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NO-BREAK P.R.F. GENERATING EQUIPMENT

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

L. T. Durrett

Ministry of Defence

FOR USE IN THE
ROYAL AIR FORCE

(Prepared by the Ministry of Technology)

A.L.4, August 68

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AMENDMENT RECORD SHEET

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GENERAL AND TECHNICAL INFORMATION

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Clive Whitmore.

Ministry of Defence

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◄The reference number of this publication was altered from A.P.4769E, Vol. 1 to A.P.115Z-0100-1 in August 1968. No general revision of page captions has been undertaken but the code number appears in place of the earlier A.P. reference on new or amended leaves subsequent to that date.►

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GENERAL INFORMATION

Chapter 1

INTRODUCTION
(completely revised)

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GENERAL DESCRIPTION

1 The function of the no-break trigger system is to produce a repetitive series of output pulses, at various timings with respect to a datum pulse, for triggering a variety of external equipment. Provision is made for the overall p.r.f. to be synchronized with demands from the external circuits. To maintain operational facilities, and to prevent damage to external components, such as magnetrons, due to loss of triggering, the system has to provide a high degree of reliability.

2 To obtain the degree of frequency stability required, crystal oscillators are used as the fundamental frequency sources. The fine tuning of the oscillators and thereby the final p.r.f. is controlled by an error signal fed in from the external equipment. The required reliability is catered for by providing dual channel operation, main and standby, with automatic fault monitoring and consequent changeover. These circuits are so designed that output can be maintained, not only from a fault free channel, but can also be provided from combinations of serviceable main and standby units. Speed of changeover is ensured by the use of electronic gates.

3 The equipment is contained in two cabinets, one housing the main units and the other the standby units, plus two further units designed for underfloor mounting. These latter units, the distribution unit, pulse 5945-99-948-9262 and the relay assembly 5945-99-948-9225, are concerned with the distribution of the outputs and the error signal input, and are common to both channels. There is also a wall-mounting unit, panel indicator, pulse 5840-99-951-3254 whose function is to give a continuous indication of the presence or absence of the inputs to the distribution unit, pulse.

EQUIPMENT CHARACTERISTICS

Inputs

4 The only inputs required are the p.r.f. correction signals and the power supplies, as follows:

4.1 Error signals. A 500 Hz signal whose phase and amplitude represent respectively the sign and frequency deviation of the p.r.f. from the required, and a 500 Hz fixed phase reference signal.

4.2 Power supplies:

240V a.c. 50 Hz. Two supplies at 5A rating each.

-50V d.c. Two supplies at 3A rating each.

-50V flashing return. A connection to the station indicator system.

+450V d.c. unregulated. Eight supplies at 0.8A rating each.

-425V d.c. unregulated. Two supplies at 0.4A rating each.

-625V d.c. unregulated. Two supplies at 50 mA rating each.

-500V d.c. reference supply. Two supplies used only as references.

Outputs

5 The nominal timings of the pulse outputs are illustrated on fig.1. All timings are with respect to the 0 microsecond datum pulse, the timings of normal (undelayed) pulses being fixed, while those of delayed pulses are variable over the range of +5 μs to 170 μs with respect to the initiating pulse. The p.r.f. can be anywhere in the range 245 Hz to 275 Hz as determined by the selected crystals in conjunction with the external p.r.f. correction. To provide a reference for the external p.r.f. comparison circuits, a sine wave at a nominal frequency of 500 Hz is derived from a sub-division of the crystal frequency and is fed to the comparison circuits. An output at the crystal frequency is provided as an external clock signal. Additional sinusoidal outputs of 6.14 and 8.19 MHz derived from L-C oscillators are provided.

6 A complete list of the signal titles and numbers of output, together with the timing conditions, is given in Table 1. The specifications of the various outputs are as follows:

6.1 Normal pulse outputs except for those listed in sub-para.6.2 to 6.5.

Nominal amplitude 16V peak.
Rise time not greater than (0.3) μs.
Pulse width 4 μs ±10%.

6.2 Delayed pulse outputs and one 8 microsecond normal pulse output:

Nominal amplitude 30V peak.
Rise time not greater than (0.3) µs.
Pulse width 4 µs ±10%.

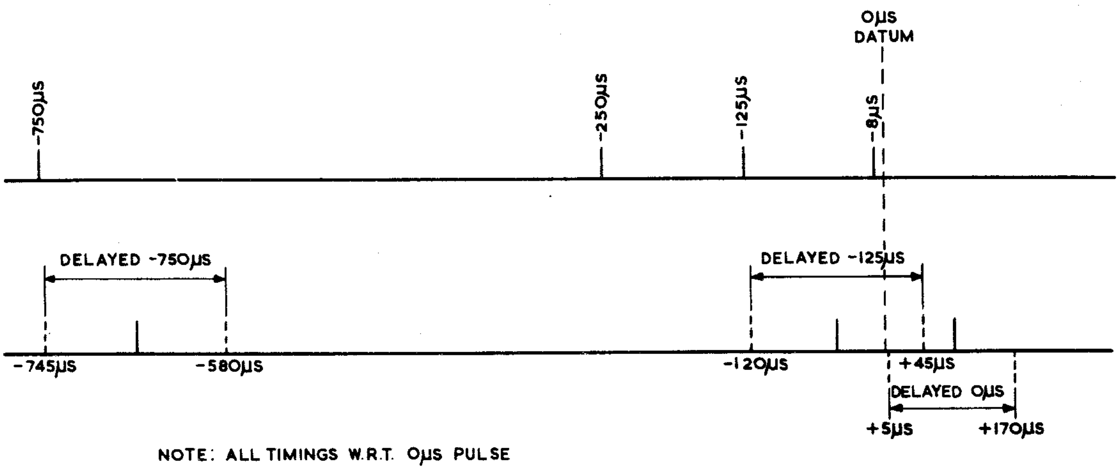

Fig.1 Pulse timing relationship

6.3 The -750 microsecond normal pulse output:

Nominal amplitude 24V peak.
Rise time not greater than 0.3 µs.
Pulse with 4 µs ±10%.

6.4 One -0 µs and one -125 µs normal pulse outputs:

Nominal amplitude 25V to 30V peak.
Rise time not greater than 0.3 µs.
Pulse width 4 µs ±10%.

6.5 One -125 microsecond normal pulse output:

Nominal amplitude 20V peak.
Rise time not greater than 0.3 µs.
Pulse width 4 µs ±10%.

6.6 PRF reference nominal frequency 500 Hz (twice the p.r.f. nominal amplitude 30V peak-to-peak.)

6.7 4, 6.14 and 8.19 MHz outputs, nominal amplitude 4V peak-to-peak.

TABLE 1 OUTPUT SIGNALS

Signal title	Number of outputs	Timing conditions
0 microsecond pulse	7	Fixed (datum)
Delayed 0 microsecond pulse	4	Preset +5 μs to 170 μs
-8 microsecond pulse	5	Fixed
-125 microsecond pulse	12	Fixed
Delayed -125 microsecond pulse	6	Preset -120 μs to +45 μs
-250 microsecond pulse	2	Fixed
-750 microsecond pulse	1	Fixed
Delayed -750 microsecond pulse	1	Preset -745 μs to -580 μs
PRF reference	1	500 Hz nominal (sub-division of crystal frequency)
6.14 MHz	3	Preset
8.19 MHz	4	Preset
Crystal frequency (4 MHz nom.)	1	

Note ...

All pulse timings with respect to the 0 microsecond pulse.

PART 2

TECHNICAL INFORMATION

Chapter 1

PRF GENERATING EQUIPMENT

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CONTENTS (Cont.)

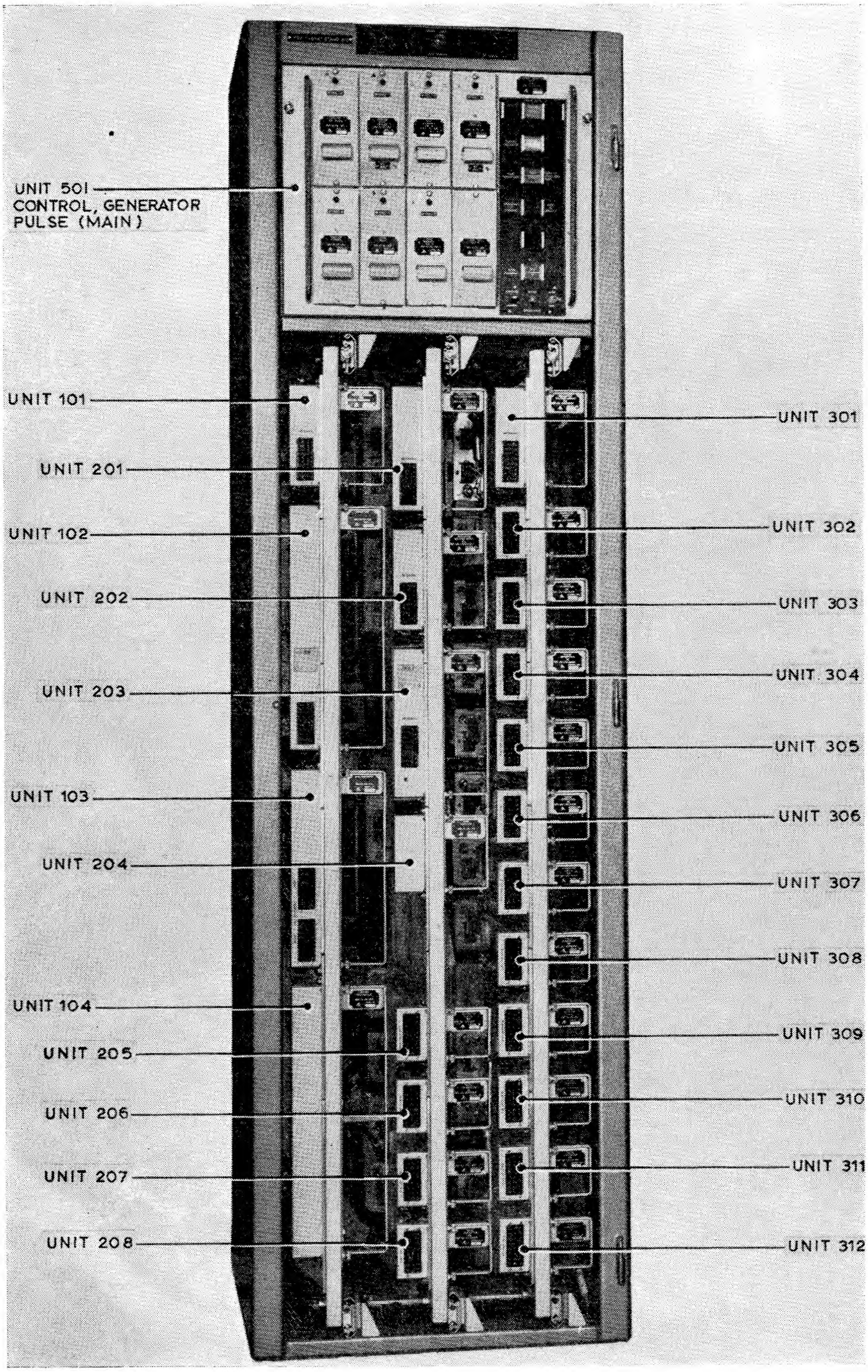


Fig. 1. P.R.F. cabinet (main): front view

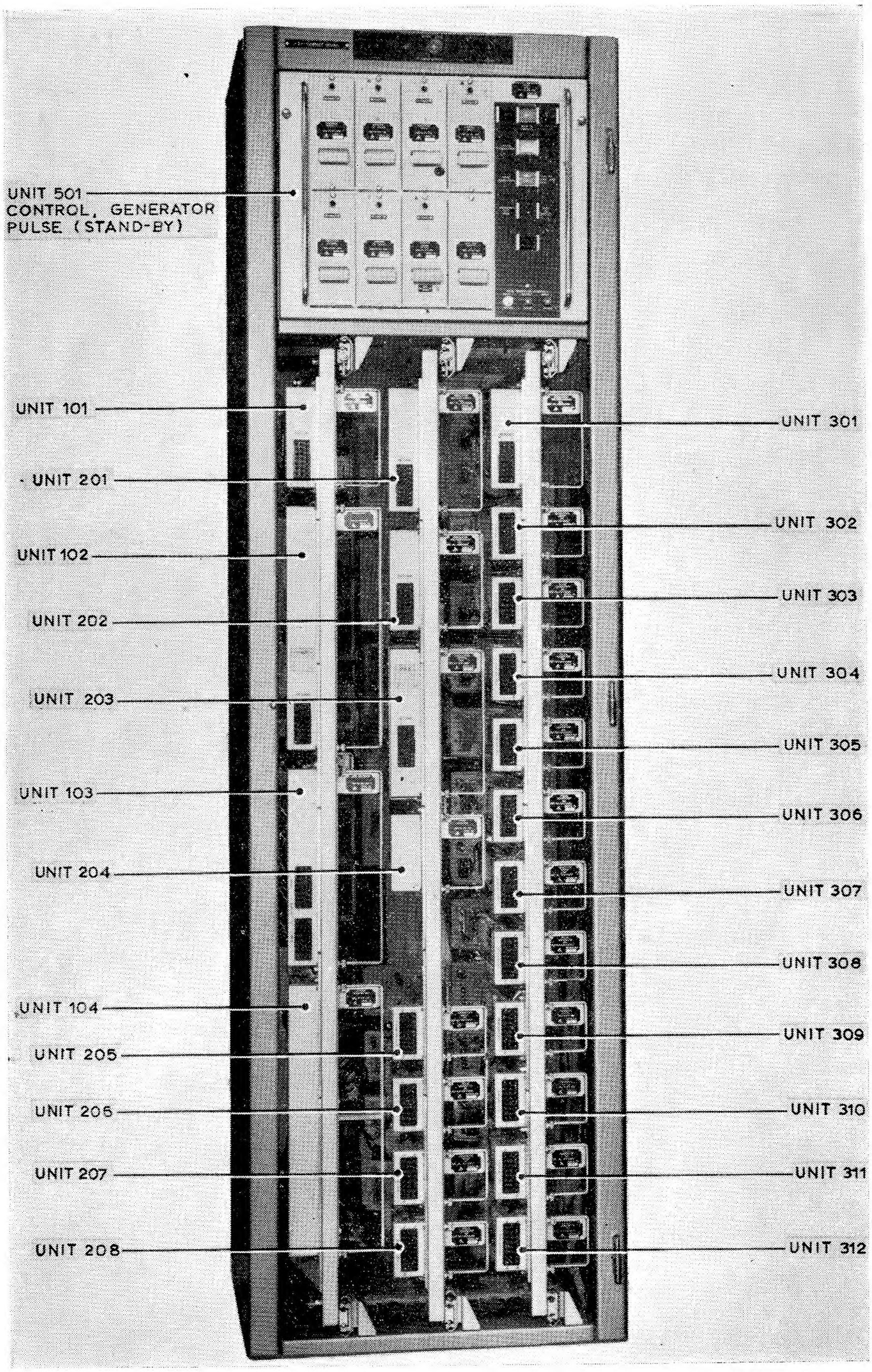


Fig. 2. P.R.F. cabinet (standby): front view

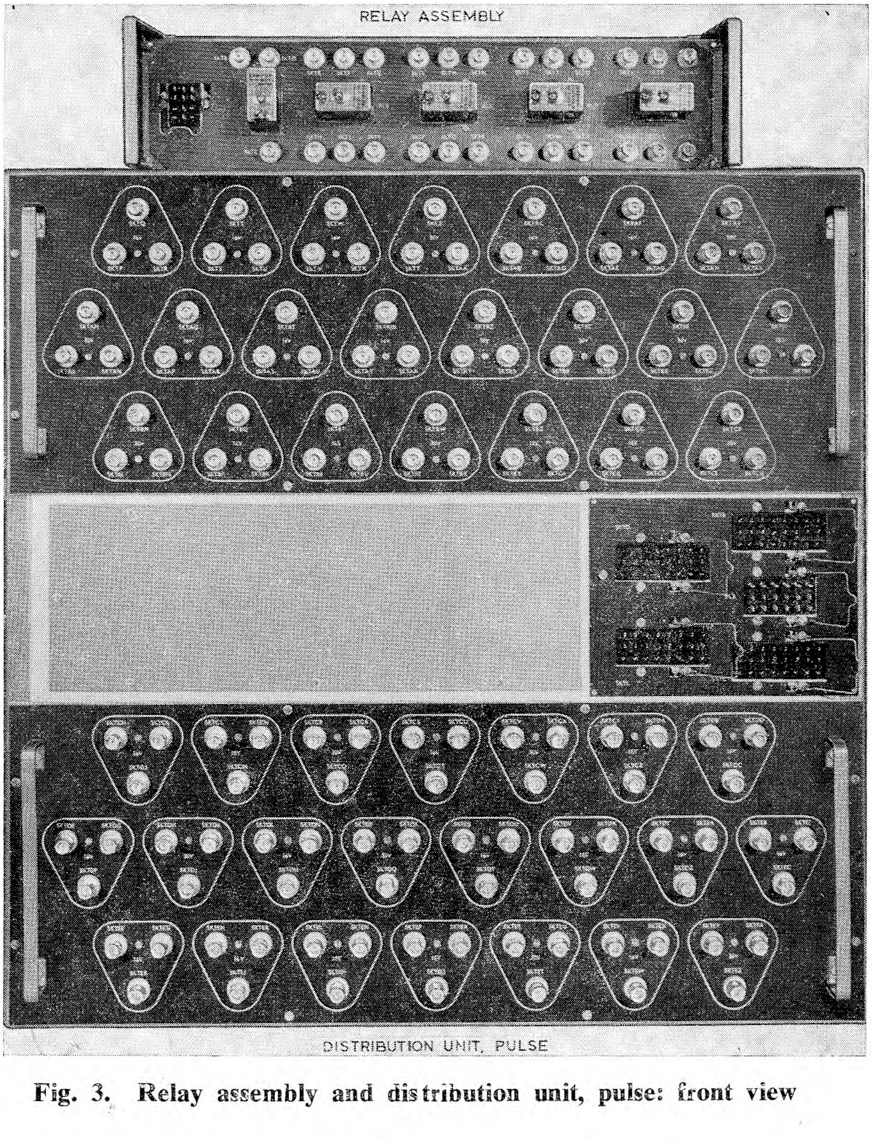


Fig. 3. Relay assembly and distribution unit, pulse: front view

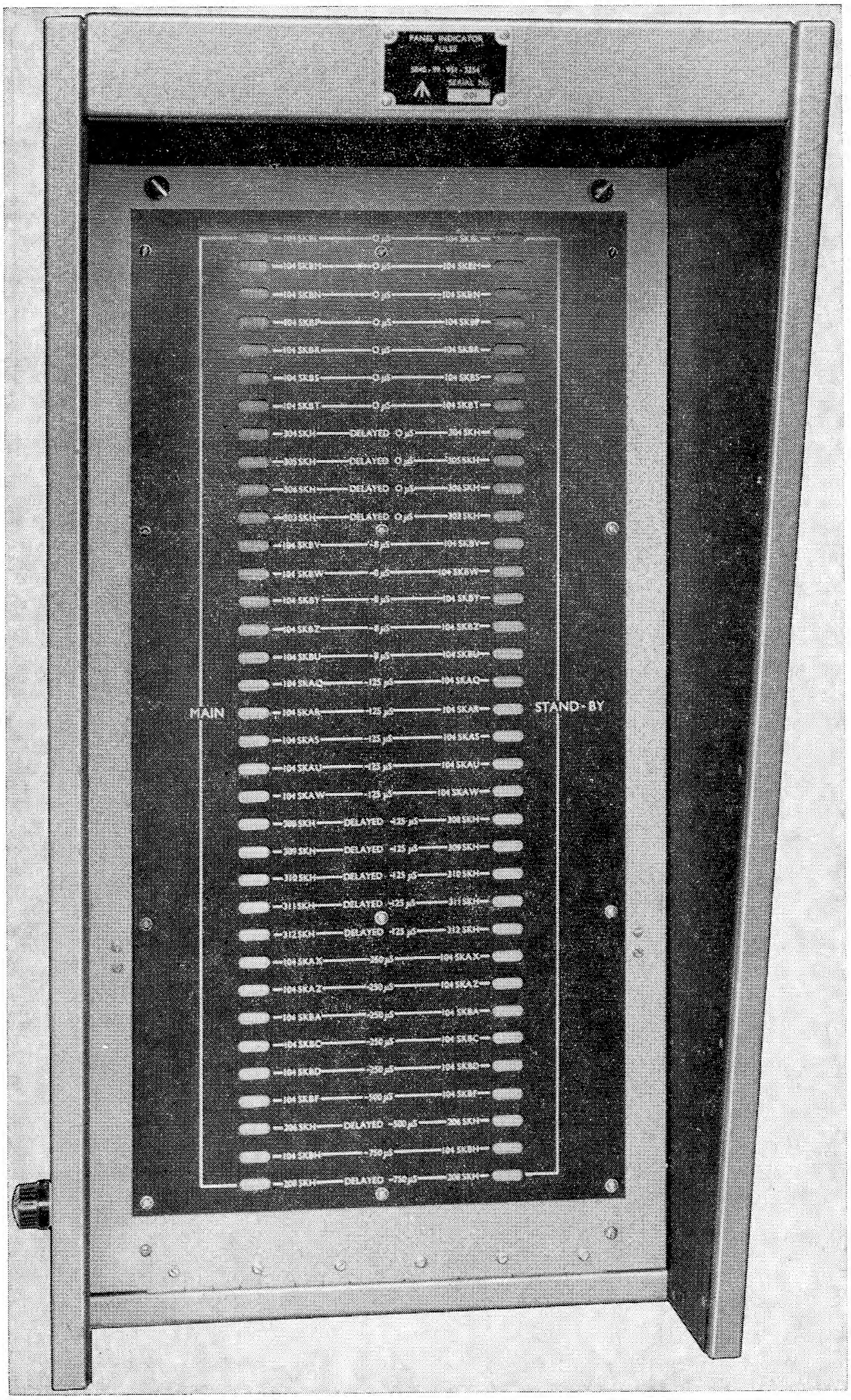


Fig. 4. Panel indicator, pulse: front view

INTRODUCTION

1 Views of the equipment forming the no-break trigger system are given in figs.1 to 4 and 11. The equipment comprises the following items:

1.1 PRF cabinet (main), figs.1 and 11. This contains the units of the main timing chain and a control, generator pulse, unit (main) associated with control and fault monitoring.

1.2 PRF cabinet (standby), figs.2 and 11. This contains the units of the standby timing chain, which are identical with those in the main timing chain, and a control, generator pulse, unit (standby) which differs electrically from the equivalent main unit, but which works in conjuction with it. Both control, generator pulse, units have the same physical dimensions and the remaining units are common to both cabinets, so this has made it possible to design the cabinet frameworks and wiring so that they are completely interchangeable.

1.3 Relay assembly and distribution unit, pulse, fig.3. These two units are mounted under the floor, close to the two p.r.f. cabinets. The relay assembly is concerned with the distribution of the crystal frequency (4 MHz nom.), 6.14 and 8.19 MHz signals and the 500 Hz p.r.f. reference signal from the cabinets to the external equipment, and also with the distribution of the external p.r.f. correction signals to the cabinets. The distribution unit, pulse is concerned with the distribution of the pulse outputs from the cabinets to the external equipment.

1.4 Panel indicator, pulse, fig.4. This unit is mounted on a wall close to the cabinets and continuously monitors the presence or absence of pulse inputs to the distribution unit, pulse.

FUNCTIONAL DESCRIPTION

General

2 A block diagram of the no-break trigger system is given on fig.10. Except for the two control, generator pulse, units, the individual units within the main and standby cabinets are identified, together with their functions; the two underfloor distribution units and the wall-mounting monitoring unit are also separatly identified. The functions of the control, generator pulse, units are so interdependent that they are shown combined as one block; these units are concerned with:-

1.1 Control - through which pulse output is switch on and certain operational decisions are set into the equipment.

1.2 Fault monitoring - by means of which faults are detected, the necessary changeover actions are carried out, and the fault conditions are analysed and indicator lamps are lit showing the state of the system and the probable area of the fault.

1.3 In addition, the main unit contains a flywheel oscillator which forms part of the main timing chain, while the standby unit contains a similar flywheel oscillator and also a motor-driven goniometer, both of which form part of the standby timing chain.

3 The functional description can be conveniently divided into three parts, namely: r.f. generation, pulse generation and output distribution, and is described under those headings.

RF generation

4 From both oscillator (crystal) units the crystal frequency, and the 6.14 MHz and 8.19 MHz signals, derived from L-C oscillators, are fed to the relay assembly. No automatic monitoring or fault detection is employed for these signals: the choice of which is selected for feeding to the external equipment depends upon the state of the timing circuits.

5 A second output from the main crystal oscillator passes through a divide-by-two stage. RF output from this stage at half the crystal frequency is routed to an r.f. gate, the presence of the r.f. signal being continuously monitored. From the standby crystal oscillator a similar r.f. is generated and is also presented to an r.f. gate, whose output is joined to the one presented with the main r.f. Outputs from the detectors which monitor the presence or absence of the main and standby r.f. signals are fed to a select main or standby electronic switch, whose alternative states are:

5.1 With both main and standby r.f. present, or with main r.f. present and standby r.f. absent, the circuit demands select main.

5.2 With standby r.f. present and main r.f. absent, the circuit demands select standby.

6 Outputs from the select main or standby switch circuit are taken to the r.f. gates and also to the relay assembly, then:

6.1 With main selected, the r.f. from the main crystal oscillator is allowed through the r.f. gates and that from the standby crystal oscillator is inhibited. At the relay assembly the 4, 6.14 and 8.19 MHz signals from the main oscillator (crystal) unit are passed out, the 500 Hz p.r.f. reference output from the main divider unit is passed out, and the p.r.f. correction inputs are applied to a motor in the main oscillator unit. This motor drives a frequency-pulling capacitor across the oscillator until the error is reduced to zero; that is when the p.r.f. generated is that demanded by the external equipment.

6.2 With standby selected, r.f. from the standby crystal oscillator is allowed through, and at the relay assembly the standby 4, 6.14 and 8.19 MHz and 500 Hz signals are passed out, and p.r.f. correction is applied to the standby crystal oscillator.

7 Because the range over which frequency pulling can be satisfactorily accomplished is limited, the crystals used in the crystal oscillators are chosen in accordance with the nominal p.r.f. in use.

8 The nature of the pulse output distribution circuits (para.15), which are designed to eliminate any interval between change from main to standby pulse outputs or vice versa, requires that the main and standby pulse are in alignment in time. this requirement, in conjunction with the further requirement that pulse output be maintained even if both crystal oscillators fail, determines the manner in which the pulse generation circuits are driven. The method adopted is

to drive these circuits from the outputs of flywheel oscillators, which are L-C oscillators tuned to oscillate at the nominal half crystal frequency.

9 As long as at least one of the crystal oscillators continues to function, r.f. output from the r.f. gates, at half crystal frequency and derived from either the main or standby crystal oscillator, is fed in parallel to the main and standby flywheel oscillators. These oscillators lock on to the input frequency and are thus synchronized to the crystal oscillator and with each other. Output from the main flywheel oscillator drives the main pulse generation circuits directly, while that from the standby flywheel oscillator passes through a motor-driven goniometer before driving the standby pulse generation circuits. The reason for this is that the subsequent frequency dividers in each chain cannot be relied upon to automatically start counting from the same pulse. When the equipment is switched on, or in the event of any subsequent phase slip, main and standby pulses are displayed and the goniometer is driven until they are in alignment.

10 If there is a failure such that no r.f. input is available to the flywheel oscillators, they are designed to oscillate at their pre-tuned frequency in order to provide an emergency p.r.f. output. Of course the p.r.f. obtained is no longer subject to external p.r.f. correction, and a remote warn of this fact is given. If both flyweel oscillators were allowed to oscillate under these circumnstances, then, since they are no longer locked to each other, the main and standby pulses would not be in alignment. For this reason only one flywheel oscillator is allowed to function, the other being inhibited. The decision as to which flywheel oscillator shall provide the emergency p.r.f. is preset into the equipment by the operation of a switch. With main emergency p.r.f. selected, the fault output from the r.f. detector monitoring the input to the flywheel oscillators is routed to inhibit the standby flywheel oscillator; with standby emergency p.r.f. selected, fault output is routed to inhibit the main flywheel oscillator.

<u>Pulse generation</u>

11 The action in the main and standby pulse generation circuits is identical. From its r.f. input, the divider unit produces groups of pulses, at various recurrence frequencies and timings, which are fed to the assoicated gate, electronic. As well as these outputs, an output at the basic p.r.f., nominally 250 Hz is monitored to prove that information is available for pulse production, while an output at twice this frequency, 500 Hz nominal, is fed to the relay assembly. This latter signal is routed out, main or standby according to the selected crystal oscillator.

12 At the gate, electronic, the inputs are gated together to derive outputs at each of the basic timings, namely -750, -500, -250, -125, -8 and 0 microseconds, which are taken to buffer amplifiers in the cathode follower unit. Except for three high impedance outputs, which are in parallel with similar ones of low impedance, each output from the cathode follower unit is fed through a separate amplifier. Normal pulse outputs, as opposed to delayed ones, are taken to the distribution unit, pulse, while one -8 microsecond pulse output is supplied to the fault monitoring circuits. the -750, -500, -125 and 0 microsecond pulse outputs from which the delayed pulses outputs are obtained are each fed to a generator, sweep, unit. At these units the input pulse initiates a sawtooth waveform, which is fed to a separate pulse generator unit for every delayed pulse output that is required. The pulse generator units contain a threshold

gate followed by a thyratron, the preset bias on the gate determining the delay between the pulse initiating the sawtooth and the output produced by the pulse generator. Outputs from all of the pulse generator units are taken to the distribution unit, pulse.

13 Fault monitoring of the 250 Hz output from the divider unit reveals failures early in the pulse generation circuits. If this signal is absent, then output from the faulty pulse generation circuits, main or standby, is inhibitied. This inhibition is accomplished by gating signals applied to both the gate, electronic and the cathode follower unit. Under these conditions, the only output allowed through is the -8 microsecond pulse which is used for fault monitoring.

14 The -8 microsecond pulses from the main and standby circuits are compared to detect any misalignment between the two sets of pulses which are generated. Having determined there is misalignment, either the main or the

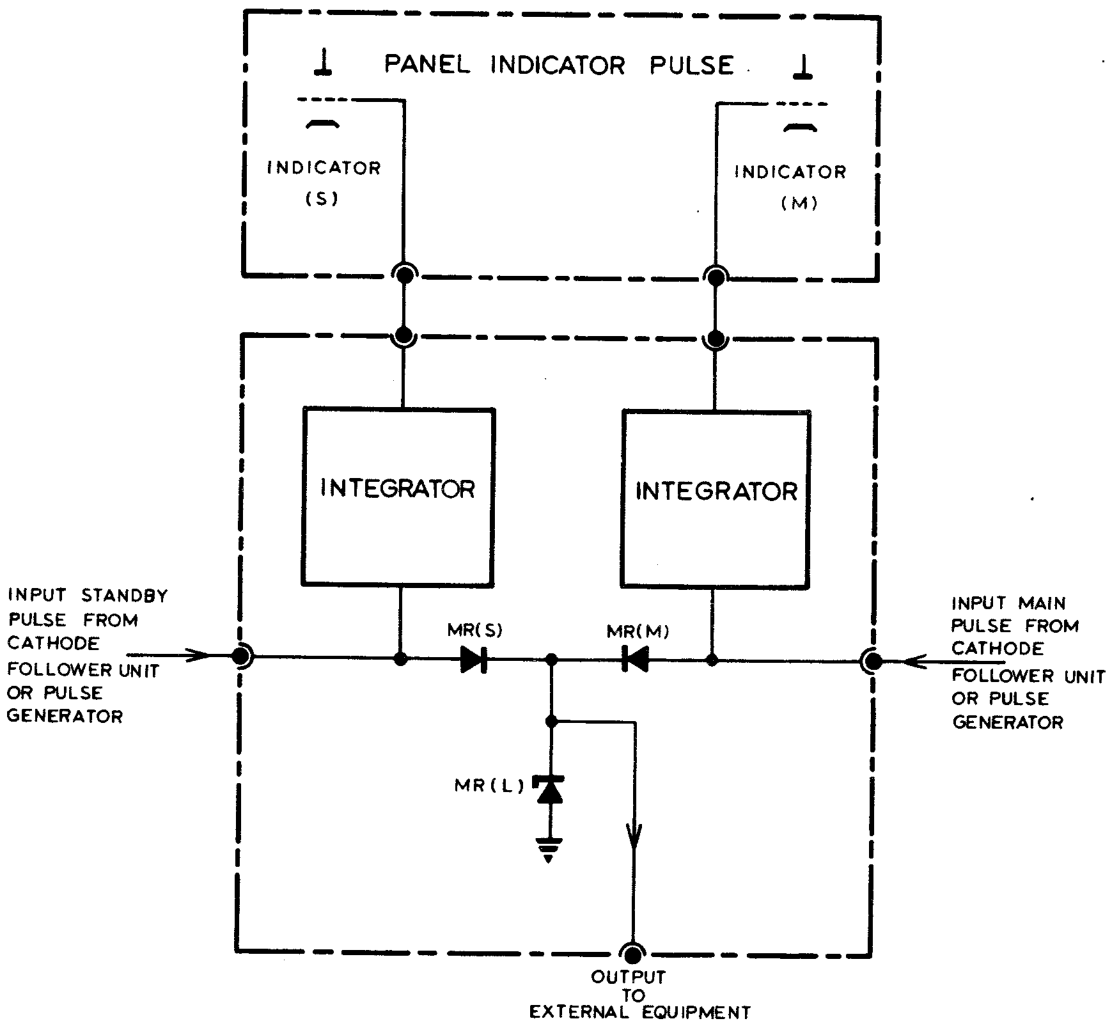


Fig.5 Typical pulse distribution circuit

standby pulses must be inhibited. This decision is initially made when the emergency p.r.f. selection switch is operated, but is subject to overriding conditions which are determined by the state of the equipment. The final result is:–

(1) With main emergency p.r.f. selected the standby pulse outputs are inhibited, but this inhibition is overriden if:

(a) The main –8 microsecond pulse is absent, or

(b) there is a fault in the main pulse generation circuit, or

(c) The +250V or –250V supply in the control, generator pulse, main is interrupted.

(2) With standby emergency p.r.f. selected the main pulse outputs are inhibited, but this inhibition is overriden if:–

(a) The standby –8 microsecond pulse is absent, or

(b) there is a fault in the standby pulse generator circuits, or

(c) the +250V or –250V supply in the control, generator pulse, standby is interrupted.

When inhibition does occur, the actions are identical with those caused by 250 c/s failure.

Output distribution

15. Pulse ◄ outputs ► are distributed via the distribution unit, pulse, each separate input of which, except for the three parallel connected high impedance ones, is continuously monitored. A typical circuit for the distribution of one pulse output is shown in fig.5. The main and standby pulse inputs are fed to an OR-gate, diodes MR(M) and MR(S), for distribution and to separate integrating circuits for monitoring. Outputs from the integrators are fed to fluorescent grid ◄ miniature ► indicators; output from the OR-gate is fed to the external circuits, its amplitude being limited to the desired level (+16V, 20V, 24V, or +30V) by a Zener diode, MR(L).

16. Output from the OR-gate is illustrated at (a) and (b) ◄ of ► fig.6. As long as the misalignment between the main and standby pulses is small, as at (a), the only effect it has is to broaden the output pulse by the amount of misalignment (ta). Since triggering is accomplished by the leading edge of the pulse, this has no effect on the external equipment. However, if the amount of misalignment exceeds one pulse width then two output pulses are generated, with resultant double triggering of the external equipment. Not only does this interfere with operation, but it can also cause damage to components such as magnetrons. For this reason, the alignment of the equivalent main and standby pulses with each other must always be checked before both sets of pulses are connected through for distribution (para. 18). The advantage of this system of distribution is of course that there is absolutely no loss of triggering pulses during a change from main to standby circuits or vice versa, hence a no-break system.

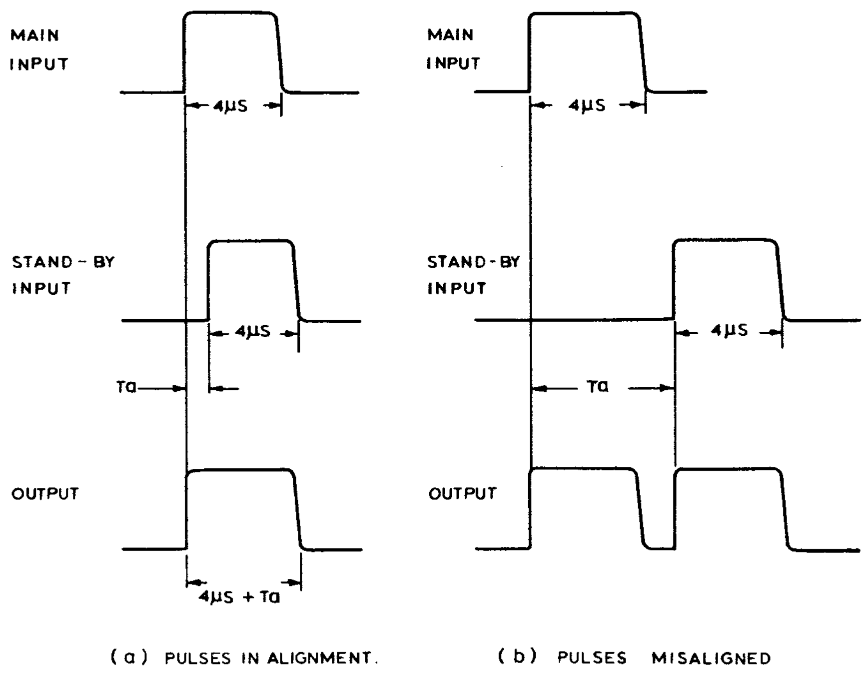


Fig.6 Effect of pulse misalignment

17. Signals that are distributed through the relay assembly are those that it is permissible to interrupt momentarily, the distribution being made through the changeover contacts of relays. Distribution is as follows:–

(1) With the main selected.

[4MHZ, 8.19MHZ and 6.14MHZ]
(a) The ~~8·19 Mc/s and 6·14 Mc/s~~ outputs from the main oscillator (crystal) unit are routed out, as is the 500 c/s p.r.f. reference signal from the main divider unit.

(b) The p.r.f. correction signals are applied to the main crystal oscillator.

(2) With standby selected.

[4MHZ, 8.19MHZ and 6.14MHZ]
(a) The ~~8·19 Mc/s and 6·14 Mc/s~~ outputs from the standby oscillator (crystal) unit are routed out, as is the 500 c/s p.r.f. reference signal from the standby divider unit.

(b) The p.r.f. correction signals are applied to the standby crystal oscillator.

Pulse alignment

18. The alignment of the normal (underlayed) pulse output is continuously monitored using the main and standby –8 microsecond pulses as reference. If the misalignment exceeds about 1 μs, either the standby or the main pulse outputs are automatically inhibited (para. 14). Double triggering from these pulses is thus avoided.

19. With the delayed pulse outputs, there is no such automatic monitoring of pulse alignment after the delay inserted through the generator, sweep, and pulse generator units. The delays of these pulses are set up on site, so as to take into consideration the delays through external cabling and in the unit to be triggered. Such setting up must be accomplished by routing only the outputs from one set of pulse generators (main or standby) to the distribution unit, pulse, and disconnecting the outputs of the others (standby or main). Once one set of pulse generators is correctly adjusted, the other set must be aligned with them before being connected to the distribution unit, pulse; monitor points are provided in the equipment to enable this comparison to be made (fig.10). After the pulses have been thus aligned, the outputs from the second set of pulse generators can be connected to the distribution unit, pulse.

By-pass facility

20. It is a feature of the design of the equipment that a fully operational system can be maintained even though either the standby or main p.r.f. cabinet be completely ◀ isolated ▶. To enable this to be done, a BY-PASS switch is installed in each cabinet. Since, although a full set of outputs is obtained, the operation of this switch means that the changeover facilities are lost, the switch is mounted internally to afford protection against misuse.

21. The main effects of the BY-PASS switches are (fig.10):–

(1) If the BY-PASS switch in the main cabinet is operated

(a) The output from the main crystal oscillator is routed directly to the main flywheel oscillator, by-passing the main/standby changeover circuits. Fault inhibition of the flywheel oscillator is overridden.

(b) Misalignment fault action in the main pulse generation circuit is inhibited.

(c) Whatever the state of the select main or standby electronic switch, the relay assembly is directed to select main.

(d) The +250V supply to the control, generator pulse (standby) is removed. This causes the standby flywheel oscillator and the standby pulse generation circuits to be inhibited.

(e) The equipment now functions with main pulse outputs available only, and with the main ~~8·19 Mc/s, 6·14 Mc/s~~ [8.19MHZ, 6.14MHZ] and 500 c/s p.r.f. reference signals selected. [4M] P.R.F. correction is applied to the main crystal oscillator. The standby cabinet ◀ is completely isolated ▶.

(2) Similarly, if the BY-PASS switch in the standby cabinet is operated, all outputs are obtained from the standby equipment and the main p.r.f. cabinet ◀ is completely isolated ▶.

MECHANICAL DESCRIPTION

General

22. A complete list of the equipment in the no-break trigger system, including the units contained in the p.r.f. cabinets, is given in Table 1, which includes weights and dimensions and quantities of the individual items. The unit numbers given against the units contained within the cabinets refer to their location in the cabinets (para. 25).

TABLE 1

Units: dimensions, weights and quantities

Title	Dimensions (inches)	Weight (pounds)	Quantity	N.A.T.O. Stock No.	Unit No.	Chap. No.
P.R.F. CABINET (MAIN)						
Cabinet, electrical equipment	$84\frac{1}{4} \times 25\frac{1}{4} \times 23\frac{1}{2}$	425	1	5975-99-948-9241		1
Oscillator (crystal)	$17\frac{1}{2} \times 10\frac{1}{2} \times 6\frac{1}{4}$	$9\frac{1}{2}$	1	5840-99-999-2171	203	2
Divider unit	$17\frac{1}{2} \times 16\frac{1}{2} \times 6$	$14\frac{1}{2}$	1	5840-99-948-9103	102	3
Gate, electronic	$17\frac{1}{2} \times 13\frac{1}{2} \times 6$	$10\frac{3}{4}$	1	5840-99-948-9102	103	4
Cathode follower unit	$17\frac{1}{2} \times 18 \times 6$	$16\frac{1}{4}$	1	5840-99-948-9289	104	5
Generator, sweep	$17\frac{1}{2} \times 6 \times 4\frac{1}{2}$	$4\frac{1}{4}$	4	5840-99-999-2838	205 207 302 307	6
Pulse generator	$17\frac{1}{2} \times 6 \times 4\frac{1}{2}$	$4\frac{1}{2}$	11	5840-99-999-9050	206 208 303-306 308-312	7
Control, generator pulse (main)	$19\frac{1}{4} \times 15\frac{3}{8} \times 18\frac{3}{8}$	28	1	5840-99-948-9238	501	8
Panel indicator	$17\frac{1}{2} \times 6 \times 6$	7	1	5840-99-948-9235	204	1
Regulator, voltage (−250V)	$17\frac{1}{2} \times 9 \times 6$	$9\frac{1}{2}$	1		201	◄14►
Regulator, voltage (+250V)	$17\frac{1}{2} \times 7\frac{1}{4} \times 6$	9	3		101 202 301	◄13►
P.R.F. CABINET (STANDBY)						
	Units as for p.r.f. cabinet (main) except:					
Control, generator pulse (standby)	$19\frac{1}{4} \times 15\frac{3}{8} \times 18\frac{3}{8}$	40	1	5840-99-948-9237	501	8
	which replaces the control, generator pulse (main)					
UNDERFLOOR UNITS						
Relay assembly	$17\frac{3}{8} \times 3\frac{7}{8} \times 4\frac{1}{8}$	4	1	5945-99-948-9225	—	9
Distribution unit, pulse	$24 \times 29 \times 8$	20	1	5945-99-948-9262	—	10
WALL-MOUNTING UNITS						
Panel indicator, pulse	$12 \times 12 \times 22$	14	1	5840-99-951-3254	—	11

Cabinet construction

General

23. The cabinets, electrical equipment which, when complete with units, form the p.r.f. cabinet (main) and p.r.f. cabinet (standby), are mechanically and electrically identical. The cabinet identification labels, which are fixed to the top left-hand corner of the framework, are inscribed on one side with the title P.R.F. CABINET (MAIN) and on the other with P.R.F. CABINET (STANDBY). The wording that is displayed is determined by which cabinet houses the control, generator pulse, unit (main) and which the standby unit.

24. Front views of the cabinets, complete with units, are given in figs. 1 and 2, while an exploded view of the rear is given in fig. 11. The cabinet is of the standard Air Ministry type, constructed of pre-formed sheet steel sections, the top and bottom sections being bolted to the sides. Electrical earth continuity is ensured by the use of bonding connectors at each inside corner of the cabinet.

25. Full length doors are fitted at the front and rear of the cabinet, giving access to the units and their interconnections. It should be noted that door interlocks are not provided, so that with either door open points are exposed which carry h.t. potentials. The cabinet is divided into an upper compartment, which houses the horizontally mounted control, generator pulse (unit 501) appropriate to the cabinet, and beneath this and extending to the bottom are three unit frames (Nos. 1, 2 and 3, left to right) which provide mounting for the remainder of the units.

26. The compartment for housing the control, generator pulse is provided with runners; the unit is attached by means of six captive screws (three to each runner) and may be withdrawn from the front of the cabinet to gain access to the test points (lower front right-hand side) and internal circuits. To enable this to be done with the unit functioning, flexible loops are left in the cabling to the connectors at the rear of the unit, the free ends being clamped to a rail which is secured to the cabinet runners and comes forward with the unit. When the unit is pushed fully in, it is secured to the cabinet by means of two captive screws through the front panel. On the inside of the right-hand side panel of the cabinet, adjacent to the control, generator pulse, unit, a tool clip is provided to hold a lamp extractor tool. This tool is used when removing certain lamps from the control, generator pulse, unit (Chap. 8).

27. The unit frames are mounted on telescopic runners, enabling the frames to be extended clear of the cabinet; flexible loops are left in the cabling to enable this to be done with the units functioning. When the frames are fully inserted in the cabinet they are automatically locked in position by a spring-loaded catch on the top runner. To release a frame for withdrawal from the cabinet, the catch is released by moving the lever to the left, and while holding it in this position the frame is pulled towards the operator.

28. The frame-mounted units are all of similar construction, each consisting of a shallow chassis which is secured to the frame by means of four captive screws. Main components, such as valves and transformers are mounted on the front of the chassis, while small components and wiring are carried on the rear. With the frame withdrawn, preset controls and monitor sockets are accessible from the front of the chassis, as are certain of the coaxial interconnection leads. The remaining coaxial and all multi-pole connectors are mounted on the rear edge of the chassis, and are accessible from the rear of the cabinet. The front edge of the chassis carries multi-pole sockets provided for voltage monitoring. The left-hand frame (No. 1) provides mounting for units 101-104, the centre frame (No. 2) for units 201-208, and the right-hand frame (No. 3) for units 301-312, top to bottom in each case. Each of these frame-mounted units is fully illustrated in the chapter describing it.

29. Attached to the cabinet framework itself are four further units, consisting of panels which carry connectors and also, in two cases, relays. These are all accessible from the rear of the cabinet, and are as follows:—

(1) Left-hand side, as viewed from the rear:

(a) Unit 404 (top), subsidiary h.t. relay panel, through which the system state lamps on top of the cabinet framework are controlled.

(b) Unit 403 (centre), h.t. relay panel through which h.t. fault signals are distributed.

(c) Unit 401 (bottom), distribution panel via which all multi-pole external connections are made to the cabinet.

(2) Right-hand side, as viewed from the rear. Only one unit is mounted on this side, at the bottom. This is unit 402, which is a coaxial distribution panel via which all co-axial external connections are made to the cabinet.

Unit removal

30. To remove the control, generator pulse, proceed as follows:—

(1) Remove all connections from the rear of the unit.

(2) Undo the two captive screws securing the unit to the cabinet.

(3) Withdraw the unit from the cabinet as far as the runners will allow, and undo the three captive screws securing the unit to each runner (these are accessible from the top). Remove the unit.

Note . . .

The main unit weighs 28 *lb, the standby unit* 40 *lb.*

31. When it is required to remove one of the frame-mounted units, the following procedure should be adopted:—

(1) Remove all connections from the rear of the unit.

(2) Withdraw the frame from the cabinet to the full extent of the runners.

(3) Remove all coaxial connectors, if any, from the unit chassis.

(4) Unscrew the four captive screws securing the unit to the frame and remove the unit.

Frame removal

32. Remove all the units from the frame, as described in para. 31, and release the cable harness from the clips at the rear. The frame is secured to the runners by means of four hexagon-headed bolts. To remove a frame from the cabinet it is only necessary to extend the frame to the full extent of the runners, and remove the four bolts.

Ventilation

33. Each of the p.r.f. cabinets is provided with forced air ventilation. Air is ducted into the bottom of the cabinet, passing over and between the units and is finally exhausted via a trunking at the top of the cabinet. The front or rear door of the cabinet may be opened without interrupting the air flow.

Underfloor and wall-mounting units

34. The distribution unit, pulse, is in the form of a rectangular cabinet (fig. 3), designed for underfloor mounting beneath the p.r.f. cabinets. It is provided with two brackets at the top, to which the relay assembly is secured. This latter unit (fig. 3) is in the form of a shallow sealed chassis which is secured in position by means of two captive screws which pass through the unit and into the brackets on the distribution unit, pulse. The panel indicator, pulse (fig. 4) consists of a shallow rectangular unit, which is intended for wall-mounting at some location adjacent to the p.r.f. cabinets. The sides and top of the unit are extended forwards, to act as a light shield. Further illustrations of all three of these units are given in the chapters describing them.

TYPES OF INSTALLATION

35. Only one version of the no-break trigger system exists, but it can be installed in either of two configurations which are referred to as p.r.f. 'A' and p.r.f. 'B', and are made up as follows:—

(1) P.R.F. 'A'—in which the no-break trigger system drives a primary radar, from which it derives p.r.f. correction, and also provides general station triggering services. At the same time this single no-break trigger system may also drive another primary radar and an impulsive interference suppression system Type A.

(2) P.R.F. 'B'—in which the no-break trigger system drives an impulsive interference suppression system Type B, from which it derives p.r.f. correction in a similar manner to the method used in the primary radar: the only other equipment that this no-break trigger system drives is the associater secondary radar.

36. The two configurations are illustrated on fig. 7. In use, both configurations may be employed at one station, or p.r.f. 'A' may be used by itself.

ELECTRICAL DESCRIPTION

Interconnections

37. Within the cabinets, apart from the coaxial connections made between the fronts of the frame-mounted units, inter-unit wiring is carried in cable harness at the rear of each frame or unit. The individual cables are identified by sleeves adjacent to the free connector, which give the unit number and connector letter reference of the fixed mating item.

38. Connections to the cabinets enter via the bottom of the cabinet, the coaxial cables going to the coaxial distribution panel (unit 402). All other wiring is taken to the multi-pole plugs and sockets on unit 401.

39. Interconnection information is broken down as follows:—

(1) A block diagram of the system interconnections is given on fig. 12.

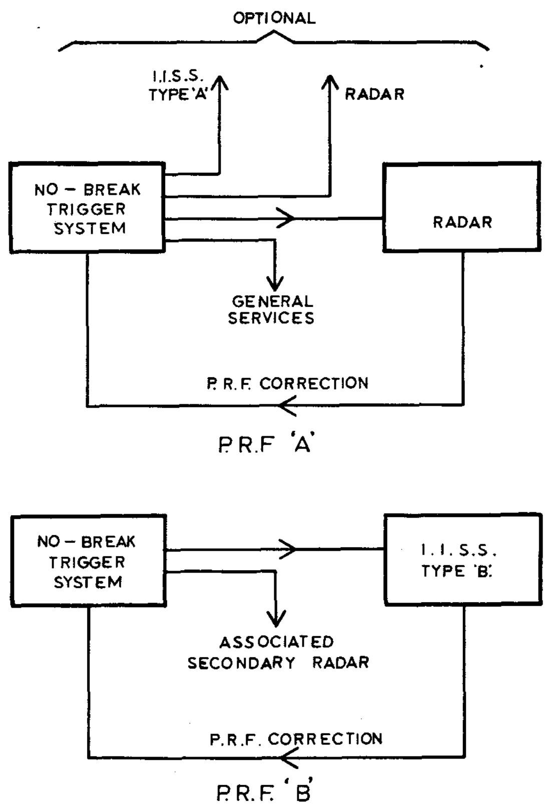


Fig. 7. Types of installation, p.r.f. 'A' and p.r.f. 'B'

(2) A connector-to-connector diagram of the signal interconnections (main) is given on fig. 13; this embraces all coaxial connectors carrying main (as opposed to standby) signals. The multi-pole connections carrying the monitoring signals to the panel indicator, pulse are also given.

(3) A connector-to-connector and pole-to-pole diagram of the power distribution and control signal interconnections (main) is given on fig. 14; this embraces all multi-pole connectors carrying main supplies and signals, except for the monitoring signals (2).

(4) An equivalent diagram to fig. 13 is given on fig. 15 to cover the standby signal interconnections.

(5) An equivalent diagram to fig. 14 is given on fig. 16 to cover the standby power distribution and control signals.

(6) Additional information is given in Tables 2 to 6. Because of the differing types of installation in which the no-break trigger system is used, the external connections can vary; for this reason no specific details of the connections to external equipment are given.

Power supplies and distribution

General

40. All units utilizing valves contain their own heater transformers, the primaries of which are supplied with 240V a.c. The 240V a.c. supplies for the trigger generating equipment are not controlled locally, but are switched through the station mains system switch. No power supply rectification circuits are provided in the trigger generating equipment, which contains voltage regulators supplied with d.c. from the radar office h.t. distribution; the regulators then produce regulated +250V and −250V supplies for internal use. At each of the p.r.f. cabinets, three regulator voltage (+250V) units are provided (units 101, 202 and 301), and one regulator voltage (−250V) unit (201). The +250V regulators provide the supplies for all units in the frame in which they are contained, and one output from each regulator for use in the control generator pulse units, main and standby. The −250V regulators provide the supplies for all units in the cabinet containing them, these being distributed via the regulator voltage (+250V) units, and one output for both the main and standby control, generator pulse units.

41. Panel indicator, 5840-99-948-9235 (unit 204) provides distribution and indication facilities for certain of the inputs to the regulator units. This panel indicator is described in para. 42 and illustrated on figs. 8 and 9. ►◄

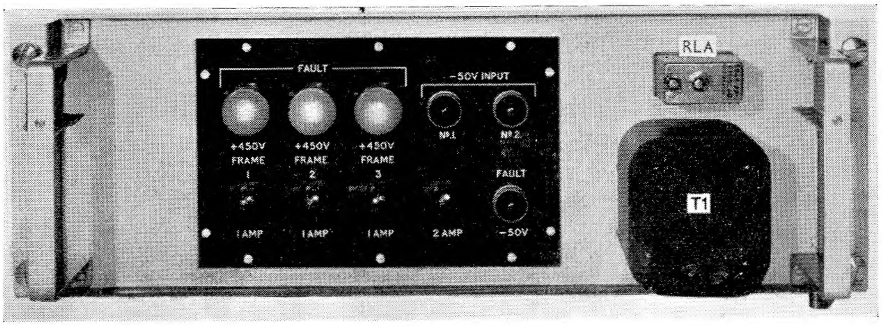


Fig. 8. Panel indicator: front view

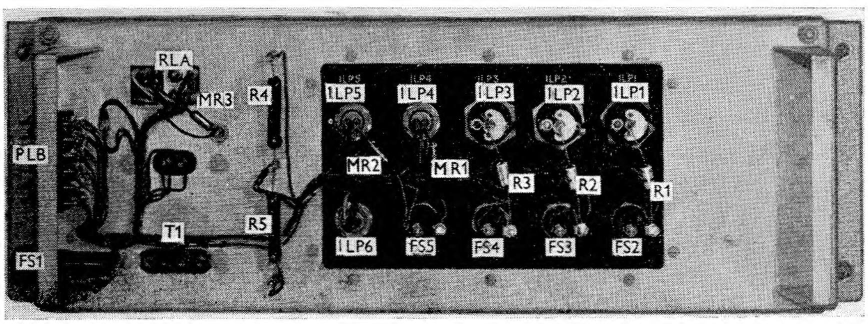


Fig. 9. Panel indicator: rear view

Panel indicator, 5840-99-948-9235

42. The panel indicator, whose circuit is shown on fig. 17, is concerned with three functions, as follows:—

(1) The distribution of the +450V supplies to the three regulator voltage (+250V) units.

(2) The supply of 6·3V a.c. to the fault lamp circuits in the four regulator units (three +250V and one −250V), and to the cabinet system state lamps.

(3) The indication, combining and distribution to the regulator units of a −50V supply used for signalling. This same supply is also fed to units 403 and 404, and to the relay assembly.

43. When called up, the +450V unregulated supplies, which are the source of the +250V regulated h.t., appear at PLB/1, 2 or 3. They are fed through fuses to the respective regulator voltage (+250V) units, a neon indicator being connected across each supply to verify its presence.

44. From a primary input of 240V a.c. transformer T1 produces a secondary voltage of 6·3V which is:—

(1) Used internally to supply the −50V FAULT lamp ILP6.

(2) Fed directly to the three system state lamps on the cabinet framework (para. 50).

(3) Switched via contact RLA3 and taken to the fault lamp circuits in the four regulator units.

45. Two −50V d.c. supplies are presented to the panel indicator at PLB/8 and 9, their presence being monitored by lamps ILP4 and ILP5. The two supplies are combined through an OR-gate which consists of diodes MR1 and MR2; this combined supply is fused (FS5) and used to energize relay RLA and is taken through an isolating diode MR3:—

(1) To the regulator units.

(2) To units 403 and 404 on the cabinet framework.

(3) To the relay assembly.

46. As long as one or the other of the −50V inputs is present, relay RLA remains energized and normal operation ensues. If both supplies fail, or if fuse FS5 fails, relay RLA is de-energized and:—

(1) Via contact RLA2, the −50V FAULT lamp lights.

(2) Via contact RLA3, the 6·3V fault lamp supply to the regulator units is inhibited. This cancels fault indication by these units, since the prime fault is loss of −50V supply, not of h.t.

Power switch-on

47. When the station mains system switch is turned on, the 240V supply is present at the trigger generating equipment and all valve heater supplies are on. Initially the −425V and +450V basic supplies are not present, so no negative or positive h.t. supplies are available. The +450V supplies cannot be called up until the −250V h.t. is available, and the basic −425V supply for this negative h.t. cannot be called up until the valve heaters have had time to reach their operating temperature. The actions and circuit responses at power switch-on can be summarized as follows:—

(1) The 240V a.c. supply is switched on.

(2) At the regulator voltage (−250V) unit, the POWER OUTPUT switch is turned on. This sends out −50V on a callwire demanding that the −425V supply is switched through to the unit, but the −50V call signal is inhibited until a thermal delay switch in the unit has operated. With the −425V supply present, the −250V h.t. is produced.

(3) At each regulator voltage (+250V) unit, operation of the POWER OUTPUT switch calls up the +450V supply for that unit, but only if the −250V h.t. is present.

Note . . .

When any of the four regulator units is switched off, its FAULT lamp is lit; in addition, when any +250V regulator is switched off the −250V regulator FAULT lamp is lit.

Power supply fault indication and h.t. relay panel, unit 403

48. If there is a fault on any of the regulator units, the FAULT lamp at that unit lights and a frame fault signal is generated and fed out for external display if required. An internal power supply fault signal is also generated. The actions are as follows:—

(1) Frame No. 1 fault. If output from unit 101 fails, an earth is fed from 101 PLB/2 to unit 403 PLA/1, causing relay 403 RLA

to be energized. Contact RLA1 open circuits the frame No. 1 fault line; contact RLA2 earths 403 PLA/4, see (4).

(2) Frame No. 2 fault. If output from units 201 or 202 fails, an earth is fed from 201 PLB/17 to unit 403 PLA/2, causing relay 403 RLB to be energized. Contact RLB1 open circuits the frame No. 2 fault line; contact RLB2 earths 403 PLA/4, see (4).

(3) Frame No. 3 fault. If output from unit 301 fails, an earth is fed from 301 PLB/2 to unit 403 PLA/3, causing relay 403 RLC to be energized. Contact RLC1 open circuits the frame No. 3 fault line; contact RLC2 earths 403 PLA/4, see (4).

(4) Whenever a power fault occurs, unit 403 PLA/4 is earthed. This causes the system state FAULT lamps to be lit, via the control, generator pulse, units.

49. If the −50V supply from unit 204 to the regulators fails, although the −50V FAULT lamp at unit 204 lights, no direct system indication is given. However, the consequent failure of all h.t. supplies within the cabinet is detected by the control, generator pulse, units and system state indication is given. Since the relays in units 403 and 404 are driven from this supply it should be noted that:—

(1) No power fault or frame fault signals are generated.

(2) The system state lamps on the cabinet framework are unlit.

Cabinet system state indicator lamps and subsidiary h.t. relay panel, unit 404

50. This unit contains three relays whose function is to cause the system state lamps mounted on the top of the cabinet framework to repeat the state of the lamps in the control generator pulse unit 501. When a lamp is required to be lit, an earth is fed from unit 501 to unit 404, energizing the relay whose contact is in series with the 6·3V supply to the lamp.

TABLE 2

Relay assembly: input and output services

Source/destination main or standby	Relay assembly Input connector	Output connector	Service
Main Standby	PLA/4	PLA/1 PLA/5	Variable phase 500 c/s (input)
Main Standby	PLA/3	PLA/6 PLA/2	Reference phase 500 c/s (input)
Main Standby	SKTC SKTB	SKTD	500 c/s p.r.f. reference (output)
Main Standby	SKTE SKTF	SKTG	6·14 Mc/s
Main Standby	SKTH SKTJ	SKTK	6·14 Mc/s
Main Standby	SKTL SKTM	SKTN	CRYSTAL FREQUENCY (4 MH ~~6·14 Mc/s~~
Main Standby	SKTP SKTQ	SKTR	6·14 Mc/s
Main Standby	SKTS SKTT	SKTU	8·19 Mc/s
Main Standby	SKTV SKTW	SKTX	8·19 Mc/s
Main Standby	SKTY SKTZ	SKT AA	8·19 Mc/s
Main Standby	SKTAB SKTAC	SKT AD	8·19 Mc/s

TABLE 3

Distribution unit, pulse: output pulse services and characteristics

***Notes . . .**

(1)◄*All pulse outputs*►

(*a*) *Pulse width* 4 *μs* ± 10%

(*b*) *Rise time* ◄0·3► *μs maximum*

Source main or standby	Distribution unit, pulse: Input socket SKT	Distribution unit, pulse: Output socket SKT	Service	Line term. ohms	Pulse* amplitude nominal	Delay
Main	P	Q	−125 μs	75	16V	Fixed
Standby	R					
Main	S	T	−125 μs	75	◄25-30V►	Fixed
Standby	U					
Main	V	W	−125 μs	75	◄20V►	Fixed
Standby	X					
Main	Y	Z	Delayed 0 μs	75	30V	+5 μs to +170 μs
Standby	AA					
Main	AB	AC	−125 μs	75	16V	Fixed
Standby	AD					
Main	AE	AF	−125 μs	220	16V	Fixed
Standby	AG					
Main	AH	AJ	Delayed −125 μs	75	30V	−120 μs to +45 μs
Standby	AK					
Main	AL	AM	Delayed −125 μs	75	30V	−120 μs to +45 μs
Standby	AN					
Main	AP	AQ	−125 μs	1K	16V	Fixed
Standby	AR					
Main	AS	AT	◄−125 μs►	1K	16V	Fixed
Standby	AU					
Main	AV	AW	◄−125 μs►	1K	16V	Fixed
Standby	AX					
Main	AY	AZ	Delayed −125 μs	75	30V	−125 μs to +45 μs
Standby	BA					

TABLE 3—(contd.)

Source main or standby	Distribution unit, pulse: Input socket SKT	Distribution unit, pulse: Output socket SKT	Service	Line term. ohms	Pulse* amplitude nominal	Delay
Main	BB	BC	Delayed −125 μs	75	30V	−120 μs to +45 μs
Standby	BD					
Main	BE	BF	Delayed −125 μs	75	30V	−120 μs to +45 μs
Standby	BG					
Main	BH	BJ	◄−125 μs►	75	16V	Fixed
Standby	BK					
Main	BL	BM	Delayed 0 μs	75	30V	+5 μs to +170 μs
Standby	BN					
Main	BP	BQ	◄−125 μs►	220	16V	Fixed
Standby	BR					
Main	BS	BT	◄−125 μs►	220	16V	Fixed
Standby	BU					
Main	BV	BW	Delayed 0 μs	75	30V	+5 μs to +170 μs
Standby	BX					
Main	BY	BZ	−250 μs	220	16V	Fixed
Standby	CA					
Main	CH	CJ	−250 μs	220	16V	Fixed
Standby	CK					
Main	CL	CM	◄−125 μs►	75	16V	Fixed
Standby	CN					
Main	CP	CQ	Delayed ◄−125 μs►	75	30V	◄−120 μs to +45 μs►
Standby	CR					
Main	CS	CT	−750 μs	◄220	24V►	Fixed
Standby	CU					
Main	CV	CW	Delayed −750 μs	75	30V	−745 μs to −580 μs
Standby	CX					
Main	CY	CZ	−8 μs	220	16V	Fixed
Standby	DA					
Main	DB	DC	−8 μs	220	16V	Fixed
Standby	DD					
Main	DE	DF	−8 μs	75	24 ~~16V~~	Fixed
Standby	DG					
Main	DH	DJ	−8 μs	75	30V	Fixed
Standby	DK					

AL9

TABLE 3–(contd.)

Source main or standby	Distribution unit, pulse Input socket SKT	Output socket SKT	Service	Line term. ohms	Pulse* amplitude nominal	Delay
Main	DS	DT	–8 µs	220	16V	Fixed
Standby	DU					
Main	DV	DW	0 µs	75	25-30V	Fixed
Standby	DX					
Main	DY	DZ	0 µs	75	16V	Fixed
Standby	EA					
Main	EB	EC	0 µs	75	16V	Fixed
Standby	ED					
Main	EE	EF	0 µs	75	16V	Fixed
Standby	EG					
Main	EH	EJ	0 µs	220	16V	Fixed
Standby	EK					
Main	EL	EM	0 µs	220	16V	Fixed
Standby	EN					
Main	EP	EQ	0 µs	220	16V	Fixed
Standby	ER					
Main	ES	ET	Delayed 0 µs	75	30V	+5 µs to +17 µs
Standby	EU					

TABLE 4

Panel indicator, pulse: connections to external equipment

Panel indicator, pulse connector	Service	Source
PLA/1	L. 240V a.c.	Radar Office a.c. mains distribution
PLA/3	N. 240V a.c.	
PLA/6	earth	

TABLE 5

P.R.F. cabinet (main): external connections via distribution unit 401

P.R.F. cabinet (main) unit 401 connector	Service		Source/destination	Connector
PLA/ 1	L.240V a.c.	Frame		
2	N.240V a.c.	1		
3	earth			
4	L.240V a.c.			
5	N.240V a.c.	Frame		
6	earth	2	Radar Office	
7	L.240V a.c.		a.c. mains distribution	
8	N.240V a.c.	Frame		
9	earth	3		
10	L.240V a.c.			
11	N.240V a.c.	Unit		
12	earth	501		
PLB/ 1	+450V d.c. (Frame 1)			
2	+450V d.c. (Frame 2)			
3	+450V d.c. (Frame 3)			
4	+450V d.c. (Frame 2)			
8	−500V d.c. ref. (Frame 2)		Radar Office	
9	h.t. call −ve (Frame 2)		h.t. distribution	
10	−625V d.c. (Frame 2)			
13	−425V d.c. (Frame 2)			
14	h.t. call +ve (Frame 1)			
15	h.t. call + ve (Frame 2)			
16	h.t. call + ve (Frame 3)			
20	−50V No. 1			
21	−50V No. 2		Radar Office	
22	−50V No. 1		−50V distribution	
23	−50V No. 2			
24	earth			
SKTC/1	Reference phase 500 c/s		Relay assembly	PLA/6
2	Variable phase 500c/s		Relay assembly	PLA/1
3	Frame No. 1 fault		Mimic diagram and	
4	Frame No. 2 fault		external fault indicators	
5	Frame No. 3 fault			
6	+250V No. 4 in			SKTC/9
7	+250V No. 5 in			SKTC/10
8	+250V No. 6 in			SKTC/11
9	+250V No. 1 out		P.R.F. cabinet (standby)	SKTC/6
10	+250V No. 2 out		distribution unit 401	SKTC/7
11	+250V No. 3 out			SKTC/8
12	−250V No. 2 in			SKTC/13
13	−250V No. 1 out			SKTC/12
15	Flashing −50V return		Radar Office dist., also	
15			P.R.F. cabinet (standby)	PLC/15
			unit 401	
17	−50V fused out		Relay assembly	PLA/8
18	earth			
SKTD/1	Maint. lamp in		External system state in-	
1			dicator, also p.r.f. cabinet	SKTD/1
			(standby) unit 401	
◄ 3	By-pass control			SKTD/3 ►
5	Regulator fault in		P.R.F. cabinet (standby)	SKTD/6
6	Regulator fault out		unit 401	SKTD/5

TABLE 5 (Contd.)

P.R.F. cabinet (main) unit 401 connector	Service	Source/destination	Connector
SKTD/7	−5·1V (monitor bias)	Distribution unit, pulse	PLA/3
10	+43V (monitor h.t.)		
11	Emergency trigger lamp	External indicator	
13	Switched earth (select main or standby)	Relay assembly	PLA/7
16	Switched −50V (system state normal)	Unused	
17	Switched −50V (system state fault)	Unused	
18 18	Ref. phase return	External connection, also to p.r.f. cabinet (standby) unit 401	SKTD/18
19	Variable phase return	External connection, also to p.r.f. cabinet (standby) unit 401	SKTD/19
24	earth		
PLE/ 1 to 24	Ancillary interconnections: main to standby p.r.f. cabinets	P.R.F. cabinet (standby) unit 401 PLE/16 & 18 (system states normal and fault) are also taken to remote system state indicators	PLE/1 to 24
SKTF/1 to 24	Ancillary interconnections: main to standby p.r.f. cabinets	P.R.F. cabinet (standby) unit 401	SKTF/1 to 24

TABLE 6

P.R.F. cabinet (standby): external connections via distribution unit 401

P.R.F. cabinet (standby) unit 401 connector	Service		Source/destination	Connector
PLA/ 1	L.240V a.c.	Frame 1	Radar Office a.c. mains distribution	
2	N.240V a.c.			
3	earth			
4	L.240V a.c.	Frame 2		
5	N.240V a.c.			
6	earth			
7	L.240V a.c.	Frame 3		
8	N.240V a.c.			
9	earth			
10	L.240V a.c.	Unit 501		
11	N.240V a.c.			
12	earth			
PLB/ 1	+450V d.c.	(Frame 1)	Radar Office h.t. distribution	
2	+450V d.c.	(Frame 2)		
3	+450V d.c.	(Frame 3)		
4	+450V d.c.	(Frame 2)		
8	500V d.c. ref.	(Frame 2)		
9	h.t. call − ve	(Frame 2)		
10	−625V d.c.	(Frame 2)		
13	−425V d.c.	(Frame 2)		
14	h.t. call + ve	(Frame 1)		
15	h.t. call + ve	(Frame 2)		
16	h.t. call + ve	(Frame 3)		

TABLE 6 (contd.)

P.R.F. cabinet (standby) unit 401 connector	Service	Source/destination	Connector
PLB/ 20	−50V No. 1	Radar Office −50V distribution	
21	−50V No. 2		
22	−50V No. 1		
23	−50V No. 2		
24	earth		
SKTC/1	Reference phase 500 c/s	Relay assembly	PLA/2
2	Variable phase 500 c/s	Relay assembly	PLA/5
3	Frame No. 1 fault	Mimic diagram and external fault indicators	
4	Frame No. 2 fault		
5	Frame No. 3 fault		
6	+250V No. 1 in	P.R.F. cabinet (main) unit 401	SKTC/9
7	+250V No. 2 in		SKTC/10
8	+250V No. 3 in		SKTC/11
9	+250V No. 4 out		SKTC/6
10	+250V No. 5 out		SKTC/7
11	+250V No. 6 out		SKTC/8
12	−250V No. 1 in		SKTC/13
13	−250V No. 2 out		SKTC/12
15 } 15	Flashing −50V return	Radar Office dist., also p.r.f. cabinet (main) unit 401	PLC/15
18	Earth		
SKTD/1 1	Maint. lamp out	External system state indicator, also p.r.f. cabinet (main) unit 401	SKTD/1
2	Remote maint. switch (input)	External connection	
◄ 3	By-pass control	P.R.F. cabinet (main) unit 401	SKTD/3 ►
5	Regulator fault out		SKTD/6
6	Regulator fault in		SKTD/5
7	−5·1V (monitor bias)	Distribution unit, pulse	PLA/4
10	+43V (monitor h.t.)		PLA/2
SKTD/18 } 18	Ref. phase return	External connection, also p.r.f. cabinet (main) unit 401	SKTD/18
19 } 19	Variable phase return	External connection, also p.r.f. cabinet (main) unit 401	SKTD/19
24	Earth		
PLE/ 1 to 24	Ancillary interconnections: standby to main p.r.f. cabinets	P.R.F. cabinet (main) unit 401 PLE/16 & 18 (system states normal and fault) are also taken to remote system state indicators	PLE/1 to 24
SKTF/1 to 24	Ancillary interconnections: standby to main p.r.f. cabinets	P.R.F. cabinet (main) unit 401	SKTF/1 to 24

FAULT LOCATION

General

51. The pulse generating equipment contains fault monitoring circuits which are located in the main and standby control, generator pulse, units. The function of these circuits is twofold; firstly they maintain pulse outputs by initiating changes to switch out faulty circuits and switch in serviceable ones; secondly by a system of lamp logic, they cause indicator lamps to light in specific patterns according to the nature of the fault. The ensuing paragraphs of this chapter are devoted to the recognition of the faults, and descriptions of the effects, probable locations, and actions to be taken on their occurrence.

52. Broadly, the indicator lamps may be divided into four classes:—

(1) System state lamps—three states of the system are recognized, these being NORMAL (green), FAULT (red), and MAINT. (amber). These lamps are repeated at five locations, which are: on the front panels of both the main and standby control, generator pulse, units, at the top of the front framework of both the main and standby p.r.f. cabinets, and at a remote location together with other station fault indicators. Also at this last location is an emergency trigger lamp, which gives a warning when the pulse outputs from the pulse generating equipment are not subject to p.r.f. correction.

(2) Equipment state lamps—these lamps are mounted on the front panels of the main and standby control, generator pulse, units. Apart from two lamps concerned with pulse alignment, IN (green) and OUT (red), the lamps at the two units are duplicated to give equivalent information on the states of the main and standby crystal oscillators and pulse generation circuits, indication of whether the main or standby circuits have been selected to give emergency p.r.f. generation, and indication as to whether either the main or standby p.r.f. equipment is bypassed.

(3) Unit fault lamps—this term is reserved for the FAULT lamps on the front panels of sub-units 1 to 7 of both the main and standby control, generator pulse, units. These lamps are caused to light through the lamp logic circuits. Such indication is intended as a guide to the specific cause of the fault; it does not necessarily mean that the unit whose FAULT lamp is lit is the cause of the fault.

(4) Power supply indicators—each of the regulator voltage (+250V) and (−250V) units has its own FAULT lamp which lights if there is a fault at that unit. The panel indicator (unit 204) has indicators which monitor the incoming +450V supplies to the voltage regulators, and also has a −50v FAULT lamp which lights on the failure of the −50V output from the panel.

53. The patterns of indication from the first three classes of indicators (para. 52) are shown on fig. 18, which covers r.f. faults, and fig. 19, which covers pulse generation faults, and power supply faults within the control, generator pulse, units. Each particular condition is illustrated by two columns representing the respective states of the main and standby lamps. On fig. 18 the first condition illustrated is the normal fault-free one, with main emergency p.r.f. selected; subsequent conditions represent the specific faults recognized by the logic circuits. If more than one fault occurs at the same time, the diagrams must be interpreted accordingly.

54. In the ensuing description, units identified by a single digit number (1 to 7) are the sub-units of the control, generator pulse, units, while those identified by a three digit number are the frame mounted units of the p.r.f. cabinets, for example unit 203, oscillator (crystal). In either case the suffix (M) or (S) denotes main or standby unit. Circuit action on the detection of faults is described in Chap. 8.

R.F. faults (fig. 18)

Failure of r.f. from main crystal oscillator

55. Equipment condition—r.f. is derived from the standby crystal oscillator; select standby is demanded of the relay assembly; both main and standby pulse generation is normal.

56. Fault location—the most likely cause of the fault is that the r.f. output from the oscillator (crystal) unit 203 (M) has failed.

57. Action—monitor the outputs from unit 203 (M), refer to Chap. 2.

Failure of r.f. from standby crystal oscillator

58. Equipment condition—r.f. is derived from the main crystal oscillator; select main is demanded of the relay assembly; both main and standby pulse generation is normal.

59. Fault location—the most likely cause of the fault is that the r.f. output from the oscillator (crystal) unit 203 (S) has failed.

60. Action—monitor the outputs from unit 203 (S), refer to Chap. 2.

Unit 1 (M) fault indication

61. Equipment condition—no r.f. input is available to either the main or standby flywheel oscillators. According to the manual selection of emergency p.r.f., either the standby or main flywheel oscillator is inhibited, the other flywheel oscillator free runs. Only one set of pulses is produced, main or standby, and these are not subject to p.r.f. correction.

62. Fault location—both the CRYSTAL OSCILLATOR SELECT lamps are out, but since neither CRYSTAL OSCILLATOR FAULT lamp is lit, then r.f. from both the main and standby crystal oscillators must be present at the control, generator pulse unit (M). The most likely cause of the fault is a failure of unit 1 (M).

63. Action—remove unit 1 (M) and test it in accordance with the instructions contained in Chap. 12. Subject to the appropriate authority being obtained, the BY-PASS switch at either the standby or main p.r.f. cabinet should be operated; this will restore p.r.f. corrected pulse outputs either from the standby or main circuits according to which switch is operated. The BY-PASS switch must be returned to its normal position as soon as the fault has been cleared.

Unit 2 (*M*) *fault indication*

64. Equipment condition—this indication is caused by a failure of unit 2 (M) which monitors the r.f. from the main crystal oscillator into the control, generator pulse (M). According to the state of the output of unit 2 (M) in this fault condition either the main or standby crystal oscillator may be selected and the appropriate SELECT lamp lit. Lighting of the CRYSTAL OSCILLATOR FAULT lamp is inhibited.

65. Fault location—as already stated, the cause of the fault is the failure of unit 2 (M).

66. Action—remove unit 2 (M) and test it as detailed in Chap. 12. Whatever the state of the equipment before, the removal of this unit will cause the main crystal oscillator to be selected. If, while unit 2 (M) is removed, the main crystal oscillator fails, this fact will not be detected, nor will the selection of the standby crystal oscillator be initiated. The occurrence of such a fault will give rise to unit 3 (M) fault indication (para. 73) with consequent change to emergency p.r.f. operation. Under these conditions, subject to the appropriate authority having been obtained, the BY-PASS switch at the standby p.r.f. cabinet may be operated. This will restore p.r.f. corrected pulse outputs, from the standby circuits. As soon as the fault has been cleared the BY-PASS switch must be returned to its normal position.

Unit 1 (*S*) *fault indication*

67. Equipment condition—this indication is the standby equivalent of unit 2 (M) fault indication. Indication is caused by the failure of unit 1 (S) which monitors the r.f. from the standby crystal oscillator into the control, generator pulse (S). Whatever the fault state of the output of unit 1 (S), the main crystal oscillator will continue to be selected and the CRYSTAL OSCILLATOR SELECT (M) lamp lit. Lighting of the CRYSTAL OSCILLATOR FAULT lamp is inhibited.

68. Fault location—as already stated, the cause of the fault is the failure of unit 1 (S).

69. Action—remove unit 1 (S) and test it as detailed in Chap. 12. Removal of unit 1 (S) does not affect the operation of the equipment in that it will continue to operate with the main crystal oscillator selected, and if this fails a change to standby crystal oscillator will be initiated.

Unit 3 (*M*) *fault, de-energization of relays RLC* (*M*) *or RLD* (*M*)

70. Equipment condition—the main or standby select voltages are derived from simulated voltages instead, of, as is normal, from the outputs of unit 3 (M). Standby crystal oscillator is selected, even though the main crystal oscillator is not faulty.

71. Fault location—no fault lamps are lit; the only abnormal indication is that though neither crystal oscillator is faulty, the CRYSTAL OSCILLATOR SELECT (M) lamp will be out and the standby one lit. The cause of the fault is a failure of unit 3 (M) such that either (or both) of the associated relays, RLC (M) or RLD (M), are de-energized.

72. Action—remove unit 3 (M) and test it as detailed in Chap. 12. Removal of the unit does not affect the operation of the equipment, since simulated voltages have already been substituted for its outputs. If subsequently the r.f. from the standby crystal oscillator fails, a change back to the main crystal oscillator is initiated.

Unit 3 (*M*) *fault indication*

73. Equipment condition—r.f. from the main crystal oscillator has failed and the system has not responded by changing over to the standby crystal oscillator. As a result, according to the manual selection of emergency p.r.f., either the standby or main flywheel oscillator is inhibited, the remaining one is free running, initiating emergency p.r.f. output.

74. Fault location—main or standby select switching demand is applied to unit 3 (M) whose outputs, among other things, control the routeing of the main or standby crystal oscillator r.f. through the r.f. gates in unit 1 (M). The fault could be either that unit 3 (M) is failing to change to demand select standby or that unit 1 (M) is failing to respond to the demand.

75. Action—the operation of units 3 (M) and 1 (M) should be verified in the following order:

(1) Monitor the outputs from unit 3 (M) at test sockets SKTQ and SKTR of the control, generator pulse (M), referring to Chap. 8.

(2) If the outputs under (1) are not at the correct level for select standby, remove unit 3 (M) and test it according to the instructions given in Chap. 12. The de-energization of relays RLC (M) and RLD (M), consequent on the removal of unit 3 (M), demands select standby from unit 1 (M) all as described in para. 70.

