TRAINEE NOTES

F.G.R.I. 18119

TACAN (BRITISH)

This training note is issued for the guidance of trainees during training at R.A.F. Locking. No amendments will be issued in respect of modifications introduced to the equipment referred to in this note.

This note is not intended as a substitute for the relevant Air Publication and must not be regarded as authority for modifications, servicing procedures, etc.

JUNE, 1962

FGRI 18119 TACAN BEACON

REFERENCE TO AP.2534L (FGRI 18119 TACAN)

1. Function. Tacan is a short range ground transponder beacon working in the 962 to 1213 Mc/s frequency band. It is used for tactical and general navigation purposes with a range of approx. 200 nautical miles. It will only function with its complimentary airborne installation ARI 18107 (British) or AN/ARN-21 (American.) The pilot of an aircraft is provided with the following information:-

(a) Continuous meter indications of the beacon bearing w.r.t. the aircraft.

(b) Continuous meter indication of the beacon distance.

(c) Aural confirmation of the identity of the beacon.

2. Concise Details.

Frequency Coverage. 126 channels in the following frequency bands. Transmitter 962 to 1024 Mc/s and 1151 to 1213 Mc/s. Receiver 1025 to 1150 Mc/s. Interrogation and reply frequencies differ by 63 Mc/s.

Intermediate Frequency. 63 Mc/s with a hand width of 3.5 Mc/s.

Transmitter. Peak power output 5 KW. Modulation of pulse pairs spaced 12 µs apart. Pulse width 3.5 µs. Duty cycle 3600 ± 90 pulse pairs per second.

Video Reference Pulses. The North reference pulse train consists of 12 pulse pairs spaced 30 µs apart and transmitted once every revolution of the aerial. The harmonic reference pulse train consists of 6 pulse pairs spaced 24 µs apart and transmitted eight times for every revolution of the aerial.

Beacon Identification. The beacon identity code is derived from a keying wheel, and is transmitted in the form of a Morse signal which can be recognised by the pilot.

Handling Capacity. Bearing information is available to any number of aircraft. The beacon will respond to 95 aircraft in the "track" condition and 5 in the "search" condition.

Power Supply. 416 or 440 V, 3 phase at a frequency between 45 and 65 c/s.

Power Consumption. Approximately 8 KVA.

Monitor. Monitoring equipment provides continuous visual and aural indication of certain fault conditions.

GENERAL DISCRIPTION OF OPERATION.

3. Basic Principles. The Tacan system provides the following facilities:-

(a) Distance information of the aircraft from the beacon provided by interrogator - transponder - responsor circuits.

(b) Bearing indications of the aircraft from the surface beacon, provided by the technique of a rotating amplitude - modulated radiation pattern which contains reference pulse signals.

(c) Identification information. At regular intervals the beacon transmits a series of pulse-pair signals which are keyed in Morse code. These signals are finally fed to the pilot's headset as a Morse coded signal at 1350 c/s.

4. Distance Information. Interrogating pulse-pairs are transmitted by the aircraft equipment. The beacon on receipt of the pulses transmits distance reply pulse-pairs back to the aircraft. Special circuits in the responsor measure the time interval between the transmission and reception of the pulse - pairs, and convert this time into nautical miles. Range is displayed to the pilot in the centre window of the bearing indicator.

5. Code Identification. This is provided by pulse-pairs separated by the normal 12µs and transmitted at a repetition rate of 1350 c/s. To maintain the duty cycle of the beacon transmitter each pair is followed by a second pulse-pair spaced 100 µs later. The identification pulses provide a 1350 c/s tone in the pilot's headset, consisting of dots of 0.125 seconds duration and dashes of 0.375 seconds duration. The dots and dashes are keyed in the beacon by a mechanical coder which produces the beacon call sign every 37.5 seconds.

6. Bearing Information. All signals transmitted from the beacon are amplitude modulated by a set of rotating parasitic elements which rotate round the beacon central aerial array at 900 r.p.m. The parasitic elements consist of a single reflector mounted in an inner fibreglass cylinder, and nine equally spaced directors mounted in an outer cylinder, the whole rotating at 900 r.p.m.

The resultant polar diagram due to these parasitic elements produces a modulation of all transmitted signals as follows:-

(a) Due to the single reflector $\frac{900 \text{ r.p.m.}}{60 \text{ secs.}} = 15$ c/s

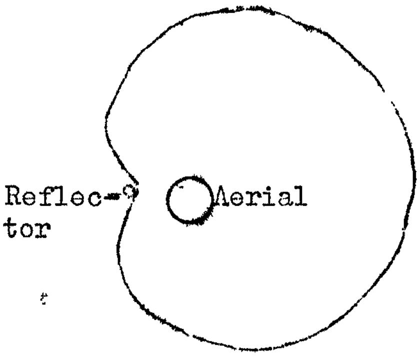
(b) Due to the nine directors $\frac{9 \times 900 \text{ r.p.m.}}{60 \text{ secs.}} = 135$ c/s.

The combined amplitude modulation will appear as a 135 c/s sine wave superimposed on a 15 c/s sinewave.

TL/488.
JUNE, 1962.

7. Aerial Polar Diagrams.

(a) Due to single reflector.



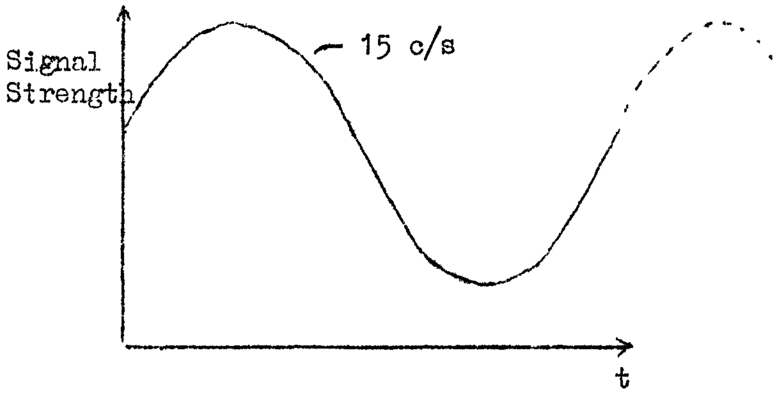
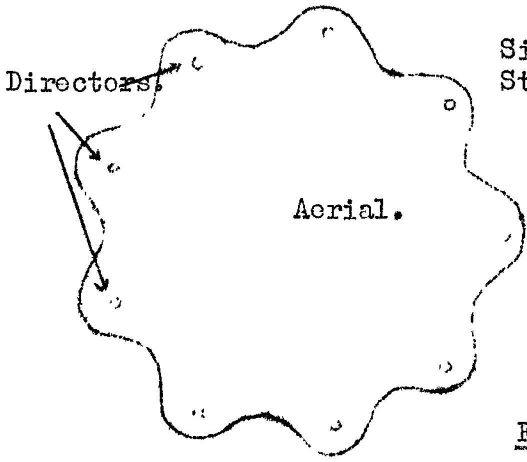


Fig. 1 Variation of signal strength at any point round the beacon when the reflector is rotated round the aerial.

(b) Due to nine directors.



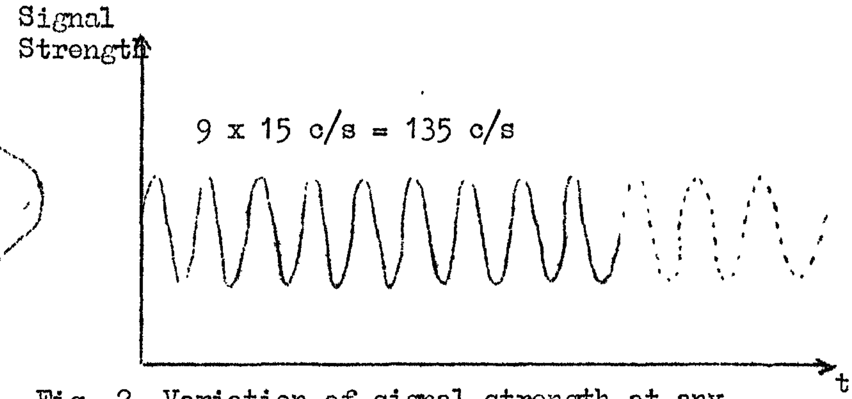
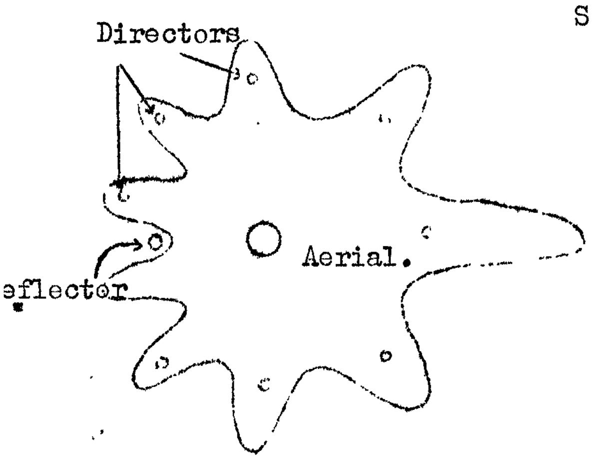


Fig. 2. Variation of signal strength at any point round the beacon when the nine directors are rotated round the aerial at the same speed as above.

(c) Combined polar diagrams of (a) and (b).



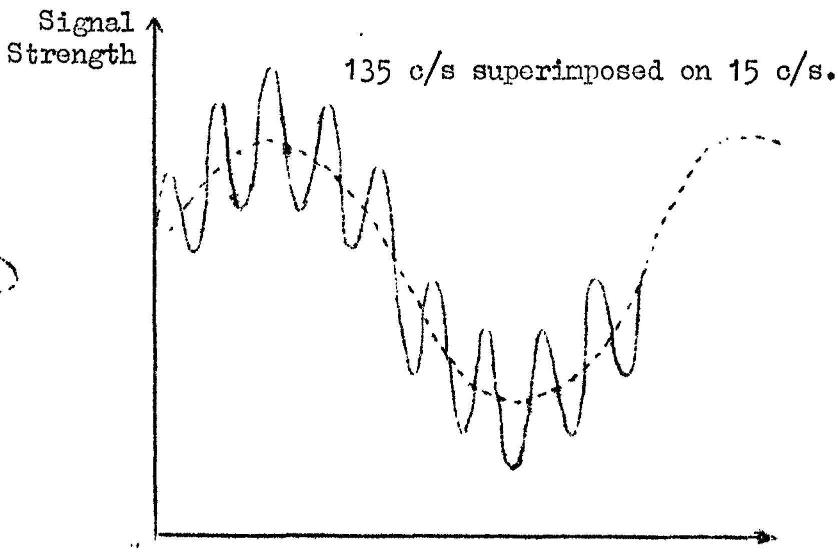
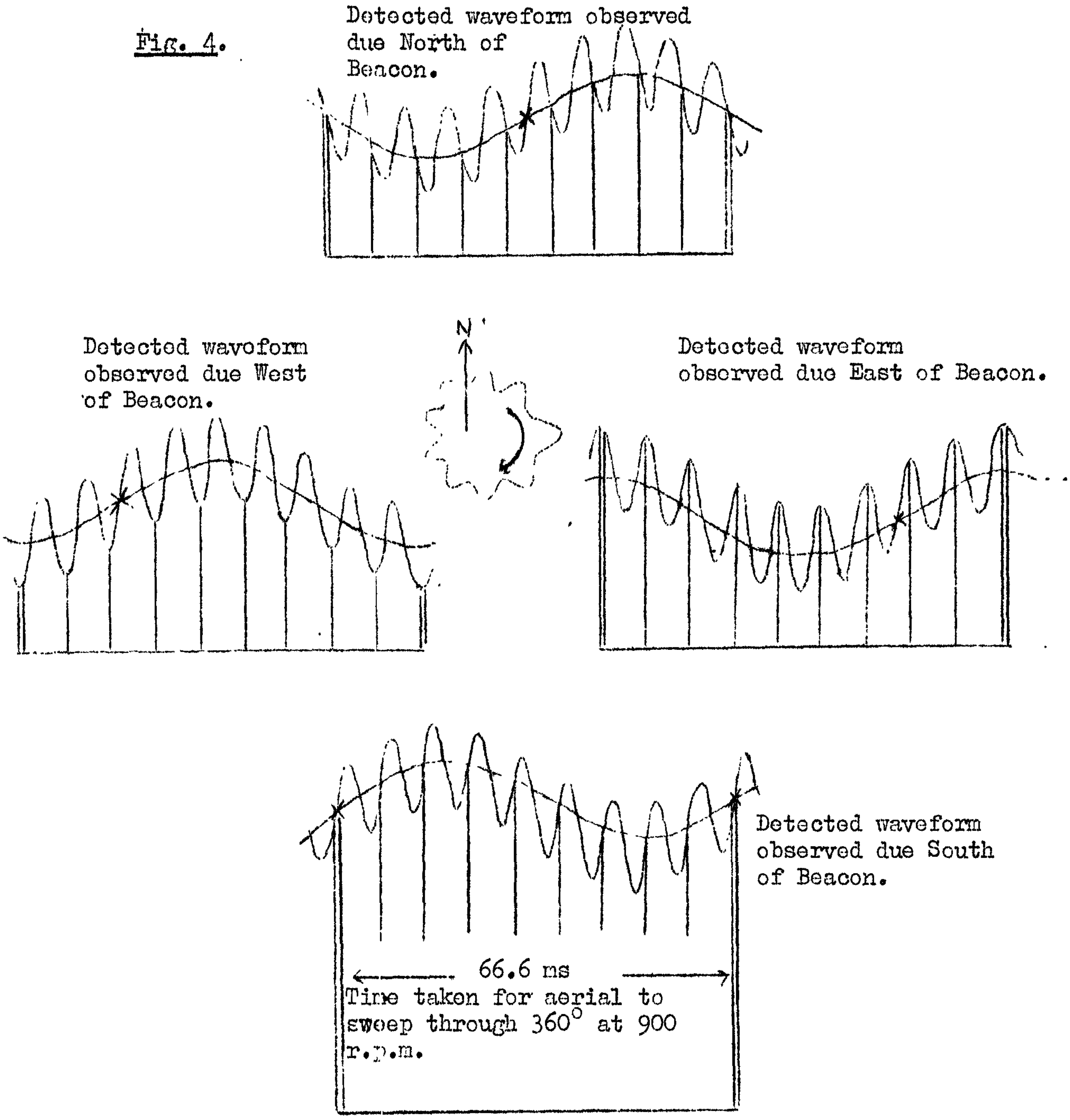


Fig. 3. Variation of signal strength at any point round the beacon when the single reflector and nine directors are rotated round the aerial.

8. Bearing Reference Bursts.

Fig. 4.



NOTE.

(a) All figures show the same point in time as illustrated in the centre.

(b) X indicates the datum point where both waveforms are going positive together at their mean level.

(c) ‖ indicates 15 c/s reference signal bursts.

(d) | indicates 135 c/s reference signal bursts.

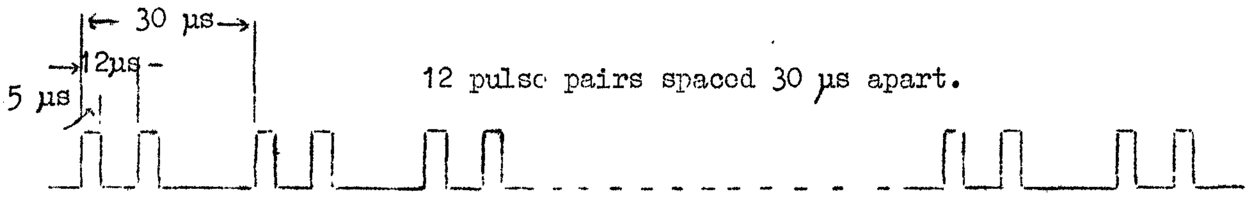
TL/488.
JUNE, 1962.

9. The detected waveforms for one rotation of the beacon aerial system are illustrated in fig. 4, which shows how the same succession of pulses is received at the four cardinal points. Between successive 15 c/s reference signals (represented by double vertical lines), eight equally spaced 135 c/s reference signals are transmitted (represented by single vertical lines). In the waveform at a point due South of the beacon it will be seen that both the 15 c/s and 135 c/s components are increasing at the time the 15 c/s reference signal is received. At the point due North the waveform is inverted, and both components are decreasing when the 15 c/s reference signal is received. Due East both components are at a maximum and due West both components are at a minimum when the 15 c/s reference signal is received. At intermediate points the waveform is changing progressively.

10. The function of the bearing circuits in the aircraft equipment is to adjust the phase of the 15 c/s and 135 c/s components with respect to their respective reference signals until the waveforms and reference signals are related as in the due South position of fig 4, whatever the position of the aircraft. In this position the datum point X which corresponds to where both the 15 c/s and 135 c/s waveforms are increasing (the since wave is going positive) is coincident with the 15 c/s reference signal. The amount of phase shift necessary to achieve this pattern is a measure of the bearing of the aircraft relative to the beacon.

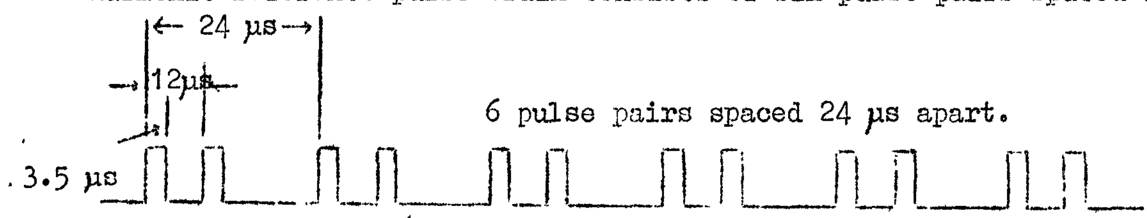
11. The accuracy of bearing obtained by this 15 c/s coincidence. is of a low order, and greater accuracy is obtained by employing the 135 c/s waveforms and 135 c/s reference signal bursts. The 15 c/s coincidence circuits in the aircraft equipment select the correct 40° sector of bearing, and as nine degrees of electrical phase of the 135 c/s system correspond to one electrical phase of the 15 c/s system, both equal to one degree in azimuth, the 135 c/s coincidence circuits provide a vernier nine times more accurate than the 15 c/s circuits.

12. <u>15 c/s Reference Signal Burst</u>. In order that the aircraft equipment can distinguish the reference signals from distance reply signals, the 15 c/s reference signal burst consists of 12 pulse-pairs spaced 30 μs apart.



<u>Fig. 5 15 c/s Reference Signal Burst.</u>

13. <u>135 c/s Reference Signal Burst</u>. This reference signal, called the harmonic reference pulse train consists of six pulse-pairs spaced at 24 us.

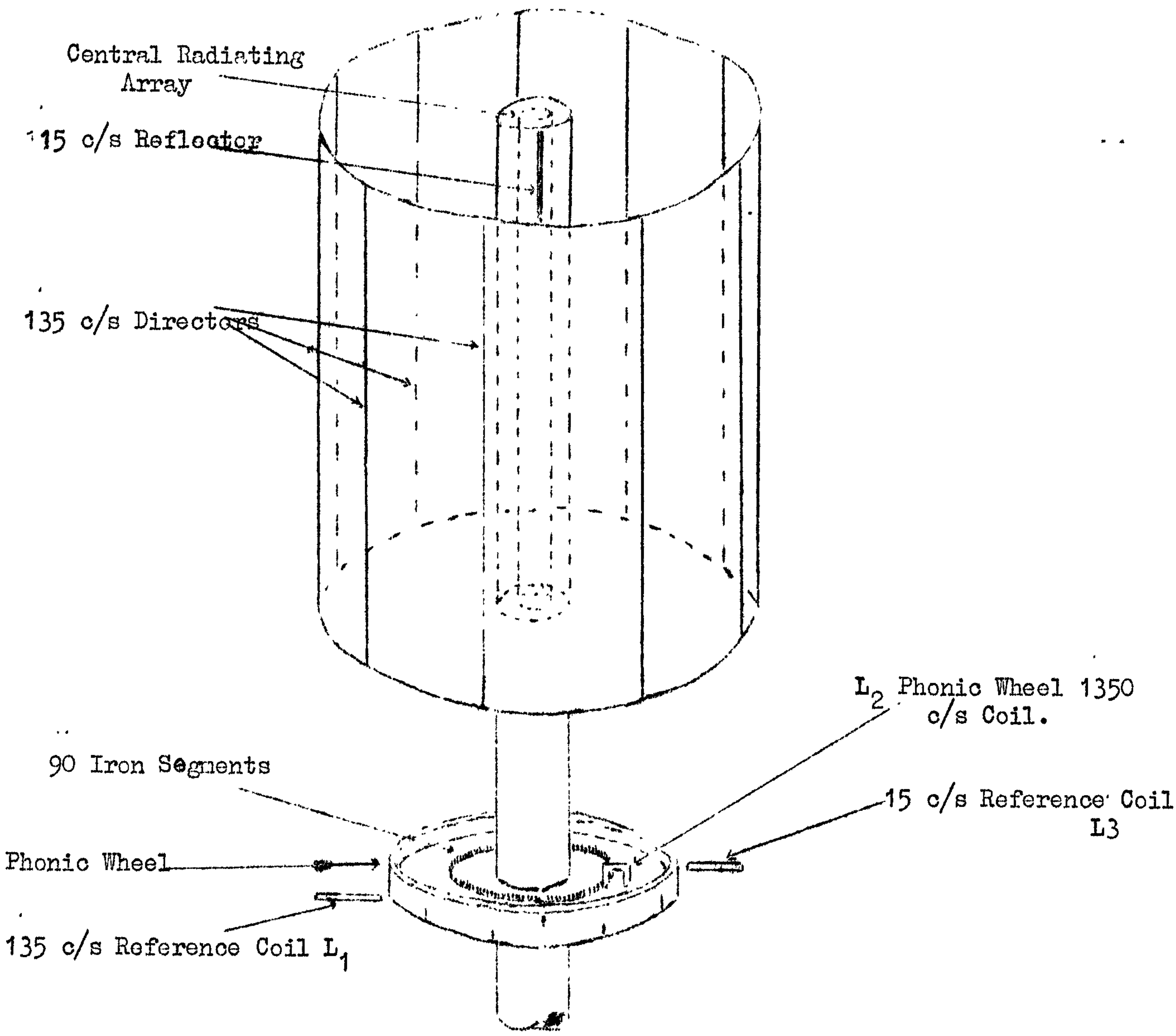


<u>Fig 6. 135 c/s Reference Signal Burst.</u>

14. As the aerial array rotates through certain "fixed" points of the compass these reference signal bursts are transmitted through the action of the iron slugs mounted in the Phonic Wheel, shown in fig 7. During installation the Coil Mounting assembly (para 16) is orientated so that the 15 c/s reference signal burst is transmitted when the reflector in the inner cylinder is due West of the dipole stack.

Aerial Construction.

Fig 7. Aerial and Phonic Wheel.



15. The central radiating array consists of seven biconical dipoles stacked vertically, and mounted in a fixed fibre-glass cylinder. The two outer cylinders rotate round the central array at 900 r.p.m., and as can be seen in fig. 7 the 15 c/s reflector is enbedded in the inner cylinder, and the nine directors making the 135 c/s modulation pattern are enbedded in the outer cylinder.

16. The non-ferrous phonic wheel serves three purposes as it rotates at 900 r.p.m, namely:-

(a) Generates a 1350 c/s waveform from a series of 90 iron segments which stand vertically on top of the phonic wheel. This waveform is used to check the speed of aerial rotation and also to generate identity tone signals. A coil is used to pick up these signals.

(b) Generates the 135 c/s reference trigger pulse in coil L_1 by action of eight iron slugs in lower edge of wheel as they pass through the pole pieces.

(c) Generates the 15 c/s reference trigger in coil L3 which picks up a pulse each time the iron slug passes the pole pieces.

17. <u>Aerial Speed Control</u>. The speed of rotation of the aerial parasitic elements must be maintained at 900 r.p.m. $\pm$ 0.2. As each of the 90 iron segments mounted on the phonic wheel passes through the coil L_2 a pulse of current is produced. Since the wheel is rotating at 900 r.p.m. (i.e. 15 r.p.second) these current pulses will be at a frequency of 90 x 15 = 1350 c/s. If the phonic wheel changes speed the 1350 c/s increases or decreases accordingly, and the aerial speed control unit produces a variation in the current flowing in a magnetic coupling between the driving and the driven shafts.

TL/488.
JUNE, 1962.

CABINET ELECTRICAL EQUIPMENT (TR)

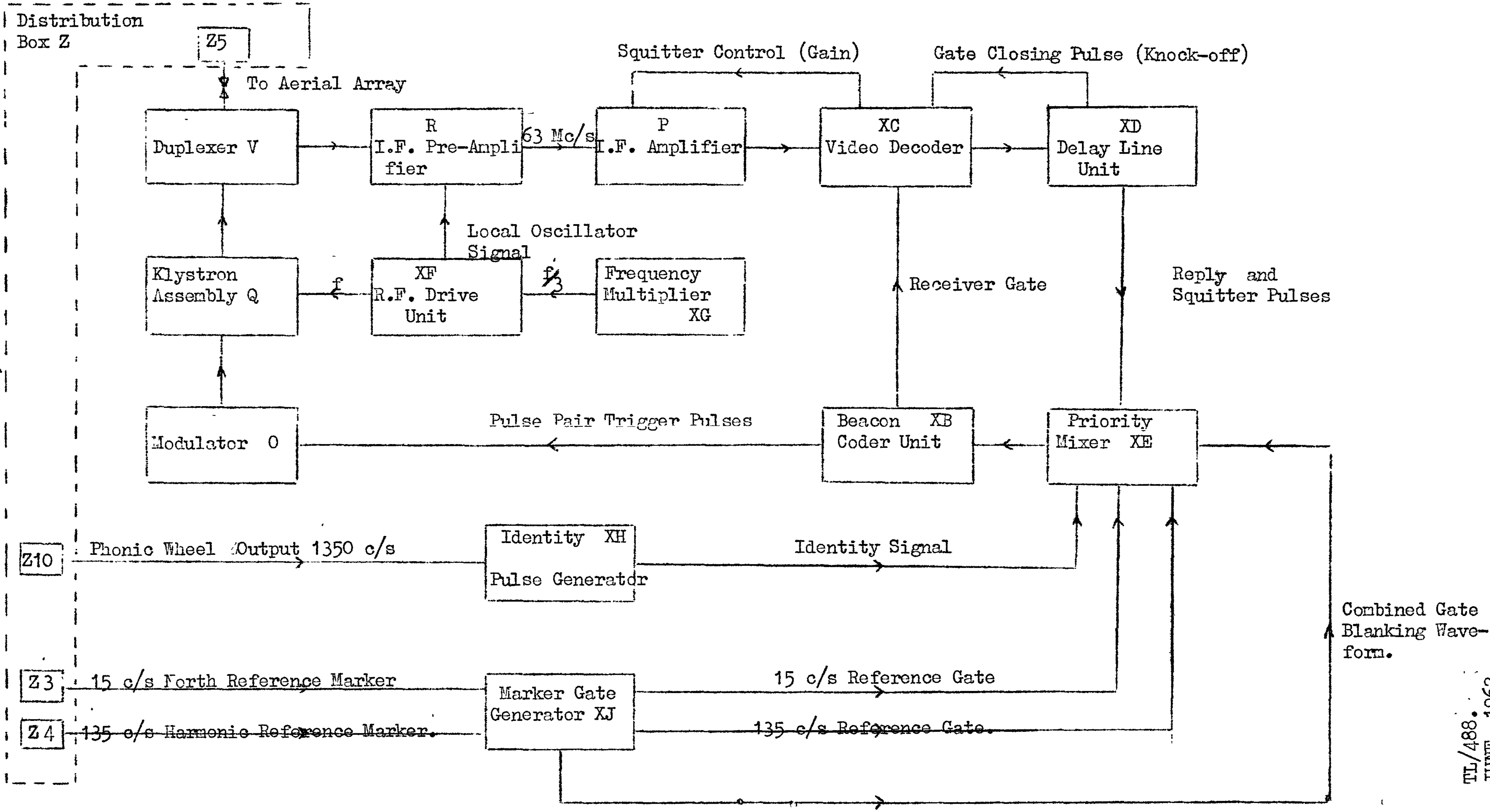
Introduction.

18. The Cabinet electrical equipment (TR) is the right-hand cabinet of the beacon and in it are housed almost entirely the units comprising the transmitter - receiver. The units whose code letters are prefixed X are mounted on the right-hand inner door, the remainder are in the right-hand bay except Z which straddles both cabinets. Table 1 gives the title and unit code of each unit and fig. 8 shows the simplified block diagram of the transmitter-receiver. Fig. 9 illustrates the detailed block diagram.

Table 1. Title And Code Of Units.

Pre-heating relay	G	Meter panel	XA
-15 kV. power unit.	N	Beacon coder unit	XB
Modulator	O	Video decoder	XC
I.F. Amplifier	P	Delay line unit	XD
Klystron assembly	Q	Priority mixer	XE
I.F. pre-amplifier	R	R.F. drive unit	XF
Thermistor unit	U	Frequency multiplier unit	XG
Duplexer	V	Identity pulse generator	XH
Control unit	W	Marker gate generator	XJ
Distribution box	Z	Fan distribution block	XK

FIG: 8. TRANSMITTER-RECEIVER BLOCK DIAGRAM (SIGNAL).



TL/488.
JUNE, 1962.

GENERAL DESCRIPTION OF UNITS (MOUNTED IN RIGHT-HAND CABINET)

19. Duplexer (V). The duplexing system separates the interrogations and reply pulses on the basis of their 63 Mc/s frequency difference, and enables the transmitter and receiver to use a common aerial and feeder system.

20. I.F. Amplifiers (R and P). The incoming interrogation signals are fed to the I.F. pre-amplifier unit (R) from the duplexer (V). The signals are applied to a balanced mixer which also receives the local oscillator signal from the R.F. drive unit (XF). The two signals are mixed producing an I.F. of 63 Mc/s, which is amplified and passed to the main I.F. amplifier (P) which has seven stages. The gain of the first two stages is controlled by A.G.C. applied from the video decoder unit (XC). The output from the final I.F. amplifying stage is fed to a Ferris discriminator, which is a detector, and by the use of broad and narrow band circuits coupled together, provides a high degree of adjacent channel rejection. The output is fed via a video amplifier to the video decoder unit (XC).

21. Video Decoder Unit (XC). This unit performs the following functions:-

(a) Decodes the interrogation pulse pairs.

(b) Generates a blanking waveform for system operation.

(c) Generates the A.G.C. (D.C. squitter voltage) to control the gain of the first two stages of the main I.F. amplifier (P).

The beacon duty cycle is 3600 pulse pairs per sec, 900 of which are produced by the reference bursts. The remaining 2700 are made up of reply pulses and squitter. Squitter is the name given to pulse pairs produced by random noise pulses in the receiver. The decoded pulses are counted and produce the AGC bias to the receiver. Thus when interrogation is a minimum bias is a minimum and the receiver produces maximum noise to provide the squitter "fill in" pulse pairs.

22. Delay Line Unit (XD). This unit consists of delay lines and amplifiers. It provides the beacon overall delay, and supplies a pulse to feed back to the blanking gate generator in the video decoder unit (XC) in order to define the end of the blanking period (knock-off pulse). The delays provided by this unit are highly stable.

23. Identity Pulse Generator (XH). The input to this unit is provided by the aerial phonic wheel and is a 1350 c/s sinewave. From it is produced the identity signal consisting of two pulses spaced 100 µs apart, at a repetition rate of 1350 p.p.s. The identity signal is dependent upon the aerial rotation, thus it has a fixed phase relationship with the 15 c/s and 135 c/s marker bursts.

24. Marker Gate Generator (XJ). This unit provides two gates used to provide two reference pulse trains namely:-

(a) The 15 c/s North reference pulse train.

(b) The 135 c/s harmonic reference pulse train.

25. The reference pulses originate from a rotating non-ferrous disc bearing an iron slug. The disc is attached to the aerial. As the aerial pattern maximum passes through a given point (East), the iron slug passes a magnetic coil system and produces a pulse. The aerial is rotating at 900 r.p.m., thus the magnetic coil produces 15 pulses per second. Also mounted on the disc are a further eight slugs to produce a 135 p.p.s. signal. Both the 15 c/s and 135 c/s signals are fed to the marker gate generator.

26. The 15 c/s pulse is used to trigger a phantastron which produces a rectangular gate having a length corresponding to 12 marker pulses of 30 µs spacing. The 135 c/s trigger pulse is used in a similar way and produces a gate length equal to 6 marker pulses spaced 24 µs apart. The 15 c/s and 135 c/s gating waveforms are fed to the priority mixer (XE). In addition the two signals produce a blanking pulse which is also fed to the priority mixer (XE).

27. Priority Mixer (XE). The priority mixer performs two main functions namely:-

(a) Produces from the 15 c/s and 135 c/s reference gates, phase coherent marker pulse trains.

(b) Mixes the marker pulse trains, squitter and reply, and identity signals in the correct order of priority for application to the beacon coder unit (XB).

28. The order of priority required for system operation is as follows:-

(a) 15 c/s and 135 c/s marker pulse trains.

(b) Identity signal.

(c) Reply and squitter pulses.

29. The information fed into the priority mixer is produced by the circuits described in para. 22 to 26 and is as follows:-

(a) 15 c/s reference gate from marker gate generator (XJ)

(b) 135 c/s reference gate from marker gate generator (XJ).

(c) A combined 15 c/s and 135 c/s blanking waveform from the marker gate generator (XJ).

(d) The identity signal from the identity pulse generator (XH)

(e) Squitter and reply pulses from the delay line unit (XD).

(f) Keying from the identity keyer (MD).

30. The 15 c/s reference gate is applied to a recycling circuit consisting of an amplifier, cathode follower and delay lines, which produce a pulse every 30 µs until the end of the gating period. The 135 c/s reference gate is fed to a similar circuit producing a pulse every 24 µs until the end of the gating period. The two pulse trains are fed out through a mixer circuit to the beacon coder unit (XB).

31. The identity signal and the reply and squitter signals are fed to a double gating circuit, which is operated by the identity keying from the identity keyer (MD). Normally the double gate passes the reply and squitter pulses, but once every 37.5 seconds the identity keyer switches the double gate and allows the identity signal of the appropriate beacon code to be transmitted. This system causes a continuous stream of reply and squitter pulses or identity signals to be applied to the mixer circuit.

32. However, the 15 c/s and 135 c/s reference pulses are also applied to the mixer circuit so a further pulse is applied to the double gate to cut it off during reference pulse bursts. The cutting-off pulse is the combined blanking waveform from the marker gate generator (XJ),. The output of the mixer circuit is fed out via an amplifier-inverted to the beacon coder unit (XB).

TL/488.
JUNE, 1962.

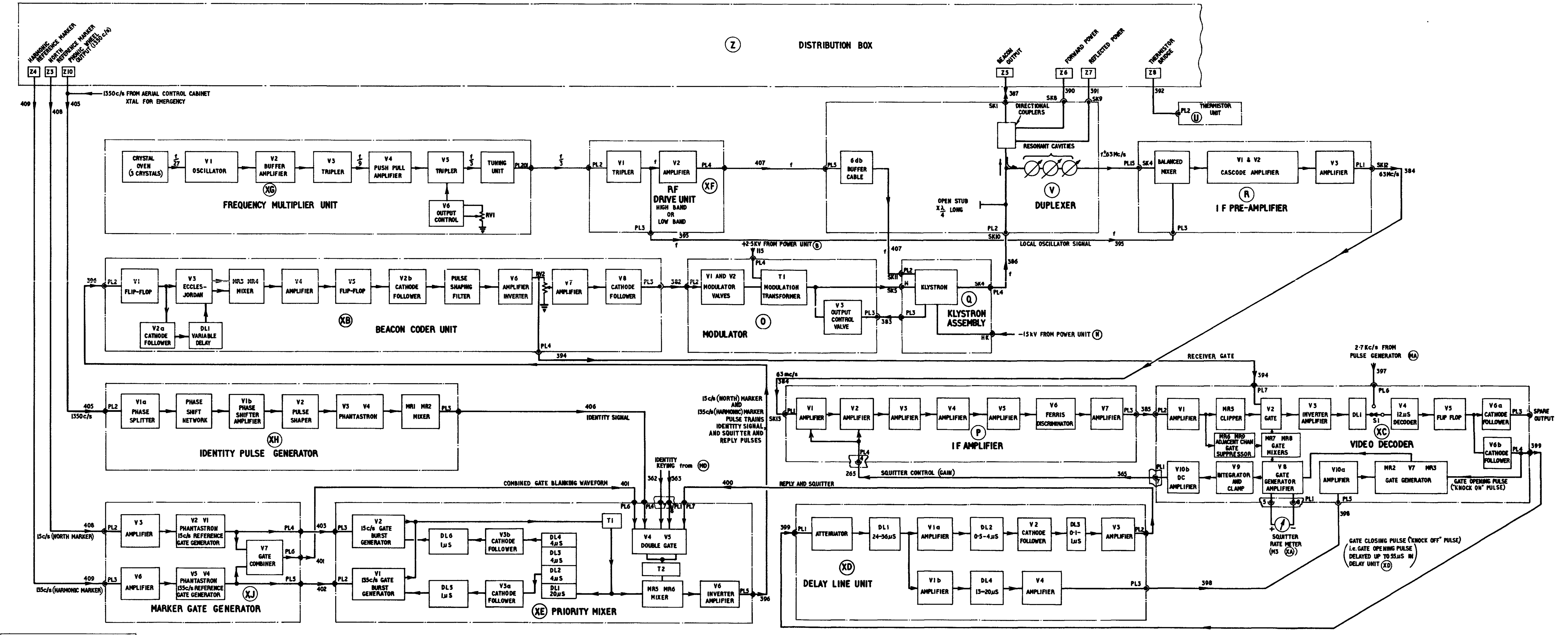
33. Beacon Coder Unit (XB). The composite video output of the priority mixer (XE) is applied to the beacon coder unit. The function of this unit is to convert each single pulse input into a pulse pair spaced at 12 µs at a level suitable for driving the modulator (O). This is achieved by triggering a bi-stable multivibrator and a cathode follower simulataneously. The cathode follower output is applied via a 12 µs delay line back to the other side of the bi-stable multivibrator. This results in a 12 µs rectangular pulse which is differentiated, and the resultant waveforms are shaped and amplified and applied to the modulator unit (O).

34. Modulator (O). The coded pulse pairs are fed into the modulator unit and applied simultaneously to three modulator valves. These valves produce a controlled output pulse-pair of the order of 5 kV peak. The output pulses are fed to the Klystron modulation electrode.

35. R.F. System (XG and XF). The RF drive to the klystron is(CW,) and is produced by the Multiplier unit (XG) and the RF drive unit (XF). The beacon transmitter frequency is determined by one of 3 quartz crystals mounted in a temperature controlled oven. The crystals are of the overtone type and resonate at $\frac{1}{27}$ of the beacon output frequency.

The crystal oscillator output is amplified and multiplied in the multiplier unit (XG), and at a frequency of $\frac{1}{3}$ the output frequency is applied to the RF drive unit (XF). This unit triples and amplifies the input and feeds a CW signal at approximately 15W to the klystron input cavity. A small amount of signal is extracted for use as the local oscillator signal in the mixer stage of the IF pre-amplifier (R).

36. Klystron Assembly (Q). The output from the RF drive unit (XF) is fed to the klystron which raises the RF signal to approximately 7kW peak. The klystron has three external cavities and is magnetically focused; it is pulse modulated by signals applied to its control grid from the modulator. E.H.T. is applied to the klystron cathode from the - 15KV power unit. The output from the klystron is fed out to the aerial system via the duplexer (V).



AIR DIAGRAM 6264A/MIN.

ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Transmitter-receiver, 5825-99-932-5320 — block diagram (signal)

Fig.1

(A.L.1, Aug.58)

CIRCUIT DESCRIPTION OF UNITS.

