. P.G. S6/2	V2B anode
4	Trig. P.G. S6/2	SKT10.
5	Trig. P.G. S6/2	SKT1. Prepulse.
6	Trig. P.G. S6/2	SKT5 Prepulse.
7	Trig. P.G. S6/2	As 6.
8	Trig. P.G. S6/2	V3 anode.
9	Trig. P.G. S6/2	V4 grid.
10	Trig. P.G. S6/2	V4 anode.
11	Trig. P.G. S6/2	PL5. Modulator trigger.
12	Trig. P.G. S6/2	SKT5. Secondary radar trigger.
13	Trig. P.G. S6/2	PL1. Sync. from m.t.i.
14	Rad. mod. S1/1	Modulator grid drive socket. Unloaded (no e.h.t.) condition.
15	Rad. mod. S1/1	As 14 but loaded.
16	Rad. T.R. Ass. S1/2	Magnetron current monitor socket. Magnetron pulse.
17	Sig. Comp. S3/1	SKT1. Coho gate.
18	Sig. Comp. S3/1	As 17.
19	Sig. Comp. S3/1	SKT2 with output plug removed from I.F. amp. S7/1. Coho gate.
20	Sig. Comp. S3/1	As 19 with coho gate incorrectly set.
21	Sig. Comp. S3/1	SKT1. Coho gate and coho pulse. NORMAL/TEST switch on front panel of sig. comp. S2/2 at TEST. Test pulse showing after gate pulse.
22	Sig. Comp. S2/2	Measured at video out socket on front panel. Coho gate and first test pulses.
23	Sig. Comp. S2/2	As 22 but with coho oscillator unlocked. (R.F. osc. S5/1). First test pulse
24	Sig. Comp. S2/2	As 23 with coho oscillator locked.
25	Sig. Comp. S2/2	As 22 with NORMAL TEST switch at NORMAL.
26	Sig. Comp. S2/2	SKTI. Output of I.F. Amp. S6/1 to R.F. osc. S5/1.
27	Sig. Comp. S2/2	Knock off gate. Measured at mon'tor socket (SKT12).
28	Sig. Comp. S2/2	V2B cathode.
29	Sig. Comp. S2/2	V3 grid.
30	Sig. Comp. S2/2	V7B cathode.
31	Sig. Comp. S2/2	V5B grid.
32	Sig. Comp. S2/2	V5A anode.
33	Sig. Comp. S2/2	V1 suppressor grid.
34	Sig. Comp. S2/2	V1 control grid. Knock off pulse delayed one period.
35	Sig. Comp. S2/2	V1 screen grid.
36	Sig. Comp. S2/2	V9 cathode. Signal gate.
37	Sig. Comp. S2/2	V8 anode. Coho gate.

Waveform	Unit	Monitoring point
38	M.T.I. group S1/2	Knock off pulse measured at monitor socket.
39	M.T.I. group S1/2	Delay line input. Tx pulse and signals at T_0-100.
40	Pulse gen. S14/1	Monitor waveform sockets. Position 1 of monitor waveform switches. T_0 trigger.
41	Pulse gen. S14/1	As 40 with switch in position 2. End of scan.
42	E. mark. gen. S21/1	M.t.i. input with signals at monitor waveform socket. Position 3 of monitor waveform switch.
43	E. mark. gen. S21/1	M.t.i. out (m.t.i. and normal radar signals) at monitor waveform socket for balanced condition. Position 4 of monitor waveform switch.
44	E. mark. gen. S21/1	As 43. Position 5 of monitor waveform switch. Unbalanced condition.
45	E. mark. gen. S21/1	Position 6 of monitor waveform switch. Normal radar signals in.
46	E. mark. gen. S21/1	Position 7 of monitor waveform switch. Normal radar signals out.
47	E. mark. gen. S21/1	Position 9 of monitor waveform switch. Range markers out.
48	Sweep gen. S20/1	Position 3 of monitor switch. Gate pulse at monitor socket.
49	Sweep gen. S20/1	Position 5 of monitor switch. Y channel integrator out at monitor socket.
50	Sweep gen. S20/1	Position 8 of monitor switch. Main scan brightener pulse at monitor socket.
51	Video amp. S17/1	SKTD. Brightener pulse.
52	Sweep gen. S15/1	TP1. X Voltage monitor 10 M range.
53	Sweep gen. S15/1	TP1. As 52 for 50 M range.
54	Sweep gen. S15/1	TP2. X current monitor 10 M range.
55	Sweep gen. S15/1	TP2. As 54 for 50 M range.
56	Sweep gen. S15/1	TP3. X slave current 10 M range.
57	Sweep gen. S15/1	TP3. As 56 for 50 M range.
58	Amp. conv. S25/1	SKTD. Prepulse.
59	Amp. conv. S25/1	Slider of RV1. M.t.i. video.
60	Amp. conv. S25/1	PLM. Prepulse and m.t.i. video.
61	Amp. conv. S25/1	MN2. Prepulse (positive-going) and m.t.i. signals. MN2. Prepulse (negative-going) and m.t.i. signals.
62	Sync. sig. amp. S23/1	Lock out at monitor socket.
63	Sync. sig. amp. S23/1	Prepulse and m.t.i. video out.
64	Sync. sig. amp. S23/1	V1 anode. Monitor switch in position 3.
65	Sync. sig. amp. S23/1	V2 anode. Monitor switch in position 4.
66	Sync. sig. amp. S23/1	Monitor switch in position 5 with aerial follow switch at FOLLOW modulator output.
67	Sync. sig. amp. S23/1	Monitor switch in position 6. Amplifier output check.
68	Sync. sig. amp. S23/1	Monitor switch in position 7. Motor phase check.
69	Sync. sig. amp. S23/1	Monitor switch position 8. Tacho output check.
70	Sync. sig. amp. S23/1	Monitor switch position 10. Ambiguity signal check.

Fig.7 0125911 D842061 SW 7/61 FGRl. 26008/1 waveforms Fig.7

Appendix 1

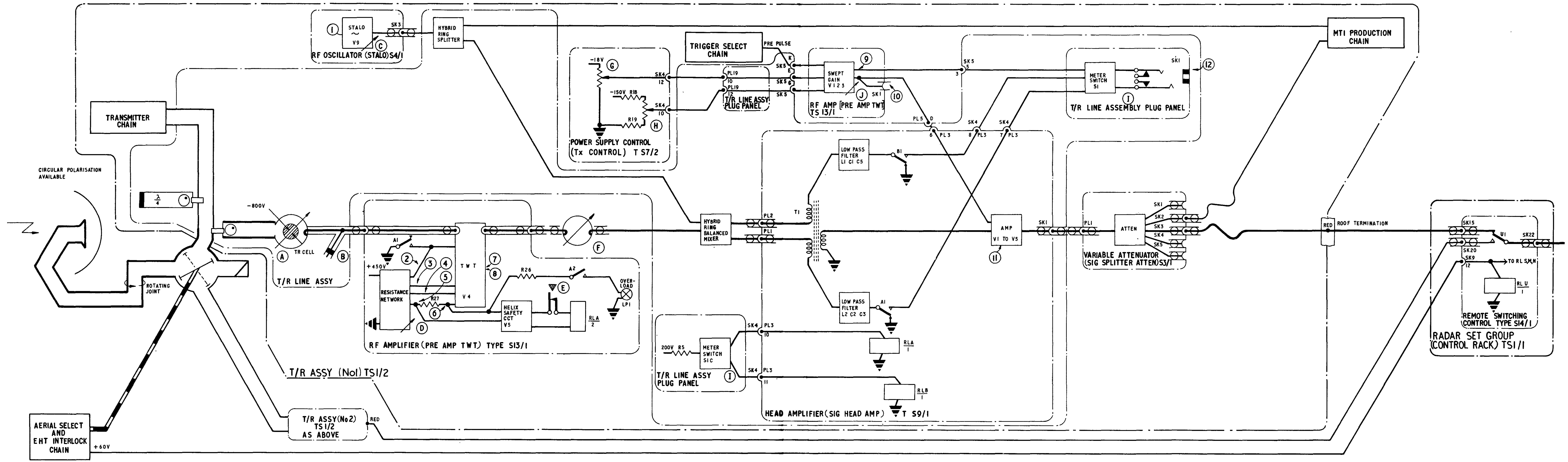
FUNCTIONAL DIAGRAMS

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Thirty functional diagrams for FGRI. 26008/1 produced for training purposes are reproduced here for reference and use during servicing. They were prepared by Technical Training Command.