(3) If the outputs (1) from unit 3 (M) are at the correct levels for select standby, or if unit 1 (M) fails to change to standby when unit 3 (M) is removed, then remove and test unit 1 (M) as detailed in Chap. 12.

(4) The cause of the failure of main crystal oscillator r.f. must also be located, see para. 55.

(5) If unit 1 (M) is the apparent cause of the fault, then, subject to the appropriate authority being obtained, the BY-PASS switch in the standby p.r.f. cabinet should be operated; this will restore p.r.f. corrected pulse outputs from the standby circuits—

the BY-PASS switch must be returned to its normal position as soon as the faults have been cleared.

Unit 2 (S) fault indication

76. Equipment condition—unit 2 (S) monitors the two outputs from unit 3 (M) or their simulated equivalents. These two outputs should always be of opposite polarities, 0V or −15V (−30V of simulated), one representing select and the other inhibit. If unit 2 (S) itself fails or if both outputs from unit 3 (M) are at the same level without either relay RLC (M) or RLD (M) being de-energized, then unit 2 (S) fault indication is given. This means that the equipment condition can vary, as follows:

(1) Unit 2 (S) fault—the equipment continues to function normally.

(2) Unit 3 (M) fault

(a) Both outputs at the inhibit (−15V) level; then unit 4 (M) and unit 1 (M) fault indications are also given, and the equipment condition is as described in para. 61.

(b) Both outputs at the select (0V) level; then unit 4 (M) indication is given. The main and standby crystal oscillator outputs are both allowed through unit 1 (M) and the mixture is presented to the flywheel oscillators. Then:—

(i) One oscillator may lock on to the main r.f. and one on to the standby r.f. In this case a pulse misalignment fault is generated (para. 90).

(ii) Both oscillators may lock on to the same r.f., which might or might not be the one, normally the main, to which p.r.f. correction is being applied. In any case an external emergency trigger warning is given.

77. Fault location—the common factor with all the possible types of fault described in the previous paragraph is that the unit 2 (S) fault lamp lights. Then:—

(1) If the indication is as shown on fig. 18, the fault almost certainly lies in unit 2 (S). Remove this unit and test it according to the instructions given in Chap. 10; the operation of the equipment is unaffected by the removal of unit 2 (S).

(2) If besides the indication shown on fig. 18 a unit 4 (M), unit 1 (M) or pulse misalignment fault is signalled or if the remote emergency trigger warning lamp lights, unit 3 (M) is probably the faulty one. Monitor the outputs from unit 3 (M) at test sockets SKTQ and SKTR on the control, generator pulse (M), refer to Chap. 8. Then:—

(a) If the monitored voltages are abnormal, remove and test unit 3 (M). Removal of the unit should cause relays RLC (M) and RLD (M) to switch in simulated voltages, causing the equipment to operate on the standby crystal oscillator and normal pulse outputs to be produced. If pulse misalignment has occurred it will be necessary to operate the appropriate START AND RESET switch, and possibly to realign the −8 microsecond pulses.

(b) If the monitored voltages are normal, investigate the operation of those contacts of relays RLC (M), RLD (M) and RLA (S) which are connected between the output of unit 3 (M) and the input to unit 2 (S).

(3) If the fault is such as to cause emergency trigger operation, then, subject to the appropriate authority being obtained, operate the BY-PASS switch in the main or standby p.r.f. cabinets; this will restore p.r.f. corrected outputs. The BY-PASS switch must be returned to its normal position as soon as the fault has been cleared.

Unit 4 (M) fault indication

78. Equipment condition—unit 4 (M) operates from the outputs of unit 3 (M) or their simulated equivalents. The contacts of the two relays, RLK (M) and RLM (M), operated by unit 4 (M) are concerned with indication and with demanding select main or select standby of the relay assembly. If unit 4 (M) fault indication is accompanied by unit 2 (S) fault indication, then conditions are as described in para. 76. If unit 4 (M) fault indication occurs by itself it means that either both relays RLK (M) and RLM (M) are energized or that both are de-energized. In the former case select main is demanded of the relay assembly and in the latter select standby. This selection is quite independent of which crystal oscillator is providing the r.f. for pulse generation, so that the output pulses may or may not be subject to p.r.f. correction. An external emergency trigger warning is given in either instance.

79. Fault location—if unit 4 (M) fault indication only is given, as shown on fig. 18, then the fault almost certainly lies in that unit.

80. Action—remove unit 4 (M) and test it as described in Chap. 12. Whatever the state previously, removal of unit 4 (M) will cause select standby to be demanded of the relay assembly. As the equipment normally operates with main crystal r.f. selected, this means that pulse outputs are not subject to p.r.f. correction. Subject to the appropriate authority being obtained, operate the BY-PASS switch in the main or standby p.r.f. cabinets; this will restore p.r.f. corrected outputs. The BY-PASS switch must be returned to its normal position as soon as the fault has been cleared.

Unit 6 (M) fault indication

81. Equipment condition—unit 6 (M) fault indication is given on the detection of a fault within that unit; the operation of the equipment is normal, but if r.f. output from unit 1 (M) subsequently fails neither flywheel oscillator will be inhibited; inhibition of either main or standby pulse outputs would take place on consequent misalignment fault action.

82. Fault location—as stated, this fault indication is due to a fault in unit 6 (M).

83. Action—remove unit 6 (M) and test as described in Chap. 12. Removal of the unit does not affect the conditions described in para. 81.

Loss of 6·14 Mc/s or 8·19 Mc/s carriers

84. Loss of any of the 6·14 Mc/s or 8·19 Mc/s carrier outputs causes no reaction or indication within the no-break trigger system. Only if they are the actual signals in use will there be any reaction, and this will be from the user's equipment. These outputs may be monitored at the oscillator (crystal) unit 203 (Chap. 2).

Pulse generation faults (fig. 19)

Unit 5 (M) fault indication

85. Equipment condition—main pulse outputs are inhibited, standby pulse generation is normal.

86. Fault location—the unit 5 (M) FAULT lamp will light only if main emergency p.r.f. has been selected; if emergency p.r.f. standby has been selected, the unit 5 (M) lamp will not light but the remaining indication will be the same. Under either of these conditions fault indication can be due to either of the following causes:—

(1) Lack of r.f. output from unit 5 (M), which provides the input for the main divider unit 102 (M).

(2) Output from unit 5 (M) present, but output from the divider unit 102 (M) absent.

87. Action:—

(1) Check the presence of r.f. output from unit 5 (M) by monitoring at SKTS of the control, generator pulse (M), see **Chap. 8.** If output is abnormal remove unit 5 (M) and test as detailed in Chap. 12. Removal of the unit does not affect the conditions described in para. 86. If the output from unit 5 (M) is normal proceed to (2).

(2) Test the divider unit 102 (M) to verify that the 250 c/s output is being produced, see Chap. 3.

(3) Once the fault is cleared it is necessary to operate the START AND RESET switch at the control, generator pulse (M) to regain main output pulses; it may also be necessary to realign the main and standby −8 microsecond pulses before the switch circuit will hold in.

Unit 5 (S) fault indication

88. This is the standby equivalent of the unit 5 (M) fault and the details are as described in paras. 85 to 87, except that they apply to standby units instead of main units.

Pulse misalignment

89. Equipment conditions—misalignment faults can occur because of the loss of either the main or standby −8 microsecond pulses, or because of genuine misalignment with both pulses present. Such a fault causes pulse production to originate from the source selected by the operation of the appropriate EMERGENCY P.R.F. SELECT switch, while pulse outputs from the unselected source are inhibited. This arrangement is however subject to certain overriding conditions so that the final conditions are:—

(1) With main emergency p.r.f. selected, on the recognition of a pulse misalignment fault main p.r.f. generation is permitted, standby pulse generation is inhibited, unless

(a) There is a main pulse generation fault (250 c/s absent) or a failure of the control, generator pulse (M) +250V or −250V supplies. In any of these events main pulse generation is inhibited, standby is permitted.

(b) The reason for pulse misalignment is that the main +8 microsecond pulse is absent. In this event, as long as the main 250 c/s is still present, pulse generation is permitted in both the main and standby circuits.

(2) With standby emergency p.r.f. selected, on the recognition of a pulse misalignment fault, standby p.r.f. generation is permitted and main pulse generation is inhibited unless

(a) There is a standby pulse generation fault (250 c/s absent) or a failure of the control, generator pulse (S) +250V or −250V supplies. In any of these events standby pulse generation is inhibited, main is permitted.

(b) The reason for pulse misalignment is that the standby −8 microsecond pulse is absent. In this event, as long as the standby 250 c/s is still present, pulse generation is permitted in both the main and standby circuits.

(3) If the BY-PASS switch at either of the p.r.f. cabinets is operated, the pulse generation circuits in that cabinet can only be inhibited by the loss of the corresponding 250 c/s signal, or control, generator pulse +250V or −250V failures, and not by pulse misalignment.

90. Fault location—in the absence of the failure of the +250V or −250V supplies, which would be shown by further fault indication, then:—

(1) With main emergency p.r.f. selected:

(a) With both −8 microsecond pulses present, or with the standby −8 microsecond pulse missing, the standby PULSE GENERATION FAULT lamp is lit, the main NORMAL lamp is lit.
(b) With main −8 microsecond pulses missing but no main 250 c/s fault, both the main and standby PULSE GENERATION NORMAL lamps are lit.
(c) With a main 250 c/s fault, whether or not the main −8 microsecond pulses are missing, the main PULSE GENERATION FAULT lamp is lit, the standby NORMAL lamp is lit.

(2) With standby emergency p.r.f. selected:—
(a) With both −8 microsecond pulses present or with the main −8 microsecond pulses missing, the main PULSE GENERATION FAULT lamp is lit, the standby NORMAL lamp is lit.
(b) With the standby −8 microsecond pulses missing but no standby 250 c/s fault, both the main and standby PULSE GENERATION NORMAL lamps are lit.
(c) With a standby 250 c/s fault, whether or not the standby −8microsecond pulses are missing, the standby PULSE GENERATION FAULT lamp is lit, the main NORMAL lamp is lit.

91. Action—according to the nature of the fault:
(1) Loss of −8 microsecond pulse input, check the outputs of the main and standby cathode follower units, see Chap. 5.

(2) Misalignment, with both pulses present. At the control, generator pulse (S) display the output from SKTAN on an oscilloscope and operate the GONIO DRIVE CONTROLS until the two pulses displayed, main and standby, exactly overlap. Then operate the START AND RESET switch at whichever control, generator pulse unit is displaying PULSE GENERATION FAULT. Occasional slips in pulse alignment are to be expected, but if the condition recurs frequently then investigate the main and standby divider units 102, as one or the other of them may not be looking satisfactorily on to its input frequency.

Unit 4 (S) fault indication

CAUTION . . .

With this fault double pulsing can occur. Subject to the appropriate authority, the bypass switch at the main cabinet should be operated immediately.

92. Equipment condition—a pulse alignment fault has been detected but the outputs from unit 4 (S) are in such a state as to override any misalignment fault action in either the main or standby pulse generation circuits. The state of the equipment varies with the cause of the fault:

(1) If the fault is caused by the failure of both the main and standby −8 microsecond pulses, then:

(a) If the 250 c/s signals are still present, both main and standby output pulses are produced; these may or may not be in alignment.
(b) If one or both 250 c/s have failed, then pulse outputs from one or both sides are inhibited.

(2) If the fault is caused by the failure of unit 4 (S) itself, plus alignment, then:

(a) There is misalignment with both −8 microsecond pulses present, then pulse outputs from both sides are produced which are not in alignment.
(b) Again, if one or the other 250 c/s signal fails, then pulse output from that side is inhibited.

93. Fault location—if both −8 microsecond pulses are missing, then this accounts both for the misalignment indication and for the unit 4 (S) fault indication. If one or both −8 microsecond pulses are present, then, in addition to some form of pulse misalignment, unit 4 (S) is faulty.

94. Action—proceed as follows:—

(1) Monitor the −8 microsecond pulses (main and standby) at socket SKTAN on the control, generator pulse (standby).

(2) If both −8 microsecond pulses are absent, monitor the outputs of the cathode follower units, see Chap. 5.

(3) If one or both −8 microsecond pulses are present:

(a) Remove and test unit 4 (S), see Chap. 12.
(b) Investigate the cause of pulse misalignment, see para. 89.

Unit 7 (T) fault indication

95. Equipment condition—main pulse generation is inhibited, standby pulse generation is normal.

96. Fault location—this fault is indicated when r.f. input to the flywheel oscillators is normal, so neither of them is inhibited, and when there is no pulse misalignment fault, so that the main

−8 microsecond pulse is present, and yet a pulse generation fault has been indicated. It could be caused by the loss of the 250 c/s signal from the divider unit 102 (M), but since this same signal is used within the divider as part of the conditions for the formation of the main −8 microsecond pulse, then this is unlikely. The most likely cause is the failure of unit 7 (M) itself.

97. Action—proceed as follows:

(1) Remove unit 7 (M) and test it according to Chap. 12. Removal of this unit has no effect on the conditions described in para. 93. If no fault is found, proceed as under (2).

(2) Investigate the 250 c/s output from divider unit 102 (M), see Chap. 3.

Unit 6 (S) fault indication

98. Equipment condition—this fault is the standby equivalent of the unit 7 (M) fault. Standby pulse generation is inhibited, main pulse generation is normal.

99. Fault location—for similar reasons to those given in para. 96, the suspect unit is unit 6 (S), though with the possibility that divider unit 102 (S) is at fault.

100. Action—proceed as follows:

(1) Remove unit 6 (S) and test it according to Chap. 12. Removal of this unit has no effect on the conditions described in para. 98. If no fault is found, proceed as under (2).

(2) Investigate the 250 c/s output from divider unit 102 (S), see Chap. 3.

Units 3 (S) and 7 (S) indication

101. Equipment condition—this fault indication can be given when any of the following conditions exist. They are:

(1) If no pulse misalignment fault exists and either unit 3 (S) or unit 7 (S) has failed in such a way as to cause misalignment indication, relay RLH (S) de-energized, but the output from unit 7 (S) to unit 6 (S) or 7 (M), according to emergency p.r.f. selection, to remain at its normal (+30V) level. Operation is then normal.

(2) If a pulse alignment fault exists to which units 3 (S) and 7 (S) have responded correctly, but with main p.r.f. selected, unit 6 (S) has failed to respond or with standby p.r.f. selected unit 7 (M) has failed to respond. In this condition neither main nor standby pulse output is inhibited, though the pulses are misaligned.

(3) If conditions are as under (2) but:

(a) With main emergency p.r.f. selected, the reason that unit 6 (S) has failed to respond is due to the fact that misalignment action is overridden by a main pulse generation fault, or by the loss of the +250V or −250V supplies in the control, generator pulse (main).

(b) With standby emergency p.r.f. selected the reason that unit 7 (M) has failed to respond is due to the fact that misalignment action is overridden by a standby pulse generation fault, or by the loss of the +250V or −250V supplies in the control, generator pulse (standby).

In either of the instances quoted, (a) or (b), either the main or standby pulse outputs are inhibited by the fault which creates the overriding action.

102. Fault location—with conditions as under para. 101(1) or (2) the fault may be in units 3 (S) and 7 (S) or, with main emergency p.r.f. selected in unit 6 (S), with standby emergency p.r.f. selected in unit 7 (M). With conditions as under para. 101(3), units 3 (S), 7 (S), 6 (S) and 7 (M) are reacting normally and the fault lies elsewhere, as shown by the pattern of indication.

103. Action—proceed as follows:

(1) Since the fault can result in misaligned pulses being fed out, the inhibition of one source of pulses must be made immediately. If main emergency p.r.f. is selected, then, subject to the appropriate authority, operate the BY-PASS switch in the main p.r.f. cabinet; if standby emergency p.r.f. is selected, then, again subject to authority, operate the BY-PASS switch in the standby p.r.f. cabinet.

(2) Remove units 3 (S) and 7 (S) and test them as described in Chap. 12. Removal of these units does not affect by-pass operation. If no fault is revealed proceed as in (3).

(3) Units 6 (S) and 7 (M)

(a) If the BY-PASS switch in the main cabinet has been operated, that is the standby circuits are inhibited, remove and test unit 6 (S) as detailed in Chap. 12.

(b) Similarly, if the BY-PASS switch in the standby cabinet has been operated, remove and test unit 7 (M) as detailed in Chap. 12.

(4) Once the fault has been cleared, restore the BY-PASS switch to its normal position.

Loss of individual pulse outputs

104. Loss of individual pulse outputs does not initiate any fault action or system fault indication within the no-break trigger system. However, these outputs are continuously monitored by the indicators at the panel indicator, pulse. If any such loss occurs, monitor first at the cathode follower unit (Chap. 5) and, for delayed pulses only, check their passage through the appropriate generator, sweep (Chap. 6) and pulse generator (Chap. 7). If both equivalent main and standby pulses are lost, then this will cause loss of triggering pulses at the external equipment which employs them, with consequent reaction; this also occurs if the pulses are being generated and indicated but there is a fault at the output distribution OR-gate on the distribution unit, pulse.

Frame power supply faults

General

105. For the purpose of discrimination, frame power supply faults are defined as those originating at the +250V voltage regulators in frames 1, 2 and 3, or the −250V voltage regulator or panel indicator contained in frame 2. The indications when these faults occur are not illustrated, but they are described in the following paragraphs. Except where otherwise stated the remarks apply equally to the equivalent main or standby units.

+250V regulators

106. If one of the +250V regulators (units 101, 202, 301) fails then:

(1) The FAULT lamp on the faulty unit lights.

(2) A relay in unit 403 is energized causing an external frame 1, 2 or 3 fault warning signal to be generated, and also causing system state indication to change to FAULT.

(3) All +250V supplies in that frame are lost.

107. Further indication may be caused on the equipment state and unit fault lamps at the control, generator pulse, units according to which regulator has failed. The failures have the following effects at the cabinet concerned:

(1) If unit 101 fails then the +250V h.t. is removed from the divider unit 102, gate electronic unit 103, and cathode follower unit 104. All pulse generation is thus lost, as indicated on the panel indicator, pulse.

(2) If unit 202 fails, then the +250V h.t. is removed from the oscillator (crystal) unit 203, and from generator, sweep units 205 and 207 and pulse generator units 206 and 208. Crystal oscillator and carrier frequency outputs are lost, and ◄one of the −125► and −750 microsecond delayed outputs are lost. The loss of these pulses is indicated on the panel indicator, pulse.

(3) If unit 301 fails then the 0 and −125 microseconds delayed pulse outputs are all lost, as indicated on the panel indicator, pulse.

−250V regulator

108. Only one −250V regulator is employed in each cabinet (unit 201). If this fails then:

(1) The FAULT light at the regulator lights.

(2) The frame 2 fault warning is given and the system state indication changes to FAULT.

(3) In consequence of the failure of the −250V supply, the +250V supplies from units 101, 202, and 301 are turned off.

(4) The control, generator pulse, unit continues to function, since it is fed with alternative +250V and −250V supplies from both cabinets; faults arising from the loss of supplies to frames 1, 2 and 3 are therefore indicated.

Panel indicator (+450V and −50V supplies)

109. The +450V supplies for the three +250V regulators are routed through the panel indicator (unit 204), where they are fused and their pressence is shown by neon indicators. The panel indicator also distributes the −50V supplies to the regulators and to the relays in units 403 and 404. These latter two units control respectively the regulator and frame fault warning signals and the system state lamps which are mounted on the cabinet framework. In addition, in the p.r.f. cabinet (main) only, the −50V supply from unit 204 is taken to the relay assembly.

110. To form the −50V supply, two d.c. supplies are fed into unit 204 and separtely indicated by lamps (−50V No. 1 and −50V No. 2). These two supplies are then combined through a 2-input OR-gate, fused and fed out to the destinations described. If this supply fails then:

(1) The −50V FAULT lamp at the panel indicator lights.

(2) Because the −50V source of the call signals from the regulator has failed, the +250V and −250V supplies are turned off. No FAULT lamps at the regulator units are lit however, as this 6·3V a.c. supply originates from the panel indicator and is inhibited in the event of a −50V failure.

(3) No regulator or frame fault signals are generated and all the system state lamps on the cabinet framework are unlit: this is because of the loss of the −50V supply to units 403 and 404.

(4) Assuming that the −50V external supply to the control, generator pulse unit is still present, remaining fault indication in consequence of the loss of +250V and −250V supplies is normal.

(5) If it is the −50V from the panel indicator in the p.r.f. cabinet (main) that has

failed, the supply to the relay assembly is lost. As a result the relays in that unit are de-energized, selecting standby.

Control, generator pulse, units—power supply faults

111. These faults are those which arise from a failure of a particular supply within the control, generator pulse, units themselves, while the remaining supplies within the cabinet are normal. Indication caused by these faults is shown on fig. 19.

112. The d.c. supplies, +250V, −250V and −50V, are all derived from OR-gates and are then fused and used within the unit. Failures of these supplies could be due to faulty diodes in the OR-gates or, more likely, to fuse failure. Only one a.c. mains supply is fed into each unit, so that the likely cause of failure in this instance is restricted to the fuse.

113. If the fault is due to a fuse failure, then the cause of the failure should be investigated and cured before the fuse is replaced. In the main and standby units the fuses are accessible from the rear of the unit; the fuse references for corresponding supplies in the units are identical and are as follows:

FS1, a.c. mains

FS2, +250V

FS3, −250V

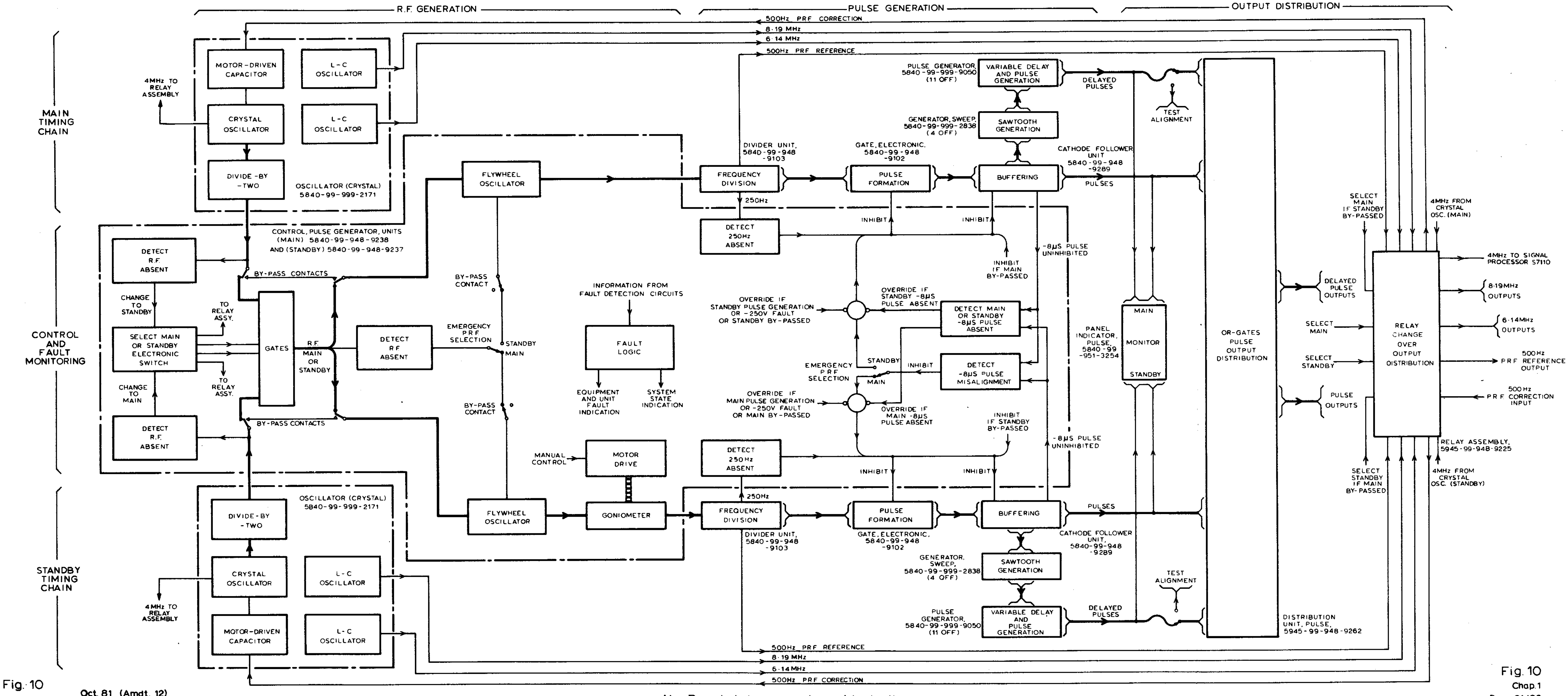
FS4, −50V

External emergency trigger lamp

114. Because of the manner in which the signal is generated for the emergency trigger lamp, this lamp is not only lit for various fault conditions depicted on figs. 18 and 19, but is also lit when:

(1) The power supplies at the p.r.f. system are not switched on.

(2) The BY-PASS switch in the standby cabinet is operated, removing the +250V supply from the control, generator pulse (main).



No-Break trigger system, block diagram.

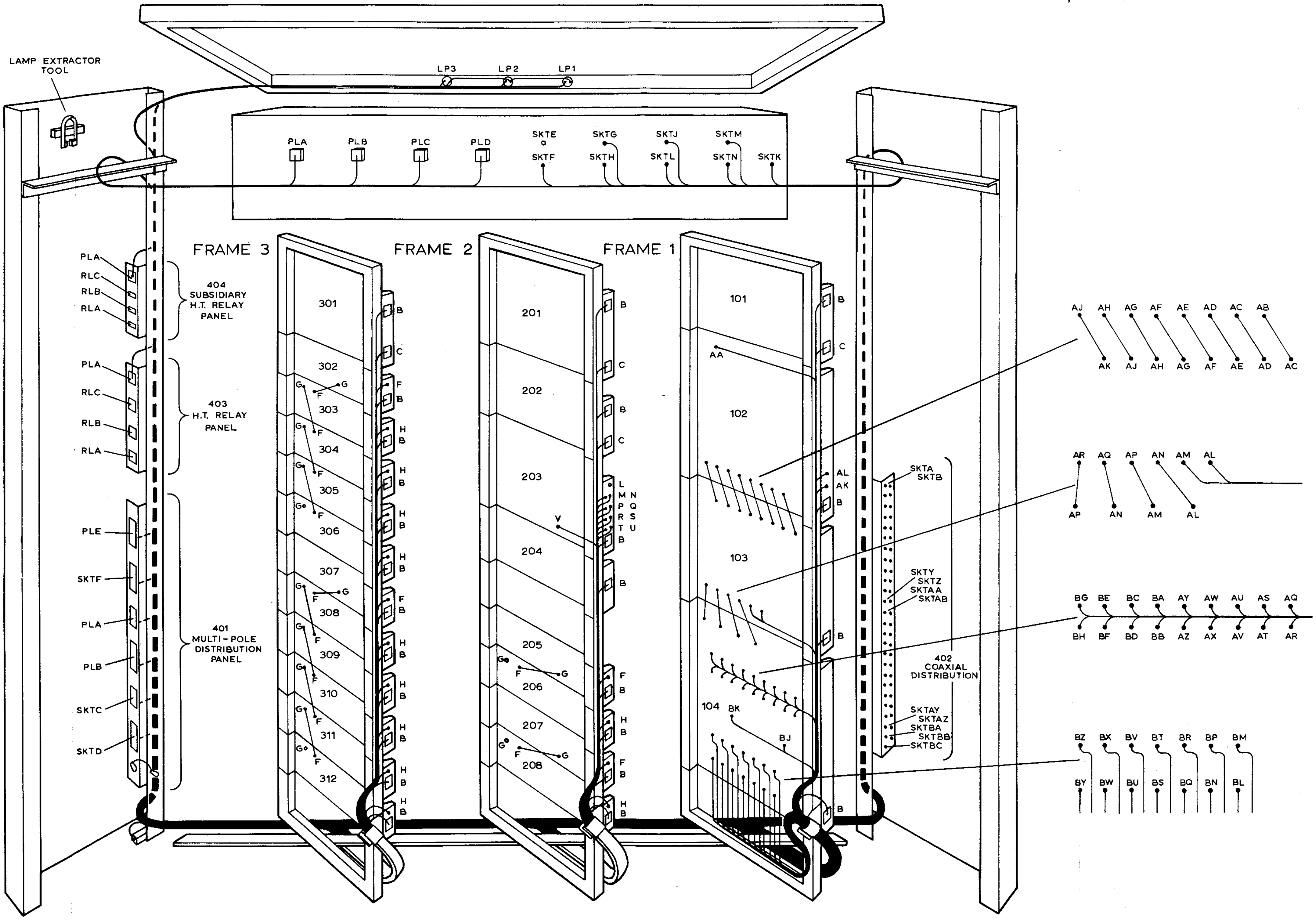


Fig. 11 D.87705. 572442. S.W. 2/66 Cabinet, electrical equipment: Exploded view of rear. Fig. 11

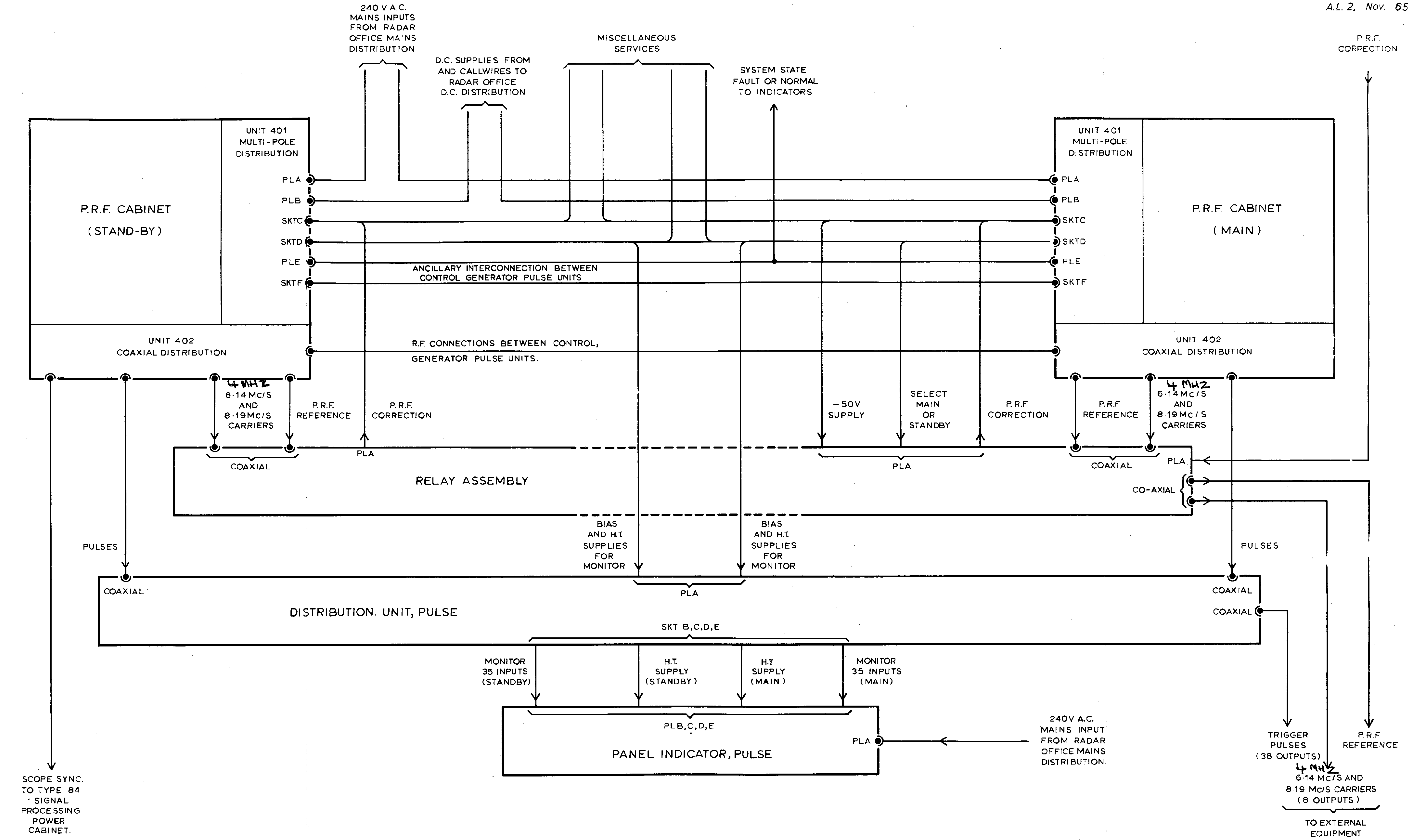


Fig. 12 D.87705. 572442. S.W. 2/66 Interconnections : block diagram. Fig. 12

Fig. 13 Signal interconnections (main) Fig. 13

Fig. 14

Power distribution and control signal interconnections (main)

Fig. 14

D.539958 R.C.1646

Signal interconnections (standby)

Fig. 15

Fig.16 Power distribution and control signal interconnections (standby) Fig.16

D.509985 R.C.1646

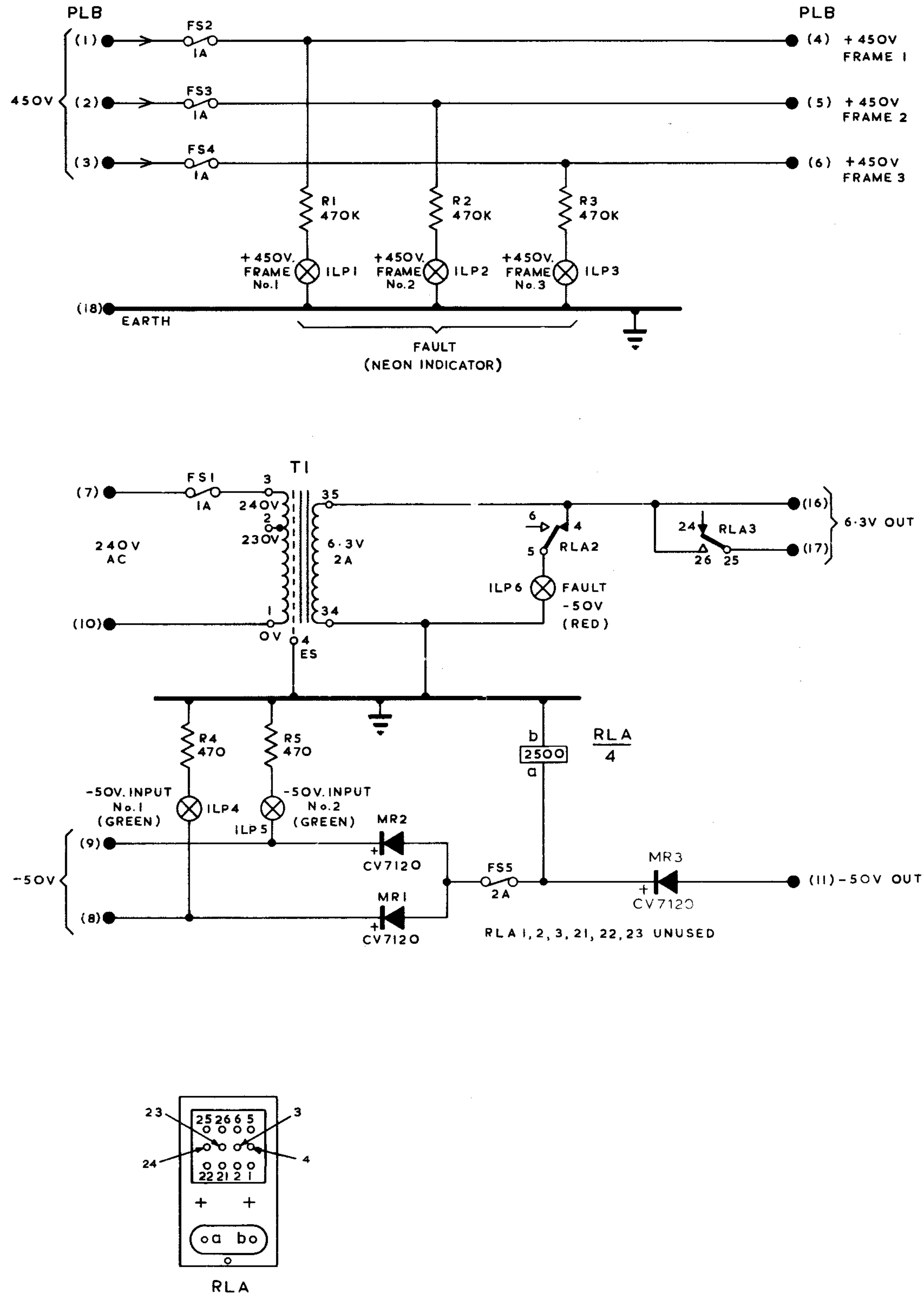


Fig. 17 Panel indicator, 5840-99-948-9235 circuit.

D.87705. 572442. S.W. 2.66

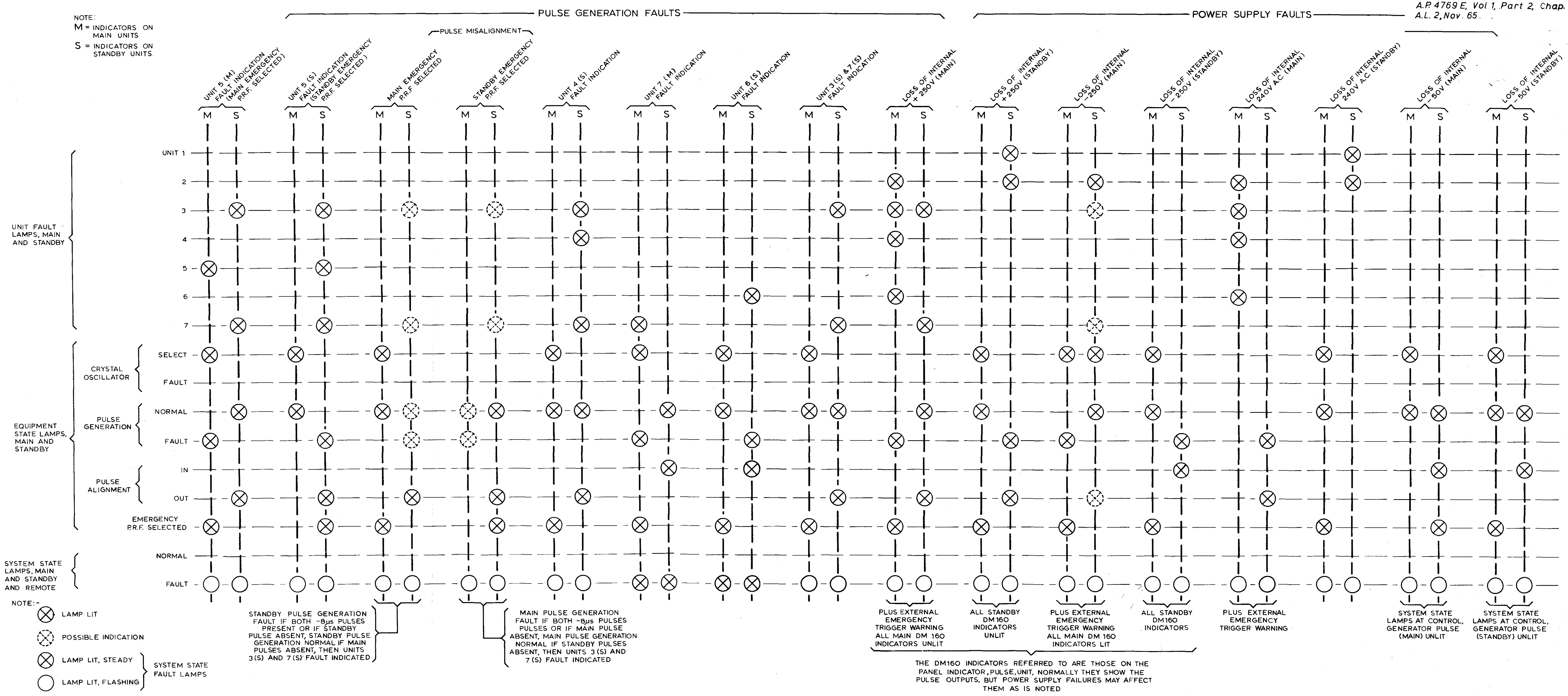


Fig. 19 — Indication pulse generation and power supply faults — Fig. 19

D.87705. 572442. S.W. 2/66

Chapter 2

OSCILLATOR (CRYSTAL) 5840-99-999-2171

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Introduction

1. The oscillator (crystal) (fig. 1) is used in two identical applications, one being in the main p.r.f. cabinet, the other in the standby p.r.f. cabinet. In both applications the oscillator produces the basic frequency from which the nominal 250 c/s trigger pulses are generated. The frequency of the oscillator lies in the range 4·043 to 4·429 Mc/s, the actual frequency being determined by operational requirements so that the required p.r.f. is obtained. A label is provided on the unit (fig. 2) so that the exact oscillator frequency can be written after it has been set up.

2. The oscillator is of the frequency modulated type with fine control of output under the direction of a p.r.f. correction voltage from external circuits. The first stage of division by two takes place in the oscillator unit to provide an output of the order of 2·0215 Mc/s to 2·2145 Mc/s, according to p.r.f. allocation, to the control generator pulse unit.

3. The unit also provides, from separate tuned anode oscillators, 6·14 Mc/s and 8·19 Mc/s carrier frequencies for external use.

Principles of p.r.f. correction

4. In most of the applications of the p.r.f. generating equipment it is necessary that the p.r.f. be locked to some external source. One example of this is when the cancellation principle used in the signal processing equipment depends upon the signal delay in a mercury delay cell being exactly equal to the pulse recurrence period. Discrepancies can occur between these delay and recurrence periods and compensation to correct them must be applied to the pulse recurrence period.

5. Such correction is obtained by providing a motor-driven variable capacitor across the crystal to pull the oscillator frequency. Reference outputs are fed from the p.r.f. generating equipment, and a continuous comparison is made between the pulse recurrence period and the cell delay time. As a result of this comparison a 500 c/s p.r.f. correction voltage is generated, the phase of which, either leading or lagging by 90 degrees with respect to the phase of a fixed 500 c/s reference, determines the direction of correction, and the amplitude of which determines the amount. The fixed 500 c/s reference and the 500 c/s p.r.f. correction outputs control power to drive the crystal-pulling capacitor in the oscillator unit.

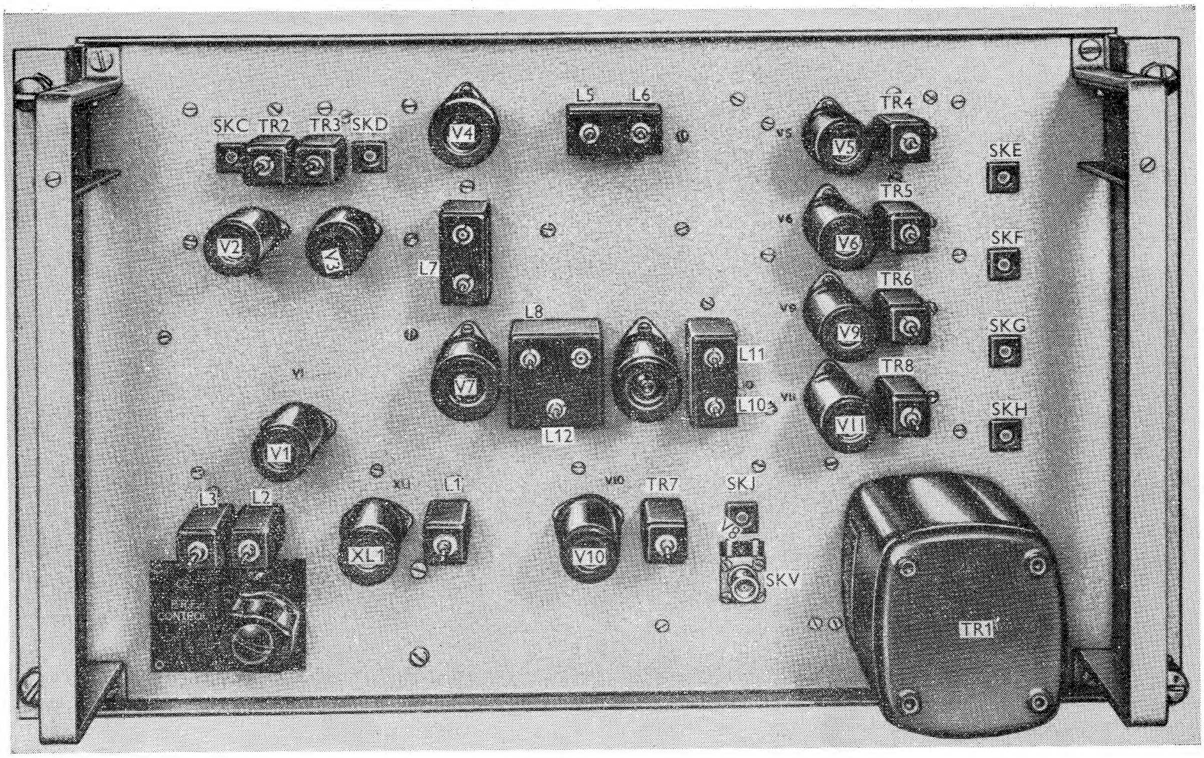

Fig. 1. Oscillator (crystal): front view

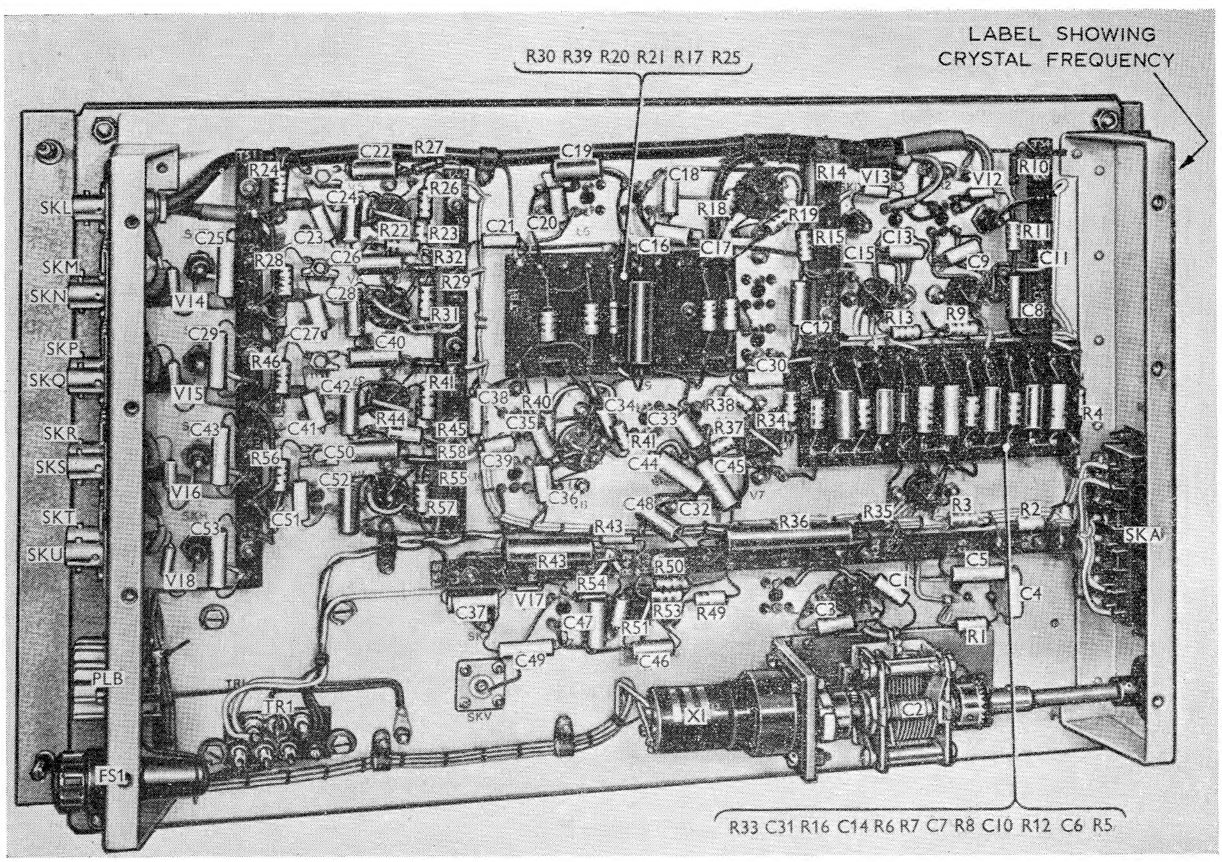

Fig. 2. Oscillator (crystal): rear view

Performance characteristics

Inputs

6. The 500 c/s inputs for the p.r.f. correction drive motor are received via main/standby relay contacts in the relay assembly (Chap. 9). The inputs are:

(1) An unbalanced fixed-phase reference input at a fixed level into PLB/2 and PLB/3.

(2) An unbalanced reversible-phase p.r.f. correction input at a variable level into PLB/1 and PLB/4.

Outputs

7. The half crystal frequency output at SKV is at such a level that with multimeter 1 connected to test socket SKJ a reading not less than 4·0V will be obtained. This output is fed to the control, generator pulse, main or standby as applicable (Chap. 8).

8. The 8·19 Mc/s output at sockets SKM to SKQ is at such a level that the multimeter reading at sockets SKE and SKF will be not less than 2·5V. These outputs are fed out via the relays in the relay assembly.

9. The 6·14 Mc/s outputs at sockets ~~SKR~~ SKS to SKU are at the same level as those from SKM to SKQ when measured at test sockets SKG and SKH. These outputs are also fed out via the relays in the relay assembly.

10. An additional output at the crystal frequency is provided at SKL, the level being such that the multimeter reading at SKC is not less than 0·6V. ~~This output is not used.~~

Capacitor drive assembly

11. The capacitor drive assembly (fig. 3) on the unit chassis consists of a supporting bracket on which is mounted the two-phase motor and variable capacitor used for p.r.f. correction. Through built-in reduction gearing of about 2500:1, the motor drive is connected by a coupling clutch assembly to the shaft of the capacitor rotor. On the other end of the capacitor shaft is fitted a bevel gear.

12. A spring-loaded adjustment control on the front panel, designated P.R.F. CONTROL, permits engagement of a pinion with the bevel gear thereby facilitating manual adjustment of the capacitor setting. This facility is used during testing procedures, and can also be used for emergency setting-up of p.r.f. and for manual setting of the p.r.f. in applications of the unit where p.r.f. correction circuits are not used. The coupling assembly between motor and capacitor shafts incorporates a slipping clutch device in the form of a tension spring which bears on the capacitor shaft. This affords mechanical protection for the high ratio reduction gearing inside the motor unit.

13. An extension shaft attached to the capacitor rotor carries a calibrated disc marked with white numerals from 0 to 9. The numeral corresponding with a particular setting of the capacitor rotor is visible through an aperture in the side of the unit chassis.

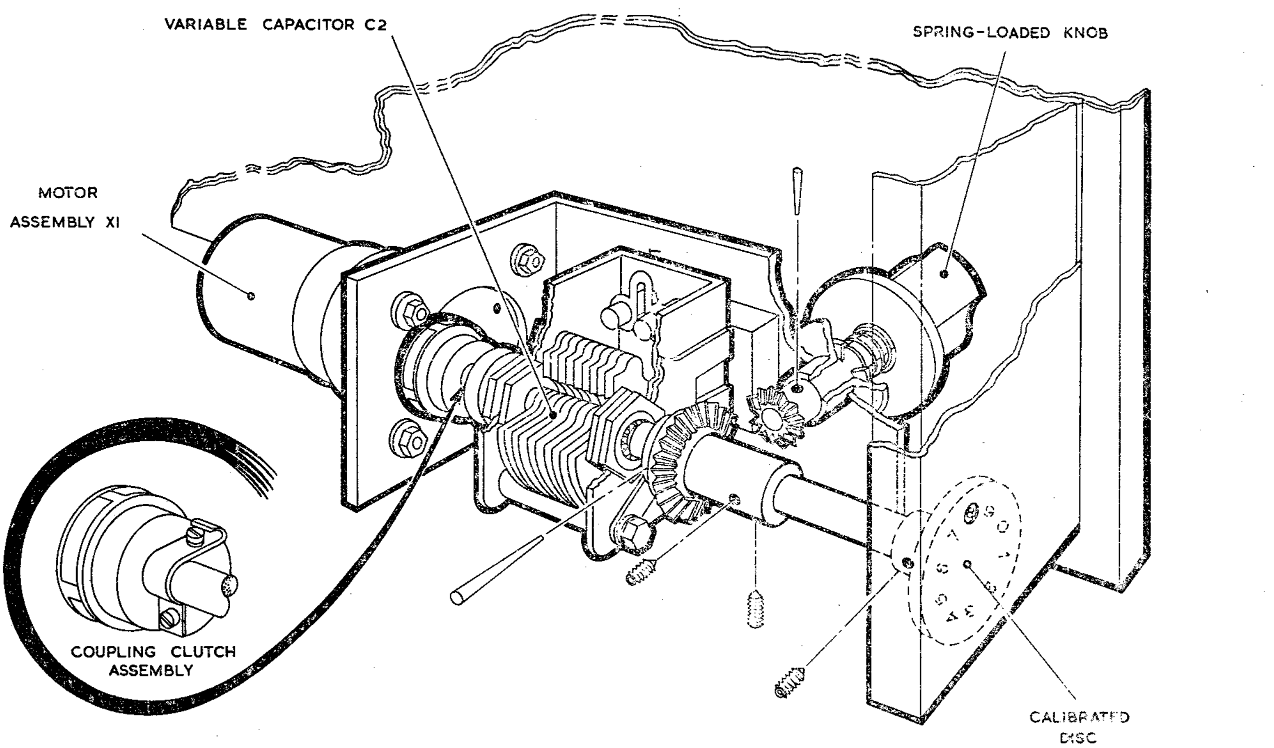

Fig. 3. Capacitor drive assembly

Brief circuit description

14. The circuits of the oscillator unit are divided into three independent groups (fig. 4) of which the main group produces the crystal oscillator frequency and the other two groups the carrier frequencies of 6·14 and 8·19 Mc/s.

15. The initial stage of the main oscillator circuits consists of a crystal-controlled Hartley-type oscillator, the frequency of which is automatically adjusted, as previously described, by a motor-driven capacitor controlled by the external p.r.f. control circuits. Two identical tuned amplifier circuits, V2 and V3, are fed from the output of the oscillator and the output from V3 feeds a divide-by-two stage V7. The resulting half crystal frequency is coupled by mutual inductance to a further tuned amplifier stage, the output from which is routed via the control, generator pulse for use as the input to the divider unit.

16. The 8·19 Mc/s and 6·14 Mc/s carrier generation circuits, V4 and V8, each consists of a push-pull Hartley-type oscillator, the frequency of which is determined by a tuned circuit. Each oscillator provides the inputs for two identical tuned amplifier stages (V5, V6 and V9, V11) with parallel inputs but separate outputs. These outputs are fed to external circuits, via the relay assembly.

Circuit description

17. Since the main function of the unit is to generate the basic frequency used in the production of the various triggering waveforms, these circuits are described first. The two carrier frequencies are produced by identical circuits and therefore only the circuits used for the production of the 8·19 Mc/s carrier will be described. The circuit of the unit is shown in fig. 7.

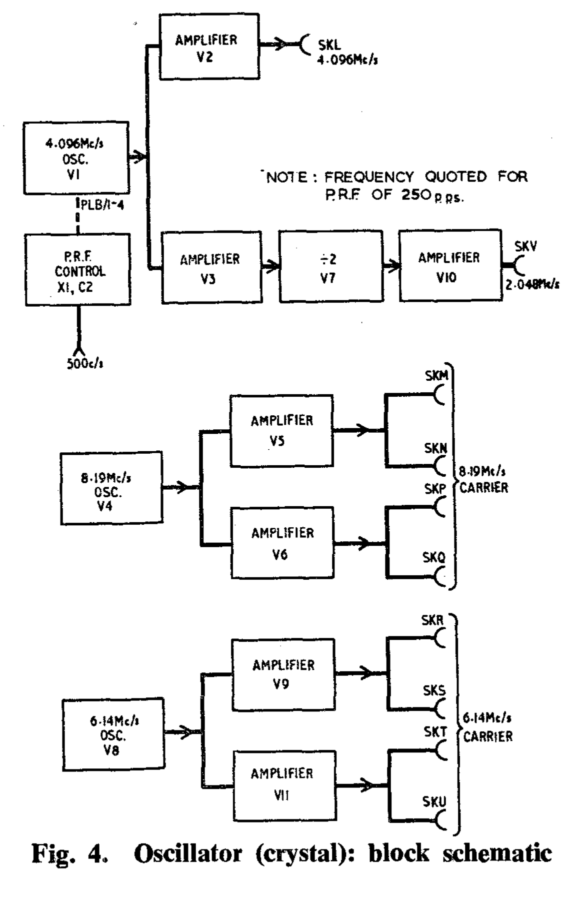

Fig. 4. Oscillator (crystal): block schematic

Half crystal frequency generation

18. V1 is a pentode stage connected as a crystal oscillator. In this arrangement the screen, control grid and cathode form a Hartley oscillator with the cathode taken to a tapping on L2 in the tuned circuit L2, C2, C3. With C2 at its mid-position the circuit oscillates at the frequency of the crystal XL1 which is shunted across the tuned circuit via capacitor C1.

19. C2 is the variable capacitor driven by the two-phase motor X1. The motor receives a 500 c/s input of fixed phase and amplitude at winding terminals 2 and 3, and a p.r.f. correction input at winding terminals 1 and 4. Inductor L1 is adjusted during initial alignment so that the frequency swing on each side of the crystal frequency in extreme positions of C2 is linear over a frequency range of approximately 20 kc/s. Under stable conditions with no p.r.f. correction applied the p.r.f. correction input is a 1000 c/s sine wave so that motor X1 remains stationary. However, with p.r.f. correction applied, a 500 c/s sine wave is applied to winding 1 and 4 of the motor. The phase of this sine wave is either leading or lagging by 90 degrees with respect to the fixed 500 c/s input so that the motor rotates in a direction to produce the required correction in the output frequency of the oscillator and therefore of the p.r.f. Components L3, C4, are tuned to the basic crystal frequency so that, with R1, an anti-parasitic circuit is formed.

20. The oscillator output is coupled through the common electron stream to the anode of V1 so that the output is developed across the anode load resistor R7. Pentodes V2 and V3 are two identical amplifier stages which receive their inputs from the anode of V1 but have separate outputs, that from V2 being taken from the secondary of TR2 to SKL whereas that from V3 is taken from the secondary of TR3 to feed the divide-by-two stage V7. The primary windings of TR2 and TR3 are tuned for maximum output at test sockets SKC and SKD at the basic crystal frequency.

21. Division by two to the half crystal frequency takes place in the double-triode stage V7 used as a regenerative modulator divider of a type which gives no output unless there is an adequate input (fig. 5). This circuit is driven at twice the frequency of the tuned circuit L8-C33. The operation of the circuit is considered on the basis of an assumption that the tuned circuit is already in oscillation.

22. With no input the voltage developed across the tuned circuit L8 and C33 cuts off V7a when the output at terminal 3 of L8 is positive and makes it conduct when it is negative. With a negative half-wave at the grid of V7a at the same time that the output from the tuned circuit is negative the circuit is energized by cathode

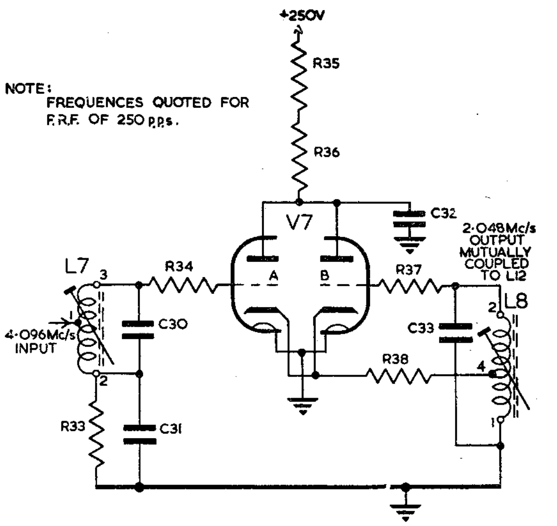

Fig. 5. Divide-by-two stage: circuit

follower action in such a direction as to increase oscillation. The next negative input half-wave to V7a grid is ineffective since the valve is already cut off by the positive input to the common cathode from the tuned circuit. Idealized waveforms showing the action of the divider stage are given in fig. 6.

23. The output is taken from the divider stage via the mutual inductive coupling between L8 and L12 which are enclosed in the same coil case. Tuned circuit L12 and C44 is tuned to give maximum output at SKV with the crystal oscillator stage producing its nominal frequency. V10 is a conventional amplifier stage with an anode load consisting of the tuned primary winding of TR7 the output being taken from the secondary of the transformer to SKV.

Carrier generation

24. The circuits for the generation and distribution of the 8·19 Mc/s and 6·14 Mc/s carrier frequencies are identical except for the values of certain components in frequency sensitive circuits and are associated with V4, V5 and V6 for 8·19 Mc/s, or with V8, V9 and V11 for 6·14 Mc/s. The operation of the 8·19 Mc/s circuits only is described below, the 6·14 Mc/s circuits being identical in operation and differing only in the circuit references of the components involved.

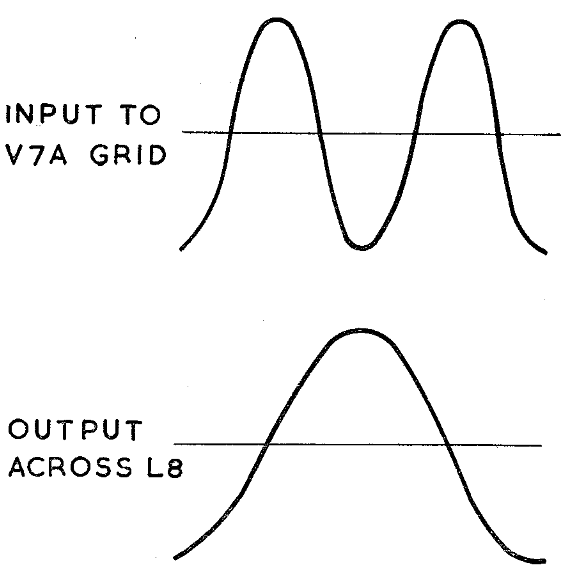

Fig. 6. Divide-by-two stage: waveforms

25. V4 is a double-triode stage arranged as a push-pull, tuned anode oscillator with the tuned circuit L5 and C18 connected between the anodes of the two halves of the valve and with the h.t. feed brought in to the centre tap of L5. The positive feedback path is completed through C16 for V4b and C17 for V4a. Capacitor C19 decouples the h.t. line. The output from the oscillator is coupled to the amplifiers V5 and V6 via the mutual inductance between L5 and L6, contained in the same coil case.

26. Amplifiers V5 and V6 accept inputs from the tuned circuit L6-C20, which is tuned to the carrier frequency, via C21 and their respective grid stoppers R23 and R29. Separate outputs are taken from the two amplifier stages via the secondary windings of TR4 and TR5, the primary windings of these transformers being tuned to the carrier frequency in association with C23 and C27.

27. In a similar manner 6·14 Mc/s outputs are obtained from the secondary windings of TR6 and TR8. The outputs of sockets SKM, SKN, SKP, SKQ, ~~SKR~~, SKS, SKT and SKU are fed out via the relay assembly.

Power supplies

28. Heater voltages for the valves are supplied from TR1, the 240V a.c. supply for the transformer being received via FS1 at PLB/7 and RLB/10. Control of the a.c. mains supply is effected externally. The +250V d.c. supply from the +250V voltage regulator is brought in at PLB/9 (+250V) and PLB/12 (earth).

Monitor points

29. A series of test sockets, SKC to SKJ, is provided on the unit for checking the levels at certain points in the circuit. By means of a CV488 diode and a 100 pF capacitor a d.c. output, proportional to the amplitude of the waveform at the points concerned, is made available for level checking by means of a multimeter Type 1 (on the 0-10V d.c. range) or equivalent meter. The voltages obtainable at these test points together with sockets requiring a 75 ohm termination, are listed in Table 1.

Multimeter readings

30. In addition to the test points detailed above the performance of the valves in the unit may be checked by connecting multimeter Type 100 to socket SKA via a plug-to-socket adaptor. The readings obtained should be as indicated in Table 2.

TABLE 1

Level test readings

D.C. voltage at	Level measurement	Terminated in 75 ohms	Reading (not less than)
SKC	Crystal Frequency at SKL	SKL	0·6V
SKD	Crystal Frequency to V7	—	0·4V
SKE	8·19 Mc/s to SKM, SKN	SKM, SKN	2·5V
SKF	8·19 Mc/s to SKP, SKQ	SKP, SKQ	2·5V
SKG	6·14 Mc/s to SKR, SKS	SKR, SKS	2·5V
SKH	6·14 Mc/s at SKT, SKU	SKT, SKU	2·5V
SKJ	Half crystal frequency at SKV	SKV	4·0V

TABLE 2

Multimeter readings

Multimeter switch position	Stage monitored	Measured across resistance	Reading	Tolerance
A	V5	R27	0·55	±0·11
B	V6	R32	0·55	±0·11
C	V8	R42	0·55	±0·11
D	V10	R54	0·60	±0·12
E	V11	R58	0·55	±0·11
F	V1 (screen)	R4	0·50	±0·1 i.e.
G	V1 (screen)	R6	0·40	±0·08 ± 20%
H	V2	R10	0·50	±0·1
J	V3	R14	0·60	±0·12
K	V4	R20	0·55	±0·11
L	V7	R35	0·45	±0·09
M	V9	R48	0·55	±0·11

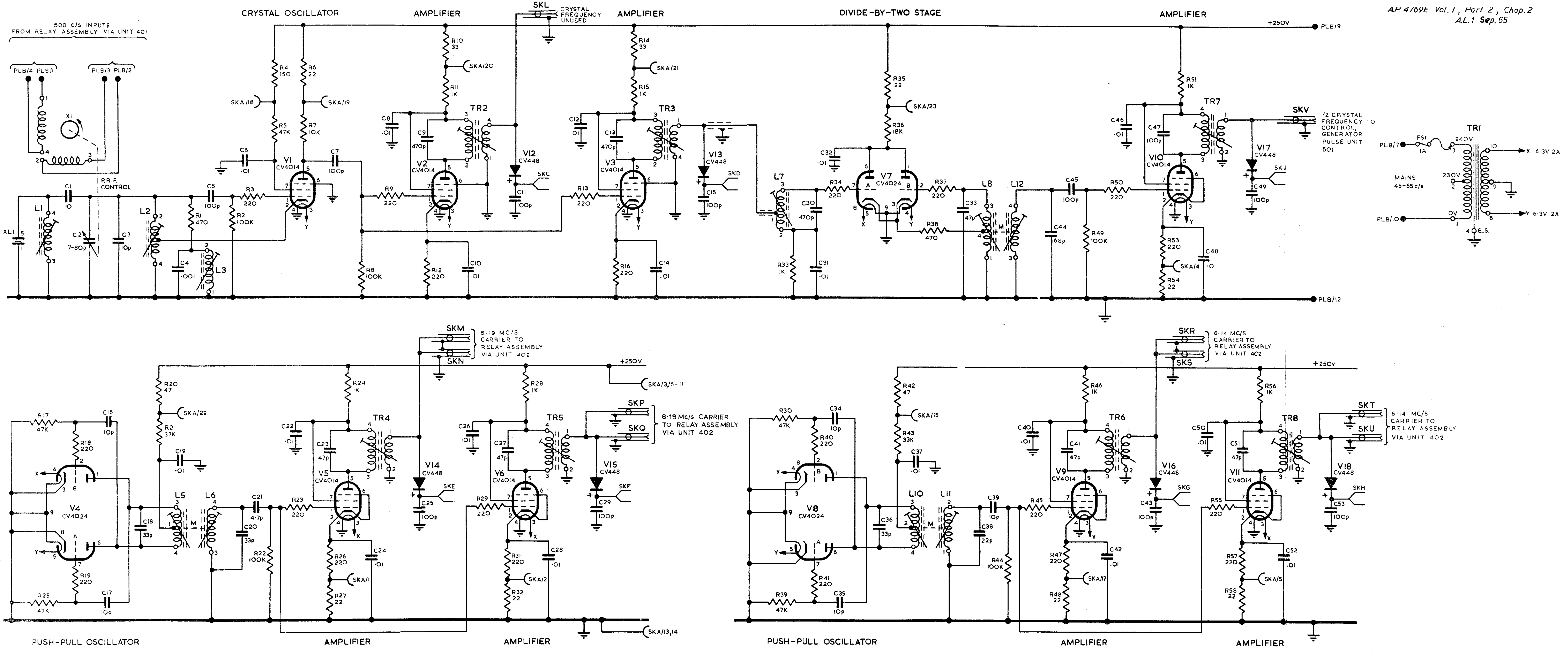

Fig. 7.

NOTE: WHEN MOD. NO CA8144/3 IS EMBODIED, CRYSTAL FREQUENCY (SKL) IS ROUTED TO THE RELAY ASSEMBLY VIA UNIT 402. THE 6.14 MHZ AT SKR IS NOT USED.

AL12

Oscillator (crystal) 5840-99-999-2171: circuit

Fig. 7.

87218 571748 104 11/65 V.B. 925/1

Chapter 3

DIVIDER UNIT 5630-99-948-9103

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Introduction

1. The divider unit (fig. 1) is used in two applications, one unit being located in frame 1 of the main p.r.f. cabinet, the other in frame 1 of the standby p.r.f. cabinet. In each application the unit produces a number of pulse and gating waveform outputs (fig. 2) from the sine wave input received from the crystal oscillator unit (Chap. 2) in the same cabinet. As shown in the functional block schematic (fig. 3), the pulse and gating waveform outputs are fed to the electronic gate (Chap. 4) where they are used in the production of the timing and trigger pulses required. A sine wave output of approximately 500 c/s is fed to the relay assembly (Chap. 10) where it is fed to the units requiring the supply.

2. The frequency of the sine wave input, and hence the frequency, pulse width and timing of the outputs, differs slightly for different stations; the input frequency lies in the frequency range 2·0215 to 2·2145 Mc/s but for the purpose of

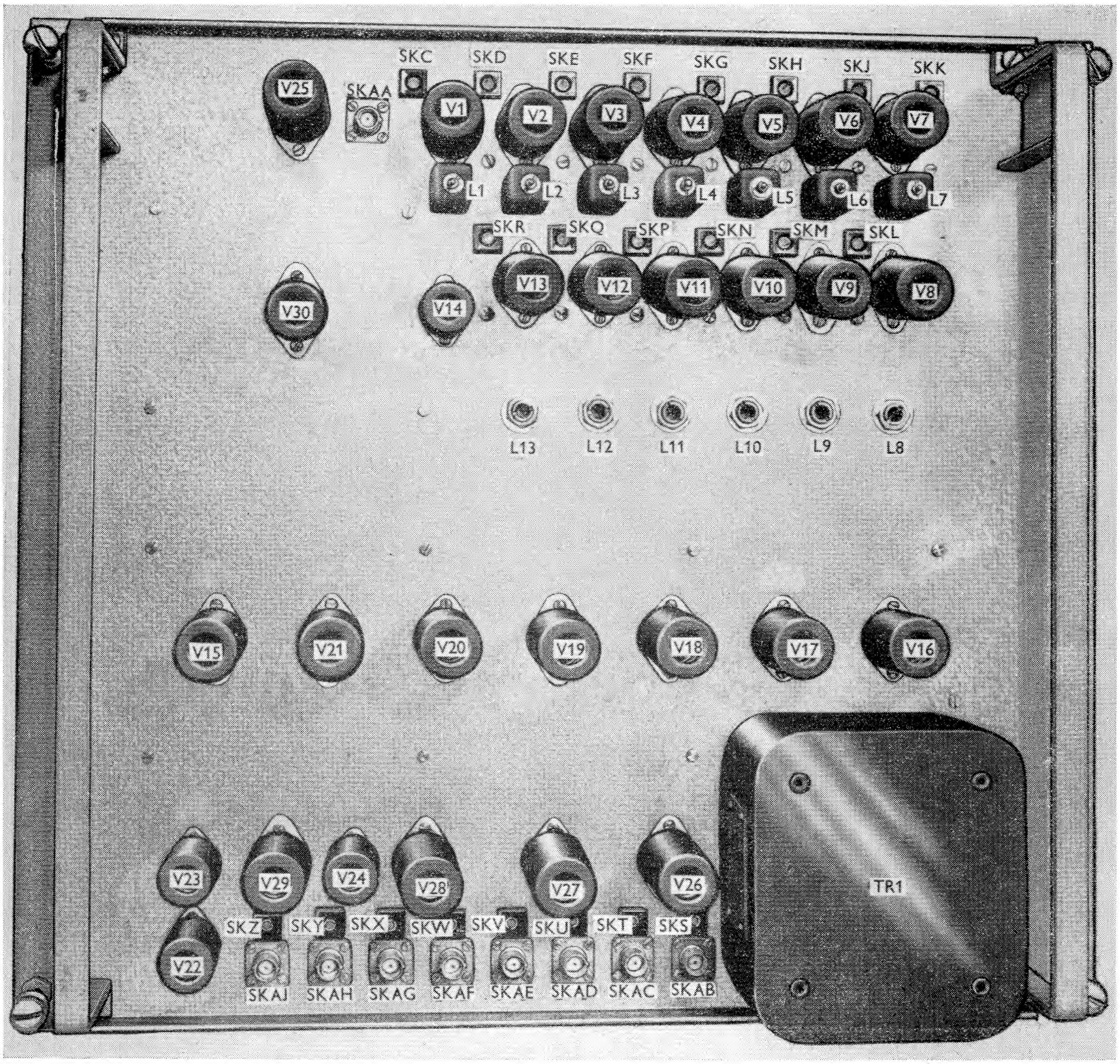

Fig. 1. Divider unit: front view

this description it is assumed to be 2·048 Mc/s. A small perspex label is fixed to the front of the unit on which servicing personnel can mark the input frequency for reference.

Performance characteristics

Input

3. The sine wave input at SKAA is at a frequency of 2·048 Mc/s in the example described herein but the frequency may be 2·038, 2·043, 2·053 or 2·058 Mc/s with an amplitude of approximately 6V peak-to-peak. This input is received from oscillator (crystal).

Outputs

4. All outputs, except that of the 500 c/s sine wave at SKAK and the 250 c/s sine wave at SKAL are of positive-going pulses or gating waveforms and are fed to the electronic gate. These outputs are as follows:—

(1) SKAE delivers groups of five pulses, the spacing between individual pulses being approximately 8 microseconds and the recurrence frequency of the groups approximately 8 kc/s (input frequency divided by 256), with an amplitude of not less than 1V.

(2) SKAB delivers single gating waveforms with a pulse width of approximately 8 microseconds at a p.r.f. of approximately 32 kc/s (input frequency divided by 64) and an amplitude of not less than 1V. These gating waveforms are designated 0 microseconds 32 kc/s waveforms.

(3) SKAF delivers single gating waveforms of the same duration and p.r.f. as for (2) above but these pulses are advanced in time by 8 microseconds with respect to the 0 microseconds gating waveforms and are designated −8 microseconds 32 kc/s waveforms.

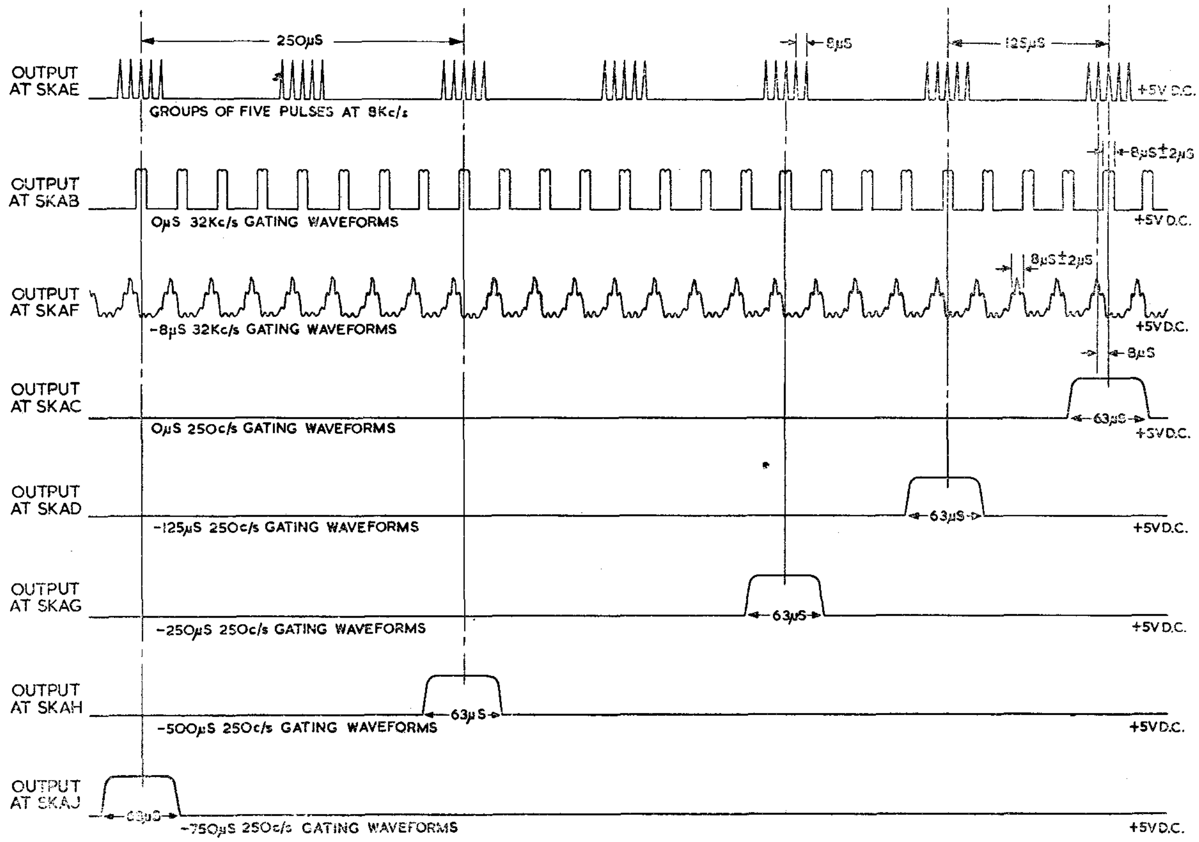

Fig. 2. Divider unit: output waveforms

(4) SKAC delivers gating waveforms with a pulse width of approximately 63 microseconds at a p.r.f. of 250 c/s (input frequency divided by 8,192) and an amplitude of not less than 1V. The timing of these waveforms is the same as those produced at SKAB and they are designated 0 microseconds 250 c/s waveforms.

(5) SKAD delivers gating waveforms identical to those produced at SKAC but advanced in time by 125 microseconds and designated −125 microseconds 250 c/s waveforms.

(6) SKAG delivers gating waveforms identical to those produced at SKAC but advanced in time by 250 microseconds and designated −250 microseconds 250 c/s waveforms.

(7) SKAH delivers gating waveforms identical to those produced at SKAC but advanced in time by 500 microseconds and with an amplitude of not less than 0·5V. These waveforms are designated −500 microseconds 250 c/s waveforms.

(8) SKAJ delivers gating waveforms identical to those produced at SKAC but advanced in time by 750 microseconds and designated −750 microseconds 250 c/s waveforms.

5. In addition to the above, a 500 c/s (input frequency divided by 4,096) sine wave is delivered at socket SKAK with an amplitude of approximately 60V peak-to-peak. This output is fed, in both applications of the unit, to the relay assembly. Also a 250 c/s (input frequency divided by 8,192) sine wave is delivered at SKAL with an amplitude of approximately 60V peak to peak. This output is fed to the Detector Failure unit associated with the Divider Unit considered.

Brief circuit description

6. A simplified block diagram of the divider unit is shown in fig. 22 from which it can be seen that the circuit consists of a series of thirteen sine wave divide-by-two stages. From these divide-by-two stages, selected groups of frequencies are applied, in a phase relationship suitable for the production of the pulses or rectangular waveforms required, to eight independent gating circuits. In the gating circuits coincidence of the appropriate half cycles of the selected sine waves results in a positive input to the cathode follower stages. This provides positive going pulse or rectangular waveform outputs which bear the correct inter-relationship in time as required by the gating circuits of the electronic gate unit. Additionally, 500 c/s and 250 c/s sine wave outputs are taken directly from the final divider stages. Final production of the trigger pulses for the system takes place in the electronic gate unit.

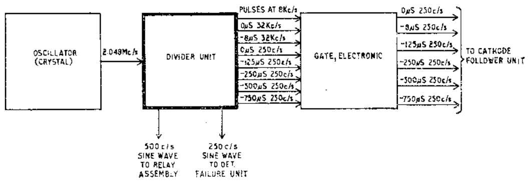

Fig. 3. Divider unit: block schematic

7. Four different forms of gate circuit are used. The first form is equally suitable for production of groups of five pulses at a p.r.f. of 8 kc/s, single rectangular pulses at zero time with a p.r.f. of 32 kc/s or single rectangular pulses at zero time with a p.r.f. of 250 c/s. In this method the righthand anodes of the double triode valves in the appropriate divider stages are fed through a common anode load resistor (e.g. R119 for V5 and V6). A 100V h.t. supply is provided by a constant voltage triode strapped pentode cathode follower stage with its grid returned to a potential of +100V with respect to earth, this potential being produced by a potential divider network across the +250V supply. At the instant when the right-hand anodes of the divider stages (fig. 24) are all cut off, a diode (e.g. V36) is made to conduct and the resultant increase in positive potential at its cathode is fed to the cathode follower stage via an a.c. coupling.

8. A second form of gate circuit is that used for production of rectangular waveforms with a p.r.f. of 32 kc/s but advanced in time by 8 microseconds. This circuit uses the double diode V14 with a 64 kc/s sine wave fed to its two anodes and the 32 kc/s sine wave, suitably delayed, fed to one cathode. With coincidence of positive half-cycles of these two sine waves a positive output is produced at the second cathode and this is d.c. coupled to the cathode follower stage.