DUPLEXER AND RECEIVER SUB-ASSEMBLY (V AND R)

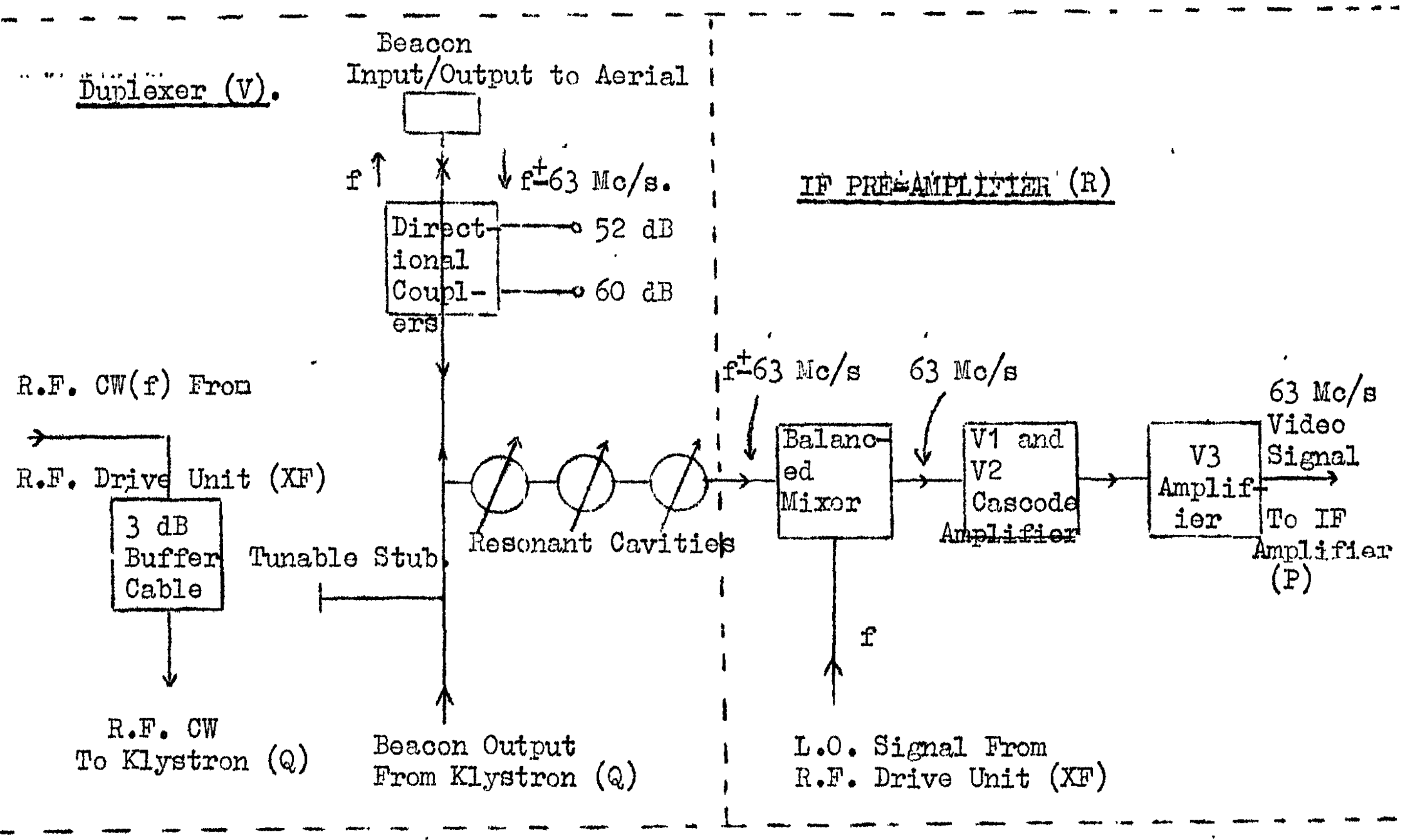


Fig. 10 Duplexer and Receiver Sub-Assembly Block Diagram.

37. Introduction. The duplexer (V) and the receiver sub-assembly (R) are physically integrated. The duplexer separates the outgoing and incoming pulses on the basis of their frequency difference. The receiver sub-assembly accepts the incoming pulses and by mixing them with the L.O. signal produces the required I.F. of 63 mc/s. This is amplified and fed to the video signal.

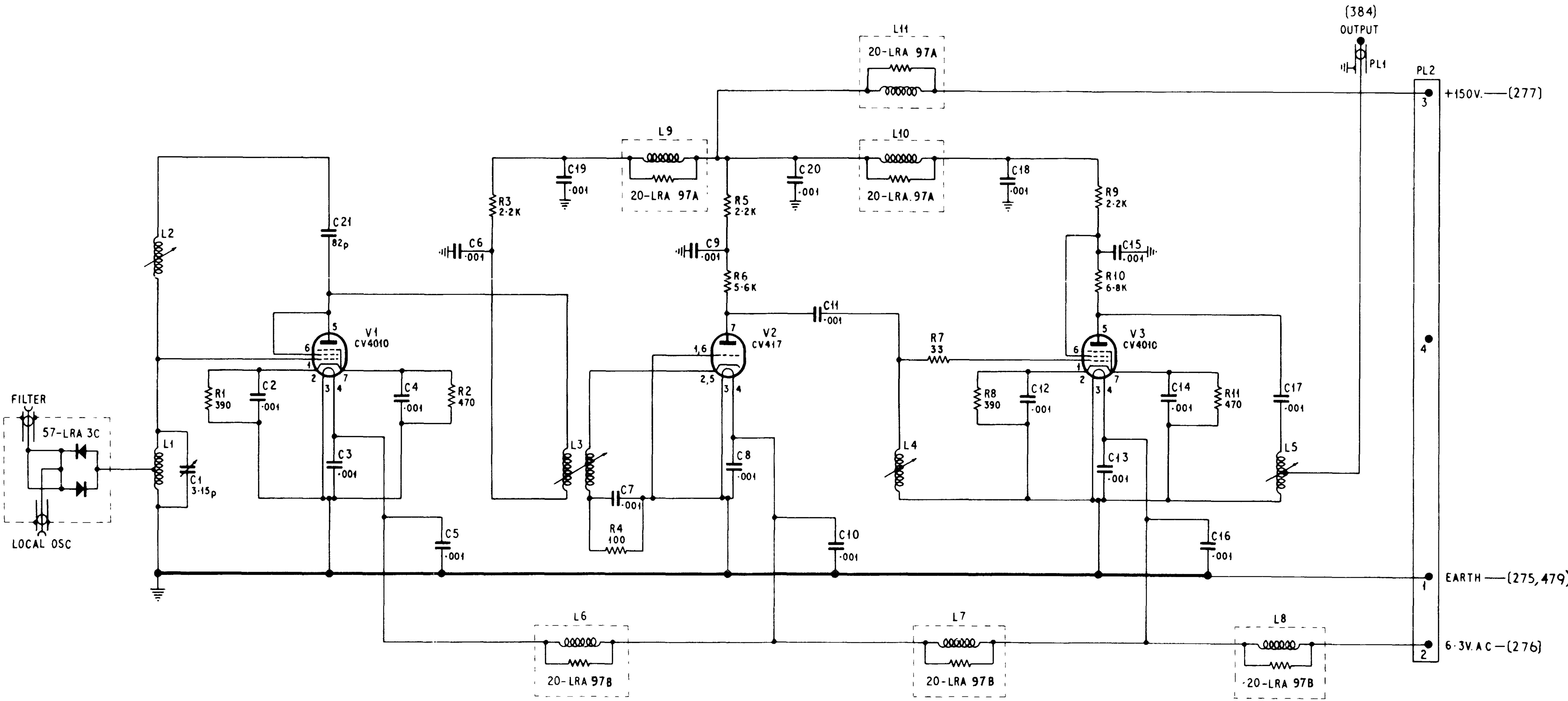
38. Duplexer (V.) Interrogation pulses from the aerial are fed into a coaxial line and transmitter pulses are fed into the other end of the line. Attached to this line are two stubs. The first stub feeds into three resonant cavities in series; these are tuned to the interrogation frequency and transmitter pulses are rejected. The second stub is open-ended and variable. It is adjusted to an odd number of quarter wavelengths long at RX frequency and an even number at Tx frequency, thus presenting a short circuit at RX frequency and an open circuit at TX frequency. This will not effect the transmitted power while preventing loss of received energy to klystron.

The directional couplers provide a means of checking pulse shape and mean output power.

The buffer cable is to match the R.F. drive unit output into the klystron input circuit and in doing so attenuates the signal by 3 db.

39. I.F. Pre-Amplifier. (R)Interrogation pulses at beacon frequency ± 63 Mc/s are fed from the resonant cavities in the duplexer to the balanced mixer, consisting of a hybrid ring and two crystal diodes of opposite polarity. The local oscillator signal at beacon frequency is also fed into the mixer from the R.F. drive unit (XF.) The two signals are mixed providing an I.F. of 63 mc/s which is amplified by V1 and V2, a cascode amplifier. This circuit provides wide band low noise amplification with the gain of a pentolde but the low noise factor of a grounded grid tiode. V3 is an output amplifier. The H.T. and heater supplies are extensively decoupled to prevent feedback and instability.

RESISTORS	R1	R2 R3	R4	R5 R6	R7 R8	R9 R10	R11																	
CAPACITORS	C1	C2	C21 C3	C4	C5 C6	C19	C7	C9	C8	C20 C11 C10	C18 C12	C13 C15	C14	C16	C17									
MISCELLANEOUS	L2 L1	V1	L3 L6	L9	V2	L11 L4 L10	L7	V3	L5 L8	PL1	PL2													



AIR DIAGRAM 6264U/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119 – IF pre-amplifier – circuit

Fig. 2.

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(A.L.7, Nov. 58)

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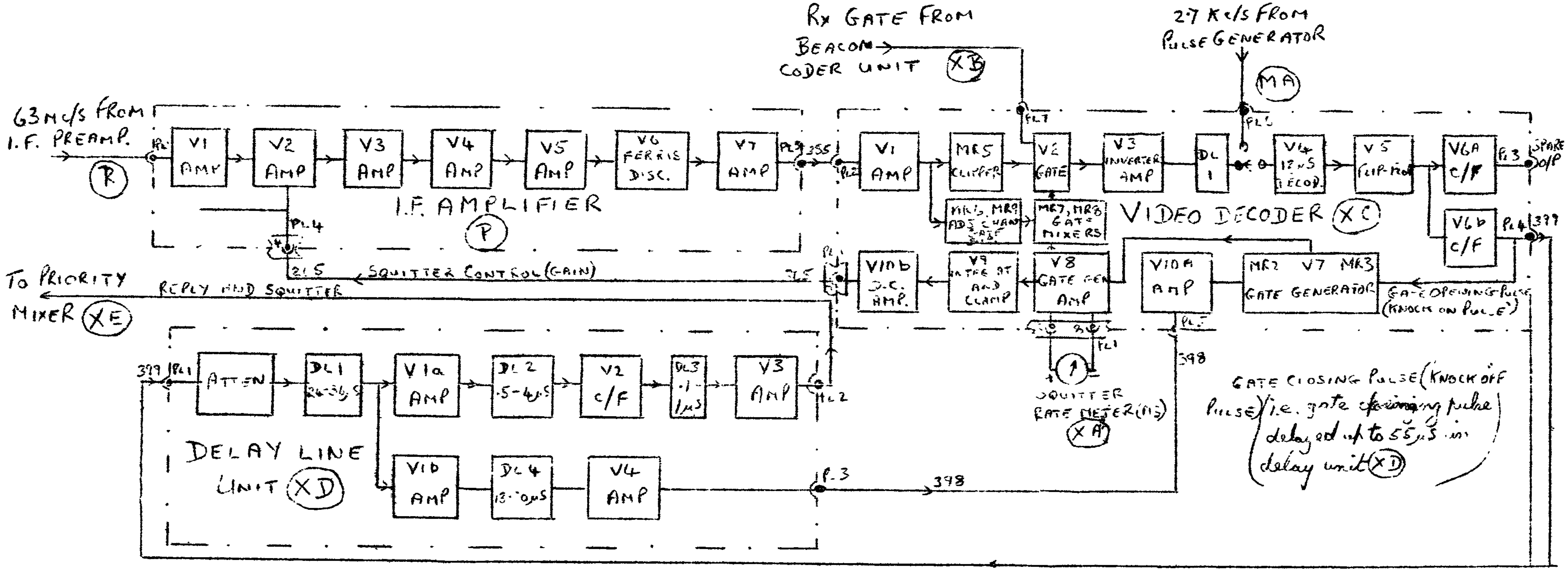


Fig. 12. Block Diagram of IF Amplifier, Video Decoder and Delay Line Units

I.F. AMPLIFIER P, VIDEO DECODER XC AND DELAY LINE UNIT XD.

Introduction.

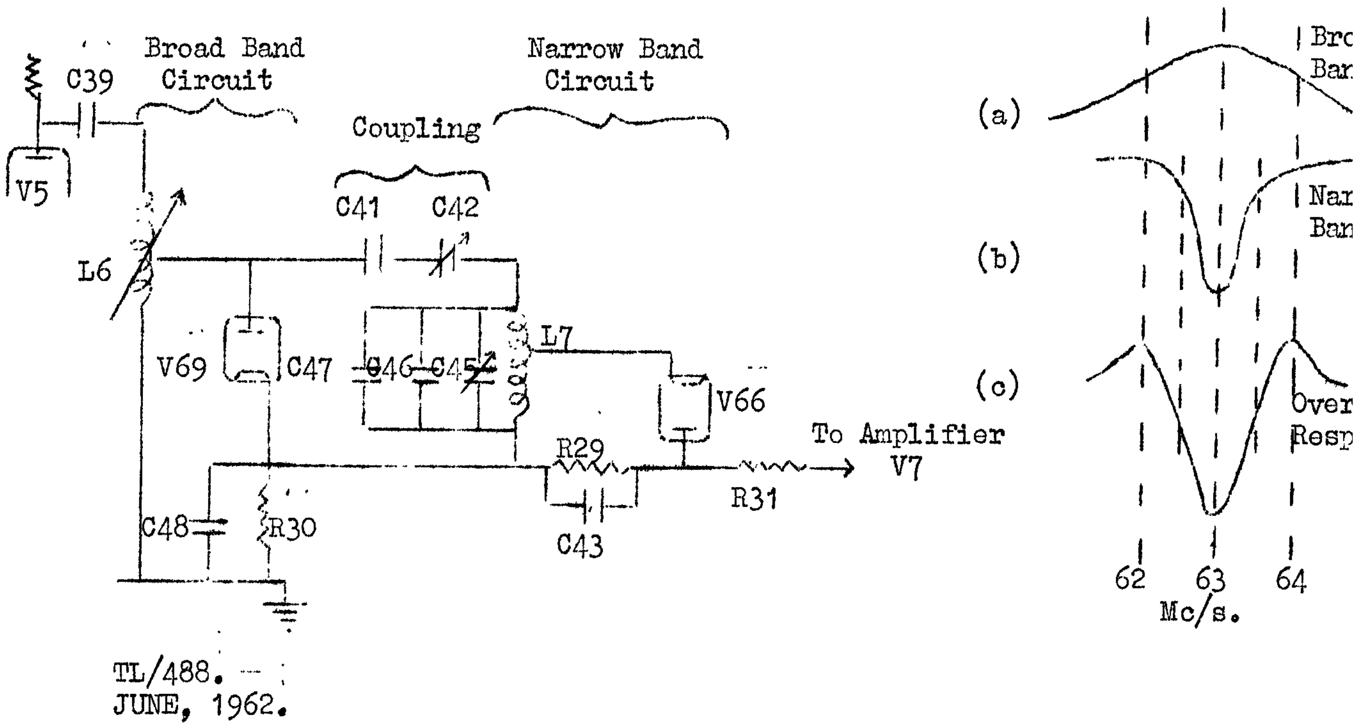
40. The i.f. amplifier, video decoder and delay line unit are associated together because they contain the video circuits required to produce the squitter and reply pulses from the interrogations, and the overall time delay required for distance measuring facilities. The sequence of valve stages is shown in the block diagram (fig 12).

I.F. Amplifier (P)

41. The input signal from the i.f. pre-amplifier R is applied to five amplifier stages in cascade which raise the level by approximately 60 db. These stages are all tuned to 63 Mc/s and the resistive damping of the tuned circuits produces a bandwidth of 3.5 Mc/s. Each stage is extensively decoupled to prevent feedback and instability, and each valve is provided with two combinations of cathode bias and decoupling. This is because the valve cathodes have two external connections and the r.f. impedance to earth is made as small as possible which is important for a low noise factor.

42. An a.g.c. voltage is applied to V1 and V2 from the video decoder XC. This voltage controls the gain of the first two stages and hence the noise level. The system requires that the number of interrogations and random noise pulses above a certain amplitude (squitter) shall be constant. Hence as the number of interrogation pulses received drops, the a.g.c. voltage is increased to raise the noise level and vice versa.

43. Ferris discriminator V6. The output from V5 is coupled to a Ferris discriminator which serves a dual purpose; it acts as a detector and at the same time reduces the interference caused by an adjacent channel signal.



TL/488.
JUNE, 1962.

Fig. 13. Ferris Discriminator - Circuit and Response Curves.

44. The operation of the circuit may be explained with reference to fig 13. V6a together with L6, C48 and R30 form a broadband positive detector which produces the response curve shown in fig 13 (a). V6b and its associated components C45, C46, C47, L7, C43 and R29 form a narrow band negative detector which produces the response curve shown in fig. 13 (b). The detector loads R29 and R30 are in series, hence the final response curve will be that shown in fg. 13 (c).

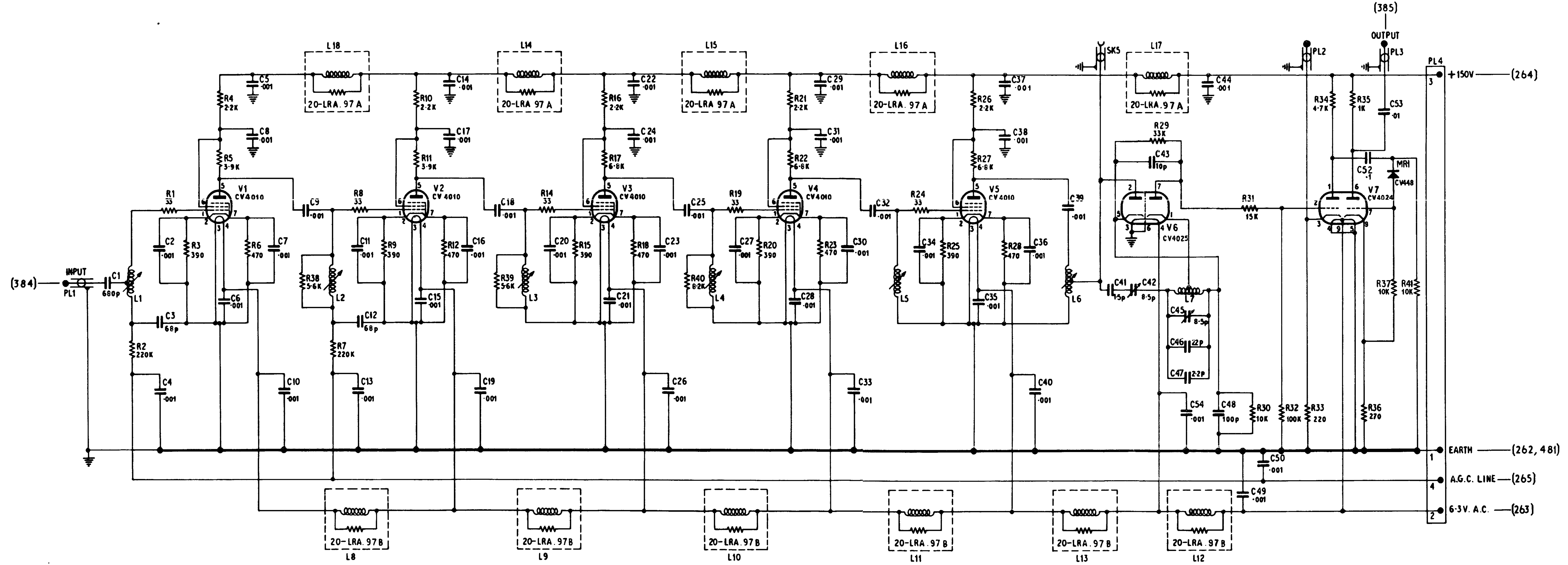
45. L6 matches V5 output to the low input impedence of V6a. L6 has a very flat response and is tuned to a centre frequency of 63 Mc/s with a handwidth of 3 Mc/s at 3 dB down. The broadband circuit is coupled to the high Q narrow band negative detector by C41 and C42.

46. For an on-channel signal of 63 Mc/s a negative output is obtained. On either side of 63 Mc/s the output signal amplitude decreases to zero and then increases positively. The frequency separation between zero points should be between 1.0 and 1.25 Mc/s, and is adjusted by tuning C42.

47. As the subsequent circuits will only respond to negative going signals from the discriminator it can be seen that signals at a frequency outside these zero points will be positive going and rejected.

48. <u>Output Amplifier V7</u>. This circuit forms a double triode amplifier. The diode MR1 is included to prevent large positive signals restoring on V7b grid and causing C52 to charge thus causing grid current. The amplified signals are fed via C53 to the video decoder XC.

RESISTORS	R1 R2 R3 R4 R5 R6 R38 R7 R8 R9 R10 R11 R12 R39 R14 R15 R16 R17 R18 R40 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28 R29 R31 R30 R32 R33 R34 R35 R36 R37 R41
CAPACITORS	C1 C2 C3 C4 C6 C5 C8 C7 C10 C9 C11 C12 C13 C15 C14 C17 C16 C19 C18 C20 C21 C22 C24 C23 C26 C25 C27 C28 C29 C31 C30 C33 C32 C34 C35 C37 C38 C36 C40 C39 C41 C42 C43 C45 C46 C47 C54 C44 C48 C49 C50 C53 C52
MISCELLANEOUS	PL1 L1 V1 L2 L18 L8 V2 L3 L14 L9 V3 L4 L15 L10 V4 L5 L16 L11 V5 L6 L13 SK5 V6 L17 L7 L12 PL2 V7 PL3 MR1 PL4



SRI. 18118, FGRI. 18119 — IF amplifier (P) - circuit

Fig. 6

(A.L.16 Dec. 58)

8316 351011 1/59 630+500 C&S L^TD GP 924

Video Decoder (XC)

49. The function of the video decoder is to accept the output of the i.f. amplifier and to perform the following functions:-

(a) To decode the interrogation and random pulse pairs.

(b) To generate a stable blanking waveform for system operation.

(c) To generate the a.g.c. ("squitter" control voltage) to control the gain of the first two stages of the i.f. amplifier(P).

The sequence of the valve stages can be followed by reference to the block diagram (fig.12) and the component references on the circuit diagram (fig. 15).

50. Amplifier and adjacent pulse suppression stages (V1 to V3). The incoming pulse pairs are negative going for on-channel signals and positive going for adjacent channel signals. These signals are fed to V1 grid which amplifies and inverts, and the output is fed two ways:-

(a) Via C28 to the adjacent channel pulse suppression circuit.

(b) Via C1 to amplifier/gating circuit V2.

51. The adjacent channel pulse suppression circuit consists of MR6, MR9, R73, R49, R74 and C29. The purpose of the circuit is to eliminate interference caused by:-

(1) Negative overshoot on on-channel pulses.

(2) Positive overshoot on large amplitude adjacent channel pulses.

52. When an adjacent channel pulse appears at V1 output it will be of opposite polarity to an on-channel pulse, i.e. negative going main pulse followed by small positive overshoot. This combination will be fed via MR6 and MR9 to C29 which will charge negatively (because pulses are predominantly negative). This negative voltage will be passed via the gating diode MR7 to V2 suppressor which will be held cut off for the period of the positive overshoot;

53. When an on-channel pulse is received it will be a large positive pulse with a small negative overshoot. The whole combination will be passed by MR6 and MR9 and the resultant charge on C29 will be positive. This will be blocked by MR7 and V2 will conduct normally. All pulses fed to the suppression circuit are fed simultaneously to V2 grid circuit, thus it can be seen that on-channel pulses will be passed by V2 to subsequent circuits whilst adjacent channel pulses will be rejected.

54. V2 is an amplifier/Gating valve, and the gating pulses which are all negative going are applied to the suppressor grid as follows:-

(a) The adjacent channel suppression pulses.

(b) The receiver suppression pulses from the beacon coder unit (XB). These pulses (in the form of a pulse pair spaced by 12 μs) are fed via isolating diode MR4 to cut off V2 while the beacon is transmitting, in order to prevent the transmitter power triggering the receiver.

(c) The 50 μs blanking waveform from V8 output circuit which is generated whenever a correctly coded pulse pair has been decoded, and the waveform is fed back to de-sensitize V2 immediately after it has passed a pulse pair to prevent squitter pulses simulating north (15 c/s) or harmonic (135 c/s) marker trains.

55. The signal is fed to V2 grid via clipper MR5. Diode MR5 is normally conducting and the network R6, MR5 and R16 holds V2 cut off. The positive input pulse causes V2 to conduct the larger pulses being clipped by MR5 and any negative overshoot drives grid further negative.

56. V3 amplifies and inverts the pulses which are coupled to the decoding circuit by C7 and C8.

57. Pulse pair decoding circuit (V4 and V5). Valve V4 is normally cut off at both control and suppressor grids. The positive going pulse pair from V3 is fed direct to V4 suppressor and also via a 12 µs delay line to V4 grid. It can be seen that the first pulse of the pulse pair after being delayed by 12 us delay line will be fed to the control grid of V4 coincident with the second pulse of the pulse pair which will be fed to the suppressor of V4. Hence a single negative-going pulse will be produced at V4 anode for every correctly spaced pulse pair appearing at V3 anode, irrespective of whether the pulse pair is an interrogation pair or random noise pulses with the same 12 µs spacing.

58. A 2700 c/s signal from the test equipment can be applied to V4 grid in order to check the 2700 pulses per second squitter rate indicating system.

59. V4 anode is coupled to V5a grid via C11 and MR1. V5 is a cathode coupled flip-flop, and as MR1 cathode is held at +40V, only negative triggers above a certain amplitude will fire V5. A positive pulse of fixed amplitude and width is fed from V5a anode to the grids of V6a and V6b.

60. Cathode follower and phase-splitter (V6). V6a provides a spare output. V6b provides a positive output pulse from the cathode to the delay line unit (XD) where it is delayed by 50 µs before being fed back as a "knock-off" pulse to the gate generator V7. The output from V6b anode provides a negative pulse which is fed as a "knock-on" pulse to the gate generator V7.

61. Gate generator. This circuit consists of V7, V10a, V8, MR2 and MR3. V7 is a cathode coupled flip-flop, while V10a and V8 are amplifiers. As MR2 cathode is biased positively to about +36V, only "knock-on" pulses above this amplitude will fire V7. Initially V7a is conducting because the grid is at cathode potential and the "knock-on" pulse from V6b will start flip-flop action. The "knock-off" pulse, now delayed by 50 µs in the delay unit (XD), is fed back into the video decoder, amplified and inverted by V10a and applied to V7b grid. This will stop flip-flop action and a 50 µs positive gate is fed via C17 to V8. MR3 is a d.c. restorer.

62. V8 is normally held cut off by bias. The 50 µs positive gate drives it into grid current. Thus the valve is either fully conducting or cut-off, and since the anode waveform will be a train of pulses of constant amplitude and length the average anode current will be a true measure of the mean rate of pulses decoded.

63. V8 has three outputs as follows:-

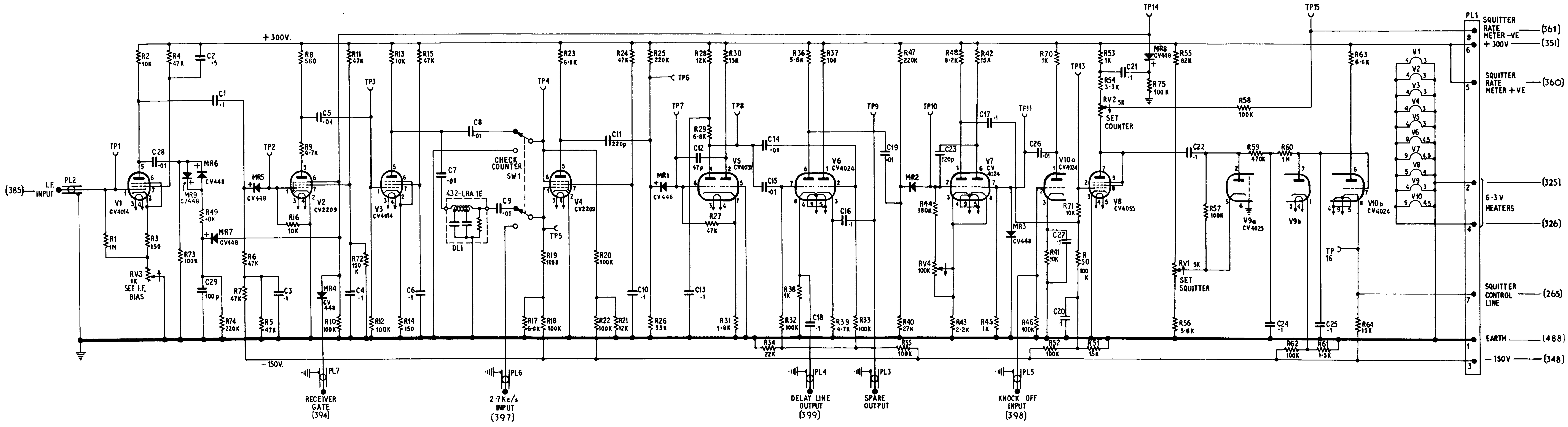
(a) Via isolating diode MR8 to V2 suppressor as a blanking pulse (para 54 (c))

(b) From RV2 (Set Counter) slider to the squitter rate meter on panel XA. There is a smoothing circuit mounted on the meter panel to give a steady indication.

(c) To the a.g.c. output circuit.

64. <u>A.G.C. output circuit.</u> The a.g.c. circuit consists of V9a a d.c. restorer, V9b a limiter and V10b a cathode follower. The negative going 50 µs pulses are d.c. restored by V9a negatively with respect to the level set by RV1 (Set Squitter) between +18V and +34V. From V9a the pulses pass through a smoothing circuit R59, R60, C24 and C25 to limiter V9b. The cathode of V9b is held at about -1V, so the valve limits the a.g.c. voltage fed to the i.f. strip should the squitter fail for any reason. The signal is finally fed through cathode follower V10b whose output is the a.g.c. voltage to control the gain of the first two i.f. stages in the i.f. amplifier (P). The cathode load R64 is returned to the -150V line to maintain V10b output reference level at about earth potential.

RESISTORS R1 R2 R3 RV3 R4 R73 R74 R49 R6 R7 R5 R16 R9 R8 R10 R11 R72 R12 R13 R14 R15 R17 R19 R18 R23 R22 R20 R21 R24 R25 R26 R29 R28 R27 R30 R31 R34 R32 R38 R36 R37 R39 R33 R47 R40 R35 R44 R4 R43 R48 R42 R45 R46 R70 R41 R71 R52 R50 R51 R53 R54 RV2 R75 RV1 R55 R56 R57 R59 R58 R60 R62 R61 R63 R64
CAPACITORS C28 C2 C29 C1 C3 C5 C4 C6 C7 C8 C9 C11 C10 C13 C12 C14 C15 C18 C16 C19 C23 C17 C26 C20 C27 C21 C22 C24 C25
VALVES V1 V2 V3 V4 V5 V6 V7 V10a V8 V9a V9b V10b
TEST POINTS TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP13 TP14 TP15 TP16
MISCELLANEOUS PL2 MR9 MR6 MR7 MR5 MR4 PL7 DL1 PL6 SW1 MR1 PL4 PL3 MR2 MR3 PL5 MR8 PL1



AIR DIAGRAM
6264V/MIN.
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119 - Video decoder (XC) - circuit

Fig. 7

(A.L 16, Dec. 58)

6316 351011 1/59 630+500 C.B.& S. LTD. GP 924

DELAY LINE UNIT (XD).

65. The function of the delay line unit is to accept the positive pulses from V6b in the video decoder (para 60) and from them produce the following pulses with the appropriate delays:-

(a) The squitter and reply pulses for inclusion in the composite beacon signal.

(b) The pulse to define the end of the blanking period in the video decoder (knock-off pulse).

66. Attenuator and main delay line. The input pulses are applied to an attenuator R2 to R7 and C1, which is included to sharpen the pulse. The attenuator has an adjustable tap, and the output is fed to the main delay line DL1. which has connections giving 24 µs, 28 µs, 32 µs and 36 µs delays. Two outputs are used:-

(a) From the 36 µs tapping a connection to V1b. This is the "knock-off" pulse feed.

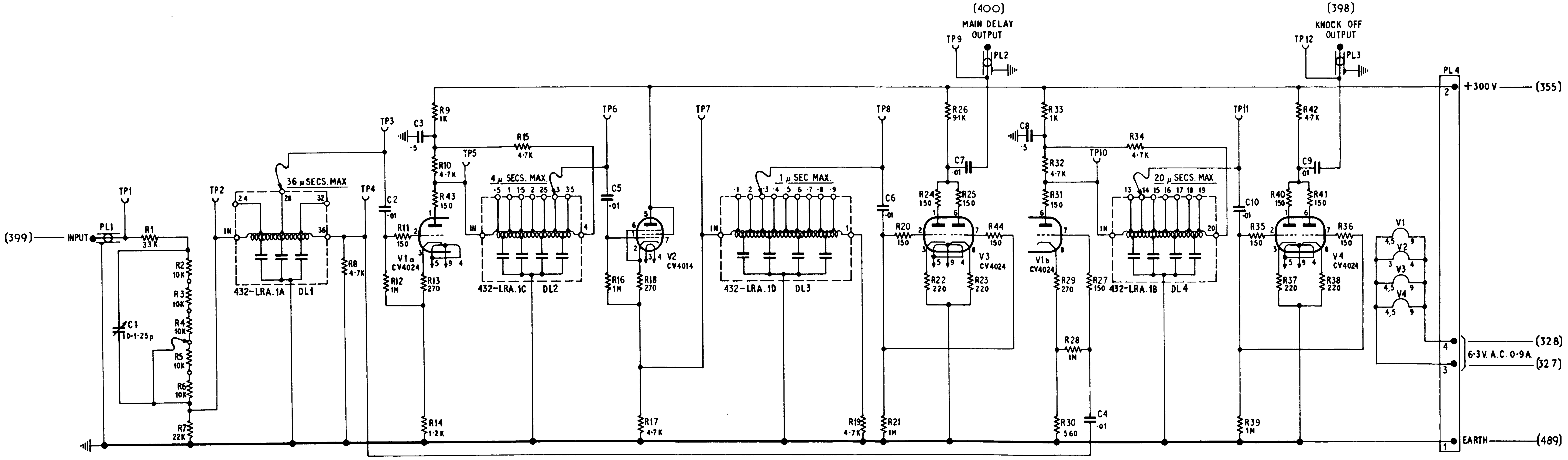
(b) From the 28 µs tapping a connection to V1a. This is the main output pulse to produce reply pulses.

67. "Knock-off" pulse delay chain. The pulse in (a) above is fed from DL1 to V1b grid which is an amplifier. V1b feeds into a further delay line DL4 which provides a maximum delay of 20 µs. An output from the 14 µs tap is amplified by V4, and fed to V10a in the video decoder (XC) giving a total delay of 50 µs.

68. Reply pulse delay chain. The 28 µs tapping on DL1 (para 66 (2)) is connected to amplifier V1a whose grid leak R12 is returned to junction of R13, R14 to provide negative feedback and reduce Bias on the valve. V1a output is connected to delay line DL2 which gives a maximum delay of 4 µs. The pulse output from DL2 is cathode followed by V2 and fed into DL3 a "vernier" delay line which has a maximum delay of 1 µs. DL2 (4 µs maximum) and DL3 (1 µs maximum) are adjusted so that together with the 28 µs delay in DL1, the overall delay of the delay line unit is about 32 µs and the overall delay of the beacon is 50 µs.

69. The output from DL3 is amplified by V3, and the positive pulses appearing at the anode are fed to the priority mixer (XE).

RESISTORS	R1 R2 R3 R4 R5 R6 R7 R8 R12 R11 R13 R9 R10 R14 R43 R15 R16 R18 R17 R19 R21 R20 R24 R26 R25 R22 R23 R44 R33 R32 R31 R29 R30 R28 R27 R34 R35 R40 R42 R41 R39 R37 R38 R36
CAPACITORS	C1 C2 C3 C5 C6 C7 C8 C4 C10 C9
TEST POINTS	TP1 TP2 TP4 TP3 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12
MISCELLANEOUS	PL1 DL1 V1a DL2 V2 DL3 V3 PL2 V1b DL4 V4 PL3 PL4



AIR DIAGRAM 6264AE/MIN.
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119 – Delay line unit (XD) – circuit

Fig. 8

(A.L.16, Dec. 58)

8316 351011 1/59 630+500 C.B & S. Ltd. GP 824

IDENTITY PULSE GENERATOR (XH) AND MARKER GATE GENERATOR (XJ)

Introduction.

70. The identity pulse generator (XH) and the marker gate generator (XJ) are grouped together because they receive their input signals from the aerial system and together generate those parts of the beacon output signal not produced by the video system.

Identity Pulse Generator (XH)

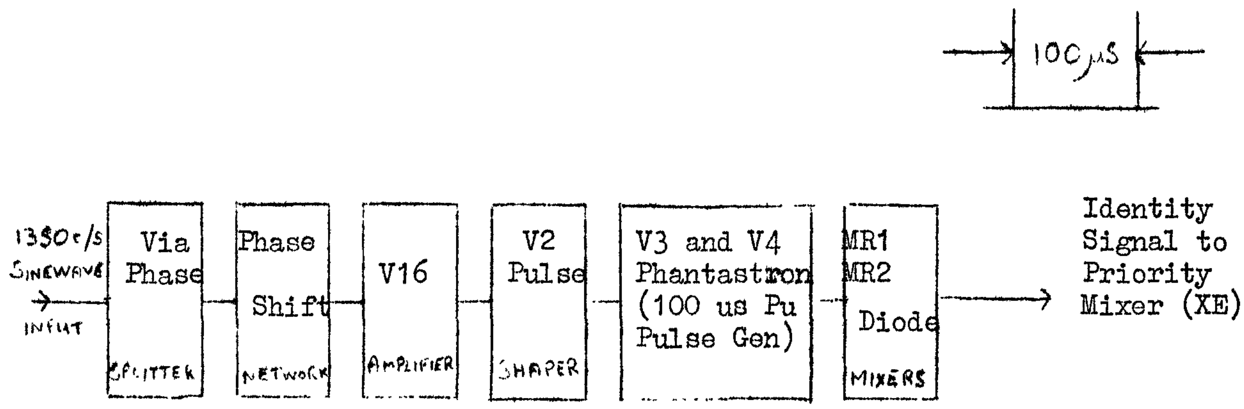


Fig. 17. Block Diagram of Identity Pulse Generator.

71. The circuit sequence can be followed by reference to the block diagram (fig. 17) and the component references to the circuit diagram (fig. 18)

72. Phase splitting and pulse shaping networks. The 1350 c/s sine wave from the aerial phonic wheel is applied to a phase splitter V1a. The 1350 c/s identity signal applied to the identity pulse generator and the marker trigger pulses applied to the marker gate generator both depend on aerial rotation, they are therefore, in a fixed phase relationship (phase coherent). The identity pulses and the initial pulses in the marker trains need to coincide, it is therefore, necessary to have some degree of phase adjustment between the 1350 c/s signal and the marker trigger pulses.

73. The sine-waves appearing at the anode and cathode of V1a are 180 degrees out of phase, they are applied to a phase shifting network C2, RV1 and R7 resulting in an adjustable phase sinewave appearing across RV1, with a range of about 110 degrees of phase shift. This is fed to amplifier V16.

74. V1b output is fed to clipper V2a which runs into grid current thus cutting off the positive peaks of the sinewave. V2b performs a similar function thus clipping the other peak of the sinewave. The resultant "squared" waveform is then applied to the primary of transformer T1, the low frequency response of which is very poor and the sharp rise and fall of V2b anode current results in a "differentiated" waveform appearing across the secondary winding. This waveform is fed to V3 where the negative part is used as a trigger for the phantastron circuit.

75. Phantastron circuit (V3 and V4). V3 is a double diode which together with V4, a pentode, forms a phantastron circuit. This circuit generates a stable 100 µs rectangular waveform on the screen grid of V4. The trigger is applied to V3a cathode whose d.c. potential is determined by the potentiometer chain R18 to R21 between +300V and earth.

76. In the quiescent state V4 control grid is held at cathode potential of V3b by the flow of current through R22 to R26, V3b and R20, R21. V4 cathode is held positive with respect to suppressor by cathode bias. Under these conditions V4 anode current is cut-off and cathode current is the sum of the screen and control grid currents. The anode is held at V3a cathode potential by current through R27 and V3a.

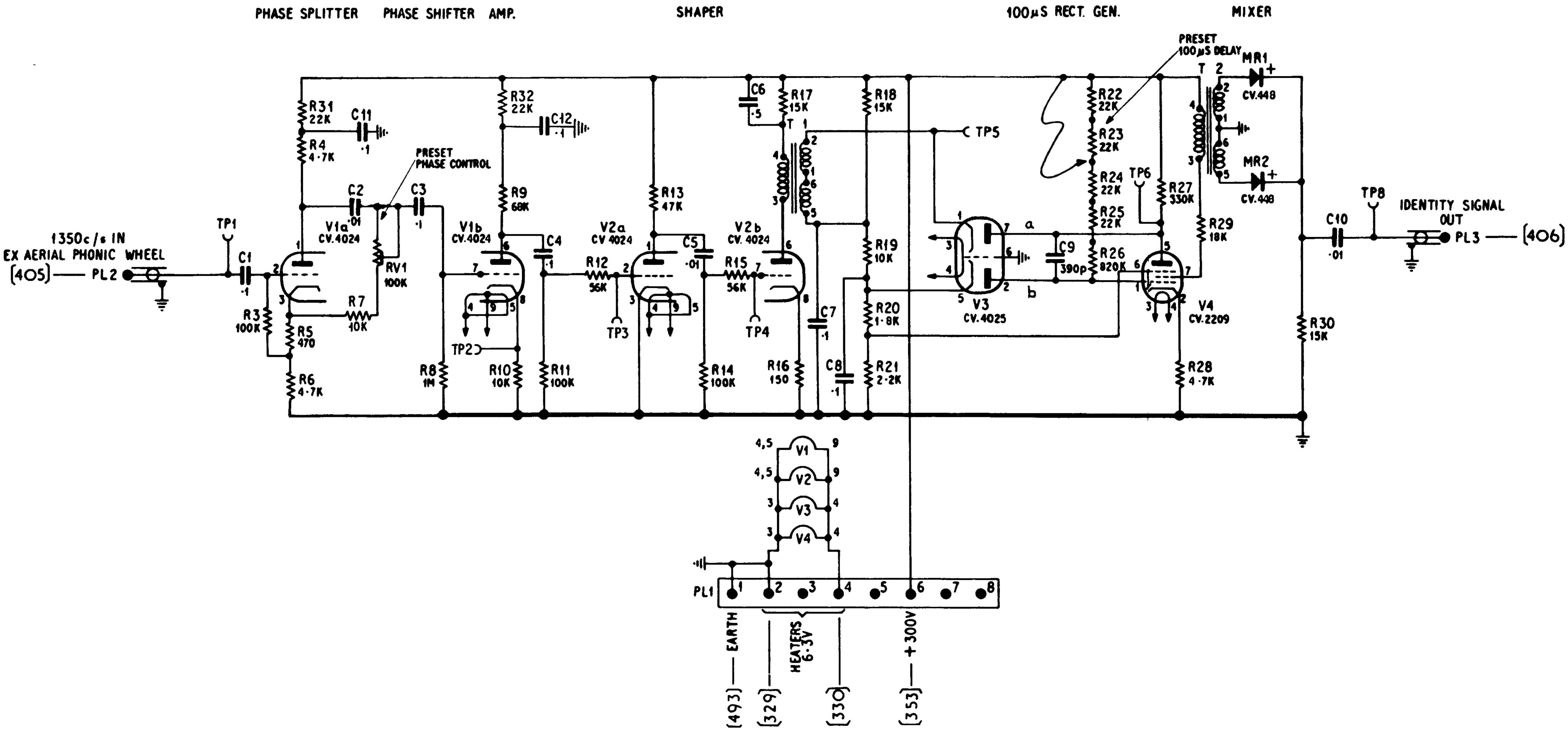
77. When the negative trigger is applied to V4 control grid via V3a and C9 the cathode voltage falls, and is instantaneously lowered relative to suppressor voltage which allows anode current to flow. Anode voltage falls and this fall is coupled back to control grid by C9; reducing grid voltage causes cathode voltage to fall further. This action is comulative until the anode - grid feedback balances the grid potential derived from the potentiometer chain R22 to R26.