FRGI 26008/1 (COSSOR 787A) NORMAL RADAR SIGNAL CHAIN SHEET 1

FIG. 1
D1379

CONTROLS	(A) TR CELL TUNE; (B) MATCHING PLUNGER; (C) COARSE TUNING, FINE TUNING, CATHODE TUNING, PROBE INSERTION; (D) TWT G2 (RV4) BEAM I SET, TWT G4 (RV2) VELOCITY ADJUST, TWT G3 (RV3) VELOCITY ADJUST, TWT HELIX (RV5) OPTIMUM GAIN; (E) O/L RESET SW3; (F) IMAGE REJECTION ADJUST; (G) SWEPT GAIN AMP RV3; (H) SIGNAL GAIN RV2 (HEAD AMP); (I) S1 METER SELECT; (J) SWEPT GAIN LAW SW1
TEST POINTS	(1) TESTPOINTS ON DC CHAIN; (2) TWT G2 METER SWITCH 2 POSN 6; (3) TWT G4 METER SWITCH 2 POSN 4; (4) TWT G3 METER SWITCH 2 POSN 5; (5) TWT HELIX (CURRENT) METER SWITCH 2 POSN 1; (6) TWT HELIX (VOLTS) METER SWITCH 2 POSN 3; (7) TWT COLLECTOR METER SWITCH 2 POSN 2; (8) TWT MAGNET METER SWITCH 2 POSN 7; (9) V3b Ia SW1 POS 5 (ON TR LINE ASSY); (10) SKT 1 SWEPT GAIN WAVEFORM; (11) TESTPOINT ON DC DIST CHAIN; (12) HYBRID RING CRYSTAL CURRENT S1 POSN 6 NEGATIVE XTAL (SIGNAL) CURRENT POSN 7 POSITIVE XTAL (SIGNAL) CURRENT

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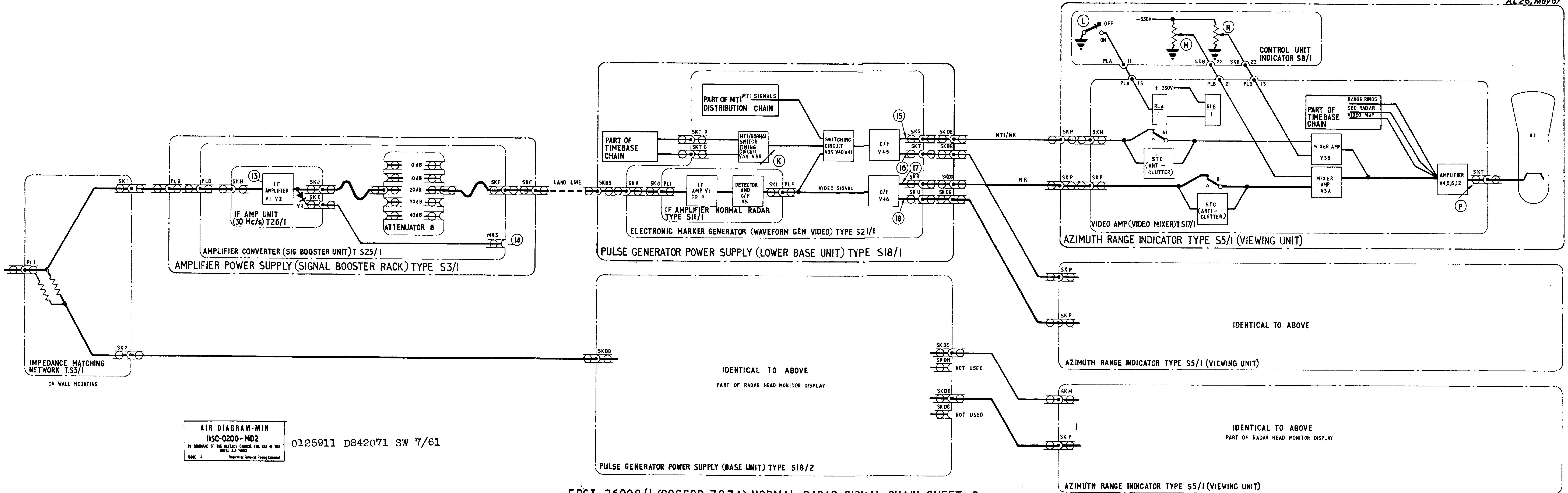

FRGI 26008/1 (COSSOR 787A) NORMAL RADAR SIGNAL CHAIN SHEET 2

FIG.2

D1363

(K) RV28 MTI DURATION
(L) SWITCH B STC ON/OFF
NOTE STC=SHORT TIME CONSTANT
(M) RV7 NORMAL RADAR (CONTRAST)
(N) RV6 MTI/NR GAIN
(P) VIDEO LIMIT RV1 CABLE COMP RV2
(13) TEST POINTS ON DC & AC DIST CHAIN
(14) NORMAL RADAR OUT
(15) MTI/NR O/P 1 MONITOR SW POS 4
(16) MTI/NR O/P 2 MONITOR SW POS 5
(17) NR O/P 1 MONITOR SW POS 7
(18) NR O/P 2 MONITOR SW POS 8

FGR1 26008/1 (COSSOR 787A) M.T.I. PRODUCTION SHEET 1

FIG. 3
D1388

CONTROLS	(A) MATCHING PLUNGER; (B) PHASE SHIFTER; (C) COHO CAVITY TUNE; (F) RV2 SIGNAL GAIN, RV3 SWEPT GAIN AMP; (D) TR CELL TUNE; (E) STALO {COARSE TUNING, FINE TUNING, CATHODE TUNING, PROBE INSERTION}; (G) MATCHING PLUNGER; (H) GAIN RV1 (COHO HEAD AMP); (J) SW1 SWEPT GAIN LAW; (K) T.W.T. G2 (RV2) BEAM CURRENT SET, T.W.T. G3 (RV3) VELOCITY ADJUST, T.W.T. G3 (RV3) VELOCITY ADJUST, T.W.T. HELIX (RV5) OPTIMUM GAIN; (L) SW3 OVERLOAD RESET, IMAGE REJECTION ADJUST; (N) SW 2 TEST/NORMAL SWITCH; (M) LOCK BIAS RV1; (P) RV9 COHO GATE WIDTH, RV12 COARSE PRF; (Q) RV10 KNOCK-OFF GATE WIDTH; (R) LIMIT AMP. GAIN RV11; (S) FREQUENCY CONTROL; (T) COHO BALANCE RV2; (U) SIG. BALANCE RV5; (V) COHO GAIN RV4; (W) COHO GAIN RV3; (X) SIGNAL GAIN RV7; (Y) SIGNAL GAIN RV6
TEST POINTS	(1) METERING POINTS REFER DC DISTRIBUTION CHAIN DIAGRAM; (2) T.W.T. G2 METER SWITCH 2 POS'N 6, T.W.T. G4 METER SWITCH 2 POS'N 4, T.W.T. G3 METER SWITCH 2 POS'N 5, T.W.T. HELIX (CURRENT) METER SWITCH 2 POS'N 1, T.W.T. HELIX (VOLTS) METER SWITCH 2 POS'N 3, T.W.T. COLLECTOR METER SWITCH 2 POS'N 2, T.W.T. MAGNET METER SWITCH 2 POS'N 7; (3) METERING POINTS REFER D.C. DIST CHAIN; (4) NEGATIVE CRYSTAL CURRENT (SW1 POS'N 6), POSITIVE CRYSTAL CURRENT (SW1 POS'N 7); (5) SWEPT GAIN V3 CURRENT (SW1 POS'N 6) } SW1 T/R LINE ASSEMBLY; (6) SWEPT GAIN OUTPUT MONITOR (PRE-AMPLIFIER FRONT); (7) METERING POINTS REFER D.C. DISTRIBUTION CHAIN; (8) V2b Ia SWITCH 1 POS'N 8; (9) V5A Ia SWITCH 1 POS'N 10; (10) V3 Ia SWITCH 1 POS'N :; (11) V9 Ia SWITCH POS'N 11; (12) (13) METERING POINTS REFER DC DISTRIBUTION CHAIN; (14) METERING POINTS REFER DC DISTRIBUTION CHAIN; (15) MONITOR KNOCK OFF GATE; (16) MONITOR VIDEO OUTPUT

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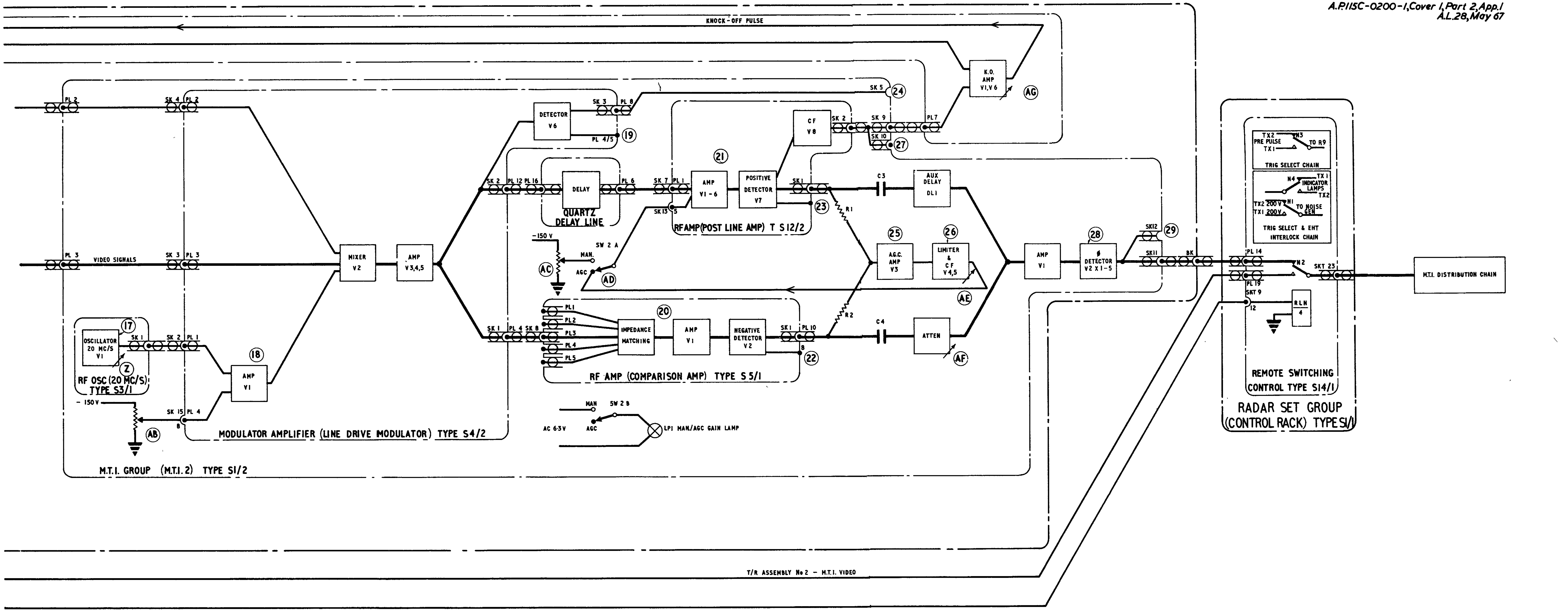