9. The gate circuits employed for the production of the nominal 250 p.p.s. waveforms advanced 125, 250 and 750 microseconds are identical and use a circuit in which the cathode outputs of the last five divider stages, V9 to V13, suitably altered in phase, are fed to the grids of four halves of double-triode valves. The anodes of these valves are fed via a common anode load (e.g. R70 in fig. 24), the 100V h.t. supply for the valves in all these circuits being provided by a triode-strapped pentode cathode follower stage V15 with its grid at +100V with respect to earth. At the instant when all four triodes are cut off a diode (e.g. V33) is made to conduct, thus producing a positive input to the appropriate cathode follower stage.

10. The fourth form of gate circuit is that used for the production of the 250 c/s gating waveform advanced 500 microseconds. This circuit uses the double-diode valves V22 to V24 which are so connected that coincidence of positive-going halves of sine waves, suitably altered in phase, from the cathodes of the last five divider stages causes a positive rectangular waveform to be developed across resistor R145 in the grid input circuit to the cathode follower stage.

11. Each output, except the 500 c/s sine wave, is taken directly from the cathode of a separate cathode follower stage valve to an output socket.

Circuit description

12. Heater voltages for the valves are supplied from TR1, the 240V a.c. primary supply for the transformer being received via FS1 at PLB/7 and PLB/10. The +250V supply from the +250V regulator is applied across PLB/9 (+250V) and PLB/12 (earth). The h.t. supply for the double-triode valves in the divider stages (V1 to V13) and the gating circuits (V16 to V21) is obtained from three pentode valves (V15, V25 and V30) operating as triodes with their anodes connected directly to the +250V supply and their grids returned to a +100V connection at the junction of two resistors connected across the +250V supply; the cathode follower output stages operate from the full 250V supply.

Note . . .

> *Owing to the large number of valve heaters supplied by TR1 there is a high current surge upon switching-on when the valves are cold. For this reason a fuse-link of the anti-surge type is used for FS1. The requirement is indicated by a green dot adjacent to the fuse-holder on the unit panel.*

Frequency divider circuits

13. The input at SKAA is terminated in 75 ohms by resistor R1 and fed to the grid of V1a, the first of a series of thirteen divide-by-two stages V1 to V13, via the grid stopper R2. Each of the divider stages is a similar circuit, the only difference being in the component values and in form of the inductance in the tuned circuit, an additional winding being provided in the divider circuits associated with V9, V10, V12 and V13 where a second anti-phase output is required.

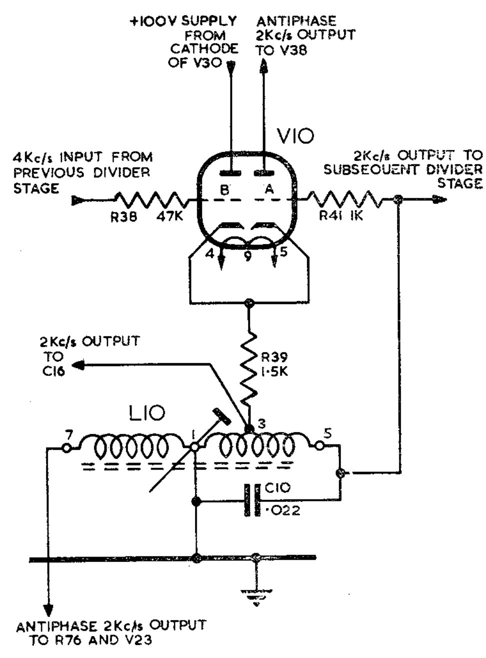

Fig. 4. Typical divider stage: circuit

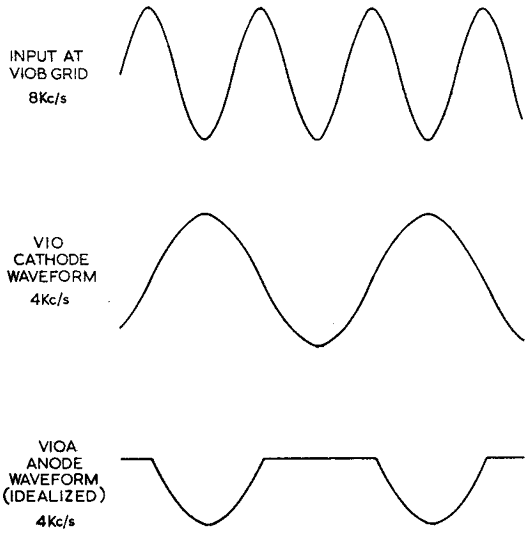

Fig. 5. Typical divider stage: waveforms

14. A typical divider stage circuit is shown in fig. 4. The circuit operates as a regenerative divider which gives no output unless an adequate input is provided. The cathodes are connected via a resistor to the centre tap of the inductor in the tuned circuit so that with no external input any swing of potential on one grid is balanced by an equal and opposite swing on the second grid so that there is no feed to the tuned circuit as the combined current from the two cathodes is unchanged. For this reason the two heaters are series-connected across the 12·6V a.c. supply with no earth connection at the centre tap since otherwise, should one heater fail, the cathode currents would become unbalanced and the circuit might self-oscillate.

15. When the stage is driven at a frequency twice that of its tuned circuit by an input at V10b grid it becomes synchronously regenerative. With the tuned circuit assumed to be in oscillation and with no input, the voltage developed across the tuned circuit has the effect of cutting-off V10b whenever the output voltage at tag 5 of L10 is positive and causing the valve to conduct when it is negative. If a negative half-wave is applied to V10b grid when the output of the tuned circuit is negative, the tuned circuit becomes energized in such a direction as to increase the amplitude of oscillation. The next negative half-cycle of input occurs at a time when the output of the tuned circuit is positive and has no effect on V10b since this triode section is already cut off (fig. 5). Thus, oscillation is maintained in the tuned circuit at all times when an input at twice the frequency of the tuned circuit is available at the grid of V10b.

16. The output of the tuned circuit is taken from tag 5 of L10 to V10a grid and also to the grid of V11b in the next divider stage so that during negative half cycles of oscillation V10a is cut off by the voltage applied between its grid and cathode from winding 5 and 3 of the inductor.

17. The divider stages are provided with h.t. at the reduced voltage of 100V in order to reduce current requirements and to prolong valve life, the left-hand sections of V1 to V8 receiving the supply from the cathode of V25 and those of V9 to V13 from the cathode of V30.

18. In general, two outputs are taken from each divider stage, one output being taken from the right-hand anode (fig. 24) and the other from the centre tap of the inductor in the tuned circuit. An additional winding is provided on L9, L10, L12 and L13 from which an output is taken. These outputs are fed to the appropriate gating circuits, the outputs from the anodes and from tag 7 of the inductor being opposite in phase to those taken from tag 3 of the inductor.

Initial production of waveforms

19. The first stage in the production of the final trigger pulses produces an output in the form of groups of five narrow pulses with a time interval between pulses of 8 microseconds, the groups of pulses occurring at a p.r.f. of 8 kc/s.

20. The anodes of V1b to V4b, V7b and V8a are fed through a common anode load resistor R120 (fig. 6) and a gating diode V37 is connected between the anodes of these valves and the junction of R116 and R118 in a divider network R114, R116 and R118 across the 100V h.t. line and earth. When any one or more of the right-hand anodes of these divider stages are conducting the current through R120 is such that the potential at the junction R120-V37 causes V37 to be cut off. At any instant when all the above mentioned anodes are cut off the potential difference across R120 decreases to such a value that V37 conducts and current flows from the cathode of V25 through R120, V37 and R118 to earth. The potential difference across R118 is therefore increased in a direction positive with respect to earth. Since this potential difference is coupled to the grid of the cathode follower V27a via C30, a positive pulse will appear at socket SKAE at each instant when the relevant anodes of the 1·024 Mc/s, 512, 256, 128, 16 and 8 kc/s divider stages, are all cut off.

21. The production of the required output pulses can best be considered by first examining the pulse output which would be produced by coincidence gating of positive half-cycles from the first four divider stages. The pulses thus produced would consist of a single positive pulse of a width corresponding to one half-cycle of the 1·024 Mc/s frequency occurring at a frequency of 128 kc/s, i.e. with a time interval of 8 microseconds between pulses. However, since these pulses are also gated by the 16 kc/s and 8 kc/s outputs of the seventh and eighth divider stages, outputs will only be produced during periods corresponding to one half-cycle at 16

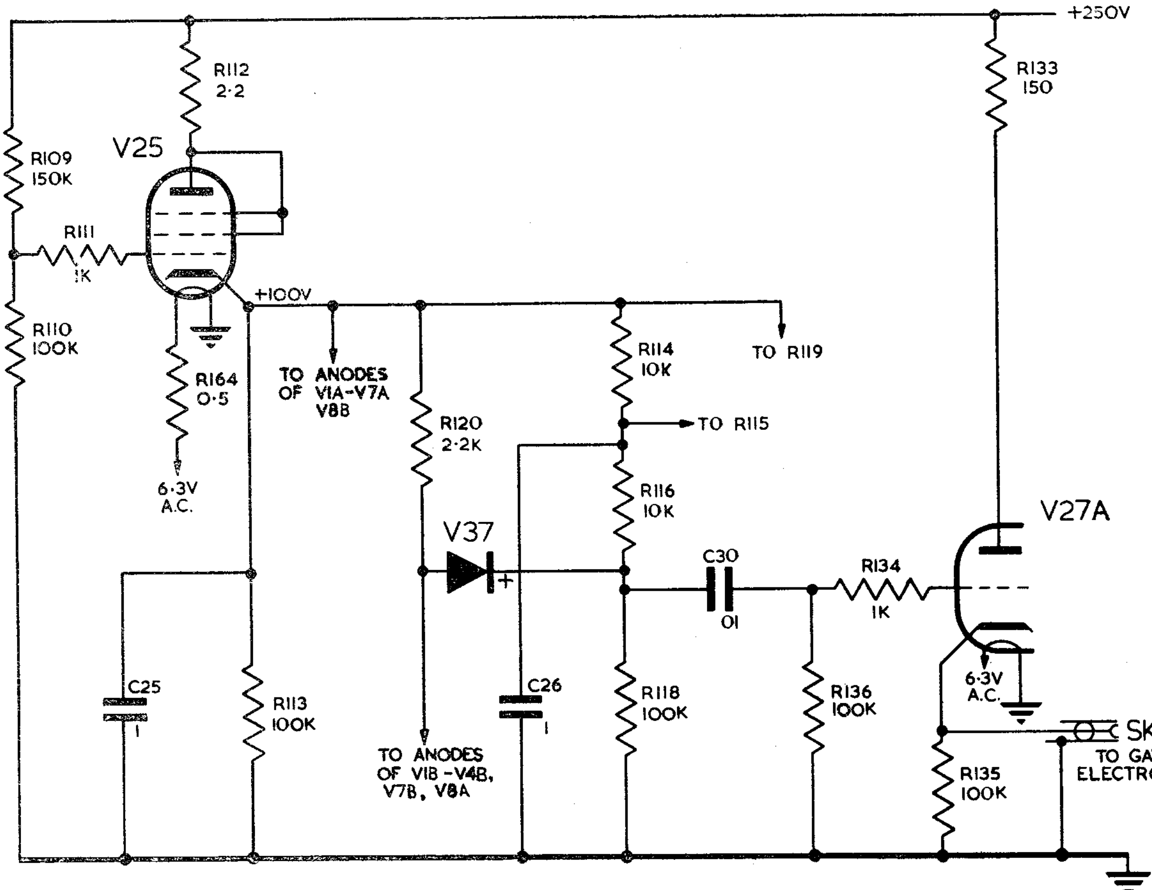

Fig. 6. Circuit for initial production of waveforms

kc/s, i.e. 31·25 microseconds. These periods will occur at a recurrence frequency of 8 kc/s since the component values of the gating circuit are so arranged that only the most positive pulses are passed, the remainder being clipped off. By referring to the idealized waveforms shown in fig. 7 it will be seen that the resultant output will be in the form required with the centre pulse of the group of five occurring exactly in the centre of the 31·25 microseconds period quoted above. Since the outer pulses of the group occur at the edges of the gating period these pulses are of a lesser amplitude than the remaining pulses but, as these pulses are not used in the system, this is unimportant.

Production of 0 μS 32 kc/s gating waveforms

22. A similar circuit to that used for initial production of pulses (paras. 19 to 21) is used to produce waveforms 8 microseconds in width at a recurrence frequency of 32 kc/s (fig. 8). The anodes of V5b and V6b are fed through a common anode load resistor R119 associated with gating diode V36. When positive half-cycles coincide at the anodes of the two divider stages, V36 is caused to conduct and the resultant positive pulse across R117, applied to the cathode follower stage V26b, produces a positive pulse output at SKAB. The width of the pulse is, as before, determined by the highest frequency used, i.e. 64 kc/s, and single pulses are produced at a pulse repetition frequency of 32 kc/s with a pulse width of approximately 8 microseconds (fig. 9(a) to (d)). The timing of the waveforms produced is such that the centre of each fourth waveform coincides with the centre pulse of the groups of five initially produced.

Production of −8 μS 32 kc/s gating waveforms

23. A pulse, similar to that described in para. 22, but advanced 8 microseconds, is produced by gating the outputs of the tuned circuits for the fifth and sixth dividers in a double-diode circuit V14 (fig. 10). It will be remembered that these outputs are antiphase to those produced at V5b and V6b anodes.

24. The 64 kc/s output from L5 is fed to the two anodes of the double-diode, which are connected together, via R54. The 32 kc/s output from L6 is fed to the cathode of V14b via the phase shift network R55 and C14 so that the input to the cathode is delayed by approximately $\frac{\pi}{4}$ radians. Coincidence of positive half-cycles of the inputs to the valve results in V14b being cut off and a flow of current from V14a cathode through R157 in the grid circuit of the cathode follower stage V28b. The resultant positive output at SKAF is advanced by a time equivalent to one half-cycle of oscillation at 64 kc/s, i.e. approximately 8 microseconds, with respect to the 0 microseconds waveforms (fig. 9(e) to (j)).

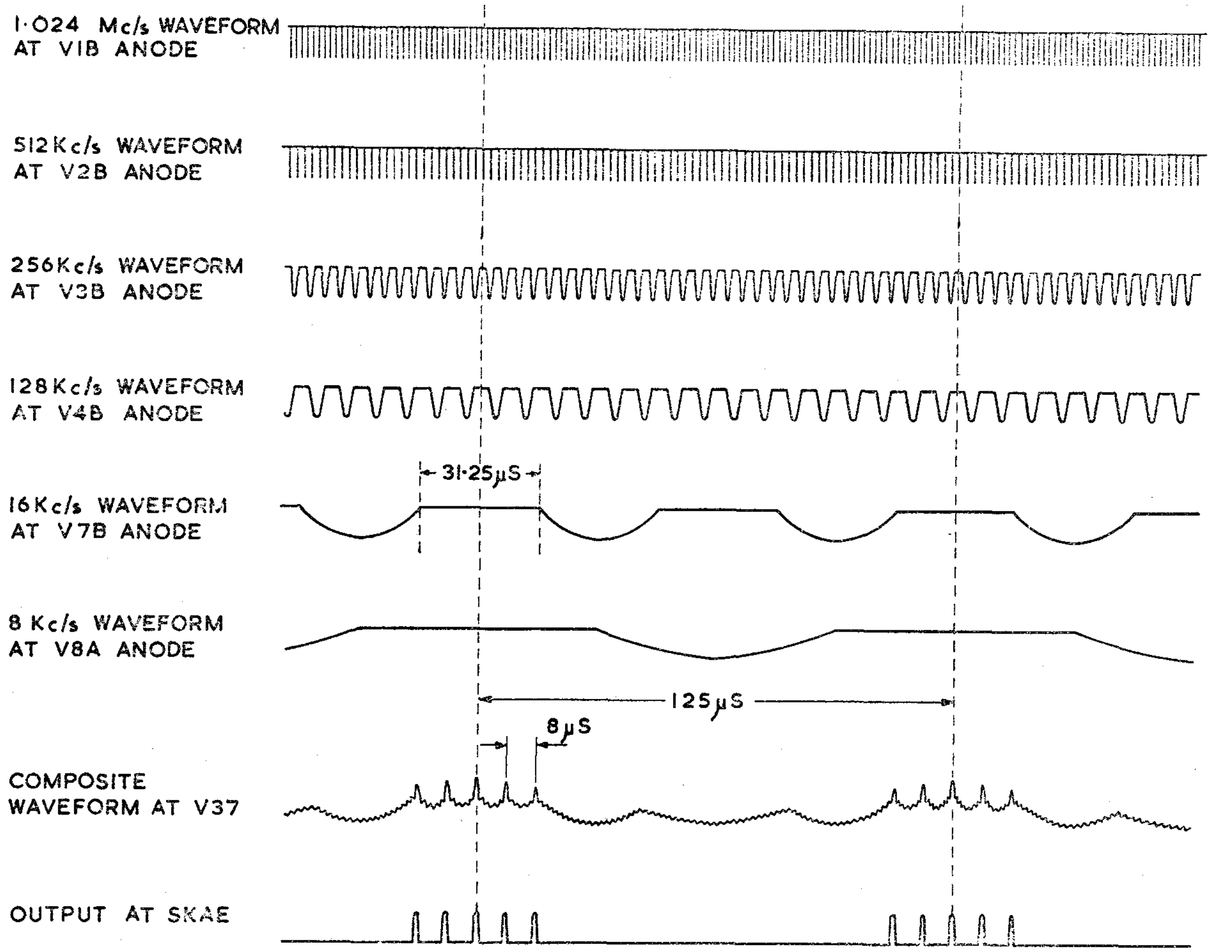

Fig. 7. Production of 8 kc/s pulses

Production of 0 μS 250 c/s gating waveforms

25. The circuit used for the production of gating waveforms at an arbitrary time 0 microseconds and at a p.r.f. of 250 (fig. 11) is similar to that described in paras. 19 to 21. The anodes of V9a to V13a are fed through a common anode load resistor R154 and the gating diode is V38. The cathode of the gating diode is connected to a fixed potential produced in the divider network R155, R156, R157 across the 100V h.t. line and earth. With any one or more of the divider stage valves conducting V38 is cut off due to the potential difference produced across R154, but at the instant when all valves are cut off V38 conducts. A positive waveform is produced due to the increase in current through R156 via R154 and this is coupled to the cathode follower stage V26a via C28. The width of each pulse is about 63 microseconds and single pulses are produced at a pulse repetition frequency of 250 per second (fig. 12). The timing of the pulses is such that the centre of the pulse occurs at an arbitrary time t = 0 and is synchronized with the centre pulse of each thirty-second group of the groups of five pulses originally produced and also with the appropriate 32 kc/s 0 microseconds pulses.

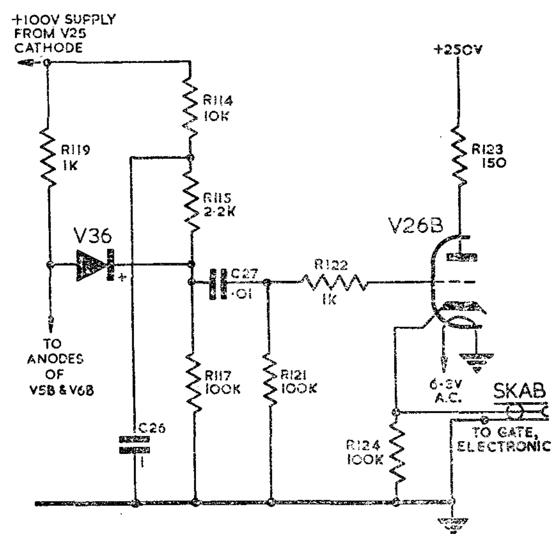

Fig. 8. Circuit for production of 0μS 32 kc/s gating waveforms

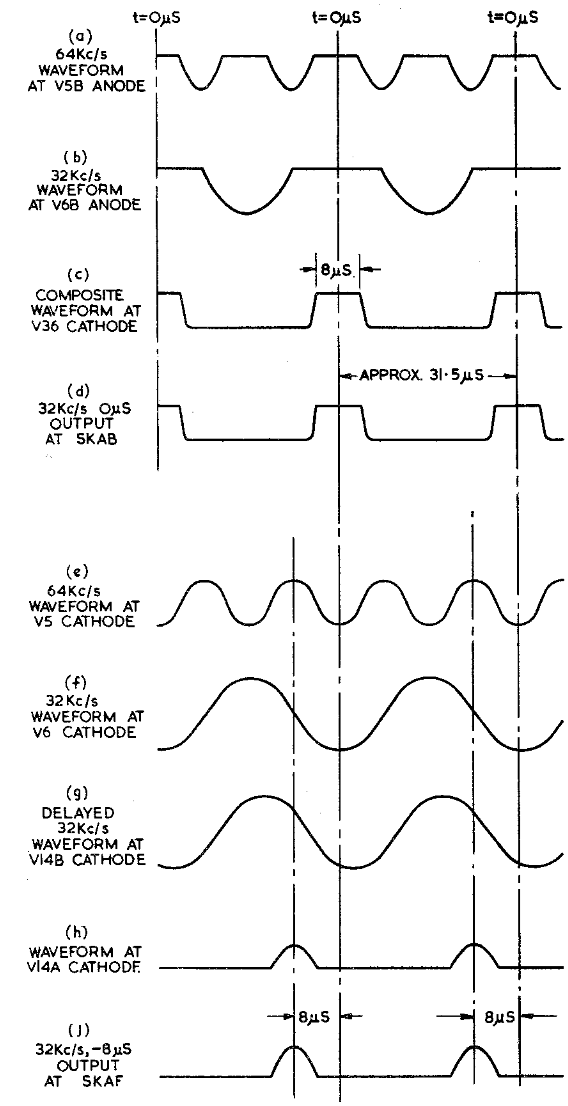

Fig. 9. Production of 0 μS 32 kc/s gating waveforms

Production of −125 μS 250 c/s gating waveforms

26. The outputs from the tuned circuits of the ninth to thirteenth dividers are fed to the grids of the triode valves V16b, V17a, V19b, and V20a (fig. 13) so that V16b grid receives an input consisting of a 2 kc/s input from L10 which has been advanced approximately 60 degrees in phase by the phase shift network C16, R72 and also a 4 kc/s antiphase input from tag 7 of L9. Alternate negative half-cycles of the 4 kc/s input are removed by the action of the diode V31 in conjunction with the 2 kc/s input developed across R72. Triode section V17a receives a 1 kc/s input from L11 that has been advanced in phase by approximately 47 degrees by C17 and R80, whereas the 500 c/s and 250 c/s inputs from L12 and L13 to V19b and V20a are unchanged in phase. The anodes of these valves are fed through a common anode load resistor R68 which is associated with V35 in a gating circuit similar to that used for initial production of pulses (paras. 19 to 21). V35 conducts only when all the anodes of the four valves are cut off simultaneously, i.e. when all the grids are fed with negative half cycles of input frequency at the same instant (fig. 14). The resultant waveform produced across R65 is coupled to the output cathode follower stage V27b to produce an output gating waveform at socket SKAD which is identical in width and p.r.f. to the 0 microseconds 250 c/s waveform but is advanced in time by 125 microseconds with respect to that waveform.

Production of −250 μS 250 c/s gating waveforms

27. The circuit used for production of waveforms advanced by 250 microseconds is almost identical to that used for the −125 microseconds waveforms. In this circuit V16a receives a 4 kc/s input from L9 and a 2 kc/s input, which is inverted in phase, from tag 7 of L10. As alternate negative half cycles of the 4 kc/s input occur when the 2 kc/s input is positive, diode V32 is cut off so that these negative half cycles are ineffective. A 1 kc/s input advanced in phase by the network C18 and R82 is fed to V18b, a 500 c/s input advanced in phase by the network C20 and R93 is fed to V19a, and a 250 c/s input is fed to V21b. The gating diode is V34 and the positive pulse produced across R66 is fed to the cathode follower stage V28a (fig. 15). The output waveform at SKAG is identical in width and p.r.f. to the −125 microseconds waveform but is advanced 250 microseconds with respect to the 0 microseconds waveforms (fig. 16).

Production of −500 μS 250 c/s gating waveforms

28. The outputs of the tuned circuits for the ninth to thirteenth dividers are also used in the production of gating waveforms advanced 500 microseconds. Whereas, in the production of the previous two sets of waveforms coincidence of negative half cycles of output from the dividers

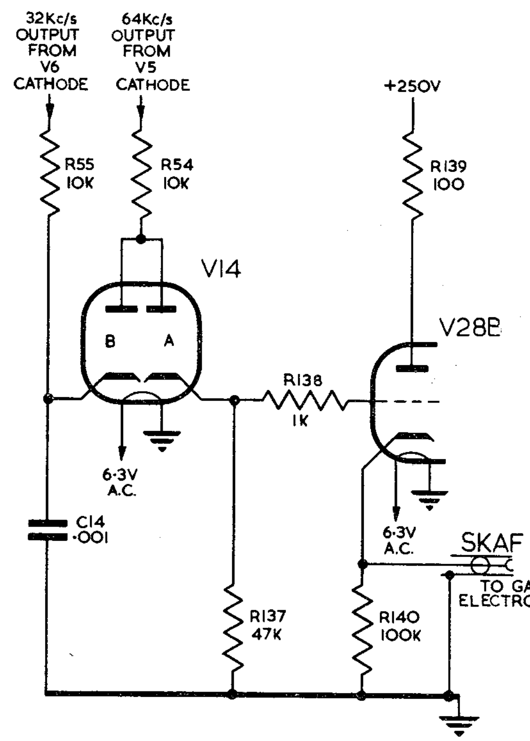

Fig. 10. Circuit for production of −8 μS kc/s gating waveforms

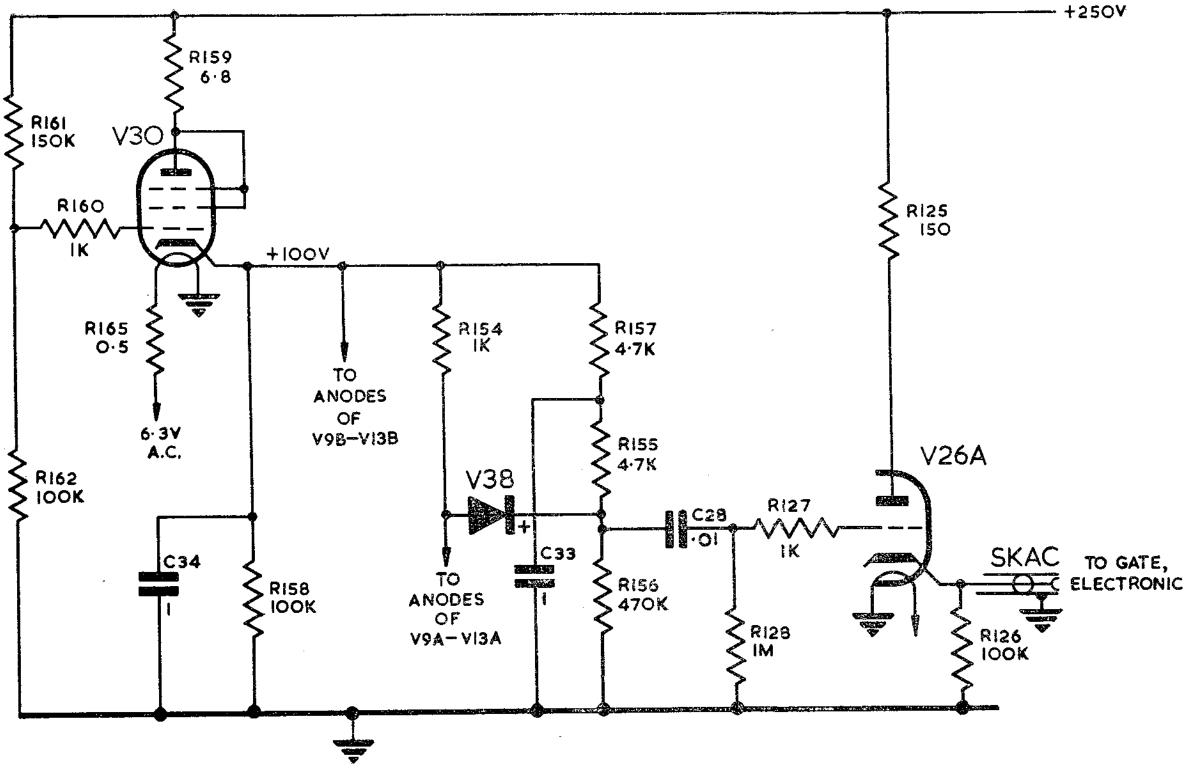

Fig. 11. Circuit for production of 0 μS 250 c/s gating waveforms

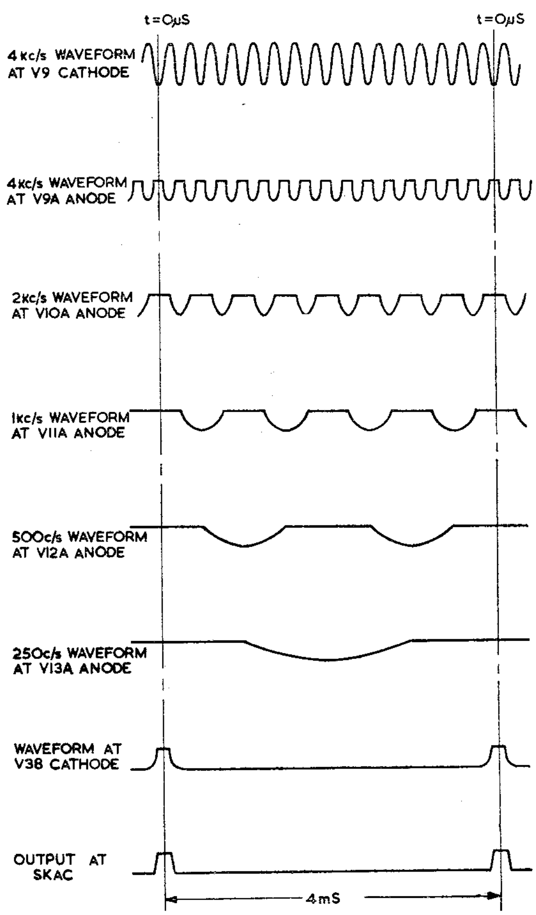

Fig. 12. Production of 0 μS 250 c/s gating waveforms

is used to determine the timing of the waveforms, the −500 microseconds waveform is produced at the coincidence of positive half cycles of output from the dividers, altered in phase where necessary, by the use of three double diode valves as a gating circuit (fig. 17). The antiphase 4 kc/s and 2 kc/s outputs of the ninth and tenth dividers are fed to the cathodes of V23b and V23a respectively. The 500 c/s output is delayed approximately $\frac{\pi}{4}$ radians by the network R107 and C24 and the 250 c/s output advanced approximately $\frac{\pi}{4}$ radians by C23 and R106, these two frequencies being fed to V22b and V22a cathodes respectively. The 1 kc/s output is fed to the anodes of V22, V23, V24 connected in parallel and the output from the gating circuit is taken from the cathodes of V24. With a negative input at any one or more of the cathodes of V22 and V23, the appropriate diode will conduct and V24 is cut off. However, at any instant when both diodes in V22 and V23 are cut off by positive half cycles of input any positive input at the anodes of the valves will be conducted through V24 to produce a positive potential across R145 and hence an input to the cathode follower stage V29b (fig. 18). The periods of coincidence of positive pulses are such that an output is produced at SKAH that is approximately 63 microseconds in width with a p.r.f. of 250 per second, the centre of the waveform occurring 500 microseconds before the centre of the 0 microseconds pulse.

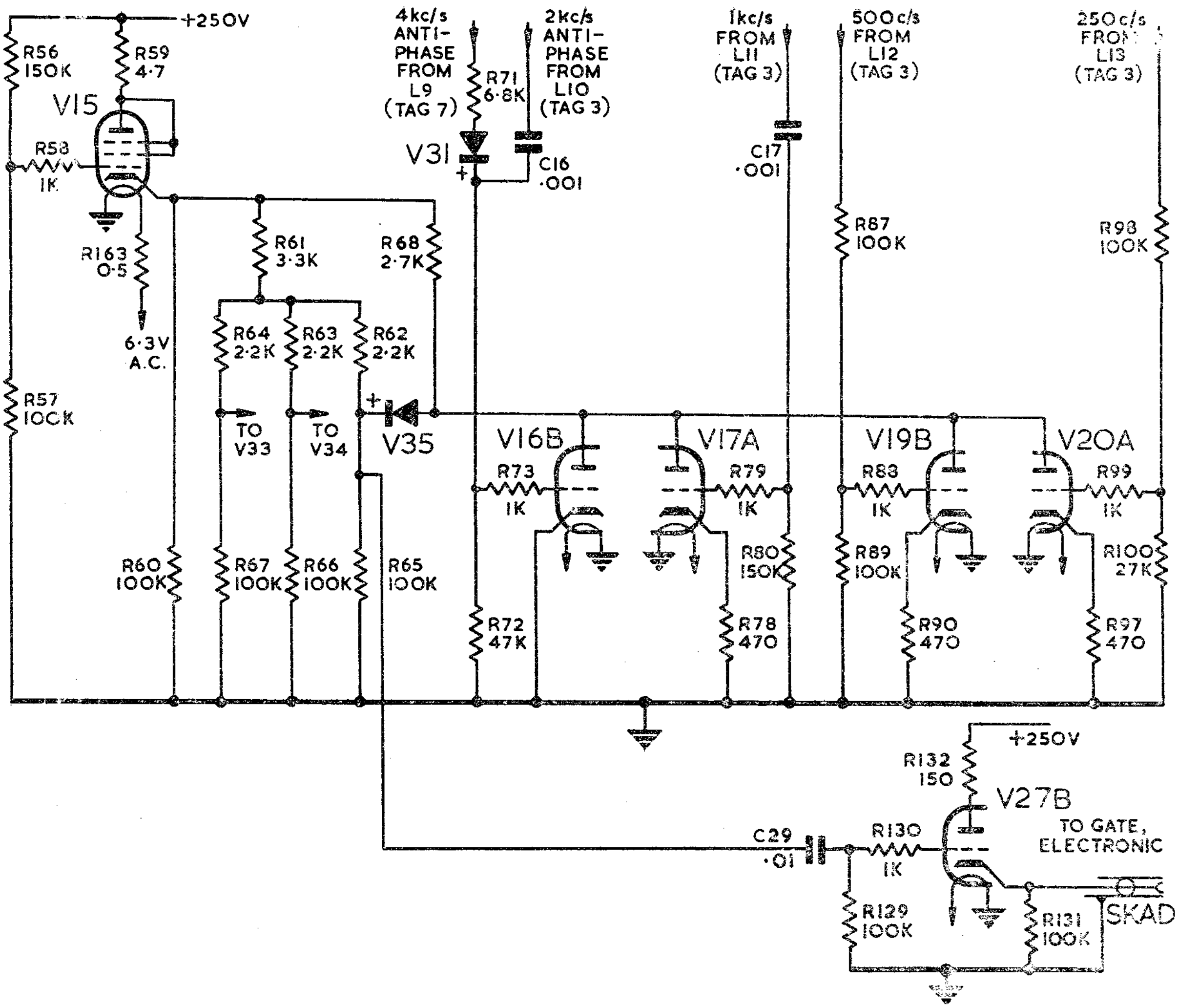

Fig. 13. Circuit for production of −125 μS 250 c/s gating waveforms

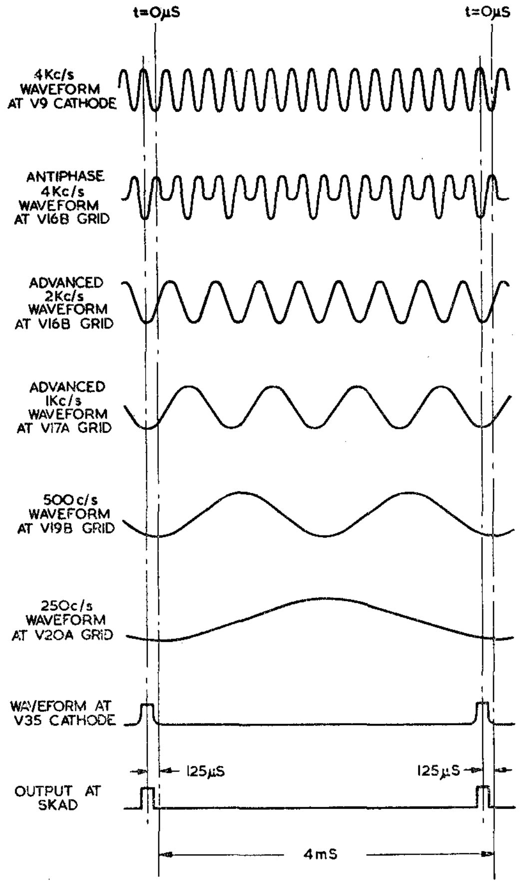

Fig. 14. Production of −125 µS 250 c/s gating waveforms

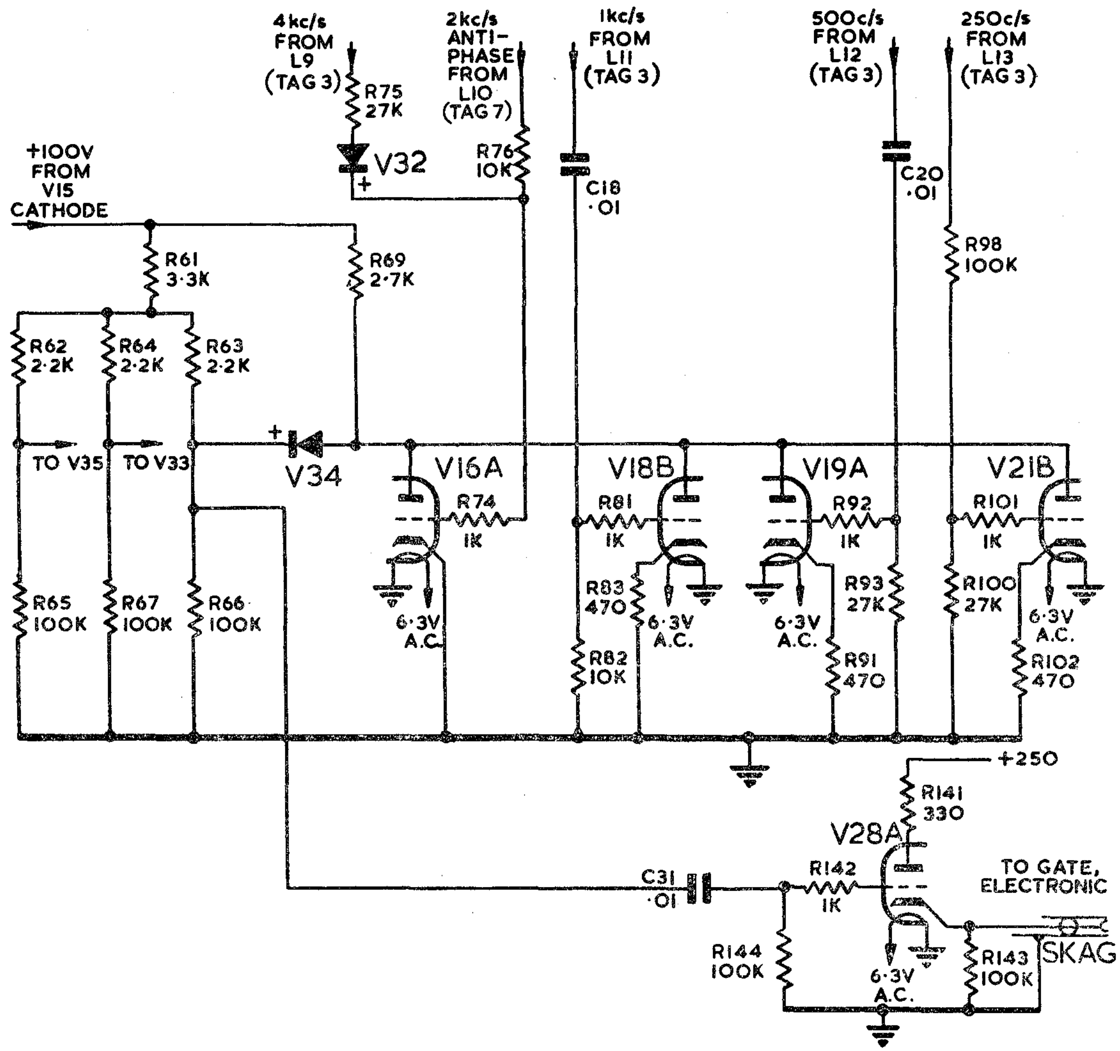

Fig. 15. Circuit for production of −250 µS 250 c/s gating waveforms

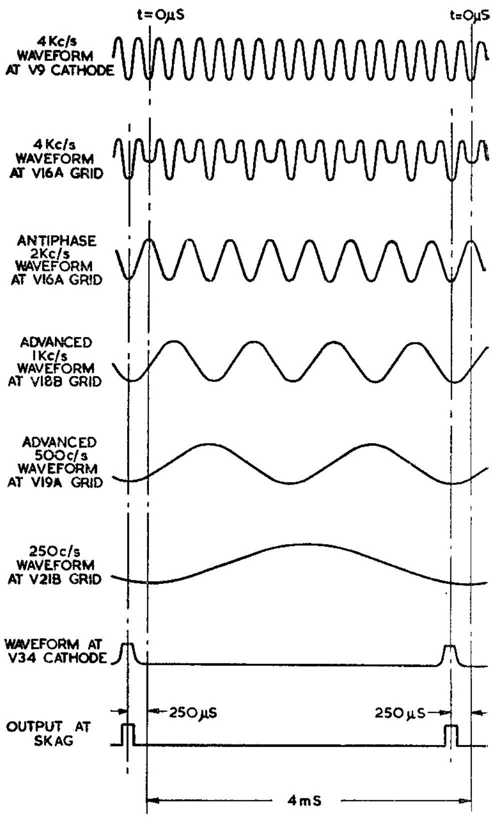

Fig. 16. Production of −250 μS 250 c/s gating waveforms

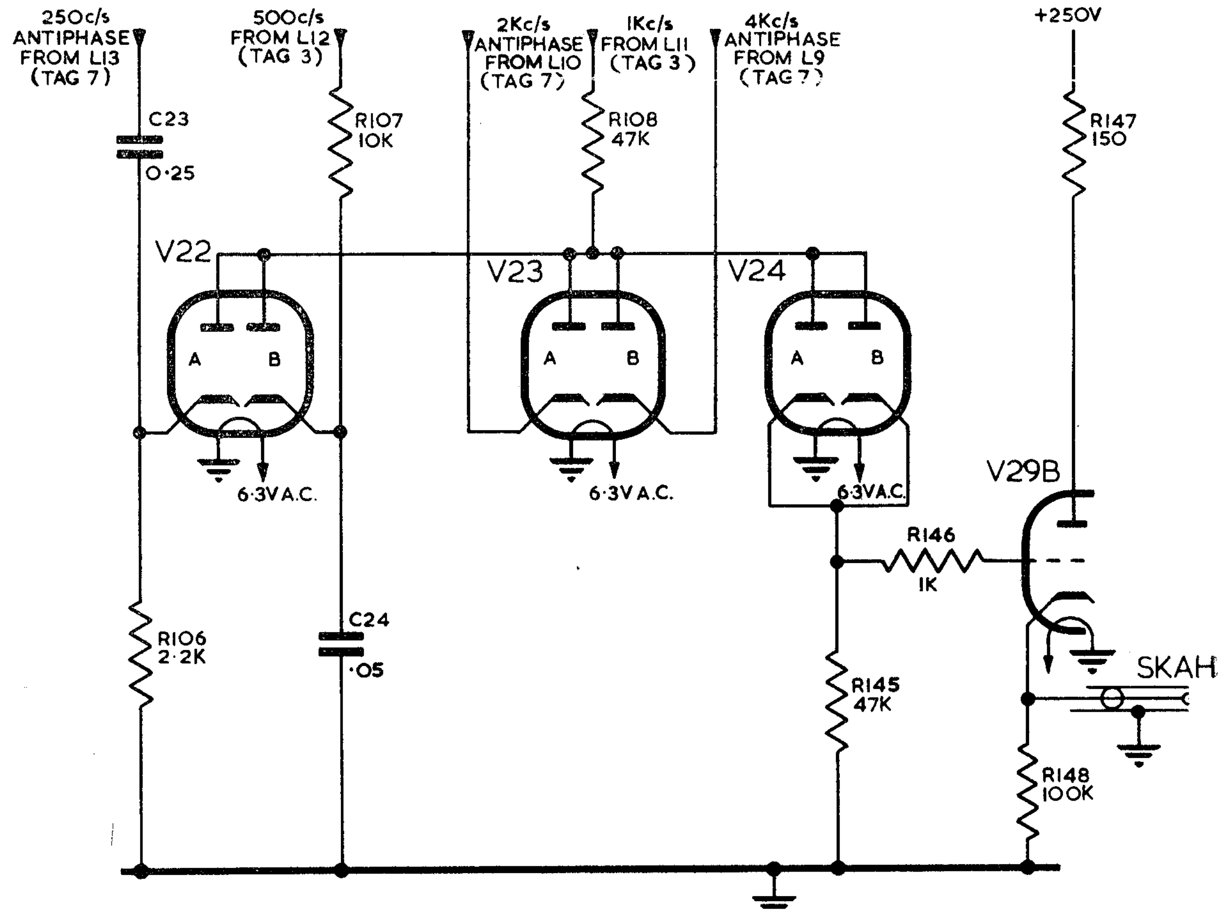

Fig. 17. Circuit for production of −500 μS 250 c/s gating waveforms

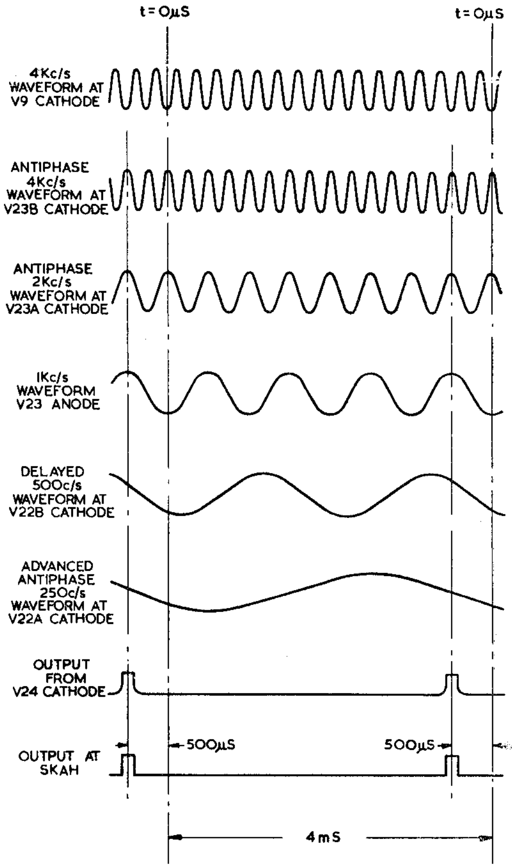

Fig. 18. Production of −500 µS 250 c/s gating waveforms

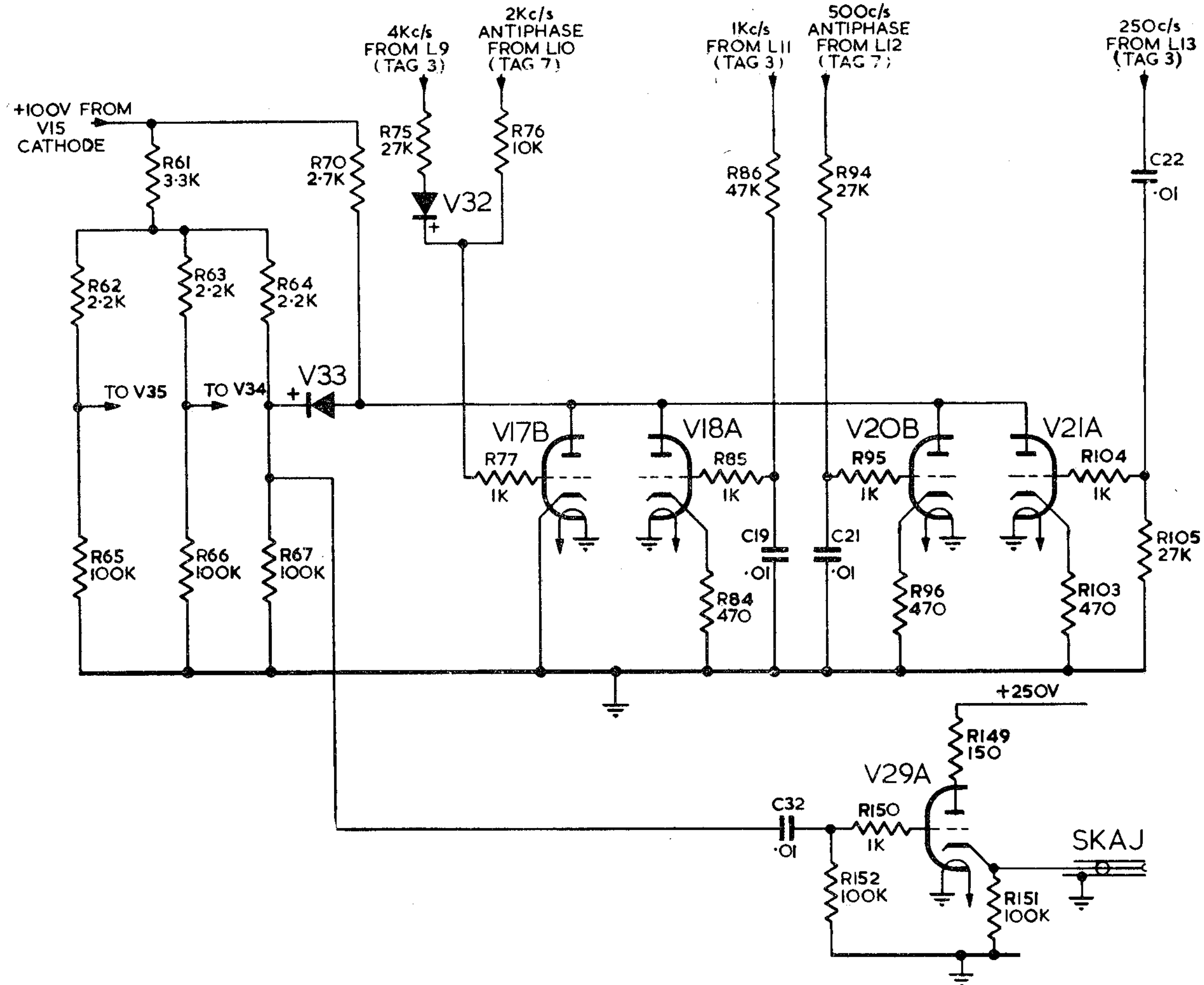

Fig. 19. Circuit for production of −750 µS 250 c/s gating waveforms

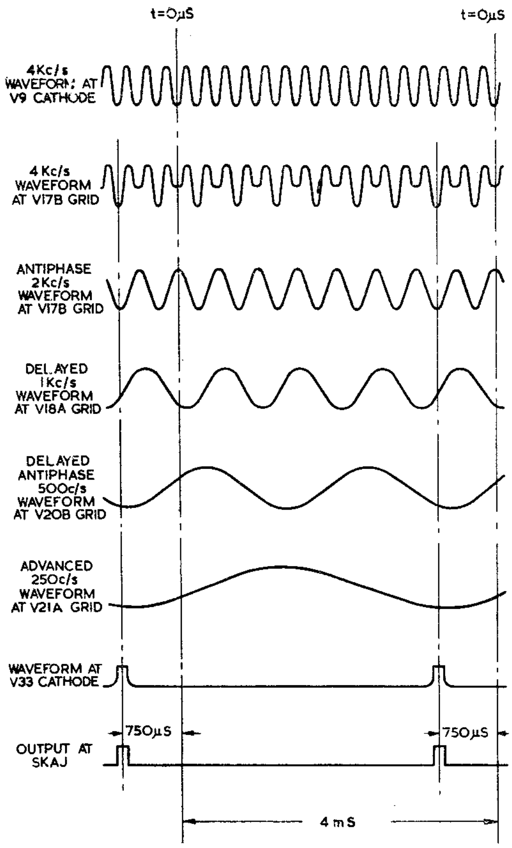

Fig. 20. Production of −750 μS 250 c/s gating waveforms

Production of −750 μS 250 c/s gating waveforms

29. The circuit for production of waveforms advanced 750 microseconds (fig. 19) is similar to that used in the production of −125 and −250 microseconds waveforms. The 4 kc/s and 2 kc/s inputs to V17b are the same as those for V16a, the 1 kc/s input to V18a is delayed in phase $\frac{\pi}{8}$ radians by the network R86 and C19, and the antiphase 500 c/s input to V20b is delayed $\frac{\pi}{4}$ radians by R94 and C21; the 250 c/s input to V21a is unchanged in phase. The gating diode is V33 and the resulting positive waveform is produced across R67 and fed to the cathode follower stage V29a (fig. 20). The periods of coincidence of the negative waveform at the grids of the triode stages are such that an output is produced at SKAJ that is approximately 63 microseconds in width with a p.r.f. of 250 per second, the centre of the waveform occurring 750 microseconds before the centre of the 0 microseconds waveform.

500 c/s and 250 c/s sine wave outputs

30. A direct output is taken from tag 3 of L12 via resistor R153 to the output socket SKAK to provide a 500 c/s sine wave. The 250 c/s sine wave output is taken directly from the output of the final divider stage V13.

Multimeter readings

31. With the multimeter Type 100 connected to socket SKA via a plug-to-socket adaptor the readings obtained should be as indicated in Table 1.

TABLE 1

Multimeter readings

Multimeter switch position	Valve	Measured across resistor	Reading	Tolerance
A	V15	R59	0·55	±0·11
B	V25	R112	0·40	±0·08
C	V26b	R123	0·53	±0·11
D	V26a	R125	0·57	±0·11
E	V27b	R132	0·56	±0·11
F	V27a	R133	0·54	±0·11
G	V28b	R139	0·52	±0·1
H	V28a	R141	0·85	±0·15
J	V29b	R147	0·57	±0·11
K	V29a	R149	0·59	±0·12
L	V30	R159	0·75	±0·15

Monitor points

32. Test sockets SKD to SKZ are provided so that the divider and cathode follower outputs may be monitored using a suitable oscilloscope. Typical waveforms existing at these points are illustrated in fig. 23.

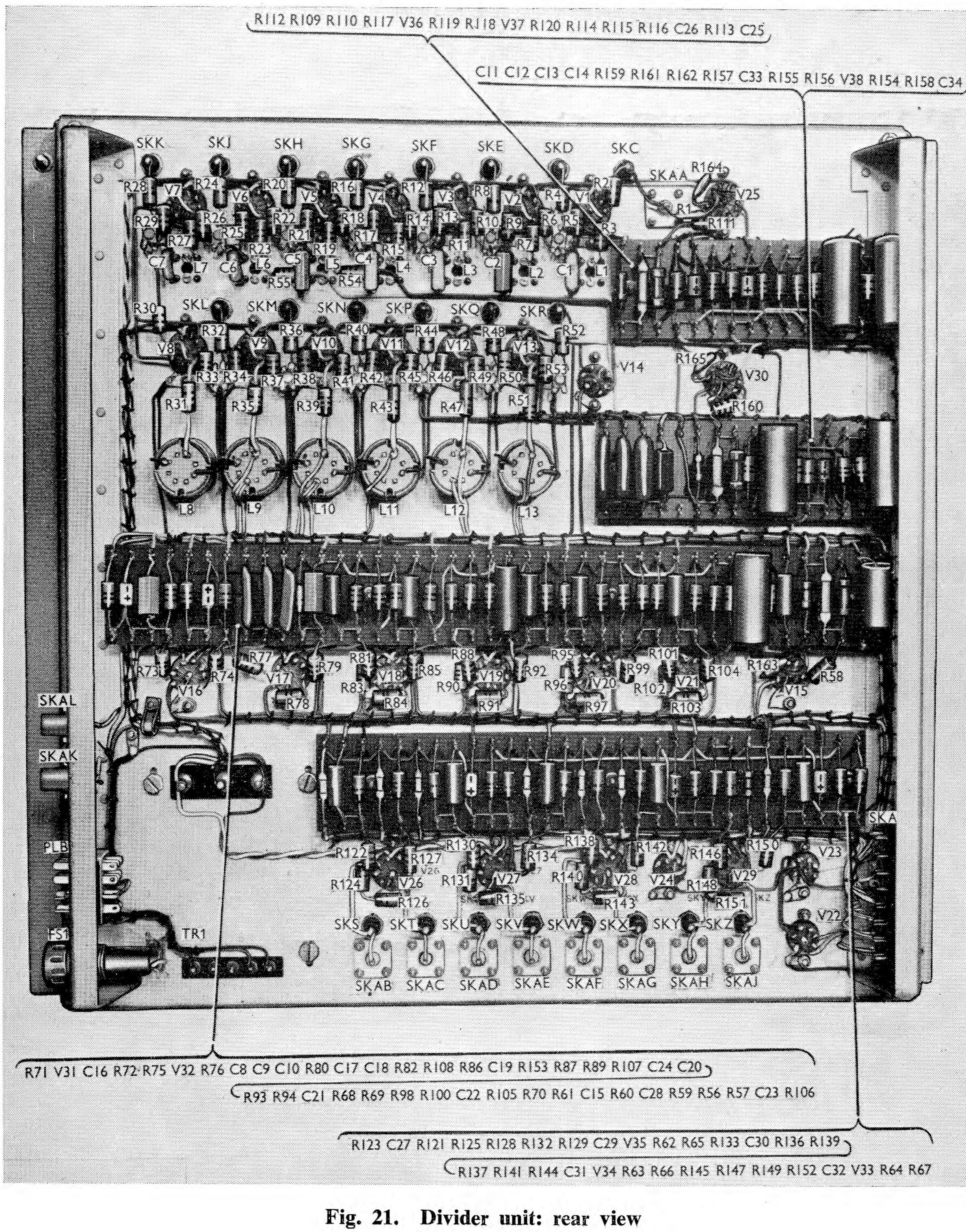

Fig. 21. Divider unit: rear view

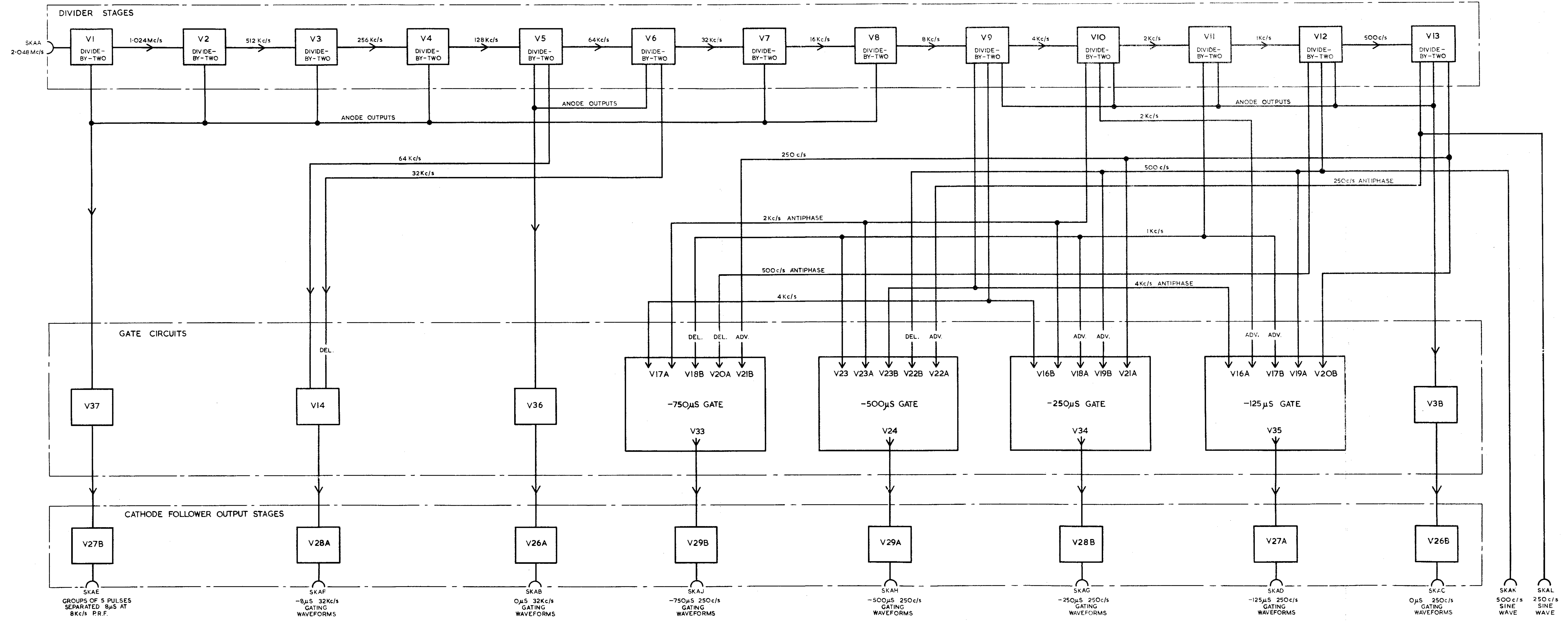

Fig. 22 Divider unit 5840-99-948-9103 : block diagram. Fig. 22

87218 571748 104 11/65 V.B. 925/1

SKTC TO SKTR
SINUSOIDAL WAVEFORMS
FREQUENCIES AS SHOWN
IN TABLE BELOW

MONITOR POINT	FREQUENCY
SKTC	2·048 Mc/s
SKTD	1·024 Mc/s
SKTE	512 kc/s
SKTF	256 kc/s
SKTG	128 kc/s
SKTH	64 kc/s
SKTJ	32 kc/s
SKTK	16 kc/s
SKTL	8 kc/s
SKTM	4 kc/s
SKTN	2 kc/s
SKTP	1 kc/s
SKTQ	500 c/s
SKTR	250 c/s

THESE AMPLITUDES ARE NOT CRITICAL, PROVIDED THEY ARE SUFFICIENT TO DRIVE THE FOLLOWING STAGES IN DIVIDER UNIT AND GATE ELECTRONIC.

NOTE :-
THESE WAVEFORMS ARE NOT DRAWN TO SCALE

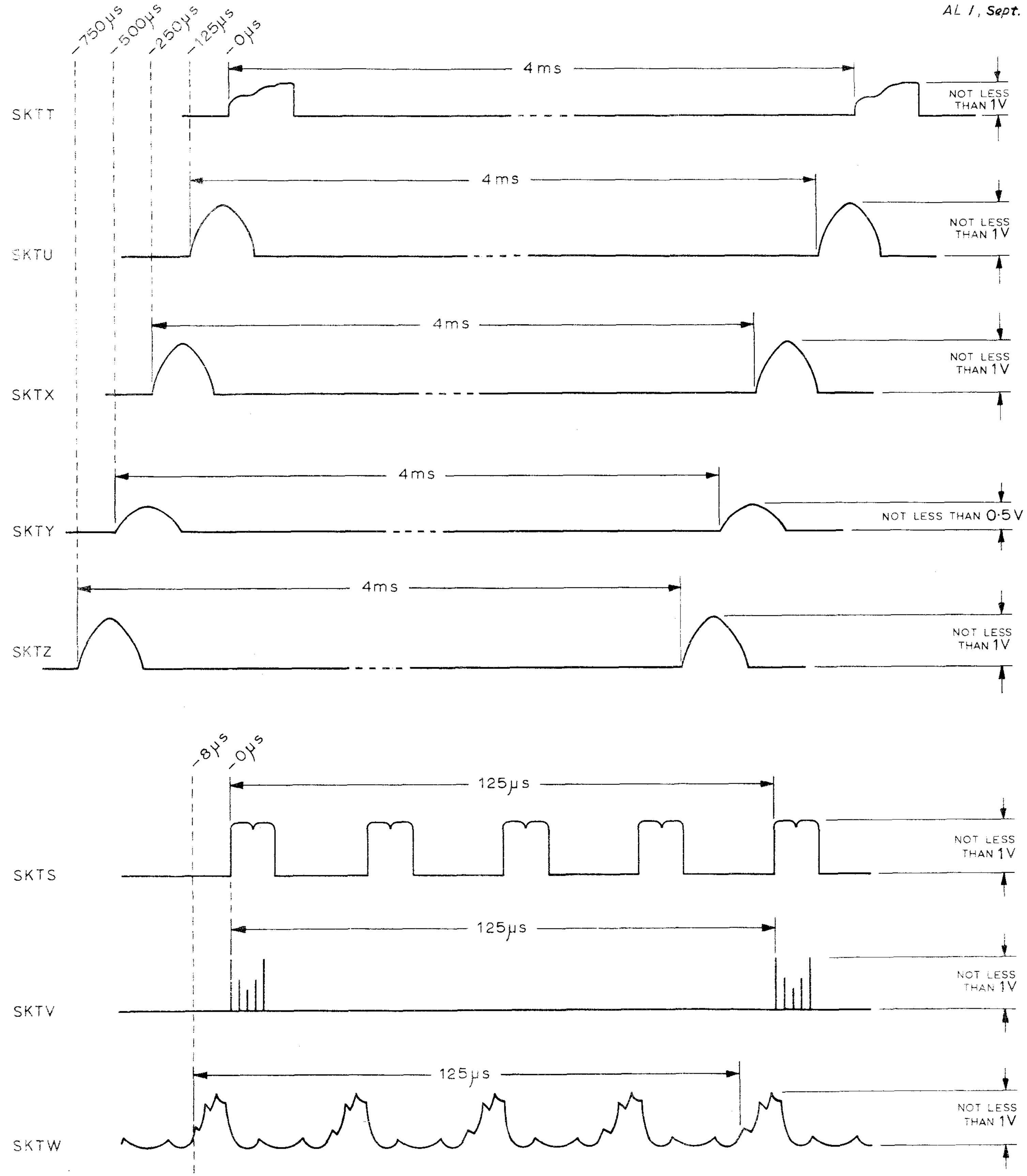

Fig. 23 Waveforms at monitor points Fig. 23

87218 571748 104 11/65 V.B. 925/1

Divider unit 5840-99-948-9103 : circuit.

D630232 100 2/69 A(W)Ltd. Gp.956/3 435M

Fig.24

Fig.24

Chapter 4

GATE, ELECTRONIC 5840-99-948-9102

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LIST OF ILLUSTRATIONS

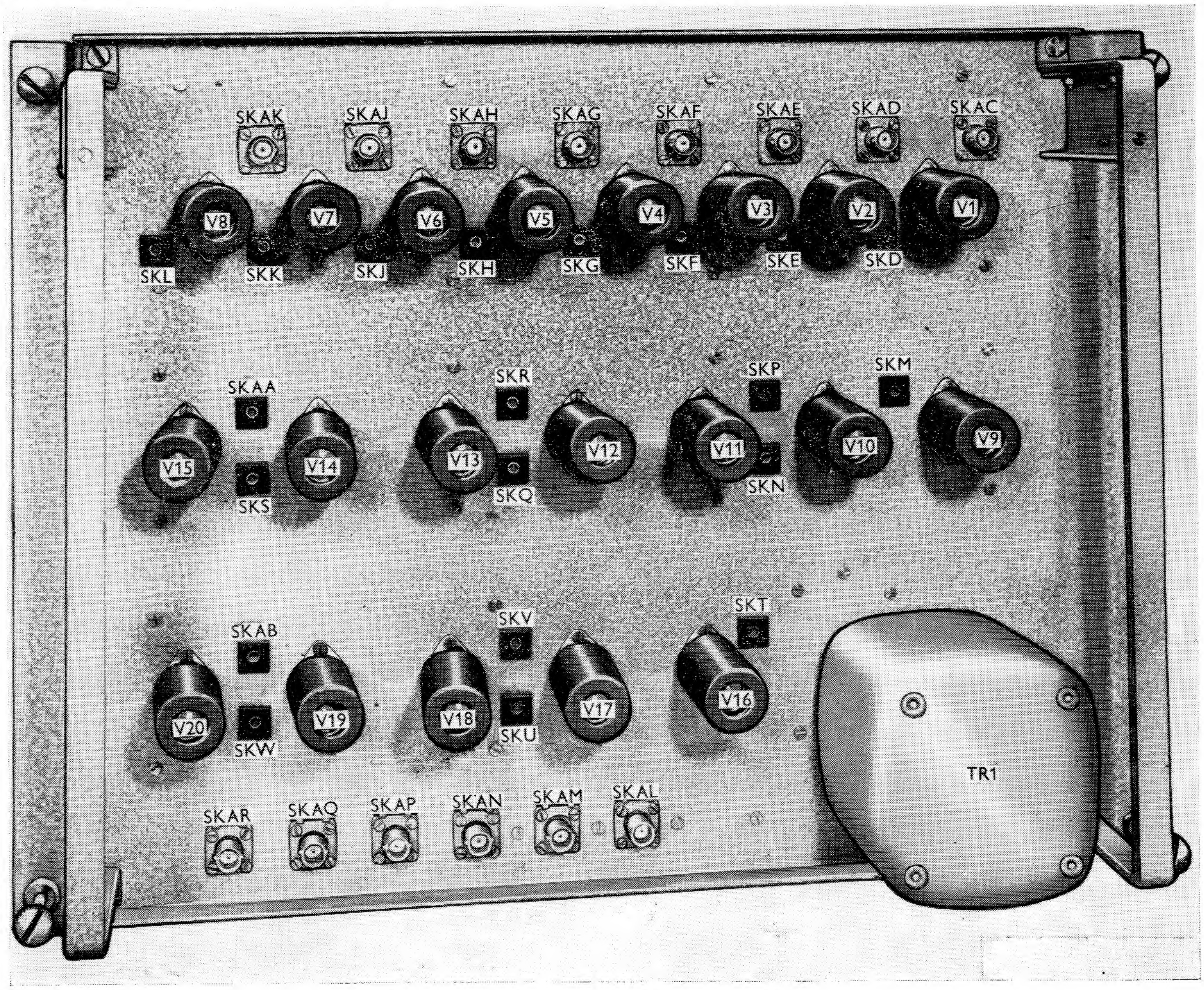
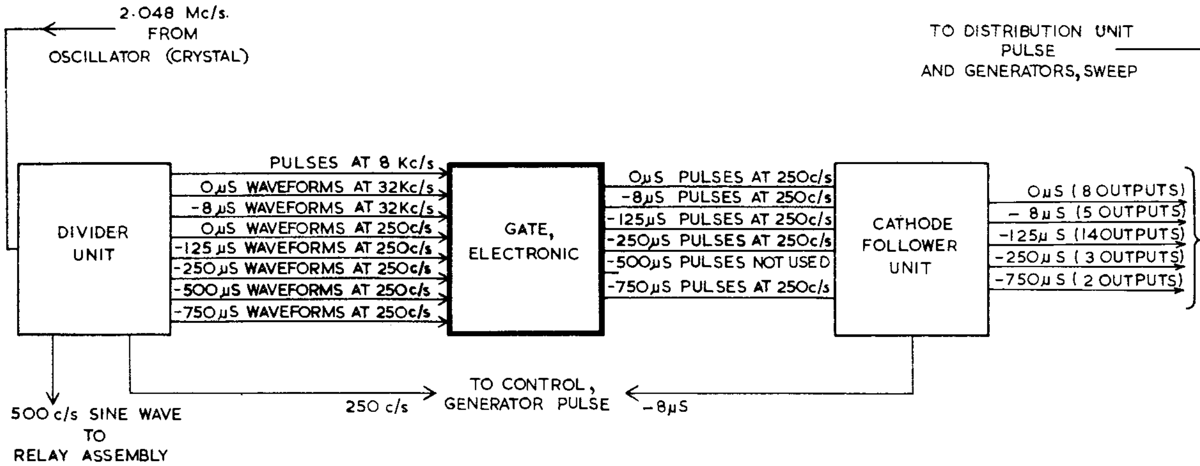


Fig. 1. Gate, electronic: front view



◄**Fig. 2. Gate, electronic: block schematic**►

Introduction

1. The electronic gate unit (figs. 1 and 8) is used in two applications, one being in the main p.r.f. cabinet, the other in the standby p.r.f. cabinet. In both applications the unit accepts eight waveform inputs from the divider unit (Chap. 3). The waveforms are amplified and six different groups of three waveforms are selected and coincidence gated to produce pulses at a nominal p.r.f. of 250. Each group of waveforms includes the 8 kc/s waveform consisting of trains of five pulses spaced 8 microseconds apart, either a 0 microseconds or −8 microseconds 32 kc/s waveform and one of five 250 c/s waveforms occurring at relative times of 0, −125, −250, −500 and −750 microseconds. ◄The 0, −125, −250 and −750 microseconds outputs of the coincidence gates are amplified and increased in width to provide fine outputs,► each consisting of a train of pulses approximately 4 microseconds in width, which are fed to the cathode follower unit (Chap. 5) for distribution (fig. 2).

2. The timing of each train of pulses is related to the input 250 c/s and 32 kc/s pulses so that the relationship between the pulses and an arbitrary time 0 microseconds is 0, −8, −125, −250►◄ and −750 microseconds (fig. 3). The nominal p.r.f. quoted in this description is 250 c/s but the unit is designed to operate over a range of p.r.f.s between 245 and 275 c/s with the input waveform characteristics, except amplitude, modified in the ratio of actual p.r.f. to nominal p.r.f.

3. Under certain fault conditions it is necessary to inhibit output from the unit, which is accomplished by placing the h.t. supply under control of the fault detection circuits (Chap. 8). The −8 microseconds output is exempted from this inhibition as it is the source of the signal used to recognise the presence or absence of a fault.

Performance characteristics

Inputs

4. Eight inputs are received from the divider unit, the p.r.f.s and time intervals quoted being those obtained for a nominal p.r.f. of 250 c/s.

(1) SKAF receives groups of five pulses occurring at a p.r.f. of 8 kc/s, the spacing between pulses in each group being 8 microseconds with an amplitude of not less than 1V.

(2) SKAC receives pulses at a p.r.f. of 32 kc/s with a nominal pulse width of 8 microseconds and an amplitude of not less than 1V.

(3) SKAG receives pulses at a p.r.f. of 32 kc/s with a nominal pulse width of 8 microseconds and an amplitude of not less than 1V. These pulses are advanced in time by 8 microseconds with respect to those obtained in (2) above.

(4) SKAD receives gating waveforms at a p.r.f. of 250 c/s with a pulse width of 63 microseconds approximately and an amplitude of not less than 1V.

(5) SKAE, SKAH, SKAJ and SKAK receive gating waveforms identical to those in (4) above but advanced in time with respect to these waveforms by 125, 250, 500 and 750 microseconds respectively, except SKAJ which should be not less than 0·5V amplitude.

Outputs

5. The positive-going output pulses all have a pulse width of approximately 4 microseconds and occur at a p.r.f. of 250 c/s with an amplitude of not less than 60V. The timing of the pulses is as follows:

(1) The output from SKAL is the 0 microseconds pulse and it occurs at zero arbitrary time.

(2) The outputs from SKAM, SKAN, SKAP, SKAQ and SKAR occur at times of 8, 125, 250, 500 and 750 microseconds respectively in advance of the 0 microseconds pulse.

Brief circuit description

6. A simplified block diagram of the unit is given in fig. 4. Each of the eight inputs to the gating unit is applied to one half of a double

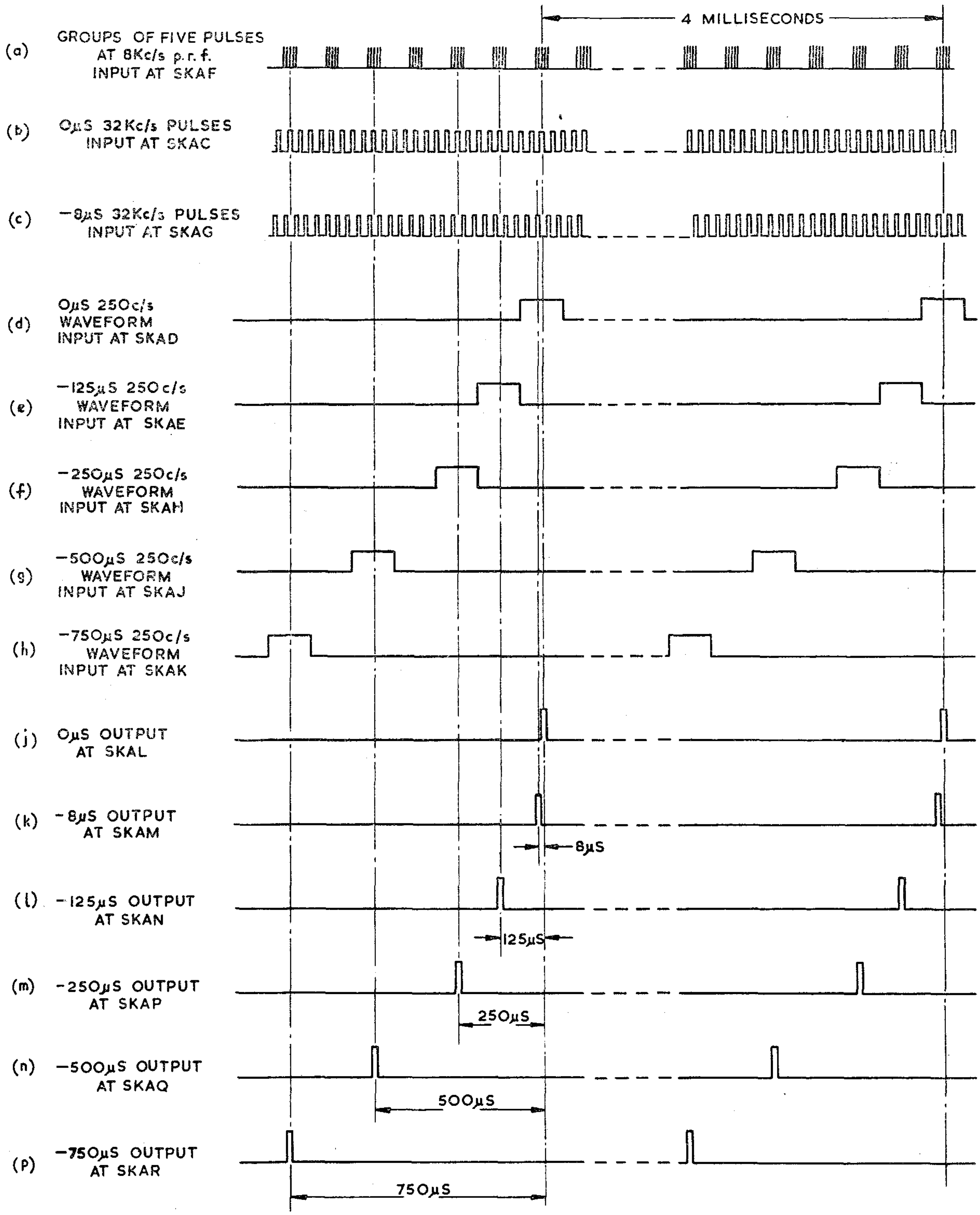


Fig. 3. Pulse generation

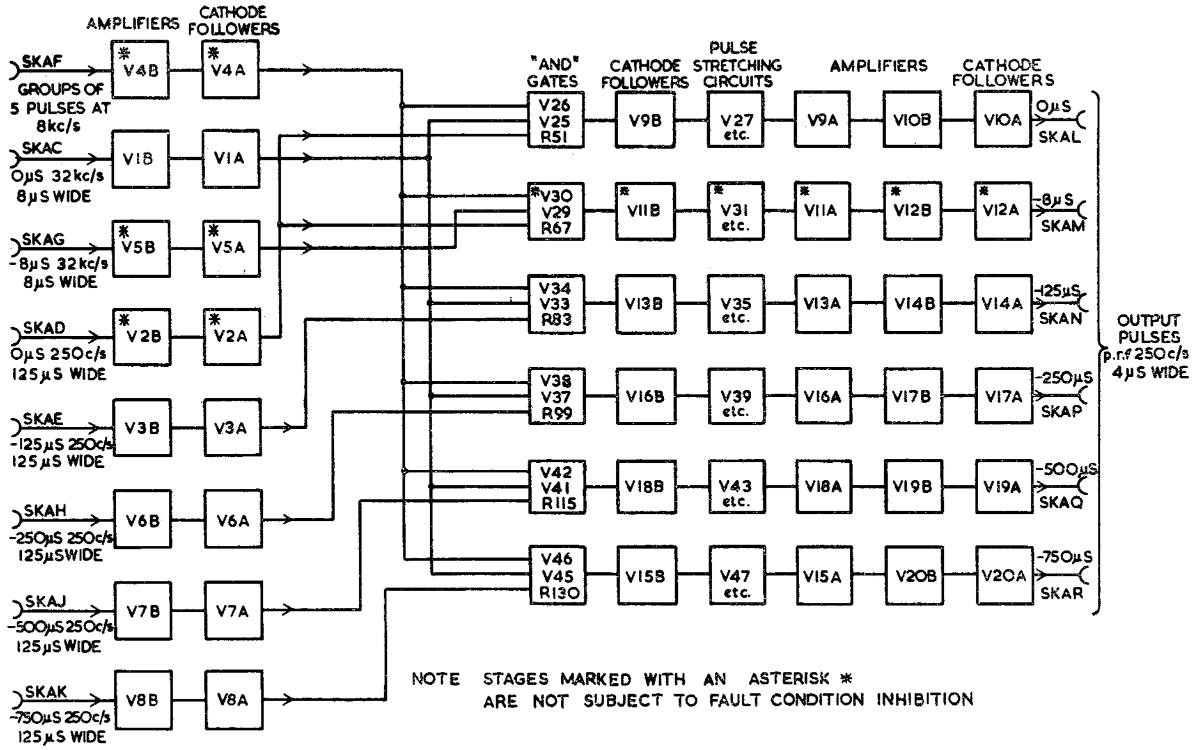


Fig. 4. Gate, electronic: block diagram

triode valve (V1 to V8) connected as a grounded grid amplifier, the output from the anode of which is applied to the second half connected as a cathode follower. The outputs from the cathode followers are applied in six groups of three, each containing the 8 kc/s output from V4, one of the two 32 kc/s outputs from V1 or V5 and one of the 250 c/s outputs from V2, V3, V6 to V8, to a simple gating circuit consisting of a 10 kilohm resistor and two germanium diodes.

7. The required pulse from the gating circuit is passed to the grid of a cathode follower stage, the output from which is applied to a pulse stretching circuit and thence to a further amplifier stage. The negative going pulses thus produced are fed to the grid of a further amplifier stage in such a manner that only pulses of a negative value exceeding 2V are applied to the valve. The output cathode follower stage is normally biased to cut off point so that the base line of the outgoing positive going pulse is flat. This is determined by the potential across the cathode load in its function as part of a potential divider network across the 250V supply. The output pulse thus produced is fed via a 0·1 μF capacitor to the cathode follower unit and has a width of approximately 4 microseconds with an amplitude exceeding 60V. Stages which are exempted from the fault condition inhibition are identified on fig. 4 by asterisks.