78. The circuit now acts as a "Miller" timebase. The control grid voltage rises at a rate determined by the time constant of R22-R26 and condenser of capacity C9 (1 + a) where A is stage gain, and the anode rundown commences and falls linearly until the anode voltage bottoms, when "Miller" effect ceases. The control grid voltage continues to rise but now at a much faster rate. The cathode voltage increases, and consequently becomes more positive with respect to the suppressor grid voltage. and anode current falls while screen current increases. This action is again cumulative until anode current is cut-off by suppressor bias with respect to cathode. The anode voltage then rises exponentially as C9 charges through R27 and V3b, until diode V3a conducts so limiting the anode voltage of V4.

79. The waveforms produced by this circuit consist of a negative going haystack waveform at the anode and a positive square wave at the screen. In this particular case only the positive going 100 µs square wave from the screen is used. It is fed to the primary of transformer T2 which "differentiates" the leading and trailing edges of the waveform, and the resultant waveforms are applied to a mixer circuit MR1 and MR2. The negative going portions are removed in the mixer and the output consisting of two pulses spaced 100 µs apart at a repetition rate of 1350 per sec. is fed out to the priority mixer (XE) for inclusion in the composite beacon signal.

TL/488.
JUNE, 1962.

RESISTORS	R3 R5 R4 R31 R6 R7 RV1 R8 R32 R9 R10 R11 R12 R13 R14 R15 R17 R16 R18 R20 R19 R21 R22 R24 R26 R23 R25 R27 R29 R28 R30
CAPACITORS	C1 C2 C11 C3 C4 C12 C5 C6 C7 C8 C9 C10
MISCELLANEOUS	PL2 TP1 V1a TP2 V1b TP3 V2a TP4 V2b T1 PL1 V3 TP5 TP6 V4 T2 MR1 MR2 TP8 PL3



AIR DIAGRAM 6264J/MIN.
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119
Identity pulse generator (XH) - circuit

Fig. 5

7981 340289 1/58 630+500 C.B.& S.Ltd. GP 924.

Marker Gate Generator (XJ).

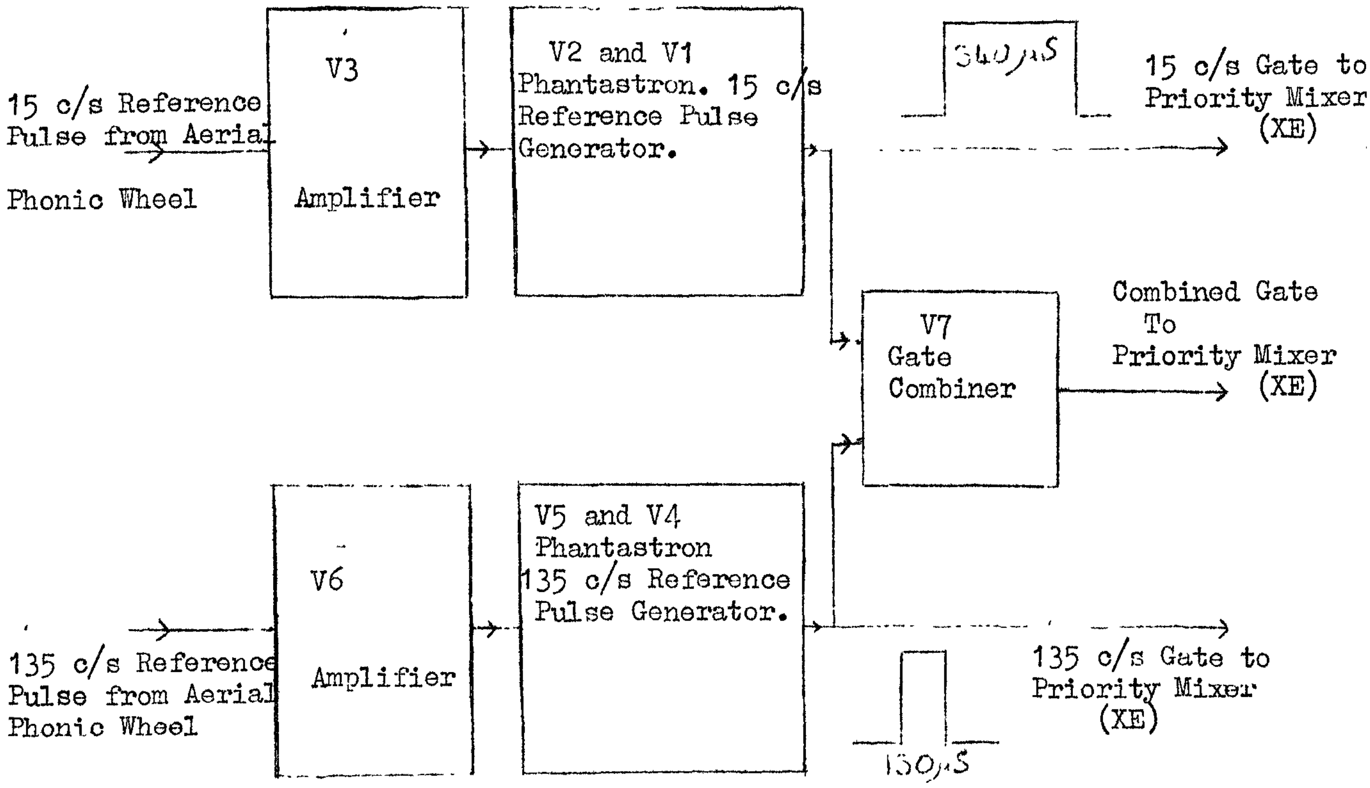


Fig. 19. Block Diagram of Marker Gate Generator.

80. The circuit sequence can be followed by reference to the block diagram (fig. 19), and component references identified on the circuit (fig. 20).

81. The 15 c/s and 135 c/s pulse signals are both derived from the pulse plate assembly in the aerial, which consists of a non-ferrous wheel bearing one iron slug in the upper edge of periphery. There are a further eight slugs on the lower edge at 40 degree intervals leaving a space where the slug is mounted in the upper edge. When the aerial pattern maximum passes through East (at this point the single reflection on the inner fibre-glass cylinder is due West of the radiating array), the slug on the upper edge passes through a magnetic coil system and produces a pulse. As the aerial rotates at 900 r.p.m. the magnetic coil produces 15 p.p.s. Similarly the eight slugs on the bottom of the plate produce the 135 c/s pulse signal. (For reference to aerial system see paras. 14 to 17).

82. North(15 c/s) marker gate generator. The 15 c/s pulse signal is fed to V3, a double triode amplifier. The negative going portion of the trigger pulse is amplified by V3a and further amplified by V3b resulting in a negative going pulse of about 90V amplitude being applied to the phantastron circuit V2 and V1. This circuit functions in a similar manner to the circuit used in the identity pulse generator (XH) described in para. 75 to 79.

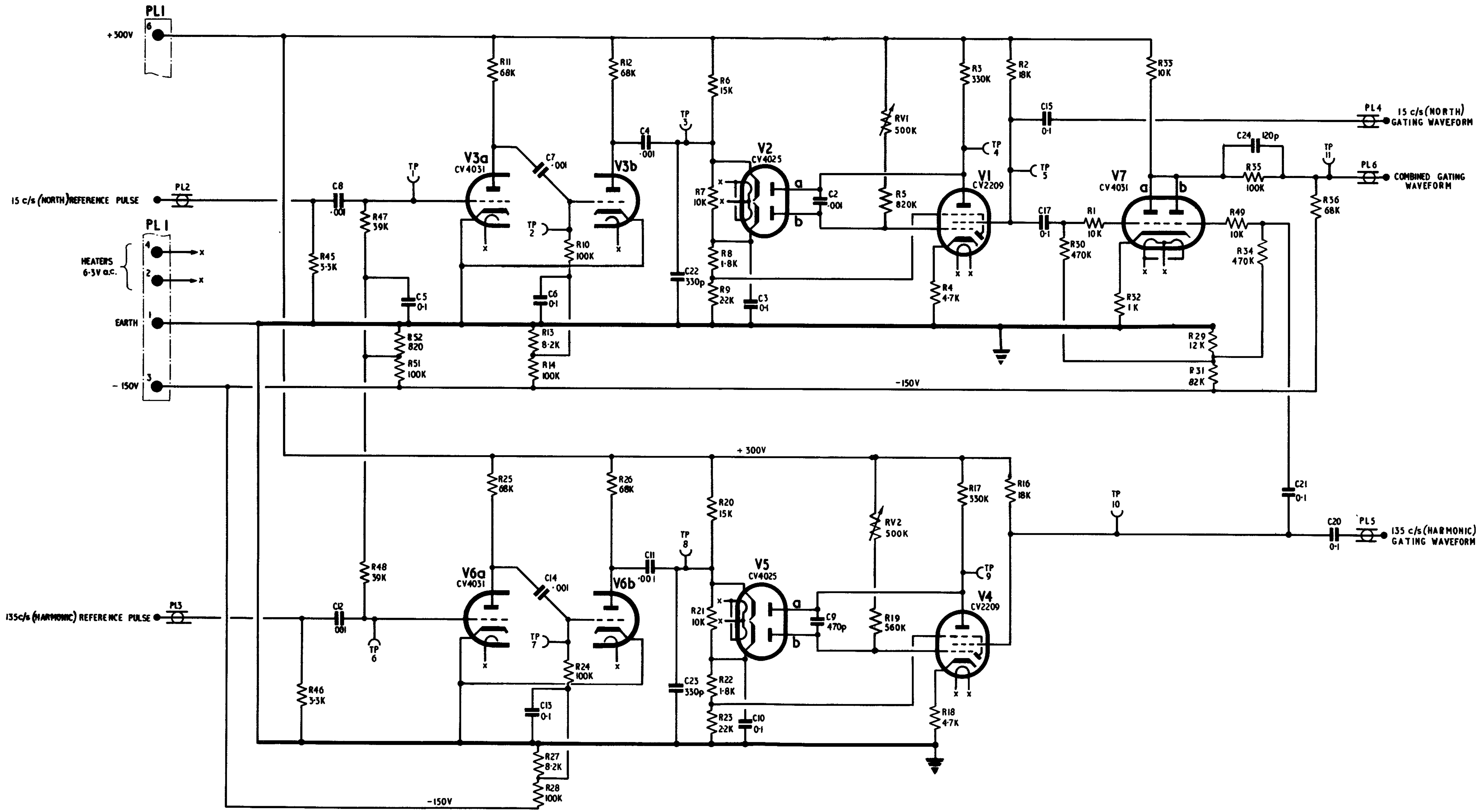
83. The duration of the rectangular waveform produced at V1 screen grid is controlled by a tapping on the resistor chain R5 and R37 to R40. This tapping is set to produce a pulse of about 340 μs duration, i.e. allowing for 12 pulses of 30 μs spacing. The north gating pulse is fed two ways as follows:-

(a) To the priority mixer (XE)

(b) To V7a the gate combining stage.

84. Harmonic (135 c/s) marker gate generator. This circuit consisting of amplifier V6 and phantastron V4, V5 operates in a similar manner to the North (15 c/s) marker gate generator circuit described in paras. 82 and 83. The phantastron produces a positive going gate of 130 μs, i.e. allowing for 6 pulses of 24 μs spacing. This waveform is fed to priority mixer (XE) and to V76 the gate combining stage.

85. Gate combing stage. The North (15 c/s) and the harmonic (135 c/s) gates are fed to V7a and V7b grids respectively. The two halves of the valve share a common anode load and when a gate is fed to either grid that half of the valve conducts producing a negative gate at the anode. This combined gating waveform is d.c. coupled to the priority mixer (XE). R35 and R36 set the d.c. level of the waveform and C24 serves to retain the sharpness of the leading edge.



SRI.18118, FGRI.18119 - Marker gate generator (XJ) - circuit

Fig. 6

AIR DIAGRAM 6264 D/MIN.
ISSUE 2
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924/8/7382/64026/1005/1/62 J. T. & S.

PRIORITY MIXER (XE)

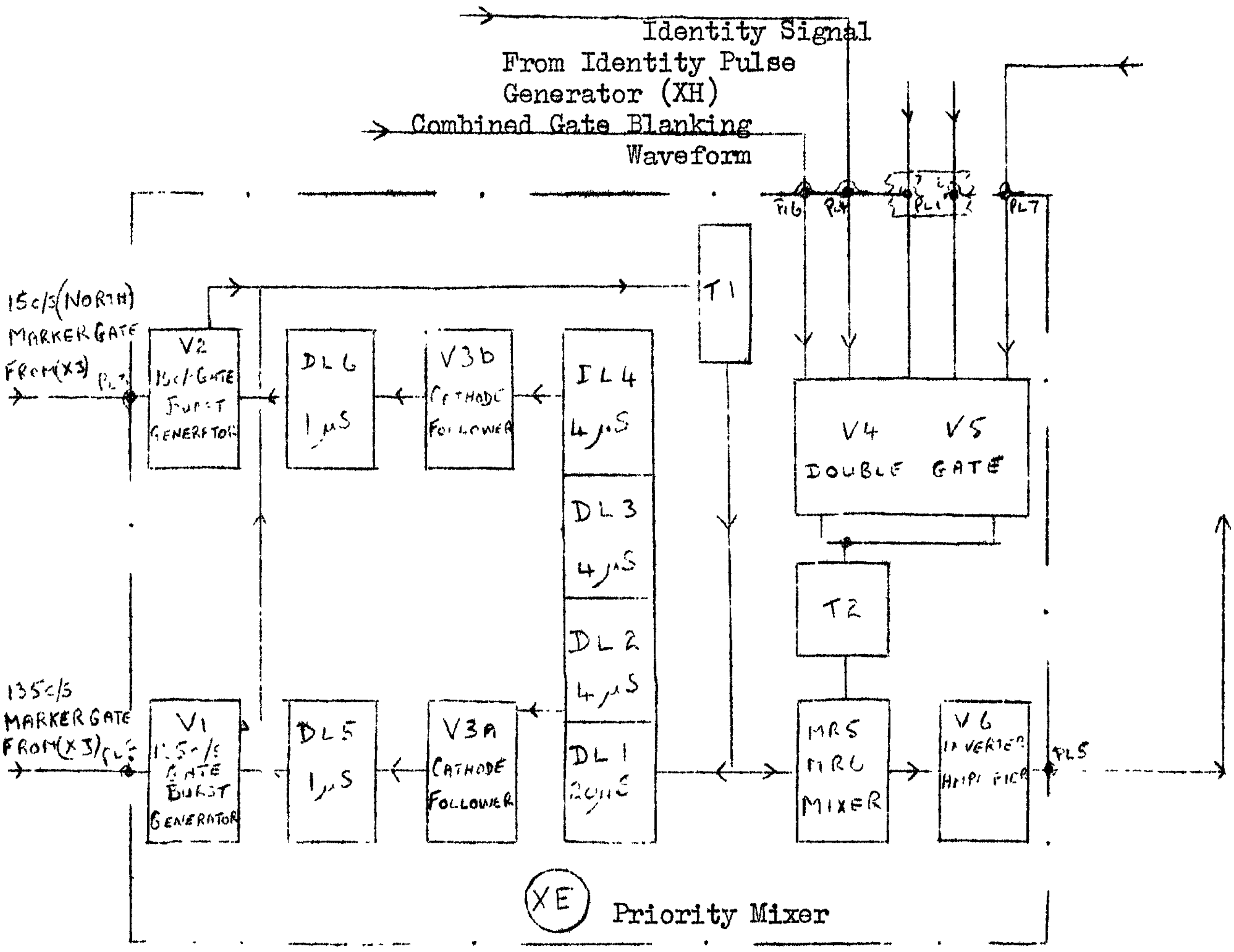


Fig. 21 Priority Mixer (XE) - Block Diagram.

Introduction.

86. The priority mixer (XE) performs two main functions:-

(a) Produces marker pulse trains from the 15 c/s and 135 c/s reference gates.

(b) Mixes the marker pulse trains, identity signal and squitter and reply signals in the correct order of priority which is as follows:-

(i) Marker pulse trains.

(ii) Identity signal.

(iii) Squitter and reply signals.

The sequence of the stages can be followed by reference to the block diagram (fig. 21) and component references can be seen on the circuit diagram (fig. 22).

87. 135 c/s marker burst generator. V1 is normally cut-off by negative bias applied to the suppressor and the grid. The 130 μs duration, positive going 135 c/s marker gate from the marker gate generator is applied to V1 as follows:-

(a) To the suppressor grid lifting the suppressor bias for the gating period.

(b) To the differentiation circuit C1, R4 which produces a positive spike followed by a negative spike. MR1 will only pass the positive spike, which is fed to the grid of the valve so lifting grid bias for the duration of the spike.

88. Due to the negative bias on both suppressor and grid being lifted V1 will conduct and a negative spike will be produced at the anode and applied to the primary of transformer T1. The positive pulse appearing across the secondary is fed two ways:-

(a) To MR5 as the first pulse of the harmonic pulse train.

(b) To a delay line DL1 for re-cycling. Immediately the first pulse is produced by V1 the valve is again cut-off at the control grid by negative bias, but the suppressor remains held on by the harmonic gate.

89. The pulse applied to DL1 (sub-para (2) above) is delayed by 20 µs and is then applied to a further delay line DL2 where it is delayed by 3.5 µs. The pulse, now delayed by 23.5 µs is then applied to the grid of V3a, a cathode follower. The pulse is fed from the cathode of V3a to delay line DL5, which is a "vernier" delay and is adjusted to give exac' y 24 µs overall delay.

90. The pulse emerging from DL5 is applied to V1 control grid via MR2, and once again the valve conducts and a pulse is applied to the anode transformer T1. Another re-cycling action will take place, and the action as described in paras. 88 and 89 will continue until the harmonic gate closes, when V1 will be cut-off by negative bias on the suppressor. Thus as the harmonic gate is set to about 13 µs, a pulse train of 6 pulses spaced at 24 µs will be produced by each harmonic gate applied to V1.

91. <u>15 c/s marker burst generator</u>. The 15 c/s (north) marker pulse train is generated in a similar manner to the 135 c/s marker pulse train. The circuit conditions of V2 are identical to those of V1 except that the duration of the north marker gate is about 340 µs. The transformer T1 is the common anode load of both V1 and V2 so the pulses from V2 anode are also fed to MR5 and DL1. The pulse fed to DL1 passes through the delay line chain DL1, DL3 and DL4 giving a total delay of 29.5 µs. The pulse is then cathode followed by V3b into a "vernier" delay line DL6 which is variable and preset to give an overall delay of 30 µs. The pulse is then applied to V2 control grid via MR4. Thus as the north marker gate is set to about 340 µs and the delay lines produce a preset delay of 30 µs, a pulse train of 12 pulses spaced by 30 µs will be produced by each north marker gating waveform applied to V2.

92. From the foregoing it can be seen that the pulse spacing within the marker gates is accurately controlled by delay lines and the duration of the bursts by the width of the gates. Both pulse trains are fed from T1 secondary to MR5, which together with MR6 forms a mixer circuit whose function is to "mix" the signals from the marker burst generators and the double gate for application to the amplifier V6. It should be noted that although both the north and harmonic marker re-cycling pulses pass through the delay lines and V3 they will only trigger the appropriate valve, because the north and harmonic gates are never generated at the same time.

93. The double gate circuit (V4 and V5). This circuit controls the priority of the component signals in the composite output signal. V4 and V5 are two pentode amplifiers with a common anode load transformer T2. There are three distinct states of operation as follows:-

(a) V5 only conducting.

(b) V4 only conducting.

(c) Both V4 and V5 cut-off.

94. V5 is normally conducting but every 37.5 seconds the identity keyer (MD) transfers an earth connection from the cathode of V5 to the cathode of V4, so that V5 becomes cut-off and V4 conducts. As the identity signal input from the identity pulse generator (XH) is applied to V4 grid, the identity signal will be developed across the anode transformer T2 as a series of dots and dashes for a period of 7.5 seconds, due to the identity keyer (MD) earthing the cathode of V4 in a series of dot and dash lengths.

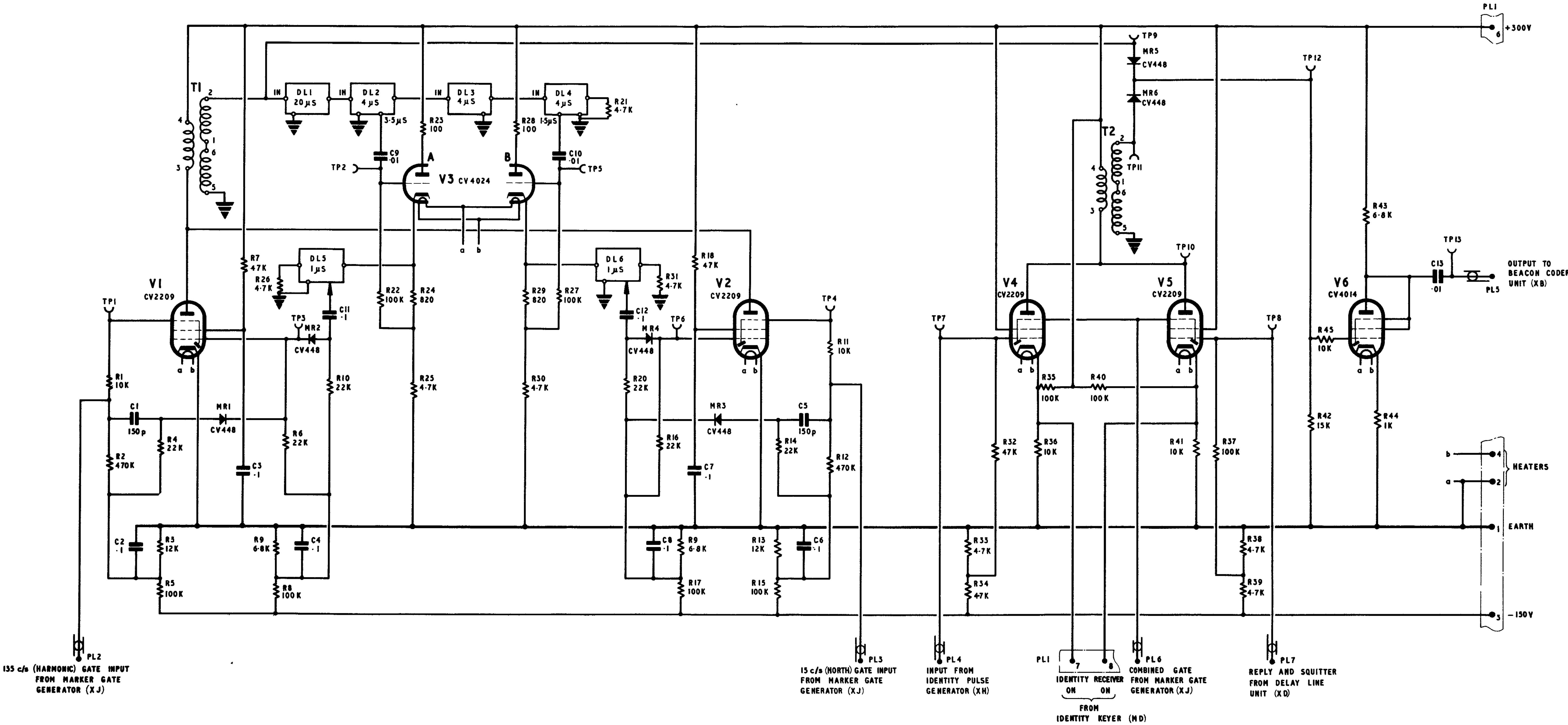
95. Squitter and reply pulses are fed to V5 control grid from the delay line unit (XD). The cathode bias resistor of V5 is normally short circuited by the earth connection in the identity keyer (MD) and consequently V5 will conduct and produce squitter and reply pulses.

96. As the transformer T2 is the common anode load of V4 and V5 the signal appearing across its primary will consist of squitter and reply pulses which will be cut off and replaced by the identity signal every 37.5 seconds thus giving the identity signal priority over the squitter and reply pulses. The output of the double gate is taken to MR6 which forms part of the mixer circuit MR5, MR6 (para. 92).

97. The reference pulse trains are also fed to the mixer circuit, so to avoid squitter and reply pulses interfering with the reference marker trains the double gate V4 and V5 is cut off during the passage of the pulse trains. This is achieved by applying the blanking waveform from the marker gate generator (XJ) to the common suppressor connection of V4 and V5. As the blanking waveform is produced whenever either the 15 c/s or 135 c/s reference gates are open, it can be seen that the marker pulse trains will receive priority over both the identity signal and the squitter and reply pulses, resulting in the priority laid down in para. 86.

98. Output amplifier V6. The combined signal from the mixer circuit is applied to an amplifier inverter V6, and the negative going pulses appearing at the anode are coupled out to the beacon coder unit (XB).

RESISTORS	R1 R2 R4 R3 R5 R7 R26 R6 R9 R8 R10 R22 R23 R24 R25 R28 R29 R30 R27 R21 R20 R31 R16 R19 R17 R18 R14 R13 R15 R12 R33 R34 R32 R35 R36 R40 R41 R37 R39 R38 R42 R45 R43 R44
CAPACITORS	C1C2 C3 C4 C11 C9 C10 C12 C8 C7 C5 C6 C13
MISCELLANEOUS	V1 DL1 DL5 DL2 V3A DL3 V3B DL4 DL6 V2 PL4 V4 TP6 MR5 MR6 V5 PL7 V6 TP13
	PL2 TP1 T1 MR1 TP3 MR2 MR4 TP6 MR3 TP4 PL3 TP7 T2 TP11 PL6 TP10 TP8



AIR DIAGRAM
6264AF/MIN.
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SRI. 18118. FGRI. 18119: Priority mixer (XE)-circuit

Fig. 3

924/8/4990/70380/1105/3/62 J. T. & S.

BEACON CODER UNIT (XB)

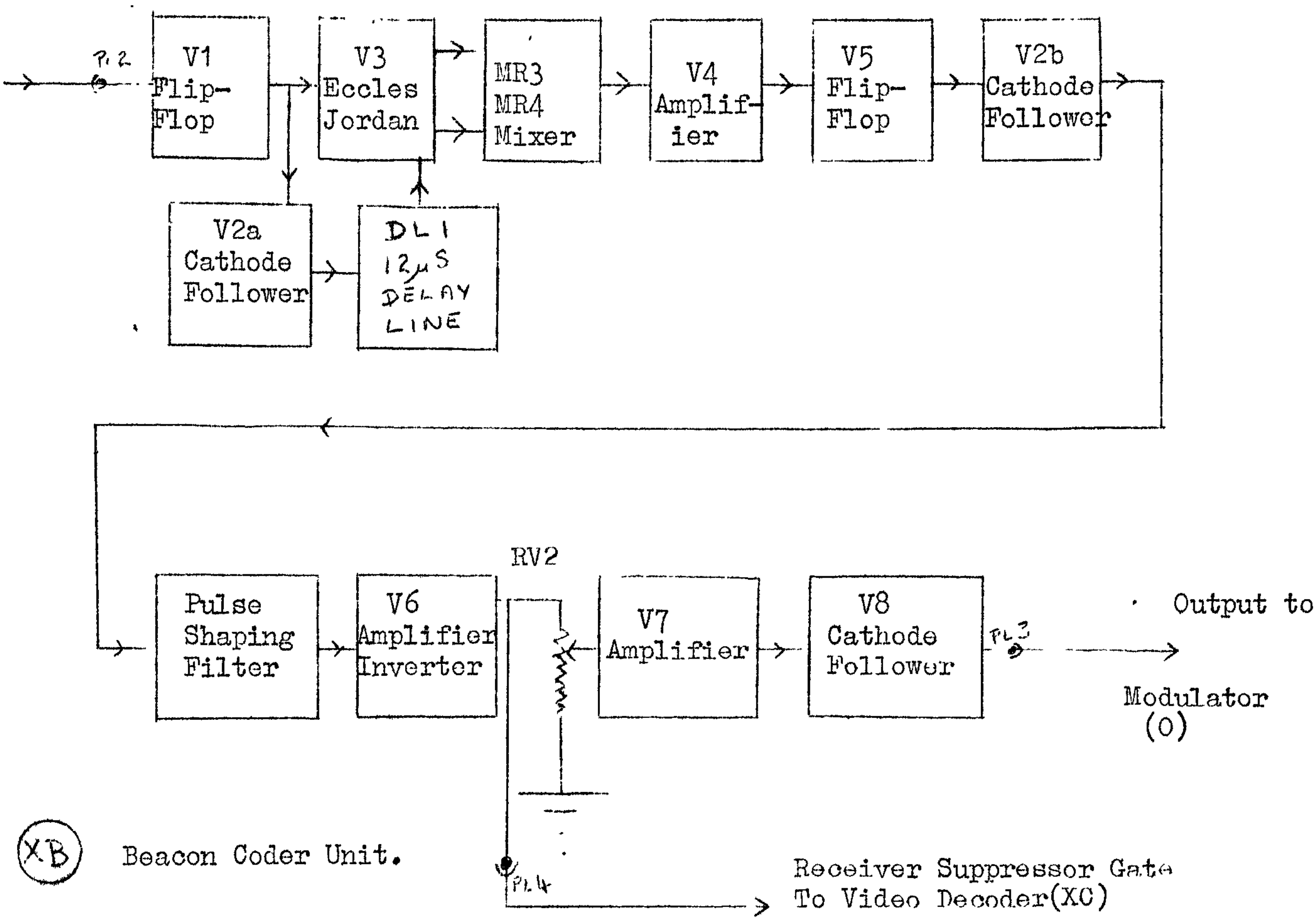


Fig. 23 Beacon Coder Unit - Block Diagram.

Introduction.

99. The function of the beacon coder unit (XB) is to accept the composite signal from the priority mixer (XE) and convert each single pulse into a pulse pair spaced at 12 µs at a level suitable for driving the modulator. The composite input signal contains the following information:-

(a) 15 c/s and 135 c/s marker pulse trains.

(b) Itentity signal.

(c) Squitter and reply pulses.

100. The pulse pairs of uniform amplitude and shape are fed out to the modulator unit (O). The sequence of the stages can be followed by reference to the block diagram (fig. 23) and component references seen on the circuit diagram (fig. 25).

101. Production of Pulse pairs. The negative going input pulses are applied to V1a which together with V1b forms a cathode coupled flip-flop. It produces at V1a anode positive going 7 µs constant amplitude pulses which are fed out two ways as follows:-

(a) To V3a grid via MR1.

(b) To V2a grid.

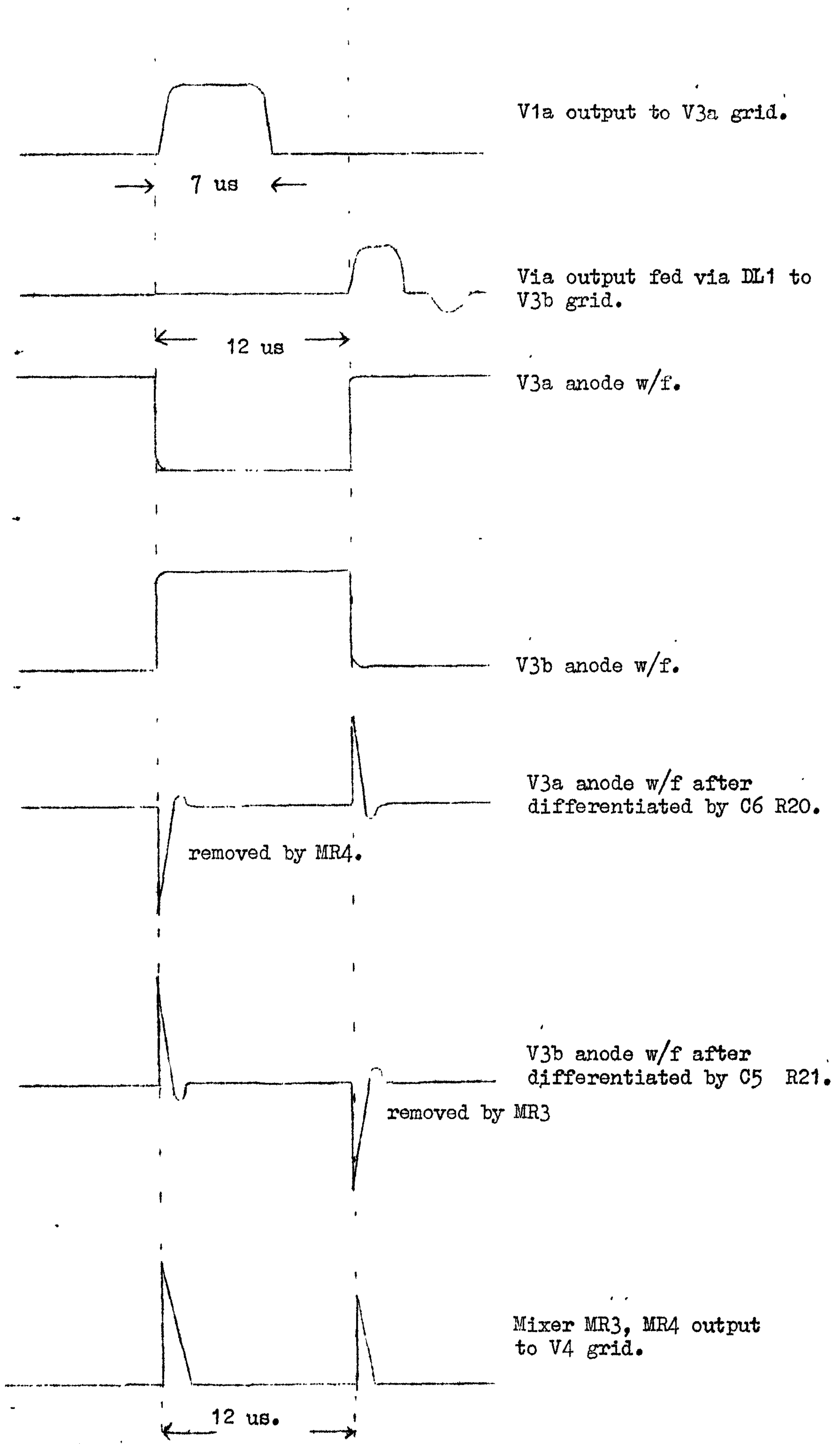
102. The single pulse produced by V1 is converted into a pulse pair spaced at 12 μs by the action of a circuit consisting of V3, V2a and DL1. V3 is a bi-stable multivibrator (Eccles-Jordan) and V2a is a cathode follower which feeds into a 12 μs delay line (DL1).

103. The pulse applied to V2a is cathode followed to delay line DL1 which is preset to give an overall delay of 12 μs. The pulse emerging from DL1 is then applied to V3b grid via C4 and MR2. In the quiescent state V3b is conducting because its grid is held at about +6 volts, while V3a is cut-off by the bias developed across the common cathode load R10. The valves are directly coupled between anode and opposite grid, therefore, a voltage change at one anode will cause a smaller voltage change at the opposite grid. There is no discharging capacitor to allow the grid to rise above cut-off potential so voltage changes can only be produced by external trigger pulses.

104. When the positive pulse arrives at V3a grid via MR1, the valve conducts and the anode voltage falls, pulling down V3b grid causing V3b anode voltage to rise and V3a grid with it. This action is instantaneous and brings V3a into full conduction and cuts off V3b. The circuit remains in this condition until 12 μs later the pulse from DL1 is applied to V3b grid and the reverse action takes place. The resulting pulses at V3a and V3b anodes are rectangular, of 12 μs duration and opposite polarities. Diodes MR1 and MR2 are grid isolators.

105. Both anode outputs are differentiated and fed to mixer circuit MR3 and MR4 which removes the negative parts of the waveforms and combines the positive spiked pulses. Thus the signal applied to V4 grid is two positive pulses spaced 12 μs apart. From the foregoing it can be seen that a pulse pair spaced by 12 μs will be produced for every input pulse fed into the unit because the delay line is fed with constant amplitude pulses.

Fig. 24 Beacon Coder Unit (XB)- Waveforms.



106. Pulse pair shaping circuit (V4, V5 and V2b). The pulse pair fed to V4 are generally of unnequal amplitude and are not the correct shape, so the next four stages are used to produce correctly shaped pulses of equal amplitude. The stages are an amplifier V4, a cathode coupled flip-flop V5, a cathode-follower V2b and a shaping filter.

107. The pulse pair are amplified and inverted by V4, and the amplified negative-going pulses are coupled to V5a grid via MR5. The tapping of R26 and R29 connected to MR5 cathode is held at about +20V so that negative trigger pulses will have to overcome this standing bias level before MR5 will conduct.

108. V5 is a cathode-coupled flip-flop and in the stable condition V5a isconducting and cathode bias holds V5b cut-off. Each negative trigger pulse from MR5 cuts off V5a, then V5b conducts. The discharge time of C9 is set so that 6 µs elapse before V5a grid voltage allows V5a to conduct again. This action results in two positive pulses of equal height and width spaced 12 µs apart being produced from V5a anode.

109. V2b is a cathode-follower which matches the output of the flip-flop into the shaping filter. In the quiescent state V2b is cut off by about -25V grid bias, R32 and MR7 acting as a d.c. restorer circuit. The positive input pulses cause V2b to conduct heavily, while R35 acts as a grid limiter. The pulses developed across the cathode load R36 are fed into the shaping filter, which is a low-pass network and its function is to convert the pulses into the shape required. by removing the higher harmonics. The filter consists of L1 to L3 and C11 to C19 inclusive, and MR6 limits overswing. The output pulses from the filter are of 7 µs width at the base and about 11V in amplitude. The pulse pair is applied to V6.

110. Amplifying and output stages (V6 to V8). V6 is an amplifier inverter, raising the amplitude to about 40V. The anode load provides two outputs as follows:-

(a) Via C20 and C21 in parallel and RV2 to V7.

(b) Via C26 and MR8 to video decoder (XC) as a receiver suppression gate.

111. The suppression pulses, (b) above, are coupled from V6 anode by C26 and developed across R47 the positive portions of the waveforms are removed by MR8, the negative pulse pairs being fed out to the video decoder (XC) to de-sensitize the receiver while the beacon is transmitting. This is to prevent the transmitted pulses triggering the receiver.

112. The main output from V6 (para. 110 (a)) is applied to a further amplifier stage V7. The input potentiometer RV2 serves to set the amplitude of the pulses fed to V7 and consequently the peak amplitude of the pulses fed to the klystron although the klystron drive will in practice be limited by the operating characteristics of the modulator valves. V7 acts as an amplifier inverter and the output pulse pairs are positive going and of an amplitude of about 200V peak. The pulses are then cathode - followed by V8, the output being directly coupled to the grids of the modulator valves. As RV3 is connected between the -150V line and earth, and is used to set the d.c. level of the grid and hence the cathode of V8, it will also set the standing bias level of the modulator valves. The pulse pairs are fed directly from the cathode of V8 to the modulator (O).

FREQUENCY MULTIPLIER UNIT (XG) AND R.F. DRIVE UNIT (XF).

Introduction.

113. The frequency multiplier unit (XG) and the R.F. drive unit (XF) are associated in this chapter because together they produce the r.f. drive and local oscillator signal. The sequence of the circuits can be followed by reference to the block diagram (fig. 26). The initial frequency at $\frac{1}{27th}$ of the beacon output frequency, is generated in a special broadband oscillator which is frequency controlled from a crystal mounted in an oven. The signal is then amplified and multiplied before application to the output klystron.