FGRI 26008/1 (COSSOR 787A) MTI PRODUCTION SHEET 2

FIG.4

D1364

(AB) CARRIER LEVEL RV 4

(Z) FREQUENCY CONTROL

(AC) MANUAL GAIN RV 2

(AD) AGC/MANUAL SW 2

(AF) VIDEO BALANCE COARSE VIDEO BALANCE FINE RV1

(AE) AGC LEVEL RV 3

(AG) FINE REP RV 8

(17) METERING POINT REFER DC DISTRIBUTION CHAIN

(18) METERING POINTS REFER DC DISTRIBUTION CHAIN

(19) V6 Ia (SWITCH 1 POS'N 11 M.T.I. 2 FRONT)

(20)(21) METERING POINTS REFER DC DISTRIBUTION CHAIN

(22) V2 Ia (SWITCH 1 POS'N 10 M.T.I. 2 FRONT)

(23) V7 Ia (SWITCH 1 POS'N 9 M.T.I. 2 FRONT)

(24) SK 5 MONITOR LINE DRIVE

(25) V3 Ia SWITCH 1 POS'N 4

(26) V5 Ia SW1 POS 5

(27) SK 10 MONITOR KNOCK OFF PULSE

(28) V2 b Ia SW 1 POS 8

(29) SK 12 MONITOR CANCELLED SIGNALS OUTPUT

AIR DIAGRAM-MIN
115C-0200-MD4

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

ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN.AD 6780 SERIES

0125911 D842071 SW 7/61

F.G.R.I. 26008/1 (COSSOR 787A) M.T.I. DISTRIBUTION CHAIN

D1365 FIG.5

CONTROLS	(A) RV2 SET 20 Mc/s DRIVE (B) RV1 PREPULSE/M.T.I. RATIO CONTROL (C) RV9 M.T.I. GAIN (D) RV27 M.T.I. GAIN; RV29 VIDEO BALANCE (E) RV28 M.T.I. DURATION (F) MIXED NORMAL RADAR/M.T.I. GAIN RV6 (G) SWITCH SB, STC ON/OFF (H) RV1 VIDEO LIMIT; RV2 CABLE COMPENSATION
TEST POINTS	(1) V1 V2 CURRENT SW1 POS 10 (SEE INSET); V3 CURRENT SW1 POS 11 (SEE INSET) (2) V1 IA SW1 POS 4 (SEE INSET); V2 IA SW1 POS 5 (SEE INSET); OSC. O/P SW1 POS 6 (SEE INSET) (3) V6 V7 IA SW1 POS 7 (SEE INSET) (4) V8 V9 IA SW1 POS 8 (SEE INSET); 20 Mc/s MOD O/P LEVEL SW1 POS 9 (SEE INSET) (5) MTI/PREPULSE INPUT (6) MTI/PREPULSE OUTPUT (7) HT CURRENT TEST POINT (SEE DC. DIST CHAIN) (9) MONITOR LOCK PULSE AND M.T.I. VIDEO. (10) MONITOR END OF SCAN PULSE SW SC B POS. 2 (11) MONITOR M.T.I. VIDEO SW SC B POS. 3 (12) M.T.I./NORMAL RADAR O/P 1 MONITOR SW SCB POS 4 (13) M.T.I./NORMAL RADAR O/P 2 MONITOR SW SCB POS 5 (TWO DISPLAYS MAYBE UTILIZED AT A.T.C.)
FUSES	FS 5 10mA

AIR DIAGRAM-MIN
115C-0200-MD5
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
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0125911 D842061 SW 7/61

F.G.R.I. 26008/1 (COSSOR 787A) M.T.I. DESCRIPTIVE DIAGRAM

FIG.6

AIR DIAGRAM-MIN
115C-0200-MD6
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
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0125911 D842071 SW 7/61

FGRI 26008/1 (COSSOR 787A) TIME BASE CHAIN SHEET 1

D 1390

CONTROLS	(A) RV 2 SET 20 MC/S DRIVE; (B) RV 1 PRE PULSE/M.T.I. RATIO CONTROL; (C) RV 9 M.T.I. GAIN; (D) RV 34 TRIGGER SENSITIVITY; (H) RV 32 PRF CONTROL; (G) AB POS/NEG INPUT LINKS; (F) CALIBRATION TEST OSCILLATOR ON/OFF SC A MONITOR SWITCH POS 11; (E) SWITCH SA NORMAL/TEST; (J) RV 35 TRIGGER DELAY; (K) RV 1 TIME DURATION; (L) SC 1 SC 2 NORMAL/TEST SWITCH; (M) C 8 Y SPIKE CONTROL; (O) T4 FREQUENCY ADJUST; (N) C 11 X SPIKE CONTROL; (P) C 21 BALANCE, RV 6 SLOPE, RV 8 RIPPLE, RV 10 ZERO LEVEL } Y; (Q) C 31 BALANCE, RV 16 SLOPE, RV 18 RIPPLE, RV 20 ZERO LEVEL } X
TEST POINTS	(1) V1 V2 Ia SW1 POS 10 (SEE INSET) V3 Ia SW1 POS 11 (SEE INSET); (2) V1 Ia SW1 POS 4 (SEE INSET) V2 Ia SW1 POS 5 (SEE INSET) OSC O/P SW1 POS 6 (SEE INSET); (3) V6,7 Ia SW1 POS 7 (SEE INSET); (4) V8,9 Ia SW1 POS 8 (SEE INSET) 20 MC/S MOD O/P LEVEL SW1 POS 9 (SEE INSET); (5) MH1 MONITOR M.T.I./PRE PULSE IN; (6) MH 2 MONITOR M.T.I./PRE PULSE OUT; (7) HT CURRENT TEST POINT (SEE D.C. DIST CHAIN); (7) MONITOR - LOCK PULSE; (8) MONITOR - LOCK PULSE AND M.T.I. VIDEO; (9) TRIGGER AT T_0 MONITOR SW. SC-8 POS 1; (10) TRIGGER AT T_0 MONITOR SW. SB POS 1; (11) COS I/P MONITOR SW. SB POS 4; (12) SINE I/P MONITOR SW. SB POS 6; (13) V4 CATHODE W/F MONITOR SW. SB POS 3; (14) NORTH MARKER I/P MON. SW. SB POS 9; (15) END OF SCAN MONITOR SW. SB POS 2; (16) BRIGHT UP MONITOR SW. SB POS 8; (17) N.M. O/P MONITOR SW. SB POS 10; (18) Y O/P MONITOR SW. SB POS 5; (19) X O/P MONITOR SW. SB POS 7; (20) CAL. OUT MONITOR SW. SC-8 POS 9
FUSES	(1) FS 5 18 mA

AIR DIAGRAM-MIN
115C-0200-MD7
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
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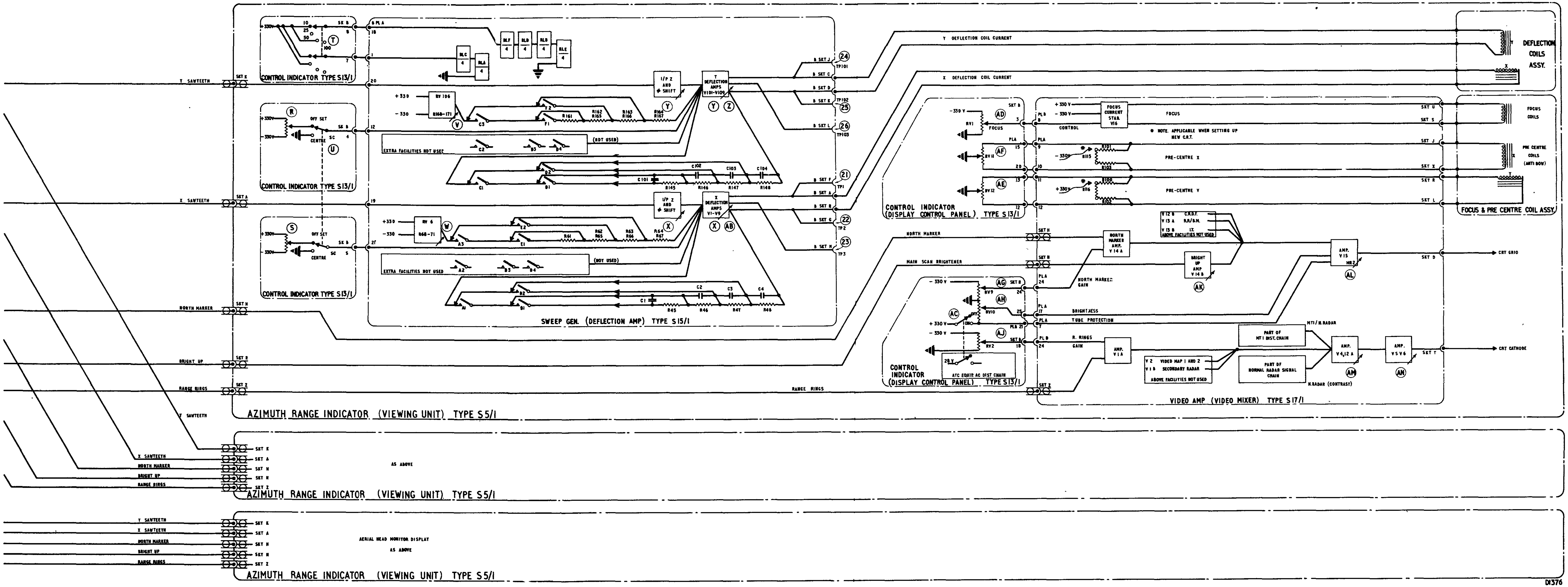