Circuit description

8. The circuit of the gate, electronic is shown on fig. 10. Heater voltages for the valves are fed from TR1, the 240V a.c. primary supply for the transformer being received via fuse FS1 at PLB/7 and PLB/10. The supply is controlled externally.

Note . . .

Owing to the large number of valve heaters supplied by TR1 there is a high current surge upon switching-on when the valves are cold. For this reason a fuse-link of the anti-surge type is used for FS1. The requirement is indicated by a green dot adjacent to the fuse-holder on the unit panel.

9. The +250V supply at PLB/9 is received direct from the +250V voltage regulator and feeds valves V2, V4, V5, V11 and V12. The +250V supply at PLB/6 is routed through the fault detection circuits and supplies the remaining stages. The return for both supplies is connected through PLB/12 (earth).

Input amplification

10. Each of the inputs is fed to the cathode of one half of a double-triode valve in one of eight identical circuits (V1 to V8) of which that for the 0 microseconds, 32 kc/s input is described below.

11. The input is brought in at socket SKAC where it is connected to the cathode of V1b (fig. 5). This half of the valve operates as a grounded grid triode amplifier, its grid being returned, via the grid stopper R3, to the junction of R1 and R2 connected across the +250V supply so that

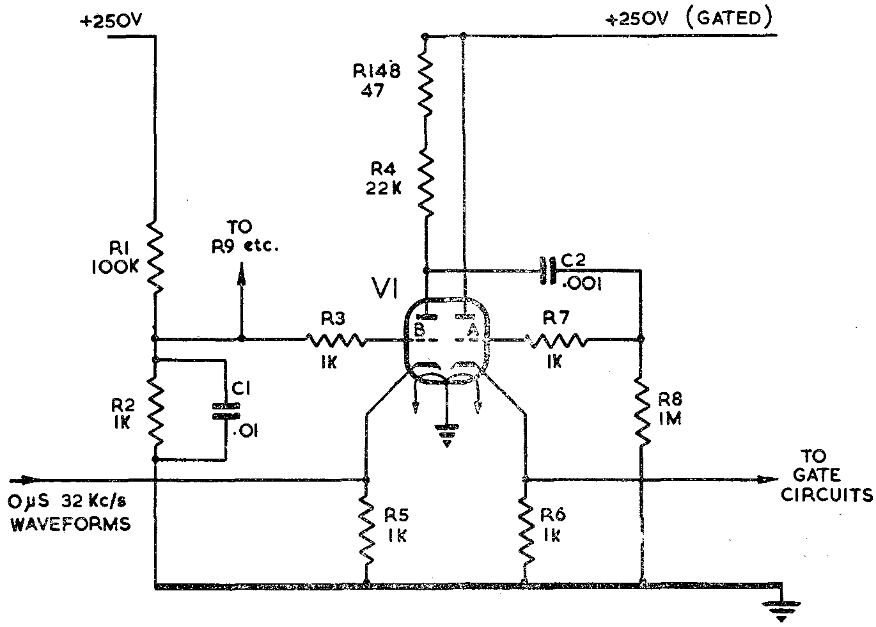


Fig. 5. Input circuit for 0 μs 32 kc/s waveforms

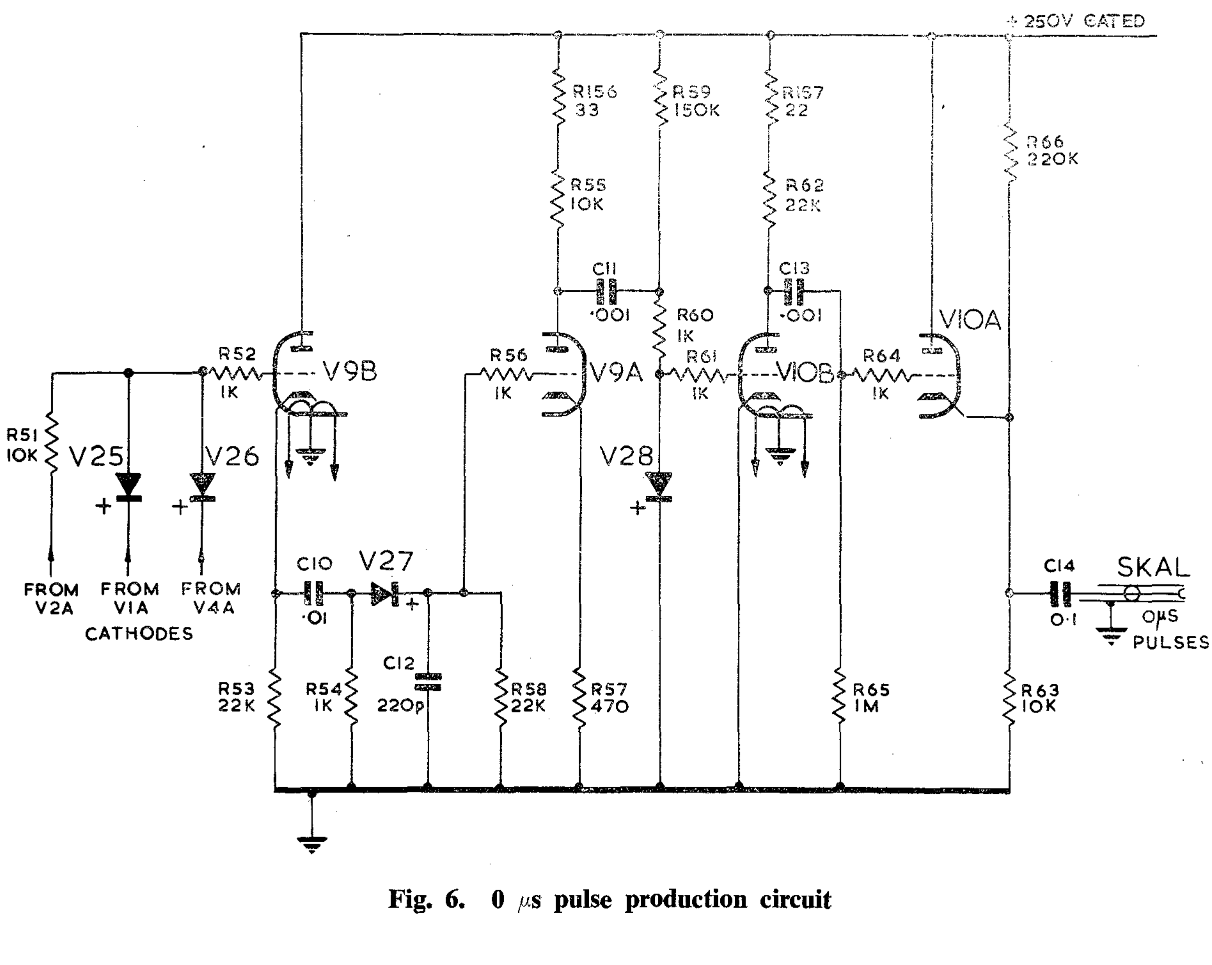


Fig. 6. 0 μs pulse production circuit

the grid is at a potential of approximately +2·5V with respect to earth. Resistance capacitance coupling is used between the amplifier and the cathode follower V1a. From each cathode follower stage (i.e. V1a to V8a) a positive-going output is taken to the appropriate gating circuit. The +2·5V bias used for all of the input stages (V1b to V8b) is derived from the h.t. supply unaffected by fault inhibition. This is done to keep V2b, V4b and V5b operative under fault conditions.

Production of gated pulse outputs

12. Each of six gating circuits accepts three inputs of which the 250 c/s waveforms with a pulse width of approximately 63 microseconds and the 0 microseconds 32 kc/s waveform are used in production of the 0, −125, −250, −500 and −750 microseconds pulse outputs. The 0 microseconds 250 c/s and −8 microseconds 32 kc/s waveforms are used in production of the −8 microseconds pulse output. The input waveforms are shown in fig. 3(a) to (h). These gating waveforms are used to select the required pulses at a p.r.f. of 250 c/s from the groups of five pulses at a p.r.f. of 8 kc/s received at SKAF and fed to the gating circuits from V4a cathode.

13. Six identical circuits are used in the production of the output pulses of which the circuit for the production of the 0 microseconds pulses (fig. 6) is described here. The gate circuit, consisting of R51, V25 and V26 receives waveforms from the cathodes of V2a, V1a and V4a respectively; these waveforms consist of 250 c/s and 32 kc/s rectangular waveforms and groups of five pulses with a separation of 8 microseconds between pulses and a recurrence frequency of 8 kc/s, respectively (fig. 7).

14. In the intervals between pulses the cathodes of the input cathode followers are virtually at earth potential so that the grid of V9b is also at earth potential. When pulse inputs are received the cathodes of the input cathode followers rise to a positive potential with respect to earth so that with pulse inputs at SKAC and SKAF the germanium diodes V25 and V26 are cut off. When positive inputs at R51, V25 and V26 coincide, the grid of V9b rises to a positive potential according to the input to R51 since the two diodes are both cut off. At the end of the coincidence period either or both of V25 and V26 will conduct so that the positive input at R51 is conducted to earth via the respective diode and the cathode load of the appropriate cathode follower. Since the majority of the input is dissipated across R51, the grid of V9b again falls to just above earth potential. A narrow positive pulse with a width according to the selected 8 kc/s pulse and timing according to the gating waveforms is thus applied to the grid of V9b via the grid stopper R52.

15. V9b is connected as a cathode follower, the output from which is developed across R53 and coupled to the pulse stretching circuit V27, C12, R58 via C10; a discharge path for C10 is completed via R54. With no pulse input to V9b the

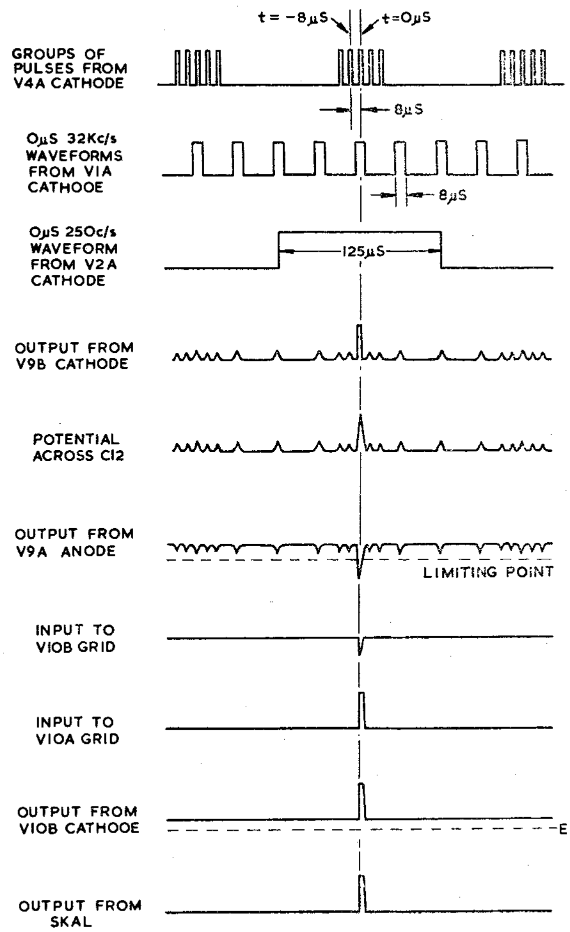


Fig. 7. Waveforms

valve is conducting at a low level so that only a small voltage, positive with respect to earth, is developed across R53; this voltage also appears across C12. Upon receipt of a positive pulse input to V9b, a positive-going potential is developed across R53 with the result that C12 is rapidly charged to the same potential via the conducting diode V27. This pulse is of very short duration, less than one microsecond, and at the end of the pulse the voltage across R53 again falls to a low level so that V27 is cut off; any charge which has developed across C10 will be dissipated in resistors R53 and R54. As soon as V27 is cut off C12 discharges through R58, the discharge time being approximately 5 microseconds.

16. The lengthened pulse thus produced is amplified by V9a and applied via the limiting circuit R59, R60 and V28 to the next amplifier stage V10b. With no output at the anode of V9a, V28 is conducting so that the grid of V10b is at earth potential, the junction of R59 and R60 is approximately 2V positive with respect to earth, and C11 is charged. Upon receipt of a positive pulse at the grid of V9a, its anode potential falls and the resulting discharge current flowing from C11 via R59 will cause V28 to be cut off for changes in anode potential of more than 2V. The grid of V10b is driven negative for the duration of the pulse so that it produces a positive output

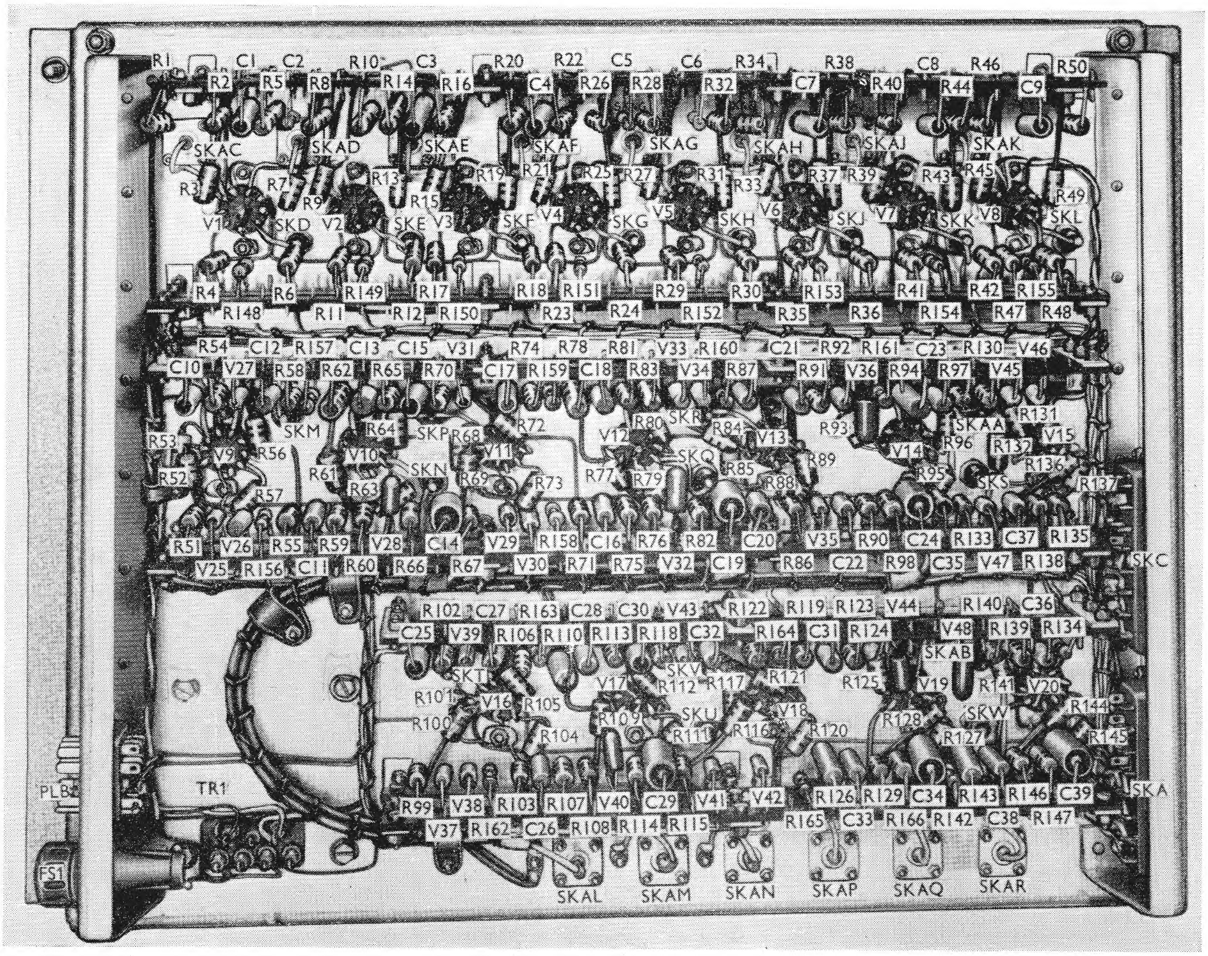


Fig. 8. Gate, electronic: rear view

at its anode. This stage of limiting is used in order that any break through of unwanted pulses due to the residual resistance of the diodes V25 and V26 in the non-conducting state is eliminated from the final output of the unit.

17. The cathode follower output stage V10a is cut off between pulses by the positive potential developed at its cathode by R63 in the divider network R63 and R66 across the +250V supply. By this means the base line of the output from V10a cathode is determined so that the output from SKAL consists of positive-going pulses approximately 4 microseconds wide with the base line at earth potential and with the leading edge of each pulse occurring exactly at an arbitrary time of zero microseconds.

18. The −8, −125, −250, −500 and −750 microseconds pulse outputs are produced in circuits that are identical to the circuit described above but which use different combinations of inputs from the eight input cathode follower stages. The 8 kc/s five-pulse input is used in the production of all six outputs but whereas the centre pulse of the five is gated through in the production of the 0, −125, −250, −500 and −750 microseconds outputs the pulse preceding the centre pulse is gated through by the −8 microseconds 32 kc/s waveform in production of the −8 microseconds output. Each of the gate circuits receives the appropriate 250 c/s waveform via a 10 kilohm resistor R67, R83, R99, R115 and R130 respectively to produce the −8, −125, −250, −500 and −750 microsecond outputs which are advanced by the appropriate time with respect to the 0 microseconds output, the pulse width of all outputs being 4 microseconds.

Test readings

19. Test sockets SKA and SKC are provided to facilitate the check of individual valve performances. These checks should be carried out by connecting multimeter Type 100 to the sockets via the plug-to-socket adaptor. The readings obtained should be comparable with those indicated in Tables 1 and 2.

Monitor points

20. Test sockets SKD to SKW, SKAA and SKAB are provided for waveform monitoring purposes. The waveforms existing at these points are illustrated in fig. 9.

TABLE 1

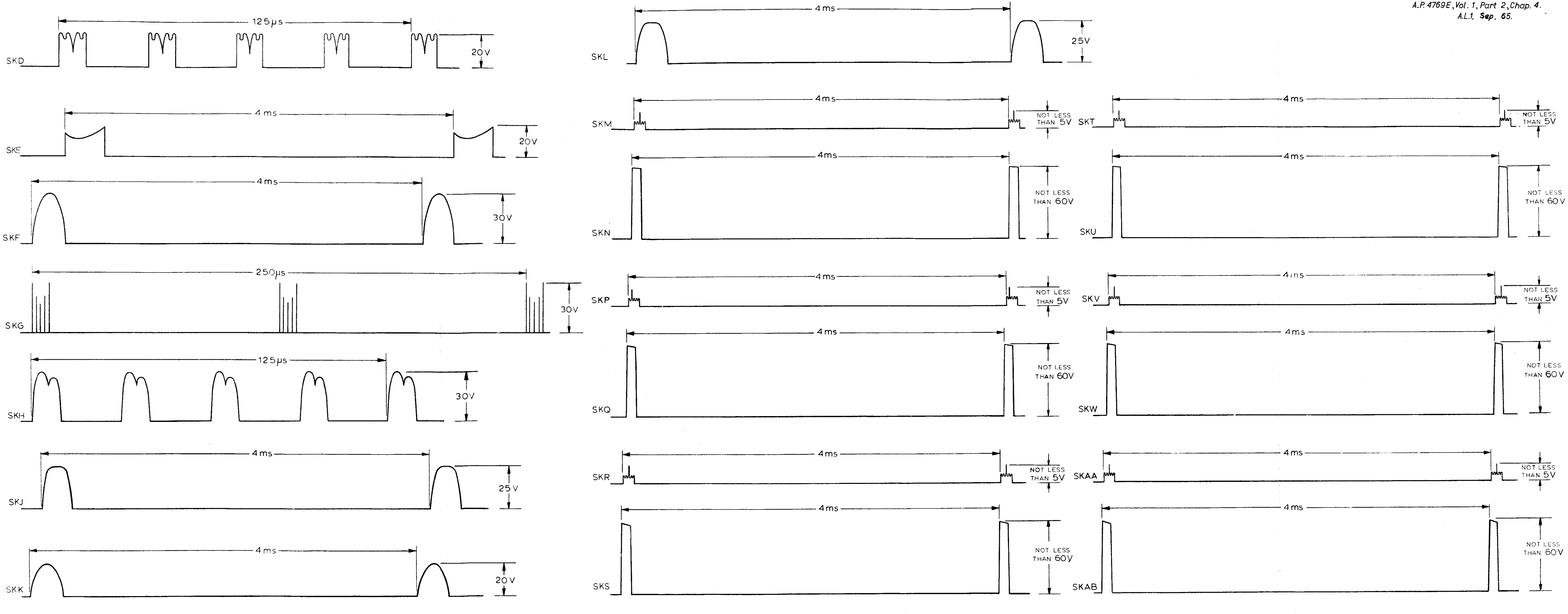
Multimeter readings at SKA

Multimeter switch position	Socket SKA pins	Measured across resistor	Valve monitored	Reading	Tolerance
A	1, 13	R148	V1b	0·6	±0·12
B	2, 14	R149	V2b	0·6	±0·12
C	3, 15	R150	V3b	0·6	±0·12
D	4, 16	R151	V4b	0·6	±0·12
E	5, 17	R152	V5b	0·8	±0·16
F	6, 18	R153	V6b	0·6	±0·12
G	7, 19	R154	V7b	0·6	±0·12
H	8, 20	R155	V8b	0·6	±0·12
J	9, 21	R156	V9a	0·3	±0·06
K	10, 22	—	—	zero	—
L	11, 23	R158	V11a	0·3	±0·06

TABLE 2

Multimeter readings at SKC

Multimeter switch position	Socket SKC pins	Measured across resistor	Valve monitored	Reading	Tolerance
A	1, 13	R159	V12b	0·48	±0·1
B	2, 14	R160	V13a	0·3	±0·06
C	3, 15	R161	V14b	0·48	±0·1
D	4, 16	R162	V16a	0·3	±0·06
E	5, 17	R163	V17b	0·48	±0·1
F	6, 18	R164	V18a	0·3	±0·06
G	7, 19	R165	V19b	0·48	±0·1
H	8, 20	R134	V15a	0·3	±0·06
J	9, 21	R142	V20b	0·48	±0·1
K	10, 22	R157	V10b	0·48	±0·1



NOTE:-
1. ALL VOLTAGES GIVEN ARE ONLY TYPICAL
2. THE WAVEFORMS ARE NOT ALL SHOWN IN THE EXACT TIME RELATIONSHIP. THIS IS SHOWN IN FIGS. 3&7

Fig. 9

Waveforms at monitoring points.

Fig. 9

87218 571748 104 11/65 V.B. 925/1

Fig 10

Gate, electronic 5840-99-948-9102 : circuit

Fig.10.

Chapter 5

CATHODE FOLLOWER UNIT

5840-99-948-9289

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Introduction

1. The cathode follower unit (fig. 1 and 5) is used in two applications, one being in the main p.r.f. cabinet and the other in the standby p.r.f. cabinet. In both applications the units provide the required number of outputs from each of the 0, −8, −125, −250 ►◄ and −750 microseconds pulse inputs from the electronic gate unit (fig. 2). Distribution of the outputs is made to four sweep generators (Chap. 6) and to the distribution unit, pulse (Chap. 10).

2. Under certain fault conditions it is necessary to inhibit output from the unit, which is accomplished by placing the h.t. supply under control of the fault detection circuits (Chap. 8). One of the −8 microsecond outputs is exempted from this inhibition as it is the signal used to recognise the presence or absence of a fault.

Operating characteristics

Inputs

3. Each unit accepts the following inputs from the electronic gate, each input having a pulse width of 4 microseconds with an amplitude of not less than 60V peak positive and a nominal p.r.f. of 250 c/s:—

(1) 0 microseconds pulse at SKBJ.

(2) −8 microseconds pulse at SKBK.

(3) −125 microseconds pulse at SKAL.

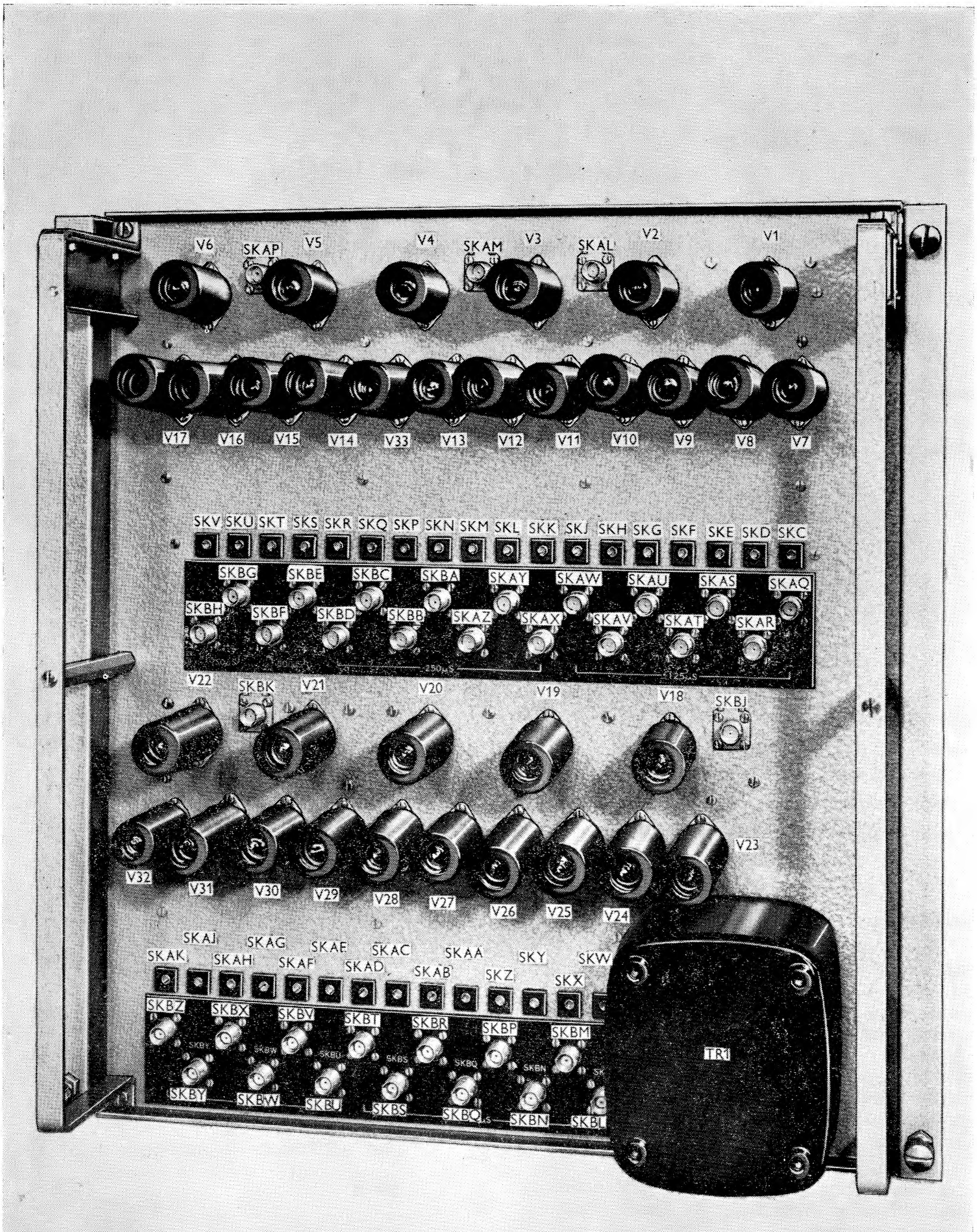
(4) −250 microseconds pulse at SKAM.

►◄

(5) −750 microseconds pulse at SKAP.

Outputs

4. With all the above-listed inputs available the unit will produce the outputs listed in Table 1. Each output has a nominal pulse width of 4 microseconds. The −8 microsecond output from SKBX is not subject to fault inhibitions, but all of the others are.

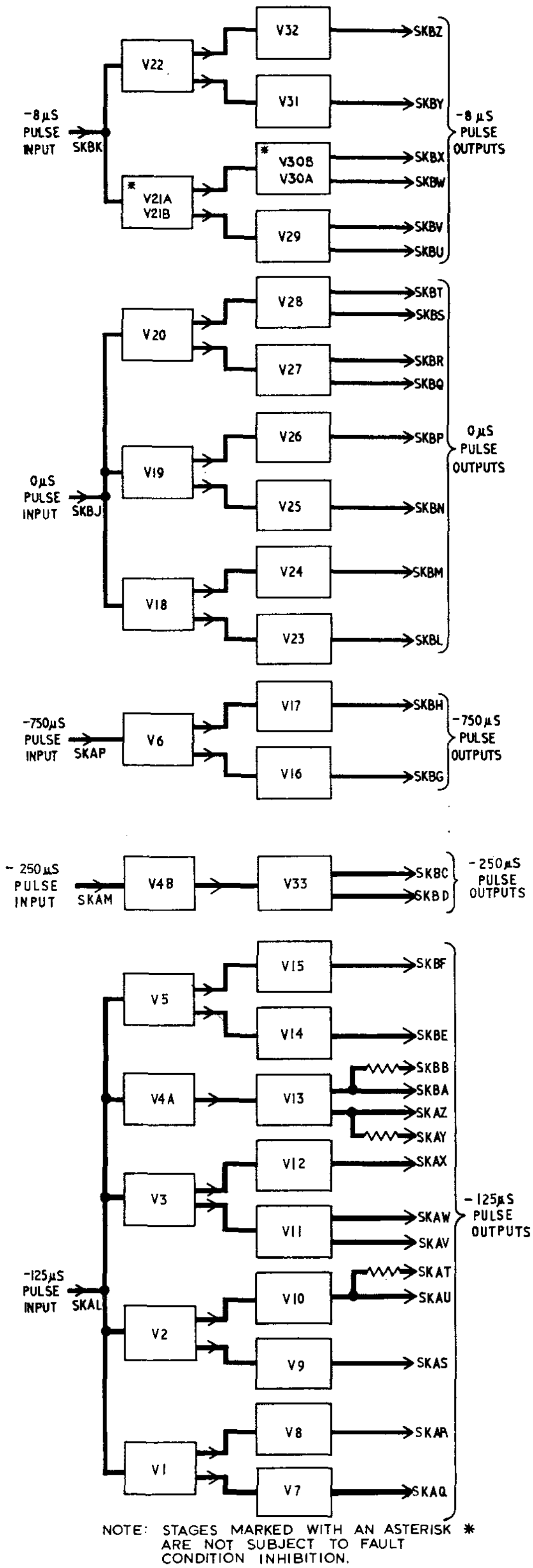


◄**Fig. 1. Cathode follower unit: front view**►

TABLE 1

Outputs

Title of pulse	Output socket	Impedance (ohms)	Minimum amplitude	Destination
0 µs	SKBL	75	15V	Distribution unit, pulse via unit 402.
	SKBM	75	15V	
	SKBN	75	15V	
	SKBP	75	15V	
	SKBQ	220	15V	Generator, sweep, unit 302.
	SKBR	220	15V	Distribution unit, pulse via unit 402.
	SKBS	220	15V	
	SKBT	220	15V	
−8 µs	SKBY	75	15V	Distribution unit, pulse via unit 402.
	SKBZ	75	45V	
	SKBU	220	15V	
	SKBV	220	15V	
	SKBW	220	15V	
	SKBX	220	15V	Control, generator pulse, unit 501.
−125 µs	SKAQ	75	15V	Distribution unit, pulse via unit 402.
	SKAR	75	15V	
	SKAS	75	15V	
	SKAU	75	15V	
	SKAV	220	15V	Generator, sweep, unit 307.
	SKAW	220	15V	Distribution unit, pulse via unit 402.
	SKAT	High impedance	15V	
	SKAX	75	15V	
	SKAY	High impedance	15V	
	SKBB	High impedance	15V	
	SKAZ	220	15V	
	SKBA	220	15V	
	SKBF	75	15V	
	SKBE	75	15V	Generator, sweep, unit 205.
−250 µs	SKBC	220	15V	Distribution unit, pulse via unit 402.
	SKBD	220	15V	
−750 µs	SKBG	75	15V	Generator, sweep, unit 207.
	SKBH	75	15V	Distribution unit, pulse via unit 402.



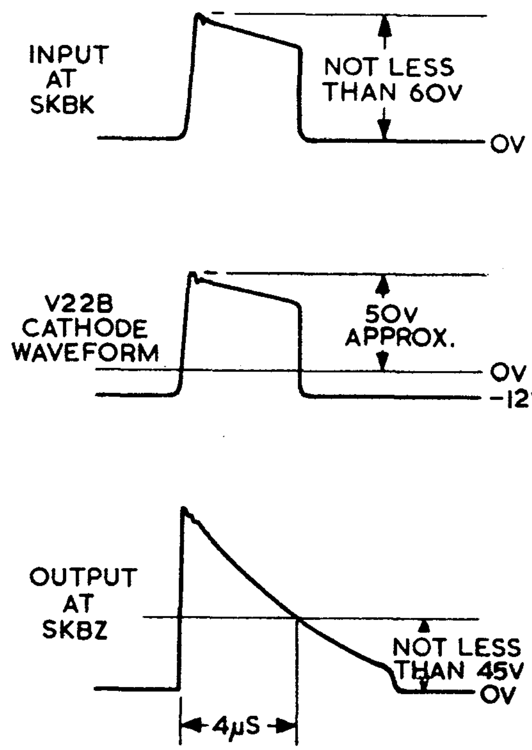
◄**Fig. 3. Cathode follower unit: block diagram**►

Circuit description (fig. 7 and 8)

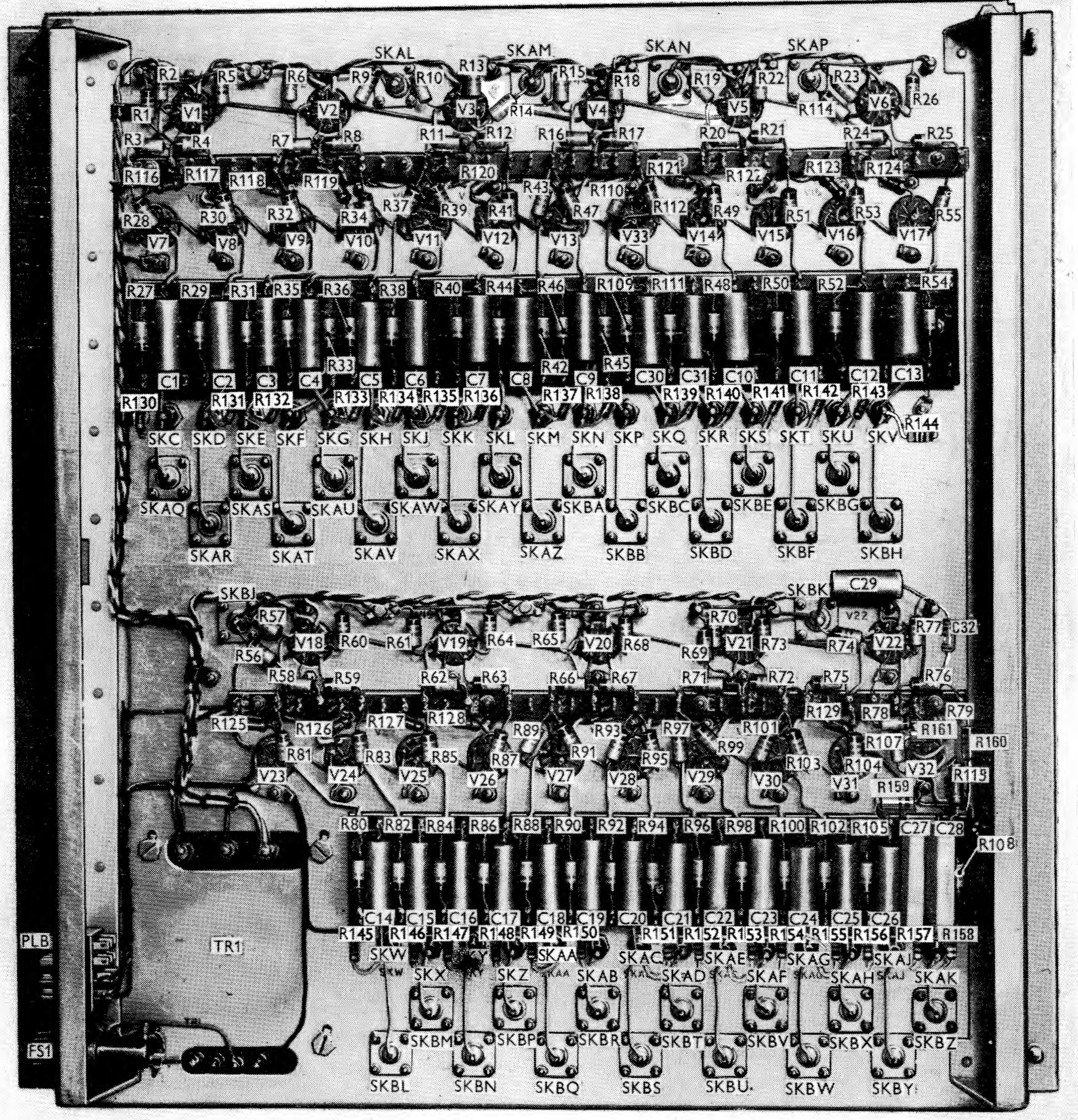
5. Heater voltages for the valves are supplied from TR1, the a.c. 240V primary supply for which is received from PLB/7(L), via FS1, and PLB/10(N). The a.c. supply is controlled externally. Owing to the large number of valve heaters supplied by TR1, there is a high current surge upon switching-on when the valves are cold. For this reason, a fuse-link of the anti-surge type is used for FS1. The requirement is indicated by a green dot adjacent to the fuseholder on the unit panel.

6. The −250V d.c. supply from the −250V regulator in frame 2 of the cabinet is brought in at PLB/11 (−250V) and PLB/12 (earth). The +250V supply at PLB/9 is received direct from the +250V voltage regulator and feeds valves V21b and V30. The +250V supply at PLB/6 is routed through the fault detection circuits and supplies the remaining stages. The return for both supplies is connected through PLB/12 (earth).

7. An overall block diagram of the unit is given in fig. 3. Each pulse input is first fed to a series of double-triode valves, V1 to V6 and V18 to V22, connected as cathode followers. Outputs are taken from these stages to further cathode followers employing three different types of valve, double-triode valves being used for the 220 ohm outputs, pentodes for the 75 ohm outputs and a thyratron for a further 75 ohm output at a higher level than the remainder. The 75 ohm and 220 ohm outputs, with the exception of that taken from SKBZ, are taken from a 100 kilohm



◄**Fig. 4. Thyratron waveforms**►



◄Fig. 5. Cathode follower unit: rear view►

cathode load via a 0·1 microfarad capacitors; the output at SKBZ is taken directly from the cathode of V32. Additional high impedance outputs at SKAT, SKAY and SKBB are obtained via 1 kilohm resistors.

8. The input cathode followers, V1 to V6 and V18 to V22a follow a conventional circuit with grids and cathodes returned to earth, and the pulse inputs fed directly to the grids of the valves. Since the grid of V22b is returned to a potential of approximately 14V negative with respect to earth, its grid is isolated by the d.c. blocking capacitor C29.

9. For outputs into imepdances of 220 ohms, double-triode stages, V11, V13, V27 to V30 and V33 are used. These stages produce positive-going outputs at a level of not less than 15V peak.

10. For outputs into impedances of 75 ohms, pentode stages V7 to V10, V12, V14 to V17, V23 to V26 and V31 are used. These are conventional cathode follower stages, each of which produces an output at a level of not less than 15V peak.

11. Addition high impedance outputs are taken from V10, V13a and V13b through the 1 kilohm resistors R33, R44 and R45 to sockets SKAT, SKAY and SKBB respectively; the levels at these sockets are substantially the same as those obtained at the main output sockets.

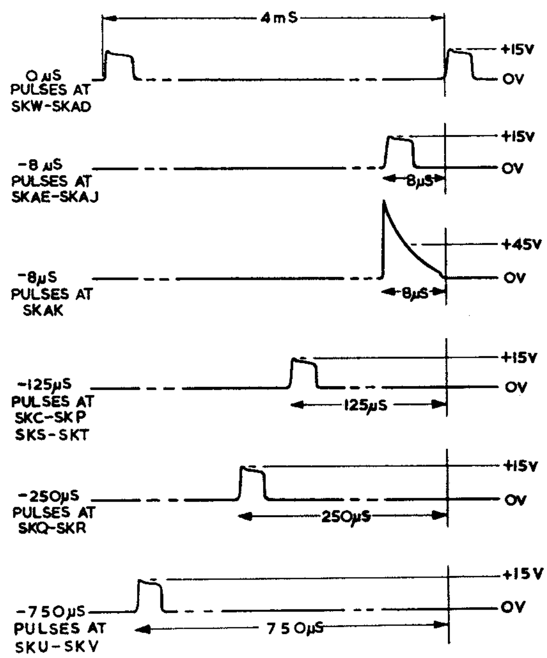
12. A high level output, with a peak level of not less than 45V, is obtained by the use of the thyratron V32. With no input at socket SKBK, the grid of V32 is held at a potential of approximately −12V with respect to earth, and is not conducting. The capacitors C27 and C28 are charged to +250V via R108.

13. When the −8 microseconds pulse is fed to the grid of V22b, the cathode potential of this valve, and hence the grid potential of V32 rises sharply to approximately +50V with respect to earth. Therefore V32 conducts and provides a discharge path for C27 and C28 via R115. The capacitors discharge exponentially, the discharge time being such that the width, at 50 per cent amplitude, of the pulse thus generated at SKBZ is approximately 4 microseconds (fig. 4).

14. When the voltage across the capacitors has fallen to a sufficiently low value V22 is again cut off as by this time the 4 microseconds input pulse will have ceased. The grid of V32 therefore resumes control of the valve which remains non-conductive until the arrival of the next input pulse.

Monitor points

15. Test sockets (SKC to SKAK) are provided at each output for monitoring purposes. The waveforms obtainable at these points are illustrated in fig. 6.



◄Fig. 6. Theoretical waveforms at monitor points►

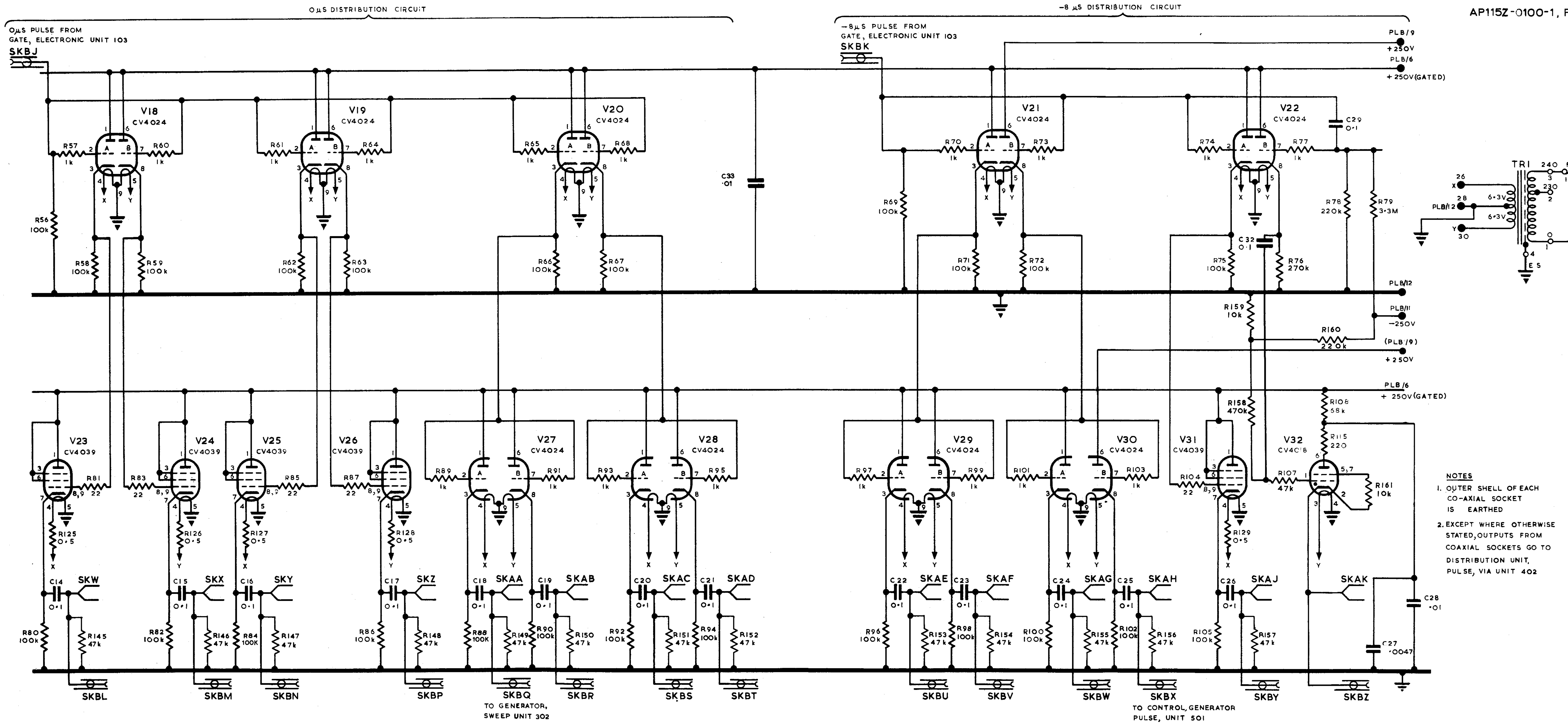


Fig. 7. Cathode follower unit 5840-99-948-9289: 0µs and -8µs distribution circuit

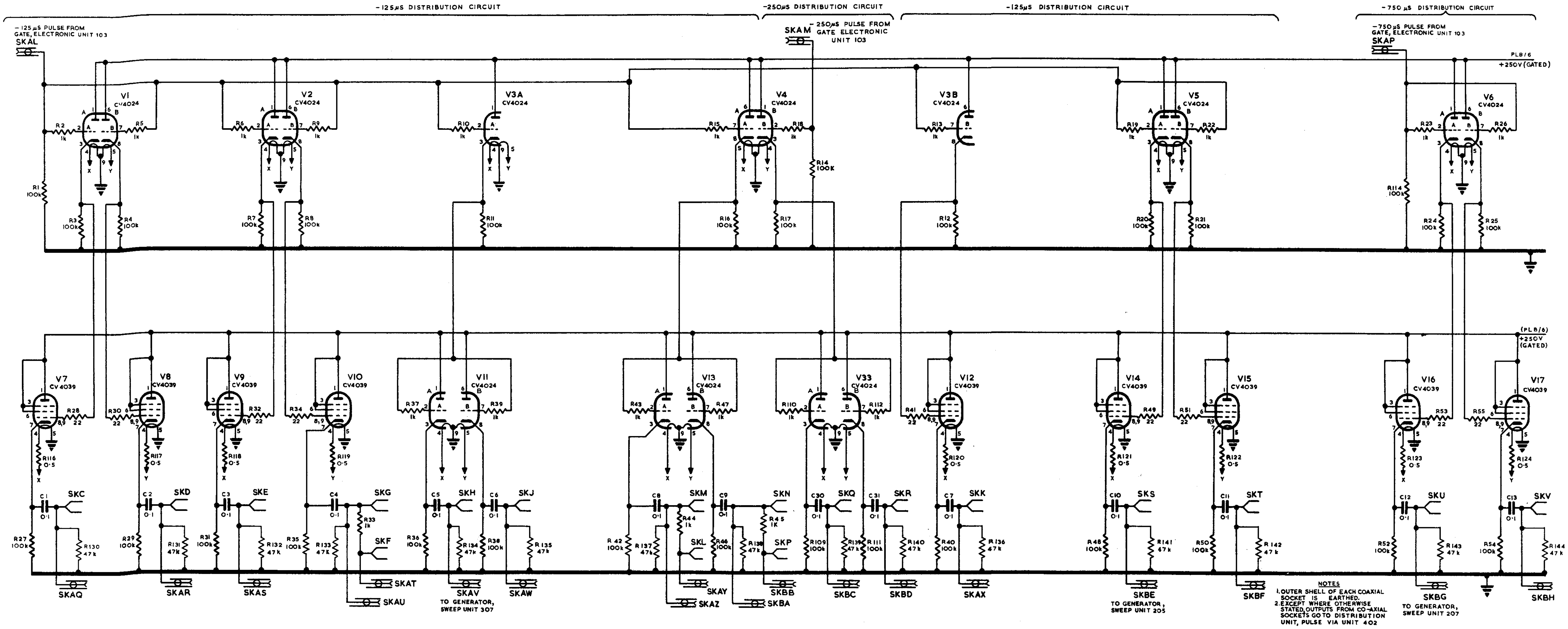


Fig 8

Cathode follower unit 5840-99-948-9289 :-125µs,-250µs, and -750µs distribution circuit

Fig. 8

Chapter 6

GENERATOR, SWEEP

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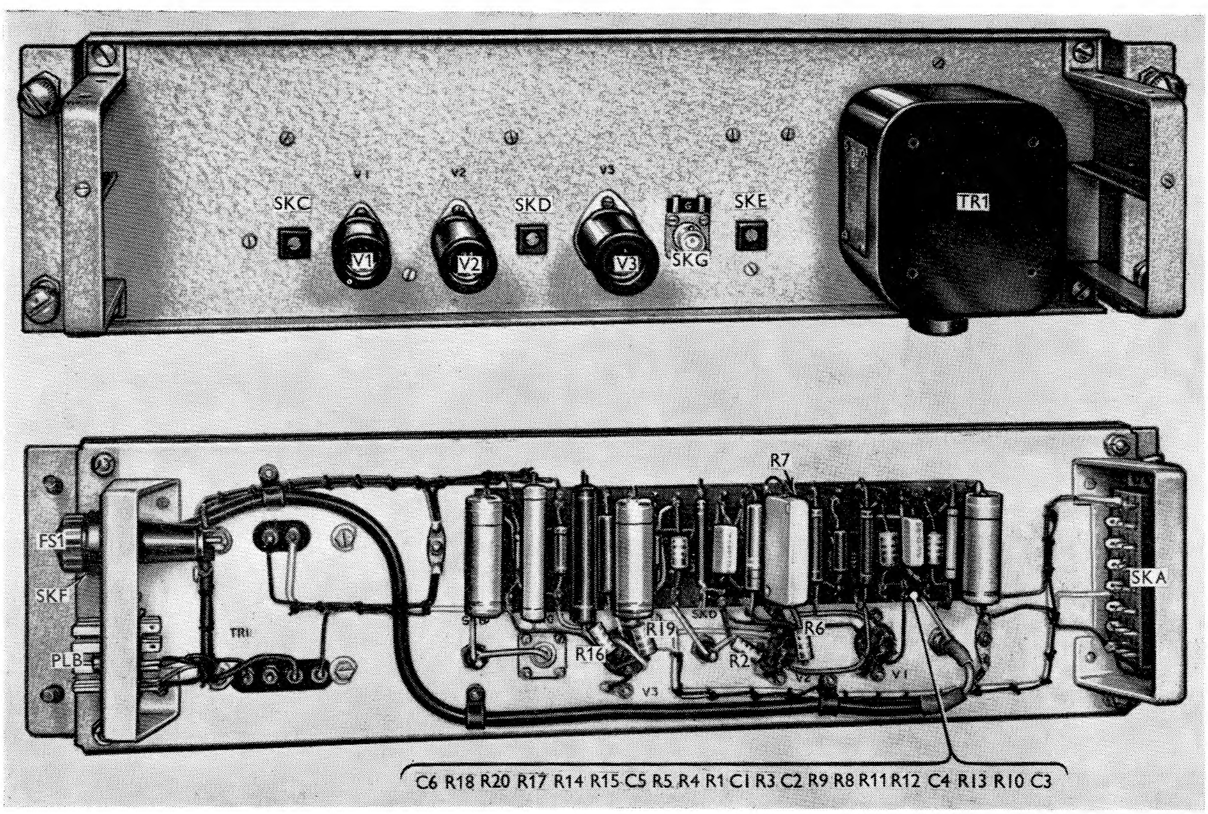


Fig. 1. Generator, sweep: front and rear views

Introduction

1. The sweep generator (fig. 1), four of which are used in each of the main and standby p.r.f. cabinets, produces a negative-going sawtooth output. The sawtooth waveform is initiated by a positive pulse input from the cathode follower unit (Chap. 5), the inputs being the 0, −125 ▶◀ and −750 microseconds pulses. The output waveforms are used in a series of eleven pulse generators (Chap. 7) for the production of output trigger pulses with a delay which may be set to occur between 5 and 170 microseconds after the input pulse to the appropriate sweep generator.

Performance characteristics

Input

2. An input pulse with a nominal duration of 4 microseconds, an amplitude of 20V and a nominal p.r.f. of 250 per second is received at SKF.

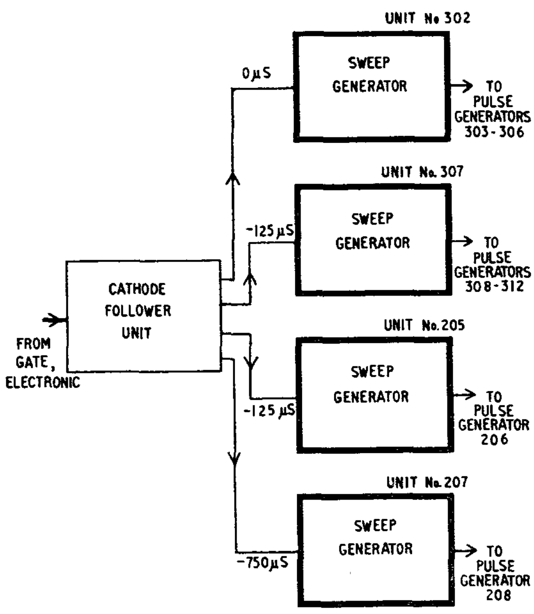
Output

3. The output at SKG consists of a negative going sawtooth waveform with a linear rundown lasting at least 170 microseconds and an amplitude of about 180V. The recurrence frequency is the same as that of the input pulse.

Circuit description

4. Heater voltages for the valves are supplied from TR1, the 240V a.c. primary supply for the transformer being received at PLB/7 and PLB/10.

5. The −250V supply appears across PLB/11 (−250V) and PLB/12 (earth). The +250V supply appears across PLB/9 (+250V) and PLB/12 (earth).



◀**Fig. 2. Generator, sweep: functional schematic**▶

6. The circuit consists of a Miller transitron stage V2 triggered by the input pulse via the diode V1b; the control grid of V2 is prevented from rising above earth potential by diode V1a. The output is taken via a cathode follower stage V3.

7. Under quiescent conditions the input at SKF is 0V (fig. 3) so that the anode of V2 is cut off due to the negative voltage at the suppressor, of approximately −15V developed by the divider network R8 and R9 across the −250V supply. The screen therefore takes all the cathode current via R10-R11 and its potential is approximately +50V; C4 is charged to the screen potential so that V1b is nonconducting. A charging path for C4 is provided by R12.

8. Upon the arrival of a positive trigger pulse at SKF, V1b conducts and, since the time constant of the circuit C2, R7, R8 is long, the junction of R6 with C2 is driven in a positive direction (fig. 3). The combination of R6 with the diode portion of V2 prevents the suppressor grid from becoming positive with respect to the cathode so that the suppressor waveform is rectangular, that portion of the suppressor input which is positive with respect to the cathode being dissipated in R6.

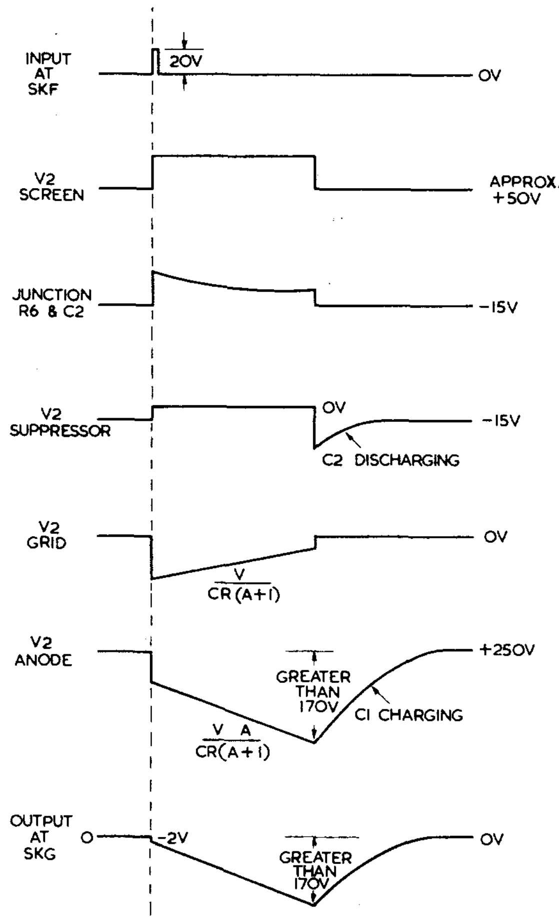


Fig. 3. Circuit waveforms

9. The anode now takes current and its potential falls as also does that of the control grid since the time constant of the circuit R1, C1, R3 is long and C1 is charged to the potential of the h.t. supply. At the end of the trigger pulse V1b is again cut-off but the suppressor of V2 remains at approximately earth potential so that anode current continues after the trigger pulse has ceased. The control grid of V2 rises towards h.t. potential as C1 discharges at a rate $\frac{V}{CR(A+1)}$ volts per second, where A is the gain of the valve and CR the time constant of the discharge circuit, R1, R3, for C1. A Miller run-down then takes place with the anode potential falling at a rate $\frac{VA}{CR(A+1)} \simeq \frac{V}{CR}$ volt/s since the gain, A, is much greater than 1. The run-down continues, with the cathode potential increasing, until the cathode potential rises to that of the suppressor. Anode current is then cut off by the suppressor and transferred to the screen, the screen potential falls and with it, that of the suppressor. The anode rises towards h.t. potential at a rate determined by the charging path for C1 via R3 and the diode V1a. At the same time capacitors C2 and C4 charge to their original potentials after which the suppressor of V2 is again at -15V with respect to earth. The recovery time for the circuit should not exceed 500 microseconds after the end of the Miller rundown.

10. The grids of the double-triode cathode follower stage V3 are returned to a position potential of 100V, due to the divider network R14-R15, in order to keep the operating conditions of V3 within the specified limits of the valve. This is necessary since the input waveform from the anode of V2 is of an amplitude in excess of 170V. The grids of V3 are driven negative by the sawtooth output from the anode of V2 so producing a similar output from the common cathodes. The output at SKG is a negative-going sawtooth waveform with a minimum negative amplitude of 170V with respect to earth.

Test readings

11. Facilities are provided whereby performance of V2 and V3 can be checked by connecting multimeter Type 100 to socket SKA via a plug-to-socket adaptor. Under normal operating conditions, i.e. with the correct input applied to SKF, the readings obtained should be as indicated in Table 1.

Monitor points

12. Test sockets SKC to SKE are provided for monitoring purposes. The waveforms existing at these points are illustrated in fig. 4.

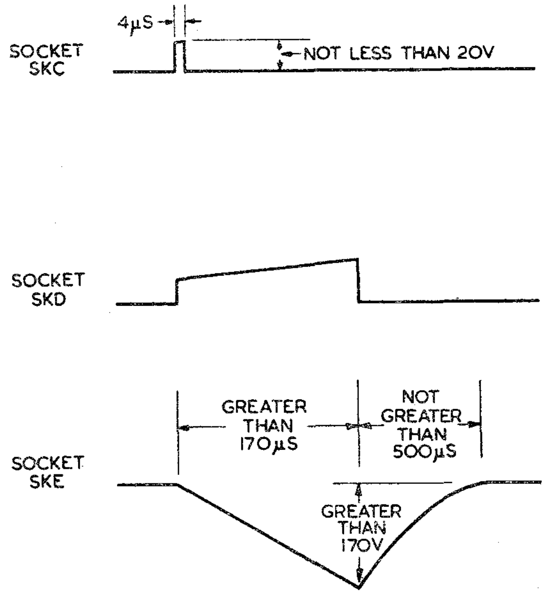
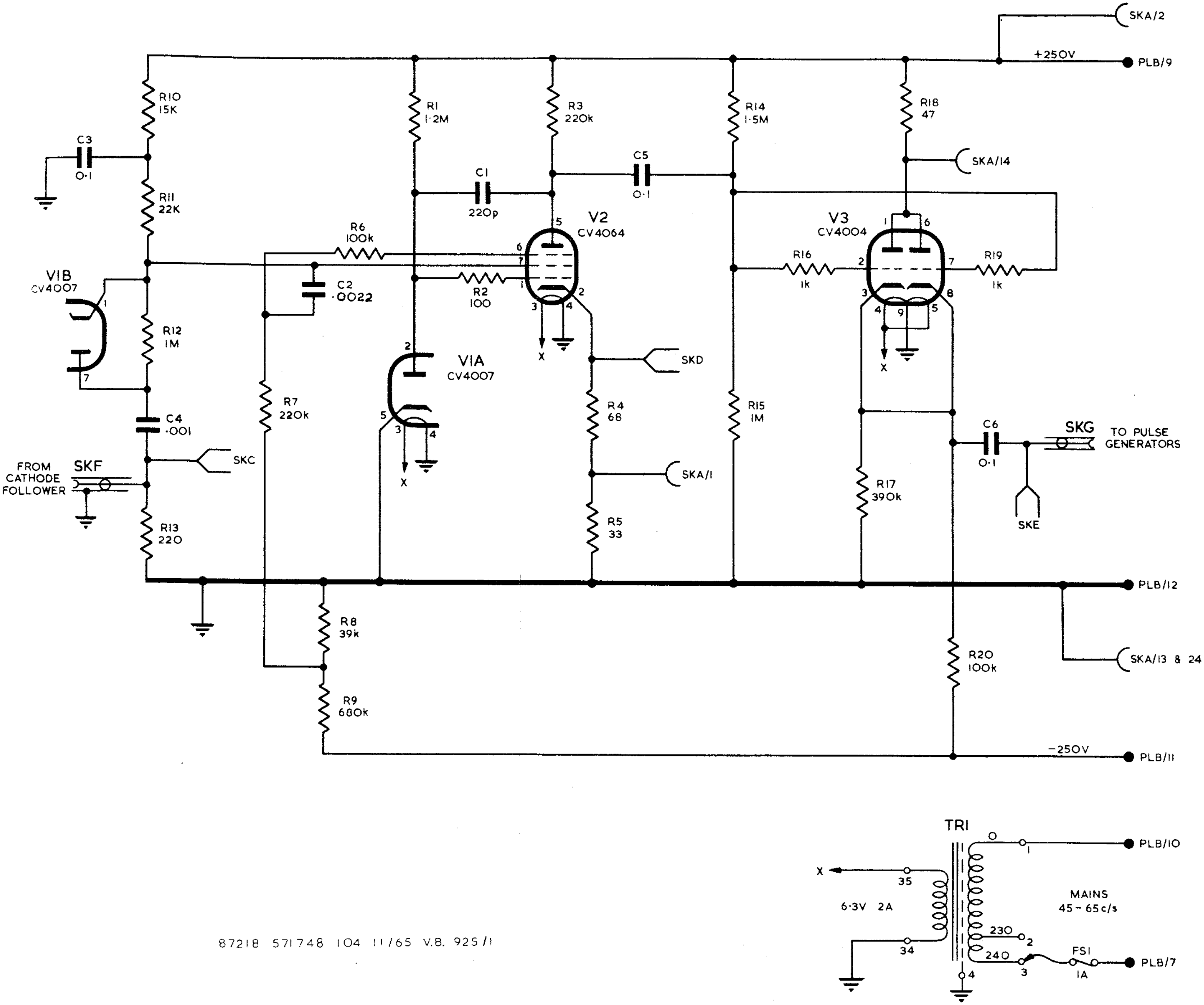


Fig. 4. Waveforms at monitor points

TABLE 1

Multimeter readings

SKA poles	Multimeter switch position	Stage checked	Reading	Tolerance
1, 13	A	V2	0·48	±0·1
14, 2	B	V3	0·48	±0·1



87218 571748 104 11/65 V.B. 925/1

Fig.5 Generator sweep 5840-99-999-2838: circuit Fig.5

Chapter 7

PULSE GENERATOR

5840-99-999-9050

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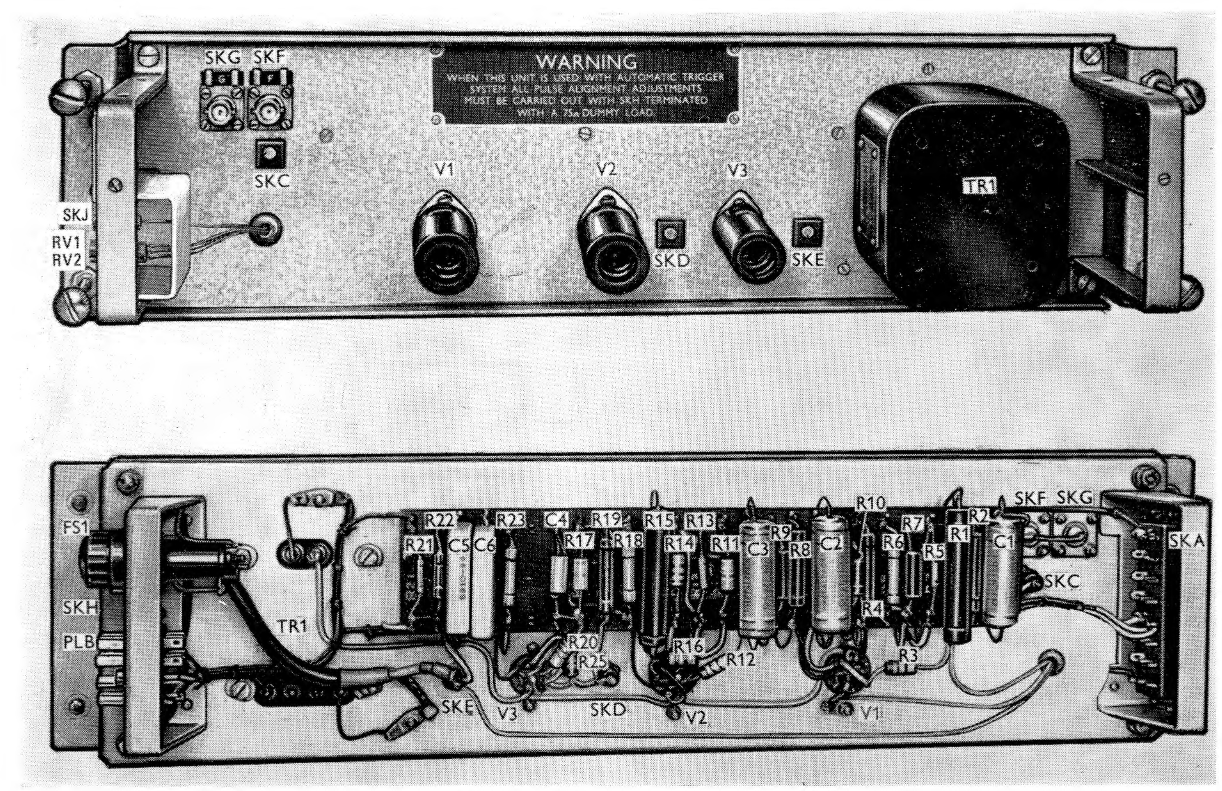
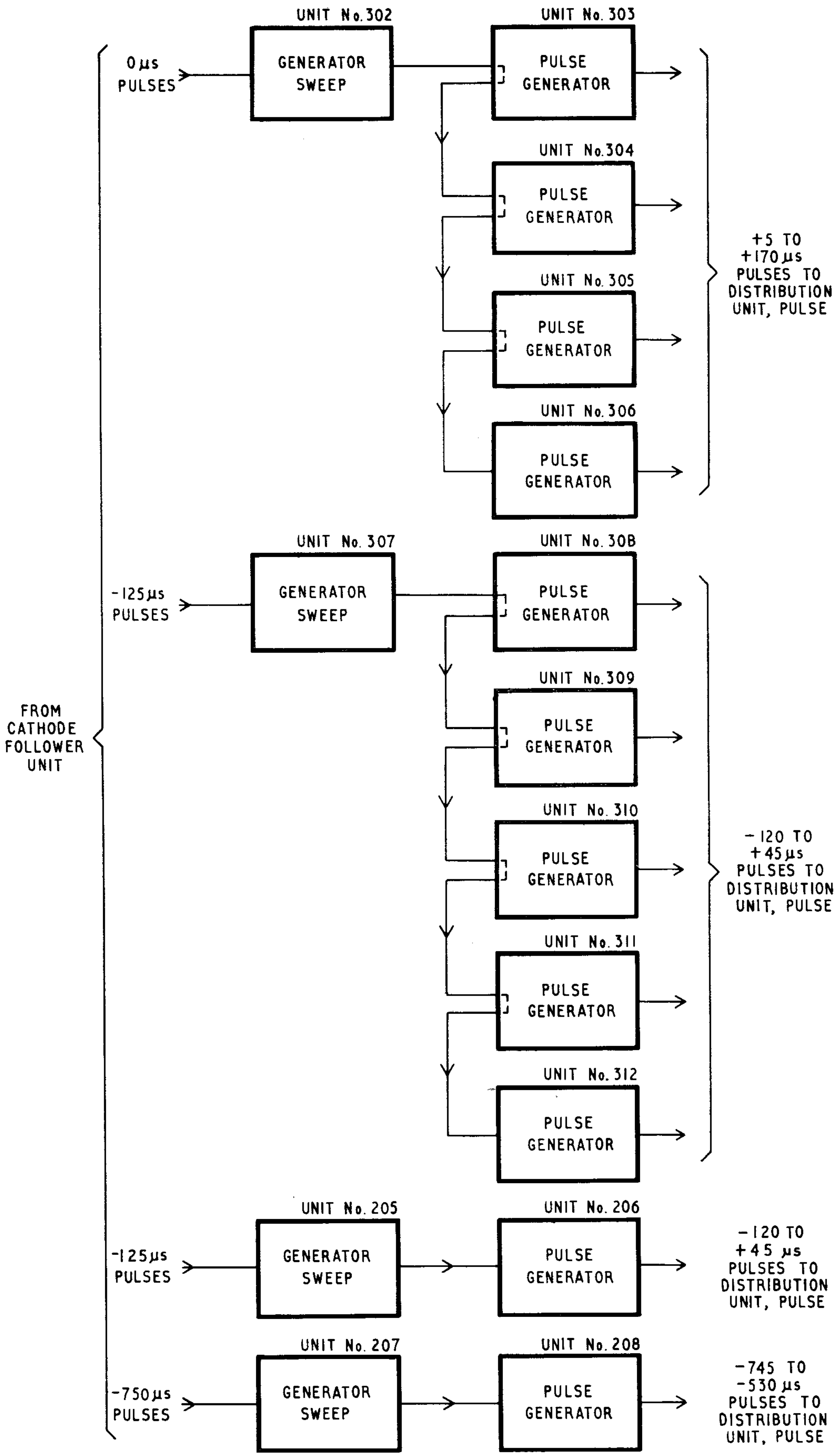


Fig. 1. Pulse generator: front and rear views



◄**Fig. 2. Functional block diagram**►

Introduction

1. The pulse generators (fig. 1) are used in a number of applications, in the main and standby p.r.f. cabinets to produce positive pulse outputs from the negative-going sawtooth inputs received from four sweep generators (Chap. 6). The time interval between the commencement of the sawtooth waveform and the leading edge of the output pulse is adjustable between 5 and 170 microseconds by means of a preset control on the unit.

2. Eleven pulse generators are mounted in each of the main and standby p.r.f. cabinets. Pulse generators 303 to 306 receive a sawtooth waveform input from the sweep generator driven by a 0 microseconds pulse from the gate unit (Chap. 4) so that their output pulses may be set to occur at any interval after the 0 microseconds pulse between 5 and 170 microseconds. ◄Units 206 and 308 to 312 are driven by the sawtooth waveforms from sweep generators, which in turn are driven by −125 microseconds pulses; the output pulse from these units may therefore be set to occur at any interval between 120 microseconds before and 45 microseconds after the 0 microseconds pulse. Similarly, pulse generator unit 208 produces output pulses set to occur in the time period of −745 to −580 microseconds after the 0 microseconds pulse.►

3. The output pulses from the pulse generators in the main and standby p.r.f. cabinets are fed to the Distribution Unit, Pulse (Chap. 11). By this means a series of trigger pulses is made available for ancillary equipments, the timing of the pulses being adjusted on site to compensate for cable delays and triggering time of various equipments. Coincidence of video with the common timebase trigger is thus ensured.

Performance characteristics

Inputs

4. A negative-going sawtooth waveform with a run-down time of 170 microseconds and occurring at a nominal p.r.f. of 250 p.p.s. is received at SKF. The maximum amplitude of the waveform is 170V and its recovery time is not greater than 500 microseconds. Where more than one pulse generator is driven from a given sweep generator, socket SKG is used to feed subsequent pulse generators.

Outputs

5. The output from SKH is a pulse with a duration of 4 microseconds and an amplitude of not less than 35V in 75Ω. The pulse occurs at a repetition frequency of 250 p.p.s. at a time relationship which may be set to any value between 8 and 170 microseconds with respect to the basic pulse, i.e. 0, −125, −500 or −750 microseconds pulses according to the particular application of the unit.

Circuit description

6. Heater voltages for the valves are supplied from TR1, the 240V a.c. primary supply for the transformer being received via FS1 from the input at PLB/7 and PLB/10.

7. The −250V supply from the −250V regulator in the cabinet is brought in across PLB/11 (−250V) and PLB/12 (earth). The +250V supply from the +250V regulator at the top of the appropriate frame is brought in across PLB/9 (+250V) and PLB/12 (earth).

8. The circuit consists of an input cathode follower V1a followed by a diode gating stage, the conducting level of which is set by the COARSE and FINE DELAY controls. The amplifier V2 is cut off by the resultant waveform to produce a rectangular wave output which, after differentiation, triggers the thyratron output stage.

9. With no input at SKF, the grid of V1a is held at a potential of +100V due to the potential divider R1-R2. V1a cathode is therefore at a potential of approximately +105V with respect to earth and V1b is cut off. The anode of V1b is at a potential set by the sliders of RV1 and RV2, and since C3 is charged the grids of V2 are at earth potential and the combined anodes at a potential of approximately 55V. The thyratron V3 is not ionized, and capacitors C5 and C6 are therefore charged to +250V. The cathode of V3 is at earth potential.

10. Upon receipt of a negative-going sawtooth input at SKF, the cathode potential of V1a falls until it reaches a value at which V1b conducts (fig. 3). A discharge path is therefore formed for C3 via V1b and the cathode load of V1a, and V2 grids are driven negative by the discharge current through R11. V2 is cut off when the grid potentials fall below 5V negative with respect

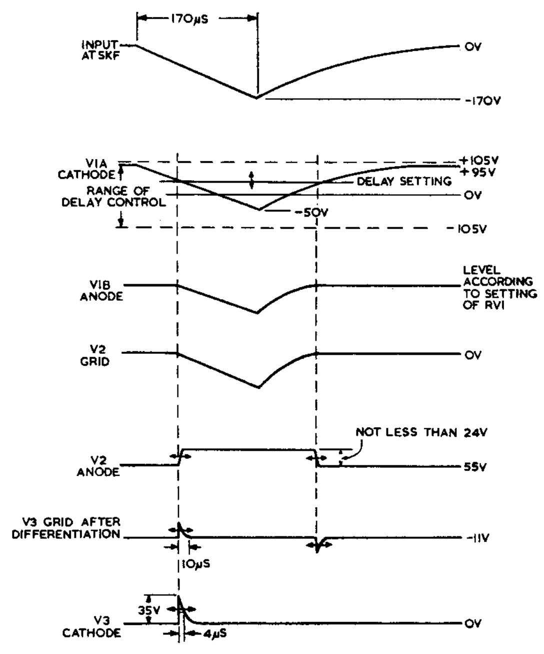


Fig. 3. Circuit waveforms

to earth and a rectangular waveform is produced at the andoes. The leading edge of the prositive rectangular waveform coincides with the conduction point of V1b, as set by RV1, and the trailing edge with the point when V1b is again cut off. The trailing edge of the waveform occurs during the recovery time of the input sawtooth waveform and is not used.

11. The anode waveform of V2 is differentiated by C4, R17 and R18 and the positive pulse so produced, approximately 10 microseconds in width, triggers the thyratron V3. Capacitors C5 and C6 discharge exponentially through R23, V3 and the 75-ohm load on SKH in subsequent equipment. The time constant of the discharge circuit is approximately 4·5 microseconds so that an output pulse is produced at SKH with a duration of approximately 4 microseconds.

Test readings

12. With the multimeter Type 100 connected to socket SKA via a plug-to-socket adaptor the readings obtained should be as indicated in Table 1.

Monitoring points

13. Test sockets SKC to SKE and SKJ are provided for monitoring purposes. The waveforms existing at these points are illustrated in fig. 4.

TABLE 1

Multimeter readings

Multimeter switch position	Stage monitored	Reading	Tolerance	Remarks
A	V1a	0·55	±0·11	No input to SKF or SKG
B	V2	0·4	±0·08	No input to SKF or SKG
C	V3	0·62	±0·12	With correct input at SKF

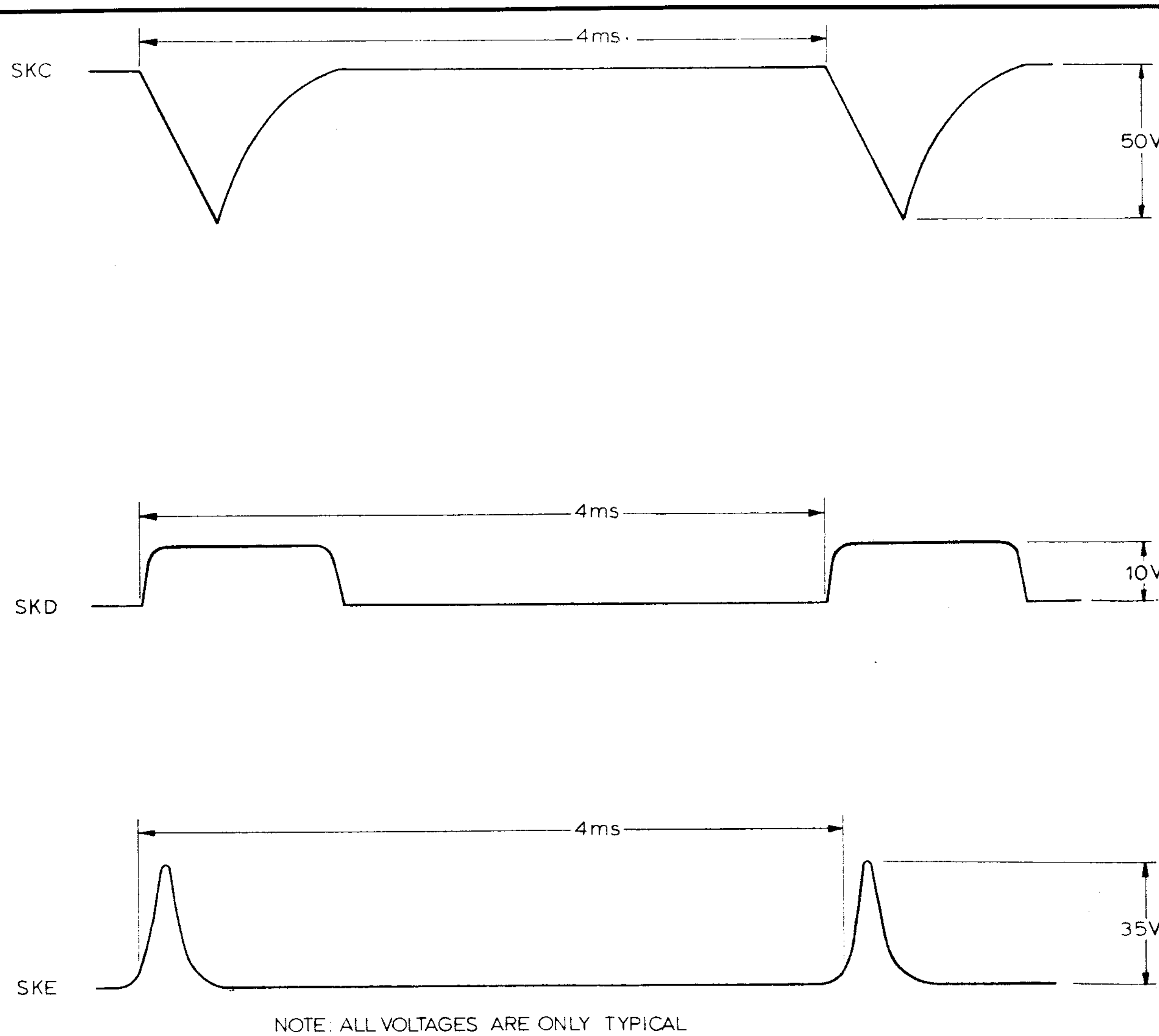


Fig. 4. Pulse generator: waveforms at monitor points

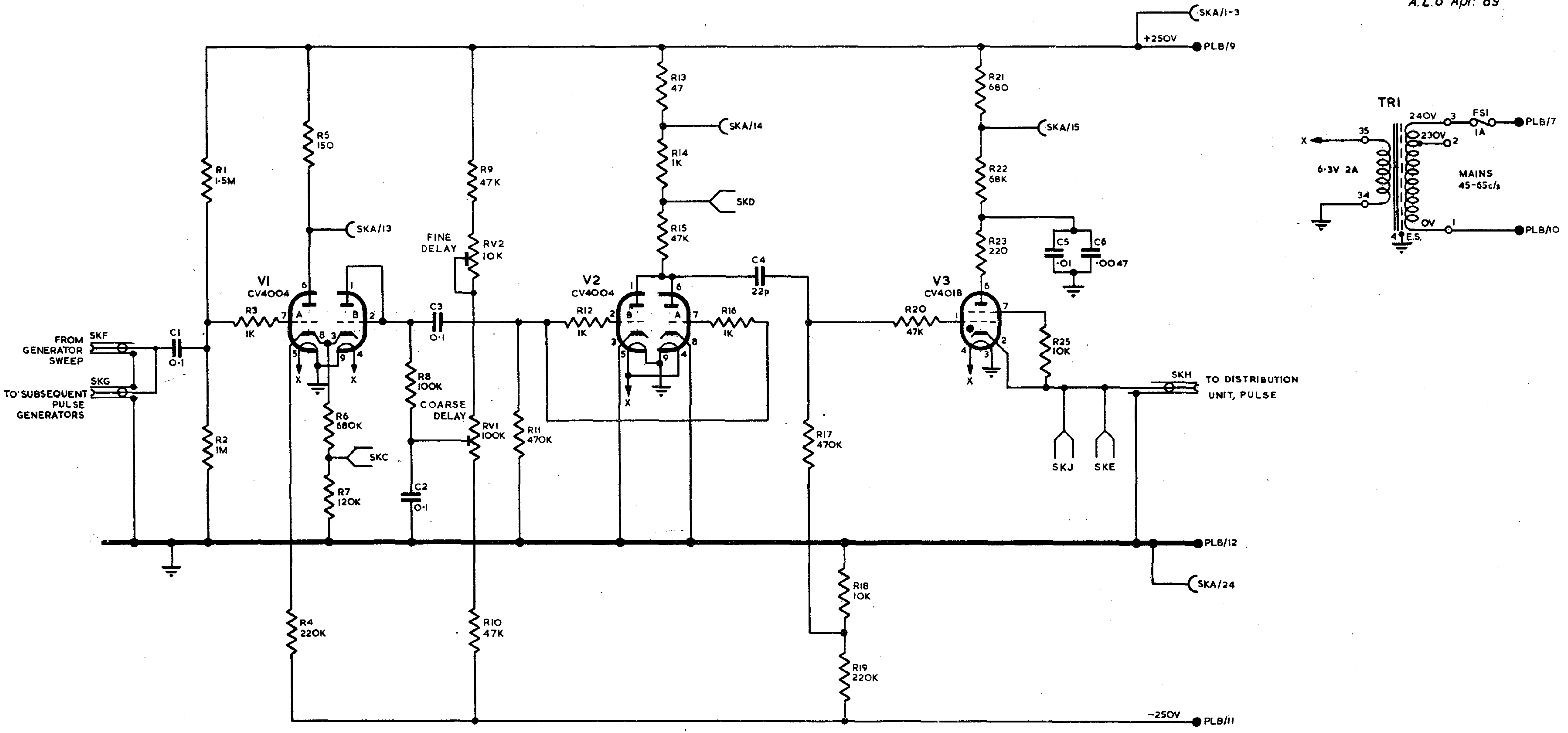


Fig.5

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Pulse generator 5840-99-999-9050: circuit

Fig.5

Chapter 8

CONTROL, GENERATOR PULSE UNITS 5840-99-948-9238 (MAIN) and 5840-99-948-9237 (STANDBY)

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INTRODUCTION

1. Between them the control, generator pulse (main) 5840-99-948-9238 and control, generator pulse (standby) 5840-99-948-9237 provide facilities for system control and for fault detection and consequent automatic changeover and indication.