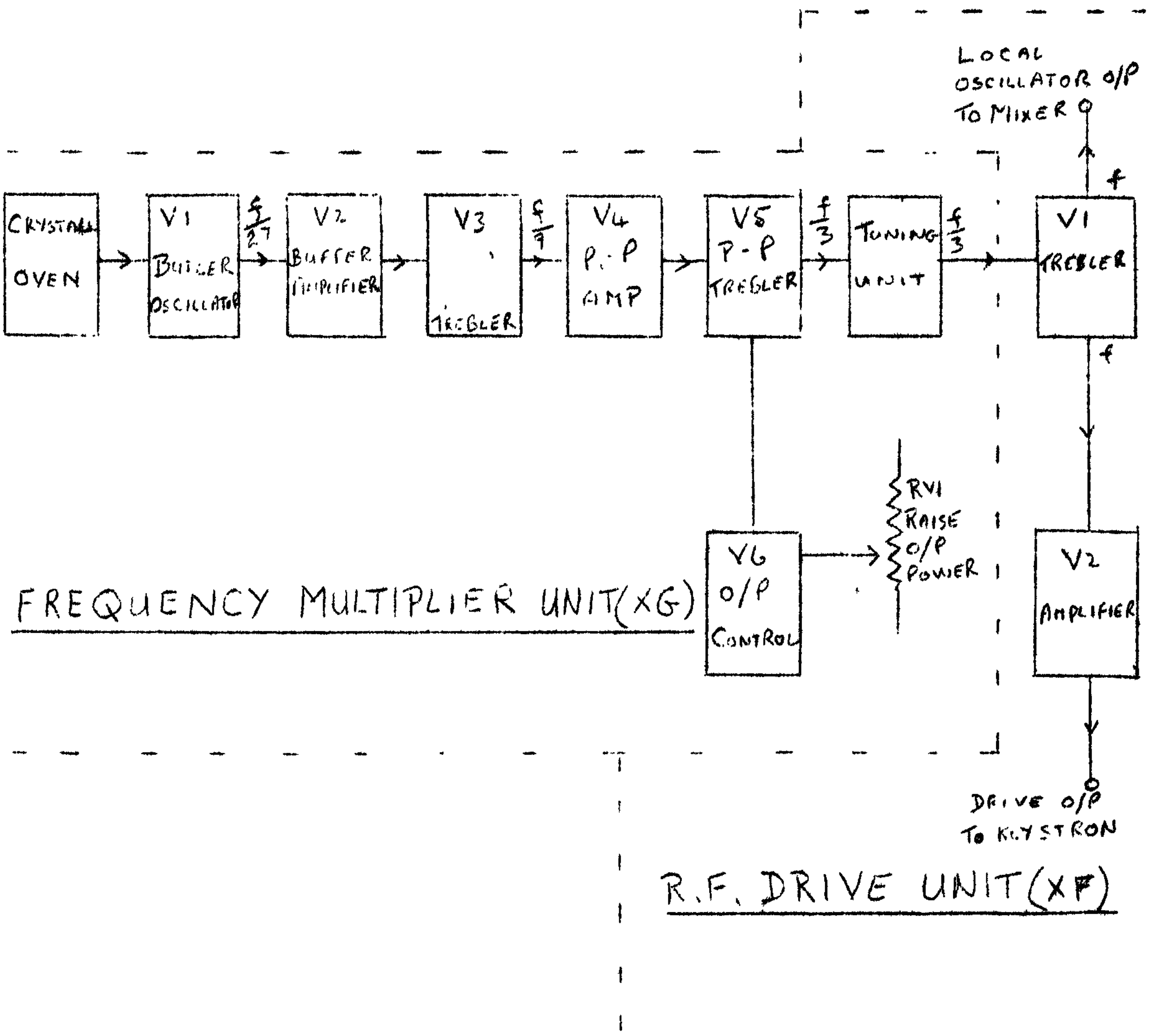
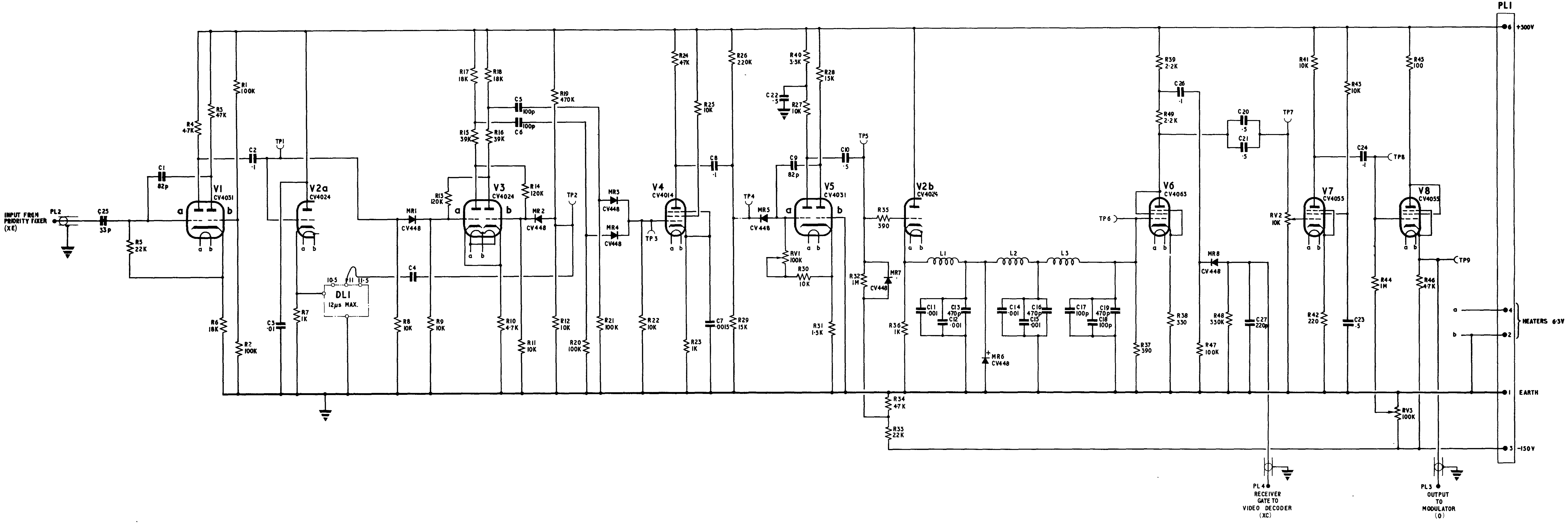


Fig. 26. Frequency Multiplier Unit and R.F. Drive Unit - Block Diagram.

Frequency Multiplier Unit (XG).

114. The crystal oven. This oven is of cylindrical form and contains three crystals. It is fitted with a thermostat which regulates the temperature to 75 ± 2 degrees centigrade. The oven is mounted on a 14-pin base with a central spigot, so arranged that any one of the three crystals can be brought into service by pulling out the oven, slightly rotating it to another position and pushing it back again. The crystals are of the overtone type and the third overtone is used. The crystals will oscillate at their fundamental frequency and at other higher odd overtones, but the gain of the circuit in which they are used is very low at these frequencies.



SRI. 18118. FGRI. 18119: Beacon coder unit (XB)-circuit

Fig.3

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115. Butler oscillator V1. The two sections of the double triode V1, together form a Butler oscillator, which is a special broadband cathode - coupled oscillator whose frequency is determined by the quartz crystal connected between its cathodes. The circuit produces a signal within the band 35.5 - 45 Mc/s. V1b functions as a grounded grid amplifier with a broadband anode tuned circuit L1 which is tuned to resonate at the crystal frequency. C2 couples V1b anode to the grid of V1a which acts as a cathode follower, the R.F. energy being developed across its cathode load R3. This R.F. energy is coupled to V1b cathode via the crystal which provides a low impedence path at its marked frequency.

116. The circuit operation relies on regenerative feedback i.e. the two cathodes must be in phase, and since the crystal operation at series resonance requires zero phase shift around the circuit loop, the various stray capacities must be compensated for in the circuit. The cathode follower is alsmost free of phase shift due to extremely low grid cathode capacitance and at resonance V1a cathode is virtually d.c. coupled to V1b cathode by the crystal. The anode-cathode capacitance of V1b is extremely small due to the grounded grid, and V1b anode circuit is resonated at crystal frequency and coupled to V1a grid. Thus phase shift around the circuit loop is negligible and oscillations occur at the marked frequency of the crystal.

117. The impedence offered by the crystal is high at frequencies on either side of crystal resonance and thus the gain of the grounded grid amplifier is low. This ensures that oscillations are only possible at the marked frequency of the crystal, thus the Butler oscillator output is a highly stable signal containing little or no oscillations at unwanted frequencies. The oscillator output is coupled from V1b anode to V2 control grid via capacitor C5.

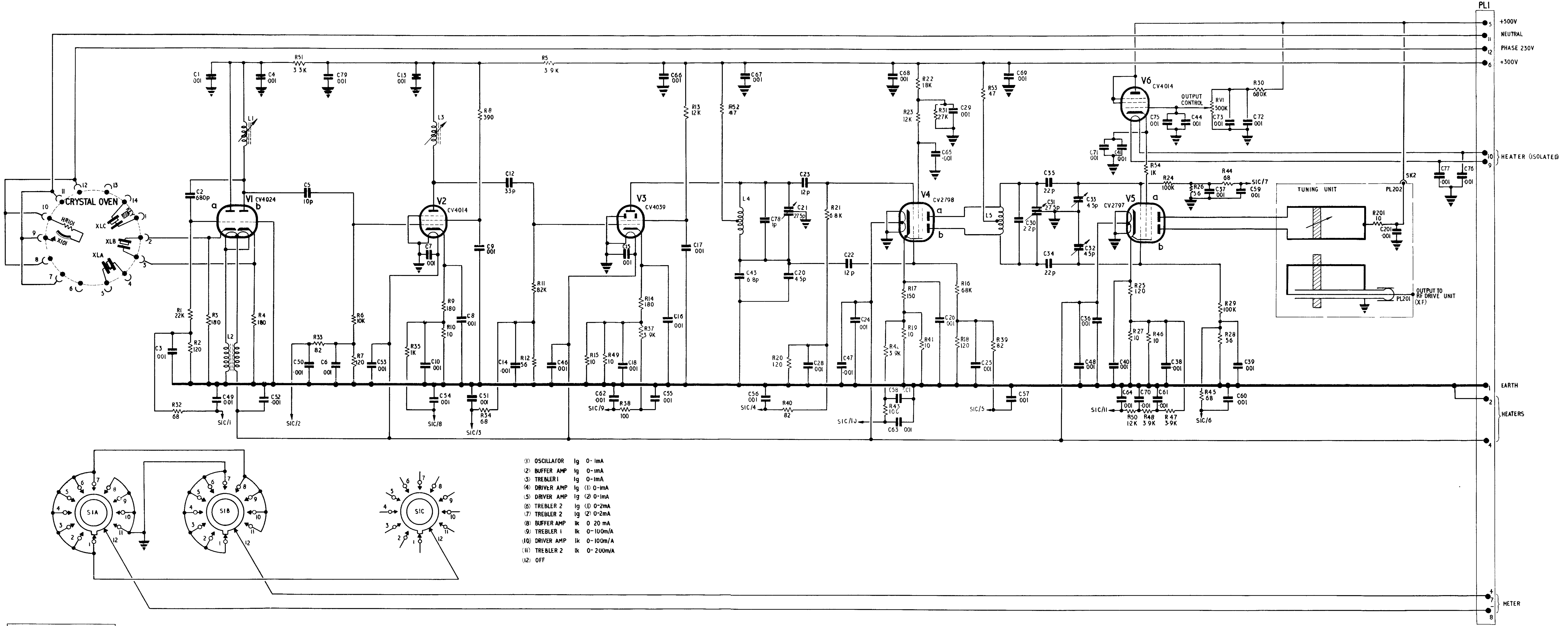
118. Trebler amplifier chain (V2 to V5). V2 is a pentode buffer amplifier which amplifies the signal from V1 for application to the first trebler stage V3. V3 is a beam-tetrode trebler which raises the signal to $\frac{1}{9}$th of the beacon output frequency. In V3 anode circuit is a centre-tapped inductor L4 which is tuned to the third harmonic of the input frequency by a split stator capacitor C21; this provides a push-pull output for application to V4. Capacitors C43 and C20 are included to balance the inputs to V4.

119. V4 is a double-pentode, push-pull driver amplifier whose function is to amplify the signal and provide a push-pull output for the trebler stage V5. Bias is provided by R17 and the parallel combination of R19 and R41. The centre-tapped anode inductor L5 is fed from the 300V line via the anti-parasitic resistor R53, and is tuned by the split-stator capacitor C31 to provide a balanced output to V5. Two presetcapacitors C32 and C33 in V5 grid circuits balance the inputs to the valve.

120. V5 is a double-pentode, push-pull tripler amplifier, which raises the signal to $\frac{1}{3}$rd of the beacon output frequency. V5 anodes are are supplied with H.T. of 500V via a tuning unit. The tuning unit is a self-contained item, with a tunable lecher line in the anode circuit of V5. Coupled to the lecher line anode circuit is a broadband circuit providing an unbalanced output at low impedence to R.F. drive unit (XF).

121. Output level control valve (V6). The screen grid potential of V5 is controlled by V6, whose anode is connected to the 500V supply and whose cathode is connected to V5 screen via R54. The impedence of V6 can be varied by its control grid voltage, thus the potentiometer RV1 in V6 control grid circuit is used to adjust V5 screen potential and consequently the output level of the multiplier unit. RV1 is marked RAISE OUTPUT POWER and the voltage at the slider may be varied from zero to about 210V.

122. Decoupling and Metering arrangements. All stages in the unit are extensively decoupled to prevent feedback and instability. Comprehensive metering arrangements are provided by S1, a three-bank, 12-way switch. It is connected to M2 on the meter panel (XA), and the metering system provides facilities for tuning the variable controls L1, L3, C21 and C31 when the crystal has been changed.



AIR DIAGRAM
6264AJ/MIN.
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SRI. 18118, FGRI. 18119. Frequency multiplier unit (XG)–circuit

Fig. 3
(A.L. 11, Nov. 58)

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R.F. Drive Unit (XF)

123. The signal at 1/3rd. of the beacon output frequency is fed in from the multiplier unit, and the function of the R.F. drive unit is to accept this signal and raise it in both frequency and power for application to the klystron (Q). The unit also provides the local oscillator signal for mixing with incoming interrogations in the I.F. pre-amplifier unit (R) (para. 39).

124. The unit has two valves, which are of the "lighthouse" type enclosed in tunable cavities and both are forced air-cooled.

125. The input from the multiplier unit is fed directly into the grid-cathode cavity of V1, a triode grounded-grid, trebler-amplifier. The input is coupled via a capacity probe into the grid-cathode cavity which is broadband and untuned. The anode cavity is tuned to the third harmonic of the input signal by means of a dialectric ring which can be moved up and down parallel to the axis of the valve. The signal at beacon transmitt frequency is coupled from V1 anode cavity via a loop to V2 grid-cathode cavit

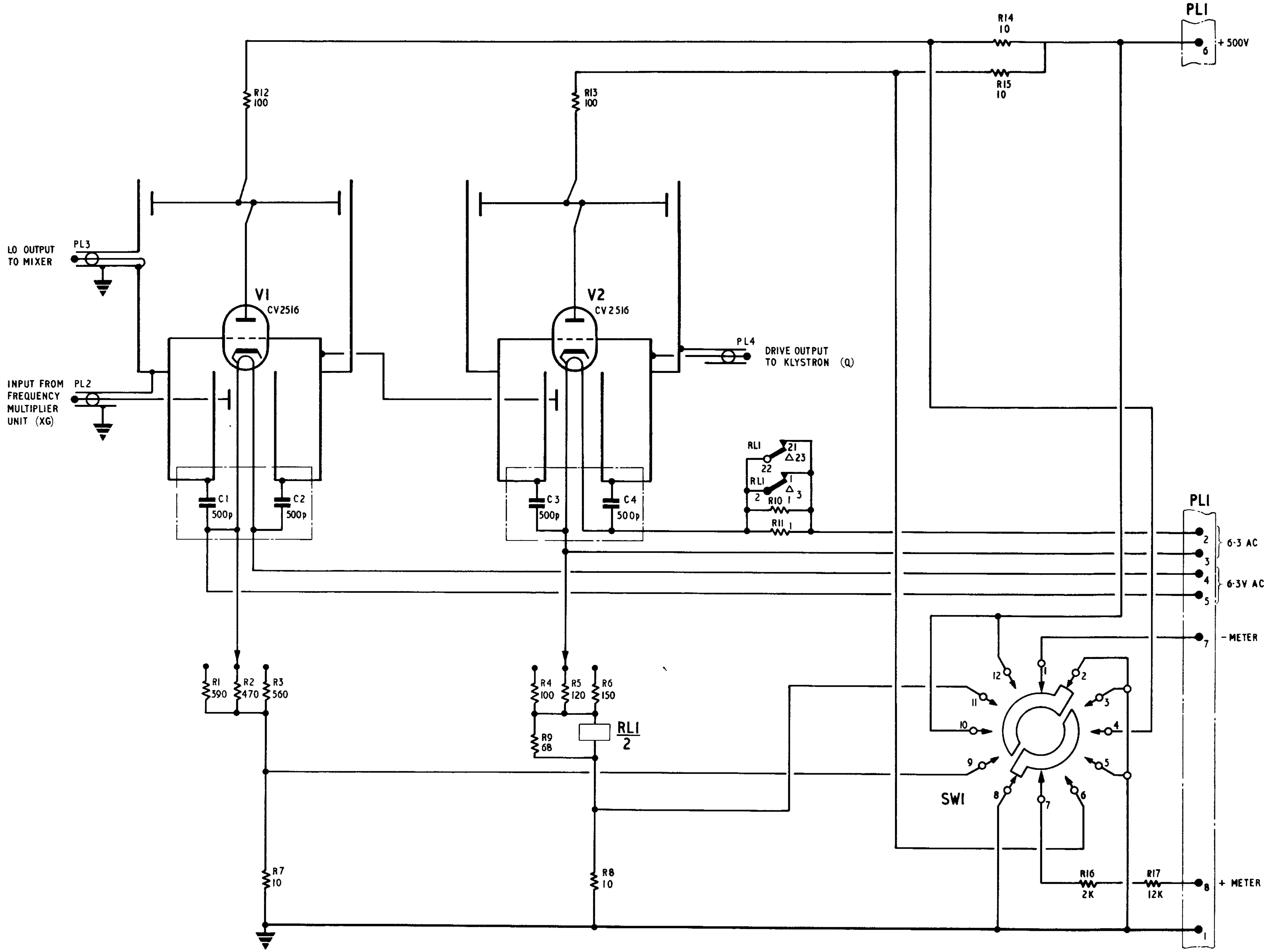
126. A probe in V1 anode cavity provides the local oscillator signal for application to the mixer in the i.f. pre-amplifier. Cathode bias of V1 is provided by one of three resistors R1, R2 or R3, the resistor giving the best results under test being selected. This system is to avoid the use of a potentiometer.

127. V2 is a triode grounded-grid amplifier which raises the signal power to the level equired for the klystron to function efficiently - between 10 and 15 watts. The signal from V1 is injected by a capacity probe into the grid-cathode cavity which is broadband and untuned. V2 anode cavity is tuned in the same manner as V1; the two motions being ganged together and controlled by a single knob. A loop in the anode cavity couples the anode cavity couples the output to the klystron (Q).

128. Both V1 and V2 have independent, isolated heater supplies of 6.3 V.A.C. In the case of V2 the heater supply passes through two parallel resistors (R10 and R11) which are normally short circuited by the contacts of relay RL1. The coil of RL1 is incorporated in V2 cathode circuit so that when the R.V. drive is applied to the valve, the increase in current causes the relay to be energised and to open its contacts, this reducing heater voltage at the filament by placing R10 and R11 in series with the filament supply. This is done to offset the cathode bombardment which takes place at the frequencies in use and thus prolong the life of the valve. Resistor R9 is across the relay coil to minimise relay chatter.

129. Metering Arrangements. Metering facilities are provided by S1 a fine-position switch, and connections are taken to meter MI on the meter panel (XA).

REFERENCE: A.P. 2534L, Vol. 1, Part 2, Section 2, Chapter 7.



AIR DIAGRAM
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SR1. 18118, FGR1. 18119. RF drive unit (XF)-circuit

Fig. 4
(A.L.11, Nov. 58)

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MODULATOR AND KLYSTRON ASSEMBLY (O and Q)

Introduction

130. The modulator and the klystron assembly are associated together as they form the transmitter. The modulator receives the composite signal from the beacon coder unit (XB) and amplifies it to a suitable level for modulation of the klystron.valve. A voltage proportional to the klystron beam current is fed back to the modulator to assist in the maintainance of constant amplitude beacon output pulses. The circuit sequence can be followed by reference to the block diagram (fig. 29), and component references can be seen on the circuit diagrams (figs. 30 and 31).

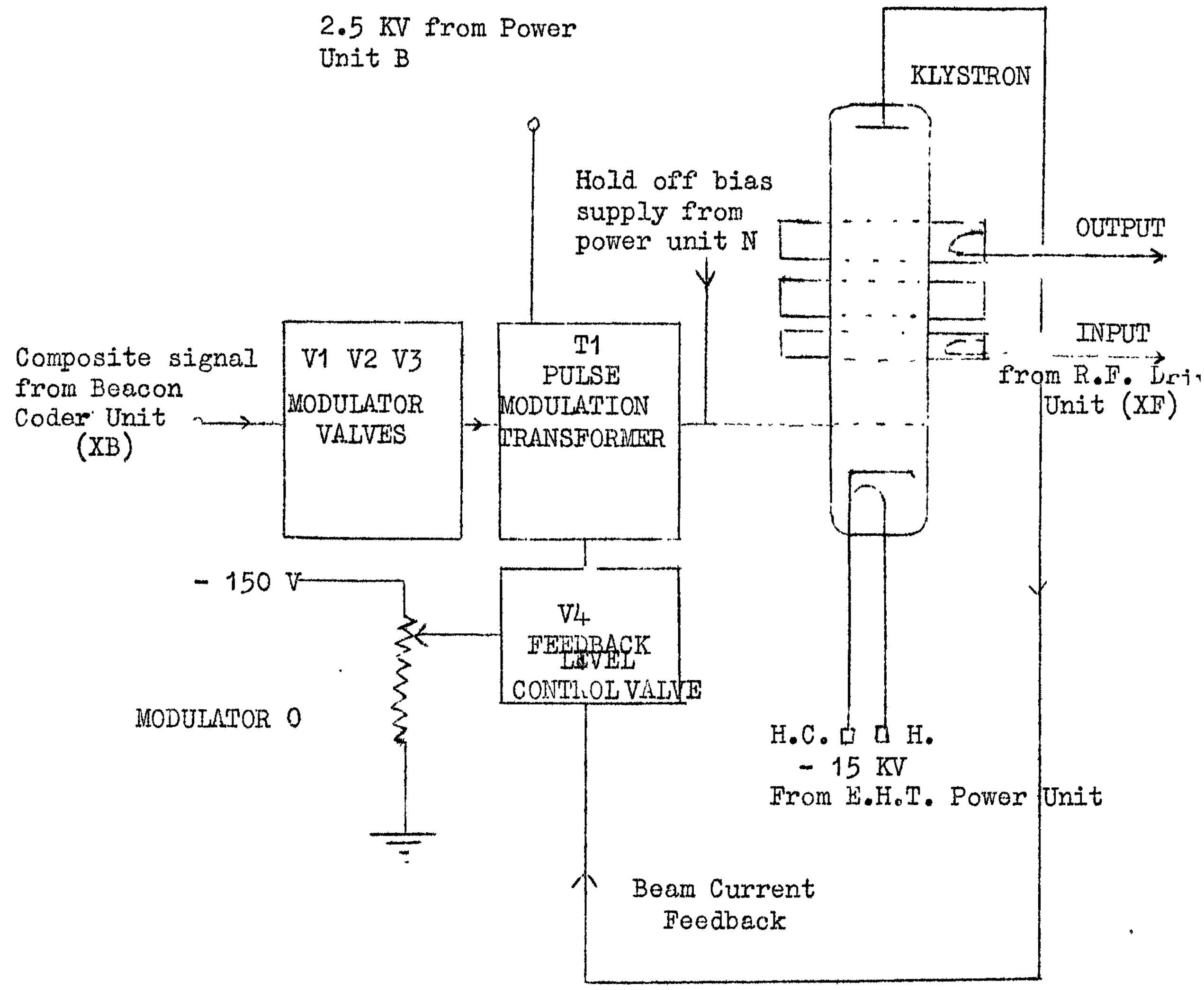


Fig. 29. Modulator and Klystron Assembly - Block Diagram

Modulator Unit (O)

131. The composite beacon signal is fed from the coder unit (XB) to three parallel-connected modulator valves V1, V2 and V3. It consists of positive pulses and is fed to the valves via an internal feedback potentiometer RV1 and grid stoppers R1, R4 and R7. The positive pulses applied to the grids of the modulator valves cause them to conduct heavily and the negative pulses produced at the anodes are fed to the primary of T1. The secondary of T, has terminal 4 connected to earth, and positive-going pulses of about 5KV amplitude appear at terminal 5 and these are fed out to modulate the klystron.

132. A tapping to terminal 3 from T1 secondary provides a feedback potential to V1 V2 and V3. This feedback potential is developed across resistors R18, R19, which also serve as a resistive load for T1 secondary, and they flatten the pulse trains to provide minimum droop.

133. The high voltage pulses are coupled from T1 terminal 5 to the klystron assembly via a capacitor C13. Also fed out on this lead is the "hold off" bias supply. This is about - 180 V in amplitude and is fed from the e.h.t power unit (N) to the klystron via this unit, the modulator.

134. Feedback Level Control Valve. The level of the feedback derived from the klystron beam current is controlled by a tetrode V4, which acts as a variable shunt impedance across T1 secondary. The feedback pulses which are negative-going are applied to V4 cathode, which increases valve current so decreasing the impedance of the valve. The extent to which current is increased depends upon the amplitude of the feedback pulses, and the shunting effect will be constant for constant amplitude pulses; the system therefore assists in maintaining a constant amplitude of output pulses from the beacon.

Klystron Assembly (Q)

135. The klystron assembly houses the klystron valve which is the transmitting valve for the beacon. It contains three r.f. cavities and four focussing coils which surround the valve V4. The klystron collector connection is at the top of the assembly and is forced-air cooled.

136. R.F. System. The r.f. circuit consists of the three cavities and their associated tuni ¸ circuits, the modulation circuit and beam current feedback network. When the cavities are clamped in position they make contact with the rings on the valve and, together with the internal elements of the valve, form resonant cavities which are tuned by plungers adjusted by knobs on the ıront of the assembly.

137. The C.W. energy from the R.F. drive unit (XF) (paras 123 to 128) is coupled into the bottom cavity by an inductive loop. The middle cavity has no external r.f. connections. The amplified pulsed r.f. is extracted from the output cavity at the top by another inductive loop and fed out to the duplexer (V) for transmission. The three cavities are tuned separately but in a similar manner by screwing plungers in or out. Meter M5 on the control unit (W) indicates the current extracted from the cavity by an - inductive loop (rectified by a crystal diode). The current passes via a microswitch (S1, S2 or S3) which has to be depressed whilst timing. The microswitch earths the crystal detector to the frame when not in use.

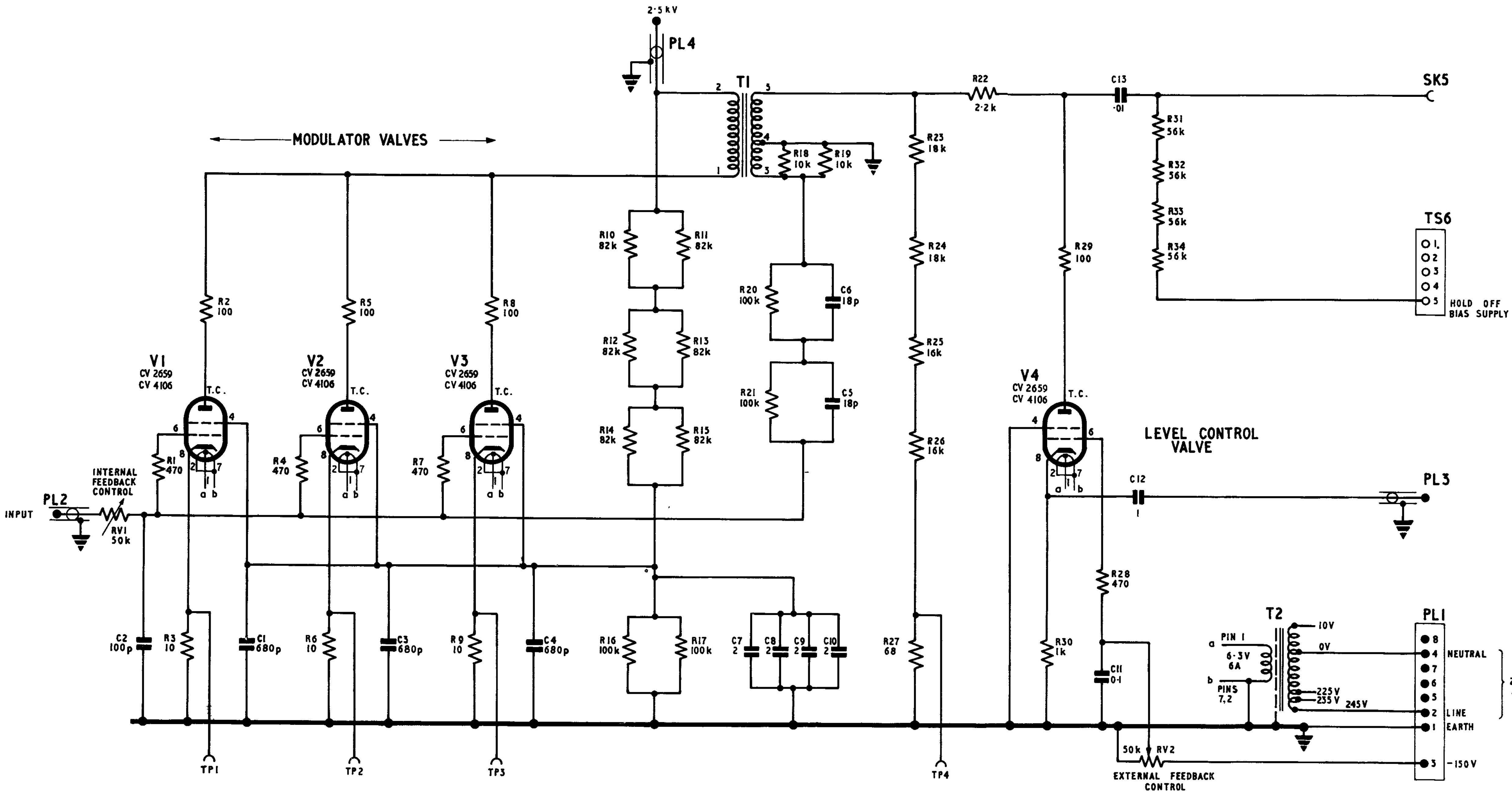
138. The modulation of the C.W. r.f. power fed into the bottom cavity is effected by the pulses fed to the modulation electrode from the modulator. The modulation pulses are of about + 5 KV peak amplitude, a "hold-off" bias of about - 180 V amplitude is also applied to the modulation electrode. The cathode is supplied with e.h.t. of about - 15 KV and the collector electrode is earthy. Thus when the modulation pulses are applied the valve conducts heavily producing pulses of 5 KW peak minimum. The "hold-off" bias ensures a definite cut-off after each transmitter pulse and prevents any spurious transmission between pulses.

139. The voltage derived from the beam current is developed across R1 and R2, and used as feedback voltage controlling the output level control valve on the modulator (para 134).

140. Focussing System. An electro-magnetic system is employed which maintains the electron beam accurately aligned along the axis of the valve. There are four focussing coils which are interleaved with the three cavities. When the beacon is in the standby or operational mode the coils are supplied from the 250 V power unit (K). When the beacon is switched off a 230 V.A.C. supply from the unregulated mains is fed to the coils to maintain the temperature of the assembly. The d.c. and a.c. supplies are switched by the pre-heating relay (G).

REFERENCE: A.P. 2534L, Vol. 1, Part 2, Section 2, Chapter 8.

RESISTORS	RV1, R1, R3, R2, R4, R6, R5, R7, R9, R8, R10, R12, R14, R16, R11, R13, R15, R17, R20, R21, R18, R19, R23, R24, R25, R26, R27, R22, R29, R30, R28, RV2, R31, R32, R33, R34
CAPACITORS	C2, C1, C3, C4, C7, C8, C9, C10, C6, C5, C11, C13, C12
MISCELLANEOUS	PL2, V1, TP1, V2, TP2, V3, TP3, PL4, T1, TP4, V4, T2, SK5, TS6, PL3, PL1



SRI. 18118, FGRI. 18119
Modulator (O): circuit

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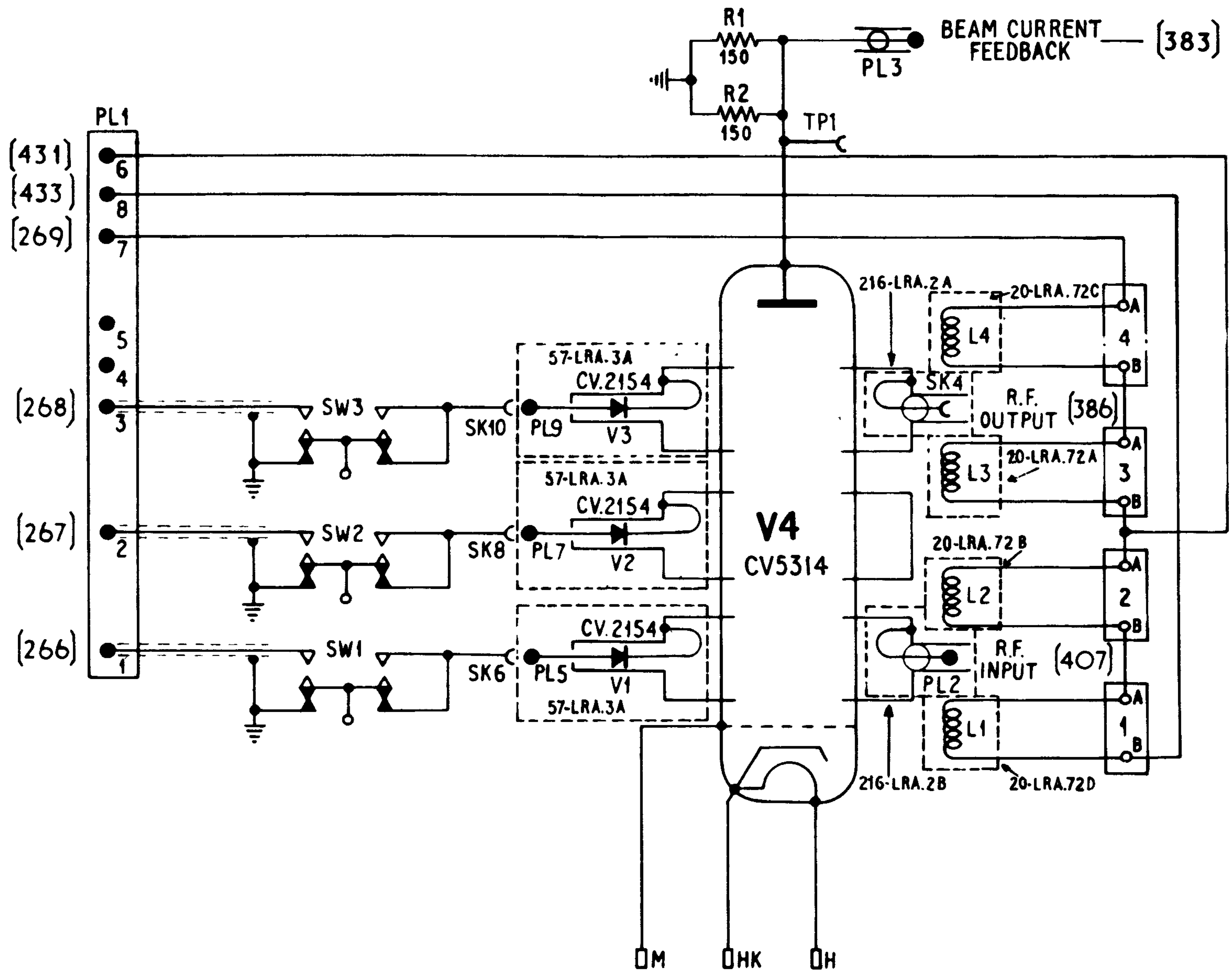
MISCELLANEOUS	PL1	SW3 SW1 SW2	SK10 SK6 SK8	PL9 PL5 PL7	V3 V1 V2	R1 R2	V4	TP1	SK4 PL3 PL2	L4 L3 L2 L1



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SRI. 18118, FGRI. 18119 — Klystron assembly (Q) — circuit

Fig. 4.

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MISCELLANEOUS ITEMS

Introduction

141. The units comprising the transmitter-receiver have been individually described in previous sections. However there are a number of items mounted in the right-hand cabinet which do not fall within the scope of these sections. Therefore these items are covered in this section.

142. Heater Transformers. There are four heater transformers mounted on the left-hand side of the inner bay. They are mounted one above the other and are numbered T7, T6, T5 and T4 from top to bottom. They are fed in parallel from the regulated mains.

143. The units supplied by each transformer are detailed below:-

(a) T4 (1) Pins 4 and 5 supply 6.3V at 3A to R.F. drive unit (XF) (isolated supply for V1).

(2) Pins 6 and 7 supply 6.3 V at 1.6A to R.F. drive unit (XF) (isolated supply for V2).

(3) Pins 8 and 9 supply 6.3 V at 1.0A to frequency multiplier unit (XG) (isolated supply for V6).

(b) T5, pins 4 and 5 supply 6.3 V at 7.8A to the following units:-

(1) Video decoder (XC).

(2) Delay line unit (XD).

(3) Identity pulse generator (XH).

(4) I.F. pre-amplifier (R)

(c) T6, pins 4 and 5 supply 6.3 V at 7.8A to the following units:-

(1) Beacon coder unit (XB).

(2) Marker gate generator (XJ).

(3) I.F. amplifier (P).

(d) T7, pins 4 and 5 supply 6.3 V at 7.8A to the following units:-

(1) Priority mixer (XE).

(2) Frequency multiplier (XG).

144. Meter Panel (XA). The meter panel is situated in the middle of the right-hand inner door. On it are mounted three meters, a distribution block, and the "over-on" lamp check circuit.

145. The three meters are used as follows:-

(1) M1 calibrated 0 - 150 mA for R.F. drive unit metering.

(2) M2 calibrated 0 - 10 mA for frequency multiplier metering.

(3) M3 the squitter rate indicator. This meter has an associated smoothing circuit to provide a steady reading, and is supplied from the video decoder (XC).

146. The distribution block has ten terminals which act as distribution points for all a.c. and d.c. H.T. supplies to the units mounted on the inner door except the blower supplies.

147. The oven lamp check circuit (fig. 32). Normally ILP1 is in series with the heater element in the crystal oven on the frequency multiplier unit (XG) through contacts 1 and 2 on S1. Thus when the thermostat contact in the crystal oven is closed the oven heater and lamp are connected across the 230 V.A.C. supply and the lamp will light. When the thermostat opens the lamp will go out, but by depressing S1 the lamp will light up and can be checked.

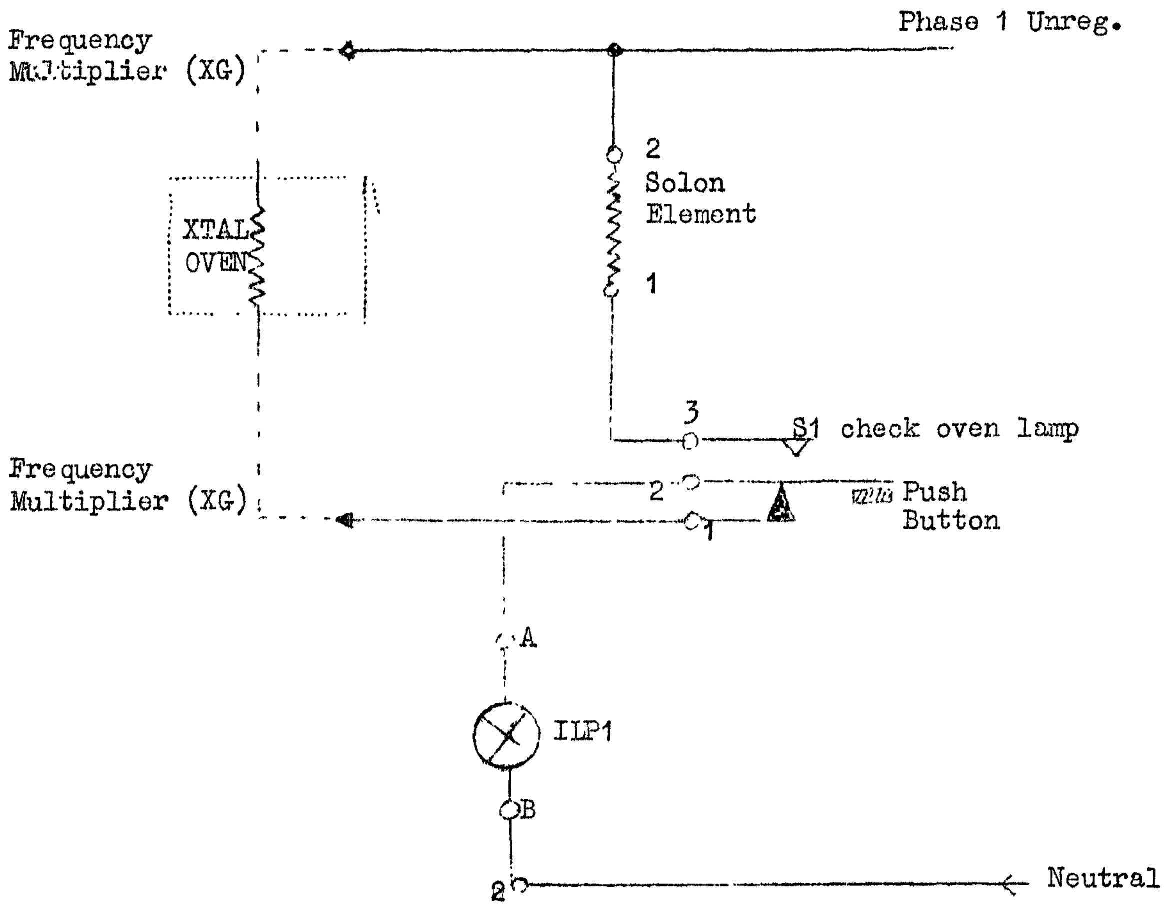


Fig. 32. Oven Lamp Check Circuit

148. Pre-Heating Relay (G). This relay is situated to the left of the bottom of the klystron assembly (Q). The unit consists of a relay whose two contacts switch the supplies to the klystron focussing coils. When the beacon is switched off, phase 1 of the unregulated mains is fed via the preheating relay to the klystron assembly to maintain the temperature of the klystron. When in the standby or operational mode a + 250 V d.c. from the 250 V power unit (K) energises the relay, which disconnects the a.c. supply and connects the + 250 V d.c. to the focussing coils. The connections of the focussing coils are detailed in fig. 31.