D1376
FIG.8

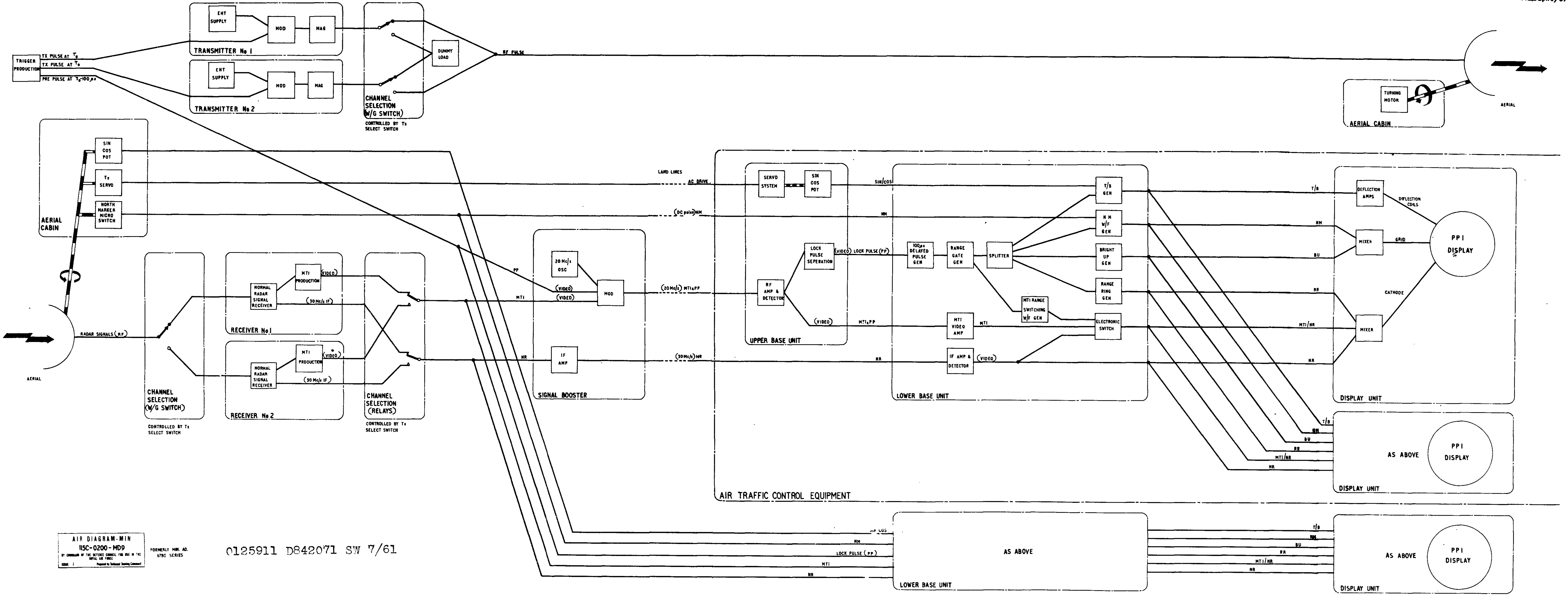
FGR1 26008/1 (COSSOR 787A) TIME BASE CHAIN SHEET 2

(R) RV4 T SHIFT (OFF SET)
(S) RV3 X SHIFT (OFF SET)
(T) SA1 RANGE SWITCH
(U) SC CENTRE/OFF SET
(V) RV106 T RE CENTRE
(W) RV 6 X RE CENTRE
(X) C10 C11 C12 PRE-SET PHASE TRIMMERS
(Y) C110 C111 C112 PRE-SET PHASE TRIMMERS
(Z) RV101 SET ZERO; RV102 MAIN AMP. LIMIT; RV103 GAIN; RV104 SLAVE AMP. LIMIT; RV105 SLAVE CURRENT ADJ. } Y
(AB) RV1 SET ZERO; RV2 MAIN AMP. LIMIT; RV3 GAIN; RV4 SLAVE AMP. LIMIT; RV5 SLAVE CURRENT ADJ. } X
(AC) SD DISPLAY ON/OFF
(AD) RV1 FOCUS
(AF) RV11 X PRE CENTRE
(AE) RV12 T PRE CENTRE
(AG) RV9 BEARING MARK (NM)
(AH) RV10 BRIGHTNESS
(AJ) RV2 RANGE RINGS
(AK) RV5 BRIGHTENER AMP.
(AL) RV4 BRIGHTENER LEVEL
(AM) RV1 VIDEO LIMIT
(AN) RV2 CABLE COMPENSATION

(21) TP1 X VOLTS
(22) TP2 X CURRENT
(23) TP3 X SLAVE CURRENT
(24) TP101 Y VOLTS
(25) TP102 Y CURRENT
(26) TP103 Y SLAVE CURRENT

AIR DIAGRAM-MIN
115C-0200-MD8
FORMERLY MIN. AD. 6700 SERIES

0125911 D842061 SW 7/61



AIR DIAGRAM-MIN
115C-0200-MD9
FORMERLY MIN. AD. 6780 SERIES

0125911 D842071 SW 7/61

F.G.R.I. 26008/1 (CR 787A) SYSTEM DESCRIPTIVE

D1361

FIG.9

AIR DIAGRAM-MIN
115C-0200-MD10
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN A.D. 6780 SERIES

F.G.R.I. 26008/1 (COSSOR 787A) TRANSMITTER CHAIN.

FIG.10 D1362

TEST POINTS	(1) V1 In SW1 POSITION 1. V2A In SW1 POSITION 2. (2) V2B In SW1 POSITION 3. (3) V3 In SW1 POSITION 4 (4) V4 In SW1 POSITION 5. (5) PRE-PULSE SQUARE WAVE. (T_0-100µs to T_0) (6) MODULATOR TRIGGER. (7) MAGNETRON CURRENT (8) STANDING WAVE INDICATOR.
CONTROLS	(A) RV1 FREE RUN PRF. RV2 PREPULSE DURATION RV4 MULTIVIB JITTER COMPENSATION (B) MATCHING PLUNGER. (C) PHASE SHIFTER. (D) COHO CAVITY TUNE. (E) TR. CELL TUNE. (F) SET POWER METER RV1

0125911 D842071 SW 7/61

F.G.R.I. 26008/1 (COSSOR 787A) TRIGGER SELECT CHAIN

FIG.11 D 1366

CONTROLS	(A) TX SELECT SW (SYMBOLIC) (B) SW 5 MASTER / AUX CONTROL (C) SW 6 CHECK PRF (D) RV 1 DELAY ADJUST (E) RV 1 FREE RUN PRF; RV 2 PRE PULSE DURATION; RV 4 MULTIVIBRATOR JITTER COMPENSATOR (F) RV3 SECONDARY RADAR TRIG DELAY
TEST POINTS	(1) V1 Ia SW 1 pos 1 (2) V2A Ia SW 1 pos 2; V2B Ia SW 1 pos 3 (3) V3 Ia SW 1 pos 4 (4) V5B Ia SW 1 pos 7; V5A Ia SW 1 pos 6 (5) V4 Ia SW pos 5 (6) SECONDARY RADAR TRIGGER, MONITOR (7) PRE-PULSE SQUARE WAVE ($T_0 - 100\mu S$ to T_0)

AIR DIAGRAM-MIN
115C-0200-MD11
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
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AIR DIAGRAM-MIN
115C-0200-MD12
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
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FORMERLY MIN. AD 6780 SERIES

F.G. R.I. 26008/1 (CR 787A) ANTI RAIN PLATE CONTROL CHAIN

FIG. 12

D1367

CONTROLS	
	(A) SW 5 MASTER / AUX CONTROL (B) CB 2 MAINS CCT BREAKER (C) CB 14 ANTI RAIN PLATE MOTOR CCT BREAKER (D) SW 8 ANTI RAIN PLATE UP/DOWN (ON/OFF) (E) ANTI RAIN PLATE MOTOR START SW (NOT USED) (F) ANTI RAIN PLATE MOTOR STOP SW

0125911 D842071 SW 7/61

F.G.R.I. 26008/1 (COSSOR 787A) STANDBY AND E.H.T. REMOTE SWITCHING CONTROL.

FIG.13

D.1371.

CONTROLS.

- (A) SW3 MASTER/AUX CONTROL
- (B) SW1 TX1 STAND BY.
- (C) SW2 TX1 EHT.
- (D) SW3 TX2 STAND BY
- (E) SW4 T
- (F) SW1 TX1 STAND BY.
- (G) SW2 TX1 EHT.
- (H) SW3 TX2 STAND BY
- (J) SW4 TX2 EHT.
- (K) SW1 TX1 STAND BY.
- (L) SW2 TX1 EHT.
- (M) SW3 TX2 STAND BY.
- (N) SW4 TX2 EHT.