GENERAL DESCRIPTION

2. The control, generator pulse (main) consists of a framework which provides mounting for eight plug-in sub-units. One of the sub-units, the oscillator, flywheel, forms part of the main timing chain; the remaining seven are concerned with fault monitoring in both the main and standby timing chains. The framework itself contains control and internal distribution circuits and components and indicators concerned with fault monitoring. It also provides interconnections to and between the sub-units.

3. The control, generator pulse (standby) is very similar to the main unit. Again it contains eight plug-in sub-units, including an oscillator, flywheel which forms part of the standby timing chain. Besides the circuits concerned with control, power distribution, indication, fault monitoring and changeover, and interconnections, it also contains a motor-driven goniometer and associated circuits. The goniometer is in series with the output from the oscillator, flywheel and allows the output from the standby timing chain to be aligned with that from the main timing chain.

4. Because the functions of the two control, generator pulse, units are so interleaved, they are both described in this single chapter. The subsequent description is arranged as follows:

(1) Mechanical description of both units.

(2) Circuit descriptions of the individual sub-units used in both the main and standby units. Full circuits of the main and standby frameworks are given but, apart from the goniometer and its associated circuits, descriptions of the framework circuit actions are deferred until the combined circuits are described (3).

(3) Combined circuits, under which heading the combined actions of the control, power distribution and fault monitoring circuits in both the main and standby units are described, are illustrated by composite schematic diagrams.

(4) Maintenance. The testing of the individual sub-units, using the test rig electrical, is described together with the test rig in Chap. 12; system fault location, by means

of the indication provided by the lamps on the control, generator pulse, units, is described in Chap. 1. A list of the voltage levels at the test sockets on the main and standby units is given at the end of this chapter, in Table 2.

MECHANICAL DESCRIPTION

Main frameworks

Control, generator pulse (main)

5. The framework of the control, generator pulse (main) consists of an open box frame to which are attached a front panel, a front framework and a recessed rear panel. The box frame is provided on each side with rails which locate with runners in the cabinet and are secured to them by means of six captive screws, three on each side. When the unit is slid home into the cabinet it is secured by two captive screws through the front panel. A group of fourteen test sockets, SKTP—SKTAC, are mounted on the right-hand side of the frame towards the front, while towards the rear on this same side the modification label is attached.

6. On the right-hand of the front panel (fig. 1) are mounted the SYSTEM STATE and equipment state indicator lamps and the control switches, except for the BY-PASS switch. The switches are incorporated in the lampholders and are operated by pushing the transparent cover over the holder concerned. Each lampholder provides mounting for up to four indicator lamps. Where a holder is concerned with the indication of only one state, the transparent cover is in one colour and two diagonally opposite lamps are used for indication. Where a lampholder is concerned with the indication of two states, the transparent cover is divided horizontally into two colours, and a pair of lamps, side-by-side, is used for each indication. Below these indicators and combined indicators and controls are mounted the PULSE GENERATOR ALIGNMENT test sockets SKT AN, AP and AQ.

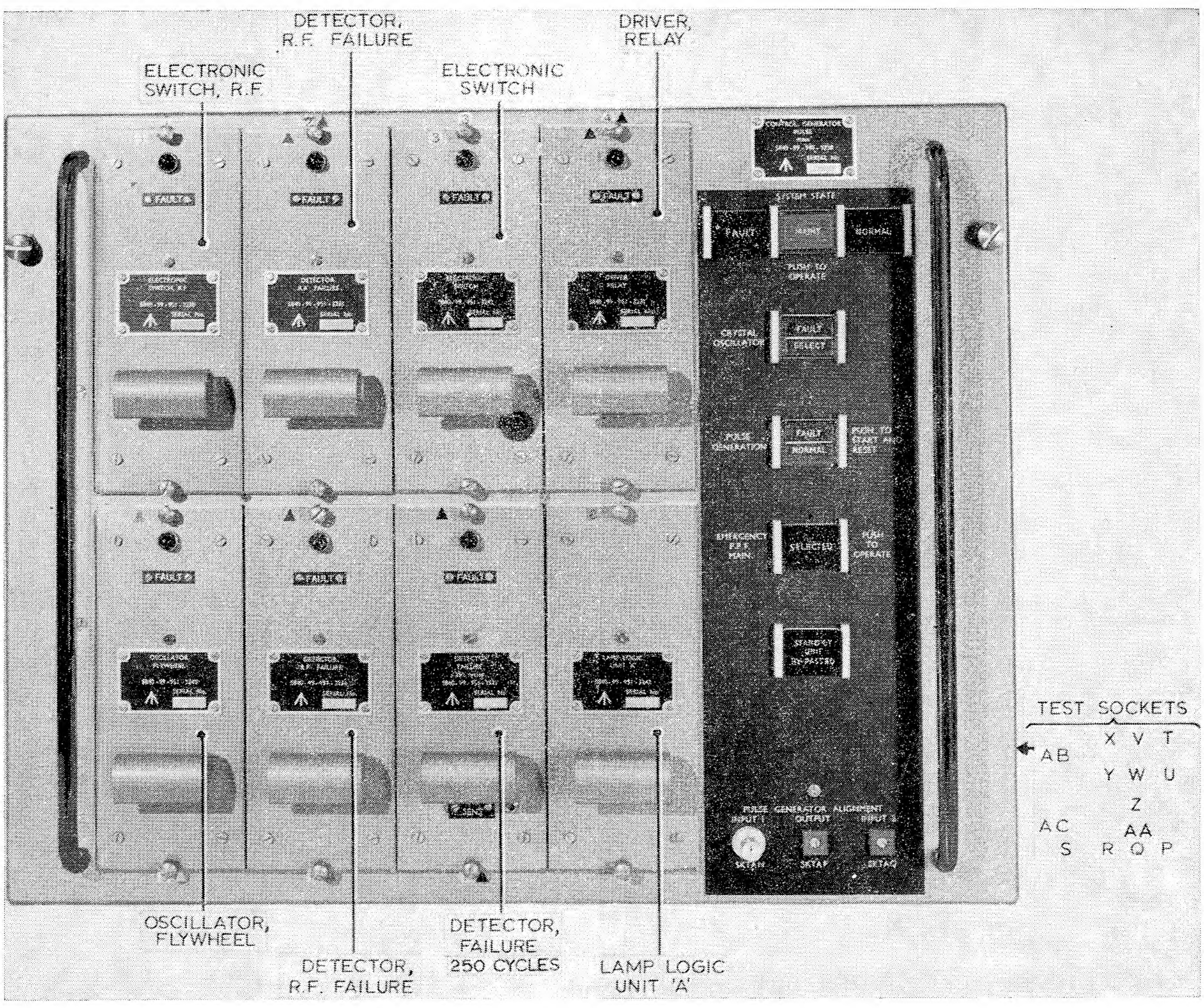

Fig. 1. Control, generator pulse (main): front view

7. The left-hand part of the front panel has two openings giving access to the front framework. This framework is divided into four compartments, each of which has guides for the location of two plug-in sub-units. Each sub-unit location is identified by a number (in red) which is stuck on to the front panel; the numbers run from 1 to 4 in the top row and from 5 to 8 in the bottom row, left to right in each case. 32-way edge connector sockets are mounted at the rear of each location to receive the pins of the plug-in units; one such socket is provided at each of locations 1 to 7 and two at location 8. The identities of these sockets are as follows:

(1) Top row:

Location:	1	2	3	4
SKT:	AD	AF	AH	AK

(2) Bottom row:

Location:	5	6	7	8
SKT:	AE	AG	AJ	AL & AM

8. In addition to the numbers, some locations bear a coloured triangle to assist in the location of types of sub-units used more than once in the equipment (para. 16). The colours of the triangles are as follows:

Location number	Triangle colour
2	Blue
4	Fuchsia
5	Yellow
6	Blue
7	Black

9. Off the right-hand side of the rear of the front framework are bracketed terminal strips, which carry various small components.

10. The rear panel (fig. 2) provides mounting for the external connectors SKTE—SKTN and PLA—PLD, for all of the relays, the BY-PASS switch SF, transformer T1 and the supply fuses FS1—FS4, and for diode MR22 which requires a heat sink. All wiring is on the inside, access to the connectors and fuses, and to the BY-PASS switch, being from the rear. The BY-PASS switch is mounted on stand-off pillars and is normally protected against misuse by a swivel cover which bears a warning notice. Components associated with relay protection are wired directly across the relay bases.

11. Connections between the front panel, front framework and rear panel are made through cableforms running around the bottom of the unit.

Control, generator pulse (standby)

12. The framework of the control, generator pulse (standby) is similar in construction and identical in dimensions to that of the control, generator pulse (main). The only differences that arise are occasioned by the differing components and types of sub-units that have to be accommodated.

13. Below the indicators and combined indicators and switches on the front panel of the stand-

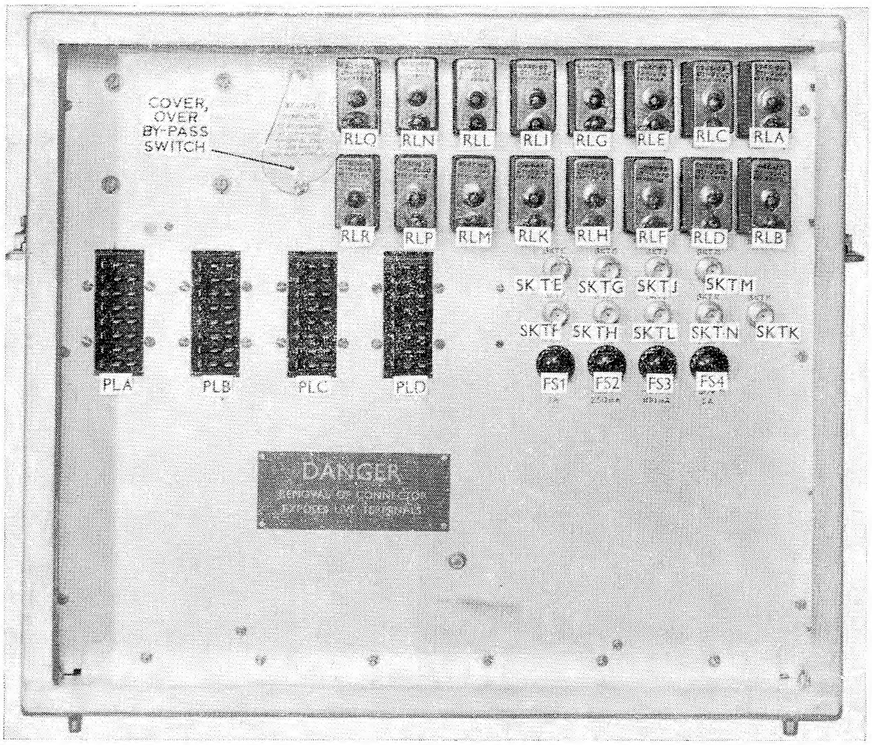

Fig. 2. Control, generator pulse (main): rear view

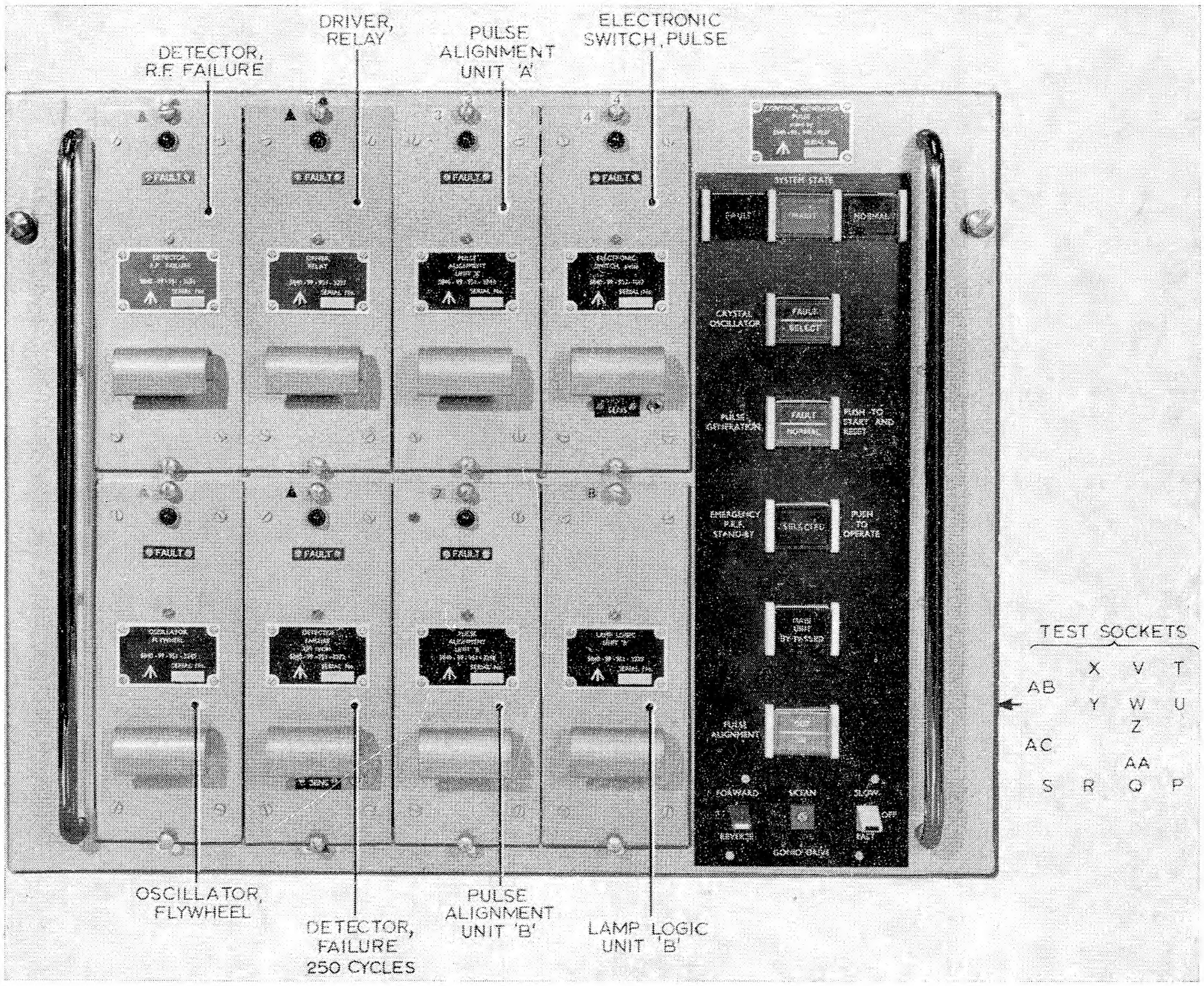

Fig. 3. Control, generator pulse (standby): front view

by unit (fig. 3) are mounted two key switches. These are the GONIO DRIVE controls SLOW/OFF/FAST and FORWARD/REVERSE; between them test socket SKT AN is mounted.

14. The colours of the triangles used to assist in sub-unit location at this standby unit are as follows:

Location number	Triangle colour
1	Blue
2	Fuchsia
5	Yellow
6	Black

15. As before the rear panel (fig. 4) carries the external connectors, relays, the BY-PASS switch, the heater and indicator supply transformer T1, the supply fuses and diode MR22. In addition it carries the goniometer, electrical, with its associated motor and gear-box and supply transformer, and the panel electronic circuit, 5840-99-951-1030 containing the input and output amplifiers for the goniometer. The goniometer and the motor with its integral gear-box are mounted on the inside of the panel, a flexible coupling drive being provided between the gear-box and the goniometer to take up mounting tolerances. The panel electronic circuit is mounted on the brackets above the goniometer. Connections to the motor are made via screw terminals at the base; those to the goniometer are made via coaxial sockets mounted on its body, and those to the panel electronic circuit are soldered to numbered terminals on the board.

Sub-units

16. Between them the main and standby units have 16 sub-units. Some types of sub-units are used at only one location, and these are identified by coloured numbers, red for those used in the main unit, and green for those used in the standby unit. Other types of sub-unit are used at more than one location, and these are identified by coloured triangles. A complete list of sub-unit Types, locations and identifications is given in Table 1.

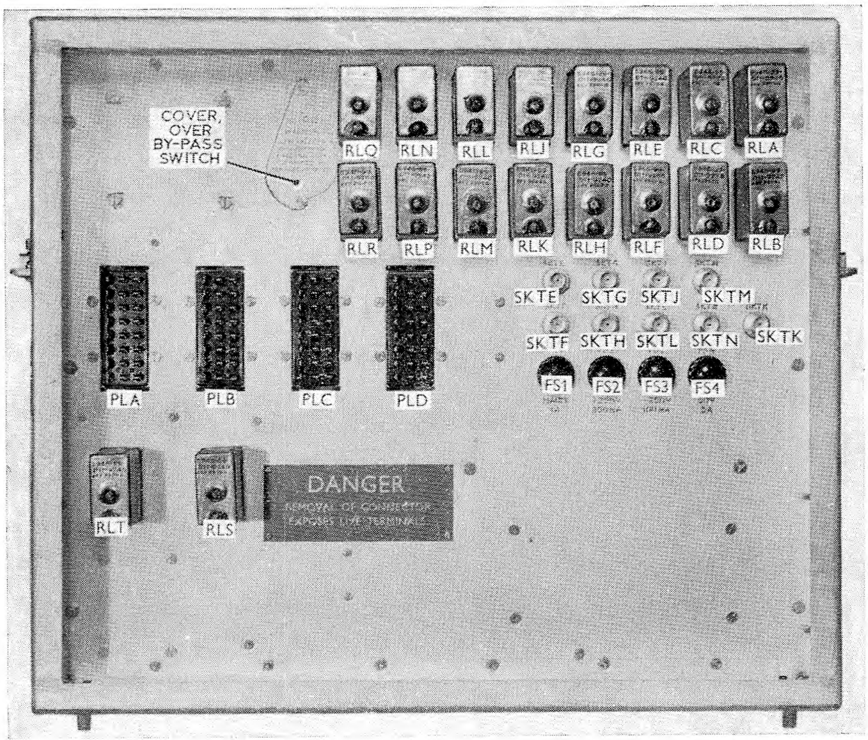

Fig. 4. Control, generator pulse (standby): rear view

TABLE 1

Sub-unit Types, locations and identification

Sub-unit title	N.S. number	Location		Identification
		Main unit	Standby unit	
Electronic switch, r.f.	5840-99-951-3238	1	—	1 (red)
Detector, r.f. failure	5840-99-951-3236	2 & 6	1	Δ (blue)
Electronic switch	5840-99-951-3242	3	—	3 (red)
Driver, relay	5840-99-951-3237	4	2	Δ (fuchsia)
Oscillator, flywheel	5840-99-951-3245	5	5	Δ (yellow)
Detector, failure 250 c/s	5840-99-951-3922	7	6	Δ (black)
Lamp logic unit 'A'	5840-99-951-3243	8	—	8 (red)
Pulse alignment unit 'A'	5840-99-951-3240	—	3	3 (green)
Pulse alignment unit 'B'	5840-99-951-3244	—	7	7 (green)
Electronic switch, pulse	5840-99-952-1017	—	4	4 (green)
Lamp logic unit 'B'	5840-99-951-3239	—	8	8 (green)

17. The basic construction of all the sub-units is identical, consisting of a framework of overall dimensions 7·05 in. height × 2·8 in. width × 4·5 in. depth (front to back), which is designed to provide mounting for either one or two panels electronic circuit. This framework is formed by a front panel to which is attached by means of channel section distance pieces, stood in from each corner, a smaller back-plate. Panels electronic circuit are then secured to the distance pieces on either or both sides, being mounted with the components on the inside and the printed wiring circuit on the outside; the edge connector pins incorporated in the panel project about 0·75 in. beyond the backplate of the framework. The sub-units locate in the main unit by means of flanges on the distance pieces, which engage with grooved runners on the main unit framework. When the sub-unit is pushed fully home, the edge connectors engage with their mating sockets and the sub-unit is secured by two captive screws through the front panel.

18. Side views of the various sub-units are given in figs. 5-11, 13-15, and 18. In practice only the lamp logic unit 'A' has two panels electronic circuit; the remaining sub-units have one each. Except for the two lamp logic units, 'A' and 'B', FAULT lamps (red) are mounted towards the top of each panel. Preset controls are all accessible from the front, being either mounted directly on the front panel, or mounted on the panel electronic circuit with access holes provided through the front panel.

CIRCUIT DESCRIPTION

Electronic switch, r.f., 5840-99-951-3238

19. The electronic switch r.f., whose circuit is shown on fig. 22, consists of two gated r.f. amplifiers, V1 and V2, whose outputs are developed across a common anode load consisting of transformer T1.

20. Input from the main crystal oscillator is fed in via pin 10 to the grid of V2, and from the standby crystal oscillator via pin 25 to the grid of V1. Both of these inputs are at half crystal frequency. Gating inputs, pin 13 for V2 and pin 30 for V1, are derived from the electronic switch. The alternative states of the circuits are as follows:—

(1) Main crystal oscillator selected:

(a) Input pin 13 = 0V, V2 conducting.
(b) Input pin 30 = 15V, V1 cut off.

(2) Standby crystal oscillator selected:

(a) Input pin 13 = −15V, V2 cut off.
(b) Input pin 30 = 0V, V1 conducting.

21. Whichever valve is conducting, its r.f. input is amplified and output is developed across T1 secondary between pin 6 and earth. The Q of the circuit is sufficient to maintain output for the period of changeover from main to standby or vice versa. The rectifying circuit MR1, R11, C8

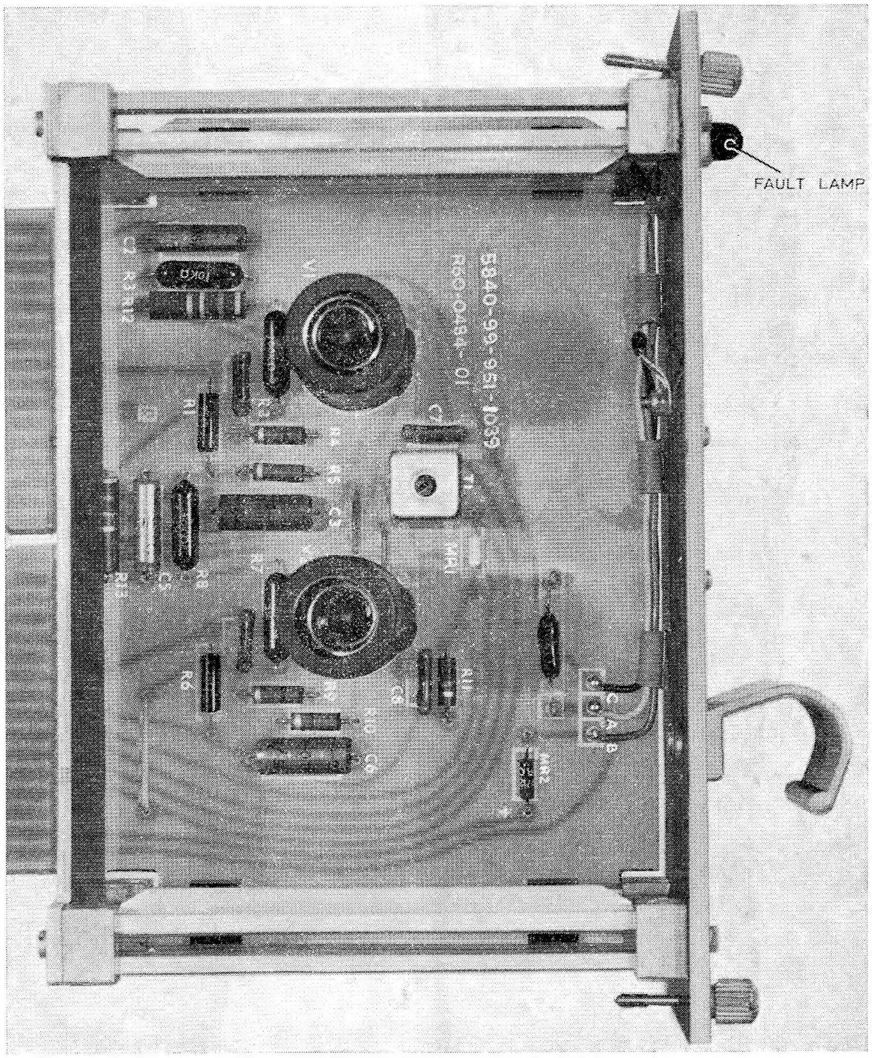

Fig. 5. Electronic switch, r.f.: side view

associated with the secondary of T1 is used to produce a d.c. level for test and setting up purposes.

22. In the event of failure or removal of the electronic switch, such that the gating inputs were open circuit, the bias on V1 and V2 is arranged to be near cut off, so that no significant output is produced.

23. A unit fault lamp circuit is provided on the unit, consisting of ILP1, MR2 and R14, which is controlled externally.

Detector, r.f. failure, 5840-99-951-3236

24. The function of this unit, a circuit of which is given on fig. 23, is to monitor an r.f. sine wave and give information as to its presence or absence, and also to provide evidence that the detector itself remains serviceable.

25. Valve V1b is concerned with monitoring the r.f. input at pin 29 and has an external anode load consisting of a relay. Initially, with no r.f. present, the cathode of V1b is at −7V derived from the potential divider R6, MR4, R7 between −250V and earth; MR3 is non-conducting. The grid is at −10V derived from the junction R3, R4. Output, through MR4 conducting, is at about −7V. The external relay is de-energized.

26. When the normal r.f. input of 4V peak-to-peak appears, it is superimposed on the −10V static level by the action of diode MR2, that is, the input to MR1 fluctuates between −10V and −6V. This is rectified by MR1 in conjunction with R2 and C4, and as the voltage across C4 rises offsetting the bias, so the voltage at the cathode follows and is fed back via R3 and speed-up capacitor C2 to reduce the bias. The effect is cumulative and the circuit rapidly reaches a stable state with the voltage across C4 equal to the peak to peak r.f. input, V1b conducting through R5 and MR3 to earth and its cathode a few volts positive. Diode MR4 is non-conducting, output is therefore at 0V, the external relay is energized. Should the r.f. input fail, the circuit will quickly change back to its initial state again assisted by the positive feedback provided.

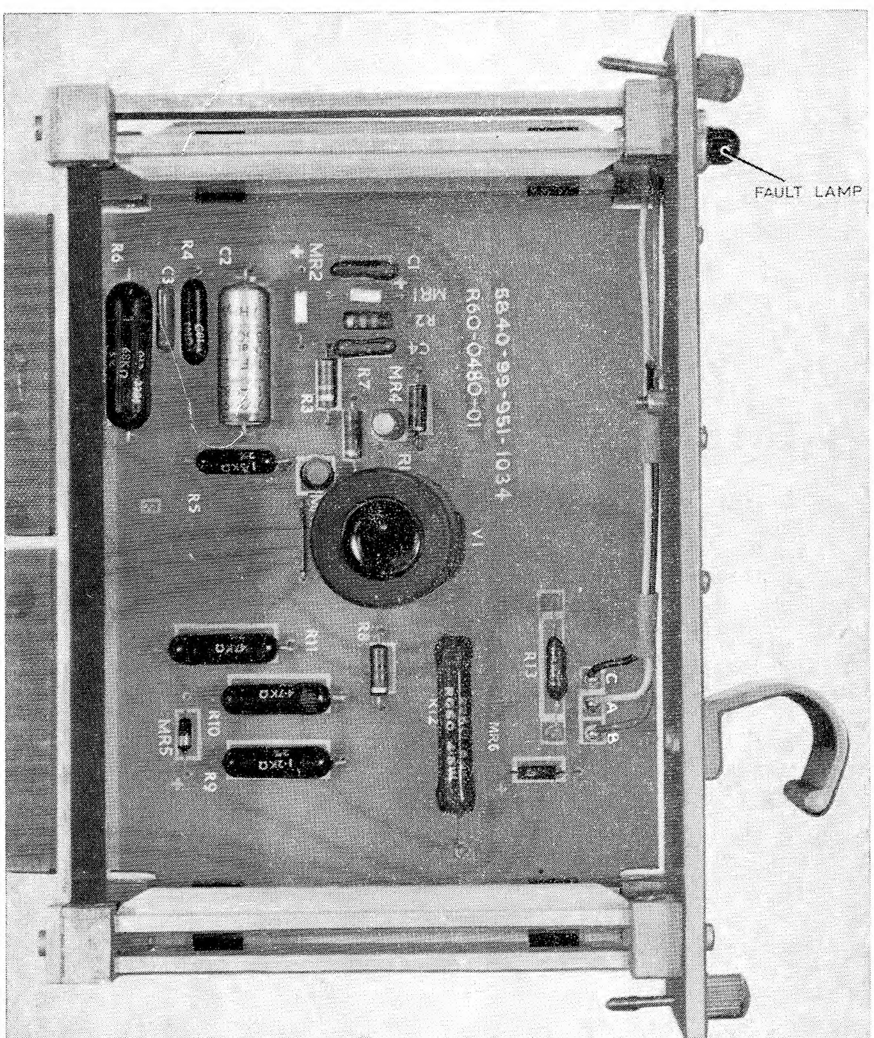

Fig. 6. Detector, r.f. failure: side view

27. The fact that the positive and negative h.t. supplies and the heater supply are actually present within the unit is accepted as evidence of its continued functioning. This evidence is provided by V1a which is connected, through an external relay anode load, between +250V and −250V. The grid is returned to a potential of −1V derived from the junction R9, R10, the potential across these two resistors being stabilized at −5·6V by Zener diode MR5. With all three supplies present the external relay is energized; with any supply absent the relay is de-energized.

28. The input and output conditions of the unit are:—

(1) R.F. input

(a) Normal, r.f. input present at pin 29. Output at pin 23 is then at 0V, the external relay connected to pin 24 is energized.
(b) Fault, r.f. input absent from pin 29. Output at pin 23 is then at −7V; the external relay is de-energized.

(2) Power supplies

(a) Normal, all supplies present. The external relay connected to pin 10 is energized.
(b) Fault, any supply absent. The external relay is de-energized.

29. A fault circuit, consisting of ILP1, MR6 and R13, is provided at the unit and is controlled externally.

Electronic switch, 5840-99-951-3242

30. The electronic switch is provided with information, obtained in each case from a detector, r.f. failure, as to whether or not the main and standby crystal oscillators are functioning. Acting on this information, the unit sends out switching voltages to the gates in the electronic

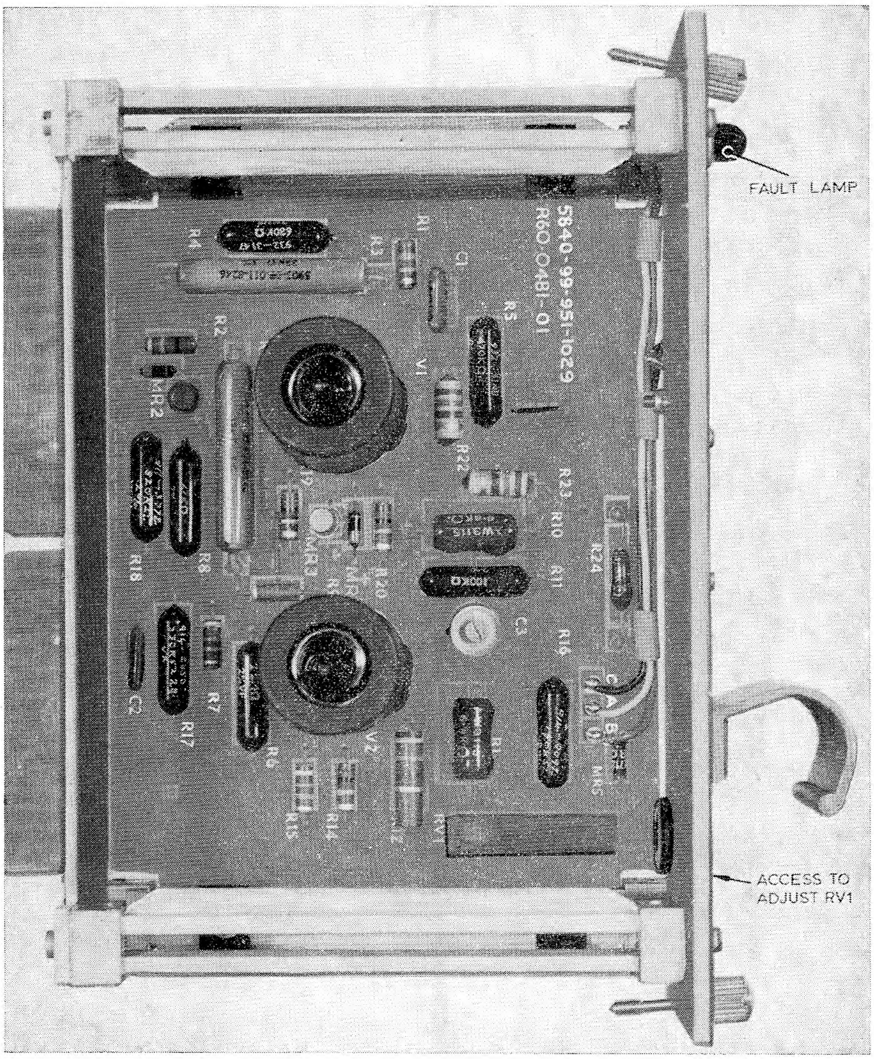

Fig. 7. Electronic switch: side view

switch, r.f. which determine whether the output from the main crystal oscillator or that from the standby crystal oscillator is fed to both the main and standby flywheel oscillators. The unit also provides evidence of its own serviceability.

31. The circuit of the unit is shown on fig. 24. The halves of V2 are connected as a monostable circuit, with triggering input at pin 10 derived from monitoring the state of the main crystal oscillator and that at pin 7 derived from the standby. In both cases 0V represents normal operation and −7V represents fault. The bias on the grid of V2b is derived from the slider of variable resistor RV1. Feedback from the anode of V2b is coupled to the grid of V2a via R11, RV1 and R14. A variable speed-up capacitor is provided across R11 and is set to give the minimum changeover time.

32. As determined by the fixed bias on V2b and the setting of RV1, the circuit is adjusted to fulfill the following conditions:—

(1) With no input at either pin 10 or pin 7, V2b conducting, V2a cut off.

(2) With 0V at pin 10 and 0V or −7V at pin 7, V2b conducting, V2a cut off.

(3) With −7V at pin 10 and 0V at pin 7, V2b cut off, V2a conducting.

33. Output from the anode of V2b is fed out through cathode follower V1a to pin 26; that from V2a through cathode follower V1b to pin 20. Outputs are limited in the positive direction to +0·7V by diodes, and in the negative direction to −15V by Zener diodes. The output conditions for the unit can be summarized as:

(1) Main crystal oscillator normal or no input information: output pin 20 = 0V, pin 26 = −15V.

(2) Main crystal oscillator faulty and standby crystal oscillator normal: output pin 20 = −15V, pin 26 = 0V.

34. Evidence of the continued serviceability of the electronic switch is provided by two external relays. One relay is connected in parallel (between pin 6 and +250V) with R23 as a common

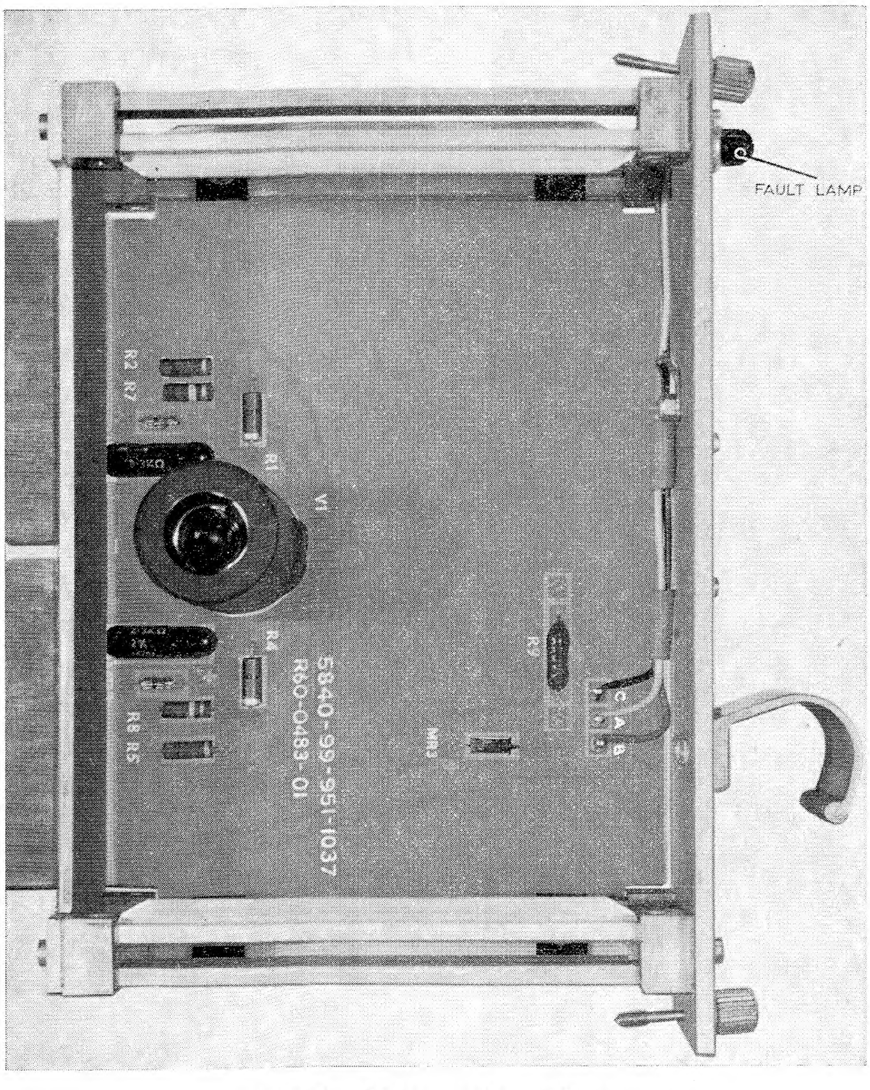

Fig. 8. Driver, relay: side view

anode load to V2a and V2b, and as long as at least one of them is conducting this relay remains energized; if both fail to conduct, the relay is de-energized. The other relay is connected across R22 (between pin 27 and +250V) and fulfills a similar function for V1a and V1b.

35. Lamp ILP1, diode MR5 and resistor R24 provide a fault indication circuit, which is controlled externally.

Driver, relay, 5840-99-951-3237

36. The circuit of the driver, relay, is given in fig. 25. The circuit consists of the double triode V1a and V1b, the halves of which are used as switches to drive relays which are connected as external anode loads between pin 23 and +250V for V1a, and between pin 10 and +250V for V1b. Each triode is provided with two alternative inputs, only one of each (pins 24 and 9) being used in the present application. These inputs are derived either from the electronic switch or from simulated switching voltages. The conditions of input and output are:

(1) Main crystal oscillator selected:

(a) Input pin 24 at 0V, V1a conducting, external relay pin 23 energized.

(b) Input pin 9 at −15V (or −30V simulated), V1b cut off, external relay pin 10 de-energized.

(2) Standby crystal oscillator selected:

(a) Input pin 24 at −15V (or −30V simulated), V1a cut off, external relay pin 23 de-energized.

(b) Input pin 9 at 0V, V1b conducting, external relay pin 10 energized.

37. Lamp ILP1, diode MR3 and resistor R9 provide a fault indication circuit, which is controlled externally.

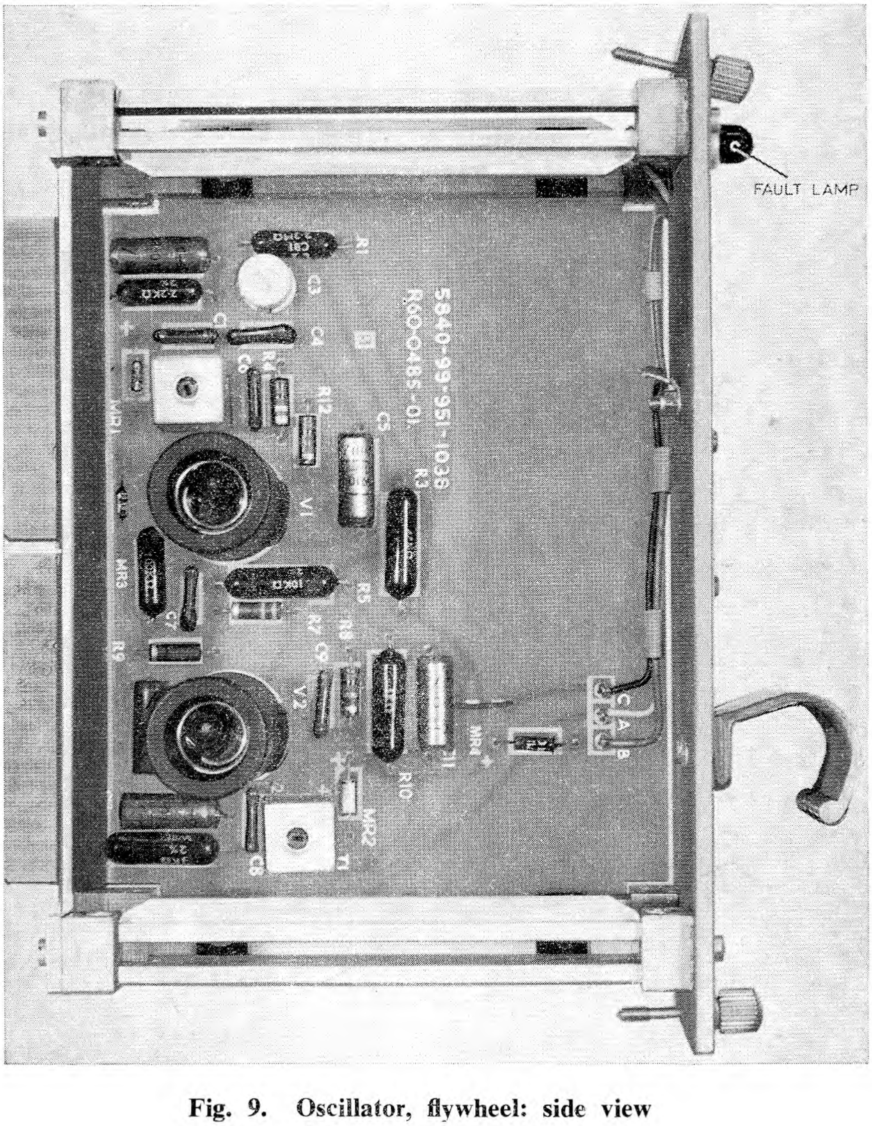

Fig. 9. Oscillator, flywheel: side view

Oscillator, flywheel, 5840-99-951-3245

38. The oscillator, flywheel (circuit, fig. 26) consists of a Hartley oscillator stage V1, followed by a tuned amplifier stage V2. The oscillator is comparatively broad band, functioning over a range of about 100 kc/s, and is tuned to the nominal half frequency of the crystal in use.

39. With normal operation, r.f. input at half crystal frequency is present at pin 25; V1 then functions as a synchronous oscillator locked to and following the half crystal frequency. Should the r.f. input fail, the oscillator continues to function, running freely at its pre-tuned frequency. Automatic p.r.f. control is of course discontinued under this last condition.

40. Whichever mode of oscillation is in force, output from the unit is stabilized by the use of the limiting diode MR1 in the grid circuit of the oscillator.

41. From the anode of V1 the r.f. is fed to the grid of the tuned amplifier V2. A gating input to this valve is also brought in, via pin 23 and diode MR3; with this input at 0V or open circuit V2 functions normally; with the input at −7V, V2 is cut off and r.f. output is inhibited. From the secondary of T1 the r.f. passes out via pin 7, and is also rectified by diode MR3, in conjunction with R8 and C9, to provide at pin 30 a d.c. level for test purposes.

42. A fault lamp circuit, ILP1, MR4, is provided on the unit, and is controlled externally.

Detector, failure 250 c/s, 5840-99-951-3922

43. This unit, the circuit of which is shown on fig. 27, serves three functions:

(1) To monitor the 250 c/s pulse output from the divider unit and to give information as to its presence or absence.

(2) To receive information from the pulse alignment units in the control, generator pulse (standby) and translate this into alignment or misalignment action.

(3) To receive information from the electronic switch, pulse in the control, generator

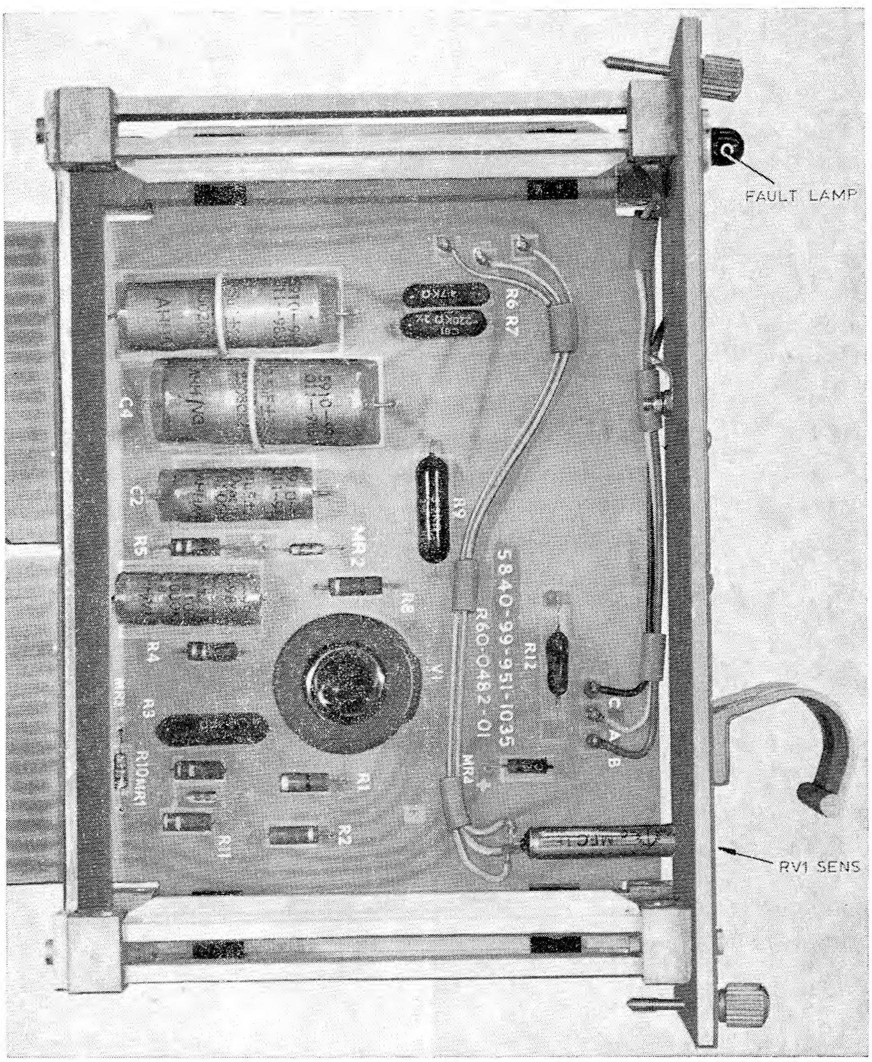

Fig. 10. Detector, failure 250 c/s: side view

pulse (standby) and to translate this into alignment pulses present or missing action.

44. Valve V1a, whose external anode load is a relay coil between pin 26 and +250V is concerned with the first of the functions listed in para. 43. The circuit is set up by means of variable resistor RV1 so that:

(1) With 250 c/s input at pin 11 absent, the current through V1a is insufficient to energize the external relay.

(2) With 250 c/s input at pin 11 present and peak rectified by MR2 in conjunction with R5 and C2, the rise in grid voltage is sufficient to cause the external relay to be energized.

45. Both the second and third functions are accomplished through V1b, whose external anode load is a relay coil connected between pin 8 and +250V. The input and output conditions are:

(1) Normal operation, input pin 7 at +30V, input pin 3 at 0V, V1b is then conducting and the external relay is energized.

(2) Fault operation, inputs at pins 7 and 3 both at 0V. V1b is then cut off and the external relay is de-energized.

(3) Fault operation can be overridden by +30V applied to pin 3 from the output of the electronic switch, pulse. Under these conditions, input pin 7 at 0V, input pin 3 at +30V, V1b conducts and the external relay remains energized.

46. In the present applications of the detector, failure 250 c/s, input pins 4 and 6 are not used. A fault circuit is provided, consisting of ILP1, MR4 and R12, which is controlled externally.

Pulse alignment unit 'A', 5840-99-951-3240

47. Verification of the alignment, in time, of the −8 microsecond main and standby pulses is accomplished through pulse alignment units 'A' and 'B'. At unit 'A' (circuit, fig. 28) the

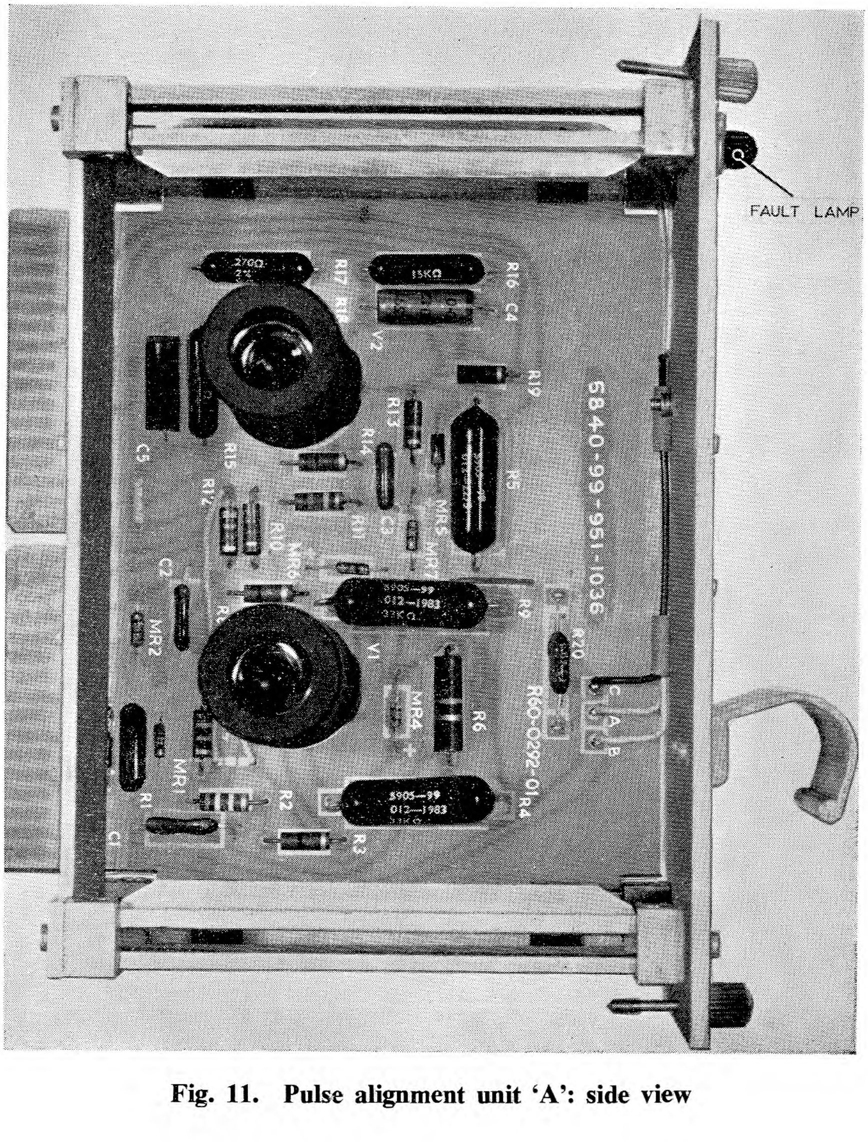

Fig. 11. Pulse alignment unit 'A': side view

main −8 microsecond pulses, 4 μs wide and at a p.r.f. of about 250 p.p.s., are fed via pin 7 and the differentiating circuit C1, R2, to the grid of cathode follower V1a. Output from the cathode of this valve, inserted as an impedance matching stage, passes to diode MR4 which, together with MR6, forms a coincidence gate. Diode MR6 is similarly fed with the differentiated standby pulses, via pin 13, C2 and V1b. The grids of V1a and V1b are returned to a potential of −9V, derived from the junction of resistors R10 and R12.

48. In the absence of pulse input, the cathodes of V1a and V1b are at about −8V and diodes MR4 and MR6 are both conducting. Diode MR7 is therefore non-conducting, with its anode negative and its cathode returned to earth. Positive-going input to either V1a or V1b raises their cathode voltage, but only when both are raised does MR7 pass the pulse on to the cathode coupled non-inverting output amplifier V2. This is illustrated by the waveforms given on fig. 12. The purpose of the differentiating circuits before the gate is to increase the sensitivity of the unit to the point where it will detect misalignment of as little as 1 μs.

49. Diodes MR1 and MR2 in the input circuit combine to produce a pulse output at pin 9 as long as either main or standby input is present. This is used as a synchronizing input for an oscilloscope during testing. Zener diode MR3 limits the output to 15V, and thereby cleans up the top of the waveform.

50. Lamp ILP1 and resistor R20 provide the unit lamp fault circuit, which, in use, is connected in series with that of pulse alignment unit 'B'.

Pulse alignment unit 'B', 5840-99-951-3244

51.◀Pulses passed by the output amplifier V2 of unit 'A' are fed via pin 26 of that unit to input pin 3 of pulse alignment unit 'B'. The amplitude of these pulses is limited to +30V by Zener diode MR30, connected between pin 26 of unit 'A' and earth, external to the unit (fig. 36). The circuit of unit 'B', shown on fig. 29, consists of a pulse broadener, V1a, V1b, followed by an integrator.▶

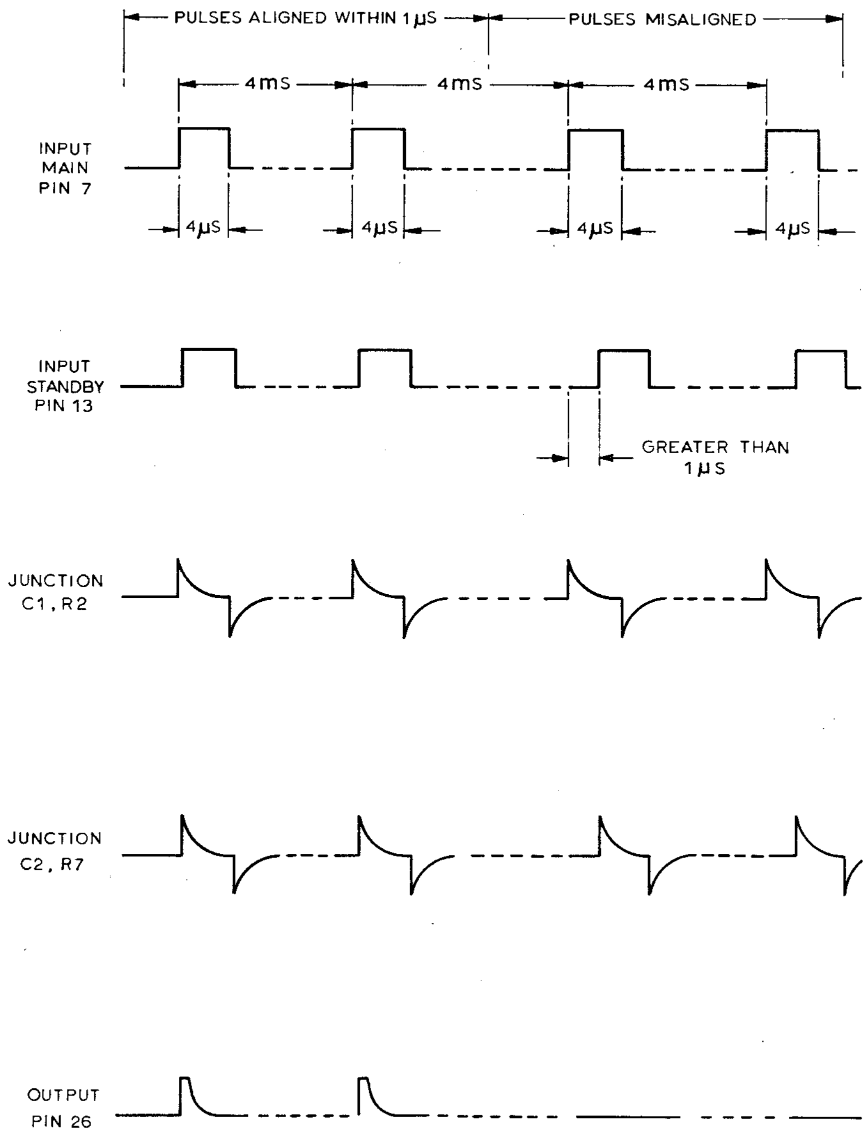

Fig. 12. Pulse alignment unit 'A': waveforms

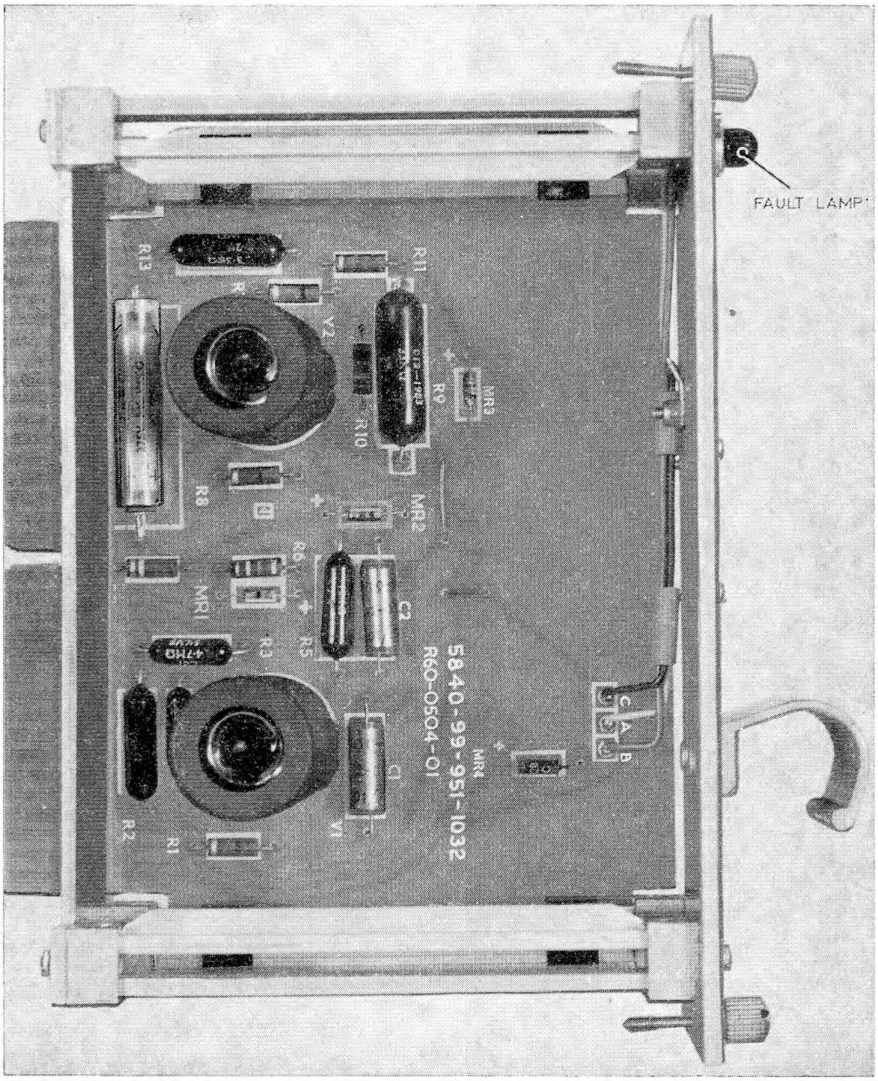

Fig. 13. Pulse alignment unit 'B': side view

MR2, C3, R7, which feeds a twin output stage consisting of a cathode follower, V2a, and a relay driver, V2b. The relay driven by V2b is external to the unit, being connected between +250V and pin 30.

52. Valves V1a and V1b are connected in a monostable circuit. The stable state is with V1a cut off and V2b conducting. The unstable state, initiated by a positive pulse on the grid of V1a, is designed to last for about 2 ms and is controlled by the time constant of R3 and C1.

53. In the absence of pulse input at pin 3, the monostable circuit remains in its stable state, output isolating diode MR3 is non-conducting, V2b is cut off and the external relay is de-energized.

54. With alignment pulse input present at pin 3, the monostable circuit is triggered at a p.r.f. of about 250 p.p.s. The resultant square wave of frequency about 250 c/s and mark : space ratio about 1 : 1, is capacitively coupled to the integrator circuit and is d.c. restored with respect to earth by MR1. As a result of integration, a d.c. level is produced at the grid of V2a, causing its cathode to rise to about +30V; this level is fed out via MR3. At the same time the rise in voltage at the cathode of V2a is passed on to the grid of V2b, causing it to conduct and the external relay to be energized.

55. Summarizing the overall conditions of the pulse alignments units 'A' and 'B', they are:

(1) With main and standby pulse alignment worse that 1 μs, or with main or standby or both pulses missing; output at pin 29 is open circuit, the external relay (pin 30) is de-energized.

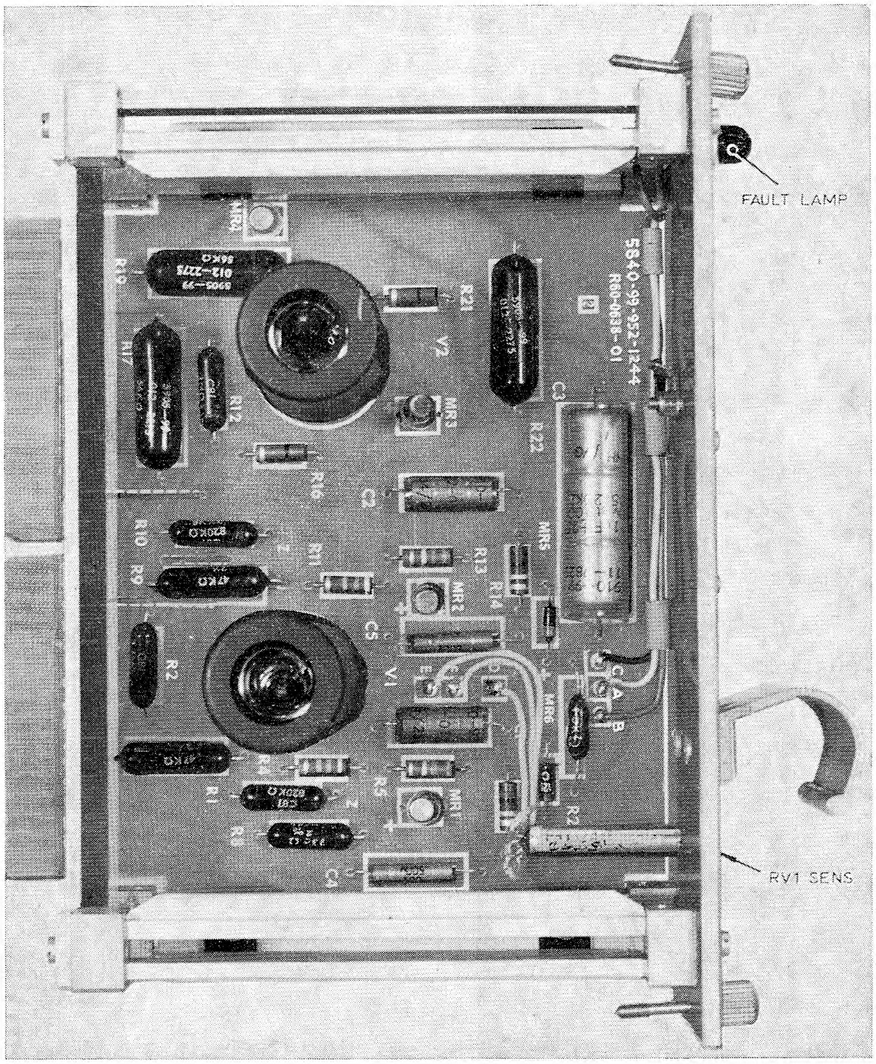

Fig. 14. Electronic switch, pulse: side view

(2) With main and standby pulse alignment within 1 μs; output at pin 29 is +30V, the external relay is energized.

56. A fault lamp circuit is provided, consisting of ILP1 and MR4. This is connected in series with that of pulse alignment unit 'A' and controlled externally.

Electronic switch, pulse, 5840-99-952-1017

57. The electronic switch, pulse (circuit, fig. 30) contains two separate but identical circuits; one, consisting of V1a and V2b, concerned with monitoring the presence of the −8 microsecond pulse from the main cathode follower unit, and the other, consisting of V1b and V2a, with monitoring the equivalent output from the standby cathode follower unit. Valves 2a and 2b are provided with a common external anode load, consisting of the coil of a relay which is connected between +250V and pin 13; this relay is concerned with the serviceability of the unit itself.

58. In the absence of main pulse input at pin 3, V1a is cut off, its grid being returned to a voltage of −8·2V, derived from the junction of Zener diode MR5 with R22. Output at pin 20 from the cathode of V2b is then at +30V. When the 5 μs wide, 250 p.p.s. (approximately) input is present, it is peak rectified by MR1 in conjunction with C1 and R5, and causes the voltage at the grid of V1a to rise. As a result, the voltage at the cathode of V2b falls and the output at pin 20 is clamped through MR4 to earth.

59. The action of V1b in conjunction with V2a is identical, input for this circuit being the standby pulses. Summarizing the input and output conditions for the unit, they are:—

(1) Main pulse input at pin 3:

(a) Pulses present; output at pin 20 = 0V.

(b) Pulses absent; output at pin 20 = +30V.

(2) Standby pulse input at pin 4:

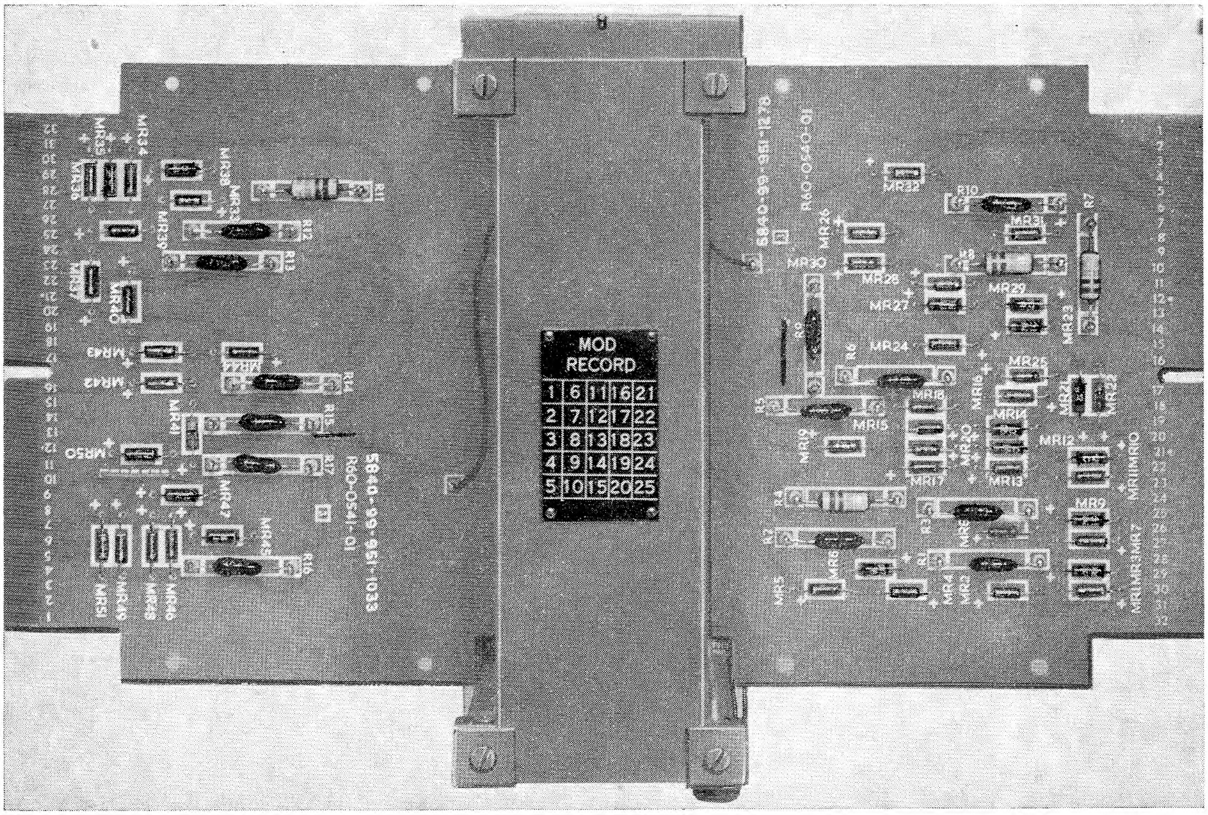

Fig. 15. Lamp logic unit 'A': view, boards opened out

(a) Pulses present; output at pin 11 = 0V.

(b) Pulses absent; output at pin 11 = +30V.

60. Should V1 fail the inputs to V2a and V2b both rise to their most positive level, and outputs at pins 11 and 20 are both at +30V. The external relay connected as the common anode load of V2a and V2b gives warning of this condition. As long as only either V2a or V2b is conducting at one time, the relay remains de-energized; if V2a and V2b conduct at the same time, indicating a failure of V1 or the absence of both pulse inputs, the relay is energized.

61. The unit fault lamp circuit comprises ILP1, MR6 and R23, and is controlled externally.

Lamp logic unit 'A', 5840-99-951-3243

62. The control of the lighting of the fault lamps on the various sub-units of the control, generator pulse (main), and the energization of fault relays is accomplished through logic circuits consisting of the interconnection of relay contacts and of diode gates. The diode gates are made up on two panels electronic circuit which are contained in the lamp logic unit 'A'. The circuit of this unit is shown on fig. 31.

63. Describing the circuit in general terms, two basic configurations of diodes are used, one to form AND-gates and the other to form OR-gates. These configurations are illustrated on fig. 16.

64. Taking first the AND-gate, if all inputs are in the fault state (open-circuit) diodes D1 to D3 are non-conducting and output at A is at earth. If any one or more input is in the normal state (−50V) the associated diode(s) conduct and output at A is −50V. This output at A is either fed out to the fault lamps at the units (earth = fault, lamp lit; −50V = normal, lamp unlit) or used as one input of an OR-gate. The load resistance R of the gate is sometimes internal, sometimes external (part of the lamp circuit) and sometimes a combination of both.

65. Taking now the OR-gate, the load for this is external, consisting of a relay coil between it and the −50V supply. With any one or more input at earth the associated diode(s) conduct and output at B is at earth (relay energized). Only if all inputs are at −50V is output at B −50V and the relay de-energized.

66. The full logic of the unit is shown on fig. 17. It consists of a series of AND-gates and OR-gates of the kinds described, with varying numbers of inputs.

67. Diodes MR1, 3, 4, 6, 7, 9, 16 and 31 on board −1278 are used as buffers; where they are used as parts of gate circuits they are not shown separately; where they are used simply to buffer signals passing through the unit (as with MR3, 6, 9) they are identified, to distinguish between these and direct connections. All of the gates and buffers are identified on the diagram by a number prefixed by the letter G (G1 to G17) which are used as references for the later descriptions of fault action and indication. Input pin 20 to board −1278 is not used, nor therefore are diodes MR19 and MR20.

Lamp logic unit 'B', 5840-99-951-3239

68. Lamp logic unit 'B' performs a similar function in the control, generator pulse (standby) to that performed by the lamp logic unit 'A' in the control, generator pulse (main).

69. As can be seen from the circuit of the unit (fig. 32) similar circuit configurations are used. The logic is shown on fig. 19, the individual gates being referenced by the letter and number combinations G18 to G25. Output pin 18 is not used, nor therefore is diode MR17.

Main frameworks

70. The circuit of the main framework of the control, generator pulse (main) is shown on fig. 34, whilst a component location diagram is given on fig. 33; equivalent diagrams for the standby unit are given on figs. 36 and 35. Apart from the goniometer, electrical and its associated circuits, which are contained in the standby unit, the framework circuits are described under the heading combined circuits (para. 77), where their actions in conjunction with the plug-in sub-units are described.

Goniometer, electrical and motor

71. The goniometer (fig. 36) is used as a continuously variable phase shifting device in series between the output from the standby flywheel oscillator and the input to the standby divider

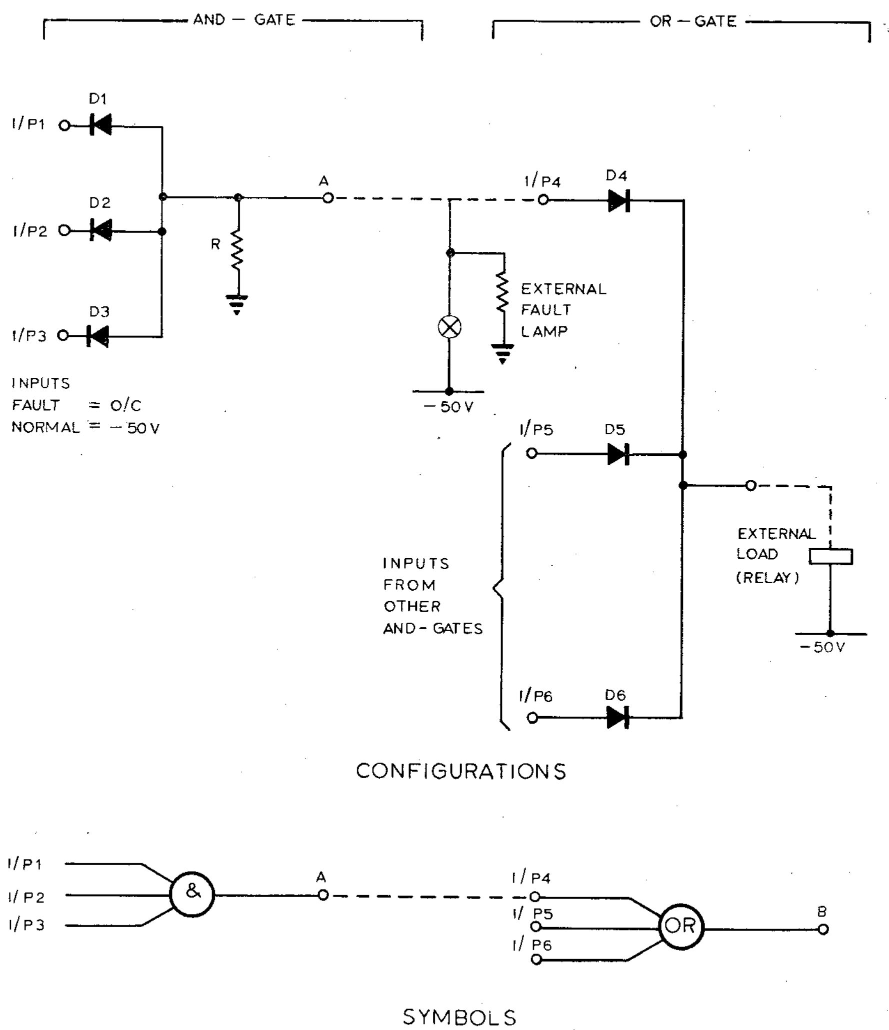

Fig. 16. Lamp logic unit 'A': circuit configurations

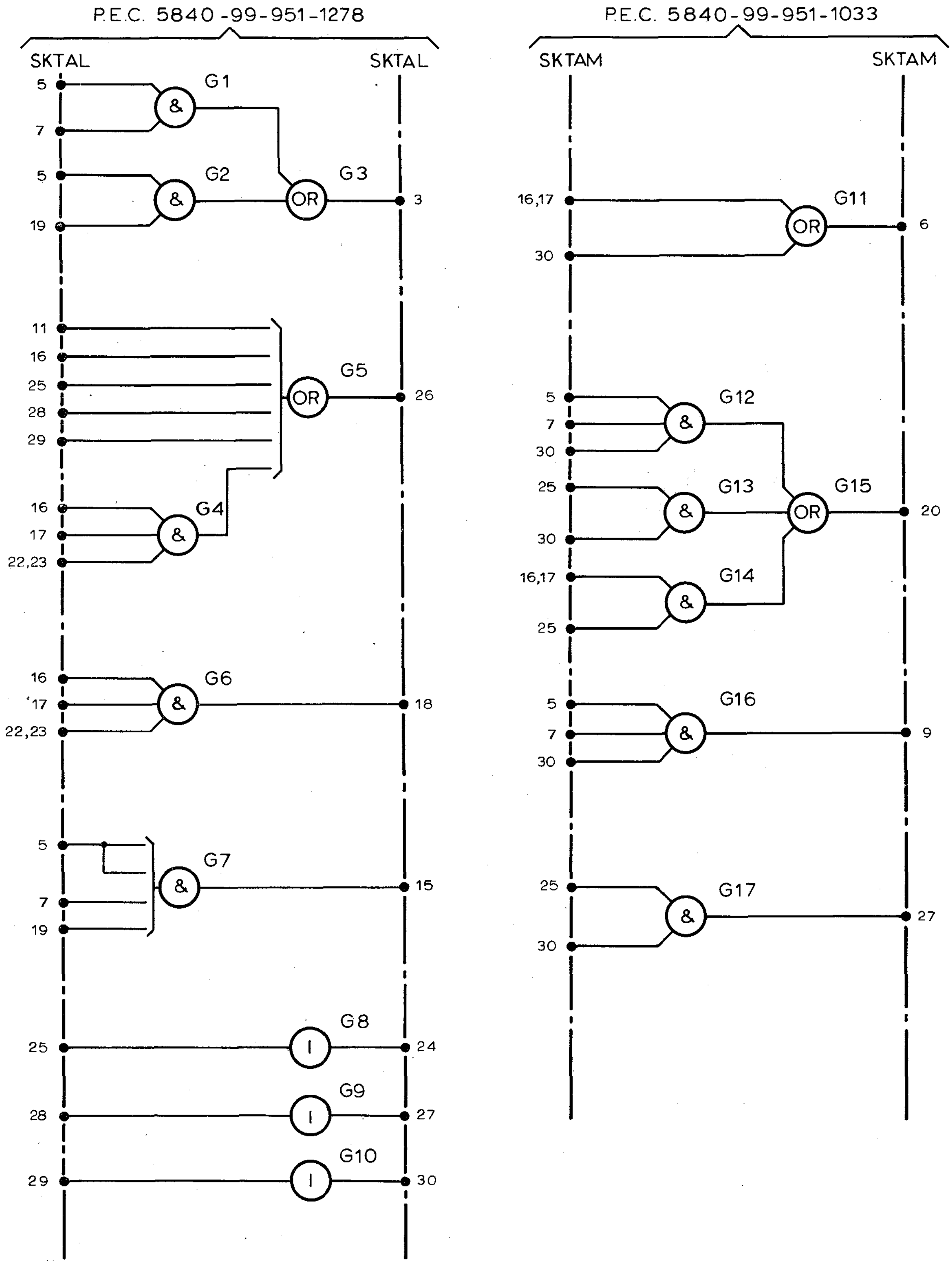

Fig. 17. Lamp logic unit 'A': logic diagram

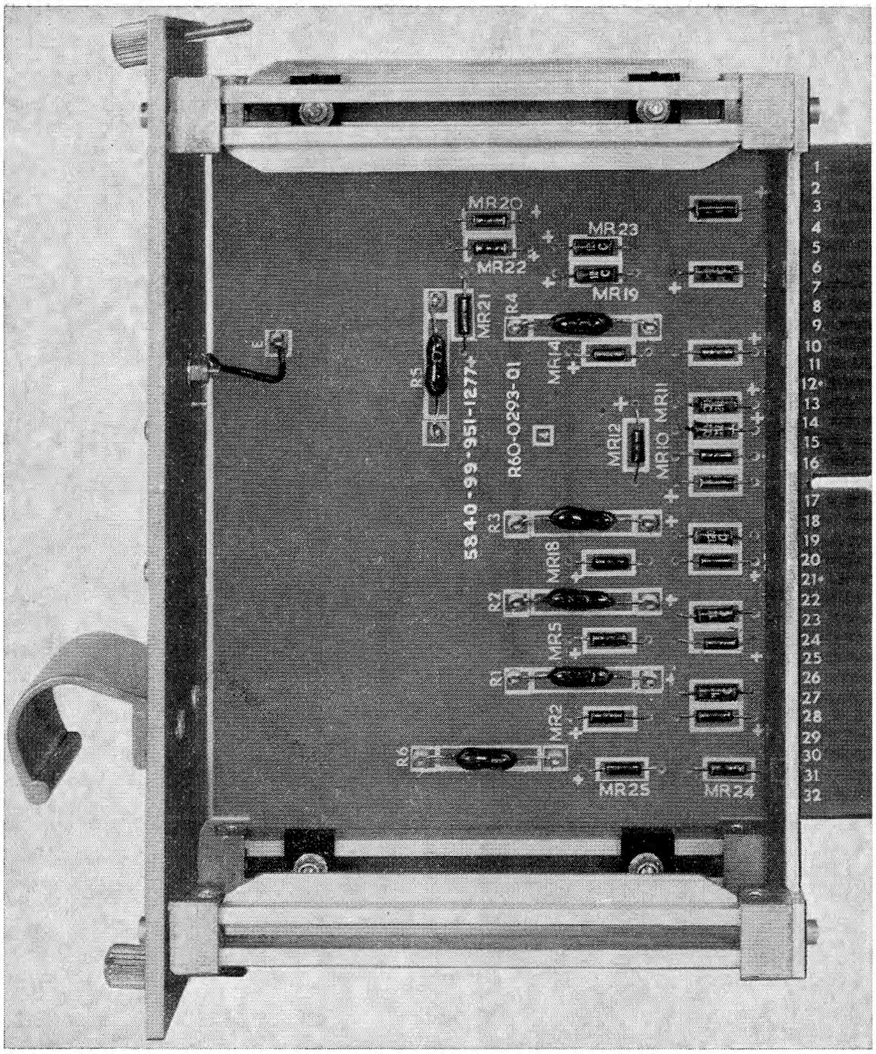

Fig. 18. Lamp logic unit 'B': side view

unit. By this means the basic (un-delayed) pulses in the standby timing chain can be brought into alignment with those in the main timing chain. The function of a goniometer used for such a purpose is explained in the Inter-Services Radar Manual, A.P.1093E.