149. Anti-Condensation Heater. The heater is mounted on the bottom left-hand side of the TR cabinet. It is fed with a 230 V or 115 V a.c. supply from an external source to make the heater independent of beacon supplies.

150. Air Blowers. There are three air blowers mounted in the TR cabinet, all are fed with 230 V.A.C. from phase 3 of the unregulated mains. Blower No. 1 is the klystron collector cooling blower and is mounted in the top right-hand corner of the TR cabinet. It is connected to the klystron assembly by a detachable flexible hose. Blowers 2 and 3 are mounted on the bottom of the inner door, and the air expelled from both blowers is fed into a common duct. The air is ducted on to the cooling fins of the CV2516 valves in the R.F. drive unit (XF) and through holes to the front of the inner door. Thus when the outer door is closed this cooling air is circulated around the valves on the units mounted on the inner door.

REFERENCE: A.P. 2534L, Vol. 1, Part, 2, Section 2, Chapter 9.

AERIAL SYSTEM

AERIAL CONTROL CABINET

Introduction

151. The aerial control cabinet contains the three-phase regulating equipment, regulator control unit (YN) and voltage regulator (YO), terminal blocks (YA to YE)and isolating switch (YH). Hinged to the top of the door is the meter panel (YJ). Mounted on the door of the cabinet are the aerial speed control unit (YR) and the aerial speed rectifier unit (YS).

152. Royal Navy installations are equipped with an aerial servo system but these items are not dealt with in this trainee note.

Voltage Regulator (YO) and Control Unit (YN)

153. The circuit diagram of the voltage regulator and control unit can be seen in Fig. 33. The 3-phase supply is regulated by motor driven sliders in regulator (YO) to between ∓ 3 volts. The motor control circuits are contained in control unit (YN). Unregulated 3-phase power is made available by isolating switch (YH). The regulating circuit is switched on and off by the stand-by switch SW8 in the control unit (W), this causes the unregulated phase two to be fed to PL1.8. The principle of operation, after the initial running up period, is for the power to the regulating motor to be controlled by relays which rely on a two-way voltage sensitive relay VR for their energising currents.

154. The relay conditions at various stages of the voltage regulation are tabulated on the circuit diagram (fig. 33). The modes of operation are as follows:-

(1) Regulator switched OFF. The motor has previously driven the sliders on the regulator to the bottom of the auto-transformer resistors so that all three sliders are at neutral line potential. The MIN. limit switch is open and the motor is de-energised. There is therefore no regulated voltage.

(2) Regulator running up. The motor is energised in a manner to drive the sliders up the auto-transformer resistors. The MIN. switch is closed and the output voltages gradually increase.

(3) Fully regulated. The motor has stopped driving the regulator sliders because the VR relay contacts have opened. Thereafter the direction in which the motor drives the sliders depends on whether VR1 or VR2 contacts are closed. When VR2 contacts are closed the sliders are being driven up and when VR1 contacts are closed the sliders are being driven down.

(4) Regulator running down. The motor now drives the slider down to the neutral line potential.

(5) Regulator switched OFF. The sliders are driven down to the position where the MIN. switch opens, this de-energises the motor only when the control switch is OFF.

155. When the regulator is switched off all relays in the YN control unit are de-energised and LP7 in the meter unit (YJ) is out. In this mode the phase one unregulated supply is always available not terminal PL1.13. of YN provided the mains isolating switch YH is closed. The circuit for the relays in YN cannot be completed until unregulated phase two is fed to the unit via the control unit (W) SW8. When this switch is closed the unregulated phase two is rectified in the bridge rectifier MR4 and relay RL4 is energised via PL1.1 of YN.

156. When RL4 is energised, contacts RL4/2 close and contacts RL4/1 and RL4/3 open. RL4/2 completes the circuits for relay RL2 to energise from unregulated phase one via FS1, MR2, contacts RL3/2, RL4/2 and contacts VR2 to neutral PL1.1. Contacts VR2 are closed because the relay is spring loaded to take up VR2 position in the absence of power. When RL2 is energised contacts RL2/1, RL2/2 and RL2/3 open and contacts RL2/4 close, thus completing the motor circuit via PL1.13, FS1, contacts RL5/2, PL1.2, TSI.4, motor winding, MAX limit switch TSL.1 of YO, PLI.5, contacts RL2/4 to neutral.

157. The motor will now drive the regulator slider up, a low voltage will appear on TS2 terminals 13 to 15 of YO and the MIN limit switch will close. Terminal TS2.13 is connected via PL1.14, FS3, and RV3 to the MR1 bridge circuit which will energise relays RL1 and VR. RL1 operates when the phase one voltage is about 100. When RL1 is energised contacts RL1/1 close and ensure that the motor circuit phase one voltage is maintained when both RL4/1 and RL5/2 are open.

158. When the regulated phase one voltage reaches 240 V, contacts VR2 open and relay RL2 is de-energised. Therefore, contacts RL2/1 close and relay RL5 is energised and locked on via contacts RL5/1. Contacts RL5/2 open and leave the motor circuit closed by contacts RL1/1. Contacts RL5/3 and 4 close so that the indicator lamp LP7 in the YJ meter unit is energised from the unregulated 140 V phase one supply via RL2 or RL3. Contacts RL2/2 close and short out the high boost resistor RV1. Contacts RL2/3 close and prepare relay RL3 circuit for use when VR1 contacts are closed. Contacts RL2/4 break the neutral line so that motor stops driving the regulating sliders.

159. With relays RL1, RL4 and RL5 all energised and relays RL2 and RL3 both de-energised, the voltage relay VR in the MR1 bridge circuit controls the regulating circuit. When the voltage is below 240 V, contacts VR2 will be closed and relay RL2 energised. When contacts RL2/4 are closed the motor is energised to turn in the direction to increase the regulated voltage. When the voltage is above 140 V, contacts VR1 will be closed and relay RL3 energised. When contacts RL3/1 are closed the low boost resistor RV2 is shorted out. When contacts RL3/2 are open relay RL2 cannot energise. When contacts RL3/3 are closed the motor is energised to turn in a direction to decrease the regulated voltage. Both motor contacts have spark quench components across them, i.e. R1 and C2 are across contacts RL2/4 and R2 and C3 across RL3/3.

160. When the equipment is switched OFF in the control unit (W), the phase two unregulated is removed from MR4 bridge circuit, relay RL4 is therefore de-energised. Contacts RL4/1 close to complete the motor run-down cycle. Contacts RL4/2 open to ensure that RL2 cannot be energised. Contacts RL4/3 close to complete the energising circuit for relay RL3, even when VR1 contacts are open, via contacts RL2/3, RL4/3, PL1.3, TS1.3 in YO and MIN limit switch to neutral. The motor is now in the run-down mode and will continue to decrease the voltage until relays RL1 and RL5 become de-energised. Contacts RL5/3 and 4 open the circuit to LP7 in unit YJ. Finally the motor circuit is de-energised by the MIN limit switch contacts opening, this also de-energises the final energised relay RL3.

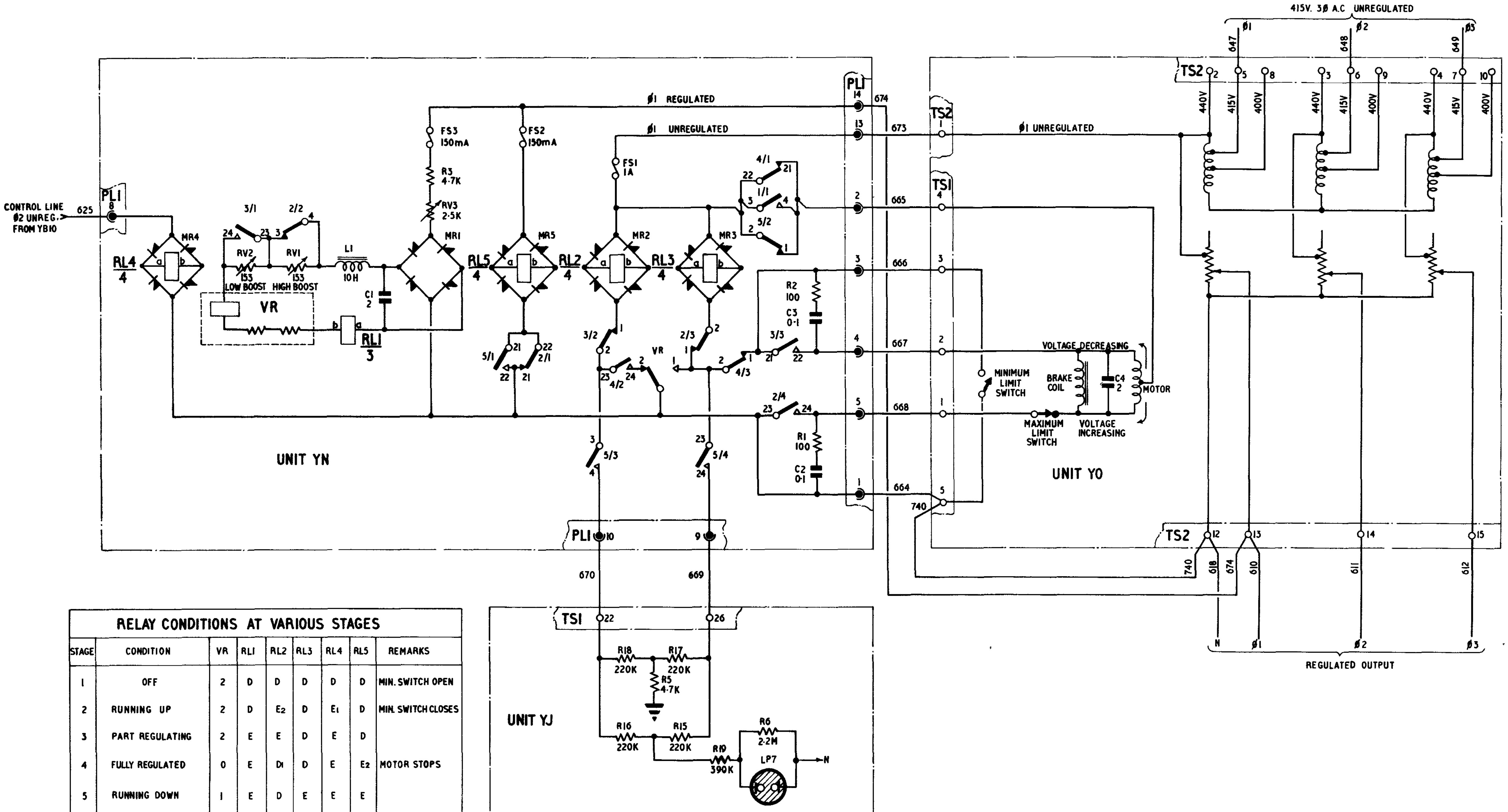
161. The relay operation of control unit (YN). The function of each relay contact is provided in the following sub-paragraphs to show the four main modes of operation of the control system, i.e. OFF, running-up, fully regulated and running-down.

(1) OFF	
Relay State	Action
All Off	ISOLATE SWITCH (YH) - ON - therefore unregulated three-phase to TS2 of YO. Unregulated phase one to PL1.13 via TS2.1. STANDBY switch (SW8) on control unit (W) - OFF. No supply to PL1.8. MIN LIMIT switch open due to slider on auto-transformer resistor at neutral end.
(2) RUNNING - UP	Action
Relay State	
All Off	STANDBY SWITCH (SW8) on control unit (W) - ON. Unregulated phase two to PL1. 8. RL4 operates via MR4.
RL4 Operated	Contact 1 opens and shorted by RL5/2. Used with RL1/1 to maintain unregulated phase one to motor in YO.
	Contact 2 closes completing neutral line for MR2. RL2 now operates.
	Contact 3 opens maintaining break in neutral line for RL3 when MIN LIMIT switch closes.
	Contact 4 No. 8 used.
RL2 Operated	Contact 1 opens breaking neutral line for RL5.
	Contact 2 opens removing short circuit across RV1 HIGH BOOST.
	Contact 3 opens ensuring RL3 cannot operate.
	Contact 4 closes completing running-up neutral line for the motor via MAX LIMIT switch.
	MOTOR STARTS RUN-UP
	Slider mechanically closes MIN. LIMIT switch. Slider runs-up increasing regulated voltage across MR1. When this voltage reaches 100 V approximately RL1 operates.

Relay State	Action
RL1 Operated	Contact 1 maintains unregulated phase one to the motor.
	Contact 2) Contact 3) Not used.
	When this voltage reaches 240 V approximately VR operates.
VR Operated	Contact 2 opens breaking neutral line to RL2 which is de-energised.
	Contact 1 Remains open.
RL2 de-energised	Contact 1 closes applying neutral to RL5 which is energised.
	Contact 2 closes applying short circuit across RV1 HIGH BOOST.
	Contact 3 closes so that VR1 and contacts RL4/3 can cause RL3 to operate when required.
	Contact 4 opens removing neutral from motor.
	MOTOR STOPS
RL5 Operated	Contact 1 closes hold on contacts.
	Contact 2 opens leaving RL1/1 to maintain phase two to motor.
	Contact 3) Contact 4) closes to operate LP7 should VR make contacts VR1 or VR2.
RL1, RL5, RL4 Operated. RL2, RL3 de-energised.	Unit now ready for condition (3), i.e. fully regulating.
(3) FULLY REGULATING	
Relay State	Action
(a)	Regulated voltage 140 + 3 V. Unit remains in stable state as at end of condition (2) above.
(b)	Regulated voltage drops below 240 - 3 V. Relay VR contacts now move to position 2.
VR to Position 2	Operates RL2 from unregulated phase one.
RL 2 Operated	Contact 1 opens shorted by RL5/1 so no change.
	Contact 2 opens removing short across RV1 HIGH BOOST.
	Contact 3 opens ensuring RL3 cannot operate.

	Contact 4 closes completing neutral "running up" line to the motor. Motor will move slider up resistors until relay contacts VR move off position 2 when neutral line to RL2 will be broken, RL2 is then de-energised, the motor stops and returns to condition (3a)
(c) VR to Position 1.	Regulated voltage increases above 240 + 3V. Relay VR contact moves to position 1. Operates RL3 from unregulated phase one.
RL3 Operated	Contact 1 closes shorting RV2 LOW BOOST. Contact 2 opens ensuring RL2 cannot operate. Contact 3 closes completing the neutral "running-down" line to motor. Motor will move slider down the resistors until relay contacts VR move off position 1 when the neutral line to RL3 will be broken. RL3 is then de-energised, the motor stops and the unit returns to condition (3a). NOTE:- RV1 HIGH BOOST and RV2 LOW BOOST settings together with contacts RL2/2 and RL3/1 ensure the movement of the slider up the auto-transformer will send the contact of relay VR into the mid-position between its two contacts. RV3 sets the regulated voltage value.
(4) RUNNING DOWN	
Relay State	Action
RL1, RL4, RL5 Operated. RL2 and RL3 de-energised.	Standby switch (SW8) in control unit (W) OFF, unregulated phase two mains removed from PL1.8. RL4 now de-energised.
RL4 de-energised.	Contact 1 closes maintaining unregulated phase one to the motor. Contact 2 opens preventing RL2 from operating when regulated voltage drop causes contact VR to move to position 2. Contact 3 closes completing neutral line to RL3 via MIN LIMIT switch. Contact 4 not used.
RL3 Operated.	Contact 1 closes shorting RV2 LOW BOOST. Contact 2 opens ensuring RL2 neutral line remains broken. Contact 3 closes completing neutral "running down" line to the motor.

	MOTOR STARTS RUN-DOWN
	VR de-energised - contacts to VR2. No effect as RL4 de-energised. As regulating voltage decreases so RL5 will be de-energised.
RL5 de-energised	Contact 1 opens breaking lock - on circuit for RL5.
	Contact 2 closes ensuring unregulated phase one to the motor.
	Contact 3) opens breaking circuit to LP7 Contact 4) in unit YJ.
	When regulating voltages run down to 100V, RL1 is de-energised.
RL1 de-energised	Contact 1 opens but is still shorted by RL4/1, and RL5/2.
	Contact 2) Contact 3) not used.
	When slider reaches neutral end of auto-transformer the MIN LIMIT switch mechanically opens breaking neutral to both motor and RS3.
	Motor Stops.
RL3 de-energised	Contact 1 opens removing short across RV2 LOW BOOST
	Contact 2 closes, no effect as RL4 de-energised.
	Contact 3 opens ensuring neutral is broken to motor.
All off.	Now returned to original condition.
	STANDBY (SW8) on control unit (W) OFF. No mains on PL1. 8. MIN LIMIT switch broken mechanically.
	REFERENCE A.P. 2534L, Vol.1, Part 2, Section 1, Chapter 1.



RELAY CONDITIONS AT VARIOUS STAGES

STAGE	CONDITION	VR	RL1	RL2	RL3	RL4	RL5	REMARKS
1	OFF	2	D	D	D	D	D	MIN. SWITCH OPEN
2	RUNNING UP	2	D	E_2	D	E_1	D	MIN. SWITCH CLOSES
3	PART REGULATING	2	E	E	D	E	D	
4	FULLY REGULATED	0	E	D_1	D	E	E_2	MOTOR STOPS
5	RUNNING DOWN	1	E	D	E	E	E	
6	OFF	2	D_2	D	D_3	D_1	D_2	MOTOR STOPS WHEN MIN. SWITCH OPENS

E = ENERGIZED
D = DE-ENERGIZED
NUMERALS INDICATE SEQUENCE OF OPERATION

AIR DIAGRAM
6264AM/MIN.

ISSUE 1 | PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

SR1. 18118. FGR1. 18119–Voltage regulator (YO) and control unit (YN)–circuit

Fig. 2

(A.L. 14, Nov. 58)

8149 347808 12/58 630+500 C.B.&S. LTD. GP 924

METER PANEL (YJ)

162. This panel contains two meters M1 and M2 (M2 has a controlling switch SW1 to vary the inputs), six fuses and their associated indicating lamps, and six independent lamps. The purpose of each circuit is as follows:-

(a) M1 indicates the control winding current of the servo drive motor.

(b) M2 indicates the potentials of the three phases, both regulated and unregulated.

(c) FS1 to FS6 protect the following circuits:-

(1) FS1, 10A. Phase one unregulated to contactor (YF).

(2) FS2, 10A. Phase two unregulated to contactor (YF).

(3) FS3, 10A. Phase three unregulated to contactor (YF).

(4) FS4, 3A. Magnetic coupling current.

(5) FS5, 3A. Phase three unregulated to lighting transformer (YK).

(6) FS6, 3A. Neutral to lighting transformer (YK).

(d) LP7 to LP12 provide the following information:-

(1) LP7. Lights when control unit YN has reached the fully regulating condition.

(2) LP8. Not connected.

(3) LP9. Lights when signals at approx. 1.5 deg. are being fed to the servo-amplifier.

(4) LP10. Lights when 6.3 V is fed to time delay relay SW4 in the aerial control unit (YR).

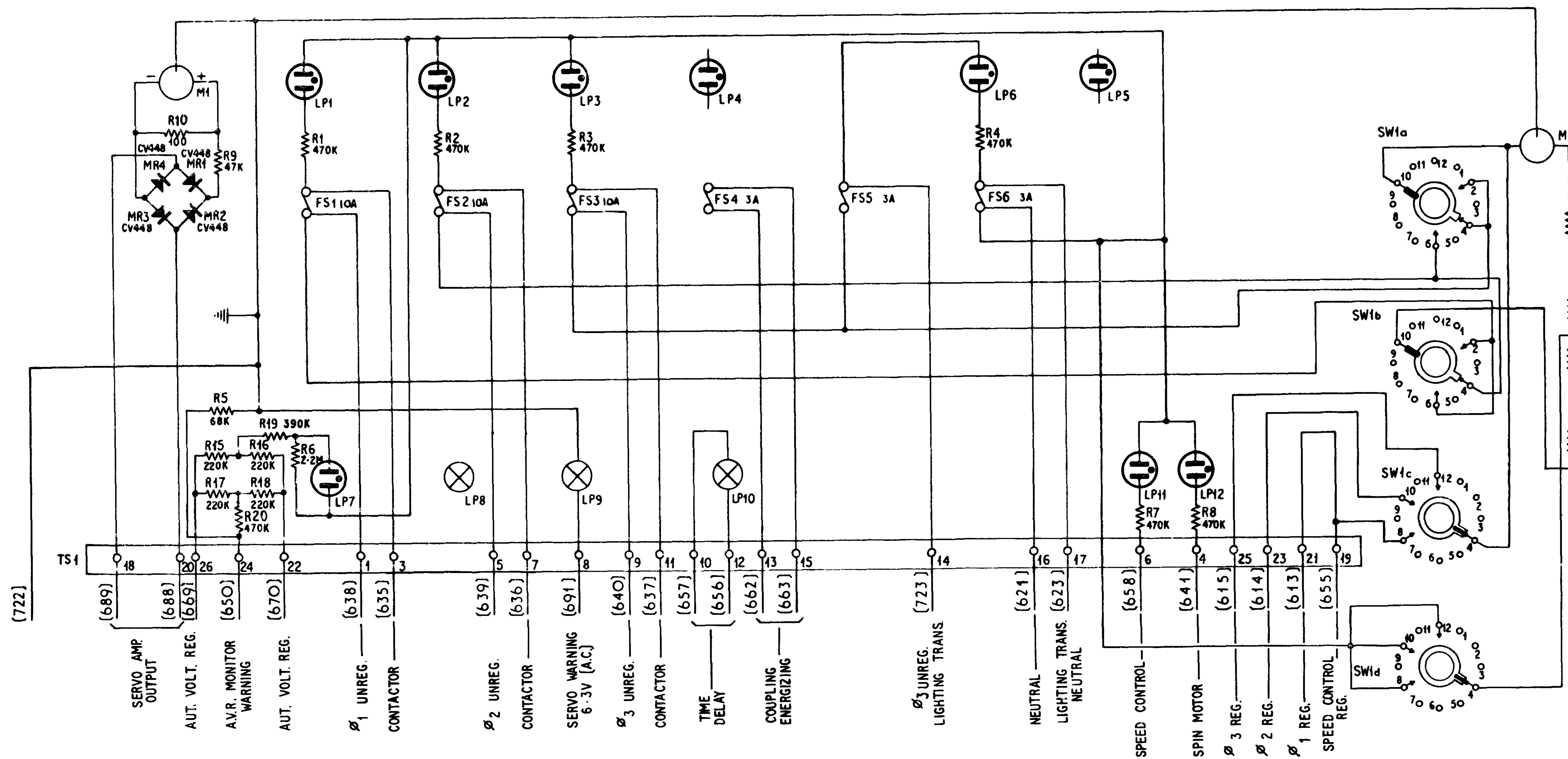
(5) LP11. Lights when power is fed to the aerial speed rectifier unit (YS).

(6) LP12. Lights when power is fed to the aerial spin motor.

<u>REFERENCE:</u> A.P. 2534L, Vol. 1, Part 2, Section 1, Chapter 1.

RESISTORS R10 R9 R5,R15,R16,R17,R18,R19,R6,R1 R2 R3 R4 R7 R8 R14 R13 R11 R12

MISCELLANEOUS MR4 MR3 M1 MR1 MR2 R20 LP1 FS1 LP7 LP2 FS2 LP8 LP3 FS3 LP9 LP4 FS4 LP10 FS5 FS6 LP6 LP5 LP11 LP12 SW1a SW1b SW1c SW1d M2



SRI 18118, FGRI 18119

Meter panel (YJ) - circuit

Fig. 3

AIR DIAGRAM 6264E/MIN.

ISSUE 1

PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

AERIAL SYSTEM AND AERIAL SPEED CONTROL UNITS (YR AND YS)

Introduction

163. The aerial system for TACAN beacons are divided into two frequency bands as follows:-

(1) FGRI 18119 aerial system (high band) 1151 to 1213 Mc/s.

(2) FGRI 18119 aerial system (low band) 962 to 1024 Mc/s.

The height is different for the two bands:- high band is 69.5 inches and low band is 77.5 inches. The Royal Navy version contains a servo loop for use with the ships compass.

Aerial System

164. Central discone cylinger. The aerial construction can be seen in fig. 7, and references to the operation in para 16 of this trainee note. The central radiating array consists of a stack of seven discones which produce the following radiation characteristics:-

(1) Circular within + 5 per cent up to an angle of 60 deg. to the perpendicular to the axis of the aerial.

(2) A maximum radiation in the vertical plane of about 6 deg. above the horizontal and approx. 60 per cent of the maximum amplitude transmitted in the horizontal plane.

(3) Signals transmitted between the gorizontal and an angle of 50 deg. to the gorizontal never fall below 25 db less than maximum.

165. The purpose of the aerial is to accept the pulsed r.f. signal from the transmitter and radiate it efficiently into space, also to receive the radiated signals from the interrogating aircraft transmitters and feed them into the receiver. The aerial must present a matched impedence over the whole frequency band to maintain radiation efficiency. In addition the central array must generate the required vertical pattern. The vertical lobe of the antenna pattern is directed slightly upwards (uptilt) so that a rapid gradient of signal exists at the horizon, this permits greater freedom in the choice of sites by providing a high direct/reflected signal ratio. This is illustrated in fig. 35.

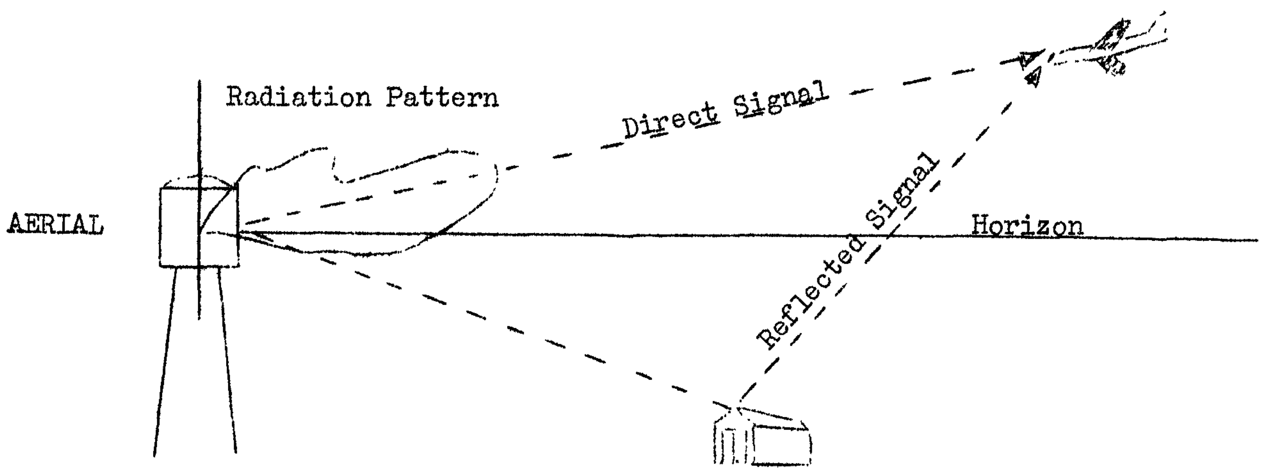


Fig. 35. Radiation Pattern Diagram

166. The central array is composed of seven biconical dipoles stacked vertically. The distribution system is self-contained in the array and consists of a number of series - driven transmission lines. The main transmission line proceeds to the centre of the array at which point it divides into the distribution network which contains matching transformers at all junctions. A block diagram of the system is shown in fig. 36.

167. In the lower six elements of the array, the central two elements are each supplied with 9 units of power, the two adjacent elements receive 4 units of power and finally the end elements receive one unit of power each. This distribution tends to repress minor lobes. To obtain uptilt the elements are phased so that the lower two lead in current and the upper two lag in current with respect to the central elements. This is illustrated in fig. 37.

168. The 7th or top element is introduced to improve the vertical angle coverage of the aerial. This element receives 9 units of power and contributes to the uptilt because its current is lagging. A counter-poise is fitted between the sixth and seventh elements; at high vertical angles this tends to mask the radiation from the lower six elements and the energy is predominatly from the top element.

Antenna	1	2	3	4	5	6	7
Power	1	4	9	9	4	1	9
Current	1	2	3	3	2	1	3
Phase	+45	+45	0	0	-45	-45	-45

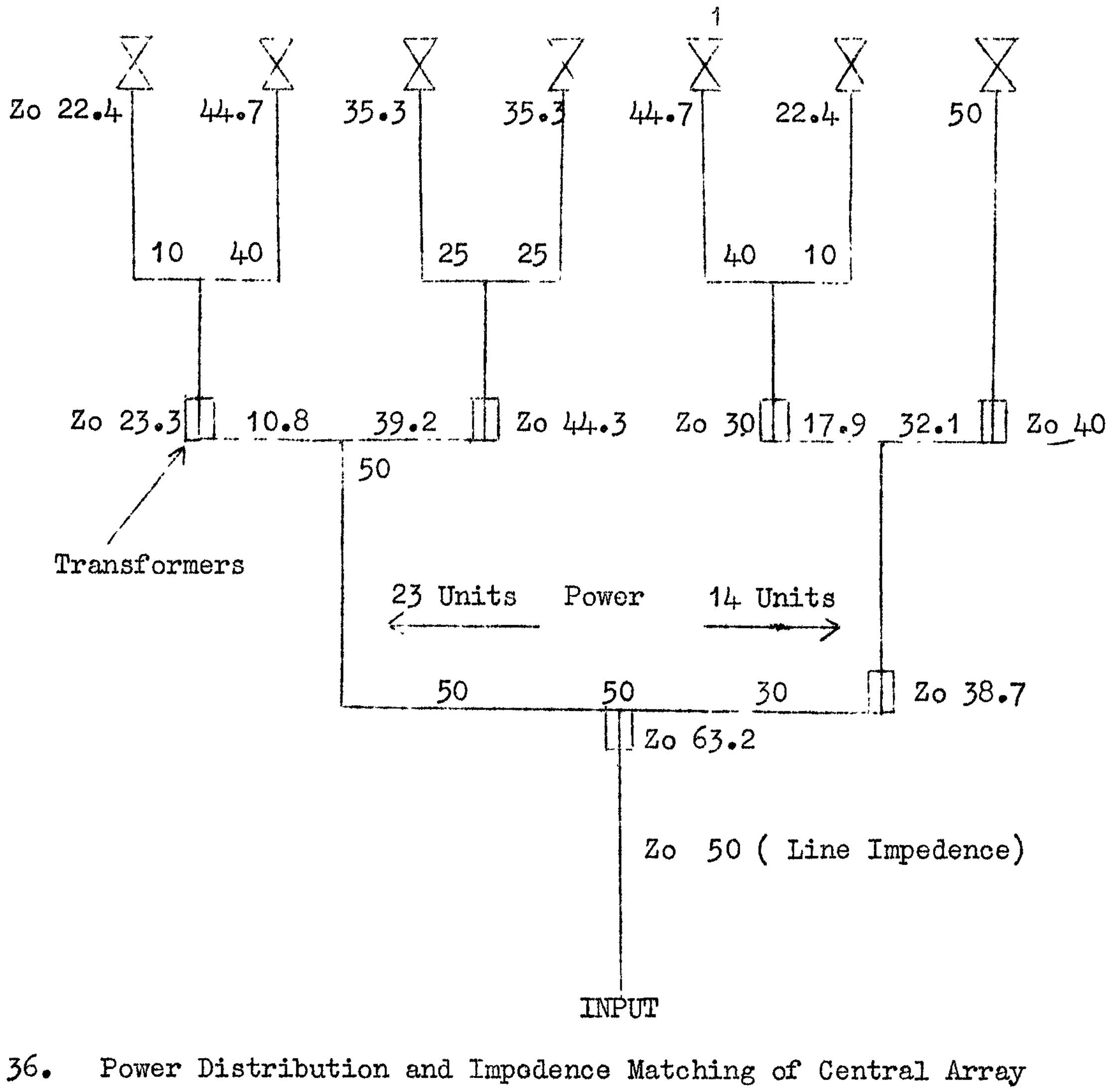


Fig. 36. Power Distribution and Impodence Matching of Central Array

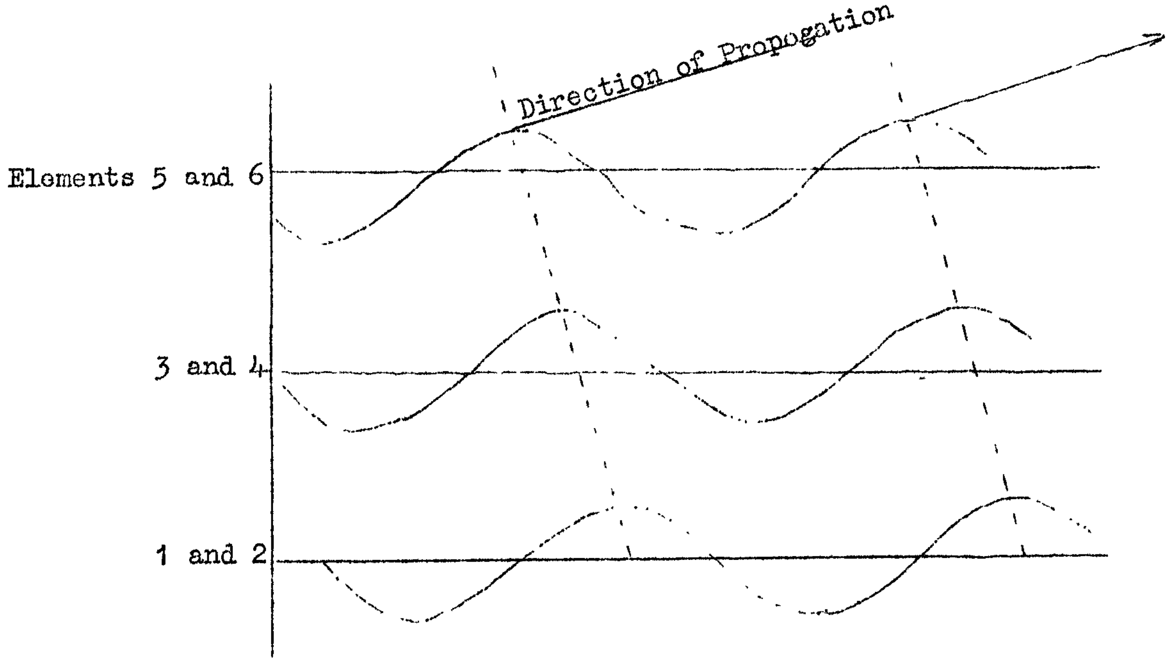


Fig. 37. Production of Uptilt of Lobe

169. Spinning Cylinders. The spinning fibreglass cylinders have wires embedded in the walls. The cylinders are shown in fig. 7. The outer cylinder has nine vertical wires which act as directors to form the 135 c/s radiation pattern. The inner cylinder has three closely-spaced wires to provide a coarse pattern, these act as a reflector to form the 15 c/s radiation pattern. The relative positions of the two cylinders are fixed and both are driven at 900 r.p.m.

170. Phonic Wheel. Keyed to the top end of the aerial support assembly shaft is the non-ferrous phonic wheel which serves three purposes as it rotates at 900 r.p.m. namely:-

(1) Generates a 1350 c/s waveform from a series of 90 iron segments which stand vertically on top of the phonic wheel. This waveform is used in a discriminator circuit to determine the speed of aerial rotation and also to generate identity tone signals. Coil L2 is used to pick up these signals.

(2) Generates the 135 c/s reference trigger pulses in coil L1, which picks up a pulse each time one of the eight iron slugs, which are in the lower edge of the phonic wheel perimeter, passes the coil.

(3) Generates the 15 c/s reference trigger in coil L3, which picks up a pulse each time the iron slug in the upper edge of the phonic wheel perimeter passes between the pole pieces.

171. <u>Coil Mounting Assembly.</u> The three pick up coils L1, L2, and L3 are mounted on an arm which forms part of the coil mounting assembly. This assembly carries the servo link gearing and associated equipment, terminals and slip-ring, starting at the top are as follows:-

(a) Earth, common to all three coils.

(b) 135 c/s reference coil L1 via yellow lead.

(c) Phonic wheel 1350 c/s coil L2 via green lead.

(d) 15 c/s reference coil L3 via red lead.

Connections from the slip-rings are taken to coaxial plugs.

172. During installation the pick up coils are orientated so that the 15 c/s reference coil generates a pulse at the moment that the three closely spaced reflector wires in the inner parasitic cylinder are due west of the central aerial array.

173. <u>Aerial Spin Motor and Magnetic Coupling.</u> The speed of rotation of the aerial parasitic elements must be maintained at 900 r.p.m. ∓ 0.2 per cent i.e. within 901.8 to 898.2 r.p.m. to obtain this speed control the aerial spin motor shaft is driven at a greater speed than is required for the aerial driving shaft. The correct driving torque is achieved through a magnetic Heenan and Froude coupling which has the energy applied to its magnetic coils from the aerial speed rectifier unit (YS); the power to this rectifier is controlled by an electronic circuit in the aerial speed control unit (YR). Both these units are situated on the aerial control cabinet door. The datum for assessing the correct speed is the 1350 c/s waveform which is generated by the phonic wheel coil L2. This waveform is fed to a discriminator circuit which controls the current to the magnetic clutch so that when the speed of the phonic wheel is too high the current is reduced and when the speed is too low the current is increased.

174. The Heenan coupling consists essentially of two parts, one rotating within the other. The outer part of the coupling is bolted to the motor driving shafts by means of a central fixing bolt, this part consists of a magnetic metal ring. The inner part of the coupling is mounted on two bearings so as to be free to rotate indepentantly of the outer part. The magnetic coil is clamped within the central part. About 1.0 A is required to flow in the coil to give full magnetic coupling between the inner and outer parts, while slip conditions for normal running require between 0.4 to 0.5 A.

REFERENCE: A.P. 2534L, Vol. 1, Part 2, Section 1, Chapter 2.

<u>AERIAL SPEED RECTIFIER UNIT (YS)</u>

175. The meter which indicates the current flow in the coupling coil is contained in this unit which is fitted in the door of the aerial control cabinet. It consists of a transformer, whose primary completes the anode circuit to the continuous control valve V1 in the aerial speed control unit (YR), metal rectifiers MR1 and MR2 which rectify the output from TR1, and a set of parallel resistors R1 to R5 which carry the d.c. from the rectifiers to the magnetic coupling. The meter M1 is connected in series with the resistor R5. The remaining resistors R1 to R4 are the meter shunts. The circuit diagram can be seen in fig. 39.

REFERENCE: A.P. 2534L, Vol. 1, Part 2, Section 1, Chapter 2.

AERIAL SPEED CONTROL UNIT (YR)

176. The control unit contains three basic circuits all of which can be seen in fig. 40. They are namely:-

(a) A continuous control valve V1 which receives its control potential from a discriminator circuit fed from the phonic wheel via PL2. The current in this stage energises the magnetic coupling coil.

(b) The power control valve V2 and the associated circuits controlled by relays RL1 to RL5.

(c) The locally generated 1350 c/s signals in crystal oscillator V3, used for checking the speed of the aerial.

177. Control Valve V1 and Discriminator. The control valve V1 is a gas filled tetrode whose anode current is fed to the aerial speed rectifier unit (YS) where it passes through a transformer and rectified to provide the magnetic clutch current. Thus the clutch current is proportional to the a.c. anode current of V1 . The anode of V1 is fed via its output transformer in YS from the a.c. mains. The control grid is also fed from the mains, the voltage being reduced by the potentiometer chain R13-R14 and further reduced and phase shifted by R12-C9. The control grid voltage lags that on the anode by about 70 degrees.

178. The point at which V1 fires depends upon both control and screen grid voltages. By varying the d.c. voltage on the screen the valve may be made to fire at any point on the + ve going portion of the grid waveform. Once it has fired the valve will conduct until the anode voltage falls to zero. Hence the length of the pulse of anode current may be controlled by varying the d.c. level on the screen grid. These pulses occur at the mains frequency so the longer they are, the greater the a.c. component of the anode current and hence the greater the clutch current. Summing up, the clutch current may be varied by varying the d.c. level on the screen grid of V1, an increase of voltage causing an increase of current and therefore an increase of clutch coupling.

179. There are two states of operation in which the screen grid is fed with different voltages, these are switched by RL2b:-

(a) In the run up state a fixed negative voltage adjusted by RV1 between 0 and approx. - 7 V, provides a fixed clutch current which is preset to about 0.6A. The negative voltage across RV1 is produced by the 6.3 V a.c. from TR1 being rectified by MR1 and smoothed.

(b) In the speed control state, the screen voltage is fed from the discriminator whose action is described in the following paragraphs.

180. The output of the phonic wheel is fed in on PL2, reduced by RV3 and fed to identical transformers TR2 and TR3. These feed respectively, tuned circuits L1 - C5 and L2 - C7 via isolating resistors R3 and R4. The tuned circuit outputs are rectified by MR2 and MR3 smoothed by C6 and C8 and appear as + ve and - ve d.c. voltages across the loads R8 and R9. L1 and C5 resonate at 1300 c/s and L2 and C7 at about 1420 c/s, so that the outputs across R8 and R9 will take the form of curves "a" and "b" in fig. 38. These outputs are added to get the discriminator characteristic,"c" and "d" is the type of curve obtained when the mean bias of the screen grid is plotted against frequency. The point where "c" and "d" inter gives the speed at which the aerial will stabilize.