AIR DIAGRAM-MIN
115C-0200-MD13
FORMERLY MIN. AD. 6780 SERIES

0125911 D842071 SW 7/61

FRGI 26008 /1 (COSSOR 787A) AERIAL TURNING CONTROL CHAIN

FIG. 15

D1373

CONTROLS	(A) SW5 MASTER/AUXILIARY CONTROL; (B) SW9 AERIAL TURNING START/STOP; (C) EARTH LEAKAGE CIRCUIT BREAKER; (D) ISOLATOR SWITCH; (E) STOP BUTTON; (F) ROOF SAFETY KEY SW1; (G) START BUTTON; (H) SLOW MEDIUM OR FAST START CONDITION SELECT
FUSES	(1) FS1 5 AMPS

AIR DIAGRAM-MIN
115C-0200-MD15
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN. AD 6780 SERIES

0125911 D842071 SW 7/61

FGR1 2008/1 (COSSOR 787A) BEARING RESOLVER CHAIN

FIG.16

CONTROLS	(A) SBC/B COARSE ATTEN, SBC/A FINE ATTEN; (B) SBB/C COARSE ATTEN., SAB/D FINE ATTEN.; (C) SBA/A COARSE ATTEN., SAC/E FINE ATTEN.; (D) SBB/B COARSE ATTEN., SAB/C FINE ATTEN.; (E) SBC/E COARSE ATTEN, SAA/B FINE ATTEN; (F) RV1 H.S. BALANCE; (G) RV2 L.S. BALANCE; (H) S A I/P SELECTOR POS 1 FREE RUN (INDEPENDENT OF AERIAL) 2 FOLLOW 3 0° 4 270°; (J) RV3 FREE RUN SPEED; (K) RV7 AMBIGUITY SIGNAL PHASE; (L) RV1 HIGH SPEED TAKEOVER; (M) RV8 TACHO PHASE ADJ; (N) RV2 MOD. BALANCE; (P) RV4 DIRECT FEEDBACK; (Q) RV5 DELAYED FEEDBACK; (R) RV6 ERROR SIG. PHASE ADJ.
TEST POINTS	(1) MONITOR SC1 POS.10 AMBIGUITY SIG.; (2) MONITOR SC1 POS.5 V1 ANODE, SC1 POS.4 V2 ANODE; (3) MONITOR SC1 POS.8 TACHO O/P; (4) SB METER POS.1 V12 Ia (SEE INSET); (5) MONITOR SC1 POS.2 L.S. ERROR; (6) MONITOR SC1 POS 1 H.S. ERROR; (7) MONITOR SC1 POS 5 MOD O/P; (8) SB METER POS.2 V4 CURRENT (SEE INSET); (9) MONITOR SC1 POS.9 MIXED F/B, SB METER POS 6 V15B Ia (SEE INSET); (10) SB METER POS 7 V15A Ia (SEE INSET); (11) MONITOR SC1 POS.7 MOTOR PHASE; (12) MONITOR SC1 POS.6 AMP. O/P; (13) SB METER POS 5 V5A Ia, POS 4 V6 Ia, POS 5 V7 & V8 Ia } SEE INSET
FUSES	AIR DIAGRAM-MIR 115C-0200-MD16. FORMERLY MIN. A.D. 6780 SERIES. (1) FS1 2mA; (2) FS2 2mA; (3) FS1 2mA; (4) FS2 2mA

D1574

0125911 D842061 SW 7/61

FGRI 26008/1 (COSSOR 787A) NOISE FIGURE CHAIN

FIG.17

D1377

CONTROLS	(A) SW2 NOISE SOURCE ON/OFF SWITCH; (B) SW3 START/RUN SWITCH; (C) S1 PERMANENTLY CLOSED SWITCH; (D) RV1 NOISE TUBE CURRENT ADJUST; (E) CALIBRATED RF ATTENUATOR; (F) TR CELL TUNE; (H) COARSE TUNING, FINE TUNING, CATHODE TUNING, PROBE INSERTION; (G) TROMBONE MATCHING PLUNGER; (J) TWT G2 (RV4) BEAM CURRENT SET, TWT G4 (RV2) VELOCITY ADJUST, TWT G3 (RV3) VELOCITY ADJUST, TWT HELIX (RV5) OPTIMUM GAIN; (K) SW5 O/L RESET; (L) RV2 SIGNAL GAIN, RV3 SWEPT GAIN AMP; (M) IMAGE REJECTION ADJUST; (N) SW1 SWEPT GAIN LAW; (P) RV4 TEST AMP GAIN; (Q) SW1 DETECTOR & SELECT ON POS 8; (R) PB1 FINE METER CHECK
TEST POINTS	AIR DIAGRAM-MIN 115C-0200-MD17 BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE. ISSUE 1. Prepared by Technical Training Command. FORMERLY MIN AD 6780 SERIES. (1) NOISE TUBE CURRENT. Note: METER SWITCH 2 AND METER M1 ARE LOCATED ON FRONT PANEL OF MICROWAVE PRE-AMP UNIT S13/1. (2) TWT G2 METER SWITCH 2 POSN 6; (3) TWT G4 METER SWITCH 2 POSN 4; (4) TWT G3 METER SWITCH 2 POSN 5; (6) TWT HELIX (CURRENT) METER SWITCH 2 POSN 1; (5) TWT HELIX (VOLTS) METER SWITCH 2 POSN 3; (7) TWT COLLECTOR METER SWITCH 2 POSN 2; (8) TWT MAGNET METER SWITCH 2 POSN 7; (9) SWEPT GAIN O/P MONITOR PRE AMPLIFIER FRONT; (10) POSITIVE CRYSTAL CURRENT S1 POSITION 7, NEGATIVE CRYSTAL CURRENT S1 POSITION 6, SWEPT GAIN V3 CURRENT S1 POSITION 5; (11) DETECTOR CURRENT
FUSES	(1) FS1 250 mA; (2) FS3 10 mA

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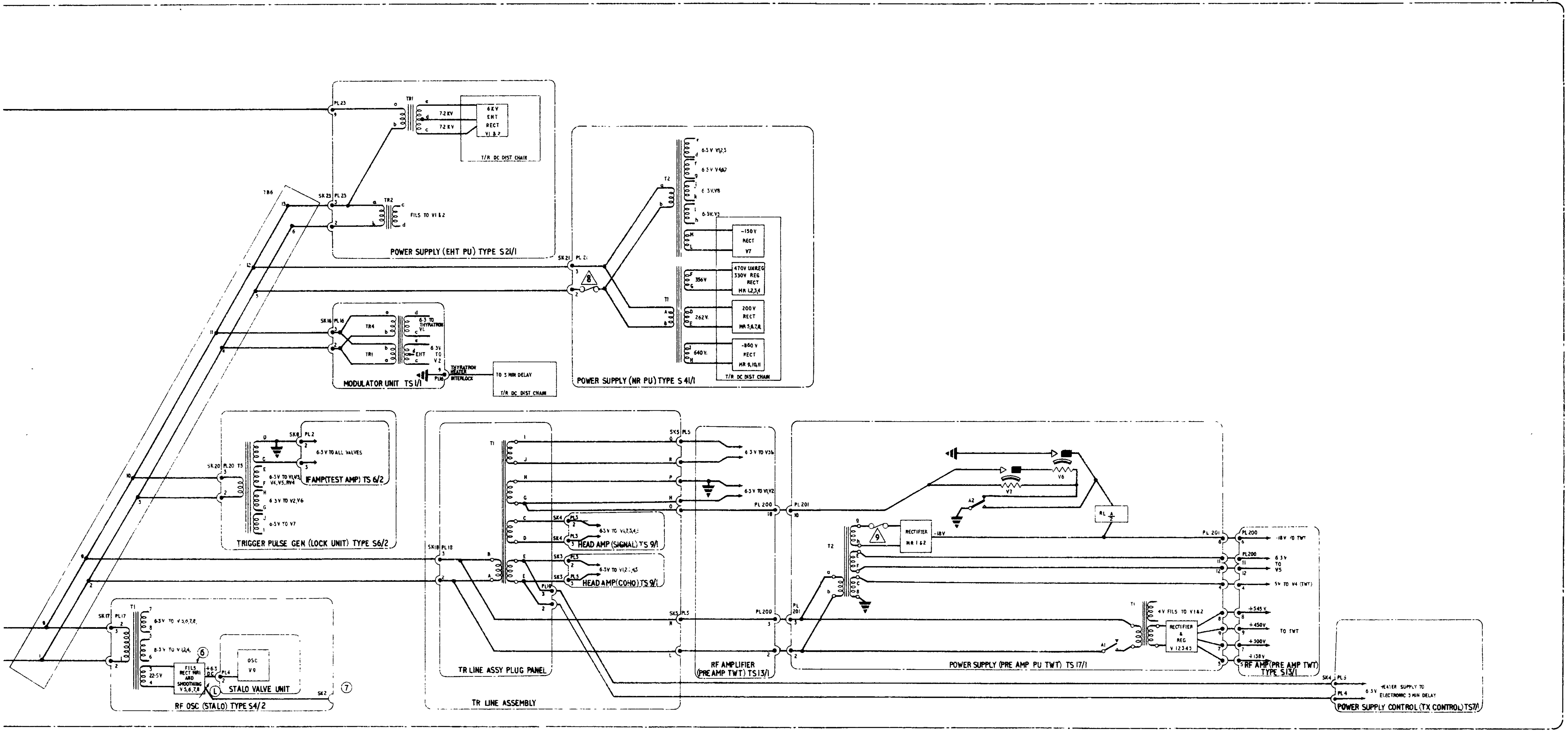
FGRI 26008/1 (COSSOR 787A) T/R ASSEMBLY AC DISTRIBUTION CHAIN. SHEET 1

D1389 FIG.18

CONTROLS	(A) ON/OFF SWITCH; (B) P1 SET FINE, P2 SET COARSE; (C) CIRCUIT BREAKER; (D) SW3 EHT ON/OFF; (E) SW2 REMOTE/LOCAL; (F) SW4 CABINET HEATERS ON/OFF; (G) NORMAL/STOP EHT SWITCH; (H) HAND CONTROL 230V ADJUST; (I) SW1 MTI MAINS ON/OFF; (J) SW2 AGC/MANUAL GAIN; (K) SW2 TEST/NORMAL
TEST POINTS	AIR DIAGRAM-MIN 115C-0200-MD18 BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE. ISSUE 1. Prepared by Technical Training Command. FORMERLY MIN. AD. 6780 SERIES; (1) METER SWITCH POSITION INPUT VOLTS; (2) METER SWITCH POSITION OUTPUT VOLTS; (3) CURRENT READING; (4) SW5 POS VARIAC I/P METER1; (5) SW5 POS O/P SET 230V METER1
FUSES	1 40 AMP FUSE; 2 10 AMP FUSE; 3 FS 15 AMPS; 4 FS 15 AMPS; 5 FS 2 10 AMPS; 6 FS1 10 AMPS; 7 FS1 3 AMPS