72. A single-phase fractional horsepower motor (fig. 36) is used to drive the goniometer, through a 10 : 1 reduction gear-box. The direction of drive may be reversed by reversing the relative phase of the input to winding 2, 4 compared to that at 1, 3. This is done by operating relay RLS which is controlled by switch SE (para. 117). Switch SD (para. 117) controls the speed of rotation.

Panel electronic circuit, 5840-99-951-1030

73. This unit, component location fig. 20, circuit fig. 37, contains the drive and output circuits for the goniometer, electrical.

74. Input, via the flywheel oscillator, at half-crystal frequency is fed in across pins 14 and 15 (earth) to two phase changing circuits which consist of R-C phase changing networks and cathode followers.

75. Outputs at pins 10 and 11, and 8 and 9, are 90° out of phase with each other (leading and lagging by 45° on the input) and are taken to the two stator coils of the goniometer.

76. The returning signal from the goniometer rotor enters the unit across pins 6 and 7 (earth) and is amplified by V3, whose anode load is the tuned transformer T1. Output from the secondary of T1 is fed via pin 2 to the standby divider unit; it is also rectified by diode MR1 in conjunction with C7 and R13, to provide a d.c. level at pin 16 for test purposes.

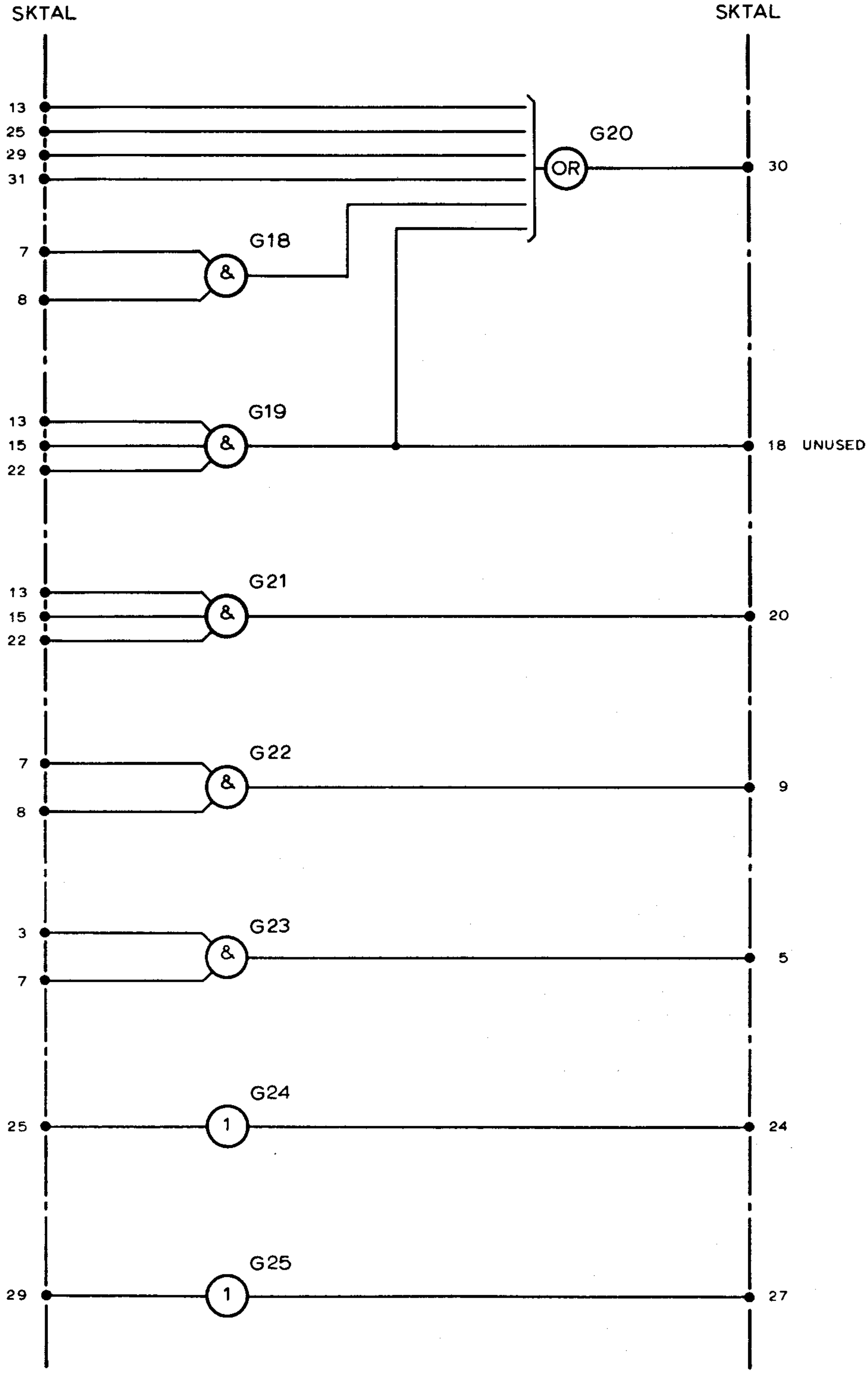

Fig.19. Lamp logic unit 'B': logic diagram

COMBINED CIRCUITS

INTRODUCTION

77. The combined circuits of the control, generator pulse units (main and standby) are shown in schematic form on fig.38 and 39. Fig.38 illustrates the power distribution to the units, controls, and the fault detection and changeover actions of the fault monitoring circuits. Fig.39 shows the indication initiated by control operation and by fault detection.

78. To render the parts of the main and standby units distinguishable from one another, on both illustrations the sub-units and components of the control, generator pulse unit (main) are shown in black, whilst

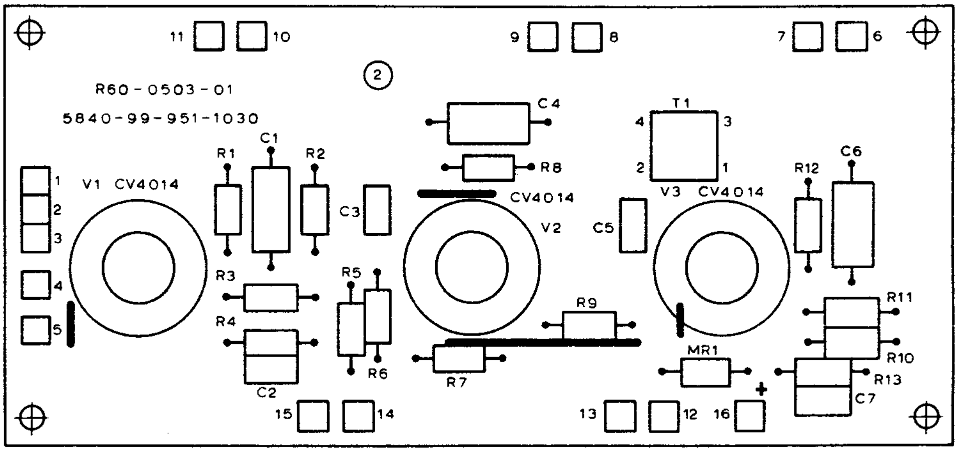

Fig.20. Panel electronic circuit 5840-99-951-1030: component location

those of the standby unit are shown in blue. In the ensuing text the suffix (M) is added to the sub-units and components of the main unit except for connectors, while the suffix (S) is added to those of the standby unit. On fig.38 the dotted lines inside the sub-unit 'boxes' indicate which inputs control which outputs.

General description

79. Distribution of the power supplies feeding the main and standby units (fig.38) is made in such a way as to ensure the continuance of operation even with the failure of some of the supply sources. Wherever possible this is done by feeding each supply from at least two separate sources each of which is capable of supporting the full load.

80. At each of the control, generator pulse units, the following controls are provided; all except the BY-PASS switches are mounted on the front panels:

(1) Emergency p.r.f. selection (fig.38)–The decision whether emergency p.r.f. generation is to be obtained from the main or standby circuits has to be preset into the equipment by the operation of a switch at either the main or standby units, as follows:–

(a) If the EMERGENCY P.R.F. MAIN switch (SA, main unit) is operated, as is normal:

(i) On the detection of the absence of r.f. output from both the main and standby crystal oscillators, the standby flywheel oscillator is inhibited.

(ii) On detection of pulse misalignment, standby pulse generator is inhibited unless the misalignment is due to the absence of the main –8 microsecond pulses or if certain other faults exist in the main equipment.

(b) If the EMERGENCY P.R.F. STANDBY switch (SA, standby unit) is operated then, instead of the conditions under (a):

(i) On the detection of the absence of r.f. output from both the main and standby crystal oscillators, the main flywheel oscillator is inhibited.

(ii) On detection of pulse misalignment main pulse generation is inhibited unless the misalignment is due to the absence of the standby –8 microsecond pulses or if certain other faults exist in the standby equipment.

(2) START AND RESET switches, SB (M) and SB (S), fig.38–The pulse generation fault detection at both the main and standby units employs a circuit which locks in the fault condition once a fault is detected; manual reset is therefore required to gain normal operation after the clearance of such a fault. Accordingly START AND RESET switches are provided at each unit, and both must be operated when switching on the equipment, or the appropriate one after the clearance of a pulse generation fault.

(3) BY-PASS switches SF (M) and SF (S), fig.38–Operation of the BY-PASS switch on the main unit inhibits pulse output from the standby equipment and simplifies the signal path for the main signal. This simplification consists of by-passing the fault monitoring circuits concerned with changeover, since an alternative channel is not available. Whatever emergency p.r.f. has been selected (1), the main flywheel oscillator cannot be inhibited, nor can the detection of pulse misalignment cause the main pulse generation to be inhibited. As a result, pulse output is produced wholly from the main equipment ▶◀. The BY-PASS switch is only intended for use when some major main-

tenance is required, and since its use greatly reduces the potential reliability of the system, the switch is mounted internally within the control, generator pulse unit, so as to minimize the risk of misuse. The BY-PASS switch on the standby unit provides the reciprocal facility of operating from the standby equipment ▶◀ .

81. In addition to the three controls described so far, which are duplicated for the main and standby units, on the main unit only there is a switch associated with maintenance, while on the standby unit only are controls for operating the goniometer. The MAINT, switch SC (M), fig.39, is connected into the station maintenance indication system and its operation causes indication to be given both locally at the trigger generating equipment and remotely. There are two GONIO DRIVE controls (fig.38) comprising a FORWARD/REVERSE switch SE (S), to control the direction of drive, and a SLOW/OFF/FAST switch, SD(S), to control the speed. As a guard against misuse the GONIO DRIVE controls are only operative when the main and standby pulses are not in alignment, or when either the main or standby START AND RESET switches (para.107) have for any reason not been operated.

82. Considering now the fault monitoring circuits, these consist of the sub-units of the two control, generator pulse units, together with the relays and indicator lamps they cause to be driven. Inputs to the sub-units represent one of two alternative states which can be:

(1) At fault detection units, the presence or absence of a fault.

(2) At changeover units, select main or select standby.

According to the state of this input information the sub-units produce switching outputs at one of two d.c. levels (normal or fault), or operate relays, or pass on the selected signal, or combine more than one of these functions. In addition some of the sub-units have 'unit fault' relays associated with them; these allow a distinction to be made between action resulting from input changes and that resulting from a failure of the unit itself.

83. For convenience, the description of the fault monitoring circuits is split into two main parts:—

(1) Fault action, which is concerned with the changes in signal routing and generation in responce to the input information. These circuits are shown on fig.38, and are sub-divided into r.f. signal fault action and pulse generation fault action. Where output levels are stated these are d.c. levels, the first being the level with normal input and the second that with fault input.

(2) Indication, which is concerned with the indicator display consequent on control operation or fault detection. These circuits are shown on fig.39.

84. With normal operating conditions, main emergency p.r.f. is selected, relays RLN (M) and RLP◀ (M) are ▶energized, and output from both the main and standby crystal oscillators is present. Referring to the r.f. signal fault action circuits, r.f. from the main crystal oscillator enters the main unit at SKT G and is fed via contact RLR2 (M) to pin 10 of unit 1 (M). The presence of this r.f. signal is monitored by unit 2 (M); with r.f. input present at pin 29, output from pin 23 is 0V, relay RLA (M) is energized; with r.f. input absent, output from pin 23 is at −7V; relay RLA (M) is de-energized. Relay RLB (M) is a unit fault relay which remains energized while unit 2 (M) is serviceable. R.F. from the standby crystal oscillator enters the standby unit at SKT G and via contact RLQ1 (S) and SKT H is also fed to unit 1 (M) but to pin 25. This r.f. signal is monitored by unit 1 (S), which is the standby equivalent of unit 2 (M).

85. Outputs from units 2 (M) and 1 (S) operate unit 3 (M), which is an electronic changeover switch. The states of this switch are:—

(1) Input to pins 7 and 10 at 0V (both main and standby r.f. present), output at pin 20 is 0V and at pin 26 is −15V, representing select main r.f.

(2) Input to pin 7 at −7V, and to pin 10 at 0V (main r.f. present, standby r.f. absent), output conditions as under (1).

(3) Input to pin 7 at 0V, and to pin 10 at −7V (main r.f. absent, standby r.f. present), output at pin 20 is −15V and at pin 26 is 0V, representing select standby r.f.

Relays RLC (M) and RLD (M) are unit fault relays associated with unit 3 (M); normally they are both energized; if either or both become de-energized their contacts change over to substitute simulated outputs for the normal output from unit 3 (M).

86. The gating voltage outputs from unit 3 (M), or their simulated equivalents, are taken to three destinations:—

(1) To unit 1 (M) which is an electronic gate allowing either the main or standby r.f. to pass through to its output on the condition (r.f. signal present & gate voltage 0V).

(2) To unit 2 (S), whose function is to monitor the fact that the gating outputs are in anti-phase. The conditions are main r.f. selected, relay RLF (S) energized, relay

RLG (S), de-energized; with standby r.f. selected, relay RLF (S) de-energized, relay RLG (S) energized.

(3) To unit 4 (M) which operates as an extension of unit 3 (M) by driving relays according to the outputs from unit 3 (M). The conditions are main r.f. selected, relay RLK (M) energized, relay RLM (M) de-energized; with standby r.f. selected, relay RLK (M) is de-energized, relay RLM (M) energized.

87. From unit 1 (M) the r.f. output, main or standby, is fed in parallel to the main and standby flywheel oscillators, units 5 (M) and 5 (S). Output from unit 5 (M) is fed directly to the main divider unit, while that from unit 5 (S) is fed to the standby divider unit via the goniometer.

88. The selection of the r.f. source in this way is entirely automatic and is always from the main crystal oscillator unless its output fails. Further selection is made via ◀ contacts RLY2 (M) and ▶ RLK3 (M); when ◀ these contacts are ▶ closed (main selected) an earth is applied via PLD/13 to the relay unit, causing the 6·14 Mc/s and 8·19 Mc/s ◀ signals ▶ from the main oscillator to be fed out of the equipment, and also causing the 500 c/s p.r.f. correction voltage to be applied to the main crystal oscillator. When contact RLK3 (M) is open (standby selected) ◀ or RLY2 (M) is open (BY-PASS (S) selected), ▶ then PLD/13 is open circuit and the equivalent standby selection is made.

89. Unit 6 (M) operates in the same way as units 2 (M) and 1 (S), except that it monitors the output from unit 1 (M). On failure of r.f. output from this latter unit, output at −7V from unit 6 (M) pin 23 is routed to inhibit one or other of the flywheel oscillators, as follows:—

(1) If main emergency p.r.f. is selected, RLN (M) energized, the inhibition is applied to the standby flywheel oscillator.

(2) If standby emergency p.r.f. is selected, RLN (M) is de-energized, the inhibition is applied to the main flywheel oscillator.

If relay RLJ (M) is de-energized, denoting the failure of unit 6 (M), the inhibition is prevented through the opening of contact RLJ1 (M).

90. Pulse generation fault action is different from r.f. fault action in that, in the latter case, the circuits resume normal action automatically as soon as the fault is cleared, whereas with pulse generation faults manual alignment and resetting is necessary to regain normal action after the clearance of the faults. Two fault conditions are recognized:

(1) The loss of either main or standby output pulses. The 250 c/s signals are used as the reference for this, the signal from the main divider unit being brought in to unit 7 (M) pin 11, while that from the standby divider unit is brought in to unit 6 (S) pin 11.

(2) Misalignment between timing of the main and standby output pulses. The −8 microsecond main and standby pulses are used to make this comparison, the main pulses being fed to unit 3 (S) pin 7 and unit 4 (S) pin 3, while the standby pulses are fed to unit 3 (S) pin 13 and unit 4 (S) pin 4.

91. Dealing first with 250 c/s faults, if 250 c/s input is present at unit 7 (M) then relay RLF (M) is energized, as is relay RLG (M). If the 250 c/s signal fails, relay RLF (M) is de-energized and brings out relay RLE (M). The opening of contacts RLF2 (M) and RLE2 (M) interrupts the h.t. supply to the gated stages of the main electronic switch and cathode follower units, inhibiting main pulse output, and also de-energizing relay RLG (M). Even when the fault is cured the circuit remains in this state, and can only be restored to normal by the operation of switch SB (M). When this switch is pressed relays RLE (M) and RLF (M) are energized, but on release of the switch only hold in if the 250 c/s signal is present and there is no pulse misalignment fault (para.93).

92. Similarly, failure of the 250 c/s standby divider unit output to unit 6 (S) de-energizes relay RLD (S), which in turn brings out relay RLC (S). The h.t. supply to the gated stages of the standby electronic switch and cathode follower units is interrupted, standby pulse output is inhibited and relay RLE (S), is de-energized. After clearance of the fault, switch SB (S) has to be operated to regain normal action.

93. The detection of pulse misalignment and consequent action is complicated by the fact that, though the pulse generation circuit (main or standby) to be inhibited is manually preselected by operation of one of the EMERGENCY P.R.F. switches, this selection must be overridden if the circuit destined to provide pulse generation is faulty.

94. Pulse misalignment is detected by the combination of units 3 (S) and 7 (S). While the main and standby pulses are both present and within about 1 μs of each other, output from unit 7 (S) pin 29 is at +30V and relay RLH (S) is energized. If one or other of the pulse inputs is absent, or if the timing is outside the limit of about 1 μs, then output at pin 29 becomes open circuit and relay RLH (S) is de-energized.

95. The presence of the main and standby −8 microsecond pulses is monitored at unit 4 (S). While both are present, outputs from pins 11 and 20 are both at 0V; if either is absent, then:

(1) If the main pulses are missing, output at pin 20 rises to +30V.

(2) If the standby pulses are missing, output at pin 11 rises to +30V.

Relay RLN (S) is concerned with unit fault indication. Normally it is de-energized, but in the event of certain unit faults or the loss of both pulse inputs, it is energized.

96. While both pulses are present and in alignment, the +30V output at unit 7 (S) pin 29 causes no further action. When there is a fault, the open circuit condition has an effect, subject to certain conditions, as follows:

(1) With main emergency p.r.f. selected, the open circuit is routed via RLN3 (M), RLG1 (M) to unit 6 (S) pin 7. This causes relay RLC (S) to be de-energized, subject:

(a) To the input at unit 6 (S) pin 3 being at 0V (main −8 microsecond pulses present). If this input is at +30V (main pulses absent) it overrides the pulse misalignment fault signal and relay RLC (S) remains energized.

(b) If there is a main pulse generation fault relay RLG (M) is de-energized and in this case the pulse alignment fault information is not passed on to unit 6 (S) pin 3; instead this input is switched to a bias of +30V. Relay RLC (S) therefore remains energized. If relay RLC (S) is de-energized the resulting actions are the same as those for a standby 250 c/s fault (para. 92).

(2) With standby emergency p.r.f. selected, similar actions occur at unit 7 (M) resulting in main pulse generation fault actions subject to similar conditions.

97. At every pulse generation fault either relay RLF (M) or relay RLD (S) is de-energized, and through contact RLF3 (M) or RLD2 (S) relay RLT (S) is energized. Energization of this relay renders the goniometer controls SD (S) and SE (S) operative, so that, after the fault has been cured, the main and standby pulses can be brought into alignment.

98. While the equipment is operating, its state is constantly shown by indicator lamps. Each alternative control demand or fault condition causes relay contacts to change over, with consequent alteration in the pattern of indication. The circuits concerned with indication are shown on fig. 39, from which it can be seen that logic elements, AND and OR-gates, are employed to assist in the interpretation of the various states.

99. The indicator lamps can be divided into the following three general classes:—

(1) System state indicators—These show whether operation is NORMAL, or if there is a FAULT, or if maintenance (MAINT.) is in progress. These lamps are repeated at four locations within the equipment, these being on the control panels of the main and standby control, generator pulse units and also, as these panels are normally enclosed by the cabinet doors, on the top framework of the main and standby cabinets. This indication is further repeated, remotely, at the station fault display. Indication by these lamps is as follows:

(a) The NORMAL lamp is lit as long as no fault exists, neither relay RLJ (S) or RLK (S) energized, see (b).

(b) The FAULT lamp is lit for any of the fault conditions detected by the equipment, indication varying with the seriousness of the fault. For faults that do not affect the operation of the external equipment or seriously reduce the facilities of the no-break trigger system, relay RLJ (S) is energized and the FAULT lamp remains continuously lit (steady). If the fault is such that the p.r.f. output is initiated by the unsynchronized output from one of the flywheel oscillators, or if it substantially reduces the facilities of the system, relay RLK (S) is energized and the FAULT lamp goes on and off (flashing). If output from the system is unsynchronized, a further warning is given to the users by a remotely situated emergency trigger warning lamp.

(c) The MAINT. lamp lights when switch SC (M) is operated. Indication changes from flashing to steady or from steady to flashing in answer to an external recognition signal.

(2) Equipment state indicators—These sets of lamps on the control panels of the main and standby unit shows the states of the main and standby equipments respectively.

(3) Unit fault indicators—Except for the lamp logic units, each sub-unit of both the main and standby control, generator pulse units is provided with its own FAULT lamp. These lamps are used to indicate particular faults or areas of fault to assist in fault location; they do not necessarily indicate that the fault is in the sub-unit to which they are attached.

POWER DISTRIBUTION CIRCUITS

100. Similar power distribution circuits are employed in the main and standby units, and are shown on fig. 38. Six alternative sources of +250V are available in the complete equipment, one from each of the three +250V voltage regulator units located in the main cabinet, and one from each of the three units in the standby cabinet. These supplies are fed in through 6-input OR-gates and fuses in both the main and standby units. The combined and fused supplies are then, subject to the action of the BY-PASS controls (para. 109), available to the circuits within the units. The purpose of combining the +250V supplies in this manner is to enable the circuits to operate in spite of faults on individual regulator units.

101. The −250V supplies from the two −250V voltage regulator units, one in each cabinet, are similarly combined through 2-input OR-gates, as are the two external −50V supplies. Supplies at 6·3V a.c. are derived from transformers T1

(M) and T1 (S) and are used to supply valve heaters and indicator lamps. The mains supplies to these two transformers are not duplicated, but that feeding the main unit is derived from a separate source from that feeding the standby unit. The fused a.c. supply at the primary of T1 (S) in the standby unit is also taken as the input to transformer T2 (S). This latter transformer provides two output voltages, either of which, 96V (FAST) or 50V (SLOW), can be selected as the input for the motor which drives the goniometer.

102. A number of Zener diode stabilized subsidiary supplies are derived in both units from the +250V and −250V d.c. supplies. These are:

(1) +43V, which is used as the h.t. supply for the DM160 pulse output indicators in the panel indicator, pulse.

(2) −5·6V, which is used as a bias supply for the DM160 indicators (1). Capacitors are provided across these Zener diodes to by-pass switching transients.

(3) +30V, which is used as a switching bias.

(4) −30V, which is produced in the main unit only, and is used as a switching bias.

CONTROLS

Emergency p.r.f. switches

103. Should both the main and standby crystal oscillators fail, the equipment operates from the output of the flywheel oscillator in its mode as an unsynchronized oscillator. If under these circumstances both the main and standby flywheel oscillators were allowed to function, double pulse outputs would be produced due to the lack of synchronization. For this reason, one or other of the two oscillators is preselected to be inhibited under such circumstances. Similarly, if pulse misalignment is detected then either the main or standby pulse generation circuits must be inhibited, the decision as to which, is again preselected, though in this case the manual selection is automatically overridden if the selected circuits are faulty. The preselections referred to are made manually by the operation of either the EMERGENCY P.R.F. MAIN switch SA (M), or the EMERGENCY P.R.F. STANDBY switch SA (S).

104. If, as is normal, it is desired that the main equipment shall provide the emergency p.r.f. the EMERGENCY P.R.F MAIN switch SA (M) is operated. This causes relays RLN (M) and RLP (M) to be energized; when the switch is released the relays continue to hold through the closed contact RLP4 (M) and the normally made contact of the EMERGENCY P.R.F. STANDBY switch. In consequence:

(1) Action (fig. 38)

(a) Via RLN1 (M) fault output from unit 6 (M) is switched through PLC/8 to the gating input of the standby flywheel oscillator, unit 5 (S). Gating input to the main flywheel oscillator, unit 5 (M), is open circuit. As a result, if absence of r.f. output from unit 1 (M) is detected by unit 6 (M), the main flywheel oscillator is allowed to run, the standby one is inhibited.
(b) Via contact RLN2 (M) +30V is applied to unit 7 (M) pin 7. This inhibits the recognition of a pulse generation misalignment fault by unit 7 (M).
(c) Via contact RLN3 (M), the pulse alignment fault output from unit 7 (S) and PLC/7 is switched through PLC/5 to unit 6 (S) pin 7.

(2) Indication (fig. 39)

(a) Via RLN4 (M) the flywheel oscillator fault indication is changed from the control of relay RLE (S) to RLG (M).
(b) Contact RLP1 (M) controls the potential fault indication which is conditional on whether main or standby emergency p.r.f. is selected.
(c) Via contact RLP2 (M) the EMERGENCY P.R.F. MAIN SELECTED lamp is lit.
(d) Via contact RLP3 (M) the −50V supply is switched to the main flywheel oscillator, unit 5 (M), fault lamp, ready for fault operation if the conditions arise.

105. If it is required that the standby equipment provide the emergency p.r.f., the EMERGENCY P.R.F. STANDBY switch SA (S) is operated. This opens the hold circuit for relays RLN (M) and RLP (M), which are therefore de-energized. As a result:

(1) Action (fig. 38)

(a) Via RLN1 (M) fault output from unit 6 (M) is applied to the gating input of unit 5 (M). Gating input to unit 5 (S) is open circuit. As a result, if absence of r.f. output from unit 1 (M) is detected by unit 6 (M), the main flywheel oscillator is inhibited; the standby one is allowed to run.
(b) Via contact RLN2 (M) +30V is applied to unit 6 (S) pin 7. This inhibits the recognition of a pulse generation misalignment fault by unit 6 (S).
(c) Via contact RLN3 (M), the pulse alignment fault output from unit 7 (S) and PLC/7 is switched to unit 7 (M) pin 7.

(2) Indication (fig. 39)

(a) Via RLN4 (M) the flywheel oscillator fault indication is changed from the control of relay RLG (M) to relay RLE (S).
(b) Contact RLP1 (M) controls a potential fault indication which is conditional on whether main or standby emergency p.r.f. is selected.

(c) Via contact RLP2 (M) the EMERGENCY P.R.F. STANDBY SELECTED lamp is lit.
(d) Via contact RLP3 (M) the −50V supply is switched to the standby flywheel oscillator, unit 5 (S), fault lamp, ready for fault operation if the conditions arise.

106. The manner in which this manual selection is overridden is described under the pulse generation faults.

Start and reset switches

107. Part of the logic at the detector failure 250 c/s units (fig.38) is accomplished by having contacts of their two fault recognition relays in series with the +250V supply to the coils of these relays. Since the relay coils are the anode loads of the fault detection valves, it means that at switch-on, or after the de-energization of the relays through a fault condition, the unit is locked in the fault state.

108. For unit 7 (M), operation of the START AND RESET switch SB (M) by-passes the contacts RLE1 (M) and RLF1 (M) and causes relays RLE (M) and RLF (M) to be energized. On release of the switch the relays remain held on in the absence of a fault, or drop out again if a fault is present. Switch SB (S) performs a similar function for relays RLC (S) and RLD (S) of unit 6 (S).

By-pass switches

109. At times, for instance when some major maintenance is taking place, it may be necessary to isolate either the main or standby cabinet and to continue to operate on the remaining one. To enable this to be done BY-PASS switches are provided in both the main and standby control, generator pulse, units, switches SF (M) and SF (S). To afford some protection against misuse, these switches are not mounted on the front panels.

110. The switches are shown in the power distribution section of fig.38. With both BY-PASS switches at NORMAL, the +250V (M) supply passes out of the main unit into the standby unit, through the closed relay contact RLQ3 (S) and then back to the supply circuits in the main unit. The +250V (S) supply follows a similar path through contact RLR3 (M).

111. With switch SF (M) operated to BY-PASS, relays RLL (M), ▶◀ RLR (M)◀ and RLX (M)▶ are energized via pole SFa. As a result contact RLR3 (M) opens, removing the +250V (S) supply from the circuits in the standby units, while closure of contact RLR4 (M) ensures the +250V (M) supply to the main circuits ▶◀ . ◀ Contact RLX1 (M) opens to isolate relay RLY (M). ▶

112. For testing purposes, ▶◀ the +250V (S) supply may be restored to the standby circuits by subsequent operation of switch SF(S) to BY-PASS.

113. The remaining effects of the operation of switch SF (M) are:

(1) Action (fig.38)

(a) Contacts RLR1 (M) and RLR2 (M) change over, and as a result the main crystal oscillator r.f. output is fed directly to the flywheel oscillator, unit 5 (M), by-passing unit 1 (M).
(b) Via pole SFb (M) +30V is applied to unit 7 (M) pin 7. This inhibits the recognition of a pulse generation misalignment fault by unit 7 (M).
(c) Via pole SFc (M) the gating input to unit 5 (M) is open circuit.
(d) Via contact ◀ RLX2 ▶ (M), PLD/13 is earthed, demanding select main from the relay assembly.

(2) Indication (fig.39)

(a) Via contact RLL1 (M) the STANDBY UNIT BY-PASSED lamp is lit.
(b) Via contact RLL2 (M) the SYSTEM STATE FAULT lamps are lit.
(c) Via contact RLL4 (M) the SYSTEM STATE MAINT. lamps are lit.
(d) Because of the loss of +250V in the standby unit, relay RLK (S) is energized (para.148) and the SYSTEM STATE NORMAL lamps are switched off via contact RLK1 (S).

Note. . .
If the main BY-PASS switch has been operated, the MAINT. switch, SC (M) must not be operated in addition while the standby unit remains connected. The reason for this is that operation of SC(M) causes relay RLM(S) to be energized which, with relay RLL(M) also energized, would result in the −50V flashing return being connected to earth.

114. (1) If switch SF (S) is operated instead of switch SF (M), relays RLP (S) and RLQ (S) are energized. The +250V (M) supply is then interrupted through contact RLQ3 (S) and the +250V (S) supply is assured through contact RLQ4 (S) ◀ Also, since PLD/3 (standby) is externally linked to PLD/3 (main), relay RLY (M) is energized. Consequently, contact RLY1 (M) opens to isolate relay RLX (M).

(2) For testing purposes, the +250V (M) supply may be restored to the main circuits by subsequent operation of switch SF (M) to BY-PASS. However, since contact RLY1 (M) is now open, contact RLX2 (M) will also remain open and the relay assembly will continue to demand select standby. ▶

115. The remaining effects of the operation of switch SF (S) are:

(1) Action (fig.38)

(a) Contacts RLQ1 (S) and RLQ2 (S)

change over, and as a result the standby crystal oscillator r.f. output is fed directly to the flywheel oscillator, unit 5 (S), by-passing unit 1 (M).
(b) Via pole SFb (S) +30V is applied to unit 6 (S) pin 7. This inhibits the recognition of a pulse generation misalignment fault by unit 6 (S).
(c) Since RLN (M) is de-energized, the gating input to unit 5 (S) is open circuit via contact RLN1 (M).
(d) Relays ◀ RLX ▶ (M) and RLK (M) are de-energized, so that PLD/13 is open circuit, demanding select standby from the relay assembly.

(2) Indication (fig.39)

(a) Via contact RLP1 (S) the MAIN UNIT BY-PASSED lamp is lit.
(b) Via contact RLP2 (S) the SYSTEM STATE MAINT. lamps are lit.
(c) Via contact RLP3 (S) the SYSTEM STATE FAULT lamps are lit.
(d) Via contact RLP4 (S) the SYSTEM STATE NORMAL lamps are unlit.

System maintenance switch

116. Only one system maintenance switch is provided, that being the MAINT. switch SC (M) on the main unit. Referring to fig.39, normally the switch is unoperated, output at PLB/17 is open circuit and no further action occurs. When it is required to carry out routine maintenance, the switch is pressed and an earth is fed via PLB/17 to energize relay RLM (S). Then:

(1) Changeover of contacts RLM1 (S) and RLM2 (S), with relays RLL and RLP de-energized, causes the –50V flashing return (PLA/13) to be applied to PLD/1 (standby) and through MR19 to the MAINT. lamp (standby). PLD/1 (standby) and PLD/1 (main) are externally connected and also feed the cabinet MAINT. lamps and an external station maintenance warning lamp. As a result the SYSTEM STATE MAINT. lamps are lit (flashing).

(2) In the absence of an equipment fault, changeover of contact RLM3 (S) causes no action. If there is a fault, either RLJ (S) or RLK (S) is energized and the SYSTEM STATE FAULT lamps are lit (steady) or (flashing).

(3) The receipt of an external flashing maintenance signal is acknowledged by applying an earth through PLD/2 to energize relay RLL (S):

(a) Contact RLL2 (S) changes over, connecting the MAINT. lamps to earth. Indication changes from flashing to steady.
(b) Contact RLL1 (S) changes over and, if a fault condition exists, the FAULT lamps indication is made steady.

(4) On subsequent release of the MAINT. switch, relay RLM is de-energized and MAINT. and FAULT indication revert to the conditions described under (1) and (2). When this state is acknowledged by the removal of the earth on PLD/2, relay RLL (S) is released and indication returns to normal

Goniometer drive controls

117. Two GONIO DRIVE controls are provided (fig. 38), one FORWARD/REVERSE switch SE (S) to select the direction of drive and one FAST/OFF/SLOW switch SD (S) to select the rate of drive. Switch SE (S) controls, through the contacts of relay RLS (S), the relative polarities of the voltages in motor winding 1, 3 and 2, 4, while switch SD (S) selects 0V (OFF) 96V (FAST) or 50V (SLOW) for application to these windings through contacts RLT1 (S) and RLT2 (S). Relay RLT (S) is provided to inhibit accidental drive of the goniometer when the main and standby pulses are already correctly in alignment: in this condition both relays RLD (S) and RLF (M) are energized, so relay RLT (S) cannot be. Only when either a main or standby pulse generation fault is recognized by unit 7 (M) or 6 (S) is relay RLT (S) energized and goniometer drive permitted.

Pulse generator alignment test circuit and scope sync. output

118. The pulse generator alignment test circuit is located in the main unit and consists of diodes MR27 (M)–MR29 (M), resistor R12 (M), coaxial socket SKT AN and test sockets SKT AP and AQ (fig.38); the three sockets are located at the bottom of the front panel. The circuit is used when aligning delayed pulse outputs from equivalent pulse generator units in the main and standby cabinets. One pulse generator is disconnected from the distribution unit, pulse, while the other is connected to it and the delay adjusted to suit the external equipment. Output from the first unit is then fed in to SKT AN, while a monitoring output from the second (set-up) unit is fed in to SKT AQ. An oscilloscope is connected to SKT AP to display the two pulses, and the delay of the first unit is adjusted until the two pulses coincide; output from this unit can then be disconnected from SKT AN and connected to the distribution unit, pulse.

119. At unit 3 (S) the main and standby –8 microsecond pulses are fed into a diode OR-gate, output from which is fed via pin 9 to coaxial socket SKT K and test socket SKT AN (fig.38); this latter socket is mounted at the bottom of the front panel of the standby unit, between the two GONIO DRIVE controls. Output from SKT K is fed as a synchronizing signal to an oscilloscope built in to external equipment; output from SKT AN is monitored whilst aligning the main and standby –8 microsecond pulses by means of the goniometer, and can also be used as a synchronizing signal.

FAULT ACTION AND INDICATION

R.F. faults

Failure of r.f. from main crystal oscillator

120. The fault is detected at unit 2 (M) and as a result output from pin 23 of the unit changes from 0V to –7V, and relay RLA (M) is de-energized. Then:

(a) Action (fig.38)

(a) At unit 3 (M) the −7V input to pin 10 causes output at pin 20 to change from 0V to −15V and at pin 26 to change from −15V to 0V. These outputs are fed to units 1 (M) and 4 (M), and also, via PLB/3 and 4, to unit 2 (S). These last outputs cause relays RLF (S) and RLG (S) to interchange states, but no further actions occur as long as one or the other of them is energized.
(b) At unit 1 (M), −15V at pin 13 inhibits the r.f. from the main crystal oscillator. The 0V at pin 30 allows the r.f. from the standby crystal oscillator at pin 25 to pass through to pin 6.
(c) At unit 4 (M), the −15V at pin 24 causes relay RLK (M) to be de-energized; the 0V at pin 9 causes RLM (M) to be energized.
(d) Contact RLK3 (M) opens, so that PLD/13 is open circuit, demanding select standby from the relay assembly.

(2) Indication (fig. 39)

(a) Contact RLA3 (M) changes over at the input to unit 8 (M), applying −50V to SKT AL/19, thus inhibiting gate G7, and open circuiting inputs SKT AL/11 and SKT AM/25. Via SKT AL/11 and gate G5 output at SKT AL/26 rises to earth, causing relay RLJ (S) to be energized. As a result, the SYSTEM STATE FAULT lamps are lit (steady, para. 99).
(b) Via contact RLA4 (M), if relay RLB (M) remains energized (not unit 2 (M) fault) the CRYSTAL OSCILLATOR FAULT (M) lamp lights.
(c) Changeover of contacts RLK1 (M) and RLM1 (M) at the input to unit 8 (M) buffer G10 and gate G5 has no effect.
(d) Contact RLK2 opens switching off the CRYSTAL OSCILLATOR SELECT (M) lamp.
(e) Contact RLM2 closes, switching out 6·3V via PLC/3, which causes the CRYSTAL OSCILLATOR SELECT (S) lamp to light.
(f) Changeover of contacts RLF1 (S) and RLG1 (S) at the input to unit 8 (S) buffer G24 and gate G20 has no effect.

121. On the reappearance of r.f. from the main crystal oscillator, the equipment automatically changes back to the normal state, with the main crystal oscillator selected. Actions and indications accompanying this change are as described in the next paragraph under standby crystal oscillator failure.

Failure of r.f. from standby crystal oscillator

122. The fault is detected at unit 1 (S) and as a result output from pin 23 of the unit changes from 0V to −7V, and relay RLA (S) is de-energized. Then:

(1) Action (fig. 38)

(a) At unit 3 (M) the −7V input to pin 7 causes no change in state unless the equipment has been working with the standby crystal oscillator selected. If it has, then the output at pin 26 changes from 0V to −15V and the output at pin 20 changes from −15V to 0V. These outputs are fed to units 1 (M) and 4 (M), and also, via PLB/3 and 4, to unit 2 (S). These last outputs cause relays RLF (S) and RLG (S) to interchange states, but no further actions occur as long as one or the other of them is energized.
(b) At unit 1 (M), −15V at pin 30 inhibits the r.f. from the standby crystal oscillator. The 0V at pin 13 allows the r.f. from the main crystal oscillator at pin 10 to pass through to pin 6.
(c) At unit 4 (M) the −15V at pin 9 causes relay RLM (M) to be de-energized; the 0V at pin 24 causes RLK (M) to be energized.
(d) Contact RLK3 (M) closes, applying an earth to PLD/13, demanding select main from the relay assembly.
(e) Changeover of contacts RLA1 (S) and RLA2 (S) has no effect with relays RLC (M) and RLD (M) energized (not unit 3 (M) fault).

(2) Indication (fig. 39)

(a) Via contact RLA3 (S), if relay RLB (S) remains energized (not unit 1 (S) fault) the CRYSTAL OSCILLATOR FAULT (S) lamp lights.
(b) Contact RLA4 (S) changes over at the input to unit 8 (S), applying −50V via PLB/10 to inhibit gates G7 and G1, and open circuiting input at pin 31 to gate G20. The output of this gate (pin 20) rises to earth, causing relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (steady, para. 99).
(c) Changeover of contacts RLK1 (M) and RLM1 (M) at the input to buffer G10 and gate G5 has no effect.
(d) Contact RLK2 (M) closes, causing the CRYSTAL OSCILLATOR SELECT (M) lamp to light.
(e) Contact RLM2 (M) opens, switching off the CRYSTAL OSCILLATOR SELECT (S) lamp.
(f) Changeover of contacts RLF1 (S) and RLG1 (S) has no effect as long as one or the other of them is energized.

Unit 1(M) fault indication

123. The fault is detected as the failure of r.f. input to unit 6 (M) and as a result, output from pin 23 of the unit changes from 0V to −7V, and relay RLH (M) is de-energized. Then:

(1) Action (fig. 38)

(a) Contact RLH1 changes over and, if contact RLJ1 is closed (not unit 6 (M) fault), connects the −7V fault output from pin 23 to the contact RLN1 (M). Actions then depend on whether main or standby emergency p.r.f. has been selected:

(i) With EMERGENCY P.R.F. MAIN SELECTED, relay RLN (M) is energized, fault output from unit 6 (M) is connected via RLN1 (M) and PLC/8 to inhibit output from the standby flywheel oscillator, unit 5 (S).

(ii) With EMERGENCY P.R.F. STANDBY SELECTED, relay RLN (M) is de-energized, fault output from unit 6 (M) is connected via RLN1 (M) to inhibit output from the main flywheel oscillator, unit 5 (M).

(2) Indication (fig. 39)

(a) Contact RLH2 (M) changes over at the input to unit 8 (M), applying −50V to SKT AL/22, thus inhibiting gates G4, G6, G12, G16 and G19, G21, and open circuiting inputs SKT AM/16 and SKT AL/5.

(i) Via SKT AM/16 and gate G11, output at SKT AM/6 rises to earth, causing relay RLK (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).

(ii) Via SKT AL/5 one input of the 3-input AND-gate G7 is open circuit. If the other two inputs are also open circuit (not main or standby crystal oscillator failure) output at SKT AL/15 rises to earth, causing the unit 1 (M) FAULT lamp to light.

(b) Contact RLH3 (M) opens and, if contact RLJ3 (M) is open (not unit 6 (M) fault) switches off whichever CRYSTAL OSCILLATOR SELECTED lamp was previously on.

(c) Contact RLH4 (M) closes and if contact RLJ4 (M) is closed (not unit 6 (M) fault) connects an earth to PLD/11. This causes an external lamp to light as a warning that emergency trigger conditions are now in operation. This is necessary because the trigger system is now operating from the flywheel oscillator, and the synchronization between the external equipment and the p.r.f. is lost.

(d) In consequence of the loss of either main or standby 250 c/s and −8 microsecond pulses fault indication is caused by pulse misalignment, para. 134, and pulse generation fault, para. 131 or 133.

Unit 2(M) fault indication

124. If there is a fault at unit 2 (M) such as to cause the unit fault relay RLB (M) to be de-energized, then relay RLA (M) will probably also be de-energized, though not as the result of main crystal oscillator failure. As a result, the following indication is caused (fig. 39):

(1) Contact RLB1 (M) at the input to unit 8 (M) open circuits input SKT AL/28 of buffer G9 and gate G5. Then:

(a) Output from buffer G9 SKT AL/27 rises to earth causing the unit 2 (M) FAULT lamp to light.

(b) Output from gate G5 SKT AL/26 rises to earth, causing, via PLC/18, relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (steady, para. 99).

(2) Contact RLB2 (M) opens in series with contact RLA4 (M) to prevent the CRYSTAL OSCILLATOR FAULT (M) lamp from lighting.

(3 Changeover of contact RLA3 (M) merely duplicates the action of energizing relay RLJ (S).

Unit 1(S) fault indication

125. If there is a fault at unit 1 (S) such as to cause the unit fault relay RLB (S) to be de-energized, then relay RLA (S) will probably also be de-energized, though not as the result of standby crystal oscillator failure. As a result, the following indication is caused (fig. 39):

(1) Contact RLB1 (S) at the input to unit 8 (S) open circuits input pin 29 of buffer G25 and gate G20. Then:

(a) Output from buffer G25 pins 27 rises to earth, causing the unit 1 (S) FAULT lamp to light.

(b) Output from gate 20 pin 30 rises to earth, causing relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (steady, para. 99).

(2) Contact RLB2 (S) opens in series with contact RLA3 (S) to prevent the CRYSTAL OSCILLATOR FAULT (S) lamp from lighting.

(3) Changeover of contact RLA4 (S) merely duplicates the action of energizing relay RLJ (S). Changeover of contacts RLA1 and 2 (S) has no effect.

Unit 3(M) fault, de-energization of relay RLC(M) or RLD(M)

126. A fault at unit 3 (M) could cause either relay RLC (M) or RLD (M) or both to be de-energized. The contacts of the relays are so arranged that whether one or the other or both relays become de-energized, the action is the same. If the fault does occur, then (fig. 38):

(1) The normal connections between unit 3 (M), and unit 1 (M) and 4 (M) are open circuited.

(2) Simulated switching voltages of −30V are applied to PLB/2 and PLC/1, and of

0V to PLB/1 and PLC/2. Action then depends on the state of the equipment:

(a) If, prior to the fault, the equipment is working normally, with both main and standby crystal oscillator outputs present, then inputs to unit 4 (M) pin 24 and unit 1 (M) pin 13 are 0V, inputs to unit 4 (M) pin 9 and unit 1 (M) pin 30 are −15V. Contacts RLA1 (S) and RLA2 (S) are in the energized position, and PLB/1 and 2 and PLC/1 and 2 are all open circuit. Relay RLK (M) is energized, the CRYSTAL OSCILLATOR SELECT (M) lamp is on (fig.39), the standby one is off, RLM (M) de-energized. When the unit 3 (M) fault occurs inputs to unit 4 (M) pin 24 and unit 1 (M) pin 13 change to −30V via PLC/1 and contact RLA2 (S), and inputs to unit 4 (M) pin 9 and unit 1 (M) pin 30 change to 0V via PLC/2 and contact RLA1 (S). Unit 1 (M) changes over to pass through standby crystal oscillator output, though main has not failed. Relay RLK (M) is de-energized and RLM (M) energized; contact RLK (3) (M) opens, demanding select standby from the relay assembly. The CRYSTAL OSCILLATOR SELECT (S) lamp is on (fig.39), the main lamp is off. This changeover from main to standby crystal oscillator is the only indication that a fault has occurred; no fault lamps are lit.

(b) Supposing that whilst working on standby with unit 3 (M) faulty:

(i) The main crystal oscillator fails. The equipment continues working on standby as under (a) but the usual fault indication occurs through unit 2 (M), contacts RLA3 (M) and RLA4 (M), para.120.

(ii) The standby crystal oscillator fails. This is detected at unit 1 (S) and as a result of the changeover of contacts RLA1 (S) and RLA2 (S), the system changes back from standby to main crystal oscillator. The usual fault indication occurs through contacts RLA3 (S) and RLA4 (S), para.122.

(3) At each changeover of the inputs to unit 2 (S), relays RLF (S) and RLG (S) interchange states. No other action occurs whilst one or the other of them is energized.

Unit 3 (M) fault indication

127. It is possible on detection of a main crystal oscillator failure para.120, that changeover of unit 1 (M) from main to standby oscillator fails to take place. In consequence, unit 6 (M) detects the absence of r.f. output from unit 1 (M) and via contact RLH1 (M) causes the system to change over to operate from the main or standby flywheel oscillators, as selected. Since this mode of operation automatically causes pulse misalignment and 250 c/s faults to be generated (paras. 131 to 134), the following fault logic is true:

(Main crystal oscillator failure) & (pulse alignment out) = failure of changeover from main to standby crystal oscillator.

The manner in which this is detected and the consequent indication is as follows (fig.39):

(1) Both inputs to gate G17 are open circuit, SKT AM/25 through contact RLA3 (M) and SKT AM/30 through contact RLH1 (S). Output at SKT AM/27 therefore rises to earth causing the unit 3 (M) FAULT lamp to light.

(2) Input to SKT AM/16 to gate G11 is open circuit through contact RLH2 (M). Output at SKT AM/16 rises to earth, causing relay RLK (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para.99).

(3) Contact RLH3 (M) opens and switches off whichever CRYSTAL OSCILLATOR SELECTED lamp was previously on.

(4) Contact RLA4 (M) changes over, switching on the CRYSTAL OSCILLATOR FAULT (M) lamp.

(5) Contact RLH4 (M) closes and causes an external emergency trigger lamp to light.

Unit 2(S) fault indication

128. This unit monitors the inputs to units 1 (M) and 4 (M), whether derived from the output of unit 3 (M) or, in the event of failure of unit 3 (M), para.126, from the simulated switching voltages. As long as the inputs retain their opposite polarity, one positive (0V) and one negative (−15V or −30V), only one relay RLF (S) or RLG (S) is energized and no action occurs. If the inputs change to the same polarity, or if unit 2 (S) itself fails, both relays will be either energized or de-energized. Then (fig.39) at the input to unit 8 (S) contacts RLF1 (S) and RLG1 (S) change over, open circuiting the input (pin 25) to buffer G24 and gate G20:

(1) Via buffer G24 output at pin 24 rises to earth, causing the unit 2 (S) FAULT lamp to light.

(2) Via gate G20 output at pin 30 rises to earth, causing relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (steady, para.99).

Other actions depend on the cause of the fault.

Unit 4(M) fault indication

129. If both inputs to unit 4 (M) are of the same polarity (both −15V or −30V, or both (0V) or if the unit itself fails, then relays RLK (M) and

RLM (M) may both become de-energized or energized at the same time. If so, then:

(1) Action (fig.38)

(a) RLK (M) and RLM (M) both de-energized.

(i) Contact ◄ RLK3 (M) ► opens, removing the earth from PLD/13, demanding select standby from the relay assembly.
(ii) The crystal oscillator selection follows the demand from unit 3 (M).

(b) RLK (M) and RLM (M) both energized:

(i) Contact RLK3 (M) closes, earthing PLD/13, demanding select main from the relay assembly.
(ii) The crystal oscillator selection follows the demand from unit 3 (M).

(2) Indication (fig.39)

(a) RLK (M) and RLM (M) both de-energized.

(i) Changeover of contacts RLK1 (M) and RLM1 (M) at the input to unit 8 (M) open circuits the inputs (SKTAL/29) to buffer G10 and gate G5. Via buffer G10 output at SKTAL/30 rises to earth, causing the unit 4 (M) FAULT lamp to light. Via gate G5 output at SKTAL/26 rises to earth, causing RLJ (S) to be energized. As a result, the SYSTEM STATE FAULT lamps are lit (steady, para.99).
(ii) Changeover of contacts RLK4 (M) and RLM3 (M) causes the external emergency trigger warning light to be lit.
(iii) The opening of contacts RLK2 (M) and RLM2 (M) causes neither the main nor standby CRYSTAL OSCILLATOR SELECT lamps to be lit.

(b) RLK (M) and RLM (M) both energized.

(i) Changeover of contacts RLK1 (M) and RLM1 (M) has the same effect as before, (a) (i).
(ii) Changeover of contacts RLK4 (M) and RLM3 (M) has the same effect as before, (a) (ii).
(iii) The closure of contacts RLK2 (M) and RLM2 (M) causes both the main and standby CRYSTAL OSCILLATOR SELECT lamps to be lit.

Unit 6 (M) fault indication

130. If there is a fault at unit 6 (M) such as to cause the unit fault relay RLJ (M) to be de-energized, then RLH (M) will probably also be de-energized, though not necessarily so. In any case:

(1) Action (fig.38). Contact RLJ1 (M) inhibits the normal fault action by contact RLH1 (M), and contact RLJ3 (M) inhibits the normal indication through contact RLH3 (M).

(2) Indication (fig.39)

(a) Contact RLJ2 (M) at the input to unit 8 (M) open circuits SKTAL/25. As a result:

(i) Via buffer G8, output at SKTAL/24 rises to earth, causing the unit 6 (M) FAULT lamp to light.
(ii) Via gate G5, output at SKTAL/26 rises to earth, causing relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (steady, para.99).

(b) If relay RLH (M) is de-energized, then through contact RLH2 (M) the unit 1 (M) FAULT lamp is lit, and the SYSTEM STATE FAULT lamps are flashing. Contact RLJ4 (M) inhibits emergency trigger indication through contact RLH4 (M).

Pulse generation faults

Unit 5(M) fault indication

131. The fault is detected at unit 7 (M) by the absence of 250 c/s main input at pin 11. As a result relay RLF (M) is de-energized and contact RLF1 (M) opens, causing relay RLE (M) to be de-energized as well. Remaining actions and indications are:

(1) Actions (fig.38)

(a) Contact RLF2 (M) opens, removing the +250V supply from relay RLG (M) and from the gated stages of the gate, electronic (unit 103) and the cathode follower unit (unit 104) in the main timing chain. As a result, all outputs except for the –8 microsecond pulses are inhibited from the gate electronic, and all outputs except for the –8 microsecond pulse used for the detection of pulse misalignment are inhibited from the cathode follower unit.
(b) Contact RLF3 (M) closes, switching out –50V (M) via PLC/6 to energize relay RLT (S). As a result the GONIO DRIVE controls are rendered operative.
(c) Contacts RLE1 and 2 (M) duplicate the actions of contacts RLF1 and 2 (M).
(d) Due to failure of the 250 c/s main signal the main –8 microsecond pulse will also have failed, causing pulse misalignment and –8 microsecond main pulse absence to be detected (para.134).
(e) Contact RLG1 (M) changes over, switching +30V via PLC/5 to pin 7 of unit 6 (S). This inhibits action in the standby chain consequent on the detection of pulse misalignment, overriding the selection of main emergency p.r.f.

(2) Indication (fig.39)

(a) Contact RLG2 (M) changes over in the input circuit to unit 8 (M). This

(i) Open circuits SKT AL/16 which, at gates G4 and G6, is part of the condition for a unit 7 (M) fault indication.
(ii) Subject to emergency p.r.f. main having been selected, relays RLN (M) and RLP (M) energized, open circuits input SKT AM/7 to the 3-input AND-gate G16. The other two inputs will also be open circuit, SKT AM/30 through contact RLH 1 (S) (pulse alignment fault) and SKT AM/5 through contact RLH2 (M) (not unit 1 (M) r.f. output failure). Output at SKT AM/9 therefore rises to earth causing the unit 5 (M) FAULT lamp to light, this being connected via contact RLP3 (M) to the −50V supply. The 3-input AND-gate G12 is presented with the same inputs as gate G16. This, through gate G15, causes relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps light (steady, para.99).

(b) Contact RLG3 changes over, switching off the PULSE GENERATION NORMAL (M) lamp and switching on the FAULT (M) lamp.
(c) Pulse misalignment and unit 3 (S) and 7 (S) fault indications are given, see paras. 134 and 141.

132. Once the fault is cleared it is necessary to operate the main START AND RESET switch to regain main pulse generation.

Note. . .
If the gated +250V supply were to fail, leaving the 250 c/s and −8 microsecond pulse fault detection signals still present, relay RLG (M) would be de-energized and the actions through its contacts RLG1(M) and RLG3(M) would still take place, though the remaining actions would not.

Unit 5(S) fault indication

133. The fault is detected at unit 6 (S) by the absence of 250 c/s standby input to pin 11. As a result relay RLC (S) is de-energized and contact RLC1 (S) opens, causing relay RLD (S) to be de-energized as well. Remaining actions and indications are:

(1) Actions (fig.38)

(a) Contact RLC2 (S) opens, removing the +250V supply from relay RLE (S) and from the gated stages of the gate, electronic (unit 103) and cathode follower unit (unit 104) in the standby timing chain. As a result, all outputs except for the −8 microsecond pulses are inhibited from the gate, electronic, and all outputs except for the −8 microsecond pulse used for the detection of pulse misalignment are inhibited from the cathode follower unit.
(b) Contact RLD2 (S) closes, energizing relay RLT (S). As a result the GONIO DRIVE controls are rendered operative.
(c) Contacts RLD1 (S) and RLDJ (S) duplicate the actions of contacts RLC1 (S) and RLC2 (S).
(d) Due to the failure of the 250 c/s standby signal, the standby −8 microsecond pulse will also have failed, causing pulse misalignment and −8 microsecond pulse absence to be detected (para.134).
(e) Contact RLE3 (S) changes over, switching +30V via PLB/7 to pin 7 of unit 7 (M). This inhibits action in the main chain consequent on the detection of pulse misalignment, overriding the selection of standby emergency p.r.f.

(2) Indication (fig.39)

(a) Contact RLE1 (S) changes over in the input circuit to unit 8 (M). This

(i) Open circuits pin 13 which, at gate G19 and G21 is part of the condition for a unit 6 (S) fault indication. Open circuit input from pin 13 to gate G20 causes RLJ (S) to be energized, duplicating the indication under (ii).
(ii) Subject to emergency p.r.f. standby having been selected, relays RLN (M) and RLP (M) are de-energized, open circuits input SKT AM/7 to the 3-input ◄AND►-gate G16. The other two inputs will also be open circuit, SKT AM/30 through contact RLH1 (S) (pulse alignment fault) and SKT AM/5 through RLH2 (M) (not unit 1 (M) r.f. output failure). Output at SKT AM/9 therefore rises to earth; causing the unit 5 (S) FAULT lamp to light, this being connected via contact RLP3 (M) to the −50V supply. The 3-input AND-gate G12 is presented with the same inputs as gate G16. This, through gate G15, causes relay RLJ (S) to be energized. As a result the SYSTEM STATE FAULT lamps light (steady, para.99).

(b) Contact RLE2 (S) changes over, switching off the PULSE GENERATION NORMAL (S) lamp and switching on the FAULT (S) lamp.
(c) Pulse misalignment and units 3 (S) and 7 (S) fault indications are given, see paras. 134 and 141.

Note. . .
If the gated +250V supply were to fail, leaving the 250 c/s and −8 microsecond

pulse fault detection signals still present, relay RLE(S) would be de-energized and the actions through its contacts RLE2(S) and RLE3(S) would still take place, though the remaining actions would not.

Pulse misalignment

134. Whenever pulse misalignment occurs, whether it be due to the loss of either the main or standby –8 microsecond pulses, or whether it be due to a genuine misalignment with both pulses present, it is detected by units 3 (S) and 7 (S) working in conjunction. As a result, relay RLH (S) is de-energized and output from unit 7 ◄ (S) ► pin 29 changes from the normal (+30V) to the fault state (open circuit). The resulting actions depend upon whether emergency or main p.r.f. has been selected and, overridingly, on the state of the selected pulse generation circuits and on the information provided by unit 4 (S). ►◄

135. The function of unit 4 (S) is to interpret the cause of pulse misalignment and to produce outputs accordingly. The three causes recognized and the outputs produced are as follows:

(1) Genuine misalignment with both the main and standby –8 microsecond pulses present. Then

(a) Output from unit 4 (S) pin 20 is 0V.
(b) Output from unit 4 (S) pin 11 is 0V.

(2) Absence of the main –8 microsecond pulses. Then

(a) Output from pin 20 rises to +30V.
(b) Output from pin 11 remains at 0V.

(3) Absence of the standby –8 microsecond pulses. Then

(a) Output from pin 20 remains at 0V.
(b) Output from pin 11 rises to +30V.

136. Combining now the actions of units 3 (S) and 7 (S) with those of unit 4 (S), then on the detection of pulse misalignment:

(1) Action (fig.38)

(a) With main emergency p.r.f. selected.

(i) The fault output from unit 7 (S) pin 29, (open circuit) is routed via PLC/7, RLN3 (M), RLG1 (M), PLC/5 to unit 6 (S) pin 7. Fault action is demanded from unit 6 (S) unless overridden as described in sub-para.(ii) to (iv). If fault action is demanded relay RLD (S) is de-energized, followed by relays RLC (S) and RLE (S) with consequent action and indication as described for a 250 c/s standby fault (para. 133).

(ii) If before the alignment fault there was a main pulse generation fault, relay RLG (M) de-energized, then unit 6 (S) fault action cannot be demanded, for changes over of contact RLG1 (M) interrupt the fault output path and apply +30V to unit 6 (S) pin 7.
(iii) If before the alignment fault there was a main unit –250V failure, relay RLQ (M) de-energized, then unit 6 (S) fault action cannot be demanded, for changeover of contact RLQ2 (M) switches +30V (S) to unit 6 (S) pin 7.
(iv) If the main unit is by-passed, +30V (S) is routed to unit 6 (S) pin 7 via switch SFb (S), inhibiting fault action.
(v) Subject to the overriding conditions detailed in sub-paras. (ii) to (iv), fault action by unit 6 (S) is premitted if the misalignment fault is caused with both main and standby –8 microsecond pulses present, or with standby pulses absent, output unit 4 (S) pin 20 at 0V, but is inhibited if the main pulses are absent, when output at pin 20 rises to +30V and is fed to unit 6 (S) pin 3, overriding the effect of the open circuit fault input to pin 7.

(b) With standby emergency p.r.f. selected

(i) The fault output from unit 7 (S) pin 29 (open circuit) is routed via PLC/7, RLN3 (M), PLB/8. RLE3 (S), PLB/7, to unit 7 (M) pin 7. Fault action is demanded from unit 7 (M) unless overridden as described in sub-paras. (ii) to (iv). If fault action is demanded relay RLE (M) is de-energized, followed by relays RLF (M) and RLG (M) with consequent action and indication as described for a 250 c/s main fault (para.131).

(ii) If before the alignment fault there was a standby pulse generation fault, relay RLE (S) de-energized, then unit 7 (M) fault action cannot be demanded, for changeover of contact RLE3 (S) interrupts the fault output path and applies +30V to unit 7 (M) pin 7.
(iii) If before the alignment fault there was a standby unit –250V failure, relay RLR (S) de-energized, then unit 7 (M) fault action cannot be demanded, for changeover of contact RLR3 (S) switches +30V (M) to unit 7 (M) pin 7.
(iv) If the standby unit is by-passed, +30V (M) is routed to unit 7 (M) pin 7 via switch SFb (M), inhibiting fault action.
(v) Subject to the overriding conditions detailed in sub-paras. (ii) to (iv), fault action by unit 7 (M) is permitted if the misalignment fault is caused with both main and standby –8 microsecond pulses present, or with main

pulses absent, output unit 4 (S) pin 11 at 0V, but is inhibited if the standby pulses are absent, when output at pin 11 rises to +30V and is fed to unit 7 (M) pin 3 overriding the effect of the open circuit input to pin 7.

(2) Indication (fig. 39)

(a) Via contact RLH2 (S) the PULSE ALIGNMENT OUT lamp lights.
(b) Via contact RLH1 (S) the input to unit 8 (M) SKT AM/30 is open circuit; this is taken as one input to gates G11 and G17; input to unit 8 (S) pin 7 is also open circuit; this is taken as one input to gates G18, G22 and G23. Then

(i) Output from gate G11, SKT AM/6 rises to earth, causing relay RLK (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).

(ii) Open circuit input to gate G17 SKT AM/30 is part of the conditions for unit 3 (M) fault indication.

(iii) Open circuit input to gates G18 and G22 pin 7 is part of the conditions for unit 4 (S) fault indication.

(iv) Open circuit input to gate G23 pin 7 is part of the conditions for units 3 (S) and 7 (S) fault indication.

(c) If main emergency p.r.f. is selected, and unit 6 (S) fault action is not overridden, relay RLE (S) will be de-energized and indication given through its contacts, as described for standby 250 c/s failure (para. 133). Similarly, if standby emergency p.r.f. is selected, and unit 7 (M) fault action is not overridden, relay RLG (M) will be de-energized and indication given through its contacts, as described for main 250 c/s failure (para. 131).
(d) If main emergency p.r.f. is selected and unit 6 (S) fault action is overridden, then a standby pulse generation fault is not indicated, but unit 3 (S) and 7 (S) fault indication is given (para. 141). Similarly, if standby emergency p.r.f. is selected and unit 7 (M) fault action is overridden, then a main pulse generation fault is not indicated, but unit 3 (S) and 7 (S) fault indication is given.

Unit 4(S) fault indication

137. This indication is given when the following conditions occur:

(RLH (S) de-energized, pulse alignment fault) & (RLN (S) energized)

Now relay RLN (S) is energized either when there is a fault within unit 4 (S) or if both the main and standby pulse inputs to unit 4 (S) have failed. In either case, outputs from unit 4 (S) pins 11 and 20 are both at +30V. Unit 4 (S) fault indication therefore gives the warning that a pulse misalignment has been detected, but the outputs of unit 4 (S) are in such a state as to override misalignment action. The actions and indication are as follows:

(1) Actions (fig. 38). Outputs from unit 4 (S) pins 11 and 20 are both at +30V, overridding at units 7 (M) or 6 (S) any fault demand from unit 7 (S) pin 29.

(2) Indication (fig. 39)

(a) Pulse misalignment fault indication is given (para. 136).
(b) The inputs to the 2-input AND-gates G18 and G22 are identical and are as follows:

(i) Pin 7 open circuit via contact RLH1 (S) de-energized.

(ii) Pin 8 open circuit via contact RLN1 (S) energized. In consequence the unit 4 (S) FAULT lamp is lit through gate G22, and through gates G18 and G20 relay RLJ (S) is energized. Since relay RLK (S) is already energized due to pulse misalignment, the energization of RLJ (S) has no effect.

Unit 7(M) fault indication

138. This indication is given when the following conditions occur:

(relay RLH (M) energized, not unit 1 (M) r.f. output failure) & (RLH (S) energized, not pulse alignment fault) & (relay RLG (M) de-energized).

The most probable reason for this state to have arisen is that relays RLE (M) and RLF (M) have become de-energized due to some fault in unit 7 (M) itself. Then:

(1) Action (fig. 38)

(a) Contact RLG1 (M) changes over inhibiting pulse alignment fault action by unit 6 (S).

(b) The usual actions occur through the contacts of RLE (M) and RLF (M), para. 131.

(2) Indication (fig. 39)

(a) The inputs to the 3-input AND-gates G4 and G6 unit 8 (M) are identical, and are as follows:

(i) SKT AL/16 open circuit via RLG2 (M) de-energized.
(ii) SKT AL/17 open circuit via RLH1 (S) energized.
(iii) SKT AL/22, 23 open circuit via RLH2 (M) energized.

In consequence the unit 7 (M) FAULT lamp is lit through gate G6, and through gates G4 and G5 relay RLJ (S) is energized, causing the SYSTEM STATE FAULT lamps to light (steady, para. 99).

(b) The open circuit input SKT AL/16 to gate G5 duplicates the energization of relay RLJ (S).

(c) Contact RLG3 changes over, switching off the PULSE GENERATION NORMAL (M) lamp and switching on the FAULT (M) lamp.

Unit 6(S) fault indication

139. This fault indication is the standby equivalent of unit 7 (M) fault indication, and the conditions for detecting it are the same except that the condition RLE (S) de-energized is substituted for RLG (M) de-energized.

140. The most probable reason for this state to have arisen is that relays RLC (S) and RLD (S) have become de-energized due to some fault in unit 6 (S) itself. Then

(1) Action (fig. 38)

(a) Contact RLE3 (S) changes over inhibiting pulse alignment fault action by unit 7 (M).
(b) The usual action occurs through the contacts of RLC (S) and RLD (S).

(2) Indication (fig. 39)

(a) The inputs to the 3-input AND-gates G19 and G21 are identical, and are as follows:

(i) Pin 13 open circuit via RLE1 (S) de-energized.
(ii) Pin 15 open circuit via RLH1 (S) energized.
(iii) Pin 22 open circuit via RLH2 (M) energized.

In consequence the unit 6 (S) FAULT lamp is lit through gate G21, and through gates G19 and G20 relay RLJ (S) is energized, causing the SYSTEM STATE FAULT lamps to light (steady, para. 99).

(b) The open circuit input pin 13 to gate G20 duplicates the energization of relay RLJ (S).

(c) Contact RLE2 (S) changes over, switching off the PULSE GENERATION NORMAL (S) lamp and switching on the FAULT (S) lamp.

Units 3(S) and 7(S) fault indication

141. The fault lamps of units 3 (S) and 7 (S) are connected in series. Fault indication is given when the following conditions occur:

[(relay RLH (S) de-energized, pulse alignment fault) & (relay RLP (M) energized, main emergency p.r.f. selected) & (relay RLE (S) energized, not standby pulse generation fault)] OR [(relay RLH (S) de-energized, pulse alignment fault) & (relay RLP (M) de-energized, standby emergency p.r.f. selected) & (relay RLG (M) energized, not main pulse generation fault)].

142. This means that:

(1) With main emergency p.r.f. selected, a pulse alignment fault has been detected, but for some reason fault action has not been caused at unit 6 (S). In the absence of any of the overriding conditions, that is with no main pulse generation fault or no loss of main −250V supply, the condition indicates either that output from unit 7 (S) pin 29 has failed to become open circuit or that unit 6 (S) has failed to respond.

(2) Similarly, with standby emergency p.r.f. selected, in the absence of any of the overriding conditions, that is with no standby pulse generation fault or no loss of standby −250V supply, it means that output from unit 7 (S) has failed or that unit 7 (M) has failed to respond.

143. No action is caused by the condition, but the indication (fig. 39) is as follows:

(1) Both inputs to gate G23, unit 8 (S), are open circuit, pin 7 via RLH1 (S) and pin 3 either via RLG2 (M) via RLG2 (M) and RLP1 (M) or via RLE1 (S) and RLP1 (M). As a result, the units 3 (S) and 7 (S) fault lamps are lit.

(2) Also via RLH1 (S) the input SKT AL/30 to gate G11 is open circuit, causing relay RLK (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).

(3) Via RLH2 (S) the PULSE ALIGNMENT IN lamp is switched off and the OUT lamp is switched on.

Power supply faults

Regulator faults

144. If a fault is present at any of the four voltage regulator units in the main cabinet, an earth, derived from the fault relay assembly 403 PLA/4, is applied to PLD/5 of the control, generator pulse (main). Similarly if there is a fault at any of the four voltage regulator units in the standby cabinet an earth is derived from unit 403 PLA/4 in that cabinet and applied to PLD/5 of the control, generator pulse (standby).

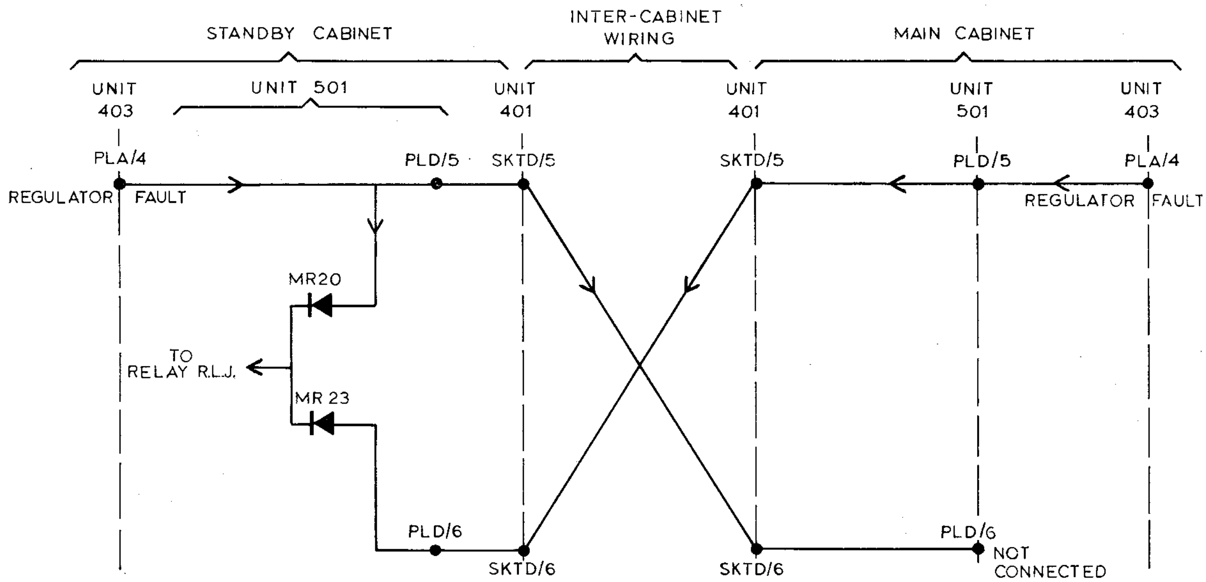

Fig. 21. Regulator faults: schematic diagram

145. The routing of these signals, which is contingent on the fact that the wiring of the main and standby cabinets has to be identical, is shown in fig. 21. As can be seen, a faulty regulator in either cabinet causes relay RLJ (S) to be energized, and thereby the SYSTEM STATE FAULT lamps to be lit (steady, para. 99); the FAULT lamp at the regulator concerned will also be lit. If the faulty unit is regulator unit 301, then since the units in frame 3 are concerned only with the production of delayed pulse outputs, the only further indication will be the loss of these outputs (delayed 0 microsecond and delayed −125 microsecond) as shown by the DM 160 indicators at the panel indicator, pulse.

146. If regulator units 101, 201 or 202 are faulty, then loss of supplies to units monitored by the control, generator pulse units will cause further fault indication to be given. If the −50V supply to the regulators is lost, all +250V and −250V supplies in the cabinet concerned are lost, and faults are signalled by all regulator units though their fault lamps will not light; instead the −50V FAULT lamp on unit 204 lights.

Loss of internal +250V (main)

147. If fuse FS2 (M) fails the +250V (M) supply is lost, and in consequence all main unit relays except RLN (M), RLP (M) and RLQ (M) are automatically de-energized and all fault monitoring circuits (main) cease to function. The h.t. supply for the DM160 indicators (main) in the panel indicator, pulse fails, as does the +30V (M) switching bias.

(1) Action (fig. 38)

(a) Although both main and standby crystal oscillator outputs are present, no r.f. output is produced by unit 1 (M). The main flywheel oscillator is out of action; any inhibition of the standby flywheel oscillator is prevented by the open contact RLJ1 (M). The standby flywheel oscillator therefore free-runs, and pulse outputs are not subject to p.r.f. correction.
(b) Because of the lack of output from the main flywheel oscillator pulse misalignment is detected, but since it is due to the loss of the main −8 microsecond pulses, output from unit 4 (S) overrides pulse generation fault action by unit 6 (S).
(c) Via contact RLK3 (M) PLD/13 is open circuit, demanding select standby from the relay assembly.

(2) Indication (fig. 39)

(a) Because of the general de-energization of relays:

(i) The PULSE GENERATION FAULT (M) lamp is lit.
(ii) The CRYSTAL OSCILLATOR SELECT (M), FAULT (M) and SELECT (S) are unlit.
(iii) Units 2 (M), 4 (M) and 6 (M) fault indications are given.
(iv) In conjunction with the detection of pulse misalignment, the de-energization of relay RLA (M) causes unit 3 (M) fault indication to be given.

(b) The EMERGENCY P.R.F. lamps display is normal since relay RLP (M) is operated from the −50V supply.
(c) The PULSE ALIGNMENT OUT lamp is lit because of the misalignment. Since action by unit 6 (S) is overriden, the unit 3 (S) and 7 (S) fault indication is given.
(d) Also as the result of the detection

of pulse misalignment, relay RLK (S) is energized and the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).
(e) The external emergency trigger lamp is lit via contacts RLM3 (M) and RLK4 (M).

Loss of internal +250V (standby)

148. If fuse FS2 (S) fails the +250V (S) supply is lost and in consequence all standby unit relays except RLJ (S), RLK (S), RLL (S), RLM (S), RLR (S) and RLT (S) are automatically de-energized and all the fault monitoring circuits (standby) cease to function. The h.t. supply for the DM160 indicators (standby) in the panel indicator, pulse fails, as does the +30V (S) switching bias.

(1) Action (fig. 38)

(a) Both the main and standby oscillator outputs are present; main crystal oscillator is automatically selected and the main pulse outputs are subject to p.r.f. correction.
(b) Output from unit 7 (S) is in the fault condition, both outputs from unit 4 (S) are at 0V, and so cannot override fault demand. With the standby flywheel oscillator out of action, it is therefore essential that main emergency p.r.f. be selected, so that fault output from unit 7 (S) cannot cause fault action at unit 7 (M).

(2) Indication (fig. 39)

(a) Because of the general de-energization of relays:

(i) The PULSE GENERATION FAULT (S) lamp is lit.
(ii) The PULSE ALIGNMENT OUT lamp is lit.
(iii) The CRYSTAL OSCILLATOR FAULT (S) lamp is unlit, as is the SELECT (S) lamp since main crystal oscillator is selected.
(iv) Units 1 (S) and 2 (S) fault indications are given.

(b) The open circuit input via RLH1 (S) to unit 8 (M) SKTAM/30 gate G11 causes output at SKTAM/16 to rise to earth, energizing relay RLK (S). As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).

Loss of internal −250V (main)

149. If fuse FS3 (M) fails, then the −250V main supply is removed from all units which employ it; relay RLQ (M), connected between earth and −250V, is de-energized. In general the removal of the −250V negative rail causes the outputs of the units using it to rise to their most positive level, irrespective of the inputs to them. The −30V (M) switching bias fails, as does the −5·6V bias for the DM160 indicators (main) in the panel indicator, pulse; this last failure causes the indicators to light whether or not main pulse inputs are present. Remaining actions and indications due to the −250V (M) failure are:

(1) Action (fig. 38)

(a) Contact RLQ2 (M) changes over, applying +30V (S) via PLC/5 to unit 6 (S) pin 7. This prevents standby pulse misalignment fault actions.
(b) Irrespective of their inputs, the conditions at the main units are as follows:

(i) Unit 2 (M), output pin 23 is at 0V, relay RLA (M) is energized, RLB (M) is de-energized.
(ii) Unit 3 (M), outputs at pins 20 and 26 are both at 0V, relays RLC (M) and RLD (M) are energized.
(iii) Unit 4 (M), relays RLK (M) and RLM (M) are both energized. Main select is called for at the relay assembly, via contact RLK3 (M).
(iv) At unit 1 (M) both the main and standby gate inputs are permissive, the r.f. gates in the unit function almost normally, with a slight shift in operating point. Output from the unit is therefore a mixture of the main and standby crystal oscillator outputs.
(v) Unit 6 (M), output pin 23 is at 0V, relay RLH (M) is energized but relay RLJ (M) is de-energized.
(vi) Because of the open contact RLQ3 (M), relays RLE (M) and RLF (M) and therefore RLG (M) are de-energized. Main pulse generation is thereby inhibited.
(vii) Units 5 (M) and 8 (M) do not use the −250V supply, and so continue to function normally.

(c) With the conditions described, the flywheel oscillators, both main and standby, are fed with both the main and standby crystal frequencies, and the sum and difference frequencies thereof. The flywheel oscillators do not respond to the sum or difference frequencies, but may lock on to either the main or standby r.f., the choice being completely random. In any case, main pulse generation is inhibited, but the standby pulse outputs are produced:

(i) If the standby flywheel oscillator locks on to the main r.f., output pulses are normal and subject to p.r.f. correction.
(ii) If the standby flywheel oscillator locks on to the standby r.f., which is not subject to p.r.f. correction since main is selected at the relay assembly, output pulses are not synchronized with the external p.r.f. demands.

(2) Indication (fig. 39)

(a) Via contact RLG3 (M) the PULSE GENERATION FAULT (M) lamp is lit.