181. If only the discriminator output is applied to the screen grid the aerial speed will be too high so a - ve voltage from RV2 is added which lowers discriminator characteristic "c" until it intersects "d" at the correct frequency. RV2 acts as a fine frequency control. As well as feeding MR3 the 1420 c/s discriminator circuit also feeds the control grid of V2. MR8 rectifies the voltage across L2 and produces a - ve d.c. voltage which will vary with speed as curve "b" of fig. 38 and applied to V2 which is part of the switching circuits.

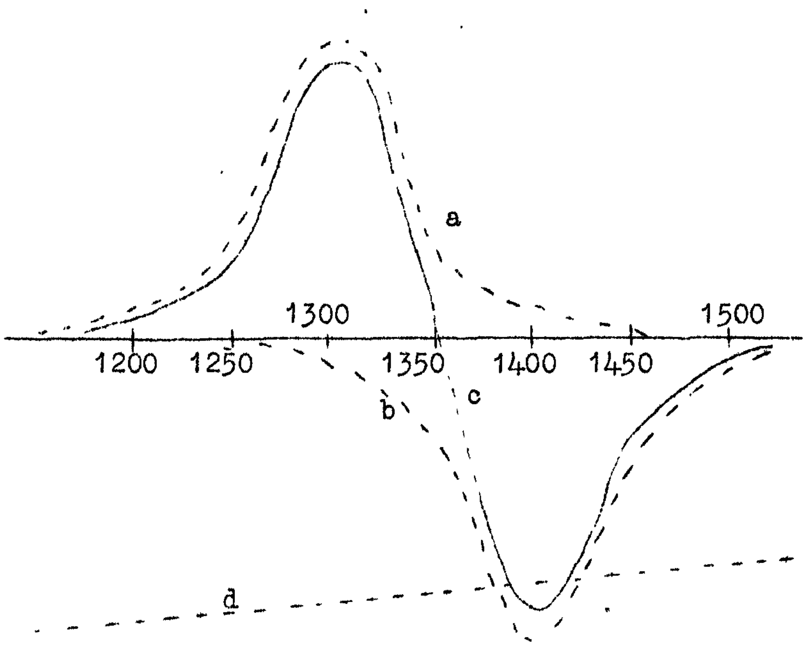


Fig.38. Discriminator Circuit-Curves

182. Switching Circuits. The switching circuits comprise power control valve V2, relays RL1 to RL5, SW4 and their associated components. The sequence of operations is as follows:- Beacon is switched on and 240 V.A.C. is fed through terminals C and B of PL1 to:-

(a) Light PL1 to show fuses FS1 and FS2 are serviceable.

(b) Energise the heater supply transformer TR1.

(c) Feed RL3 and RL4 which are d.c. relays and are consequently provided with bridge rectifier networks MR11 and MR12, and limiting resistors R30 and R32. Neither relay is energised because RL4 has no earth return and RL3 is short-circuited by contacts RL4b.

183. TR1 supplies V1, V2 and V3 heaters, thermal delay switch SW4 and the lamp on the meter panel. After 30 seconds SW4 closes applying a.c. to V2 which conducts, there being no bias supplied to it from R10. This energises RL1, RL2 and RL5 whose contacts perform the following operations:-

RL1 a is opened.
b earths V2 bias potential divider.
RL2 a removes earth from RL3 and puts it on RL4 thus energising this relay.
b applies a steady bias to V1 (g2) from RV1.
RL5 a connects oscillator V3 output to beacon identity circuits.
b applies h. t. to V3.

RL4 having energised through RL2a, performs the following operations:-

RL4 a applies a.c. mains to V1 via RL3a and the primary of TR1 in rectifier unit (YS).
b removes the short circuit from RL3 and locks RL4 on.

184. The running up state has now been reached. A constant clutch current is applied to the aerial which accelerates steadily until it is going faster than normal, by such an amount that the bias produced across R10 cuts off V2. RL1, RL2 and RL5 then de-energise performing the following operation:-

RL1 a connects a.c. to RL4a independantly of RL3a.
b opens increasing the bias on V2 so that it remains cut off until the aerial speed falls well below normal speed.
RL2 a switches earth to RL3 from RL4 (which remains locked on by RL4b). RL3 is energised.
b removes steady bias from V1 (g2) and replaces it with the discriminator output.
RL5 a switches the phonic wheel output to the beacon identity circuits.
b removes h.t. from V3.

RL3 having been energised through RL2a, performs the following operations:

RL3 a removes a path for a.c. mains to get to V1 (a path being left via RL1a) and short circuits SW4.
b removes the heater supply from SW4 and puts earth on RL3 making its operation indepentant of RL2.

185. The aerial speed now drops until correct speed is reached, where upon the speed control becomes effective, maintaining the speed until the beacon is switched off. When the spring-loaded switch SW3 is depressed, RL3 and RL4 are de-energised. When SW3 is released the aerial run-up procedure recommences.

186. <u>1350 c/s Oscillator</u>. The function of V3 is to produce 1350 c/s oscillation, when required. V3a is a crystal oscillator feeding an amplifier V3b. The output from V3b anode is fed to transformer TR4 and also to rectifier MR9 which provides a bias potential to V3 a grid. The output from TR4 is fed to:-

(a) PL4 when either RL5 is energised or SW2 is depressed.

(b) SW16 position 3 for metering purposes.

H.T. is provided by MR10 and smoothing circuit C19, R31 and C20; it is switched to V3 as appropriate by SW1, SW2 or RL5b.

187. <u>Metering</u>. M1 is used to measure three a.c. voltages which indicate whether or not the aerial drive system is working correctly. These voltages are switched in by SW1 and are as follows:-

Position 1. A voltage proportional to aerial motor current.

Position 2. The phonic wheel output as applied to the discriminator.

Position 3. Both the phonic wheel output and the 1350 c/s oscillator output in series. These voltages beat together to give a visual indication of the aerial speed error.

REFERENCE: A.P. 2534L, Vol. 1, Part 2, Section 1, Chapter 2.

MISCELLANEOUS	SK1		R5	R1	R2	M1	MR1a	MR2a
		TR1	R3	R4			MR1b	MR2b

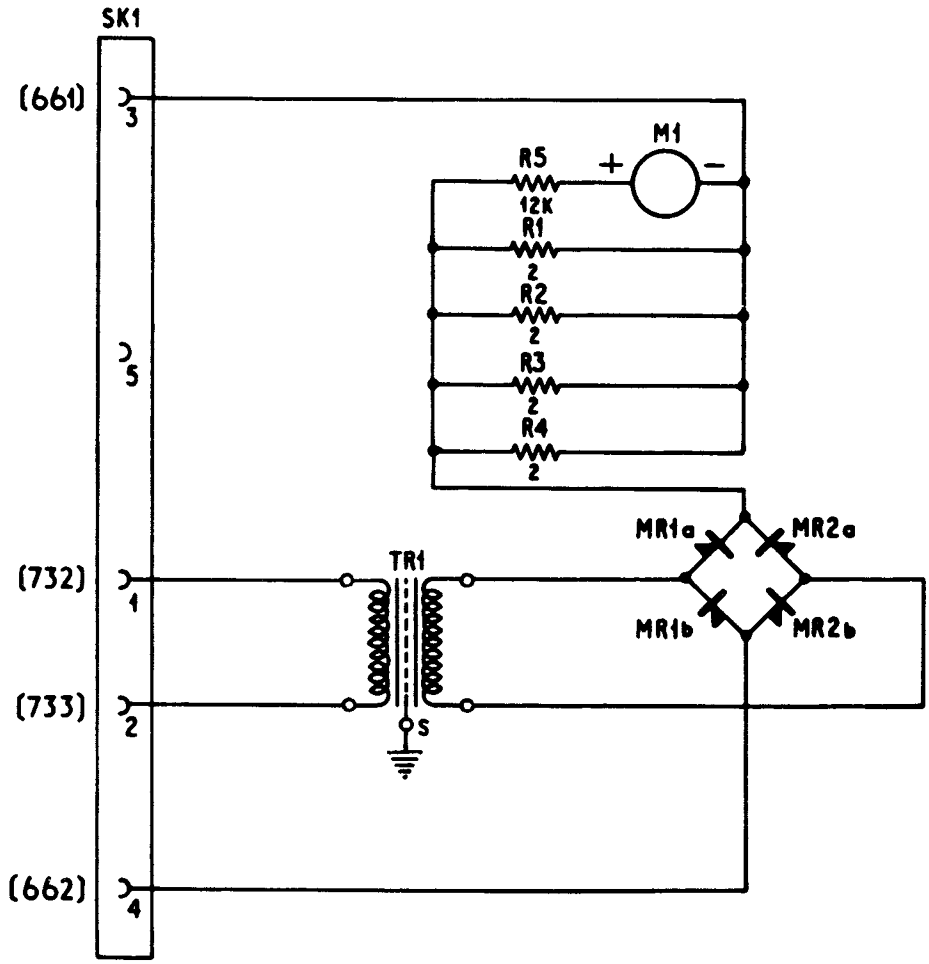


Fig. 3. SRI. 18118, FGRI. 18119
Aerial speed rectifier unit (YS) – circuit

AIR DIAGRAM
6264AA/MIN.
ISSUE 1
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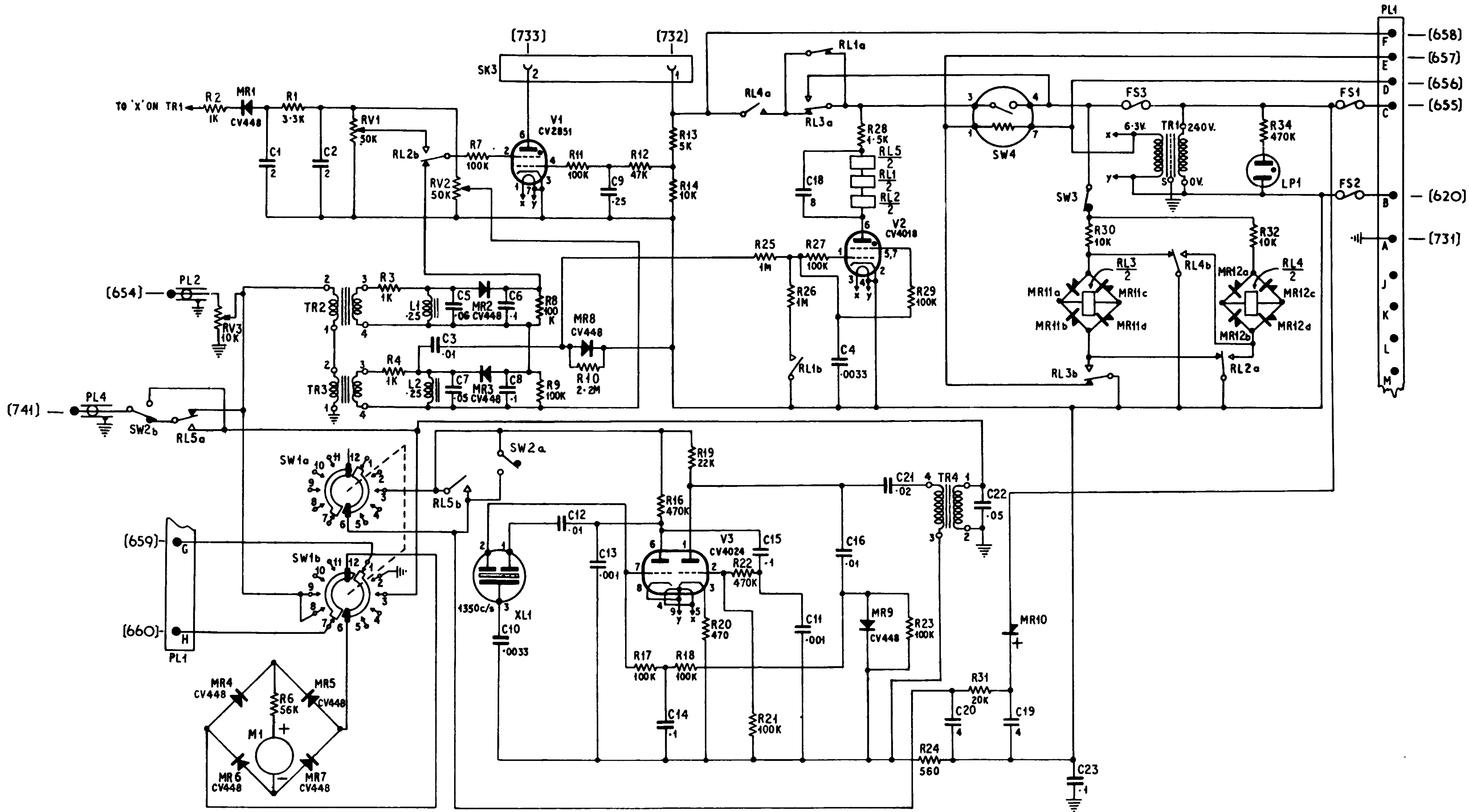
RESISTORS	RV3 R1 RV1 R3 R7 R8 R11 R12 R13 R14 R25 R26 R27 R28 R29 R30 R32 R2 R6 R4 RV2 R9 R10 R17 R16 R18 R19 R20 R22 R21 R23 R24 R31
CAPACITORS	C1 C2 C3 C5 C7 C10 C6 C8 C12 C13 C9 C14 C15 C11 C18 C4 C16 C21 C20 C22 C19 C23
MISCELLANEOUS	PL1 PL2 MR1 TR2 TR3 RL2b RL5b MR2 MR3 V1 SK3 RL4a RL3a RL1a V2 RL5 RL1 SW4 SW3 RL3b RL3 FS3 TR1 RL4b RL2a LP1 RL4 FS1 PL1 PL4 SW2b RL5a MR4 MR6 M1 MR5 MR7 SW1a SW1b L1 L2 SW2a XL1 MR8 V3 RL1b MR9 RL2 TR4 MR10 MR11a MR11b MR11c MR11d MR12a MR12b MR12c MR12d FS2



AIR DIAGRAM 6264P/MIN.
ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119 — Aerial speed control unit (YR) - circuit

Fig. 5

(A.L.15, Dec.58)

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CONTROL SYSTEM

CONTROL UNIT (W) AND REMOTE CONTROL UNIT (RC)

Introduction

187. The function of the control unit (W) is to provide the sequential switching and delays required by the beacon when it is being switched on. The unit contains all the overload, interlock and switching circuits concerned with the application of power in the beacon. It also contains a recycling system which automatically switches off and resets H.T, and E.H.T. power supplies should an overload occur. Also contained in the unit are some metering circuits associated with the E.H.T. power unit, the klystron assembly crystal detectors and the thermistor R.F. power measuring unit. Other units associated in the beacon control are the pulse generator (MA) which carries the built in test equipment control switch and the remote control unit (RC).

188. The control unit is mounted at the top of the right hand cabinet above the doors, and the front panel carries the switches, indicating lamps and meters required to switch on the beacon and give indication of some overloads and other circuit conditions. Mounted on the chassis are 20 relays, a time delay switch unit and a motor (XI) used in the recycling circuit. The circuit references can be seen on fig. 42, which also shows the external connections of PL1.

189. The beacon has three stable states :- OFF, STANDBY and OPERATIONAL and is put in the appropriate mode by three spring-loaded switches S7, S8 and S9. There is also a fourth interim stage known as "warming up" which occurs between OFF and STANDBY; the length of this period, which is preset, governs the minimum time between application of the filament supplies and H.T. voltages.

Switching From OFF to STANDBY

190. In the OFF position the switches and relays are all in the positions shown in fig. 42. The unregulated mains supply is on and the 50V supply is confirmed by ILP11 50 V LINE lamp lighting up. When the STANDBY switch S8 is momentarily depressed the following switching sequence takes place:-

(a) 50 V is momentarily applied to one coil of relay RL8 which energises and closes contact RL8/1.

(b) RL8/1 energises RLG closing its two contacts.
RL6/2 connects 50,V to two points:-

(1) To PL1/Y where it passes via Z1/89 to energise main contactor ZRL1 in the distribution box (Z); phase 3 unregulated mains is then fed via one of ZRL1 contacts, to PL1/J of control unit via Z1/63 and 65. As the neutral line is permenantly connected to PL1/K a 240V a.c. supply is therefore applied to the hour meter (M1) and to SK1 pins B and C.

(2) To SKI/F where it passes via switch S2 to SKI/D.

(c) RL6/1 connects the 50 V from SKI/D to ILP6 WARMING UP lamp to indicate that the warming up time is in progress, the 50 V is also applied to PLI/C as a remote control output.

191. Time Delay Switch Unit. This unit provides a preset time delay between pressing the STANDBY switch and the equipment coming into the standby condition, i.e. its action determines the length of the warming up time. The delay introduced is adjustable between 2 and 16 minutes and is set by a calibrated timing dial. This allows for the wide variety of temperature and humidity conditions in which the beacon may be required to operate.

192. The time delay functions as follows:- the unregulated 240 V.A.C. supply applied to pins B and C (para. 190 (2a)) is fed to a split phase motor and a bridge rectifier circuit. The motor starts to turn and at the same time the output from the bridge rectifier energises a solenoid which causes a set of gears to be connected to the motor. While the motor is running it is also winding up a spring attached to a ratchet and balance wheel system similar to a clock. After the preset time has elapsed a lever attached to the gearing actuates two micro-switches S1 and S2; S2 is actuated just before S1. S2 switches the beacon from warming up to standby and S1 switches off the motor. Since the solenoid remains energised while the beacon is switched on, the gearing remains in the final position at which the motor stops running. If the beacon is switched off the solenoid is de-energised and the gearing is driven back by the spring at the same rate as it was driven by the motor, this is to save time if the beacon is switched off accidentally or for a minute or two for adjustment, i.e. if the beacon is off for a minute it will only take a minute to come on again.

193. When S2 on the time delay unit is actuated it removes 50 V from SKI/D and places it on SKI/E. Thus ILP6 WARMING UP lamp is extinguished and 50 V is removed from PLI/C. The 50 V now available at SKI/E is distributed as follows:-

(a) Via RL10/2 to light ILP7 STANDBY lamp and to PLI/4 for remote indication.

(b) To PLI/M for interlock and switching circuits.

(c) To the contacts of spring-loaded switch S10 (INTERLOCK OVER-RIDE).

194. Door Interlocks and Over-Ride Switch. The 50 V at PLI/M is fed out to the left-hand bay door interlock (S1) via terminal block Z1 pins 70 and 35. Provided the left-hand bay door is shut the 50 V is fed back to the right-hand bay door interlock (S2) via Z, pins 36 and 71. When the right-hand door is closed it is fed to PLI/N on the control unit, and then to the power unit switching and interlock circuits via contacts RL19/1 and RL19/2. An over-ride switch S10 is provided for the door interlocks. When S10 is depressed one of its contacts feeds 50 V from SKI/E to one side of the coils of relays RL11 and RL7 which are in parallel; the other contact connects PLI/M to PLI/N. While S10 is still depressed one of the doors is opened and its interlock opens, putting an earth on PL1/L which causes RL11 and RL7 to be energised. S10 may now be released since the 50 V supply to RL11 and RL7 is maintained by RL11/2. RL11/1 connects PLI/N to PLI/M thus shorting out the door interlock circuit and maintaining the 50 V supply to the two contacts of RL19. When RL7 is energised contacts RL7/2 change over and prevent the CHECK lamp ILP9 from flashing whilst either door is open.

195. Power Unit Interlock Switching and Overload Circuits. The 50 V energising supply to the power units interlock, switching and overload circuits passes via the two normally closed contacts of RL19. Switches S1 to S6 are normally in the ON position and function as follows:-

(a) S1 switches the E.H.T. power unit (N).

(b) S2 switches the modulator E.H.T. power unit (B).

(c) S3 switches the + 500 V power unit (A).

(d) S4 switches the + 250 V power unit (K).

(e) S5 switches the - 150 V power unit (J).

(f) S6 switches the recycling circuit.

If any of these switches are left in the OFF position or the external switches fed from PLI/Q are left open, a warning is given by a flashing CHECK lamp ILP9. This warning circuit is described in para. 207.

196. The 50 V passing via contact RL19/1 is fed to S4 (250V on) only; from there it is fed to PLI/W, passing via contact RL4/2 and the 50 ohm coil (a - b) of the +250 V overload indicator relay RL4. While current is flowing in the 50 ohm coil the contacts will remain in the position shown. From PLI/W the 50 V is fed to PL2/2 on the + 250 V power unit (K) via terminal board Z1 pins 75 and 40. The 50 V energises contactor RL1 in unit K and RL1 contacts complete thecircuit for the H.T. transformer mai supply; RL1 is earthed via a contact of the overload relay RL2 in unit K.

197. The 50 V passing via contact RL19/2 is fed three ways:-

(a) To S5 the - 150 ON switch.

(b) To PLI/U for the - 150 V, + 250 V and + 500 V power unit interlock circuits and subsequently for + 2.5 KV and - 15 KV E.H.T. power unit switching when the beacon is in the OPERATIONAL mode.

(c) To energise RL14 in the recycling circuit when an overload occurs.

198. The 50 V supply to S5 follows a similar course to that taken by the supply to S4 (para. 196). It energises contactor RL101 in the - 150 V power unit (J) and RL101 contacts connect the 240 V.A.C. supply to the H.T. transformer. RL101 coil is earthed by a contact of the overload relay RL103 in unit J.

199. The 50 V fed to PLI/U (para. 197 (2)) passes via Z1 pins 73 and 38 to the - 150 V power unit (J) PL101/5. In power unit J it passes through RL102/2 back to PL101/7. RL102 is energised when the - 150 V has reached its operating level. The 50 V is then fed back to PL1/V via Z1 pins 39 and 74. From PL1/V the 50 V is fed two ways:-

(a) To PLI/O for the + 250 V interlock.

(b) To S3 + 500 V ON switch.

The 50 V to switch on the + 500 V power unit has to pass through the - 150 V interlock first, thus ensuring that bias supplies are fully operational before H.T. is applied to units.

200. The 50 V at PL1/O is fed to PL2/7 on the + 250 V power unit (K) via Z1 pins 76 and 41. On power unit K it passes through RL3/1 back to PL2/8. RL3 is energised when the + 250 V has reached its operational level, the 50 V is then fed back to PL1/P via Z1 pins 42 and 77.

From PLT/P it passes through RL3/1 to contact RL10/1 which remains open in the STANDBY mode. Thus the - 150 V and + 250 V supplies must be on before the - 15 KV and + 2.5 KV E.H.T. supplies can be switched on, because the 50 V to energise the switching circuits of the E.H.T. power units N and B passes through the - 150 V and + 250 V power units.

201. The 50 V fed to S3 (para 199 (2)) is applied to PL1/T via RL3/2 and the 50 Ohm (a-b) of RL3; it then passes via terminal board Z1 pins 79 and 44 into the left-hand bay where it passes through eight overload contacts on six units before reaching the + 500 V power unit (a) to switch it on. The sequence of units the 50 V passes through is as follows:-

(a) Monitoring unit L (contacts RL3/1, RL2/1, RL1/1 out on PL2/3)

(b) Regulating unit DF (contact RL1/1 out on PL1/14).

(c) Regulating unit DE (contact RL1/1 out on PL1/15).

(d) Regulating unit DC (contact RL1/1 out on PL1/14).

(e) Regulating unit DB (contact RL1/1 out on PL1/15).

(f) Regulating unit DA (contact RL1/1 out on PL1/14).

The 50 V emerging from PL1/14 on DA is fed to PL1/2 on the + 500 V power unit (A) where it energises contactor RL1 whose 3 contacts connect the 3 - phase mains input to the H.T. transformer. RL1 on A is earthed via contact RL2/1 of the overload relay. Thus if any of the nine overload contacts open, the + 500 V supply is switched off. When the + 500 V supply reaches its operational level the beacon is in the STANDBY mode.

<u>Switching From STANDBY to OPERATIONAL</u>

202. When the beacon is in the STANDBY mode all power supplies are available except the - 15 KV and + 2.5 KV E.H.T. voltages. When the OPERATIONAL switch S9 is momentarily depressed 50 V is applied to one coil of the polarised relay RL9 and contact RL9/1 closes causing RL10 to energise. This relay has two contacts which perform the following functions:-

(a) RL10/1 connects the 50 V available from RL3/1 (via - 150 V and + 250 V interlock circuits) to S1 via RL2/1 and to S2 via RL1/1, E.H.T. and MOD. ON-OFF switches respectively.

(b) RL10/2 disconnects the 50 V from ILP 7 STANDBY lamp and connects it to ILP8 OPERATIONAL indicating lamp and to PL1/B for remote indication. It also makes the 50 V available to energise RL20 when RL7/1 and RL13/1 are closed.

203. When the 50 V is applied to S2 it is used to switch on the + 2.5 KV modulator supply. With S2 in the ON position the 50 V is fed to the 50 ohm coil (a - b) of RL2 via contact RL2/2, it then passes through PL1/S to terminal block A1 pins 68 and 43. It is then fed to PL1/8 on power unit B; in unit B it passes through contactor RL1 coil and contact RL2/2 to earth. When RL1 is energised its contacts connect the regulated 230 V.A.C. supply to the H.T. transformer. RL2 is the 2.5 KV overload relay which breaks the earthing circuit of the switching relay RL1 in the event of an overload.

204. The 50 V fed to S1 E.H.T. ON switch is used to switch on the - 15 KV supply to the klystron. With S1 in the ON position the 50 V is fed to the 50 ohm coil (a-b) of RL1 via contact RL1/2, it then passes through PL1/R to PL1/2 on power unit N. The - 15 KV is then switched as follows:-

(a) 50 V from PL1/2 is applied to RL7 and contactor RL1. RL1 earth circuit is completed by RL5/2, when RL1 is energised its contacts connect the 3-phase mains supply to the E.H.T. transformer through voltage dropping resistors.

(b) Contact RL7/2 provides on earth for RL4 heater element.

(c) When RL4 contact closes, RL5 is energised, RL5/1 short circuits RL4 and RL5/2 competes the earth circuit for contactor RL2. At this point the load of the power unit should be drawing sufficient current to energise RL6; if this is not the case, when RL5 is energised the earth is removed from RL1 and the a.c. mains are disconnected from the E.H.T. transfromer.

S2 in unit N is a no-current over-ride switch which overcomes the effect of RL5 and RL6 by placing an earth on RL1; there is also another contact of S2 which places an earth on the warning line to give an indication that this switch is closed. When the + 2.5 KV and the - 15 KV come on, the beacon is in the OPERATIONAL mode. RL1 and RL2 in control unit (W) are the overload relays for the - 15 KV and + 2.5 KV supplies respectively. Contacts RL2/1 and RL1/1 ensure that in the event of an overload on either circuit both E.H.T. supplies are broken.

205. The overload indicating circuits for the five power units (A,B,J, K and N) all operate in a similar fashion. The relays RL1 to RL5, inclusive, all have their contacts as shown in fig. 42. Consider the action of any one; while the beacon is operating correctly current will flow in the 50 ohm coil (a-b), the 50 V from the appropriate switch will also cause a current to flow through the 2000 ohm coil (d - e) but in the opposite direction, so that the two fields cancel out and the relay is not operated. If an overload occurs the circuit through the switching relay in the power unit is broken, the mains are removed from the power unit HT transformer and the current through the 50 ohm coil ceases. The current still flowing through the 2000 ohm coil causes the relay to operate. One contact connects the 50 V to the overload indicating lamp (ILP1 to ILP5) and the other connects 50 V to RL14 to energise the recycling circuit.

206. It can be seen that the power supplies are always applied in the following sequence:-

(a) When the main breaker is closed the a.c. mains is applied to the equipment and the heater and 50 V supplies are switched on.

(b) S1 to S6 on the control unit are put to the ON position and S8 STANDBY switch is depressed. The sequence of voltages is then:-

(1) - 150 V.

(2) + 250 V and + 500 V.

(c) S9 OPERATIONAL Switch is depressed and the + 2.5 KV and - 15 KV E.H.T. voltages are switched on. The E.H.T. voltages can not be switched on until the power units detailed in sub.para. (2) above are fully operational because the 50 V to switch on the E.H.T. power units passes through the interlocks on these units.

<u>Check Lamp Circuit</u>

207. The check lamp circuit is included to provide a visual indication when a switch has been left in the incorrect position after servicing or checking the beacon. The circuit consists mainly of an indicating lamp ILP9 marked CHECK and two slugged relays RL12 and RL13. The visual indication is given by ILP9 flashing and an aural indication by the ticking sound of the relays. The warning line is connected to one pole of the six two-pole ON OFF switches S1 to S6 on the control unit.

The line is also connected to PLI/Q and out to terminal block Z1 pin 90. From there it is fed two ways:-

(a) To S1 in the remote control output in the distribution box (Z).

(b) To PL1/7 on the - 15KV power unit (N), where it is connected to one pole of the no current over-ride switch S2.

If any of the switches mentioned above are left in the OFF position an earth will be put on the warning line and the check circuit will be energised.

208. RL12 and RL13 are connected in parallel, with a normally-closed contact RL13/2 in series with RL12 coil and a normally-open contact RL12/1 in series with RL13 coil. The contacts RL12/1 and RL13/2 are shunted by spark quench capacitors C2 and C3 respectively. The common connection from the contacts is taken to the warning line and the normally-open contact of RL7/2. The other normally-closed contact of RL12 (RL12/2) is in series with the indicating lamp ILP9. The lamp is earthed on one side by the normally-closed contact of RL7/2.

209. The contact arm of RL12/2 and one side of the coils of RL12 and RL13 are permenantly connected to 50 V, so if an earth isplaced on the warning line RL12 will be energised, contact RL12/1 will complete the circuit for RL14 coil, causing it to be energised, and RL12/2 will connect 50 V to ILP9, causing it to light up. When RL14 is energised it opens its contact RL13/2 causing RL12 to be de-energised, it's contacts open and RL13 is de-energised and ILP9 is extinguished. However, as RL12 and RL13 are slow operating relays they continue to change over and ILP9 will flash as long as the earth rem ins on the warning line.

210. It should be noted that if either of the doors is left open the lamp ILP9 will not light up as RL7 will be energised due to the action of the interlock over-ride switch S10 (para. 194). RL7/2 will then remove the earth connection from ILP9 and short circuit the warning line. In this case relays RL12 and RL13 will be alternately energised but the CHECK lamp will not flash.

211. Contact RL13/1 is connected in series with the coil of RL20, contact RL7/1 and R10. RL7/1 will not close until the interlock over-ride switch S10 is pressed. When S10 is pressed RL7/2 will be actuated and will complete the earth return for the check relays. Thus RL20 will be energised intermittently by RL13/1 contact. Only one contact of RL20 is used, this is between PLI/J and PLI/Z. As PLI J has 240 V phase 3 on it this contact will put a flashing 240 V supply on PLI/Z. This supply was intended to light up an external indicator to show that the equipment was on with the doors open. However, this facility is not used at the present time.

Re-cycling Circuit

212. In the event of an overload the function of the recycling circuit is to remove the 50 V energising supply from the power unit interlock and switching circuits for about 5 seconds, then to re-apply it. If the overload is temporary the beacon will resume normal operation, if the overload persists, however, the appropriate overload indicating lamp will light and after the recycling circuit has finished operating ILP10 RECYCLING lamp will also remain alight.

213. The recycling circuit functions as follows. In the normal state S6 RECYCLING switch is in the ON position and the motor driven switch S13 is in the position shown in fig. 42. When one of the overload relays RL1 to RL5 is energised 50 V is fed to RL14 coil which has two sets of contacts. RL14/1 is not used at this stage, RL14/2 closes and energises RL15 whose two sets of contacts are used as follows:-

(a) RL15/1 places an earth on RL16 and ILP10 RECYCLING lamp, this causes RL16 to energise and ILP10 to light up.

(b) RL15/2, in parallel with RL14/2 locks on RL15.

214. When RL16 is energised (sub para (a) above) contact RL16/1 connects 240 V.A.C. from PL1/J to energise motor X1 which starts to drive S13 in the direction indicated by the arrow in fig. 42. Contact RL16/2 closes and completes the earth circuit for RL18 and RL19 in series. The two sets of RL19 contacts which are normally closed, open and remove the 50 V energising supply from the power supply interlock and switching circuits; RL14 is also de-energised at this point, RL18 is a thermal relay with only one contact, after about 5 seconds this contact closes shorting out RL19 coil thus restoring the 50 V energising supply to the power supply switching circuits.

215. If the original overload was of a temporary nature and does not re-appear when the 50 V is re-applied the beacon will resume normal operation. While the recycling of the 50V is taking place, motor X1 is driving switch S13 which takes about 10 minutes to make a full revolution. When the cut-out on S13 reaches position 12 one of two things will have happener:-

(a) There has not been another overload and RL14 is de-energised.

(b) The original overload has recurred or another power supply has had an overload, in either case RL14 and one of the overload relays RL1 to RL5 will be energised.

216. If the condition in para. 215 (1) above prevails, RL14/1 will be open and no energising voltage will be open and no energising voltage will be available for RL17. Thus the motor will continue to drive S13. When the cut-out on S13 reaches position 1, RL15 will be de-energised but the motor will continue to rotate because S13 provides an earth for RL16. When S13 cut-out reaches position 2, RL16 and consequently RL18 are de-energised and ILP10 RECYCLING lamp is extinguished, the whole recycling system is then brought to rest by the opening of RL16/1.

217. If the conditions specified in para 215 (2) prevail then RL14/1 will be closed and 50 V will be available to energise RL17 when S13 cut-out reaches position 12. When RL17 is energised contact RL17/1 disconnects the 240 V a.c. neutral line from the motor X1. The circuit will remain in this state for as long as RL14 is energised, thus the appropriate overload indicating lamp and the recycling lamp ILP10 will be alight to indicate firstly on which power unit the overload has occurred and secondly that the recycling circuit has been brought into use.

Switching OFF

218. To switch the beacon off, the switch marked OFF (S7) should be momentarily depressed. This will cause the beacon to revert to the condition detailed in para 190, whatever mode it was in before the OFF switch was depressed.

TL/488
JUNE, 1962

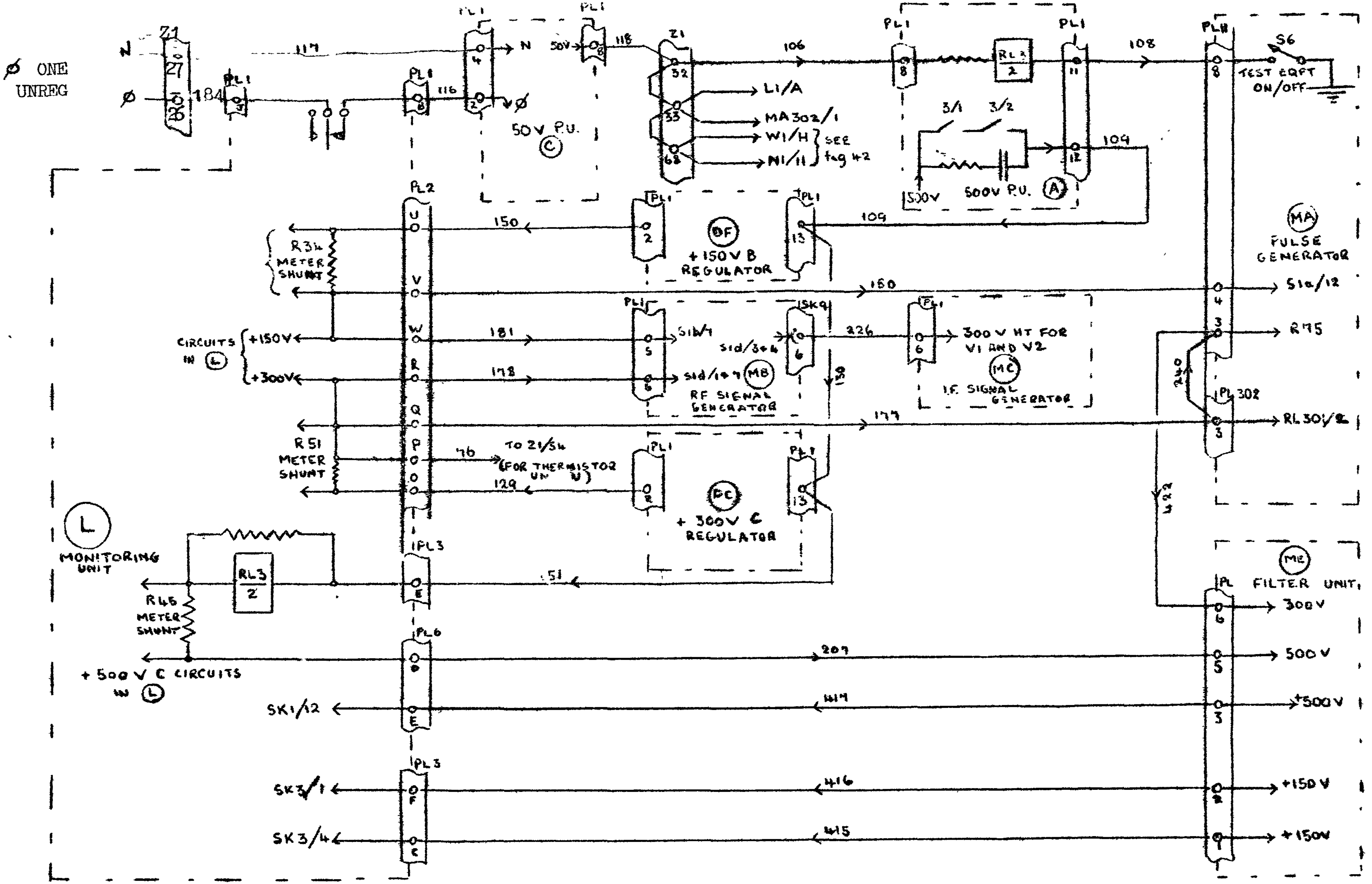


FIG. 41. TEST EQUIPMENT SWITCHING - BLOCK DIAGRAM

Mains Failure

219. Should a mains failure occur, the beacon will return automatically to the condition it was in prior to the failure as soon as the mains supply is restored. This is due to the fact that relays RL8 and RL9 are polarized, and these relays initiate the chain of events which puts the beacon in the appropriate mode. The position of the contacts of RL8 and RL9 depends on switches S7, S8 and S9 (OFF, STANDBY and OPERATIONAL respectively). Consequently when a mains failure occurs the relay contacts will remain in the position they were in before the failure, and upon resumption of the mains supply the beacon will return automatically to its previous condition in a time dependant upon the preset delays.

Metering Circuits

220. The meters M2, M3, M4 and M5 are mounted on the control unit for convenience and do not form part of the interlock and switching circuits. They are used as follows:-

(a) M2 is associated with the thermistor unit (U) and is used to indicate mean RF power.

(b) M3 is associated with the E.H.T. power unit (N) and indicates E.H.T. volts.

(c) M4 is associated with the E.H.T. power unit (N) and indicates the E.H.T. current.

(d) M5 is associated with the klystron assembly (Q). It works with S12 the KLYSTRON CAVITY SELECTOR SWITCH and indicates the three klystron cavity crystal currents.

Test Equipment Control

221. The H.T. supplies for the built-in test equipment are switched on by S6 on the pulse generator (MA) marked TEST EQUIPMENT ON-OFF. The supplies concerned are the + 500 V C, + 300 V C and the + 150 V B: these supplies are all taken from the + 500 V power unit (A), therefore switches S1 to S6 on the control unit must be ON and the beacon in the STANDBY or OPERATIONAL mode before the test equipment can be switched on. Test equipment switching and interconnections are shown in fig. 41.

222. When the main isolator switch on the aerial control cabinet is put to the ON position, one phase of the unregulated mains and neutral are connected to the 50 V power unit (C). The 50 V then available at PL1/8 on this unit is fed to pin 32 on terminal block Z1 in the distribution box (Z), there it is linked to pins 33 and 68 for distribution to the left and right-hand cabinets respectively. From Z1/32 the 50 V is fed to PL1/8 on the 500 V power unit (A) where it passes through the coil of contactor RL3 to PL1/11. PL1/11 is connected to PL11/8 on the pulse generator (MA).

223. When S6 TEST EQUIPMENT ON-OFF is switched to the ON position, an earth is put on PL11/8 on the pulse generator (MA) thus completing the circuit to energise contactor RL3 in the 500 V power unit. RL3 closes its two contacts, which are in series, thus connecting 500 V to PL1/12. This 500 V is fed three ways as follows:-

(a) To PL1/13 on the + 150 B regulator (DF).

(b) To PL1/13 on the + 300 V C regulator (DC).

(c) To PL3/E on monitoring unit (L).

The distribution of these three voltages is shown in fig. 41. The test gear heaters come on when the STANDBY switch is depressed, the regulated mains supply to them passing through fuses ZF9 and ZF10 on the distribution box Z. It should be noted that other voltages are used on the test gear but as these are not switched by S6 on the pulse generator (MA) they are not shown in Fig. 41.