FGR1 26008/1 (COSSOR 787A) T/R ASSEMBLY AC DISTRIBUTION CHAIN SHEET 2

FIG19

D 1368

(L) PRE SET HEATER VOLTS

AIR DIAGRAM-MIN
115C-0200-MD19

FORMERLY MIN. AB 6780 SERIES

(6) SW1 POS9 V8 Ia
SW1 POS5 V6,5 Ia
SW1 POS6 V6 Ia
SW1 POS8 V8 Ia
SW1 POS7 V7 Ia
SW1 POS1 TO 4 - SEE D.C. DIST CHAIN

NOTE
METER IS MOUNTED EXTERNALLY ON T/R ASSY

(7) HEATER RIPPLE

(8) FS1 5 AMPS

(9) FS1 15 AMPS

26008/1 (COSSOR 787A) T/R CONTROL AND POWER DISTRIBUTION DESCRIPTIVE SHEET 1

D1386

FIG. 20A

0125911 D842061 SW 7/61

AIR DIAGRAM-MIN
115C-0200-MD20A
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
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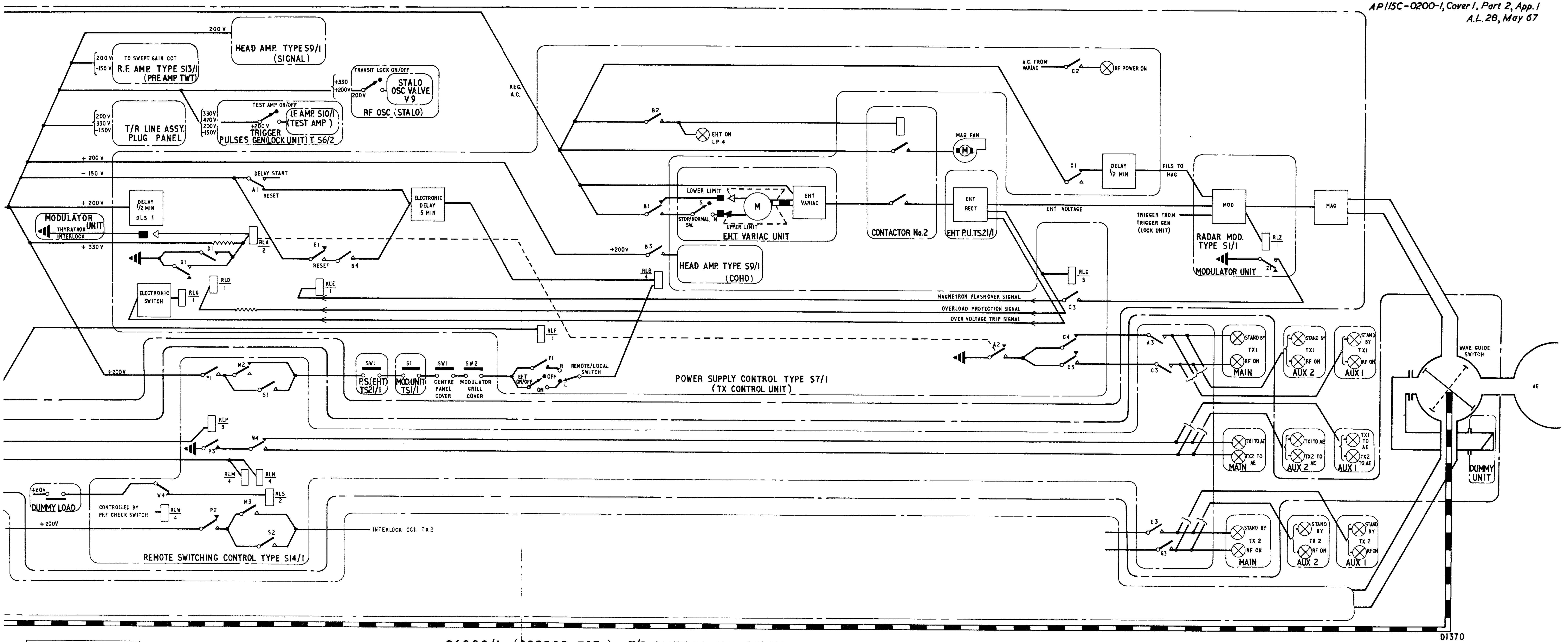


26008/1 (COSSOR 787A) T/R CONTROL AND POWER DISTRIBUTION DESCRIPTIVE DIAGRAM SHEET 2

FIG. 20B

AIR DIAGRAM-MIN
115C-0200-MD20B
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN. AD 6780 SERIES

0125911 D842071 S.W. 7/61

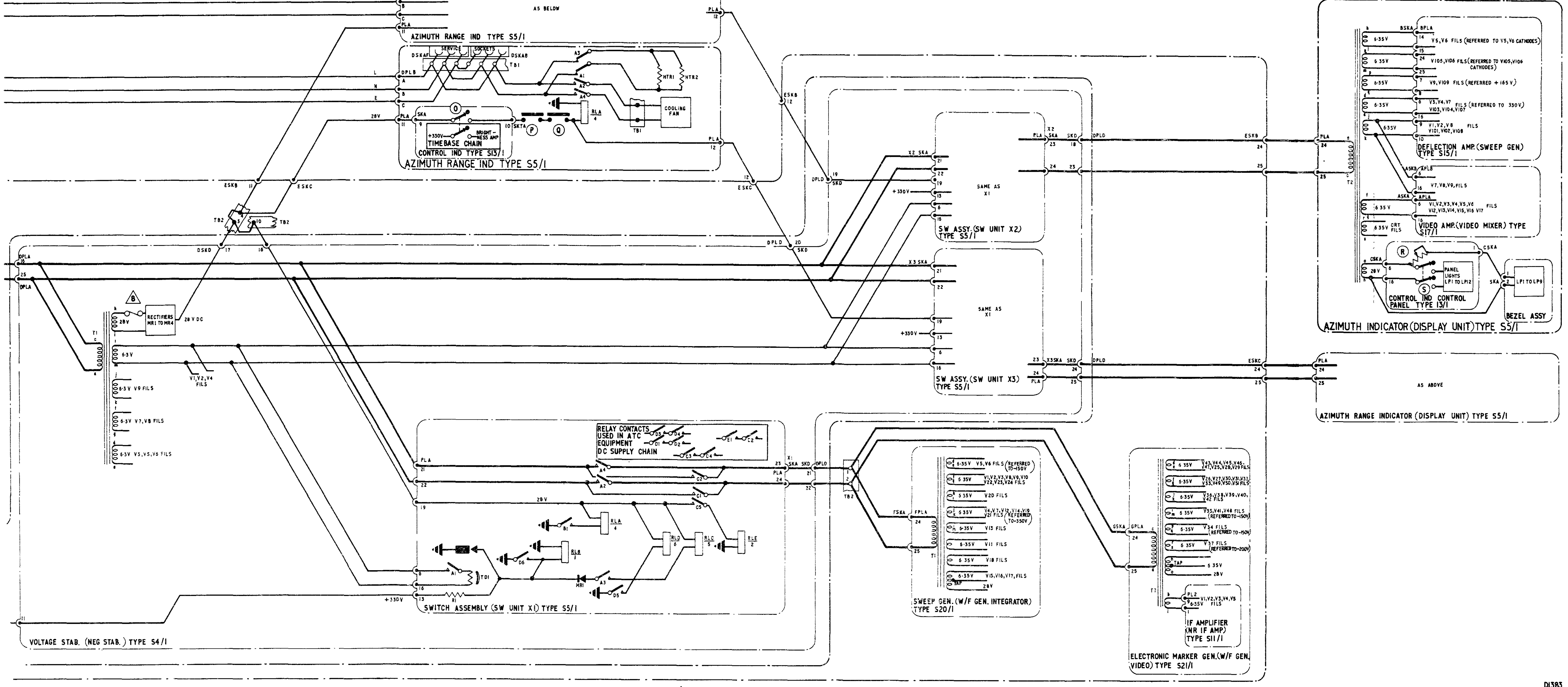
FGRI 26008/1 (CR 787A) AC DISTRIBUTION OF ATC EQUIPMENT SHEET 1

FIG. 21

CONTROLS	AIR DIAGRAM-MIN 115C-0200-MD21 BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE. ISSUE 1. Prepared by Technical Training Command. FORMERLY MIN AO. 6780 SERIES	(A) SW1-STABILISER ON/OFF (B) SWB SERVICING LAMP ON/OFF (C) SWB SERVICING LAMP ON/OFF (D) SWC MECHANICAL INTERLOCK (E) SW2 I/P & O/P VOLTAGE MONITOR (F) SWD MECHANICAL INTERLOCK (G) SWE MECHANICAL INTERLOCK (H) SWA EMERGENCY ON/OFF (I) SWC POWER UNIT ON/OFF (J) POS. DC ON/OFF (K) SWC MECHANICAL INTERLOCK (L) SWD MECHANICAL INTERLOCK (M) SWE MECHANICAL INTERLOCK (N) SWA EMERGENCY ON/OFF
FUSES		(1) FS1 (2) FS6 5A (3) FS5 5A (4) FS1 5A (5) FS2 5A (6) FS1 5A (7) FS2 5A