(b) Via contacts RLK2 (M) and RLM2 (M) both the main and standby CRYSTAL OSCILLATOR SELECT lamps are lit.
(c) Since both outputs from unit 3 (M) are at 0V, relays RLF (S) and RLG (S) are both energized and unit 2 (S) fault indication is given.
(d) Remaining equipment state indication is normal, except that a pulse misalignment fault is generated if the flywheel oscillators are locked on to alternative r.f. sources. If pulse misalignment occurs, the PULSE ALIGNMENT OUT lamp is lit via contact RLH2 (S).
(e) Contact RLQ1 (M) is open, so the −50V input supply to the gates in unit 8 (M) is interrupted, as is the −50V supply to the unit fault lamps, so no unit fault lamps are lit. The open circuit input to gate G11 via SKT AM/16 causes output at SKT AM/6 to rise to earth, energizing relay RLK (S). As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).
(f) Via contacts RLM3 (M) and RLK4 (M) the external emergency trigger lamp is lit.

Loss of internal −250V (standby)

150. If fuse FS3 (S) fails, then the −250V standby supply is removed from all units which employ it; relay RLR (S), connected between earth and −250V, is de-energized. In general the removal of the −250V negative rail causes the outputs of the units using it to rise to their most positive level, irrespective of the inputs to them. The −5·6V bias for the DM160 indicators (standby) in the panel indicator, pulse fails; this causes the indicators to light whether or not standby pulse inputs are present. Remaining actions and indications due to the −250V (S) failure are:

(1) Action (fig. 38)

(a) Contact RLR3 (S) changes over, applying +30V (M) via PLB/7 to unit 7 (M) pin 7. This prevents main pulse misalignment fault actions.
(b) Irrespective of their inputs, the conditions of the standby units are as follows:

(i) Unit 1 (S), output pin 23 is at 0V, relay RLA (S) is energized but relay RLB (S) is de-energized.
(ii) Whatever the output from unit 3 (S), output from unit 7 (S) pin 29 is at +30V, relay RLH is energized.
(iii) Unit 4 (S), outputs at pins 11 and 20 are both at +30V, relay RLN (S) is energized.
(iv) Unit 2 (S), relays RLF (S) and RLG (S) are energized.
(v) Because of the open contact RLR4 (S), relays RLC (S) and RLD (S) and therefore RLE (S) are de-energized. Standby pulse generation is thereby inhibited.
(vi) Units 5 (S) and 8 (S) do not use the −250V supply, and so continue to function normally.

(c) With the conditions described, main crystal oscillator continues to be demanded unless it is faulty. In the latter instance the standby crystal oscillator is demanded since output from unit 1 (S) is at 0V. Unit 2 (S) only affects indication, but the combination of units 3 (S) and 7 (S), together with unit 4 (S), cannot now demand pulse misalignment fault action. In any event standby pulse generation is inhibited by contact RLR4 (S), and main misalignment action is inhibited through contact RLR3 (S).

(2) Indication (fig. 39)

(a) Via contact RLE2 (S) the PULSE GENERATION FAULT (S) lamp is lit. Remaining equipment state indication is normal.
(b) Contact RLR2 (S) opens, switching off the SYSTEM STATE NORMAL lamps.
(c) Contact RLR1 (S) is open, so the −50V input supply to the gates in unit 8 (S) is interrupted, as is the −50V supply to the unit fault lamps, so no unit fault lamps are lit. The open circuit input to gate G11, unit 8 (M), via SKT AM/30 causes output at SKT AM/6 to rise to earth, energizing relay RLK (S). As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).

Loss of internal 240V a.c. (main)

151. If fuse FS1 (M) fails, all heater supplies to the units 1 (M) to 7 (M) are lost, as are the 6·3V supplies to the equipment state lamps (main) and to the EMERGENCY P.R.F. STAND-BY SELECTED and standby OSCILLATOR SELECT lamps.

(1) Action (fig. 38)

(a) Although both the main and standby crystal oscillator outputs are present, no r.f. output is produced by unit 1 (M). The main flywheel oscillator is out of action, inhibition of the standby flywheel oscillator is prevented by the open contact RLJ1 (M). The standby flywheel oscillator therefore free-runs.

(b) As the valve heaters in the main flywheel oscillator start to cool, so the frequency of the r.f. output shifts. This causes a pulse alignment fault which occurs before the main −8 microsecond pulses are lost, so no overriding action is initiated by unit 4 (S). Subsequent action depends on whether main or standby emergency p.r.f. has been selected:

(i) If main emergency p.r.f. is selected, as is normal, fault output from unit 7 (S) causes unit 6 (S) to inhibit standby pulse generation. Since output from the main flywheel oscillator also ceases, all output pulses are lost.
(ii) If standby emergency p.r.f. is selected, fault output from unit 7 (S) causes unit 7 (M) to inhibit main pulse generation, which in any case is lost. Standby pulse generation continues, the output pulses not being subject to p.r.f. correction.

(2) Indication (fig. 39)

(a) Because of the loss of the 6·3V lamp supply, all of the equipment state (main) lamps are unlit, as are the standby CRYSTAL OSCILLATOR SELECT and EMERGENCY P.R.F. STAND-BY SELECTED lamps.
(b) Because of the general de-energization of relays, units 2 (M), 4 (M) and 6 (M) fault indications are given. The detection of pulse misalignment plus the de-energization of relay RLA (M) causes unit 3 (M) fault indication to be given.
(c) Since both relays RLC (M) and RLD (M) are de-energized unit 2 (S) fault indication is not given.
(d) The detection of pulse misalignment causes the PULSE ALIGNMENT OUT lamp to be lit.
(e) If main emergency p.r.f. is selected the standby PULSE GENERATION FAULT lamp is lit; if standby emergency p.r.f. is selected the standby PULSE GENERATION NORMAL lamp is lit.
(f) Both inputs to gate G11 are open circuit, SKT AM/16 via RLH2 (M) and SKT AM/30 via RLH1 (S). Either of these inputs is sufficient to cause output at SKT AM/6 to rise to earth, energizing relay RLK (S). As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).
(g) Via contacts RLM3 (M) and RLK4 (M) the external emergency trigger lamp is lit.

Loss of internal 240V a.c. (standby)

152. If fuse FS1 (S) fails, all heater supplies to the units 1 (S) to 7 (S) are lost, as are the 6·3V supplies to the equipment state lamps, except for the EMERGENCY P.R.F. SELECTED and CRYSTAL OSCILLATOR SELECT lamps which are supplied from the main unit. All standby unit relays except RLJ (S), RLK (S), RLL (S), RLM (S), RLR (S) and RLT (S) are automatically de-energized and all the fault monitoring circuits (standby) cease to function. The supply to drive the goniometer is also lost.

(1) Action (fig. 38). The equipment continues to function with the main crystal oscillator selected. Pulse alignment output from unit 7 (S) is at the fault level, and is not overridden by the output from unit 4 (S). Therefore:

(a) With main emergency p.r.f. selected, fault output from unit 7 (S) is fed to unit 6 (S). Since this unit is already out of action, the input has no effect, and the equipment continues to run with main pulse generation.
(b) With standby emergency p.r.f. selected, the open contact RLE3 (S) inhibits the fault output from unit 7 (S), unit 7 (M) pin 7 is returned via RLE3 (S) to +30V (M), so main pulse generation is unaffected.

(2) Indication (fig. 39)

(a) The CRYSTAL OSCILLATOR SELECT (S) lamp is unlit, since main crystal oscillator is selected; the EMERGENCY P.R.F. STANDBY SELECTED lamp is lit if standby emergency p.r.f. has been selected. The remaining equipment state lamps (standby) are unlit because of the loss of the 6·3V supply to them.
(b) Because of the general de-energization of relays, units 1 (S) and 2 (S) fault indications are given; also those of units 3 (S) and 7 (S), and unit 5 (S) if standby emergency p.r.f. is selected.
(c) Via contact RLH1 (S) input to SKT AM/30 of gate G11 is open circuit, causing relay RLK (S) to be energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99).

Loss of internal −50V (main)

153. If fuse FS4 (M) fails:

(1) Action (fig. 38)

(a) Relays RLN (M) and RLP (M) are released, changing to EMERGENCY P.R.F. STANDBY.
(b) No further action takes place. The equipment continues to function in the normal manner, except that the −50V (M) supply is not available to operate relay RLT (S) should it be required.

(2) Indication (fig. 39)

(a) Changeover to EMERGENCY P.R.F. STANDBY SELECTED is made via contact RLP2 (M).
(b) The −50V input supply to the gates in unit 8 (M) and to the unit fault lamps has failed. No unit fault lamps are lit, but since input SKT AM/16 to gate G11 is open circuit then relay RLK (S) is energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para. 99), except at the control, generator pulse (main) where all SYSTEM STATE lamps are out due to the loss of −50V (M).

Loss of internal −50V (standby)

154. If fuse FS4 (S) fails:

(1) Action (fig. 38). No action takes place.

(1) The equipment continues to function in the normal manner, except that the –50V (S) supply to the gates in unit (8/S) and to the unit fault lamps are failed. No unit fault lamps are lit ▶◀ . Relays RLJ (S), RLK (S), RLL (S) and RLM (S) are not affected, since they are connected to the unfused side of the –50V supply.

(2) Indication (fig. 39). The –50V input supply to the gates in unit 8 (S) and to the unit fault lamps has failed. No unit fault lamps are lit, but since input SKT AM/30 to gate G11, unit 8 (M) is open circuit, then relay RLK (S) is energized. As a result the SYSTEM STATE FAULT lamps are lit (flashing, para.99), except for the control, generator pulse (standby) where all SYSTEM STATE lamps are out, due to the loss of –50V (S).

MONITOR POINTS

155. A series of test sockets, SKTP to SKTAC, is provided on both the main and standby units for checking the d.c. voltages, and the waveform levels at certain points in the circuits. Measurement is made by means of a multimeter Type 1 or equivalent meter, set to the appropriate ranges. The voltages obtainable at these test points are listed in Table 2, together with the service that is being monitored. At waveform monitoring points a d.c. voltage is obtained, whose amplitude is proportional to the amplitude of the waveform.

TABLE 2

Level test readings

Test socket: Main SKT	Test socket: Standby SKT		Voltage or waveform level: Reading	Voltage or waveform level: Tolerance
P	–	D.C. level proportional to r.f. output from unit 1 (M)	1·5V	Not less than
–	P	–5·6V bias for DM160 indicators	–5·6V	±10%
Q	–	Select main output from unit 3(M)	0·6V or –15V	±0·2V ±10%
–	Q	D.C. level proportional to r.f. output from panel electronic circuit	1·5V	Not less than
R	–	Select standby output from unit 3(M)	0·6V or –15V	±0·2V ±10%
–	R	+43V h.t. for DM160 indicators	43V	Not less than 39V
S	–	D.C. level proportional to r.f. output from flywheel oscillator unit 5(M)	1·5V	Not less than
–	S	D.C. level proportional to r.f. output from flywheel oscillator unit 5(S)	1·5V	Not less than
T	T	H.T. +ve No.1	+250V	±2V
U	U	H.T. +ve No.2		H.T. +ve Nos.2-6 within 0·1V of H.T. +ve No.1
V	V	H.T. +ve No.3		
W	W	H.T. +ve No.4		
X	X	H.T. +ve No.5		
Y	Y	H.T. +ve No.6		
Z	Z	H.T. –ve No.1	–250V	±2V
AA	AA	H.T. –ve No.2		within 0·1V of H.T. –ve No.1
AB	AB	+250V (fused)	+250V	±2V
AC	AC	–250V (fused)	–250V	±2V

Use of the lamp extractor tool

156. A lamp extractor tool, in the form of a pair of special forceps, is held in a tool-holder which is mounted on the interior of the right-hand side of the cabinet framework, adjacent to the control, generator pulse unit.

157. The tool is used when it is desired to replace any of the lamps in the lampholders on the control panels of the control, generator pulse units. The groups of up to four lamps are accessible by pulling off the transparent covers over them. Each lamp is held in place be means of four spring fingers; the lamp extractor tool serves the dual purpose of holding the lamp and forcing back the fingers so that the lamp may be withdrawn or inserted.

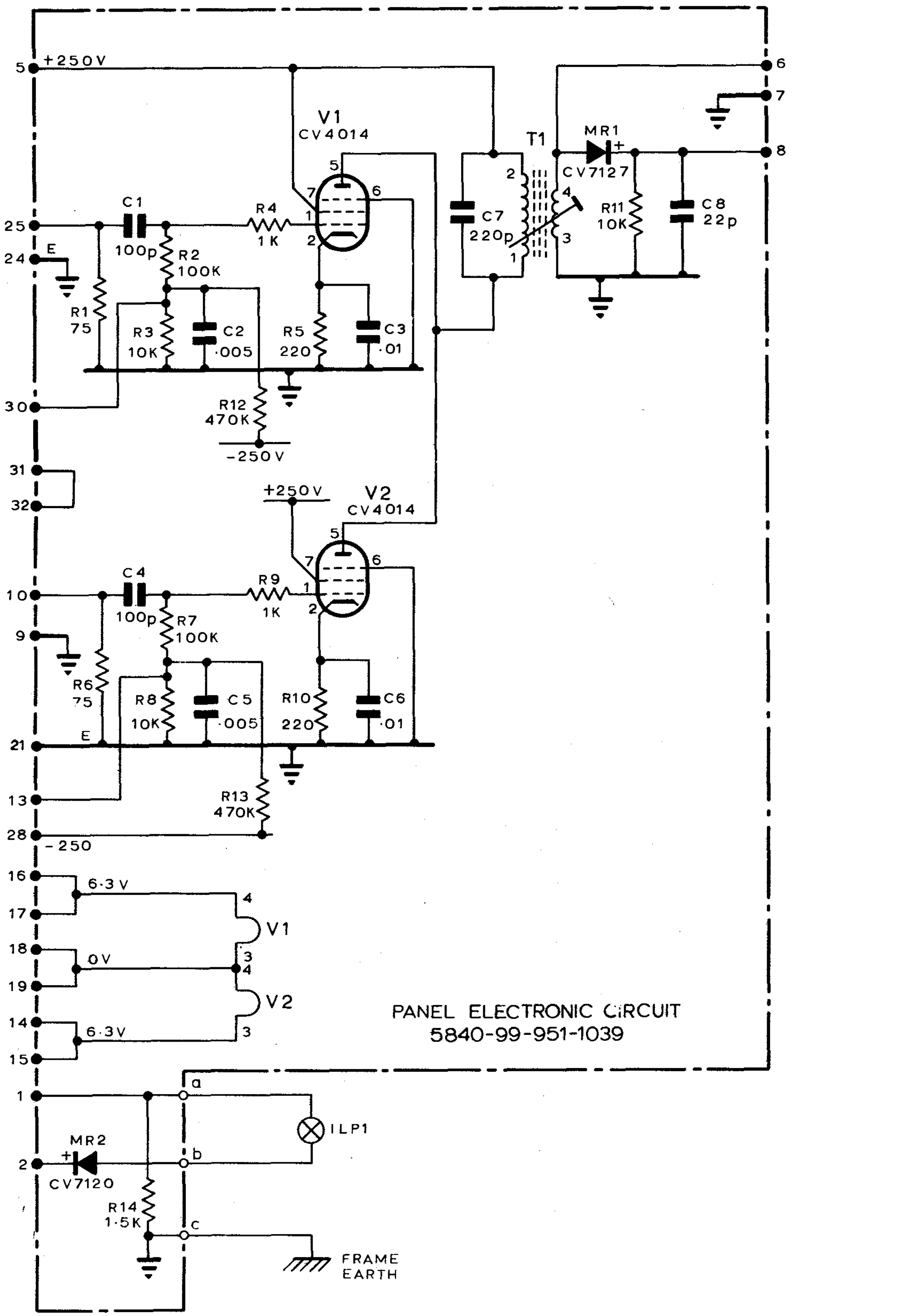

Fig.22 Electronic switch, r.f., 5840-99-951-3238 : circuit

D.87705. 572442. S\W. 2/66

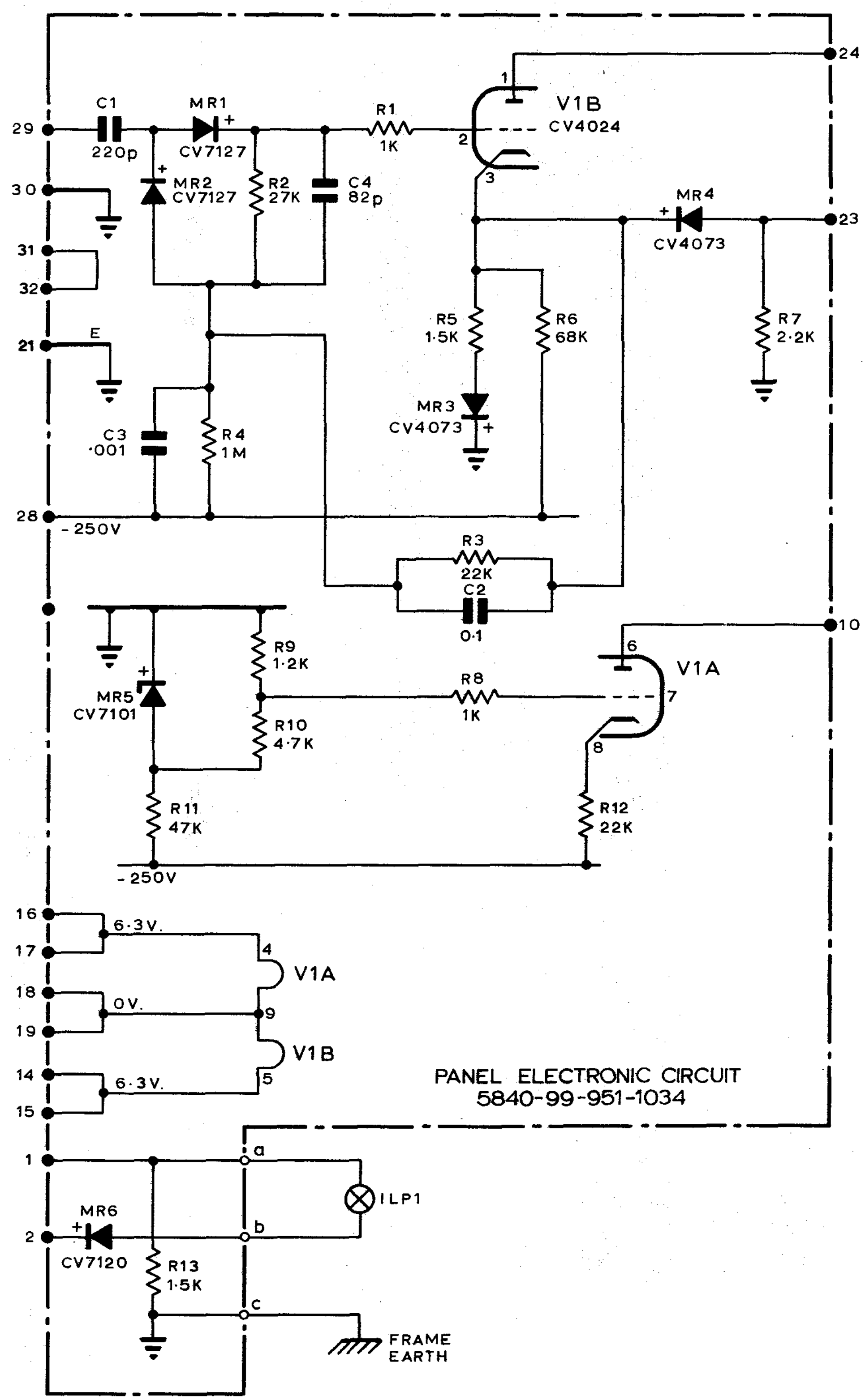

Fig.23 Detector, r.f. failure, 5840-99-951-3236 : circuit

D.87705. 572442. S.W. 2/66

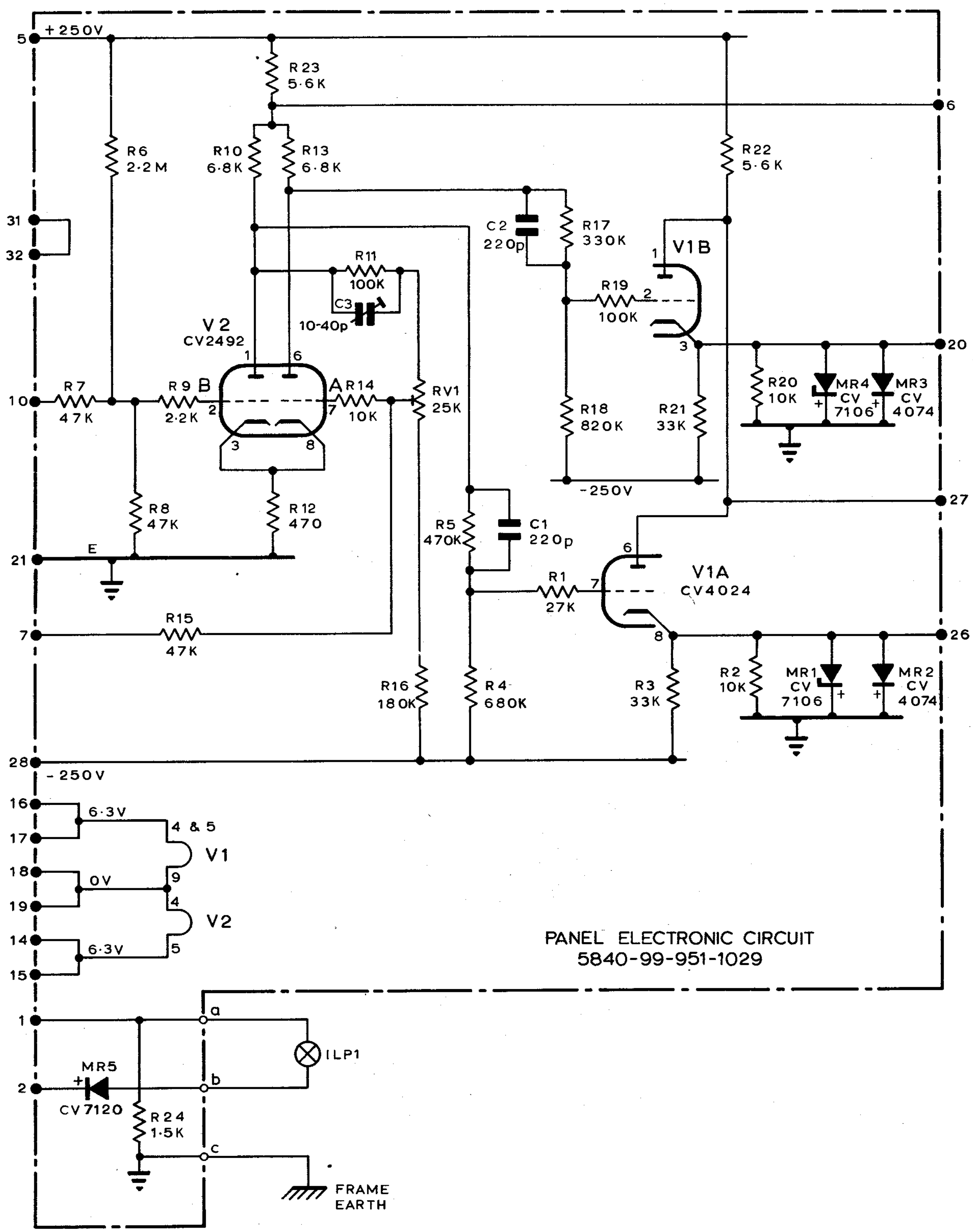

Fig. 24 Electronic switch, 5840-99-951-3242: circuit

D.87705. 572442. S.W. 2/66

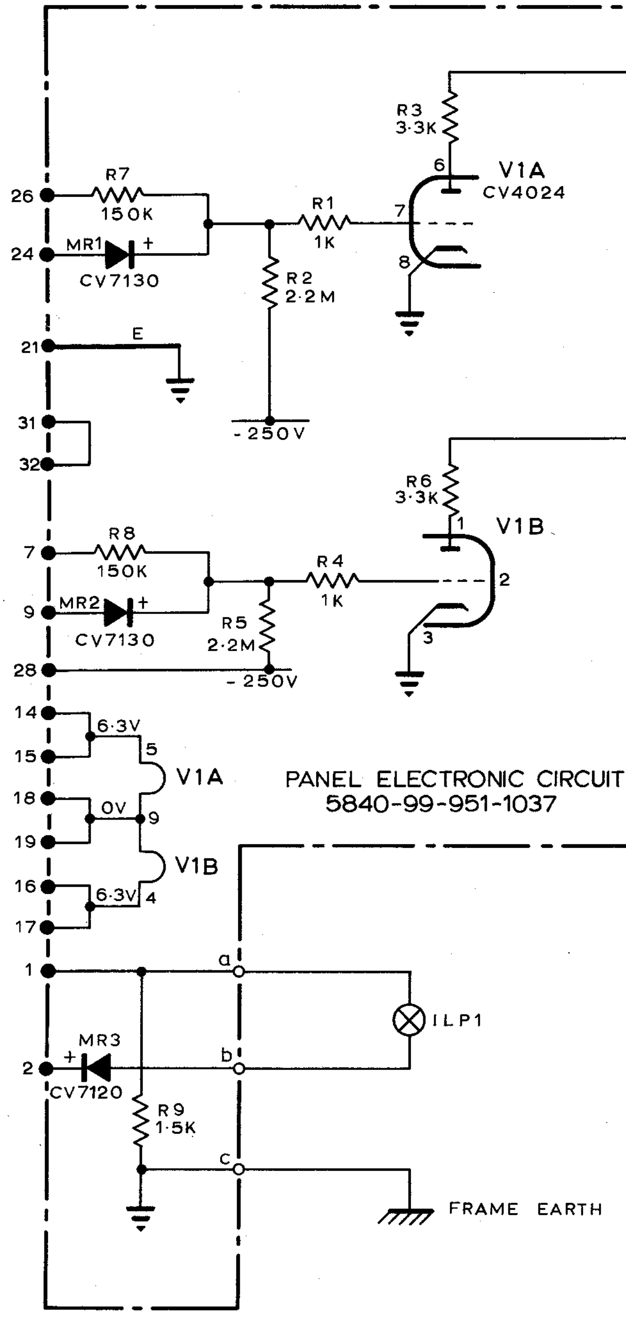

Fig. 25 Driver, relay, 5840-99-951-3237: circuit

D.87705. 572442. S.W. 2/66

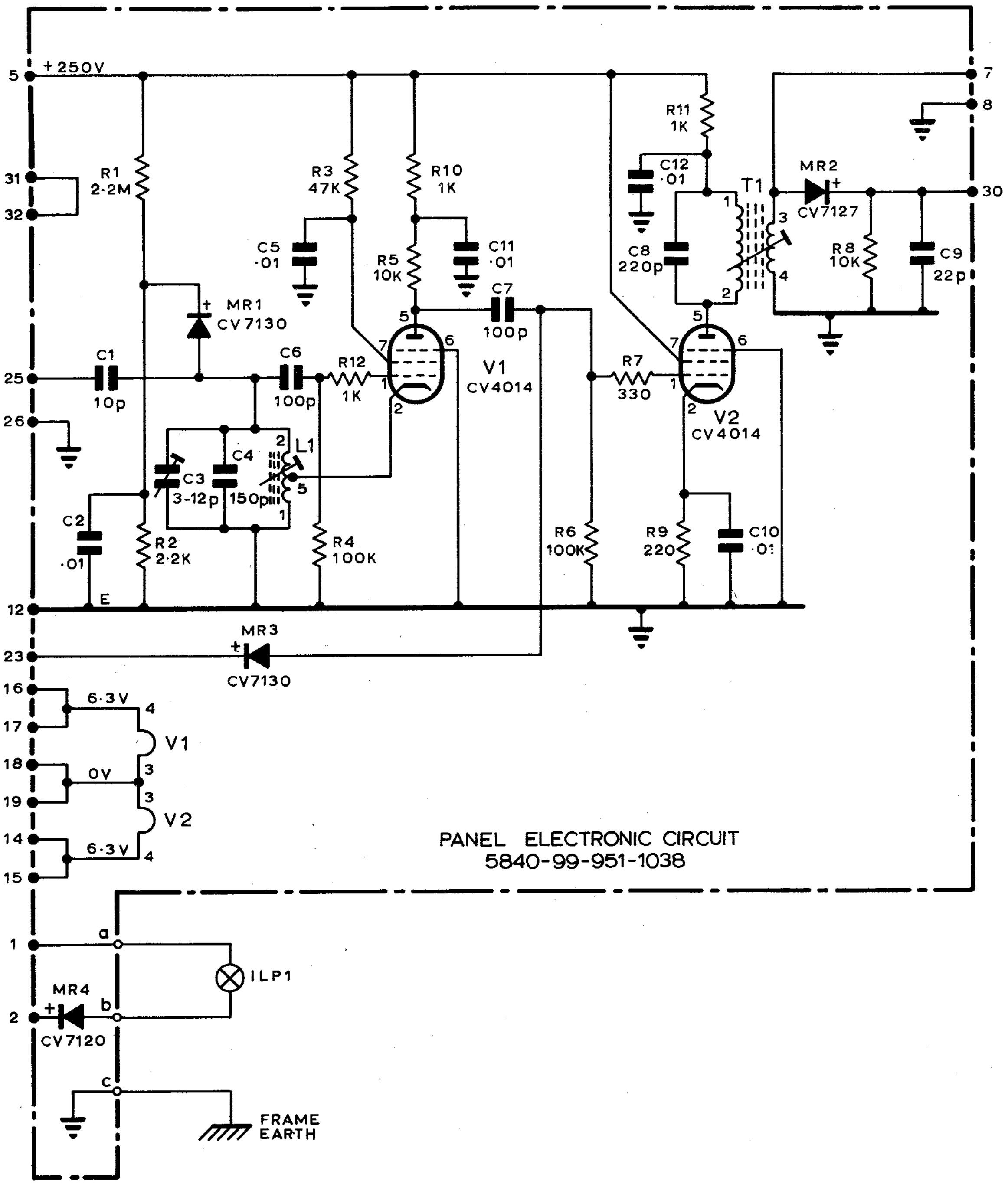

Fig.26 Oscillator, flywheel, 5840-99-951-3245: circuit

D.87705. 572442. S.W. 2/66

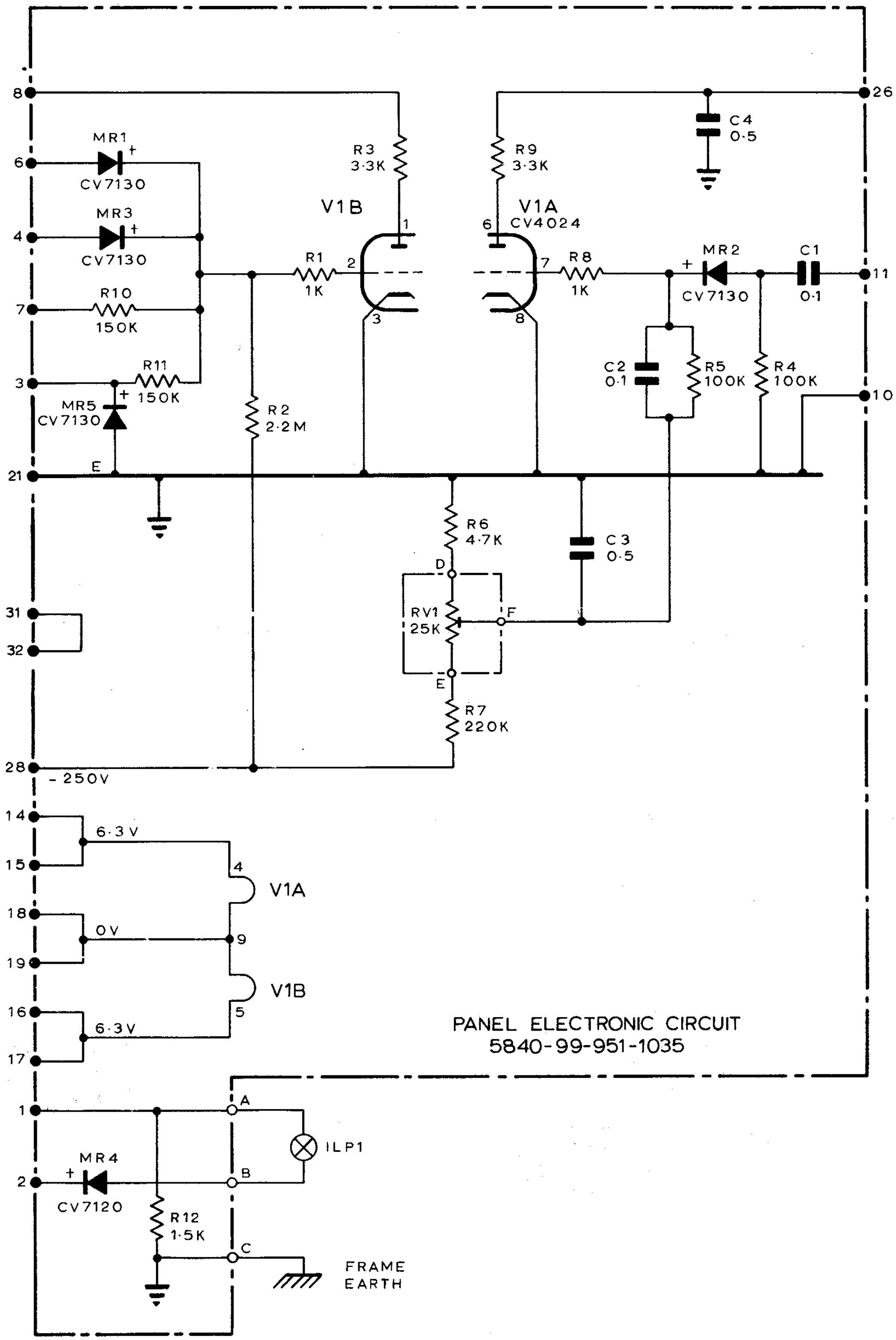

Fig. 27 Detector, failure 250 c/s, 5840-99-951-3922: circuit

D.87705. 572442. S.W. 2/66

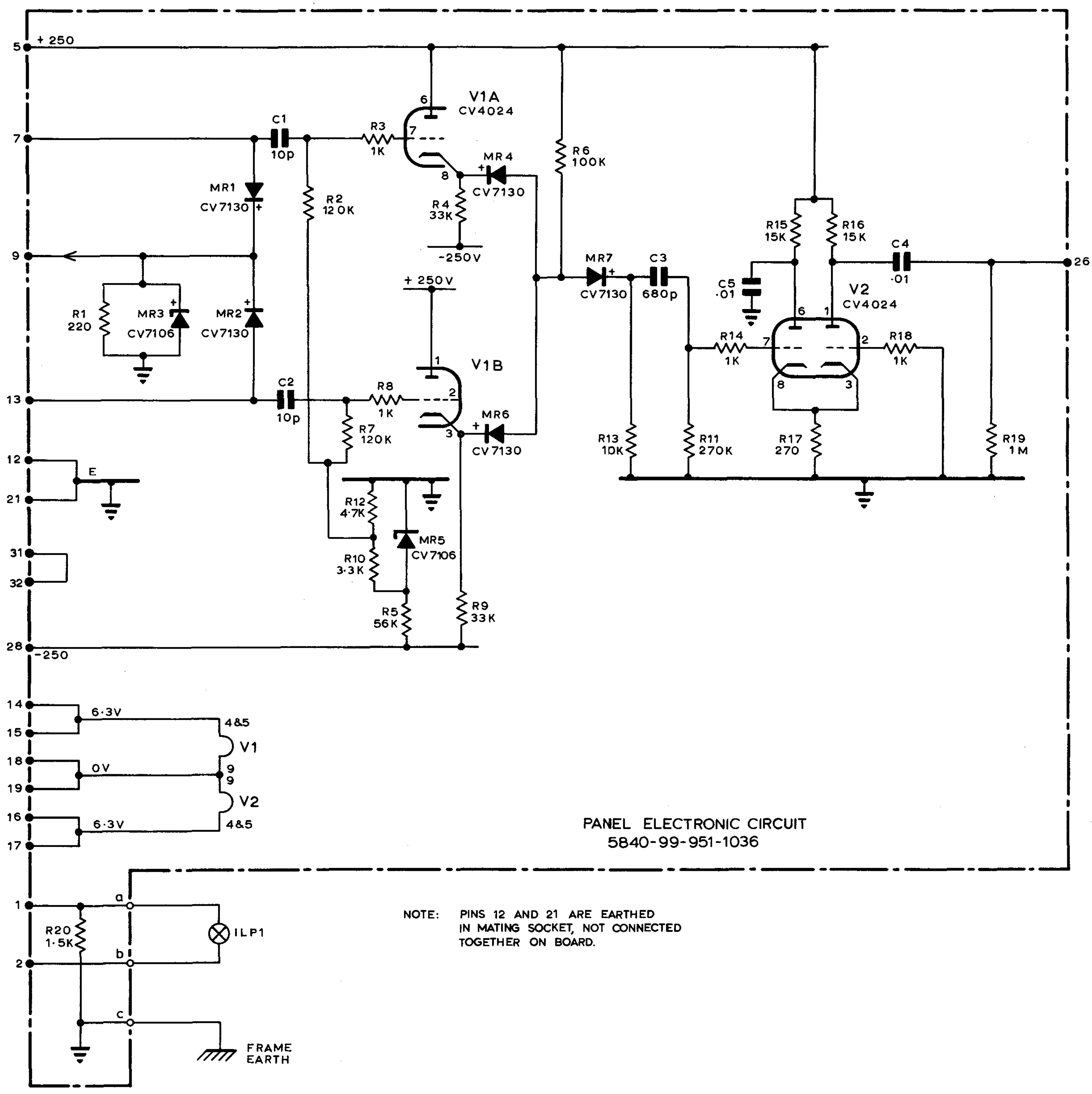

Fig.28 Pulse alignment unit 'A', 5840-99-951-3240: circuit Fig.28

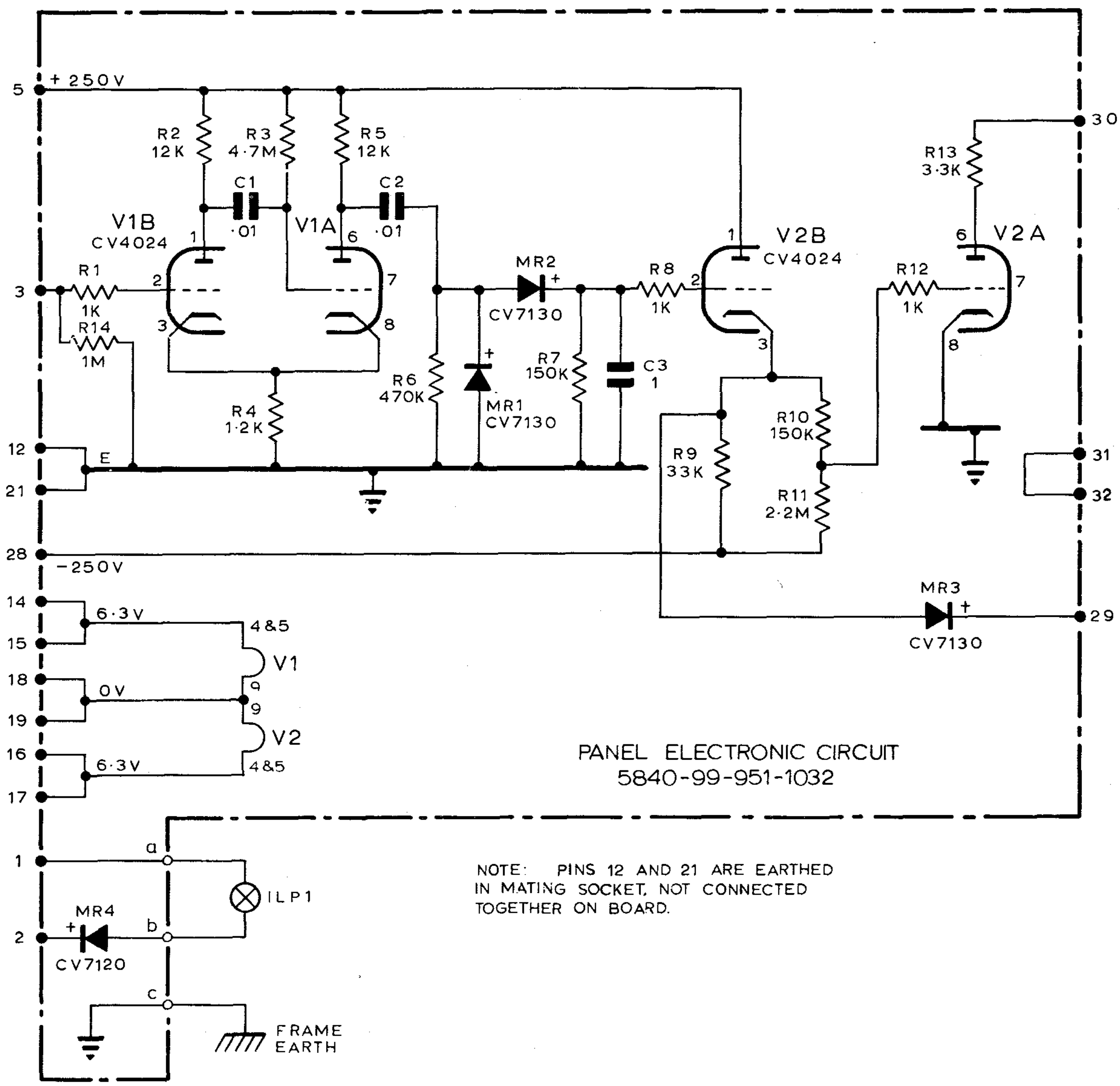

Fig. 29 Pulse alignment unit 'B', 5840-99-951-3244: circuit

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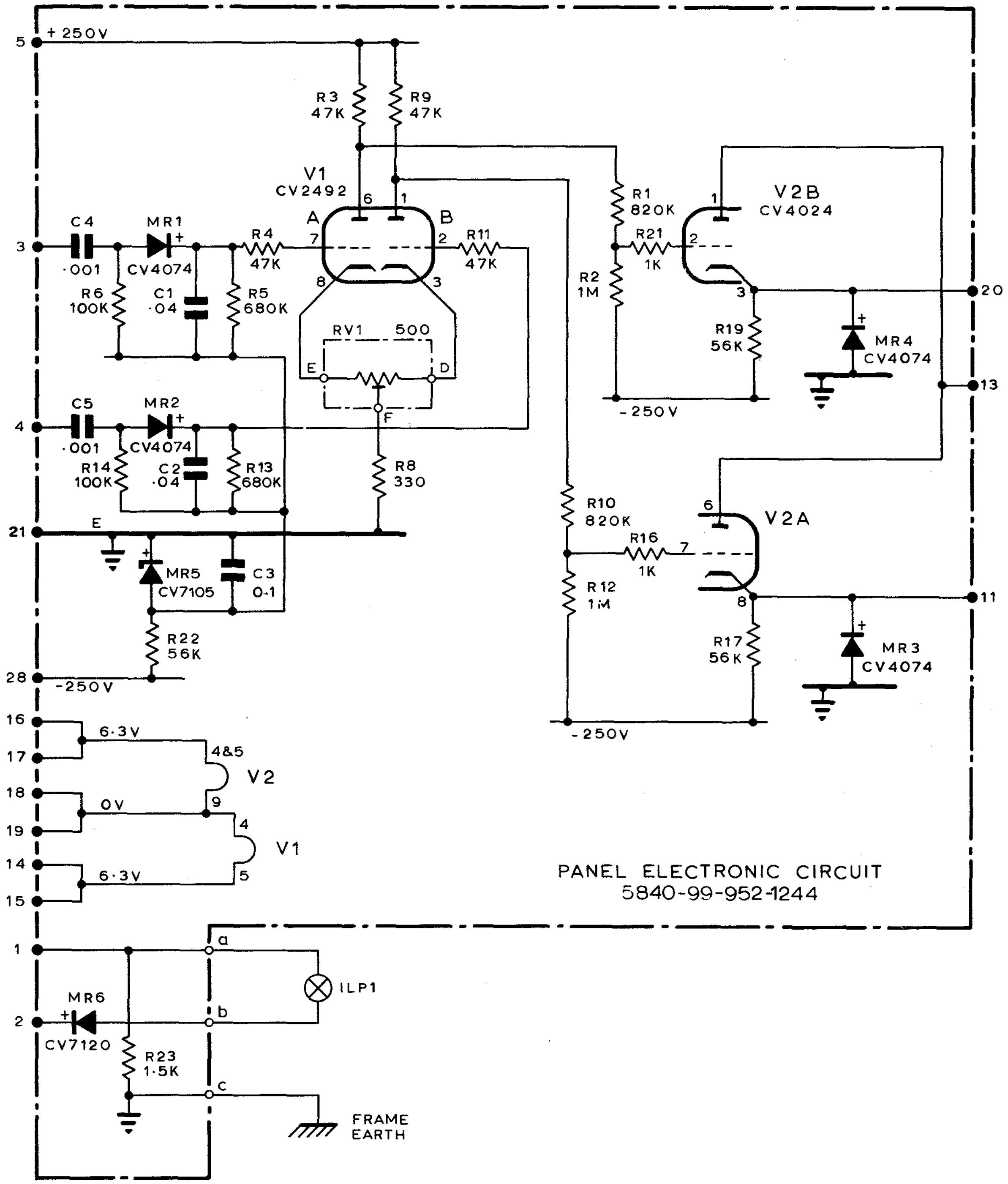

Fig. 30 Electronic switch, pulse, 5840-99-952-1017: circuit

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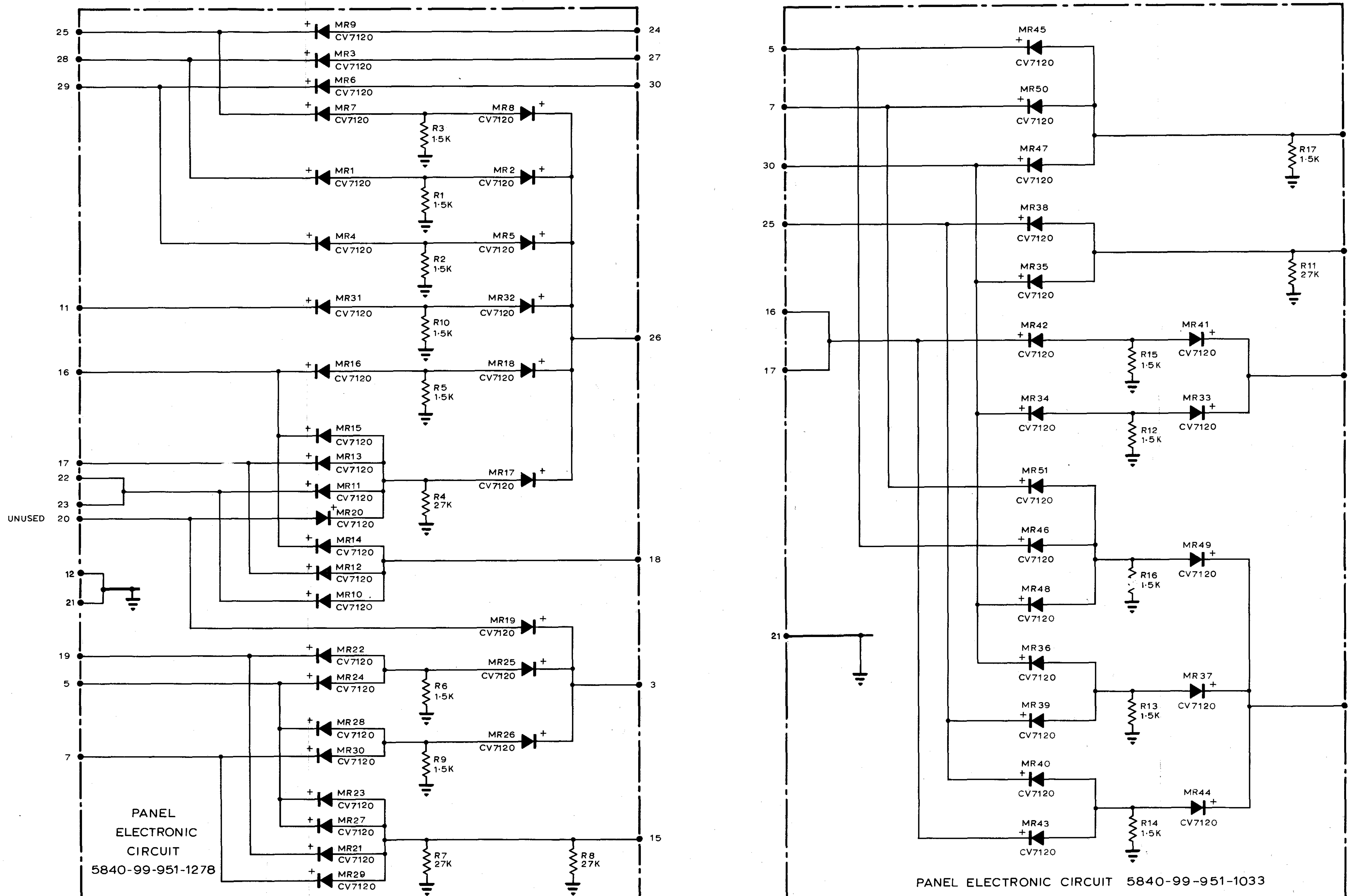

Fig. 31

D.87705. 572442. S.W. 2/66

Lamp logic unit 'A', 5840-99-951-3243 : circuit

Fig. 31

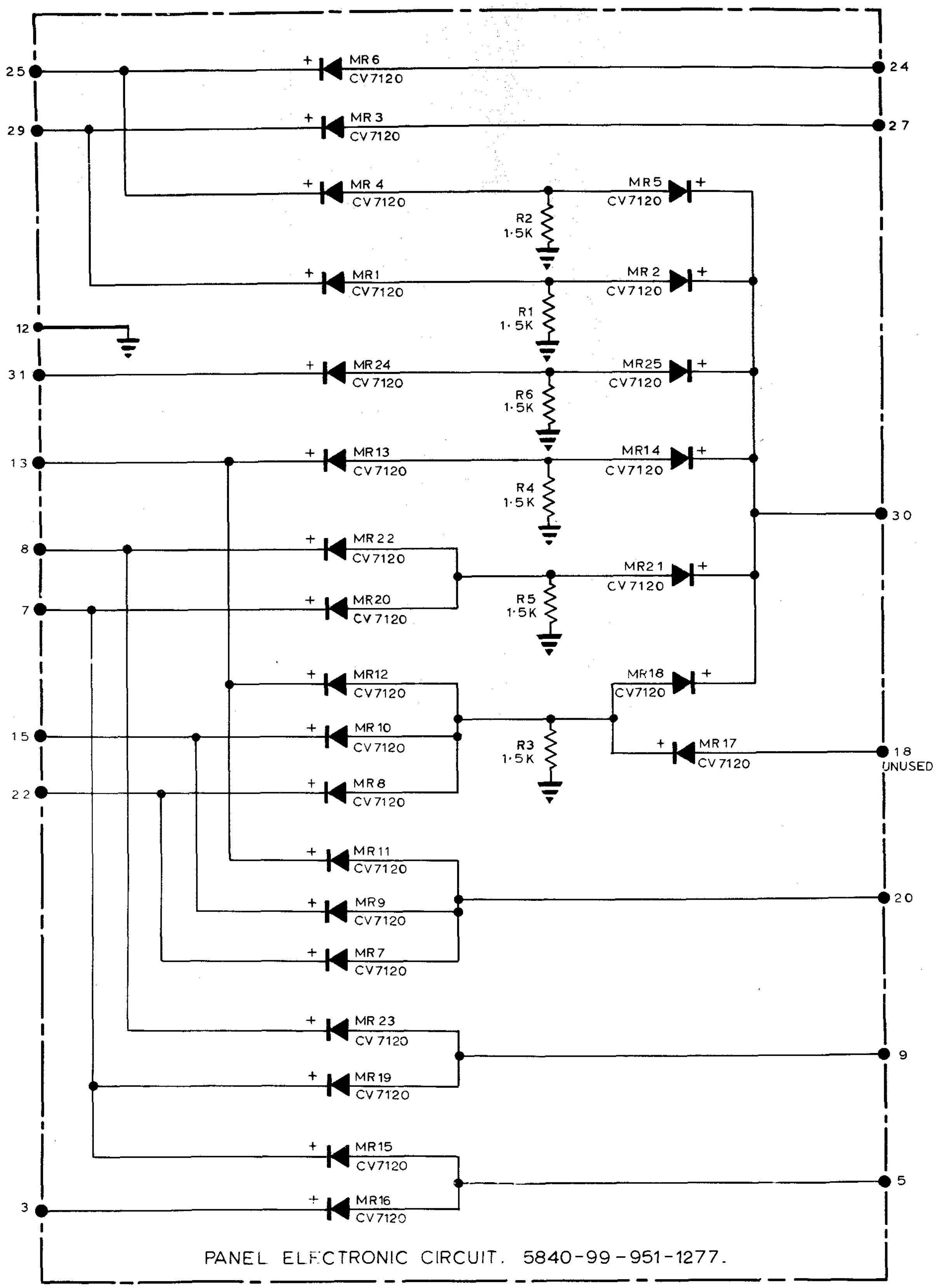

Fig. 32 Lamp logic unit 'B', 5840-99-951-3239: circuit.

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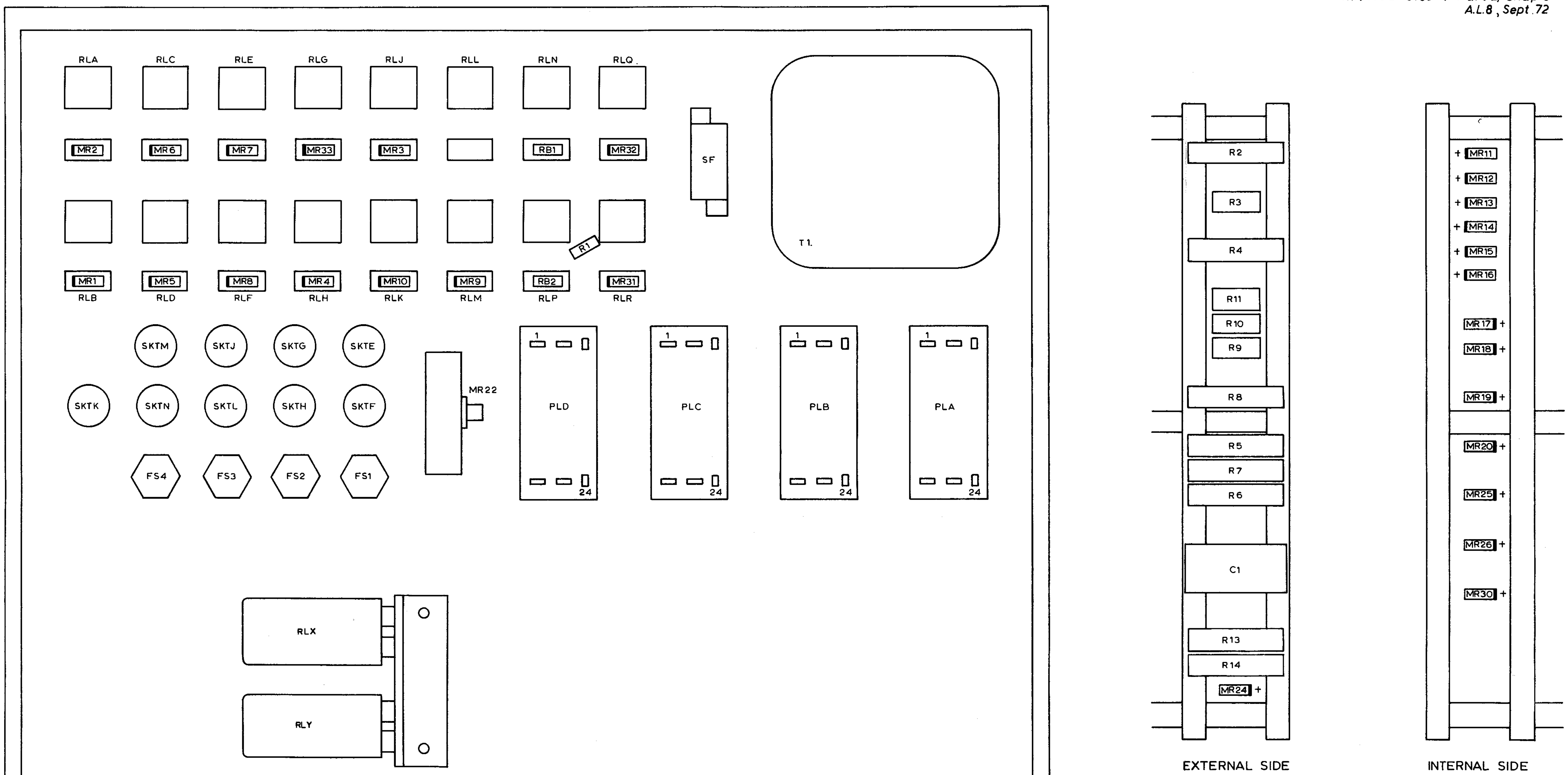


VIEWS OF TAGBOARD

Fig. 33 Control, generator pulse (main): main framework, component location Fig. 33

CA 2588

SPARE RELAY CONTACTS	
RLA	4,5,6, 24, 25,26.
RLB	1,2,3, 4, 5, 6
RLE	1,2, 21, 22
RLF	1,2,
RLG	1,2,3,
RLM	21,22,23.
RLQ	4,5,6.

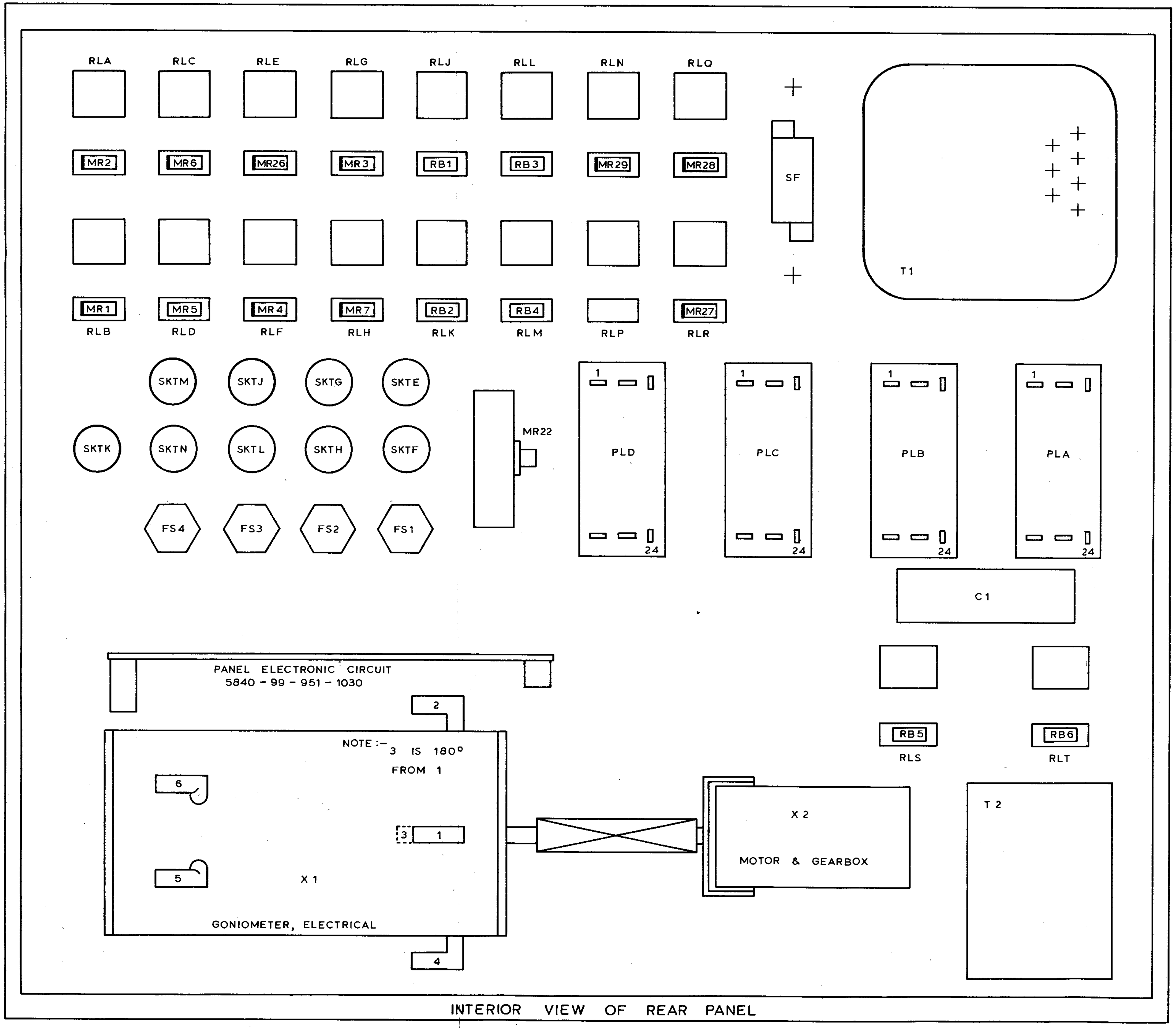
NOTE: UNITS MARKED ✱ HAVE PINS 31 AND 32 INTERNALLY CONNECTED

UNIT	FUNCTION	SKT	SPARE PINS
1	ELECTRONIC SWITCH, R.F.	AD	3,4,11,20, 22, 23, 26, 27, 29, 31, 32. ✱
5	OSCILLATOR, FLYWHEEL	AE	3,4, 6, 9,10,11,13, 20, 22, 24, 27 – 29, 31, 32. ✱
2	DETECTOR, R.F. FAILURE	AF	3 – 9, 11,13, 20, 22, 25 – 27, 31, 32. ✱
6	DETECTOR, R.F. FAILURE	AG	3 – 9, 11, 13, 20, 22, 25 – 27, 31, 32. ✱
3	ELECTRONIC SWITCH	AH	3,4,8,9,11,13, 22 – 25, 29 – 32. ✱
7	DETECTOR, FAILURE 250 c/s	AJ	4 – 6, 9, 13, 20, 22 – 25, 27, 29 – 32 ✱
4	DRIVER, RELAY	AK	3 – 8, 11, 13, 20, 22, 25 – 27, 29 – 32. ✱
8	LAMP LOGIC UNIT 'A'	AL	1,2,4,6,8 – 10,13,14,20,31,32.
		AM	1 – 4, 8,10,11,13 – 15,18,21 – 24,26 – 29,31,32.

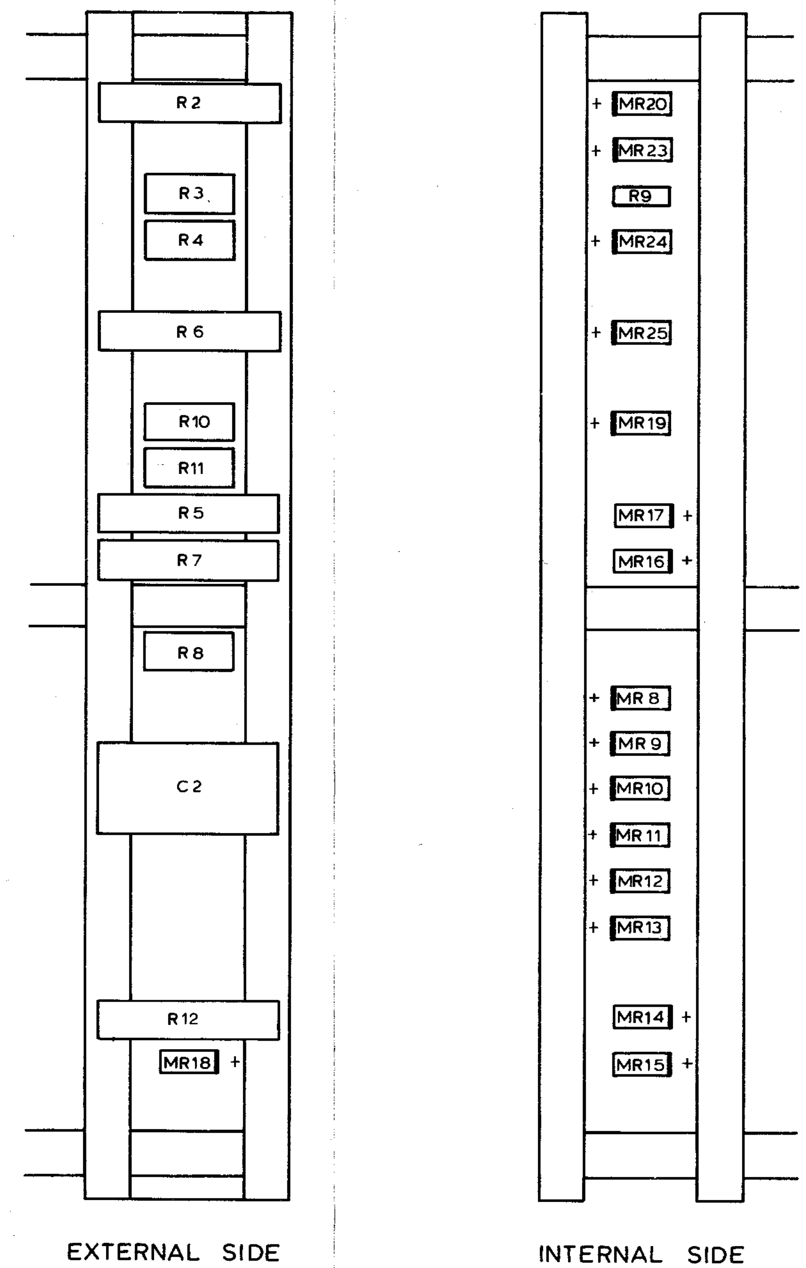
Fig. 34 CA2500 2588 CA414 9/3 D.939988 R.C.1646 BASED ON DRG. R60 – 0549Z ISSUE 4

Control, Generator Pulse (Main) main framework, circuit.

Fig. 34



INTERIOR VIEW OF REAR PANEL



VIEWS OF TAG BOARD

Fig. 35
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Control, generator pulse (standby): main framework, component location

Fig. 35

SPARE RELAY CONTACTS	
RLB	1,2,3, 4,5,6.
RLC	1,2, 21,22.
RLD	1,2,
RLE	1,2,3.
RLF	1,2,3, 4,5,6, 21,22,23.
RLG	1,2,3, 4,5,6, 21,22,23.
RLH	1,2,3, 4,5,6.
RLJ	1,2,3, 21,22,23.
RLK	21,22,23.
RLL	1,2,3, 21,22,23.
RLM	21,22,23.
RLN	1,2,3, 21,22,23,24,25,26.
RLS	4,5,6, 24,25,26.
RLT	4,5,6 24,25,26

NOTE: UNITS MARKED * HAVE PINS 31 AND 32 INTERNALLY CONNECTED

UNIT	FUNCTION	SKT	SPARE PINS
1	DETECTOR, R.F. FAILURE	AD	3-9, 11,13,20,22, 25-27, 31,32.*
5	OSCILLATOR, FLYWHEEL	AE	3,4,6,9-11,13,20,23,24,27-29,31,32.*
2	DRIVER, RELAY	AF	3-8, 11,13,20,22, 25-27, 29-32.*
6	DETECTOR, FAILURE 250 c/s	AG	4-6, 9,13,20,22-25, 27, 29-32.*
3	PULSE ALIGNMENT UNIT 'A'	AH	3,4,6,8,10,11,20,22-25,27,29-32.*
7	PULSE ALIGNMENT UNIT 'B'	AJ	4,6-11,13,20,22-27, 31,32*
4	ELECTRONIC SWITCH, PULSE.	AK	6-10, 22-27, 29-32.
8	LAMP LOGIC UNIT 'B'	AL	1,2,4,6,10,11,14,16,17,19,23,26,28,32.

Fig. 36

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CA 2720
CA 4150

D.939988 R.C.1646

Control, generator pulse (standby): main framework, circuit.

Fig. 36

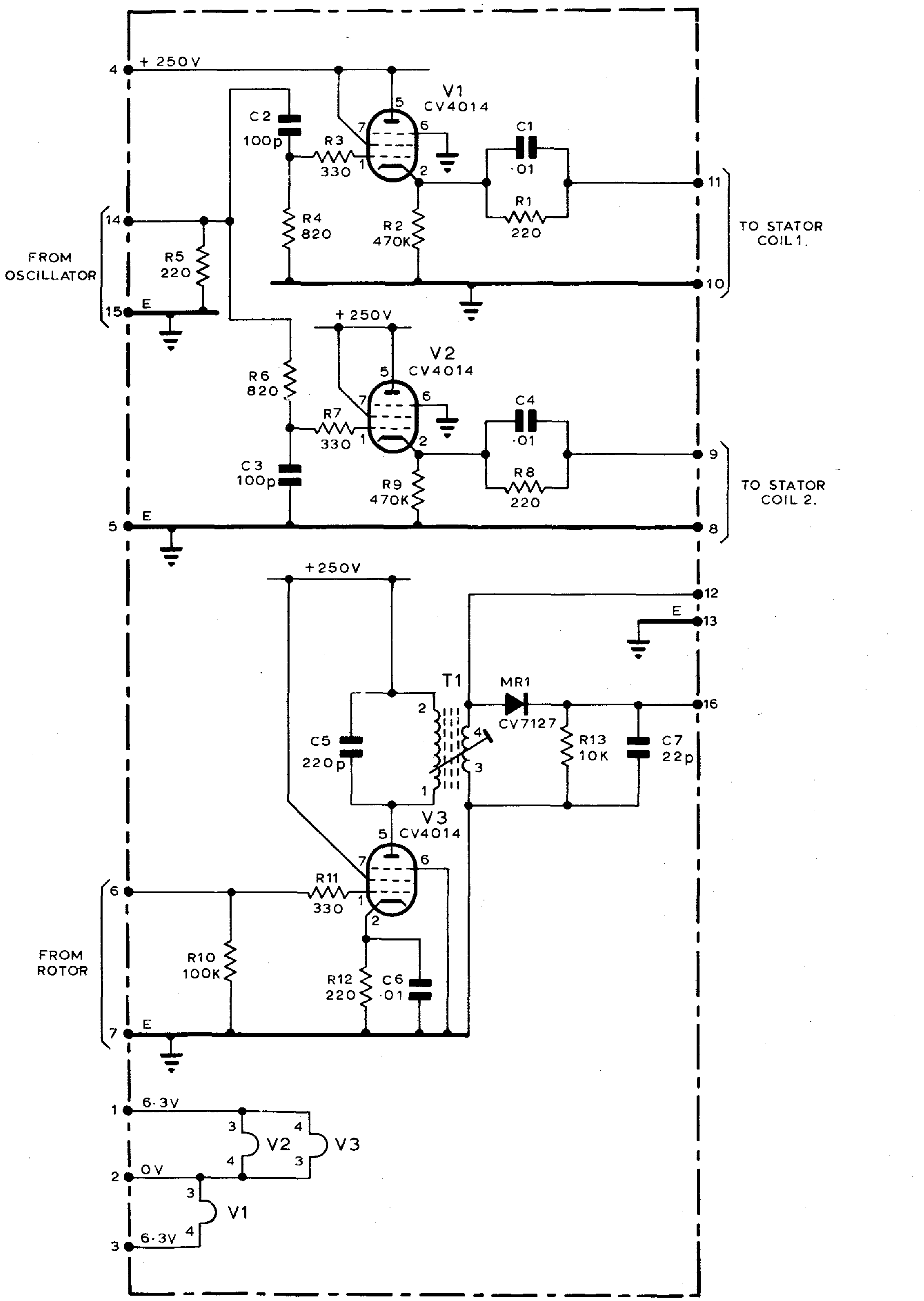
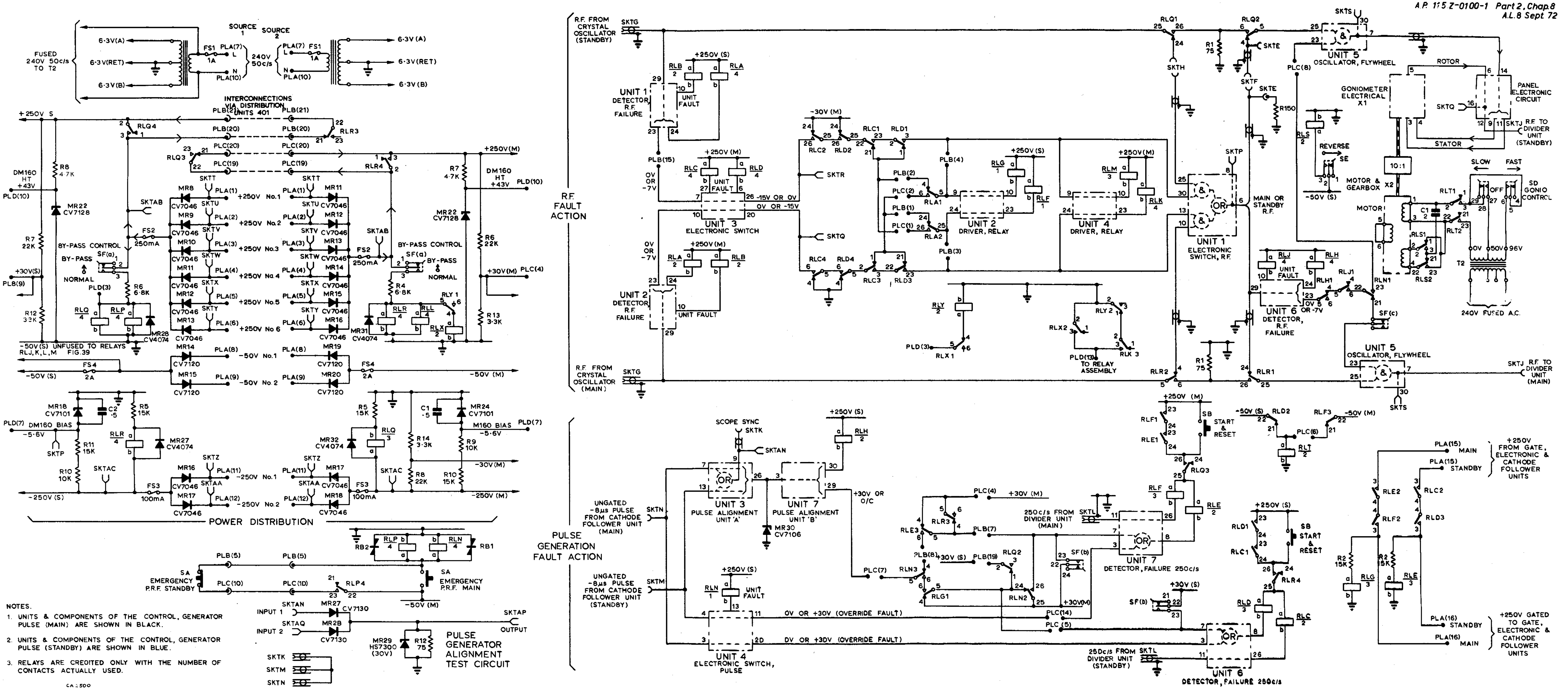


Fig. 37 Panel electronic circuit, 5840-99-951-1030: circuit

D.87705. 572442. S.W. 2/66



NOTES.
1. UNITS & COMPONENTS OF THE CONTROL, GENERATOR PULSE (MAIN) ARE SHOWN IN BLACK.
2. UNITS & COMPONENTS OF THE CONTROL, GENERATOR PULSE (STANDBY) ARE SHOWN IN BLUE.
3. RELAYS ARE CREDITED ONLY WITH THE NUMBER OF CONTACTS ACTUALLY USED.

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2501
2597
2585
4149

Fig.38 Control, generator pulse, units (main & standby): combined schematic, power distribution & fault monitoring Fig.38

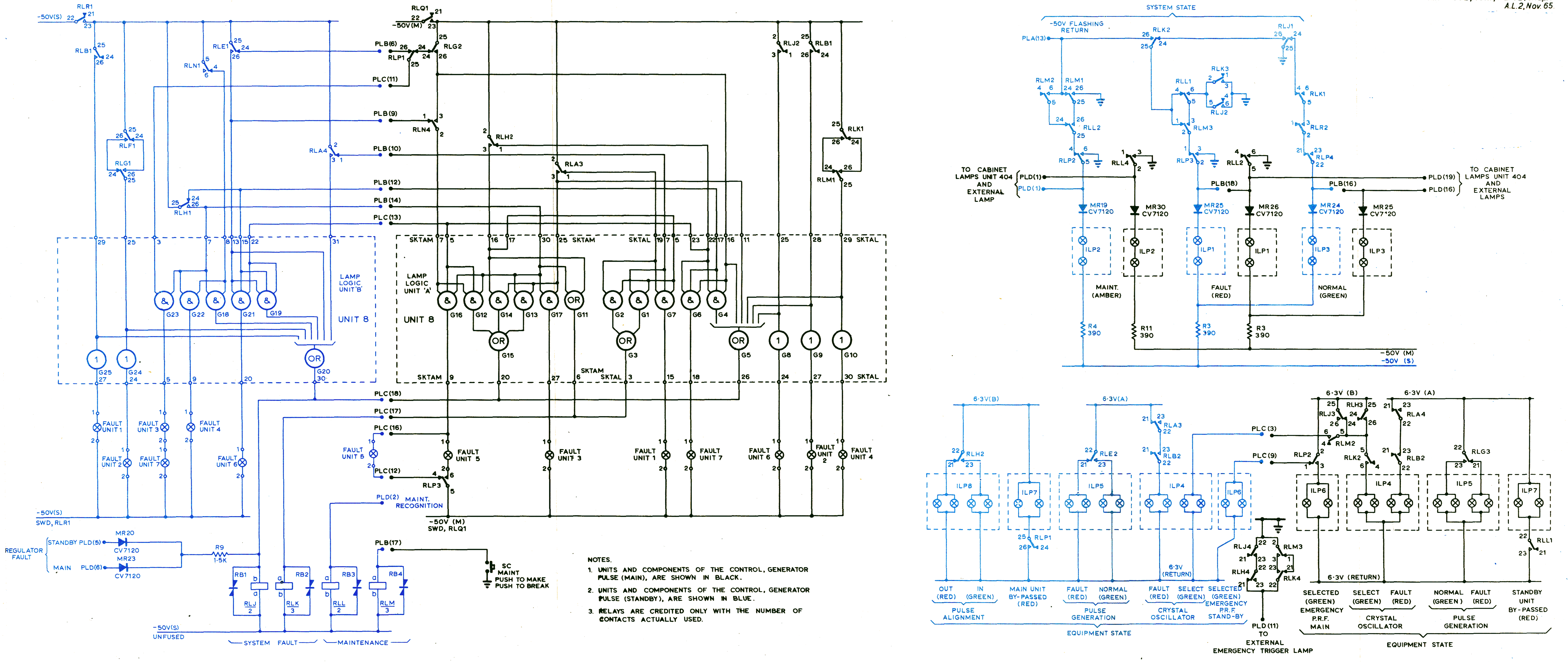

Fig.39 Control, generator pulse units (main & standby) : combined schematic, indication Fig.39

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Chapter 9

RELAY ASSEMBLY 5945-99-948-9225

CONTENTS

INTRODUCTION

1 The relay assembly (fig.1) performs a changeover function on the eight r.f. carrier signals and the p.r.f. reference signals supplied from the main and standby p.r.f. cabinets. Under normal operation the unit selects the inputs from the main cabinet, for external distribution. A failure in the main cabinet causes the relays to change over and select the inputs from the standby p.r.f. cabinet.

2 The relay assembly is mounted on brackets fixed to the distribution unit, pulse (Chap.10).

PERFORMANCE CHARACTERISTICS

Inputs

3 The relay assembly receives the following inputs from the oscillators in the main and p.r.f. cabinets:

3.1 Two inputs at the crystal frequency (4 MHz nom.) SKL (main) and (SKM (standby).

3.2 Six inputs at 6.14 MHz on sockets SKE, SKH and SKP (main) and SKF, SKJ and SKQ (standby).

3.3 Eight inputs at 8.19 MHz on sockets SKS, SKV, SKY and SKAB (main) and SKT, SKW, SKZ and SKAC (standby).

4 The 500 Hz p.r.f. reference signal supplied from the main p.r.f. cabinet enters the unit on socket SKTC while that from the standby p.r.f. cabinet enters on SKTB. The returning p.r.f. control signals, 500 Hz variable phase and 500 Hz reference phase are fed in on pins 4 and 3 of PLA, respectively.