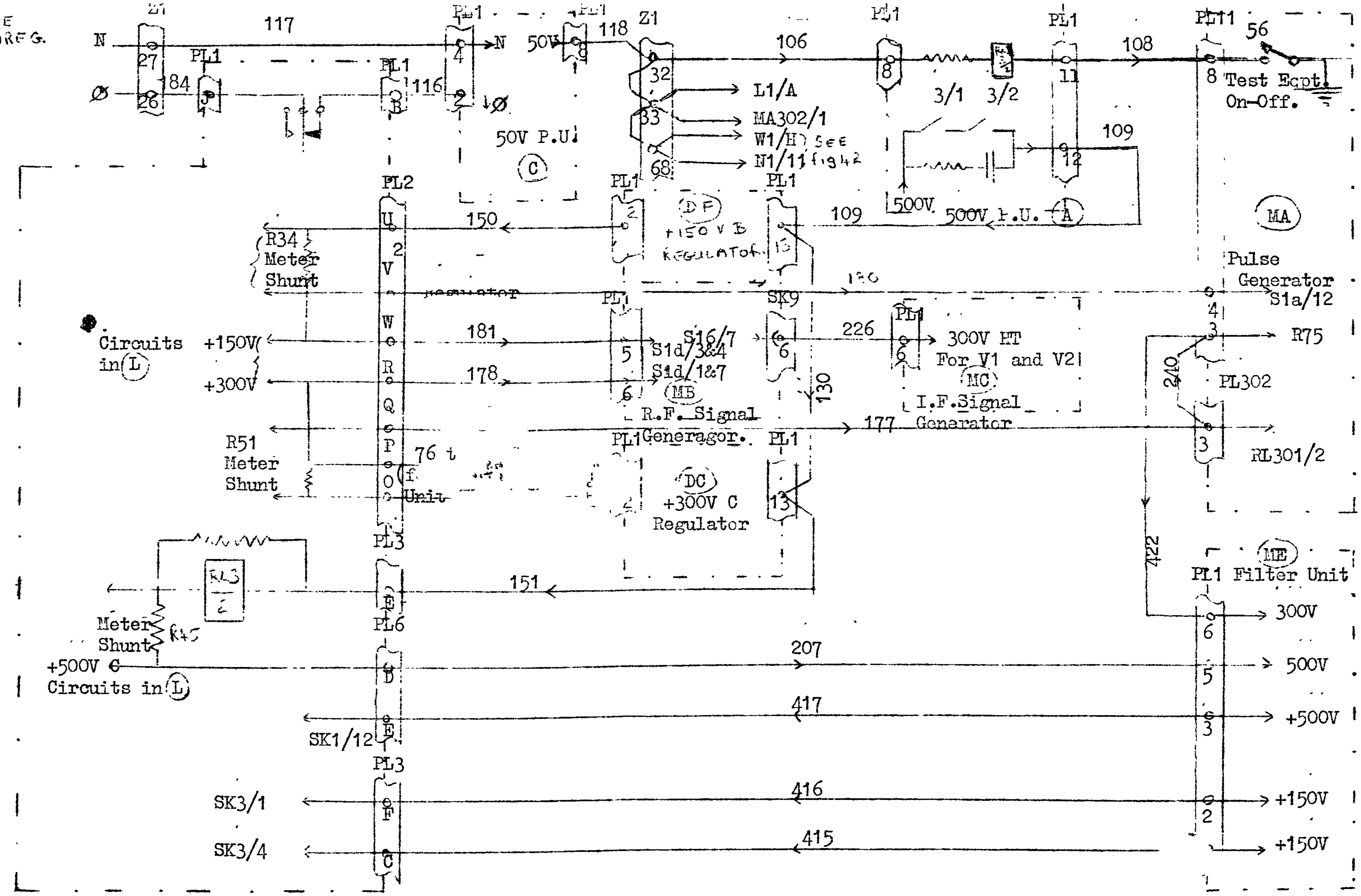


FIG. 41 TEST EQUIPMENT SWITCHING - BLOCK DIAGRAM.

Remote Control (RC).

224. The remote control unit is provided to allow for control of the OFF-STANDBY-OPERATIONAL switching of the beacon from distances up to about a mile. The unit contains four indicating lamps and three switches which are shown in fig. 42. The remote control output box on the beacon is part of the distribution box (z), and mounted on the front of the box is a two-pole switch S1 marked REMOTE CONTROL ON-OFF. When in the OFF position S1a is not used. S1b connects an earth on the warning line (para. 207). In the ON position S1a connects 50V to Z2/4 and S1b is not used.

225. The eight pins of Z2 are connected to the correspondingly numbered pins on TS1 on the remote control unit. Thus when S1 on the distribution box (Z) is in the ON position, 50 V is fed from Z2/4 to TS1/4. There it lights the blue indicating lamp ILP4(LIVE) and is also fed to the spring-loaded switches S1, S2 and S3 marked OPERATIONAL, STANDBY and OFF respectively. Thus when S2 is momentarily depressed the 50 V is fed out again on TS1/6 to PL1/F on control unit (W) via Z2/6 and Z1/87. On the control unit the 50 V energises RL8 and the same action ensues as detailed in para 190. While the beacon is warming up 50 V is fed from PL1/C on the control unit (W) to TS1/3 on the remote control unit via Z1/84 and Z2/3. On the remote control unit the white WARMING UP lamp 1LP3 lights. When the beacon comes into the standby condition the 50 V is removed from PL1/C on the control unit (W) and is fed to PL1/A (para 193 (d)); from there it is fed to TS1/1 via Z1/82 and Z2/1 to light the amber lamp ILP1 marked STANDBY.

226. When momentarily depressed S1 on the remote control unit has the same effect as S9 on the control unit (W) (para 202). Thus S1 puts the beacon in the OPERATIONAL condition and the green indicating lamp ILP2 light on in the remote control unit. It can be seen that the indication on the remote control unit will be as follows:-

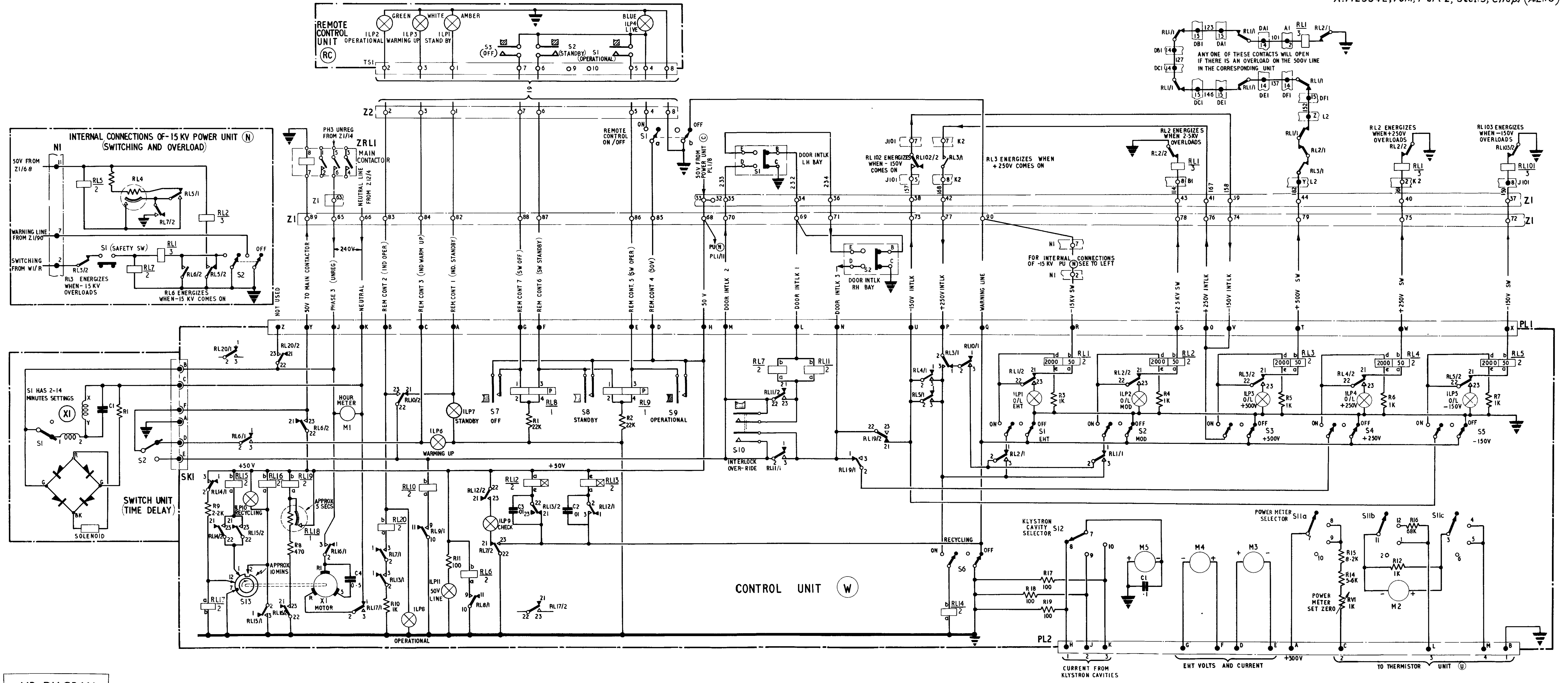
(a) With the beacon a.c. main breaker closed the blue LIVE lamp ILP4 will light. Thus when a.c. mains are on and the beacon is in the OFF condition, ILP4 only will be alight.

(b) When S2 STANDBY switch has been momentarily depressed the white WARMING UP lamp ILP3 will light for about 5 seconds., it is then extinguished and the amber STANDBY lamp ILPI will light.

(c) When S1 OPERATIONAL switch is momentarily depressed ILPI STANDBY lamp will be extinguished and the green OPERATIONAL lamp ILP2 will light.

It should be noted that ILP4 LIVE lamp will remain alight during conditions (b) and (c).

REFERENCE: AP2534L, Vol 1, Book 2, Part 2, Section 5, Chapter 1.



SRI.18118 and FGRI.18119 - Control units (W and RC) - circuit and external connections

Fig.2

(A.L.13, Nov.58)

AIR DIAGRAM
6264AK/MIN.

ISSUE.1 PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

8180 343382 12/58 630+500 C.B.&S Ltd GP924

POWER AND TEST CABINET DESCRIPTION AND POWER UNIT CIRCUITS

Introduction

227. The power and test cabinet is the left-hand cabinet of the beacon, and it contains the power units and built-in test equipment for the beacon. Table 2 provides the common name and unit code letter as marked on the units.

Table 2

+ 500 V power unit	A
+ 2.5 KV power unit	B
+ 50 V power unit	C
+ 300 V or + 150V voltage stabilizer	D
+ 250 V and - 150 V power unit	K and J
Monitoring unit	L
Pulse-generator	MA
R.F. signal generator	MB
I.F. signal generator	MC
Identity keyer	MD
Filter unit	ME

Primary Power Circuits

228. The regulated and unregulated three-phase power supplies are fed into the left-hand cabinet from the aerial control cabinet. The regulated three-phase supply is fed from Z1/9 to 11 to the following units:-

(a) The + 250 V power unit (K) via ZF/6 to 8 and terminals Z1/17 to 19; the neutral is fed from Z1/49.

(b) The + 500 V power unit (A) via ZF17 to 19 and terminals Z1/28 to 30; the neutral is fed from Z1/8.

(c) The - 15 KV power unit (N) in the right-hand cabinet via ZF/22 to 24 and Z/13, to terminals Z1/60 to 62; the neutral is fed from Z1/93.

229. The regulated phase one, two and three are fed from Z1/9, 10 and 11 respectively to the following:-

(a) Heater transformer T2 and T3, R.F. signal generator (MB) and monitoring unit (L) heater transformer via ZF9 and terminal Z1/20; the neutral is fed via ZF/10 and terminal Z1/21.

(b) Voltage stabilizers (DA) to (DF) via ZF/11 and terminal Z1/22; the neutral is fed via ZF/12 and terminal Z1/23.

(c) The + 2.5 KV power unit (B) via ZF/13 and terminal Z1/24; the neutral is fed via ZF/14 and terminal Z1/25.

(d) The modulator (O) and the heater transformers T4 to T7 in the right-hand cabinet via ZF/20 and terminal Z1/58; the neutral is fed via ZF/21 and terminal Z1/59.

(e) The - 150 V power unit (J) via ZF/4 and terminal Z1/15, the neutral is fed via ZF/5 and terminal Z1/16.

230. The unregulated phase one, two and three are fed from Z1/1, 2 and 3 respectively to the following:-

(a) Klystron heating relay (g) and klystron assembly (Q) via ZF/1 and terminal Z1/102; the neutral is fed from terminal Z1/93.

(b) Crystal oven (XA) via ZF/15 and terminal Z1/56, the neutral is fed from ZF/16 and terminal Z1/57.

(c) Lighting transformer (T1) and power unit (C) via ZF(15) and terminal Z1/26; the neutral is fed from ZF/16 and terminal Z1/27.

(d) Identity keyer (MD) and control line to aerial cabinet via ZF/2 and terminal Z1/12; the neutral is fed from terminal Z1/49.

(e) Fan distribution (XK), control unit (W) and aerial artificial load (DL) via ZF/3 and terminal Z1/63; the neutral is fed from terminal Z1/64 or 66.

Power Units - General

231. The beacon is fitted with a comprehensive overload and interlock system to provide protection against damage due to component failure or incorrect switching - on procedures. The 500 V supply cannot be switched on until the - 150 V bias supply is operating, and the modulator and E.H.T. cannot be switched on until all other supplies are available. All the main power supplies have their own overload circuits and each supply has its own overload and control relays, these are tabulated in table 3, for convenience.

Table 3. Power Supply Protection Relays.

Power Unit	Power Switching Relay	Overload Control Relay	Power On, Warning Or Interlock Relay.	W Unit Warning Relay
P.U. (A) 500 V	RL1	RL2	RL3	RL3
P.U. (B) 215KV	RL1	RL2		RL2
P.U. (C) 50 V	RL3	RL1	RL2	A11
P.U. (D) 300or150V		RL1	RL2	RL3
P.U. (J) - 150 V	RL101	RL103	RL102	RL5
P.U. (K) 250 V	RL1	RL2	RL3	RL4
P.U. (N) - 15 KV	RL1 & RL2	RL3	RL4 & RL7	RL1

NOTE: In the main control unit (W) there are automatic restoration circuits associated with each power supply.

+ 500V Power Unit (A)

232. This unit is situated at the bottom of the power supply cabinet and contains six valves. The supply from this unit has sufficient capacity for all the 500V unstabilized, 300V and 150 stabilized supplies used in the beacon circuits. These supplies are obtained from a 3-phase transformer TR1 having a delta-connected primary and a star connected secondary. V1 to V6 are conventionally connected as a full-wave, three-phase rectifier providing a nominal 500V output. A choke H2 and condensers C1 and C2 form a smoothing circuit. The circuit references can be seen in fig. 43.

233. Two relays and a contactor are included to perform the following functions:-

(a) Contactor RL1 is energised via the interlock circuit. Contacts RL1 a to c close the power circuit to the primary of TR1.

(b) Relay RL2 is the overload relay, and is connected in parallel with R3 to R5 in the earth return for the 500V supply. It will operate on overload and contacts 2 and 3 of RL2 de-energise RL1.

(c) Relay RL3 switches the supply to test equipment. The 50V supply for RL3 is completed via SW6 in the pulse generator (MA). Contacts 2, 3 and 22, 23 of RL3 switch unstabilized +500V to the monitoring unit (L).

+2.5 k V Power Unit (B).

234. This unit is fitted below the voltage stabilizers, and consists of a conventional full wave rectifier with a smoothing circuit. A voltage metering point is provided from the bleeder network via PL1/5 to the monitoring unit (L). The regulated supply is fed via terminals PL1/2 and 4 directly to the heater transformer TR2 and to the EHT transformer TR1 via contacts a and c of RL1. The contacts are closed when RL1 is energised via the interlock circuit. Relay RL2 is the overload relay which opens contacts 21 and 22 of RL2 when excessive current is drawn connected in parallel for 300V output and in series for 150V output. The alternative connections are made by the sockets in the beacon cabinet, so the regulator automatically produces either 300V or 150V according to the position in which it is placed. The circuit references can be seen in fig. 46.

238. The 500V supply from unit A is fed from PL1/13 through the overload relay RL1 and its shunts R17 to 19 before going to the regulating circuits. If excessive current is drawn RL1 operates and performs two functions:-

(a) Contracts 1 and 2 break the 500V interlock circuit causing unit A to be switched off.

(b) Contacts 22, 23 cause RL2 to operate, which locks on its own contacts 22, 23, while its contacts 2, 3 cause the appropriate overload indicator lamp in the monitoring unit (L) to light. RL2 remains operated until the reset switch in the monitoring unit is depressed.

239. The valve heaters are supplied by TR1 which has three separate windings because the three valve cathodes are at widely different potentials.

240. The principle of operation is as follows. The impedence of the series regulator valve (or valves) is varied by a suitable control grid potential so as to maintain constant output voltage. If the output voltage rises the series valve (s) grid voltage is lowered thus increasing impedence, hence the output voltage is corrected. Since the required grid signal is anti-phase with the output voltage variations it may conveniently be obtained by a single stage d.c. amplifier whose grid is fed with the difference between the output and a standard voltage. The higher the gain of this amplifier the better the regulation and the lower the output impedence.

241. In this regulator V1 and V2 are the series regulators and V3 is the d.c. amplifier. When the unit is in the 300V position V1 and V2 are in parallel and both grids are controlled by V3 anode. When in the 150V position V1 and V2 are connected in series and only the grid of V2 is controlled by V3 anode, and the grid of V1 is set by potentiometer chain R6 R11 to half the input voltage. The cathode of V3 is stabilized at +80v by neon reference valve V4 which is shunted by C3 to by-pass the higher frequencies at which the neon impedence is not negligible. V3 is fed with two voltages. The first is a fraction of the output voltage via potentiometer chain R13, R14, R15, RV1, R16 for 300V and R15, RV1 and R16 for 150V. In each case C1 connects the higher frequencies present in the output directly to V3 grid thus partially compensating for the loss of gain of V3 at these frequencies. Secondly about 1 per cent of the input voltage from potentiometer chain R2, R3, part of RV1 and R16 is fed to V3. This gives almost perfect compensation for variations in input voltage. The two voltages are fed to V3 grid via stopper R9. The anode load fed from the output line is fairly low to avoid phase shift at the higher frequencies. Since V3 cathode is held at 80V the regulating action will keep its grid, hence RV1 slider at a volt or two below this. Hence varying RV1 will vary the fraction of the output voltage that is equal to 80v and this will vary the output voltage. It gives sufficient control to permit the output to be set to 300V or 150V despite the effects of tolerances on component valves and valve characteristics.

-150V Power Unit (J).

242. This power unit is mounted on the same chassis as the +250V power unit (K). The unit contains 4 valves and the circuit references can be seen in fig. 47. Transformers TR101 and TR102 are fed from phase 3 regulated and neutral via PL101/2 and 4. TR102 is the heater transformer and TR101 provides H.T. to the full wave rectifier V101. V104 is a cold cathode, gas filled, 85V reference voltage valve. V103 is a double triode control valve with its grids connected to a potentiometer network R107, RV102 and R108. V102 is the series control valve which regulates the output voltage by means of its internal impedence. The circuit is conventional providing a regulated -150V output at a maximum current of 200 mA.

243. The positive output from the regulating circuit is earthed via R106 and RL103 which are in parallel RL103 is the overload relay which operates the warning circuits when excess current is drawn from the power unit. RL103 contacts 21 and 22 de-energise contactor RL101 and the power is removed from TR101 primary winding. Relay RL102 is energised when the -150V becomes available. Contacts 22 and 23 of RL102 close an interlock circuit which allows the 500V power unit (A) to be operated.

+250V Power Unit (K).

244. The unit is mounted on the same chassis as the -150V power unit (J). The output is norminally 250V at 2.5 amps and is used for the klystron field coils. The circuit functions in conjunction with a 3-phase transformer T8 and a smoothing choke H1. Circuit references can be seen in fig. 47.

245. The circuit consists of three xenon filled thyratron valves V1 to V3, a heater transformer TR1 fed from phase three regulated and neutral and three control relays RL1 to RL3. When the system is switched on contactor RL1 becomes energised. This causes RL1 a to c to close the primary circuit to the delta winding of T8. The outputs from the star winding of T8 are connected to PL1/1, 5 and 3. V1 to V3 rectify these supplies, and the output is smoothed by H1 and capacitors C5 and C6. Valves V1 to V3 have their grids individually controlled by balancing and current control potentiometers RV1 to RV3 respectively, which can be adjusted to fine limits. The potentiometers are fed with a negative voltage from R15 in the output circuit and apply a proportion of this voltage to the valve grids for current control.

246. The current is fed from choke H1 back to PL1/2 and further smoothing is provided by capacitors C1 to C4 which are bled by R16. The 250V d.c. supply is now fed to the output terminal PL2/5 via RL2 with R5 to R7 in parallel, RL3 in parallel with R8, and R1 to R4 in parallel. RL2 is the overload relay which only operates when the current drain becomes excessive, contacts 22 and 23 of RL2 then de-energise contactor RL1. RL3 is the interlock relay which is energised when the power output becomes avilable.

-15kV Power Unit (N).

247. This unit is mounted immediately below the modulator (O) in the right-hand cabinet. The high voltage components are mounted on an insulating gantry. When in position, the unit is fronted by a perforated metal screen with a highed door opening upwards. Both electrical and mechanical interlocks are operated by this door as a safety device. When the screen is opened, the electrical interlock removes the main power input to the unit via SW1 and relay RL1. At the same time a mechanical arm is released which operates SW101 placing R102 across the capacitor bank C101 to 104. All high voltage parts are shaped to reduce corona. Circuit references can be seen in fig. 48.

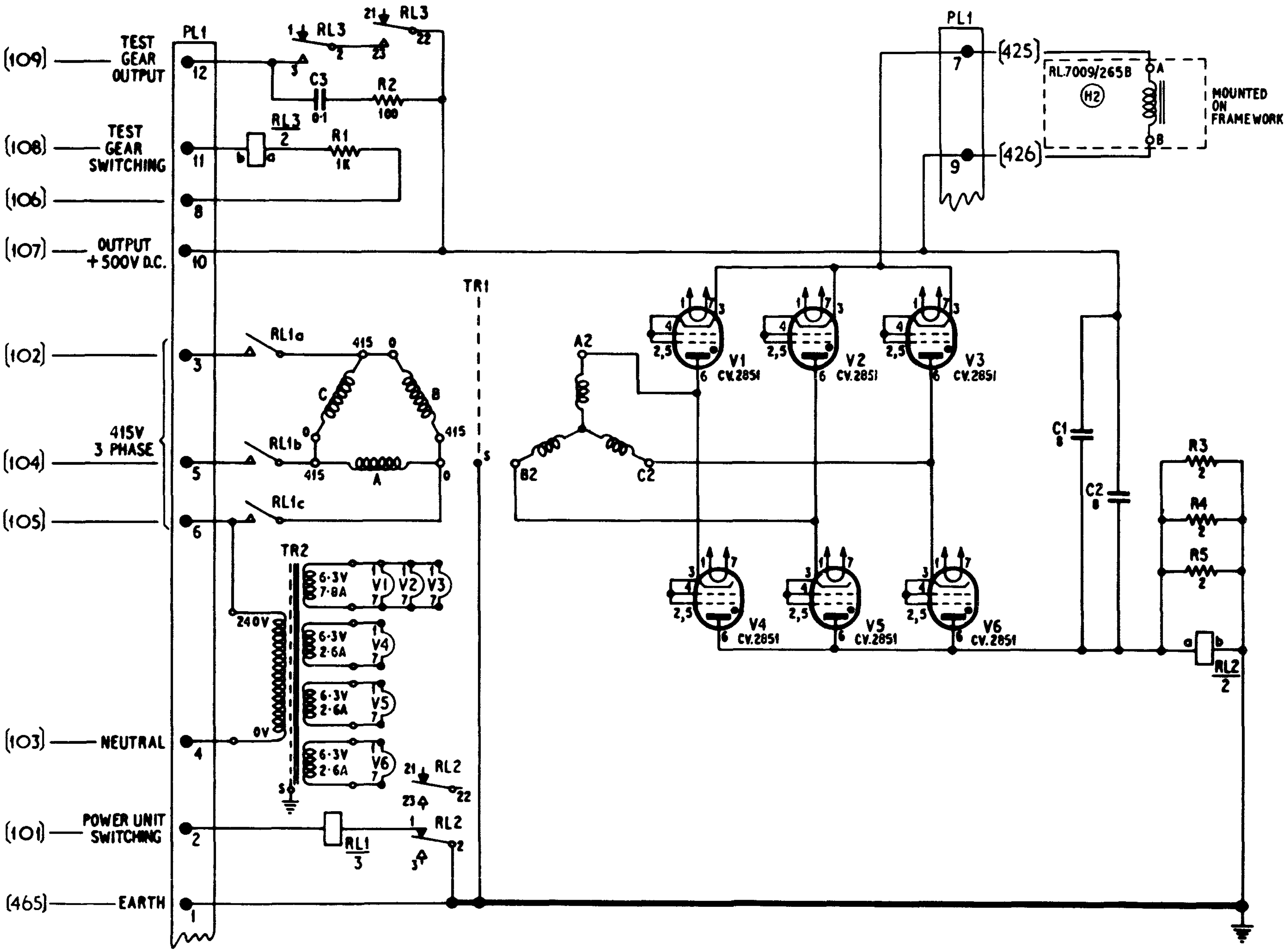
248. The power unit is fed from a 3-phase transformer which has a delta primary and a star secondary; the transformer is of the "c" core type with the actual coils only in resin cast form. V1 to V6 are conventionally connected to form a 3 phase, full wave rectifier providing a nominal 15 kV supply. Each valve has a series limiting resistor in its anode circuit R4 to R9. A metering potential is provided by potentiometer R15, R16 and fed out to control unit (W). The earth return is completed via RL6 with R23 in parallel, RL3 with R13 in parallel, and R14. RL6 is the "no - current" relay whose contacts 22 and 23 close the circuit to RL1, RL3 is the overload relay which opens the circuit to RL1 and RL7 when the current drain becomes too great. Resistor R14 is used for current metering in the control unit (W).

249. The power is switched on to transformer TR3 in two stages. First the interlock line must be complete before RL7 and RL1 can be energised, via contacts 22 and 21 of RL3 and SW1 for RL7, and further via contacts 21 and 22 of RL5 for RL1. Contacts 22 and 23 of RL7 close the circuit to thermal delay relay RL4 via contacts 2 and 1 of RL5, R17 and terminal PL1/11. When RL1 is energised contacts RL1a to c close and switch power to the primary of TR3 via R1 to R3. After the delay period of RL4, the thermal contact closes, RL5 is energised and locks itself in the energised condition via contacts 2 and 3, and simultaneously contacts 1 and 2 open the circuit to RL4. Contacts 22 and 23 of RL5 energise RL2 and resistors R1 to R3 are short circuited by contacts RL2 a to c. This action applies power in two stages; after the first stage the power output available energises relay RL6 and

contacts 22 and 23 of RL6 hold RL1 energised. RL6 is the "no-current" relay whose contacts 22 and 23 may be overridden by SW2. Should an overload occur the overload relay RL3 is energised and contacts 22 and 23 cause both RL7 and RL1 to become de-energised, thus switching off the power to TR3 and de-energising RL6, RL5 and RL2.

250. The valve heaters are fed from transformer TR1 which is fed from phase three and neutral. This supply also feeds TR2 which feeds both heater voltage and power to the full wave rectifier V7. The rectifier circuit provides about 200V to the modulator as a hold off bias for the klystron. This d.c. potential is metered by M1 and smoothed by network C1, R20, R21. The klystron heater is also fed from TR2.

RESISTORS	R1 R2 R3,R4,R5
CAPACITORS	C3 C1 C2
VALVES	V1 V4 V2 V5 V3 V6
MISCELLANEOUS	PL1 RL3 RL1a,RL1b,RL1c TR2 RL1 TR1 PL1 RL2



SRI. 18118, FGRI. 18119
+500V power unit (A)-circuit

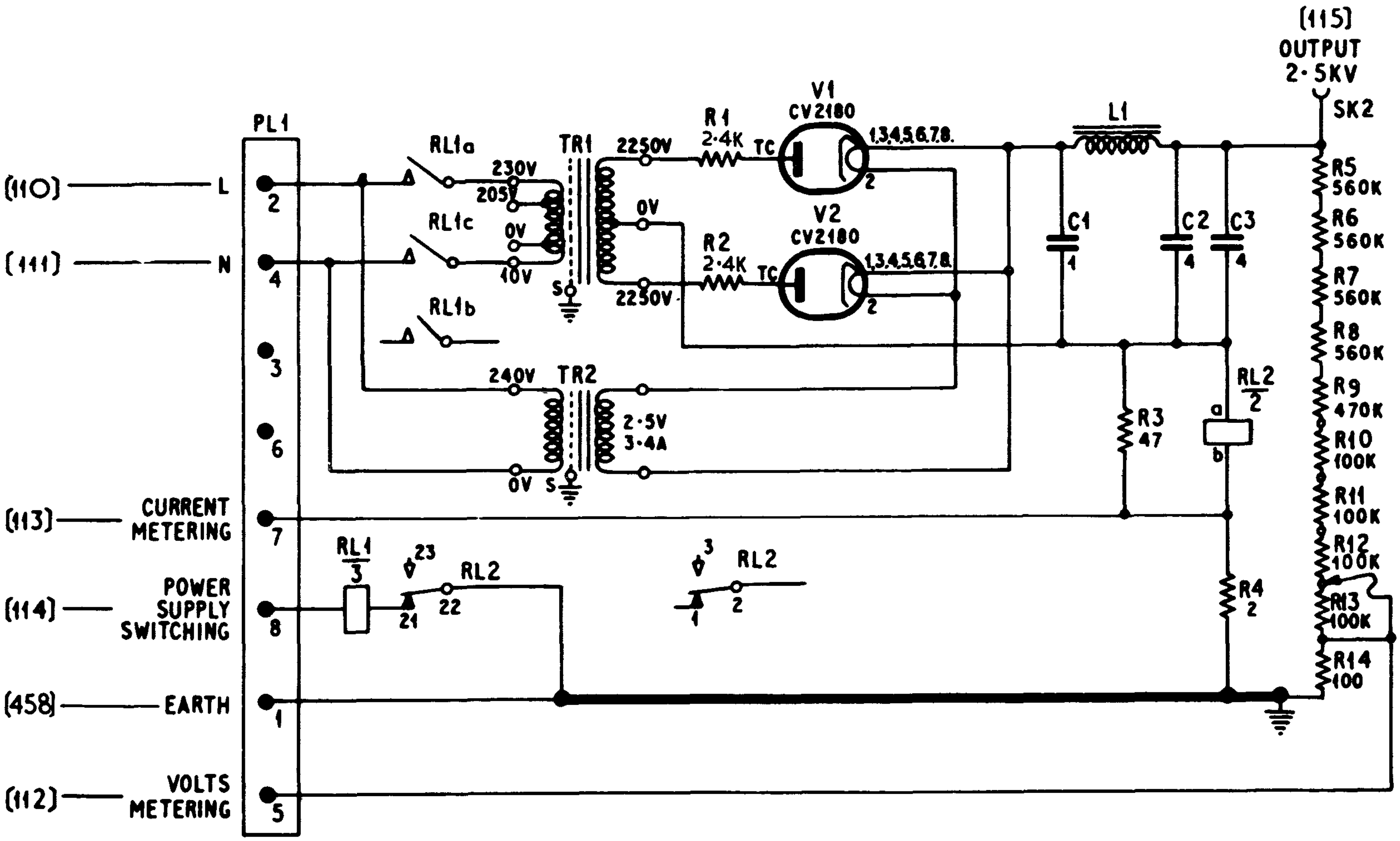
Fig.2

AIR DIAGRAM 6264Y/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

(A.L.5, Oct.58)

7938 342376 11/58 637+500 C B & S LTD GP 924

RESISTORS								R1 R2				R3		R4		R5 R10	R6 R11	R7 R12	R8 R13	R9 R14
CAPACITORS											C1		C2	C3						
MISCELLANEOUS	PL1	RL1	RL1a	RL1c	RL1b	TR1	TR2		V1	V2		L1			RL2	SK2				



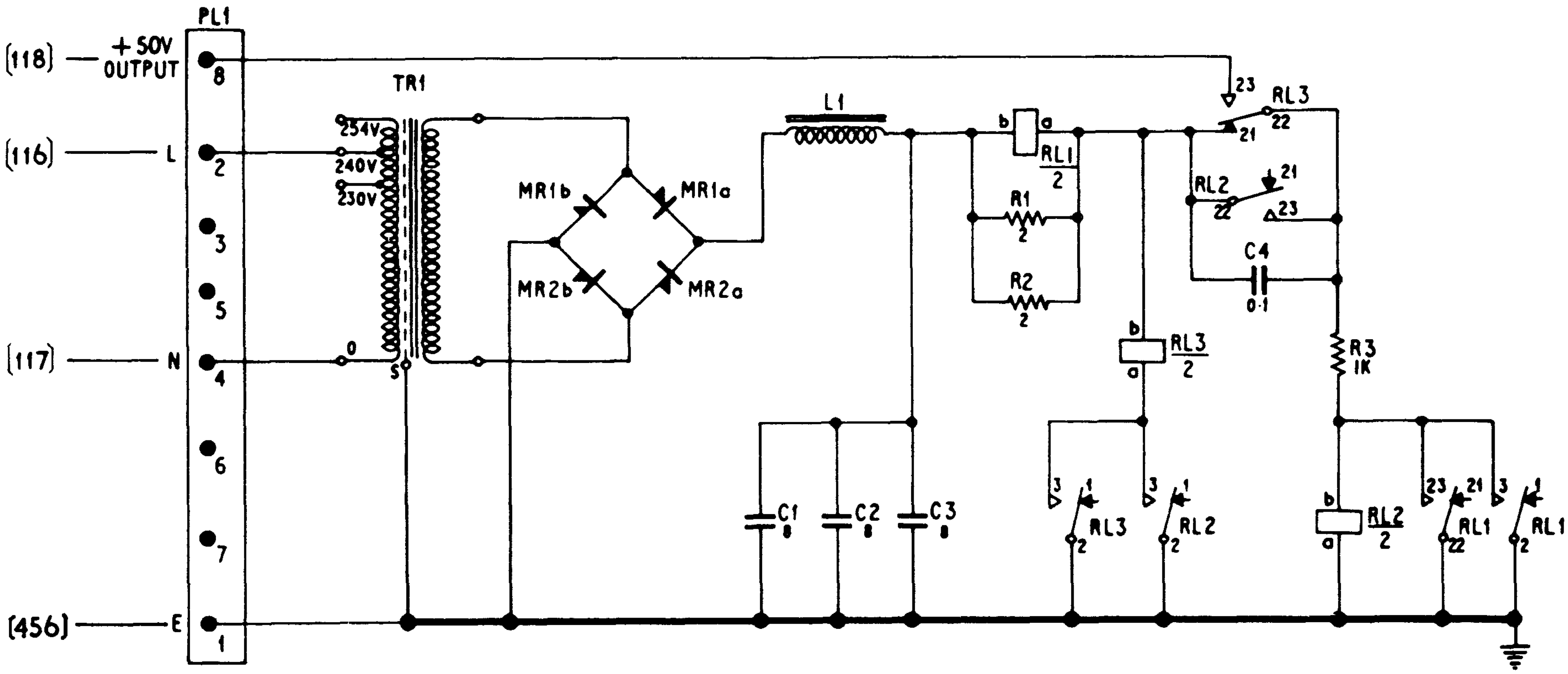
AIR DIAGRAM 6264Z/MIN.
ISSUE 2 — PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119 +2·5KV power unit (B)-circuit

Fig. 3

924/8/7382/64026/1005/1/62 J. T. & S.

RESISTORS									R1	R2			R3
CAPACITORS					C1	C2	C3					C4	
MISCELLANEOUS	PL1	TR1	MR1	MR2		L1		RL1			RL3		RL2



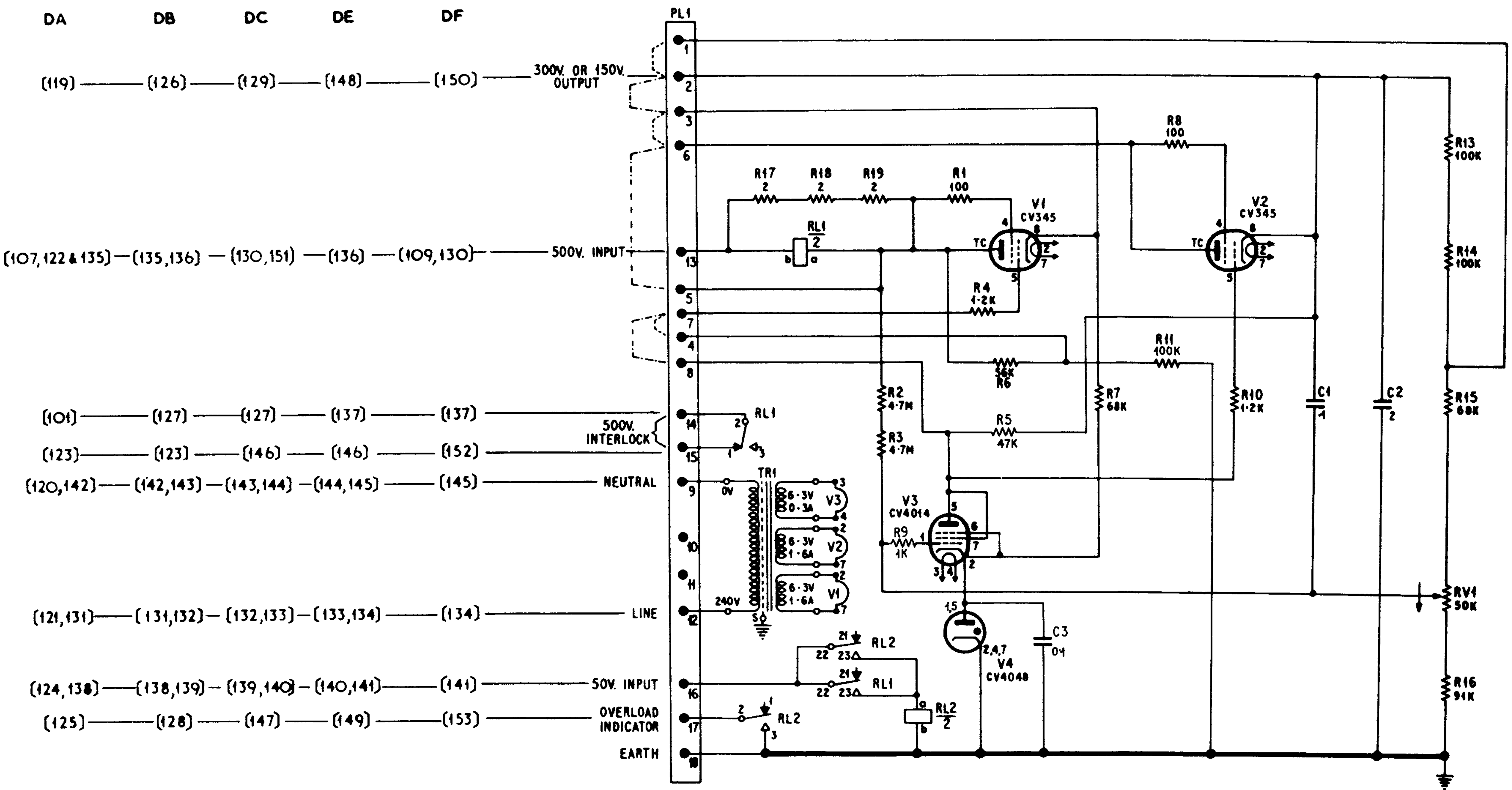
SRI 18118, FGRI 18119
+50V power unit (C)-circuit

Fig. 4

AIR DIAGRAM
6264K/MIN.
ISSUE 1
PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

7838 342376 11/58 637 + 500 C.B & S. LTD GP 924

RESISTORS		R17	R18	R19 R2	R9 R3	R1 R5	R4 R6	R7	R8 R11	R10			R13 R15 RV1 R14 R16
CAPACITORS								C3			C1	C2	
MISCELLANEOUS	PL1	TR1		RL1	RL2 V3 V4	V1				V2			



WHEN IN USE FOR
(1) 300V OUTPUT, EXTERNAL CONNECTIONS ARE SHOWN THUS —·—·— POSN'S DA, DB, DC.
(2) 150V OUTPUT, EXTERNAL CONNECTIONS ARE SHOWN THUS - - - - - POSN'S DE, DF.

SRI. 18118, FGRI. 18119

+300V or +150V voltage stabilizer (D) - circuit

Fig.5

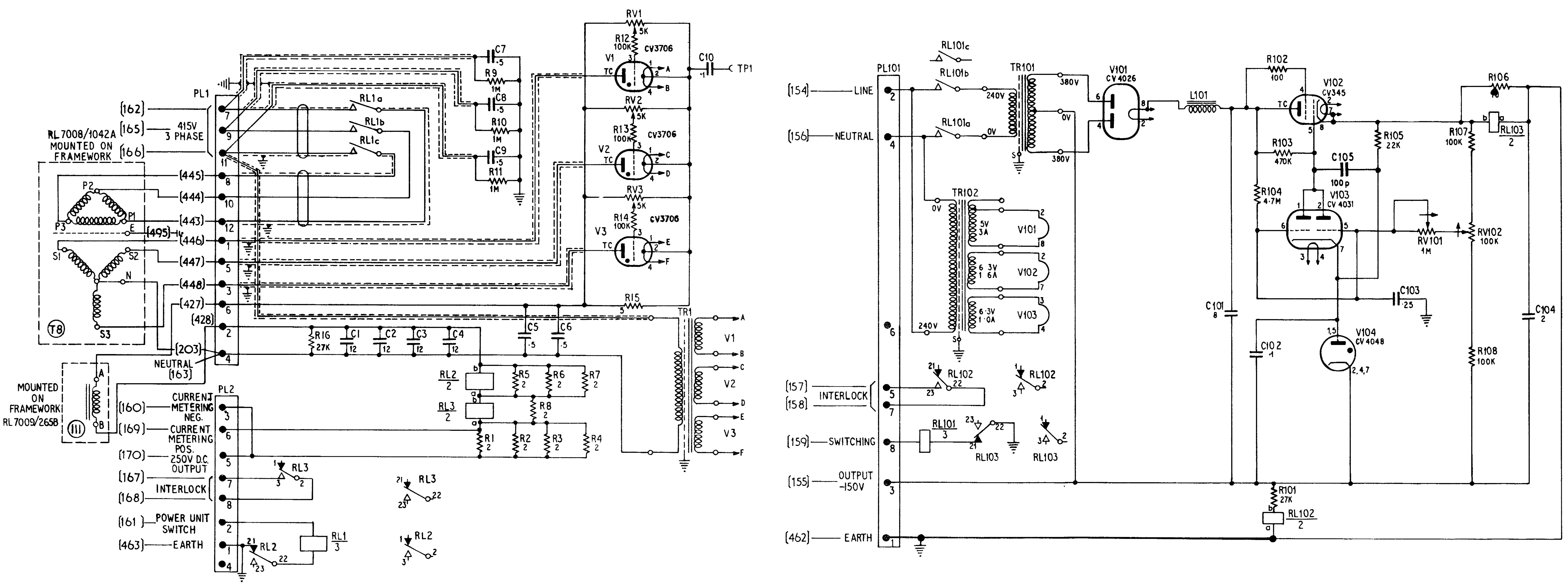
AIR DIAGRAM 6264M/MIN.