D1375

0125911 D842061 SW 7/61



FGRI 26008/1 (CR 787A) AC DISTRIBUTION OF ATC EQUIPMENT SHEET 2

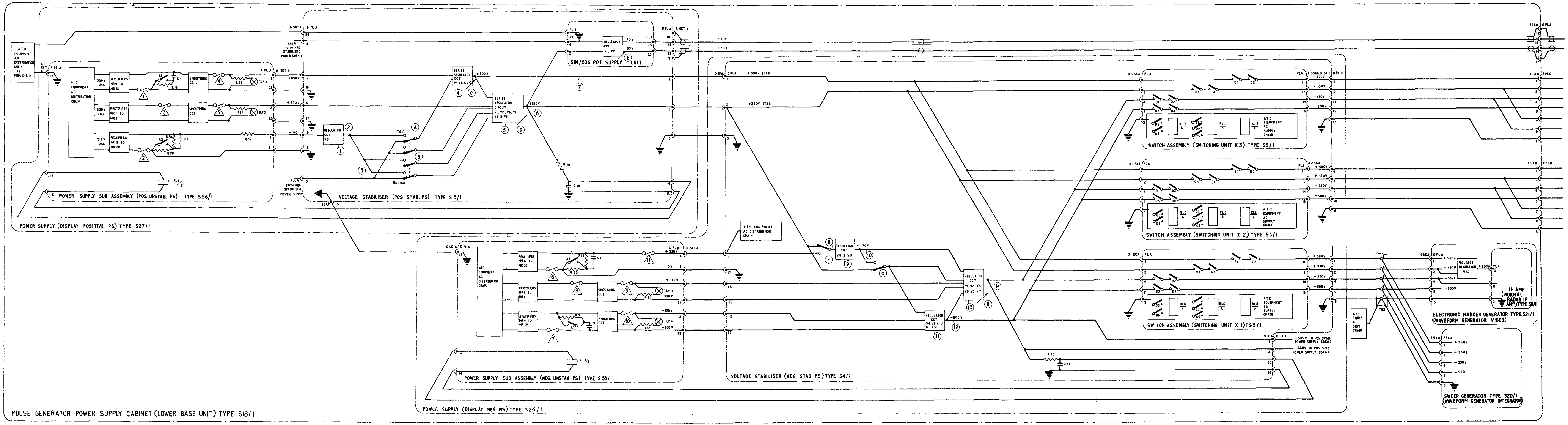
D1383
FIG.22

AIR DIAGRAM-MIN
115C-0200-MD22
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN.AD 678D SERIES

(O) SWD DISPLAY ON/OFF
(P) SWA MECHANICAL INTERLOCK (SIDE PANEL)
(Q) SWB MECHANICAL INTERLOCK (SIDE PANEL)
(R) RV15 CURSOR ILLUMINATION
(S) SWF PANEL ILLUMINATION ON/OFF
(8) FSI 2A

0125911 D842071 SW 7/61



FGRI 26008/1 (CR787A) A.T.C. EQUIPMENT DC DISTRIBUTION CHAIN SHEET 1

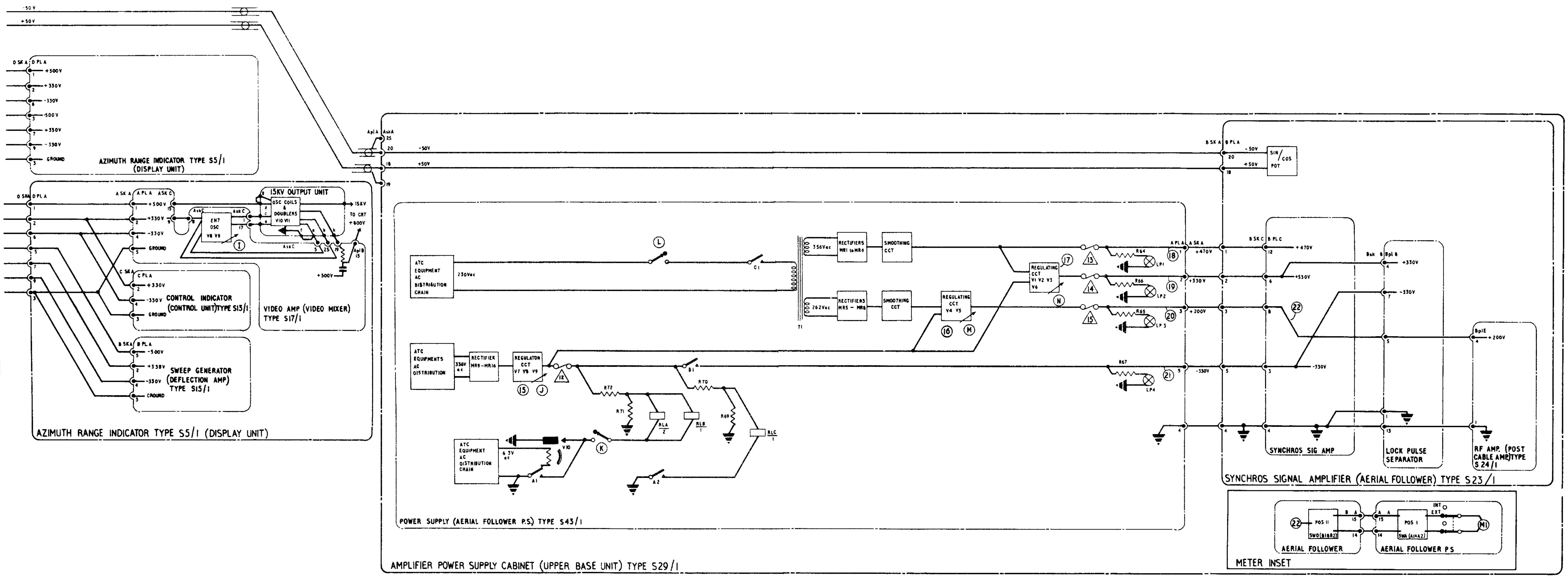
FIG. 23

D1380

FUSES	(1) FS4-0·5A (2) FS5-0·5A (3) FS5-1A (4) FS7-250 mA (5) FS6-1A (6) FS5-0·5A (7) FS4-0·5A (8) FS3 1A (9) FS6-1A (10) FS7-100 mA (11) FS8-250 mA
CONTROLS	(A) SWB2 NORMAL/TEST (B) SWB1 NORMAL/TEST (C) RV5-SET + 500V (D) RV1-BALANCE CONTROL, RV2-BALANCE CONTROL, RV3-BALANCE CONTROL, RV4-SET + 530V (E) RV1-SET +50V, RV2-SET -50V (F) SWB1-NORMAL/TEST (G) SWB2-NORMAL/TEST (H) RV1 BALANCE CONTROL, RV2 BALANCE CONTROL, RV4 BALANCE CONTROL, RV3 SET-530V
TEST POINTS	(1) V3 ANODE CURRENT-M1 SWA POS 7 (2) -85V M1 SWA POS 2 (3) -300V M1 SWA POS 1 (4) +500V LINE CURRENT-M1 SWA POS 6 (5) +300V LINE CURRENT M1 SWA POS 5, V6 Ia-M1 SWA POS 8, V7 Ia-M1 SWA POS 9, V8 Ia-M1 SWA POS 10, V9 Ia-M1 SWA POS 11 (6) +330V-M1 SWA POS 3 (7) +500V M1 SWA POS 4 (8) 330V-M1 SWA POS 4 (9) V9 Ia-M1 SWA POS 7 (10) +170V M1 SWA POS 3 (11) -500V LINE CURRENT-M1 SWA POS 5 (12) -500V-M1 SWA POS 1 (13) V5 Ia-M1 SWA POS 8, V6 Ia-M1 SWA POS 9, V7 Ia-M1 SWA POS 10, V3 Ia-M1 SWA POS 11, -530 LINE CURRENT M1 SWA POS 6 (14) -330V-M1 SWA POS 2

AIR DIAGRAM-MIN
115C-0200-MD23
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN. AD. 6780 SERIES



FGR1 26008/1 (CR787A) ATC EQUIPMENT DC DISTRIBUTION CHAIN SHEET 2

FIG.24

(12) FS4–100mA

(13) FS1–100mA
(14) FS2–500mA
(15) FS3–250mA

(I) HV3 SET EHT

(J) RV3–SET–330V
(K) SWD–STAND-BY ON/OFF
(L) SWE POS DC ON/OFF

(M) RV2–SET+200V

(N) RV1–SET+330V

(15) –330V LINE CURRENT–METER SWA4 pos 10

(16) +200V LINE CURRENT METER SWA4 POS 9

(17) +330V LINE CURRENT–METER SW A4 POS 8
V1 Ia METER SWA4 POS 5
V2 Ia METER SWA4 POS 6
V3 Ia METER SWA4 POS 7

(18) +470V SUPPLY METER SWA4 POS 1
(19) +330V SUPPLY METER SWA4 POS 2
(20) +220V SUPPLY METER SWA4 POS 3
(21) –330V SUPPLY METER SWA4 POS 4

(22) POST CABLE AMP HT CURRENT–SWD POS 11 (SEE INSET)

AIR DIAGRAM–MIN
115C–0200–MD24
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

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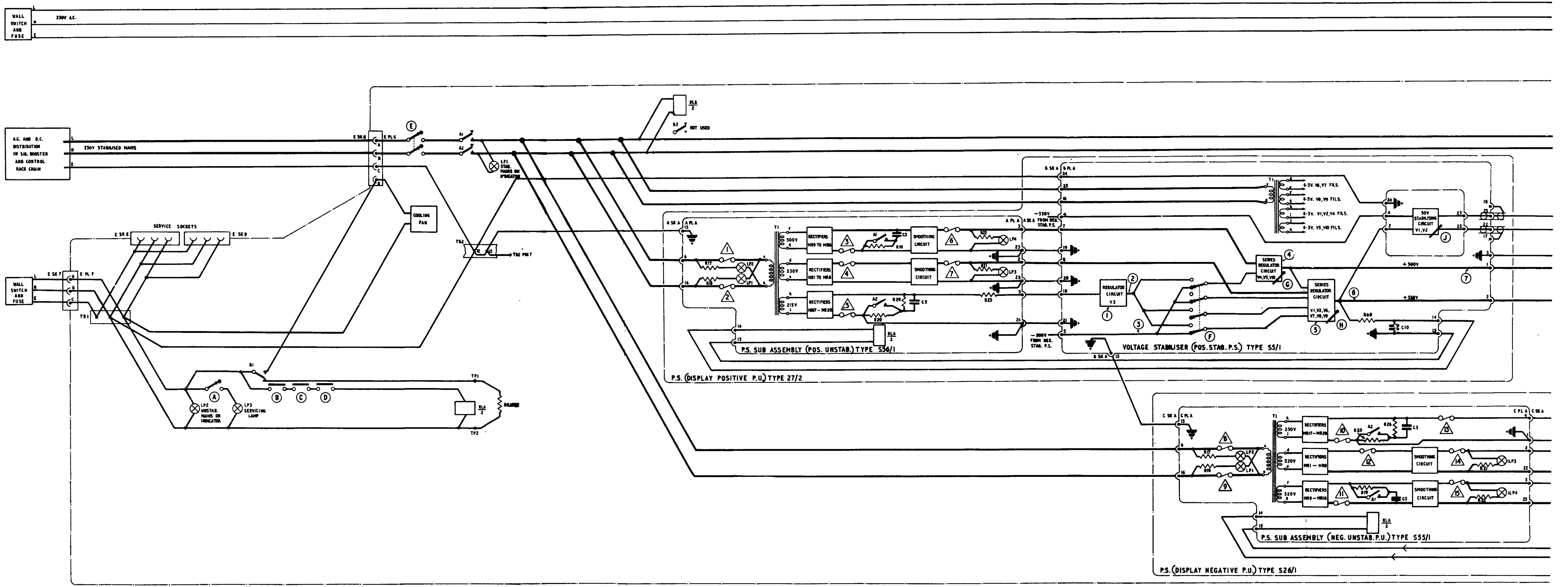
6780 SERIES