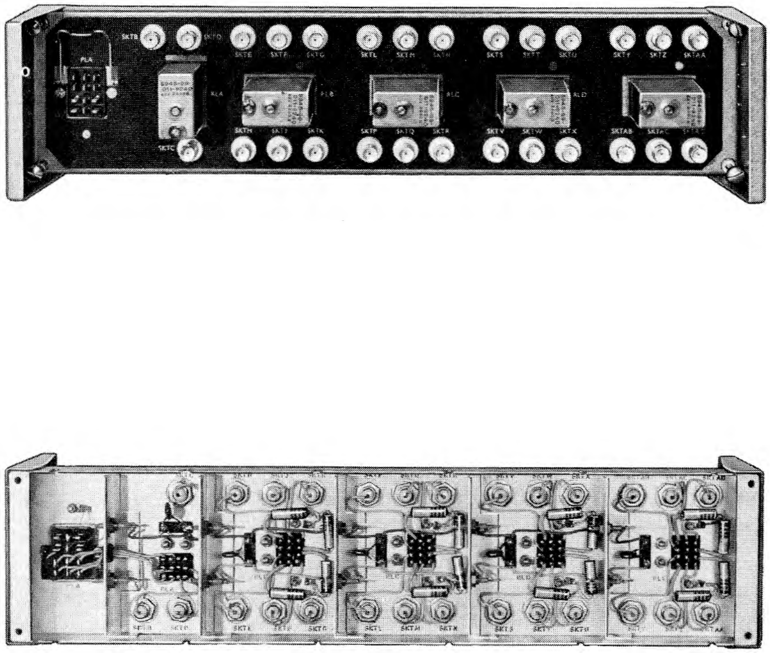


Fig.1 Relay Assembly: front and rear views

Outputs

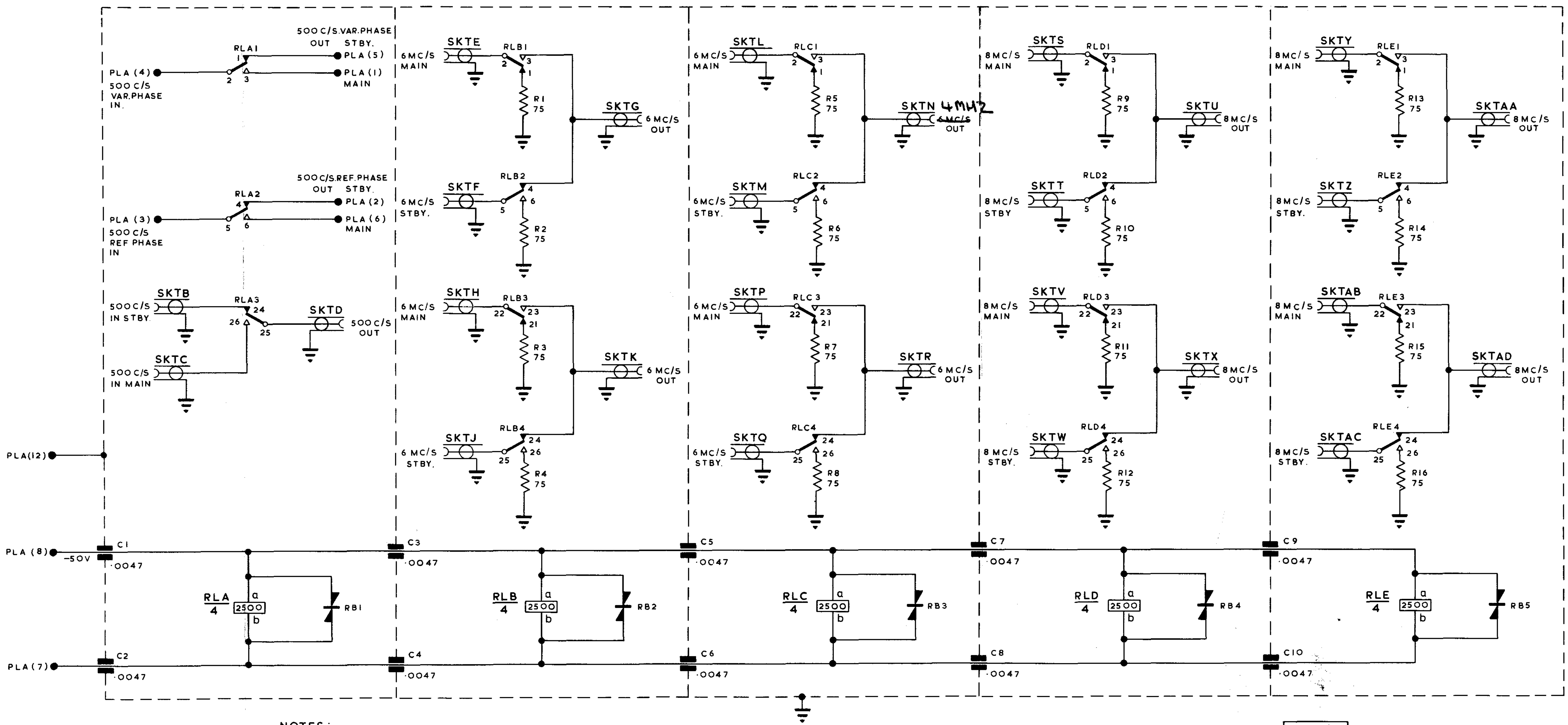
5 The selected 4 MHz signal is fed out on SKN, the three 6.14 MHz signals on SKG, SKK and SKR and the four 8.19 MHz signals on SKU, SKX, SKAA and SKAD.

6 The 500 Hz p.r.f. reference signal is fed out on socket SKTD. The 500 Hz variable phase signal is directed to the main p.r.f. cabinet via pin 1 of plug PLA or to the standby p.r.f. cabinet via PLA-5. Similarly the 500 Hz reference phase signal is fed to the main p.r.f. cabinet via PLA-6 or to the standby p.r.f. cabinet via PLA-2.

Circuit description

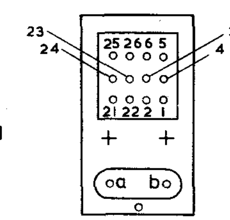
7 In normal operation all relays in the unit are energized, when PLA-7 is earthed by either the r.f. detection circuits or by the by-pass switch in the main p.r.f. cabinet. All inputs and outputs selected, are then connected to the main cabinet.

8 If an r.f. fault develops in the main cabinet, or the by-pass switch in the standby cabinet is operated, an open circuit is put on PLA-7 and all the relays are de-energized. The relay contacts changeover and all inputs are transferred to the standby p.r.f. cabinet.



NOTES:

1. CIRCUIT REFERENCE NOT USED, RLA4.
2. RB1 TO RB5 RESISTOR, VOLTAGE SENSITIVE. NATO STOCK NUMBER 5905-99-999-9051.



RELAY BASES VIEWED FROM WIRING SIDE

Fig. 2. Relay assembly 5945-99-948-9225: circuit Fig. 2.

Chapter 10

DISTRIBUTION UNIT, PULSE

5945-99-948-9262
(Completely revised)

CONTENTS

ILLUSTRATIONS

Introduction

1. The distribution unit, pulse (fig.1) acts as the changeover unit between the main and standby p.r.f. cabinets, and also as the station trigger distribution point. The corresponding main and standby pulses are fed into diode OR-gates which provides a pulse output if either, or both of the main and standby pulses are present. Thus, the gates provide, effectively, an instantaneous changeover between the main and standby pulses. The inputs to the unit are automatically monitored, indication of the presence of a pulse being given on the panel indicator, pulse (Chap.11).

Performance characteristics

Inputs

2. The main p.r.f. cabinet supplies 38 pulses each being approximately four microseconds in duration and 35V in amplitude. The standby p.r.f. cabinet supplies 38 pulse inputs which exactly correspond to the main inputs.

Outputs

3. The unit supplies 38 pulse outputs, 36 of which are approximately 4 microseconds duration and amplitude-limited to either 16V, 20V, 24V or 30V, whilst the remaining two, of similar duration are not amplitude-limited. Also, 70 bias voltages, derived from the monitoring circuits, are supplied to the panel indicator, pulse (Chap.11). The bias will vary between approximately +1V and -5V depending on the presence or absence of the input pulse monitored.

Power supplies

4. Two supplies of -5.1V d.c. are provided for the pulse monitoring circuits, one from each p.r.f. cabinet. Two 43V h.t. supplies are fed from the p.r.f. cabinets via the distribution unit, to the panel indicator, pulse.

Note...

A complete list of connections to the distribution unit is given in Part 2, Chap.1.

Circuit description

5. Fig. 2 shows the circuit diagram of the unit. Each main pulse and its corresponding standby pulse are fed to the inputs of a diode OR-gate. An output will be obtained from the gate as long as one or both of the inputs are present. The pulse at the output of the gate is amplitude limited, by a Zener diode, to either 16V, 20V, 24V, or 30V, depending on the type of diode used. The front panel of the unit is engraved to show the amplitude of each output.

6. Eight plug-in printed boards carry the pulse monitoring circuits. Each board (Panel Electronic Circuit 5840-99-951-1028) carries ten pulse monitoring circuits, as shown in fig.3. Each circuit has one pulse input and performs an integrating function on it. With pulses present at the input, the output is a d.c. voltage of approximately +1V. This is sufficient to light one of the indicator lamps on the panel indicator, pulse. In the absence of pulses at the input, the output voltage falls to about -5V d.c. which is sufficient to extinguish the indicator lamp.

7. SKTT and SKTDW feed outputs to Demodulator Coherent N.S.No.5840-99-999-2670 and Cabinet Electrical Equipment N.S.No. 5975-99-999-2682 respectively. These equipments require pulse amplitudes of 25-30 volts. In consequence, no amplitude limiting Zener diodes are fitted to the circuits.

8. Three of the 38 pulse inputs from each cabinet are not monitored, as they are parallel connections to three of the outputs of the cathode-follower unit (Chap.5). The three outputs from the distribution unit are designed to feed loads of 1 kilohm. The outputs from SKTAF, SKTBQ, SKTBT, SKTBZ, SKTCJ, SKTCZ, SKTDC, SKTDT, SKTEJ, SKTEM and SKTEQ are designed to feed 220Ω loads. All other outputs feed into 75Ω loads.

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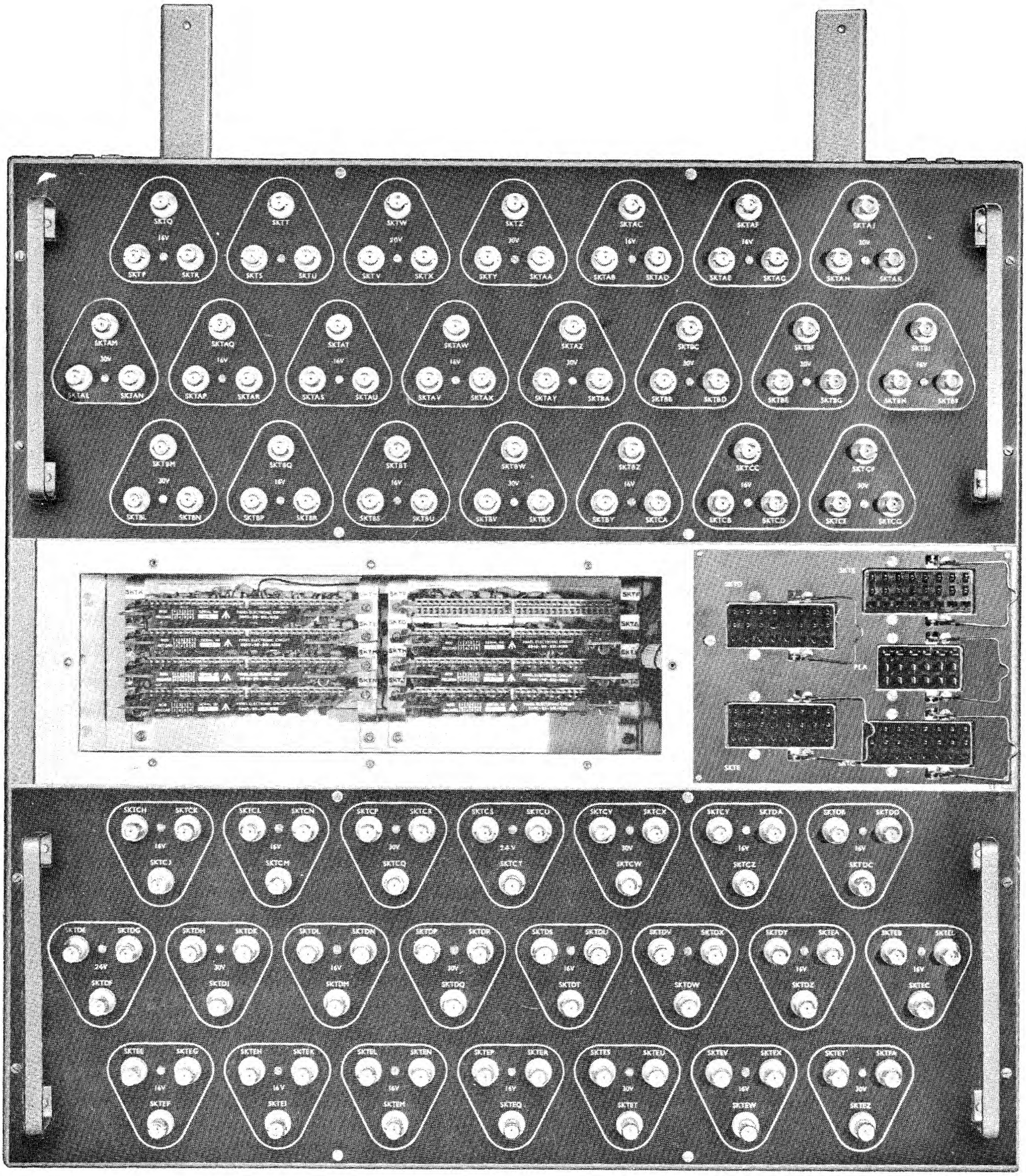
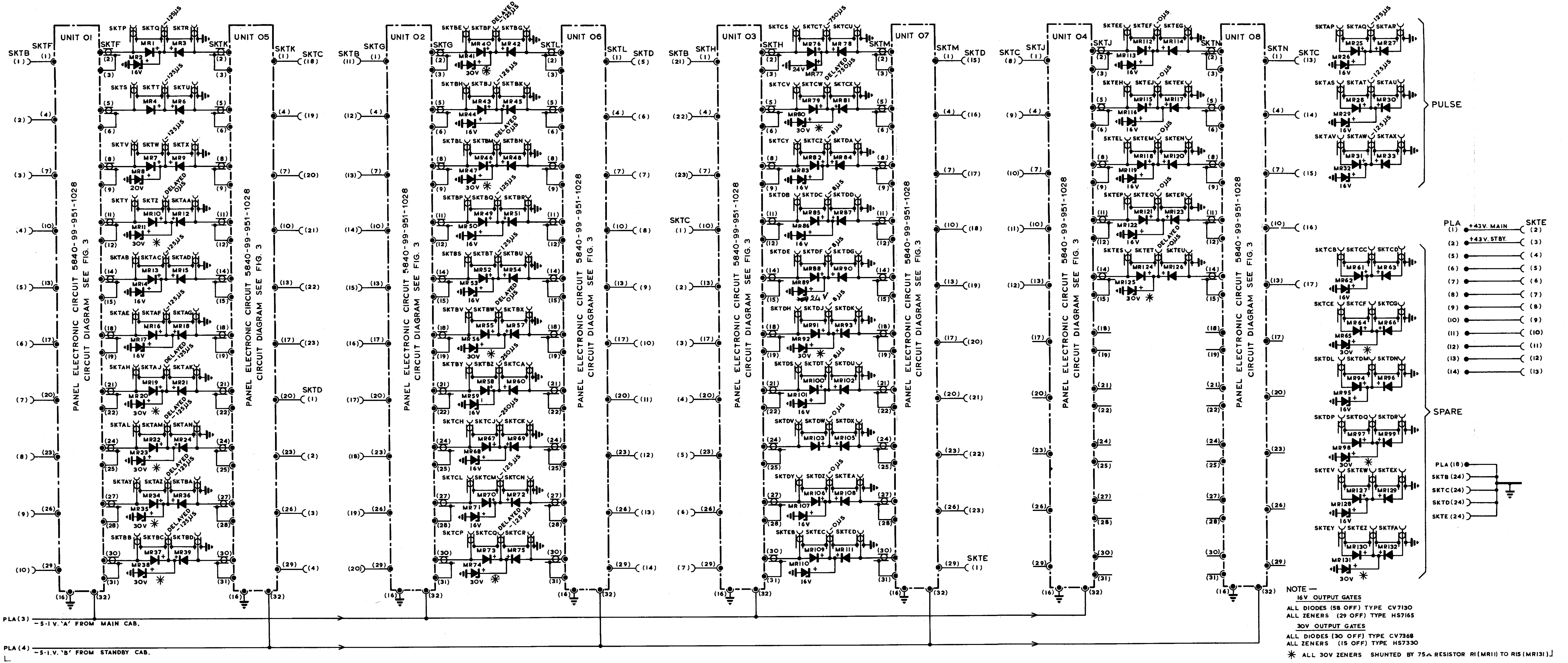


◄Fig. 1. Distribution unit, pulse: front view►



NOTE —

16V OUTPUT GATES

ALL DIODES (58 OFF) TYPE CV7130

ALL ZENERS (29 OFF) TYPE HS7165

30V OUTPUT GATES

ALL DIODES (30 OFF) TYPE CV7368

ALL ZENERS (15 OFF) TYPE HS7330

✳ ALL 30V ZENERS SHUNTED BY 75Ω RESISTOR R1 (MR11) TO R15 (MR131)

CA 2597/1

Fig. 2

Distribution unit pulse 5945-99-948-9262: circuit

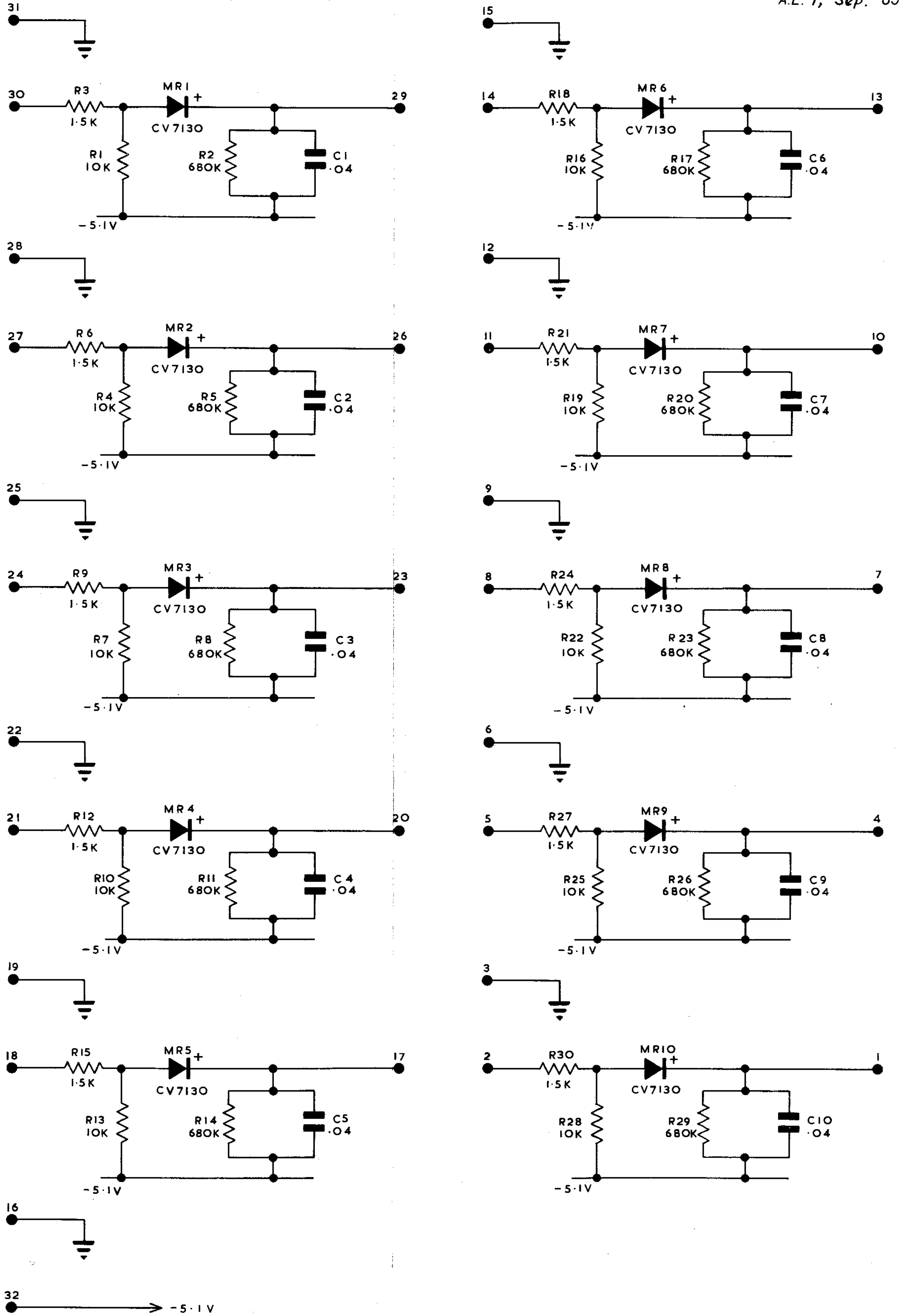


Fig. 3 Panel electrononic circuit 5840-99-951-1028: circuit Fig. 3

87218 571748 104 11/65 V.B. 925/1

Chapter 11

PANEL INDICATOR, PULSE

5840-99-951-3254

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LIST OF ILLUSTRATIONS

Introduction

1. The panel indicator pulse (fig. 1) is a wall mounted unit holding a number of indicator lamps which show the serviceability of the output pulses from the main and standby p.r.f. cabinets. A total of 70 indicator lamps are mounted on the front panel in two groups of 35, one group for each p.r.f. cabinet. The front panel of the unit is engraved with the timing and origin (unit and plug or socket reference) of each pulse monitored. Access to the input plugs and sockets at the rear of the unit is afforded via the hinged front panel.

Circuit description

2. The circuit diagram of the unit is shown in fig. 2. The mains voltage input to heater transformer T1 is obtained from the Radar Office mains distribution circuit. The two h.t. supplies of +45V are obtained, one from each p.r.f. cabinet, via the distribution unit, pulse (Chap. 10). Each group of lamps monitoring either main or standby pulses, receives its h.t. supply from the corresponding cabinet.

3. The grid voltage for each indicator lamp is obtained from the pulse monitoring circuits in the distribution unit, pulse. When a pulse is present at the distribution unit, the bias voltage on the grid of the corresponding indicator lamp is raised to approximately +1V, causing the lamp to glow. In the absence of a pulse, the bias voltage is reduced to approximately −5V and the lamp is extinguished.

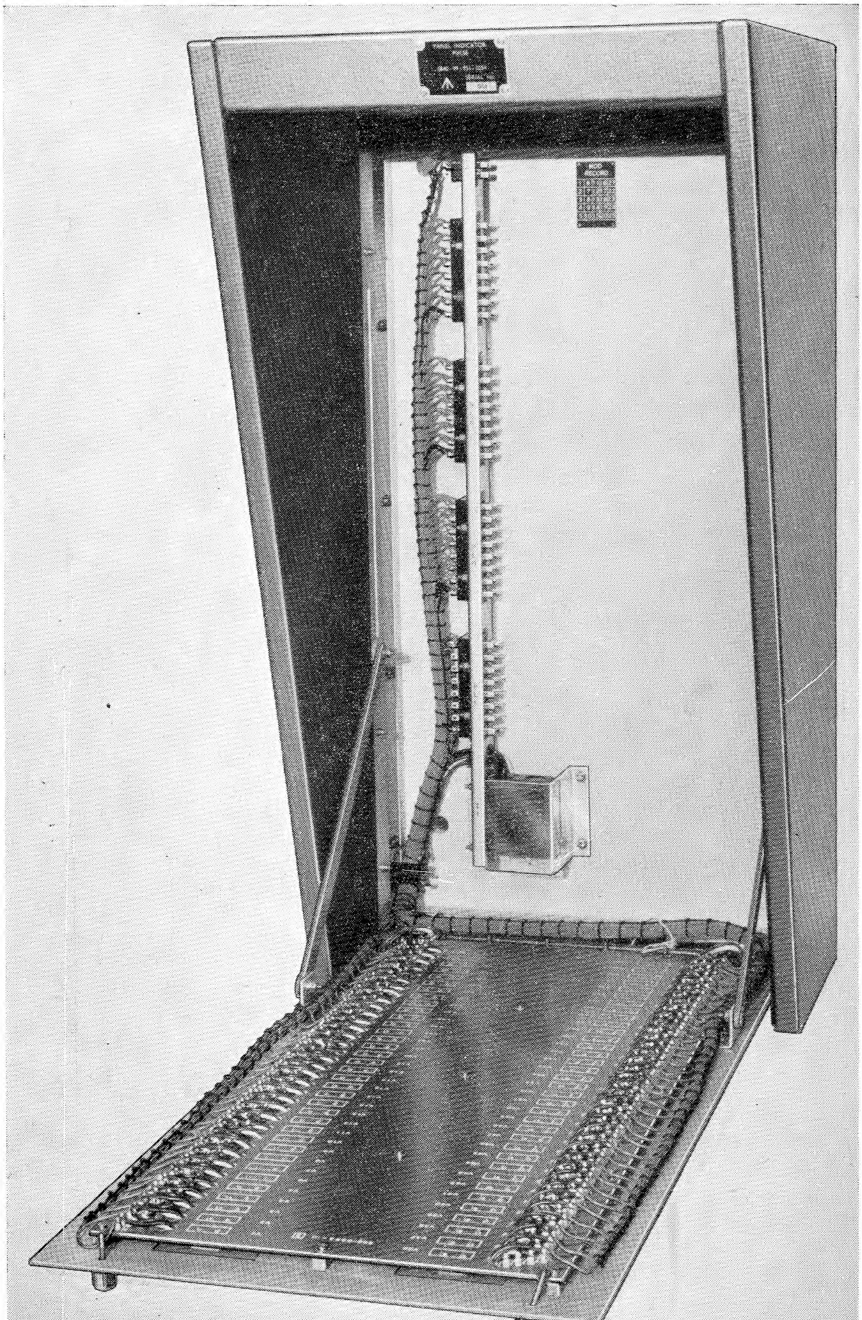
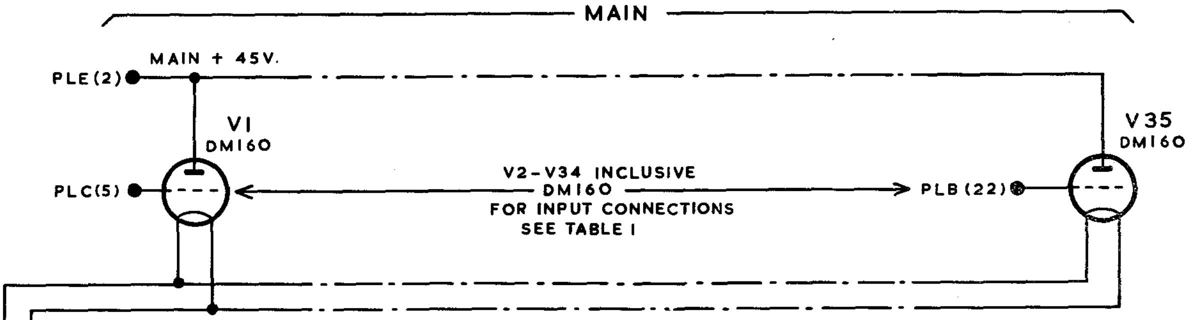


Fig. 1. Panel indicator, pulse: general view



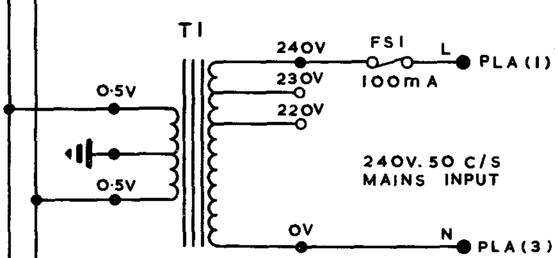
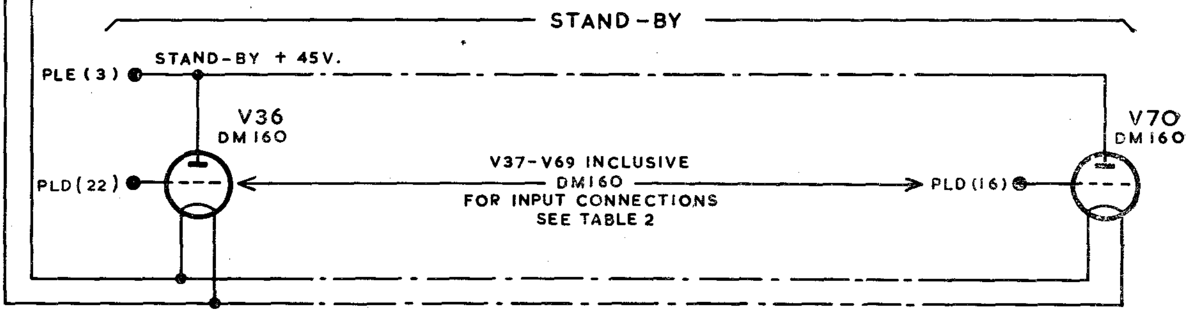


TABLE 1
INPUT CONNECTIONS
MAIN

V1	PLC (5)	V13	PLC (1)	V25	PLB (10)
V2	PLC (6)	V14	PLC (2)	V26	PLB (11)
V3	PLC (7)	V15	PLC (3)	V27	PLB (12)
V4	PLC (8)	V16	PLC (4)	V28	PLB (14)
V5	PLC (9)	V17	PLB (1)	V29	PLB (15)
V6	PLC (10)	V18	PLB (2)	V30	PLB (17)
V7	PLC (11)	V19	PLB (3)	V31	PLB (18)
V8	PLC (12)	V20	PLB (5)	V32	PLB (19)
V9	PLB (13)	V21	PLB (6)	V33	PLB (20)
V10	PLB (16)	V22	PLB (7)	V34	PLB (21)
V11	PLB (4)	V23	PLB (8)	V35	PLB (22)
V12	PLB (23)	V24	PLB (9)		



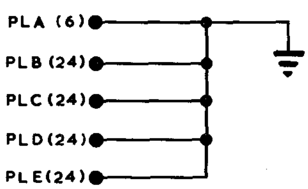


TABLE 2
INPUT CONNECTIONS
STAND-BY

V36	PLD (22)	V48	PLD (18)	V60	PLD (4)
V37	PLD (23)	V49	PLD (19)	V61	PLD (5)
V38	PLE (1)	V50	PLD (20)	V62	PLD (6)
V39	PLC (13)	V51	PLD (21)	V63	PLD (8)
V40	PLC (14)	V52	PLC (18)	V64	PLD (9)
V41	PLC (15)	V53	PLC (19)	V65	PLD (11)
V42	PLC (16)	V54	PLC (20)	V66	PLD (12)
V43	PLC (17)	V55	PLC (22)	V67	PLD (13)
V44	PLD (7)	V56	PLC (23)	V68	PLD (14)
V45	PLD (10)	V57	PLD (1)	V69	PLD (15)
V46	PLC (21)	V58	PLD (2)	V70	PLD (16)
V47	PLD (17)	V59	PLD (3)		

CA 2550

Fig. 2. Panel indicator, pulse: circuit

Chapter 12

TEST RIG, ELECTRICAL

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Introduction

1. The test rig, electrical, is used in servicing and setting up the various sub-units of each control, generator pulse (Chap. 8). Each sub-unit consists of a standard printed circuit board which can be plugged directly into a socket on the test rig, electrical. The required power supplies and test inputs are automatically connected to the sub-unit by means of a special patch board which also plugs into the test rig.

Description of test rig, electrical

2. The circuit of the test rig is shown in fig. 2. All power supplies to the test rig enter via PLA which is mounted on the right hand side of the unit. The h.t. supplies of +250V and −250V are obtained from a standard 250V power supply. The side panel of the test rig also carries the mains and h.t. fuses and indicator lamps and the H.T. ON/OFF switch, S.A. The mains supply is not switched.

3. The sub-unit to be tested is plugged into SKTB on the front panel of the test rig. Heater and h.t. supplies are then immediately connected to the sub-unit. Connections from test sockets to the sub-units are made via a special printed circuit board which plugs into SKTC on the top of the test rig. Nine special patch boards are supplied with the test rig, one for each of the sub-units which can be tested.

4. Variable bias voltages can be obtained from sockets N,P,Q and R on the front panel of the test rig. The bias voltages are set by adjustment of the BIAS A and BIAS B controls. The BIAS REVERSE/NORMAL switch, SC, allows the voltages at sockets P and N to be interchanged at will.

5. Two relays RLA and RLB can be connected to circuits which use a relay coil as a load. Operation of the relays is indicated by two lights, ILP1 and ILP2. The fault lamp on each sub-unit can be tested by means of the LAMP TEST switch SB.

Testing of sub-units

6. The test procedures have been split into general and detailed procedures for each sub-unit. The general test procedure must be carried out for all sub-units before commencing the detailed tests.

7. The basic test equipment is considered to be the test rig with its supplies and a multimeter ◄(Avo model 9 or Multimeter CT498 A.M. Ref. 5QP/17447).► Any test equipment needed for the detailed tests is termed auxiliary test equipment. A complete list of auxiliary test equipment required is given overleaf in Table 1:—

TABLE 1

List of auxiliary test equipment

Item	
◄1	Multimeter Avo model 9 or Multimeter CT498. Ref. 5QP/17447.
2	Line termination, 75Ω, N.S. No. 5999-99-999-9561.
3	Multimeter electronic Type CT471c. Ref. 10S/9556255.
4	Signal generator Type 70. Ref. 10S/16392.
5	Oscilloscope. Ref. 10S/16605.
6	Pulse generator. Ref. 10S/17230.
7	Counter/frequency meter. N.S. No. 6625-99-933-1822.
8	Signal generator Type TF1370A. Ref. 10S/1047574.
9	Power supply, Solartron Type AS1165.►

8. To assist in fault finding, notes are given in brackets, describing the effects of each step of the detailed tests on the sub-unit being checked. As a further aid, a complete list of the connections between pins of SKTC of the test rig, made by each patchboard, is given in Table 2 below.

TABLE 2

Table of patch board connections

Patchboard ref	Connection from pin	to pin	Remarks
Electronic switch, R.F. 5840-99-951-3238	1	20	
	2	16	
	3	30	
	4	24	
	5	26	
	8	28	
	13	27 and 21	
Detector r.f. failure 5840-99-951-3236	1	2	
	2	17	
	4	22	
	13	16	
	14	21	
	15	26	
Electronic switch 5840-99-951-3242	1	4 and 26	via 1 μF capacitor
	2	29	
	8	23	
	9	19	
	14	30	
Driver relay 5840-99-951-3237	2	21	
	4	19	
	8	29	
	9	27	
	14	26	
	15	22	
Oscillator flywheel 5840-99-951-3245	1	2	
	1	13	via 75 ohm resistor
	1	20	
	3	5	
	3	29	
	8	16	
	9	22	
Detector failure 250 c/s 5840-99-951-3922	1	2	
	1	25	
	4	32	
	8	31	
	9	30	
	10	29	
	13	27	
	14	28	
	15	19	
Pulse alignment unit 'A' 5840-99-951-3240	1	2	
	1	29	
	3	4	
	3	24	
	8	27	
	9	19	

Patchboard ref	Connection from pin	to pin	Remarks
Pulse alignment unit 'B' 5840-99-951-3244	1	2	
	1	12	via 10 k resistor
	12	32	via ·04 μF capacitor
	32	13	via 1 M ohm resistor
	4	17	
	14	16	
Electronic switch, pulse 5840-99-951-1017	1	2	
	1	32	
	3	4	
	3	31	
	8	23	
	9	25	
	14	24	

General procedure

9. To test one of the sub-units of the control, generator pulse units (main or standby) by means of the test rig, electrical, complete the following procedure.

(1) Set the test rig switches to the following positions.

(a) H.T. switch to OFF.

(b) BIAS REVERSE/NORMAL switch to NORMAL.

(c) LAMP TEST switch to OFF.

(2) Ensure that the following supplies are connected to the test rig.

(a) 240V a.c. line to PLA/7.

(b) 240V a.c. neutral to PLA/10.

(c) +250V d.c. to PLA/9.

(d) −250V d.c. to PLA/11.

◄(From Power Supply, Item 9, Table 1)►

(e) Earth to PLA/12.

(3) Plug the sub-unit to be tested into SKTB.

(4) Select the appropriate patchboard (marked with the title of the sub-unit under test) and plug it into SKTC.

(5) Proceed with the detailed tests on the sub-unit, which follow.

Note 1 . . .

The general procedure applies to all sub-units and must be completed before carrying on with the detailed tests.

Note 2 . . .

In the following tests all controls and connections refer to those on the test rig, electrical, unless otherwise stated.

Electronic switch, r.f. 5840-99-951-3238

10. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Signal generator (item 4, Table 1).

(b) Valve voltmeter (item 3, Table 1).

(2) Complete general procedure as in para. 9 above.

(3) Set the output of the signal generator to half the station crystal frequency, with a level of 1V r.m.s. Connect the output to SKTW.

(4) Connect SKTU to SKTD and SKTV to SKIF. (Connects r.f. signal to pins 10 and 25 of electronic switch, r.f.).

(5) Switch on the test set H.T. switch. Using a multimeter set to the ◄30V► range, adjust the BIAS A control to obtain a reading of −15V at SKTQ. Adjust the BIAS B control for a reading of 0V at SKTR.

(6) Connect SKTN to SKTG and SKTP to SKTH. (Gating voltages of 0V and −15V will appear at pins 30 and 13 respectively of electronic switch, r.f. V1 conducting and V2 cut-off).

(7) Connect the valve voltmeter to SKTE and check that it reads approximately 1V r.m.s. (Measures r.f. output at pin 6 of electronic switch).

(8) Vary the output of the signal generator 5 kc/s above and below half station crystal frequency and check that the maximum reading on the valve voltmeter occurs at this frequency.

(9) If necessary adjust the core of transformer T1 on the electronic switch, r.f., using the transformer alignment tool supplied with the test rig, until the maximum output occurs at half station crystal frequency.

(10) Set the BIAS REVERSE/NORMAL switch to the REVERSE position. (Reverses gating voltages on pins 30 and 13 of electronic switch. V2 conducting and V1 cut off).

(11) Repeat sub-paras. 7 and 8 above.

(12) Operate the LAMP TEST switch and check that the fault light on the electronic switch lights.

(13) Switch off the test equipment and the test rig H.T. switch. Disconnect and remove all test leads.

Detector r.f. failure 5840-99-951-3236

11. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Signal generator (item 4 Table 1).

(b) Valve voltmeter (item 3 Table 1).

(2) Complete general procedure.

(3) Connect the output of the signal generator to SKTD. Set the output to a frequency of 2 Mc/s and a level of 4V r.m.s. (R.F. signal now at pin 29 of detector r.f. failure).

(4) Connect the a.c. probe of the valve voltmeter to SKTG. (Measures r.f. input at SKTG). Switch on the test rig H.T. switch.

(5) Check that indicator lamps ILP1 and ILP2 light. With a multimeter check that the voltage at SKTH is zero. (Measures output at pin 23 of detector r.f. failure).

(6) Slowly reduce the output level of the signal generator until ILP1 is extinguished (V1B is cut-off). The level of the r.f. signal at this point must not exceed 1·8V r.m.s. The voltage at SKTH should now be at least −4V d.c.

(7) Operate the LAMP TEST switch and check that the fault lamp on the sub-unit lights.

(8) Switch off the test equipment and the test rig H.T. switch and disconnect and remove all test leads.

Electronic switch 5840-99-951-3242

12. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Multimeter (item 1 Table 1).

(2) Complete the general test procedure. Switch on the test rig H.T.

(3) With a multimeter measure the voltage at SKTP and adjust the BIAS A control to obtain a reading of +1V with respect to earth. Connect SKTQ to SKTH. (Connects voltage to pin 10 of electronic switch).

(4) Connect the negative lead of a second multimeter to SKTK and the positive lead to earth. (Measures output on pin 26 of electronic switch). The voltage at SKTK should be −15V with respect to earth.

(5) Slowly reduce the bias voltage by means of the BIAS A control and note the point at which the voltage at SKTK changes from −15V to 0V. (V1A cuts on). The voltage at SKTP should be between −2V and −5V with respect to earth. If necessary, adjust RV1 on the electronic switch to achieve this condition.

(6) Disconnect the multimeter from SKTK and connect it to SKTJ. Check that the voltage here is −15V with respect to earth. (V1B cut off).

(7) Slowly increase the bias voltage by means of the BIAS A control until the voltage at SKTJ becomes 0V with respect to earth. (V1B cuts on). Check that the voltage at SKTP is once more 0V at this point.

(8) Operate the LAMP TEST switch and check that the fault lamp on the electronic switch lights.

(9) Switch off the test set H.T. switch and disconnect all test leads and equipment.

Driver relay 5840-99-951-3237

13. Carry out the following procedure.

(1) Auxiliary test set equipment required.

(a) Multimeter (item 1 Table 1).

(2) Complete the general test procedure. Switch on the test rig H.T.

(3) Adjust the BIAS A control to obtain a voltage of −13·5V with respect to earth at SKTQ. Adjust the BIAS B control to obtain a voltage of −1V at SKTR.

(4) Connect SKTN to SKTG and SKTP to SKTK. (Connects SKTN to pin 24 and SKTP to pin 9 of driver relay). Check that ILP2 lights and ILP1 is extinguished. (V1A is on and V1B cut off).

(5) Set the BIAS REVERSE/NORMAL switch to REVERSE and check that ILP2 is extinguished and ILP1 lights.

(6) Operate the LAMP TEST switch and check that the fault lamp on the driver relay, lights.

(7) Switch off the test rig H.T. and disconnect all test leads.

Oscillator flywheel 5840-99-951-3245

14. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Valve voltmeter (item 3 Table 1).

(b) Signal generator (item 4 Table 1).

(c) Counter frequency meter (item 7 Table 1).

(d) 75 ohm termination (item 2 Table 1).

(2) Complete the general test procedure.

(3) Connnect the 75 ohm termination to SKTF and the input of the counter/frequency meter to SKTE. (Connects to pin 7, output of oscillator).

(4) Switch on the test rig H.T. and check that the flywheel output as measured on the frequency meter, is at half the station crystal frequency. If necessary adjust L1 in the oscillator to obtain the correct frequency.

(5) Measure the voltage at SKTJ with a multimeter and check that it is at least 1·5V. (Measures rectified oscillator output at pin 30). Adjust transformer T1, in the oscillator, if necessary.

(6) Connect the signal generator to SKTD. Monitor the signal generator output by connecting a valve voltmeter to SKTG, and adjust output to half station crystal frequency with a level of 1·5V ± 0·1V r.m.s. Check that the frequency meter still reads at the same frequency. Disconnect the frequency meter and connect the valve voltmeter to SKTE.

•(7) Adjust the BIAS B control to obtain a voltage of −◄7►V with respect to earth at SKTR. Adjust the BIAS A control to obtain a voltage of 0V at SKTQ.

(8) Connect SKTP to SKTK. (Connects gating voltage to pin 23 of oscillator). Set the BIAS REVERSE/NORMAL switch to REVERSE. Check that the r.f. output as measured by the valve voltmeter falls to less than 0·5V ◄r.m.s.►

(9) Switch off the test equipment and the test rig H.T. switch and disconnect all test leads.

Detector failure 250 c/s 5840-99-951-3922

15. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Audio signal generator (item 8 Table 1).

(b) Valve voltmeter (item 3 Table 1).

(2) Complete the general test procedure.

(3) Connect the output of the signal generator to SKTD and monitor the output at SKTG by means of a valve voltmeter. Set the signal generator to give an output of 250 c/s ± 25 c/s at a level of 15V r.m.s.

(4) Switch on the test rig H.T. switch. Check that ILP2 lights. (V1A conducting). Then reduce the output of the signal generator to 5V r.m.s. and check that ILP2 goes out. (V1A cut off). If necessary, adjust RV1, on the detector failure, to obtain this condition.

(5) Adjust the BIAS A control to obtain a voltage of +20V with respect to earth at SKTQ. Adjust BIAS B control to obtain 0V at SKTR.

(6) Connect SKTN to SKTH. (Connects bias voltage to pin 3 of detector failure). Check that ILP1 is extinguished. (V1B cut off). Switch the BIAS REVERSE/NORMAL switch to the REVERSE position and check that ILP1 lights. (V1B conducting).

(7) Disconnect the lead to SKTH and connect SKTN to SKTL. Repeat para. 6.

(8) Switch on the LAMP TEST switch and check that the fault lamp on the detector failure lights.

(9) Switch off the test equipment and the test rig H.T. switch and disconnect all test leads.

Pulse alignment unit 'A' 5840-99-951-3240

16. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Pulse generator (item 4 Table 1).

(b) Oscilloscope (item 5 Table 1).

(2) Complete the general test procedure. Switch on the test rig H.T.

(3) Connect the output of the pulse generator to SKTW. Connect SKTU to SKTD and SKTV to SKTE. (Connects pulse inputs to pins 7 and 13 of pulse alignment unit).

(4) Using the oscilloscope monitor the pulse generator output at SKTG. Set the pulse generator to deliver 20V ± 5V pulses of 5 μs ± 1 μs pulse width at a p.r.f. of 250 c/s ± 25 c/s.

(5) Connect the oscilloscope to SKTJ and check that the pulse seen is at least 15V in amplitude. (Monitored pulse input at pin 9 of pulse alignment unit).

(6) Connect the oscilloscope to SKTK and check that the pulse seen is at least 30V ± 5V in amplitude and 4 μs ± 2 μs wide. (Output pulse at pin 26 of pulse alignment unit).

(7) Disconnect the lead to SKTD and check that the pulse amplitude at SKTK falls to zero. If any small spikes are seen the amplitude of the positive spikes should not exceed 3V. Re-connect the lead to SKTD and check that the pulse at SKTK reappears.

(8) Disconnect the lead to SKTE and repeat para. 7.

(9) Operate the LAMP TEST switch and check that the fault lamp on the pulse alignment unit lights.

(10) Switch off the test equipment and the test rig H.T. switch and disconnect all test leads.

Pulse alignment unit 'B' 5840-99-951-3244

17. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Pulse generator (item 4 Table 1).

(b) Oscilloscope (item 5 Table 1).

(2) Complete the general test procedure.

(3) Connect the output of the pulse generator to SKTD. Connect the oscilloscope to SKTG and set the pulse generator to deliver 6V pulses of 3 μs pulse width at a period of 4 ms.

(4) Check that ILP1 lights. (V2B conducting). With a multimeter, measure the voltage at SKTH. This should be 30V ± 5V. (Switching voltage at pin 29 of pulse alignment unit).

(5) Reduce the output pulse amplitude at the pulse generator until ILP1 is extinguished. Check that the pulse amplitude is 3·5V ± 1V, at this point. Check that the voltage at SKTH is now less than 12V.

(6) Increase the output pulse amplitude until ILP1 lights. The pulse amplitude should now be 4·5V ± 0·5V.

(7) Operate the LAMP TEST switch and check that the fault lamp on the pulse alignment unit lights.

(8) Switch off the test equipment and the test rig H.T. switch. Disconnect and remove all test leads.

Electronic switch, pulse 5840-99-951-1017

18. Carry out the following procedure.

(1) Auxiliary test equipment required.

(a) Pulse generator (item 4 Table 1).

(b) Oscilloscope (item 5 Table 1).

(2) Complete the general test procedure.

(3) Connect the output of the pulse generator to SKTW. Connect SKTU to SKTD and SKTV to SKTE. (Connects pulse input to pins 3 and 4 of electronic switch).

(4) Using the oscilloscope monitor the pulse generator output at SKTG or SKTH, and adjust the pulse generator to deliver 20V ± 2V pulses with a pulse width of 5 μs ± 1 μs at a p.r.f. of 250 p.p.s.

(5) Using a multimeter, measure the voltage between the points marked 'z' on the printed board circuit of the electronic switch. (Points marked 'z' are anodes of V1A and V1B). Check that the voltage between the two poins is less than 5V. If necessary adjust RV1, on the electronic switch, to obtain this condition.

Note . . .

The points marked 'z' are at a high voltage with respect to earth.

(6) Using a multimeter, check that the voltages at SKTJ and SKTK are both 0V ± 1·5V with respect to earth. (Voltages at pins 20 and 11 respectively of electronic switch).

(7) Remove the connection from SKTD and check that the voltage at SKTJ rises to at least 10V. Replace the connection to SKTD and remove the connection to SKTE. Check that the voltage at SKTK rises to at least 10V. Replace the connection to SKTE.

(8) Remove the connection from SKTW and check that ILP1 lights. (Due to switching voltage at pin 13 of electronic switch).

(9) Operate the LAMP TEST switch and check that the fault lamp on the electronic switch lights.

(10) Switch off the test equipment and the test rig H.T. switch. Disconnect and remove all test leads.

Lamp logic units A and B 5840-99-951-3243 and 3239

19. These units are not tested using the test rig electrical, but the diodes on them can be tested by measuring their forward and reverse resistances by means of a multimeter. The resistances should be as indicated below.

Diode	Forward resistance not greater than:	Reverse resistance not less than:
CV 7120	50 ohm	200 k ohm

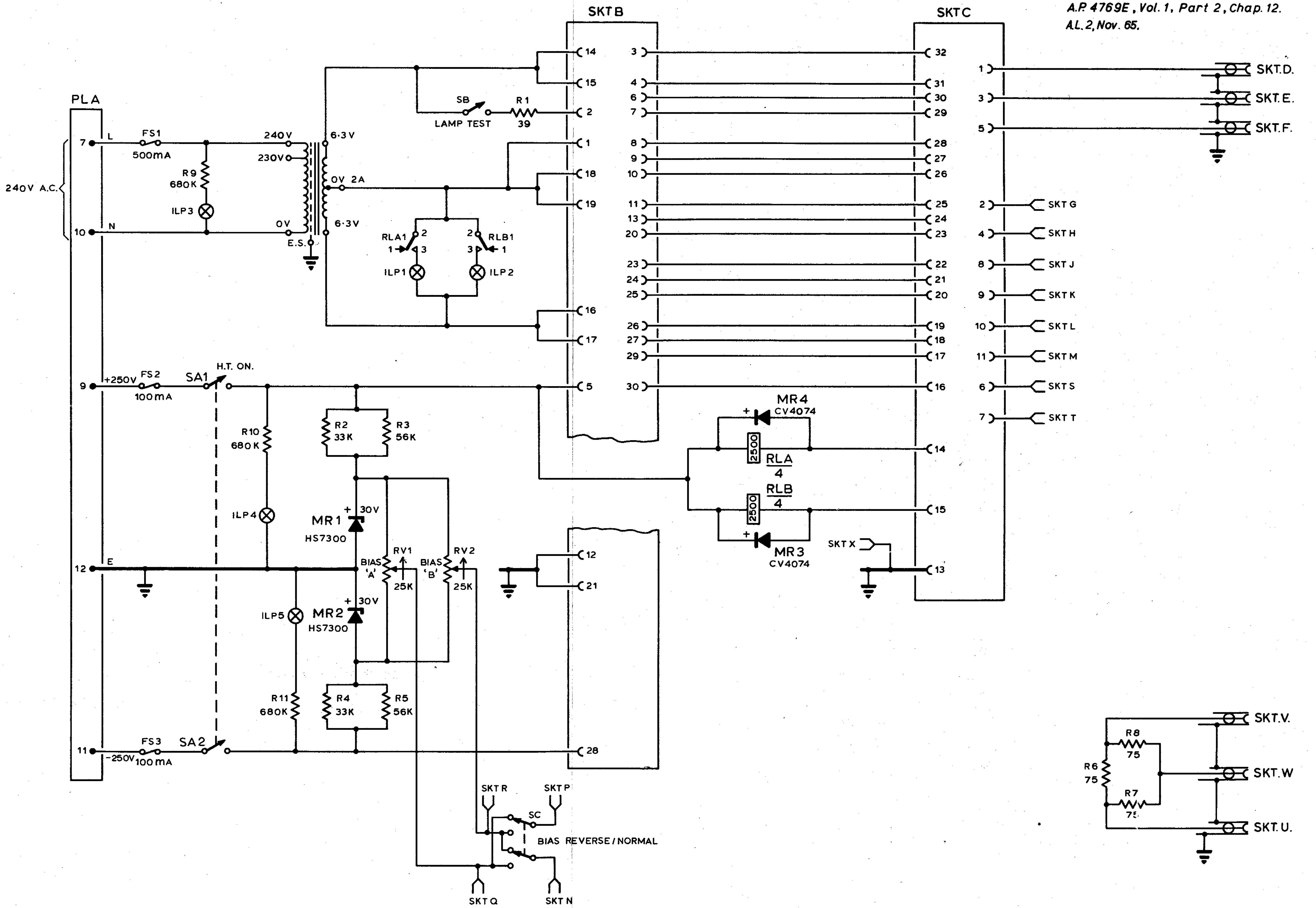


Fig. 2.

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Test rig, electrical: circuit.

Fig. 2.

Chapter 13

REGULATOR VOLTAGE (+250V)

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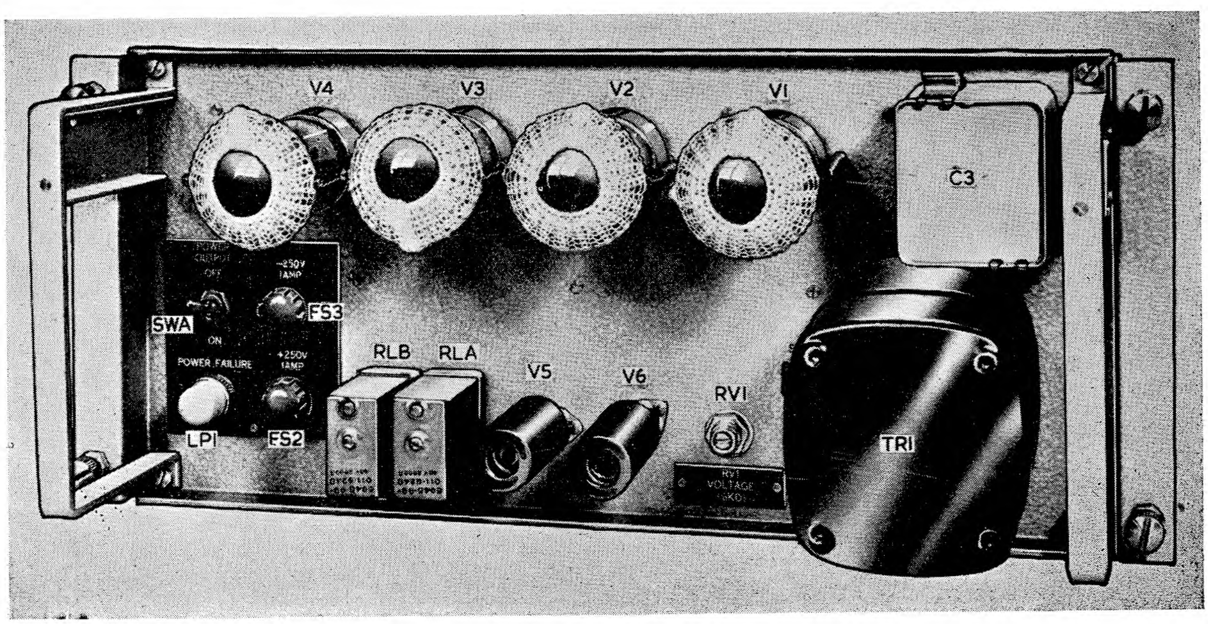

Fig. 1. Regulator voltage (+250V): front view

Introduction

1. The purpose of the regulator voltage (fig. 1 and 2) is to produce a +250V regulated supply from a +450V d.c. input. It also acts as a distribution point for +450V, −250V, −50V d.c. and the a.c. mains supply to units contained within the associated frame. In the regulator unit the −250V and +250V outputs act as hold voltages for two relays which complete the circuits of two fault lamps, when de-energized due to failure of the +450V or −250V supplies, to give a visual indication of failure.

2. Six of these units are used in the trigger system, three in the main p.r.f. cabinet and three in the standby cabinet (Units 101, 202, 301; Frames 1, 2 and 3 respectively).

Performance characteristics

Inputs

3. The regulator unit requires the following inputs:

(1) +450V unregulated supply.

(2) −250V regulated, as set by regulator voltage (−250V) (Part 2, Chap. 14).

(3) 50 c/s a.c. mains at approximately 0·25A.

(4) −50V.

(5) 6·3V 50 c/s a.c. at 0·3A.

Outputs

4. With input supplies provided as above the following outputs are available.

(1) +450V as required by individual frame units (this output is not fused in the regulator unit).

(2) +250V ± 1·25V with ripple not greater than 10 mV at 750 mA.

(3) −250V, current limitations as required by the frame being supplied (fused at 1 ampere in the regulator unit).

(4) 50 c/s a.c. mains as required by the individual frame units (this output is not fused in the regulator unit).

(5) −50V as required by the individual frame units (this output is not fused in the regulator unit).

Circuit description

Heater supplies

5. The valve heaters are supplied from TR1 (fig. 3). The a.c. supply for this transformer is fed via PLB/7 and PLB/10. This supply is controlled by the system mains switch, which routes mains to all units of the complete system.

Regulating circuit

6. The +450V supply enters the unit on PLB/1 (fig. 3). This supply cannot be made however until the −250V supply has been established, and RLB energized. Contact RLB3 routes out the −50V coming in on SKC/8 to PLB/3. This −50V operates a relay which makes the +450V supply available at PLB/1.

7. V1, V2, V3 and V4, connected in parallel, are the series control valves for the regulated +250V. V5 and V6, connected as two long-tailed pairs, function as a high gain d.c. amplifier. The −250V rail is used as the reference voltage for the regulated +250V output.

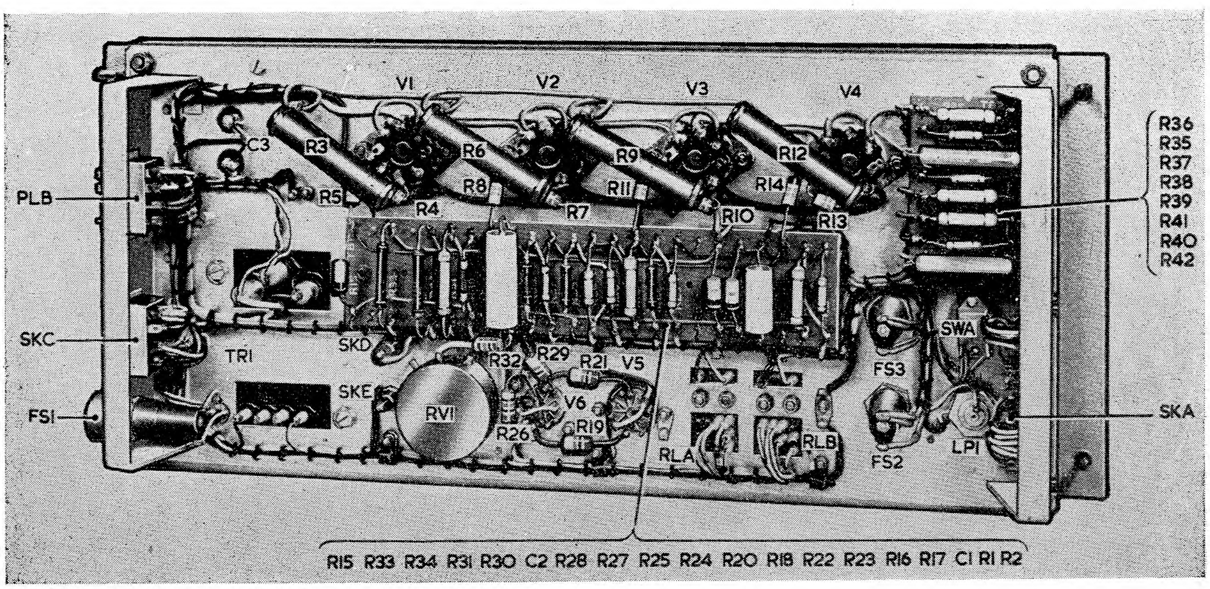

Fig. 2. Regulator voltage (+250V): rear view

8. The regulating action of the circuit can be illustrated by considering a change in the output voltage due to variation of load current.

9. Assume that the output voltage tends to rise. The voltage of V6b grid rises, the anode voltage falls, an increased voltage drop occurs across the common cathode load R30 and, as V6a grid is returned to earth, V6a anode potential rises. The two outputs of opposite polarity from V6 are then applied to V5. The result is that V5b anode potential falls. As the grids of the series valves are returned to this point, the anode to cathode potential across the four series valves increases and counteracts the original rise of output voltage. As V5b is operated in an almost cut-off condition, with resulting low amplification, the anode current is increased by connecting the anode to the +450V input line via R15. This tends to increase the ripple in the anode circuit, but as the amplification of the valve and the loop gain of the stage are increased the result is an improvement in overall performance. The regulated output voltage is set to +250V by adjustment of RV1.

10. The purpose of C2 is to improve the a.c. voltage gain and thus counteract ripple which may be present on the +250V rail. The ripple is coupled by C2 to V6b grid. The result is to produce a potential, across the controlled valves, in antiphase to the ripple.

Fault lamps

11. Three fault lamps are associated with the regulator unit; they will light if either relays RLA or RLB are de-energized. MR1 obviates incorrect fault indication in the event of RLA being incidentally de-energized. The location and method of operation of the lamps is as follows:

(1) *Front panel of the regulating unit:* This lamp POWER FAILURE LP1 will light if either or both the +450V and −250V supplies fail to enter the unit. It will also light if the regulating circuit fails. Contacts RLA1 and RLB1 connected in parallel are normally made so completing the 6·3V supply from PLB/4 to LP1. To extinguish the lamp, indicating correct operation, both relays have to be energized.

(2) *Front of the cabinet containing regulating unit:* This fault lamp has one side parallel connected through the units in the cabinet and is lit when the parallel side is earthed. In the regulating unit, contacts RLA2 and RLB2 control the operation of the lamp. Connections to the external circuit are made by SKC2 coming in and PLB/2 going out. Failure of the +450V, or −250V supplies, or the regulating circuit, will de-energize either or both RLA and RLB, completing the earth connection via contacts RLA2 and RLB2.

Test readings

12. With a multimeter Type 100 connected to SKA, via an adapter plug to socket, the readings obtained should be as indicated in Table 1. The output voltage of the +250V line can be monitored by connecting a multimeter Type 1 across the monitoring points SKD and SKE.

TABLE 1

Multimeter readings

SKA socket pole	Multimeter switch position	Voltage across Resistor No.	Reading	Tolerance
1	A	R2	0·5	±0·1 (20%)
2	B	R35	0·6	
15	C	R38	0·6	
16	D	R40	0·6	
5	E	R23	0·55	
18	F	R20	0·5	
19	G	R24	0·45	
20	H	R27	0·45	

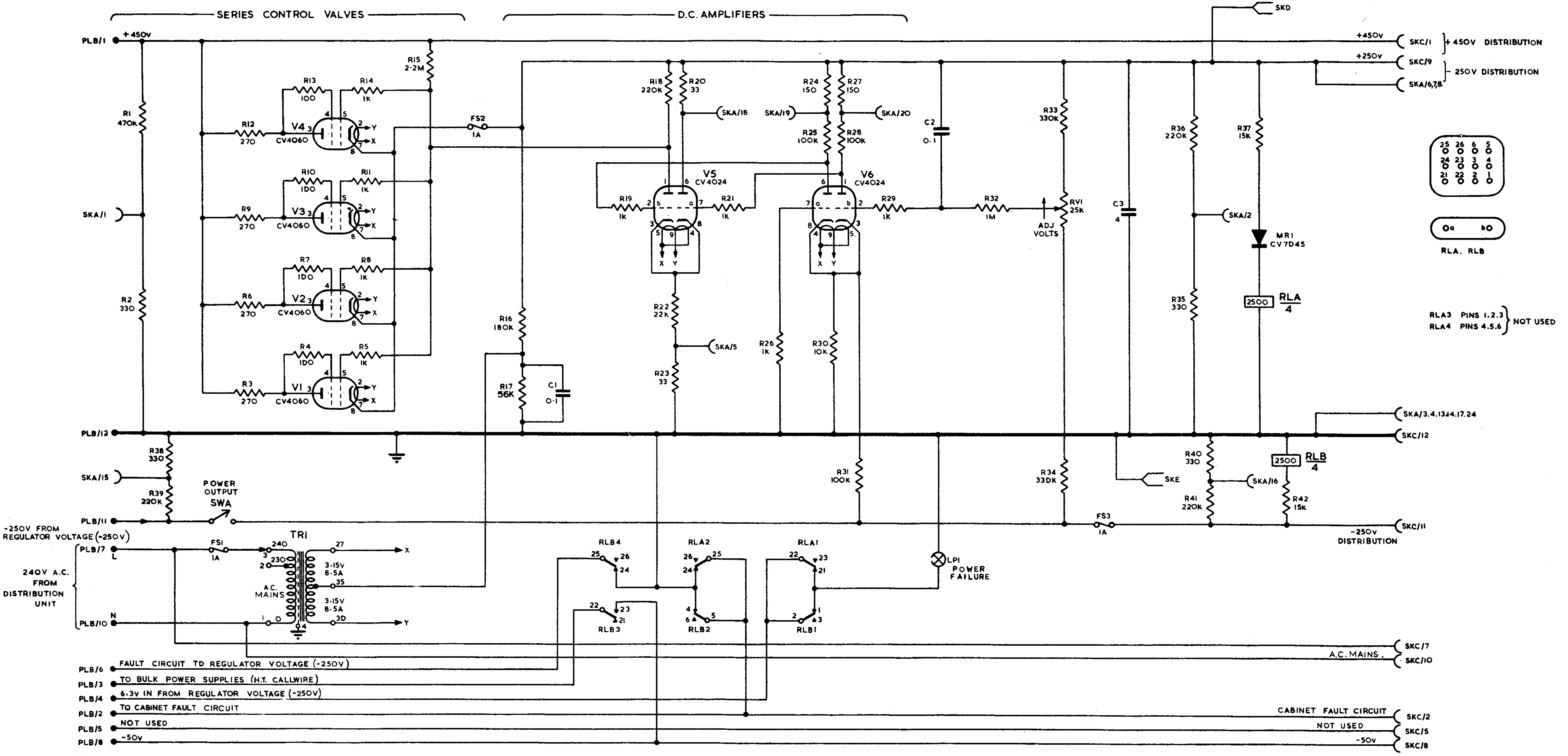

Fig. 3   D.629897. 372371. S.W. 9/68

Regulator voltage (+250V) : circuit

Fig. 3

Chapter 14

REGULATOR VOLTAGE (-250V)
6110-99-999-9003

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TABLES

ILLUSTRATIONS

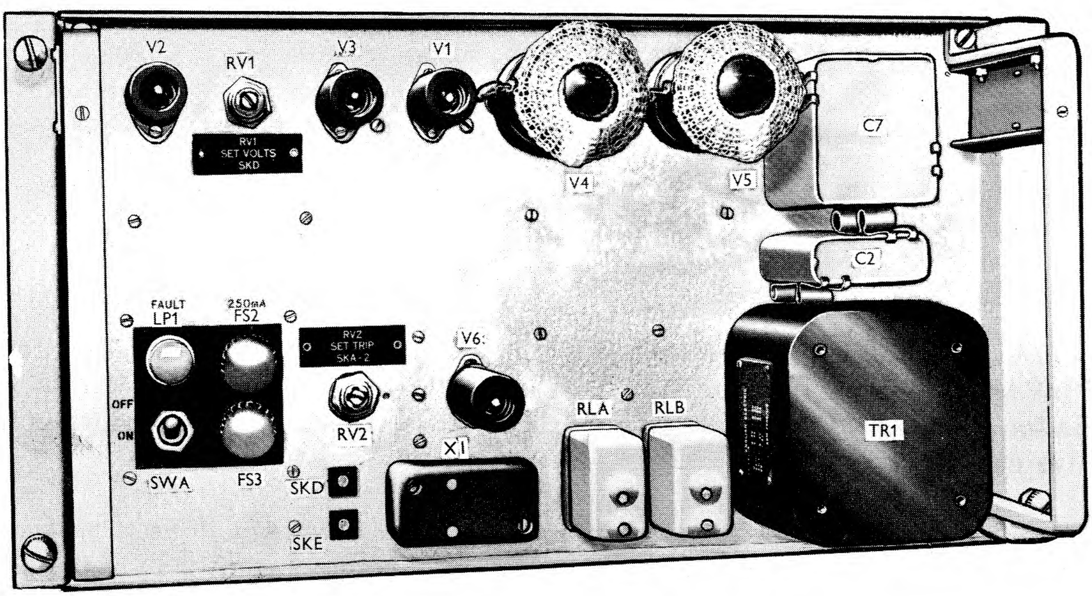

Fig. 1 Regulator voltage (-250V): front view

Introduction

1. The function of the regulator voltage (-250V) (fig. 1 and 2) is to produce a -250V regulated supply from a -425V input. Two of these units are used in the trigger system, one in the main p.r.f. cabinet, the other in the standby cabinet (Units 201, Frame 2). Each unit provides the -250V supply for the units in the particular cabinet; it also provides the reference voltage for the +250V regulators in the cabinet. Through-connections are provided for the 240V a.c. mains and -50V d.c. supplies to the +250V regulator in the frame 2 of the cabinet and also for the connection from the fault relay on the +250V regulator in frame 2 to the cabinet fault lamp circuit.

2. In the regulator unit the -250V outputs and the +450V, -425V and -625V d.c. inputs are used as "hold" voltages for two relays which are de-energized if there is a failure in any of the supplies. The circuits of two fault lamps are then completed to give indication of failure of the -250V supply; the 6·3V a.c. supply is disconnected from the +250V regualtors, to prevent illumination of the fault lamps on these units, and the h.t. supplies are switched off.

Performance characteristics

Inputs

3. The regulator requires the following inputs:

(1) +450V regulated supply at PLB/1.

(2) -425V unregulated supply at PLB/3.

(3) -625V unregulated supply at PLB/6.

(4) -500V reference supply with a peak ripple not greater than 5mV at PLB/9.

(5) -50V at PLB/13.

(6) 50 c/s single phase a.c. mains at PLB/7 and PLB/10.

(7) 6·3V, 50 c/s a.c. at 0·3A in to PLB/15.

Outputs

4. With input supplies provided as above, an output of -250V with ripple not greater than 15 mV peak-to-peak at a maximum current of 250 mA is provided at SKC/11. This supply is fed to the +250V regulators from whence it is distributed to the units in the respective cabinets.

5. The 6·3V a.c. output is taken from SKC/4 to the +250V regulators. The a.c. mains and -50V d.c. outputs to the +250V regulator in frame 2 (Unit 202) of the cabinet are taken from SKC/7, SKC/10 and SKC/8 respectively.

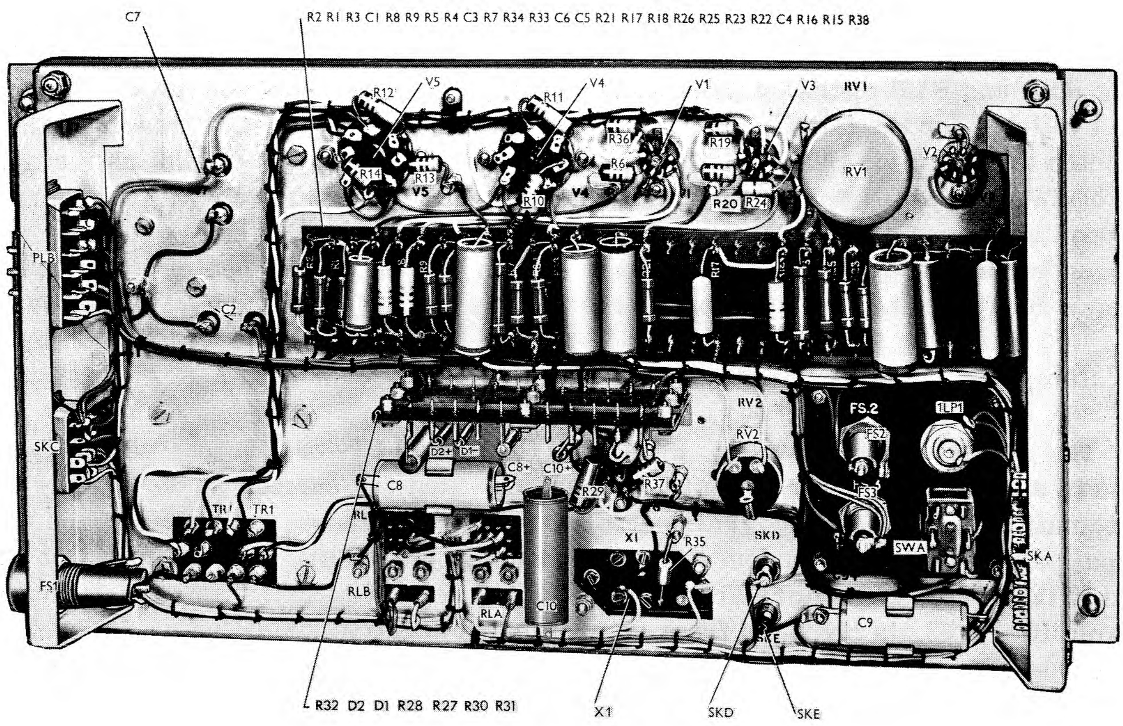

Fig. 2 Regulator voltage (-250V): rear view

Circuit description

Switching sequence

6. With the 240V a.c. supply applied to the regulator the valve heater supplies are available from the secondary windings of TR1 (fig. 3). With switch SWA in the OFF position, so that a 6·3V a.c. supply from TR1 is connected to the heater of the thermal relay X1 via SWA2 and R35, the -50V supply is disconnected from X1 and from relay contacts RLA2. Since -50V is not available at SKC/3, the h.t. relays in the bulk power supply are not energized and the h.t. supplies are not available to the regulator. Under these circumstances, the fault relays RLA and RLB are released so that the cabinet and regulator fault lamps are lit and the 6·3V supply from the panel indicator is not available for the fault lamps in the three +250V regulators.

7. After a period of approximately 30 seconds the heater of X1 has warmed sufficiently for the contacts to close. If SWA is now operated to the ON position, -50V is connected to SKC/3 with the result that the appropriate relays in the bulk power supply are operated and the heater supply is disconnected from X1. The following supplies are then available to the regulator:

(1) +450V fused at 250 mA by FS2.

(2) -425V fused at 250 mA by FS3.

(3) -625V unfused.

(4) -500V (reference) unfused.

8. With all input supplies available the regulator produces its output of -250V and relays RLA and RLB operated. The fault lamps are extinguished and the 6·3V a.c. is made available for the fault lamps in the +250V regulators. The -50V supply is then connected to SKC/3 via SWA1 and the operated contacts RLA2 and RLB2; as the operation of SWA to the ON position opens the heater circuit to X1 via SWA2, the thermal relay contacts open after a short time interval so that release of relays RLA or RLB, under fault conditions, causes the h.t. supplies to be switched off. The switching sequence must then be repeated to restore the supply.

Regulation

9. The regulation circuits (fig. 3) include the valves V1-V5. V4 and V5 are connected in a series regulator circuit which ensures that the current passed by the valves is automatically corrected by grid control so as to bring the output voltage back to its original value should any tendency for fluctuation of the -250V output occur. Due to the fact that the series regulators are employed for a negative supply, the associated control amplifier, V3, is operated from an even more negative supply which is obtained from the -500V reference. A further -625V bias input at a low current is also required.

10. The amplifier valve controlling the series regulators is the pentode V3, the grid of which is returned, via resistor R24 to the slider of the SET VOLTS (SKD) potentiometer RV1. This potentiometer forms part of a resistance chain with R25 and R26 extending from earth to the -500V reference line. The 0·1μF capacitor C6 smooths out ripple on the -500V input. The anode of V3 derives its h.t. supply from a stabilized voltage of +150V obtained from the +450V input by V2 in conjunction with the series dropping resistors R15, R38 and reservoir capacitor C4.

11. Any change occurring in the -250V output voltage with reference to the -500V line thus produces a proportional change in V3 grid-to-cathode potential. Voltage changes at V3 cathode are amplified by the valve and applied to the grids of V4 and V5 to restore the output voltage to -250V. As the potential at the anode of V3 is too high for direct control of V4 and V5, a constant current pentode V1 is included in a d.c. potentiometer chain R16, R7, V1, R8, to drop the d.c. level from V3 anode to a suitable level for application to V4-V5 grids. A constant bias voltage of -570V (with respect to earth) is tapped off at the junction of R1 and R2 and applied to V1 grid, ensuring constant current through the valve. R3 and C1 are included to eliminate hum picked up from the a.c. line. To ensure 100 per cent compensation for fluctuation of the -425V input, a feed connection is made between this input and the cathode of V3 via resistor R17. A.C. changes at V3 anode are communicated to V1 anode via C3.

12. The heater-to-cathode resistors R14, R19 and R36 bring the heaters of V1 and V3 to V5 up to cathode potential. The grid stoppers R6, R10, R13 and R20 are included to assist in prevention of parasitic oscillations.

13. The correct setting of RV1 is that at which the output voltage lies between the limits of -250V $\pm$2·0V over a load current of 150 to 250 mA.

Fault circuits

14. The fault indication circuits consist of RLB with R32 and RLA with V6. RLB caters for the -625V input and RLA for the failure of the +450V, -425V and -500V inputs.

15. Failure of the +450V input results in removal of the h.t. supply from V6 and consequent failure of the -250V output results in removal of -250V from the windings of RLA. Pentode V6 is normally conducting at a current level according to its grid potential ◀ which is between -200V and -300V as determined by R28, the 150V Zener diodes D1 and D2, and ▶ as set by the slider of the SET TRIP (SKA-2) potentiometer RV2 so that RLA is energized. RV2 is normally set so that with multimeter Type 100 connected to SKA the reading on switch position B is 0·5, the output at SKD having already been adjusted to be -250V. As the -250V output depends upon the -425V input at PLB/3, it follows that in the event of failure of the +450V or -425V inputs or the -250V output RLA is released and its contacts perform the following functions:

(1) Contacts RLA2 remove -50V from SKC/3 and therefore cause the inputs to the regulator to be removed.

(2) Contacts RLA1 disconnect the 6·3V a.c. output for the fault lamps in the three +250V regulators, so that the +250V regulators do not indicate a fault due to a failure of the -250V supply.

(3) Contacts RLA3 causes the FAULT lamp ILP1 on the regulator to light.

16. Capacitor C9 is included in the circuit of V6 to cause a delay to prevent a fault indication being given when changing over from one source of bulk power to another. The charge on the capacitor is sufficient to maintain V6 in a conducting condition, thus ensuring that RLA remains operated during the changeover period. Capacitor C10 connected across the operating coil of RLA provides additional delay to that provided by C9 during the changeover period.

17. Failure of the -625V supply causes the cathode of V1 to rise to earth potential with a consequent reduction in valve current and the -250V output becomes more negative. Similarly, the grid of V6 rises towards earth and its cathode current is increased. Consequently RLA is not released. The energizing coil of RLB is therefore connected between the -425V and -625V inputs so that with the -625V supply available the relay is energized. Independent failure of the -625V input therefore causes the relay to be released so that the h.t. inputs to the regulator are removed by contacts RLB2, in series with RLA2, and cabinet fault circuit is completed by contacts RLB1 to light the cabinet fault lamp. The cabinet fault lamp may also be lit by failure of one or more of the +250V regulators.

18. Capacitor C8 is connected across the operating coil of RLB to prevent a fault indication being given when changing over from one source of bulk power to another. The charge on the capacitor slugs the relay and makes it slow to release.

19. The fault relay contacts in the +250V regulators are connected to ILP1 via SKC/6 so that the lamp may be caused to light either by failure of the output of the -250V regulator or by failure of the -250V supply in one or more of the +250V regulators, e.g. failure of the -250V fuse. A distinction between the two causes of failure exists, in that for failure of the output of the -250V regulator only the fault lamp on that regulator is lit, whereas if the -250V failure is external to the -250V regulator, the fault lamp on the appropriate +250V regulator will also be lit.

Test points

20. Test sockets SKD and SKE are provided for output monitoring. The output should be -250V ±2V with ripple not in excess of 15 mV as checked with an oscilloscope.

Multimeter readings

21. With the multimeter Type 100 connected to SKA via the plug-to-socket adapter and with the regulator correctly adjusted the readings obtained should be as indicated in Table 1.

TABLE 1

Multimeter readings

SKA	Multimeter switch position	Voltage across resistor	Reading	Tolerance
1	A	R23	0·5	±0·1
14	B	R31	0·5	
15	C	R33	0·5	
16	D	R4	0·7	

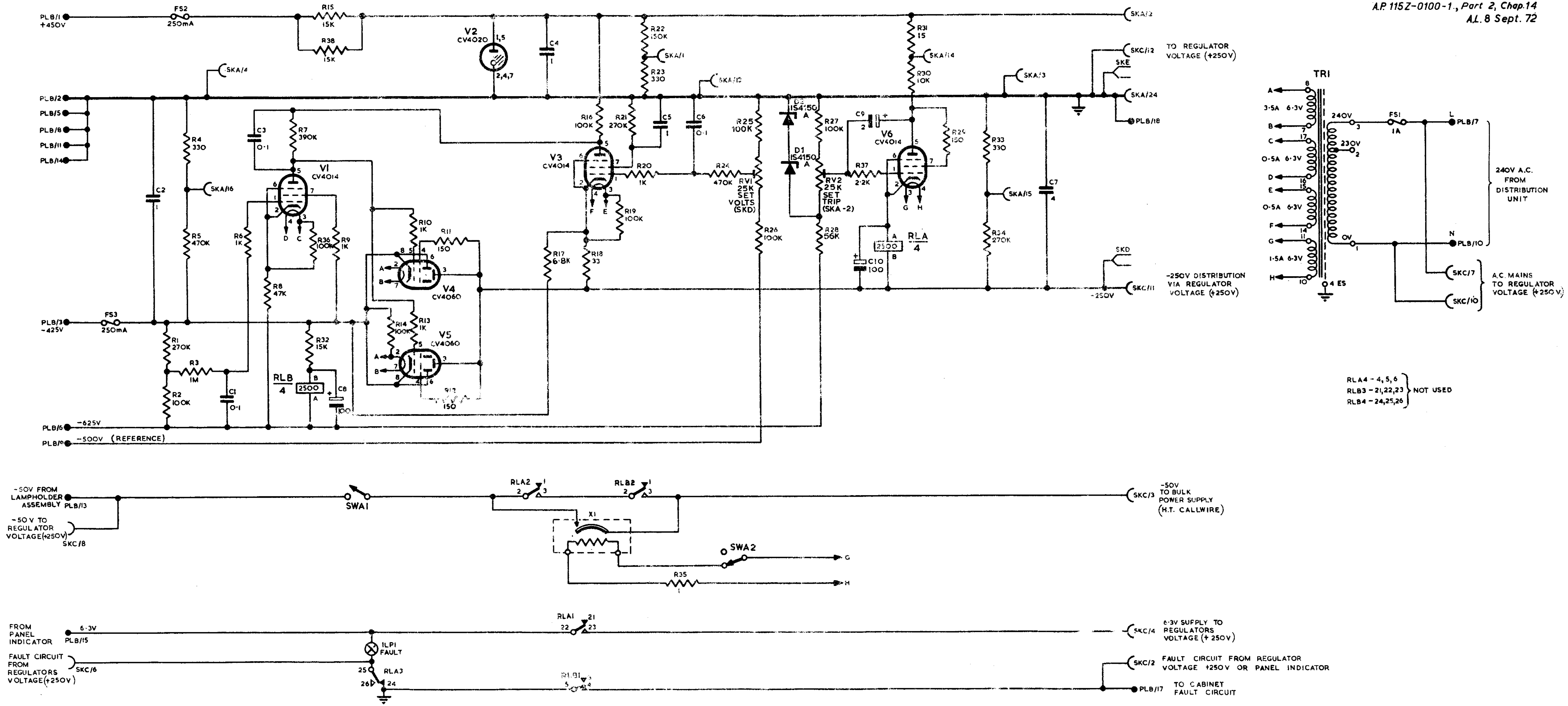

Fig. 3 Regulator voltage (-250V) : circuit Fig.3