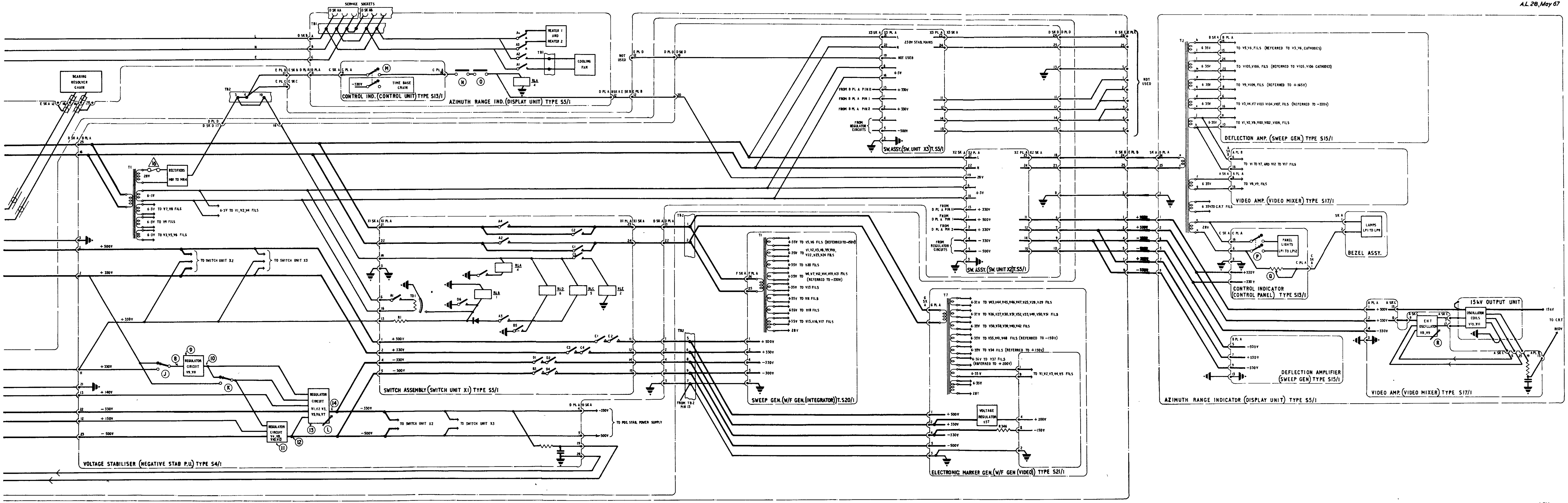
D1384



F.G.R.I. 26008/1 (CR787) MONITOR EQUIPMENT— A.C. AND D.C. DISTRIBUTION CHAIN—SHEET 1

D1382
FIG.25

CONTROLS	(A) SW.B, SERVICING LAMP ON/OFF (B) SW.C, MECHANICAL INTERLOCK (D) SW.E, MECHANICAL INTERLOCK (C) SW.D, MECHANICAL INTERLOCK (E) SW.A, EMERGENCY ON/OFF (F) SW.B, NORMAL/TEST (G) RV5, SET +500V (H) RV1, RV2, RV3, BALANCE CONTROLS RV4, SET +330V (J) RV1, SET +50V RV2, SET −30V
TEST POINTS	(1) V3 Ia, M1 SW.A POS.7 (2) −85V, M1 SW.A POS.2 (3) −500V, M1 SW.A POS.1 (4) +500V. LINE CURRENT M1 SW.A POS.6 (5) +500V LINE CURRENT. M1 SW.A POS.5 V6 Ia, M1 SW.A POS.8 V7 Ia, M1 SW.A POS.9 V8 Ia, M1 SW.A POS.10 V9 Ia, M1 SW.A POS.11 (6) +330V, M1 SW.A POS.3 (7) +500V, M1 SW.A POS.4
FUSES	AIR DIAGRAM-MIN 115C-0200-MD25 FORMERLY MIN. AD. 6780 SERIES 1 FS1-5A 2 FS2-5A 3 FS4-0·5A 4 FS3-1A. 5 FS5-0·5A 6 FS7-250mA 7 FS6-1A 8 FS1-5A 9 FS2-5A 10 FS5-0·5A 11 FS4-0·5A 12 FS3-1A 13 FS8-250mA 14 FS6-1A 15 FS7-100mA



F.G.R.I. 26008/1 (CR787) MONITOR EQUIPMENT — AC AND DC DISTRIBUTION CHAIN — SHEET 2

FIG. 26

D1385

(J) SW. B1 — NORMAL/TEST
(K) SW. B1 — NORMAL/TEST
(L) RV1, RV2, RV4 — BALANCE CONTROLS; RV3 — SET −330V
(M) SW. D — DISPLAY ON/OFF
(N) SW. A — MECHANICAL INTERLOCK
(O) SW. B — MECHANICAL INTERLOCK
(P) SW. F — PANEL ILLUMINATION ON/OFF
(Q) RV15 — CURSOR ILLUMINATION
(R) RV3 — SET EHT

(8) +330V — M1, SW. A, POS. 4
(9) V9 Ia — M1, SW. A, POS. 7
(10) +170V — M1, SW. A, POS. 3
(11) −500V LINE CURRENT M1, SW. A, POS. 5
(12) −500V — M1, SW. A, POS. 1
(13) V5 Ia — M1, SW. A, POS. 8; V6 Ia — M1, SW. A, POS. 9; V7 Ia — M1, SW. A, POS. 10; V3 Ia — M1, SW. A, POS. 11; 330V LINE CURRENT — M1, SW. A, POS. 6
(14) −330V — M1, SW. A, POS. 2

(16) FS1 — 2A

AIR DIAGRAM - MIN
115C-0200-MD26

FORMERLY MIN. AD. 6780 SERIES

0125911 D842071 SW 7/61

AIR DIAGRAM-MIN
115C-0200-MD29
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by Technical Training Command

FORMERLY MIN AB. 6780 SERIES

FGRI 26008/I (COSSOR 787A) T/R D.C. DISTRIBUTION CHAIN

FIG. 29

D1387

CONTROLS	(A) RV3 SET −150V; (B) RV2 SET +330V; (C) RV1 SET +200V; (D) SW3 EHT ON/OFF; (E) SW2 REMOTE/LOCAL SWITCH; (F) SW2 ON/OFF TEST AMP; (G) RV2 HT SET; (H) SW2 TRANSIT LOCK ON/OFF SWITCH; (J) RV1 SET HEATER VOLTS; (K) RV1 SET HEATER VOLTS; (L) RV1 T/R CELL CURRENT ADJUST
TEST POINTS	(1) SW1 POS 9 V7 Ia; (2) SW1 POS 10 −800V; (3) SW1 POS 6 V1 CURRENT, SW1 POS 7 V2 CURRENT, SW1 POS 8 V3 CURRENT; (4) SW1 POS 5 V5 CURRENT; (5) SW1 POS 3 +208V; (6) SW1 POS 2 +470V; (7) SW1 POS 4 +338V; (8) SW1 POS 1 −150V; (9) MN 3 +288V; (10) MN 4 +470V; (11) MN 2 +330V; (12) MN 1 −150V; (13) SW1 POS 2 V4 Ia, SW1 POS 1 V1 Ia; (14) SW1 POS 3 V9 HT VOLTS; (15) SW1 POS 9 V5 Ia, SW1 POS 6 V6 Ia, SW1 POS 7 V7 Ia, SW1 POS 8 V8 Ia; (16) SK1 HT RIPPLE; (17) S1 POS 3 SIG HEAD AMP I HT; (18) S1 POS 4 COHO HEAD AMP I HT; (19) JK 2 EHT VOLTS; (20) JK1 EHT CURRENT; (21) SW1 POS 7 P.S.D. V7, 8 Ia; (22) SW1 POS 5 P.S.D. V2-5 I HT; (23) SW1 POS 6 P.S.D. V1 I; (24) SW1 POS 4 LOCKING AMP I HT; (25) SW1 POS 1 COHO Ia; (26) SW1 POS 3 LIMIT AMP Ia; (27) SW1 POS 2 LIMIT AMP Ia; (28) SW1 POS 7 LINE DRIVE MOD I HT; (29) SW1 POS 6 20 MC/S OSC V1 Ia; (30) SW1 POS 2 POST AMP I HT; (31) SW1 POS 3 COMP AMP V1 Ia
FUSES	⚠1 FS1 15mA; ⚠2 FS5 100mA; ⚠3 FS2 500mA; ⚠4 FS5 60mA; ⚠5 FS5 250mA