ISSUE 1 — PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

(A.L.5, Oct.58)

7938 342376 11/58 637+500 C.B. & S. LTD. GP924

RESISTORS	R16 R1 R9 R10 R11 R5 R2 R8 R6 R3 R7 R4 R12 R13 R14 R15 RV1 RV2 RV3 R104 R102 R103 R101 R105 RV101 R107 RV102 R108 R106
CAPACITORS	C1 C2 C3 C4 C7 C8 C9 C5 C6 C10 C101 C102 C105 C103 C104
MISCELLANEOUS	PL1 PL2 RL1 RL1a RL1b RL1c RL2 RL3 V1 V2 V3 TR1 TP1 PL101 RL101c RL101b RL101a RL101 TR102 TR101 V101 L101 RL102 V102 V103 V104 RL103



SRI. 18118, FGRI. 18119 — +250V and -150V power unit (K and J) - circuit

Fig.6

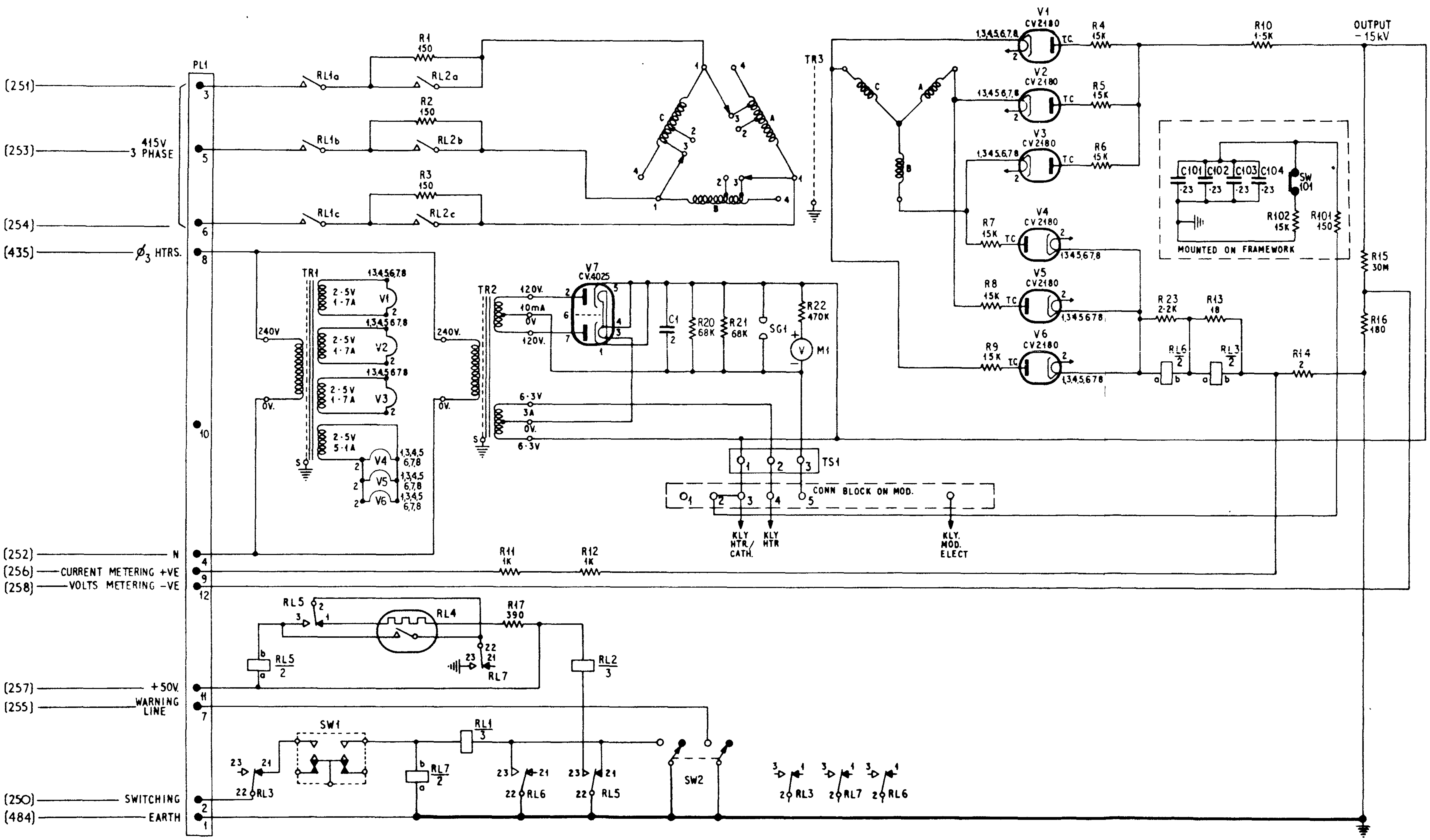
AIR DIAGRAM 6264X/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

7938 342376 11/58 637+500 C.B.&S.Ltd GP924

RESISTORS — R1 R2 R3 — R11 R17 — R12 — R20 R21 — R22 — R7 R8 R9 — R4 R5 R16 — R23 — R13 R10 R102 R14 R101 R15 R16

CAPACITORS — C1 — C101 C102 C103 C104

MISCELLANEOUS — PL1 — RL5 — TR1 RL1a RL1b RL1c RL2a RL2b RL2c TR2 — SW1 RL4 RL7 RL1 — V7 — RL2 — SW2 — SG1 M1 TR3 — TS1 — V1 V2 V3 V4 V5 V6 — RL6 — RL3 — SW101



AIR DIAGRAM 6264L/MIN.

ISSUE 1

PREPARED BY MINISTRY OF SUPPLY FOR PUBLICATION BY AIR MINISTRY ADMIRALTY

SRI. 18118, FGRI. 18119 — –15KV power unit (N) - circuit

Fig. 7

(A.L.5, Oct. 58)

7938 842376 11/58 637+500 C B & S Ltd GP924

BUILT IN TEST EQUIPMENT.

251. The beacon is equipped with sufficient built-in test units to enable all alignment and fault finding operations to be carried out without using external test equipment except for a multimeter. The items of test equipment are:-

(a) Pulse Generator Unit (MA)

(b) Monitoring Unit (L)

(c) R.F. Signal Generator Unit (MB)

(d) I.F. Signal Generator (MC)

(e) Thermistor Unit (U)

252. Pulse Generator Unit (MA). This unit is used to check the performance of the beacon by comparing pulse sequences produced by the beacon with pulse sequences (crystal controlled) produced by the generator. It can also be used, in conjunction with the R.F. signal generator, to simulate a/c interrogation pulses and check the beacon response.

253. Monitoring Unit (L). The following facilities are provided by this unit:-

(a) Voltage and current meter readings of all D.C. power supplies.

(b) Overload indication lamps for the 500V, 300V and 150V D.C. supplies. Once lit these indicators remain alight until the indicator reset switch is depressed.

(c) The focus, brilliance and astigmatism controls for the C.R.T.

(d) Time base and gating circuits in a time-base sub-unit. There are five time base speeds available and control is from the pulse generator unit (MA).

(e) Video amplifier and Y shift sub-unit controlled from the pulse generator unit (MA).

(f) Inspection lights switch.

254. R.F. Signal Generator (MB). This unit provides facilities to:-

(a) Generate R.F. signals tunable from 962 to 1213 mc/s.

(b) Modulate the R.F. output signals for C.W., square wave or pulse transmission.

(c) Control H.T. and bias supplies to the I.F. signal generator.

(d) Control amplitude of output signals using a calibrated attenuator.

255. I.F. Signal Generator (MC). Used to check the performance of the beacon I.F. amplifier and the associated Ferris discriminator. A three position switch selects output frequencies of 62, 63, or 64 Mc/s. The output stage H.T. is pulse controlled by signals from unit MA thus the output signals are pulse modulated I.F.

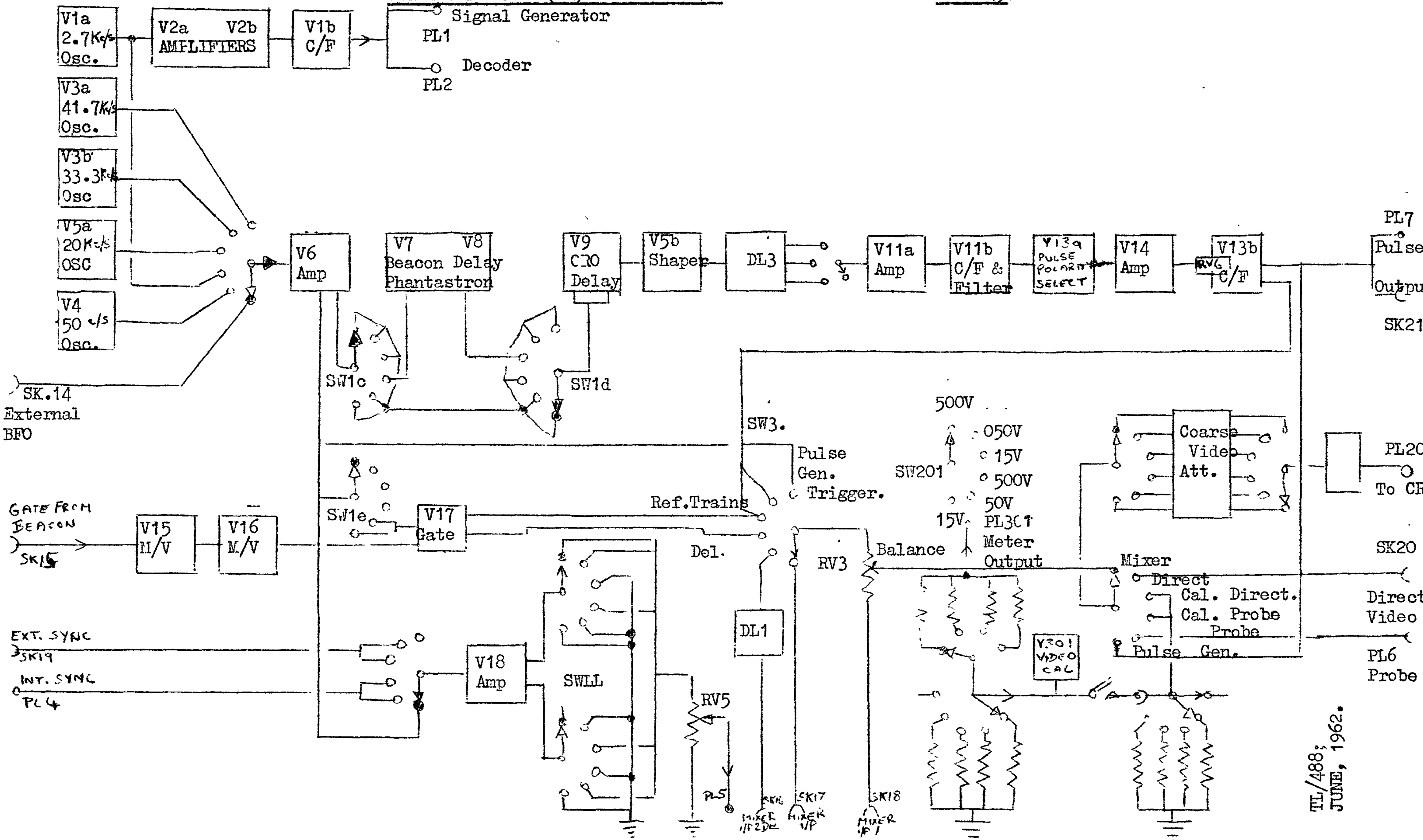
256. <u>Thermistor Unit (U)</u>. Is mounted on the duplexer unit in the right hand beacon cabinet. Is used to check:-

(a) R.F. power.

(b) During signal/noise checks.

(c) To check R.F. signal generator output.

PULSE GENERATOR (MA) - BLOCK DIAG. FIG. 49.



TL/488, JUNE, 1962.

257. Pulse Generator Unit MA. Four crystal controlled oscillator circuits can be selected by switch 1 which is the P.R.F. selection switch. The six positions of this switch select the following functions:-

(a) Pos. 1. EXT. B.F.O. Signals from and external oscillator may be fed to pulse forming circuits via input socket SHI4.

(b) Pos. 2. 150 c.p.s. A free-running multivibrator (V4) generates signals of approximately 150 cps. which are fed to the pulse forming circuits. The generator output is used to simulate interrogation pulse pairs from an airborne equipment in the "search" condition.

(c) Pos. 3. 2.7 Kc/s. A crystal controlled signal from V1a is fed to the pulse forming circuits and to the R.F. and I.F. signal generators. This position is used when checking signal to noise ratio. The output from V1a is fed continuously to the beacon video decoder unit to check the squitter rate when required.

(d) Pos. 4. 20 Kc/s. The time base unit is triggered at a P.R.F. of 20 Kc/s while the beacon is interrogated at 2.5 Kc/s. This position is used to check the 50 micro second beacon delay.

(e) Pos. 5. 33.3 Kc/s. A crystal controlled pulse train generated by V3b is used to check the 30 microsecond spacing of the North reference train.

(f) Pos. 6. 41.7 Kc/s. A crystal controlled pulse train generated by V3a is used to check the 24 microsecond spacing of the Harmonic reference train and for checking the 12 microsecond spacing of the beacon pulse pairs.

P.R.F. Selection Switch (SWI) and Associated Circuits.

258. Selection of the generator P.R.F. is obtained by a six position 5 wafer switch.

The wafers control the following functions.

(a) SW1a switches 150V. H.T. to the appropriate oscillator, V3a, V3b, V4 or V5a.

(b) SW1b switches the selected input to the first amplifier and shaper V6.

(c) SW1c and SW1d are effective only in Pos. 4, when they bring the count down phantastron (V7, V8) into the pulse forming circuits.

(d) SW1e is effective in positions 5 and 6 only. It switches the appropriate pulse train to the gating valve V17.

259. Switch and Circuit Action. SW1 in position one connects SK14 (Ext. B.F.O.) to the grid of shaper valve (V6a) via C33 andR92. The amplified and squared output is connected via C34 and R94 to V6b where it is further amplified. The anode load of V6b is a transformer (TR2) with a low R.F. response. This component differentiates the square wave and produces the triggers which are fed.

(a) From V6b anode via C60, SWIc and SW1d, C12 and MR9 to V9 grid.

(b) From TR2 secondary via C40, SW1e to V17, gating amplifier.

(c) From TR2 secondary to SW3 (mixer 1/P.1).

(d) From TR2 secondary to V18 (sync. Amplifier) via SW4c.

260. Swith 1 in position 2 connects the output of a free-running multivibrator (V4) via SW1b, C33, R92 to the shaper stage V6. The natural frequency of the symmetrical square wave output from V4 is 150 c.p.s. The output from V6b is fed via C60, SW1c, SW1d, C12 and MR9 to V9 the C.R.O. delay stage.

261. SW1 position 3 connects the output of a crystal controlled oscillator V1a to shaper circuits V6. V1a circuit forms a flexural cyrstal oscillator with a frequency of 2.7 Kc/s. The output waveform is rectified by MR1, filtered by C54, R3, R4 and C2 to provide the oscillator valve grid bias. V1a output signal is fed via SW1b to the shaper circuit V6. and thence to CRO delay stage V9. The output from V1a is also fed to V2a, shaper amplifier via C28, R77. V2a output is further shaped by V2b. The anode load of V2b is TR1, a poor H.F. response transformer, which produces the sharp triggers at 2.7 Kc/s which are cathode followed by V1b to:-

(a) R.F. Signal generator unit (MB)

(b) Video decoder unit (XC)

The signal to the video decoder is used to check beacon squitter rate at 2.7 Mc/s.

262. SW1 in position 4 connects the output of a crystal controlled oscillator V5a to shaper circuit V6. V5a circuit forms a flexural crystal oscillator with a frequency of 20 Kc/s. MR4, R12, R11, C6 form the bias circuit. The 20 Kc/s signal is fed via SW16, C34, R94 to shaper circuit V6. V6 output is fed via SW1c and SW1d to the count down phantastron V7 and V8. This circuit produces square pulses at a P.R.F. of 2.5 Kc/s. The square waves are differentiated by C23, C55 to produce the short trigger pulses fed to the CRO delay circuit V9.

263. SW1 in position 5 connects the output of a crystal controlled oscillator V3b to shaper circuits V6. V3b circuit forms a flexural crystal oscillator with a frequency of 33.3 Kc/s. MR3, R11, R12 and C6 form the bias circuit. The signal produced by V3b is fed via SW1b to V6 shaping circuit. The trigger from TR2 is fed to V17 grid via C40 and SW1e.

264. SW1 in position 6 connects the output of a crystal controlled oscillator V3a to shaper circuit V6. V3a circuit forms a flexural crystal oscillator with a frequency of 41.7 Mc/s. MR2, R8, R7 and C4 form the bias circuit. The signal produced by V3a is fed via SW1b to V6 and V6 output is fed to V17 grid via C40 and SW1e.

265. V17 gating stage and gate production circuits. When the pulse generator is used to check North and Harmonic reference trains a negative trigger from TP3 or TP8 on the Marker gate generator is used to initiate the gate to the suppressor of V17. Negative going triggers are fed via SK15, C48, MR17 to V15 a monostable multivibrator. V15a is normally conducting because its grid leak R101 is returned to the common cathode load. V15b is held cut off by the voltage developed across R98. The positive going gate produced by V15a is differentiated by C37, R102 and fed to V16 via MR18 (a series negative limiter) V16 is a cathode coupled multivibrator whose output, a positive going square wave is used to gate on V17 for a fixed period. The square wave duration is controlled by RV9 which is adjusted so that 12 pulses of the 33.3 Mc/s train or 6 pulses of the 41.7 Mc/s train are passed through the gating stage V17. V17 output is fed from TR3, the anode load to mixer switch 3. With this switch in the Reference trains position the pulse generator train can be compared with the beacon reference train and the beacon train checked for discrepancies.

Main Pulse Shaping and Output Circuits (V9 to V14).

266. These circuits perform the following functions.

(a) Delay the pulse trains in the monostable multivibrator stage V9. The delay can be varied between 4 microseconds and 60 microseconds.

(b) Selects either single or pulse pairs by the introduction of a delay line by use of Pulse separation. switch (SW2)

(c) Shapes the pulses by filtering out the high harmonics in a low pass filter circut and amplifiers V11a, V11b and V12.

(d) Selects pulse polarity (SW7) in stage V13a.

(e) Amplifies and sets the output level in the final stages V14 and V13b.

267. V9, a double triode, is a monostable multivibrator whose purpose is to produce a variable delay in the main pulse shaping circuits. This provides a pre-trigger facility for the monitoring unit 1 time-base which is fed via circuits with no artificial delay. V9a is normally conducting V9b cut off. The negative trigger to V9a grid fires the multivibrator producing a negative going square wave at the cathode load whose duration is controlled by RV2 (C.R.O. delay). This waveform is differentiated by C14, R32 and the positive spike co-incident with the trailing edge is fed via negative series limiter MR5 to V5b a cathode follower. MR6 short circuits the negative spikes of differentiation. The positive going spikes are fed to V11a grid:-

(a) Via C17, MR10 (positive D.C.R.), MR13 (negative series limiter).

(b) Via delay line DL2 (with SW2 in appropriate position), C16, MR 11 (positive D.C.R.) MR12 (negative series limiter).

Thus dependant on position of SW2, the following negative going pulse combinations can be produced at V11a anode.

(a) Single pulses.

(b) Pulse pairs separated by 10.5, 11.0 and 11.5 microseconds.

The delays produced by SW2 produce an overall delay of 12 $\pm$ 0.5 microsecs after the subsequent stages have added an additional delay. When DL2 is switched into circuit two dissimilar negative going pulses are produced at V11a anode. These pulses are fed via C19 and MR14 (positive series limiter) to trigger V12, a monostable multivibrator. V12 output is two positive going pulses of similar shape and amplitude and whose width is set by RV4. These pulses are cathode followed by V11b to the low pass filter circuit (L1 to L3, C22 to C24, R59, R61). MR7 in V11b grid circuit is a positive D.C.R. The cathode follower provides a low impedance matched input to the filter. MR15 in the filter limits the "rest" potential to earth. The low pass filter removes the higher harmonics and produces the gaussian shape required. The filter output is fed to V13a, a phase splitter. Output is taken from V13a anode or cathode dependant on the position of the polarity select switch (SW7). The selected pulse is amplified by V14 and fed via C27, RV6 to cathode follower V13b. RV6 is the pulse amplitude control. V13b outputs are fed to:-

(a) R.F. signal generator unit MB via PL7.

(b) Pulse generator output terminal SK21.

(c) Video input select switch (SW202) via PL206.

(d) Mixer switch (SW3) contact 5.

Video Mixing Circuit.

268. The purpose of SW3 is to select any one of five signals to be mixed with the signal from Mixer I/P 1 socket (SK18). Signals fed in at SK18 are fed via C43 to the bottom of RV3. Signals from the test switch are fed to the top of this potentiometer which is used to control the relative amplitudes of the signals fed to the display for comparison and checking. The wiper of RV3 is connected to the Video input select switch (SW202).

SW3 positions. Pos. 1. Direct. Signals from external source are fed to the top of RV3 via mixer I/P2 socket (SK17).
Pos. 2. Delayed. Signals from an external source are fed to the top of RV3 via mixer I/P2 delayed socket (SK17) and DL1, a delay line with a delay equivalent to that of the aerial feeder on the beacon.
Pos. 3. Reference Trains. The pulse generator produced reference trains are fed to RV3 from the gated amplifier V27.
Pos. 4. Pulse Generator. The shaped pulses from V13b are fed to RV3.
Pos. 5. Pulse Generator Trigger. The pre-trigger pulses from TR2 in V6 circuit are fed to RV3.

Monitor Sync. Selection Switch (SW4).
269. The sync. select switch selects the input to and the output from V18 the sync. amplifier. V18 is a cathode biased amplifier which, with its associated circuit and SW4 produces a sync. pulse of positive polarity for any input sync. pulse. SW4 positions are:-

(a) Pos. 1. Pulse generator. Triggers at the pulse generator set P.R.F. are fed to V18 from TR2 in V6 circuit via SW4C. V18 output from TR4 is fed via SW4a, RV5 and PL5 to the Monitor time base unit. RV5 is the sync. amplitude control.

(b) Pos. 2 +ve Internal. The video signal for display is also used to sync. the time base. It is fed from V102 circuit in the main video amplifier (Mon. Unit L) via PL4 and SW4c to V18. Output connections are as for Pos. 1.

(c) Pos. 3 +ve Internal. Identical to Pos. 2. except that the output pulse is taken from the opposite end of TR4 to maintain a positive output trigger pulse.

(d) Pos. 4 +ve External. An external source Trigger is fed to V18 via SK19 and SW4c. The output trigger is taken from TR4 via SW4a.

(e) Pos. 5 -ve External. Same as Pos. 4 except that the output trigger is taken from the opposite end of TR4 via SW4b to the monitor time base.

(f) Pos. 6 off. No input signal fed to V18 and both ends of TR4 secondary are earthed by SW4'a' and 'b' segments.

Video Amplifier Attenuator.

270. This unit forms a sub-assembly of the pulse generator unit. The following inputs are selected by the video select switch (SW202).

(a) Pos. 1. Mixer. Signals from the Mixer balance potentiometer RV3, fed via SK26 and PL203.

(b) Pos. 2. Direct. Signals connected to Direct video socket (SK20).

(c) Pos. 3. Cal Direct. Signals from the video calibrator amplitude unit fed via PL.304 and PL206. SW202a completes the circuit of the switching relay (RL301) in the calibrator sub assembly. Used to calibrate the display for pulse amplitude measurement.

(d) Pos. 4. Cal. Probe. Signals from the calibrator are fed via R201, C202 to produce the same attenuation as in the test probe position.

(e) Pos. 5. Test Probe. Signals from the probe unit fed via PL6, SK24 and PL201. The probe impedance can be checked against readings obtained in position 4.

(f) Pos. 6. Pulse generator. Signals from shaping circuits output stage V13b fed via SK25, PL202 and an attenuator network consisting of C220, R231, C224 and C225.

The output from SW202 is fed via video attenuator course switch (SW201) which selects various C. and R. potential divider networks for different values of attenuation. Signals are then fed to the video attenuator fine circuit V201.

271. The video attenuator fine control (RT201) is connected between the cathodes of the dual triode valve V201, a cathode follower pair. The grid of V201a is earthed while signals are fed to V201b grid. Maximum signals are therefore developed across RV201. By adjustment of RV201 the required amplitude of signal can be produced. The action of V201a prevents and D.C. voltage changes being fed via the direct coupling to the amplifier V101 in monitoring unit L.

Video Amplitude Calibrator Unit.

272. The calibration sub-unit is a peak voltage calibrator in which a square waveform is generated and used to calibrate the display for pusle amplitude measurement. The 300V H.T. and 6.3V A.C. supply for the carpenter relay RL302 are completed by the contacts of RL301 which is energised when SW202, video input select switch, is switched to the cal. probe or cal. direct positions. V301, a pentode, functions as a variable resistance whose value is controlled by SW301; which alters the resistance values in the cathode and screen circuits, and RV301 which is a fine control of screen potential. When the carpenter type relay is energised its contacts open and close at supply frequencys varying the amount of resistance in the cathode circuit of V301 by switching an extra resistance in and out of parallel with the existing cathode resistor. A symmetrical square waveform is produced whose amplitude can be varied by SW301 or RV301. The square wave amplitude is shown by meter M3 or the monitoring unit L. and by manipulation of the calibrator controls and attenuator controls on the pulse generator the squares on the graticule over the C.R.T. can be made to represent a given number of volts.

S.R.I. 18118, F.G.R.I. 18119 pulse generator (MA) circuit

Fig. 2

AIR DIAGRAM
6264S/MIN.
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Monitoring Unit L.

273. Provides the following facilities.

(a) Voltage and current meter checks of beacon D.C. power supplies.

(b) Overload indications of D.C. supplies.

(c) Display C.R.T. with Focus, Brilliance and astigmatism controls.

(d) Time base and gating circuits.

(e) Main video amplifier and '7' shift circuits.

274. Metering circuits:-

The three meters on the front panel provide the following information.

M1. D.C. power supply voltage switched by SW3, segments a to c.

M2. D.C. power supply currents switched by SW3 segments d to f.

M3. shows peak amplitude of signal from the calibrator unit in MA.

275. Overload warning circuits. These circuits are energised from the 50V supply. The 500V D.C. bulk supply is distributed on three different routes each one of which includes and overload relay and an associated warning relay and indicator lamp. The 300V and 150V D.C. supply circuits are similarly fitted. If an overload should occur the appropriate overload relay operates, breaking the D.C. supply and energising the warning relay whose contacts complete the warning lamp circuit. Even hen the overload is removed and the supply restored the overload lamp will remain alight and the warning relay energised until the indicator reset switch (SW2) is depressed.

Supply.	Relays.	Lamp.
500VA	RL1 RL4	LP6
500VB	RL2 RL5	LPP7
500VC	RL3 RL6	LP8
300VA	RL2 (DA)	LP1
300VB	RL2 (DB)	LP2
300VC	RL2 (DC)	LP3
150VA	RL2 (DE)	LP4
150VB	RL2 (DF)	LP5

CRT 4KV. E.H.T. Power Unit.

276. The 4 KV E.H.T. power supply to the C.R.T. is produced by valve stages V3 to V7. V3 is a transitron relaxation oscillator which produces a signal of approximately 2.2 kc/s. In this oscillator the anode is held at +300V. The resonant circuit, L1, C3 and C4 is connected between the screen and suppressor grids. The output signal is coupled from the screen grid circuit of V3 to V4 via C6R15. V4 is a pentode amplifier strapped as a Triode and it amplifies the signal which is then further amplified in a power amplified stage V5. The anode load of this stage is a step up transformer whose secondary is centre tapped to earth. One half feeds V7, a half wave rectifier which produces +2kV, developed across bleeder chain R21 to R25, C9 being the reservoir capacitor. This voltage is fed to the final anode of the C.R.T. (post deflection accelerator). The other half of the secondary supplies V6, a half wave rectifier which produces

-2KV, developed across a bleeder chain R26 to R30, RV4 and R31. C10 is the reservoir capacitor. This voltage is fed via RV2 and R5 to the CRT cathode. The cathode voltage is 1.9 KV approx.

278. Controls.
- RV1 Focus, controls potential to second anode.
- RV2 Brilliance, sets the grid voltage w.r.t. cathode
- RV3 Astigmatism, is connected between +500V and earth. Is adjusted so that final anode potential is similar to mean deflection plate potential, i.e. minimum distortion on display CRT.
- RV4 E.H.T. level adj. set for correct value of E.H.T. It. controls the value of negative voltage feed back to the grid of amplifier V4.

Time base sub-unit.

279. The time base unit consists of valve stages V201 to 209. SW201 alters time base speed, there is a choice of five speeds.

Circuit. In the quiescent state V203 and V205 are 'cut off' by grid bias voltage derived from -150V line and controlled by RV201. V201, trigger amplifier, is conducting but the cathode of V202a, series limiter, is positive w.r.t. its anode which is connected to V203 anode circuit. Because V203 is cut off V204a grid is held positive, V204a is conducting heavily and V206 anode is at some positive voltage. The 'miller' capacitor C205 is charged. The incoming positive trigger is amplified and inverted by V201, passed by series limiter V202a to the grid of V204a. V204a is cut off and V206 anode potential falls (miller step). Simultaneously V206 screen potential rises sharply, this rise is fed to V203, V205 grids causing these valves to conduct. The fall im potential at V203 anode fed to V204a grid keeps this valve cut off when the trigger pulse ends. After this commulative action (step) miller run down commences as the capacitor discharges via the associated grid resistor. Run down continues until the potential at V206, V204a anode /cathode junction falls below the potential at V204a grid. This produces the second unstable state of the circuit. V204a conducts holding V206 anode potential constant, miller effect ceases, V206 grid potential rises rapidly back to its quiesant value, screen current increases, screen volts fall consequently cutting off V203 V205. The rise in voltage at V203 anode takes V204a grid positive and the valve conducts heavily charging the miller capacitor and returning V206 anode potential to its quiescent value.

The positive square wave produced at V204a anode is used as bright up waveform and fed to the CRT. grid. L201 improves the leading edge of this waveform.V205 produces a negative gate at SK206 which is not used. RV201 is adjusted to produce a stable time base at all time base speeds.

280. The time base waveform from V206 anode is cathode followed by V204b to the paraphase amplifiers V208, V209. The diode V207 in the grid circuit of V208 prevents the grid going positive w.r.t. earth. The time base shift voltage from unit MA is also fed to V208 grid. The antiphase voltage waveforms from the anodes of V208, V209 are fed to the X deflection plates on the C.R.T.

281. Coarse and fine time base speed controls are mounted on unit MA. RV7, the fine speed control, affects the aiming potential in the grid circuit during miller run down. SW5, the coarse speed control, turns SW201 selecting the appropriate 'miller' capacitor. When a position

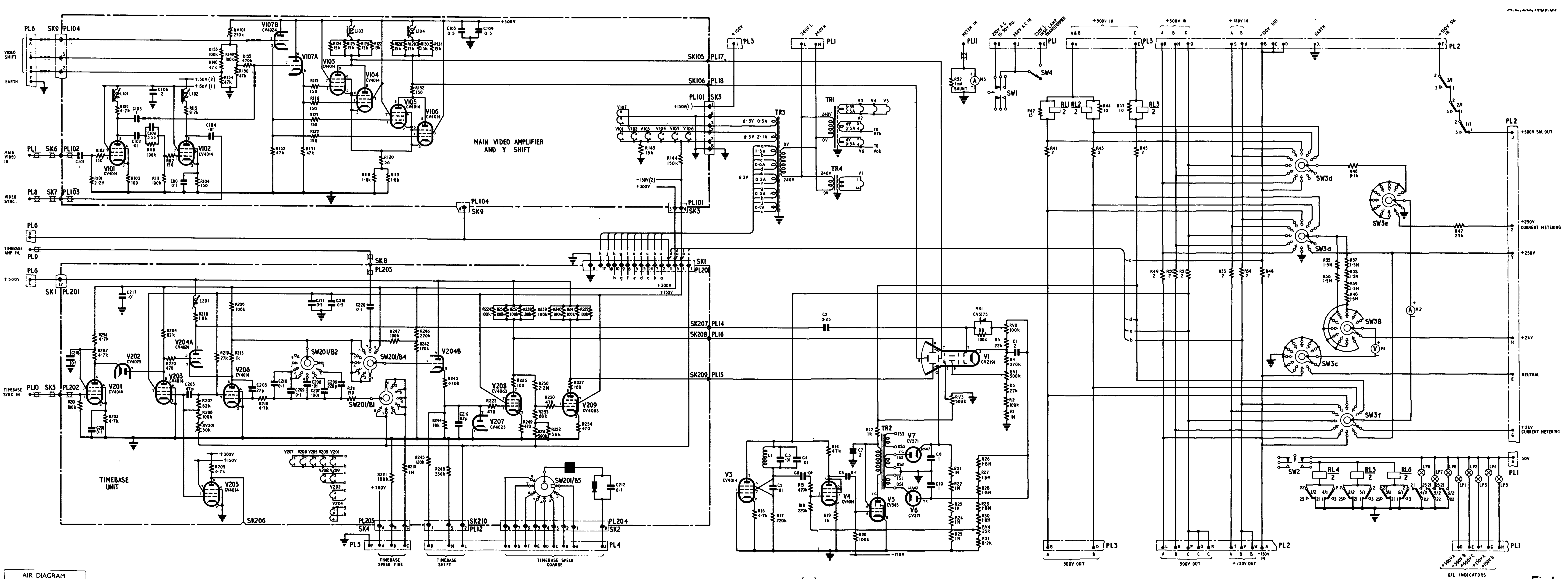
is selected by SW5 +50V is connected to a Ledex coil unit in the monitor. The switch turns until it is in the correct position relative to SW5 then a cut out portion of the wiper breaks the 50V supply to the Ledex coil. SW201 is an eight position 5 wafer switch. In the first 6 positions wafers B1 and B2 select the grid resistor and appropriate capacitor for the different time base speeds. In position 7 wafer B1 connects -150V to V206 grid preventing time base action; wafer B4 connects an external source of time base to V204b grid. In position 8, wafer B1 connects -150V to V206 grid; wafer B4 connects +300V to V204b grid, producing a large positive voltage R244, ensuring that V207 conducts clamping V208 grid to earth. This position is used to make accurate Y amplitude measurements with no time base.

282. Main Video Amplifier and Y Shift Circuit. This sub-unit contains the video amplifying stages V101 to V106 and the 'Y' shift circuit V107. The signals to be amplified are fed via input plug PL102 to the grid of the first amplifier V101. The anode load consists of R109 in series with L101, the circuit is tuned for resonance at 47 Mc/s to provide high frequency compensation - V101 output is fed to:-

(a) The second video amplifier V102 via C102, R110, while C108 and R112 extend the frequency response of the grid circuit.

(b) Cathode follower stage V107 (a double triode) V102 is the internal sync. amplifier and its output is fed via PL8 to the sync selection circuit (V18) in unit MA.

283. V107 is a double triode cathode follower, both anodes connected to H.T. Video signals from V101 are fed to V107b grid, video on Y shift volts from unit MA are fed to V107 a grid. V103 and V104 in parallel with V105 and V106 in parallel have a common cathode load and form a long tail pair. Video signals from V107b are applied to V103, V104 grids, shift volts from V107a are applied to V105, V106 grids. RV101 and RV302 (unit MA) are the video shift controls. RV101, an internal control is used to set the trace at a convenient position on the CRT. while RV302 the external control varies the trace position about this point. The phase voltage waveforms produced by the long-tail pair circuit are fed to the 'Y' deflection plates on the C.R.T.



S.R.I. 18118 F.G.R.I. 18119 Monitoring unit (L) - circuit

Fig.1

AIR DIAGRAM
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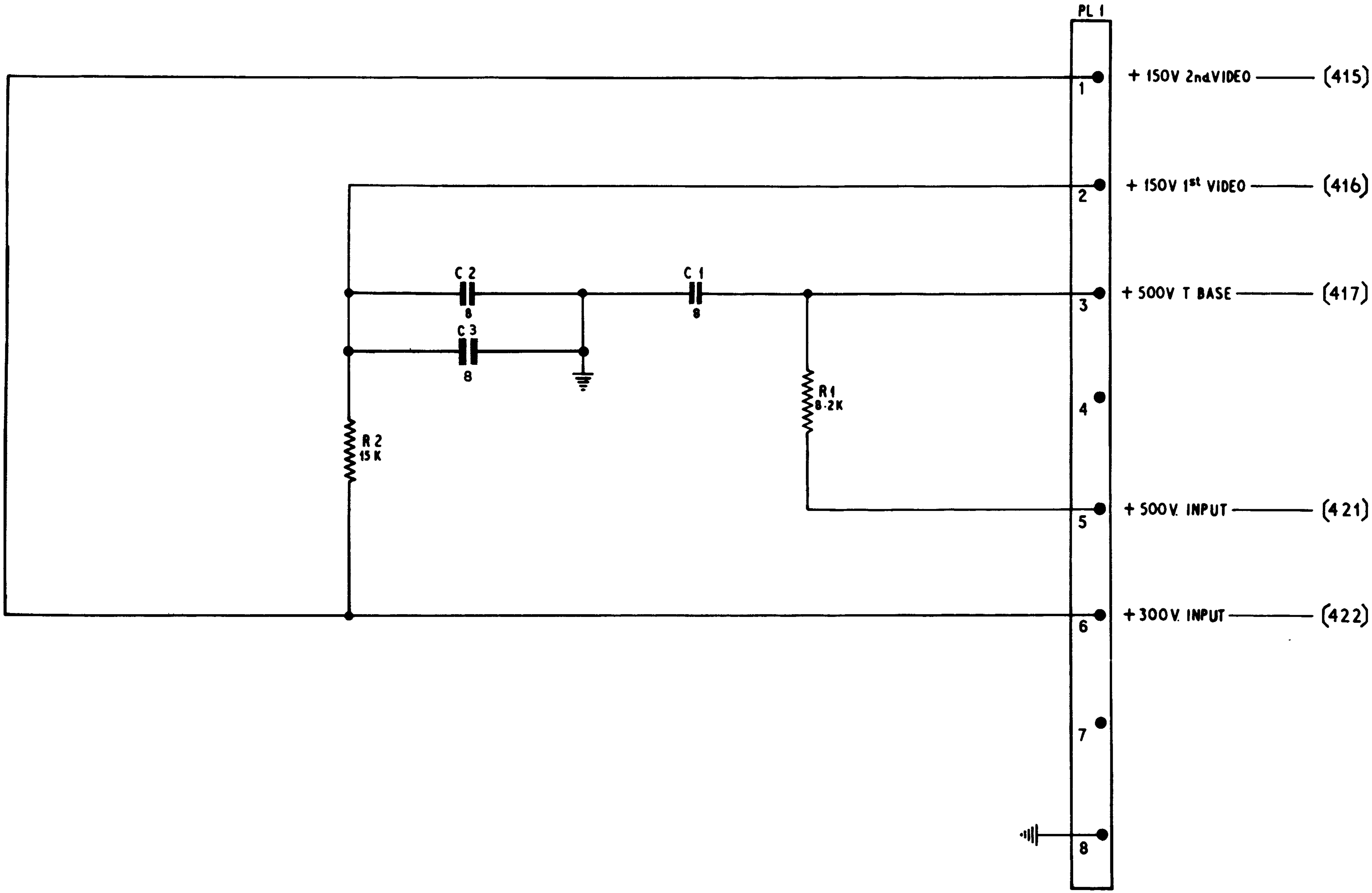
284. <u>Filter Unit (ME)</u>. The unit is situated at the base of the left hand inner door. It is used to provide extra filtering for the DC. supplies to certain units as follows.

(a) +500V H.T. supply to the paraphase amplifiers V208, V209 in monitoring unit L.

(b) +300V D.C. supply used in unit MA. is fed to this unit where it is dropped to +150V by R2, R3, filtered by C2, C3 and used as H.T. for the video and sync. amplifier stages V101, V102 in the monitoring Unit L.

RESISTORS	R 2			R 1	
CAPACITORS		C 2	C 1		
PLUGS		C 3			PL 1



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SRI 18118, FGRI 18119
Filter unit (ME) - circuit

Fig.6

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285. <u>Thermistor Unit (U)</u>. This unit is mounted on the duplexer unit in the right hand cabinet. The unit is a form of wattmeter and contains a thermistor connected in a bridge circuit whose output is fed to a voltmeter mounted on control unit W. R.F. power is probe connected into the thermistor head and the heat generated in the thermistor TH1, alters its resistance and unbalances the bridge producing a reading on the voltmeter. Special compensating circuits correct for changes in ambient temperature. The disc type thermistor TH2 is used for this purpose. The power meter selector switch, SW11, on unit W is associated with the thermistor unit. It is a 3 position switch.

(a) Off.

(b) Low sensitivity.

(c) High sensitivity.

In position (b) the H.T. Voltage fed to the bridge is reduced the H.T. of +300V is fed to:-

(a) The bridge, consisting of R1 to R3 and thermistor TH1.

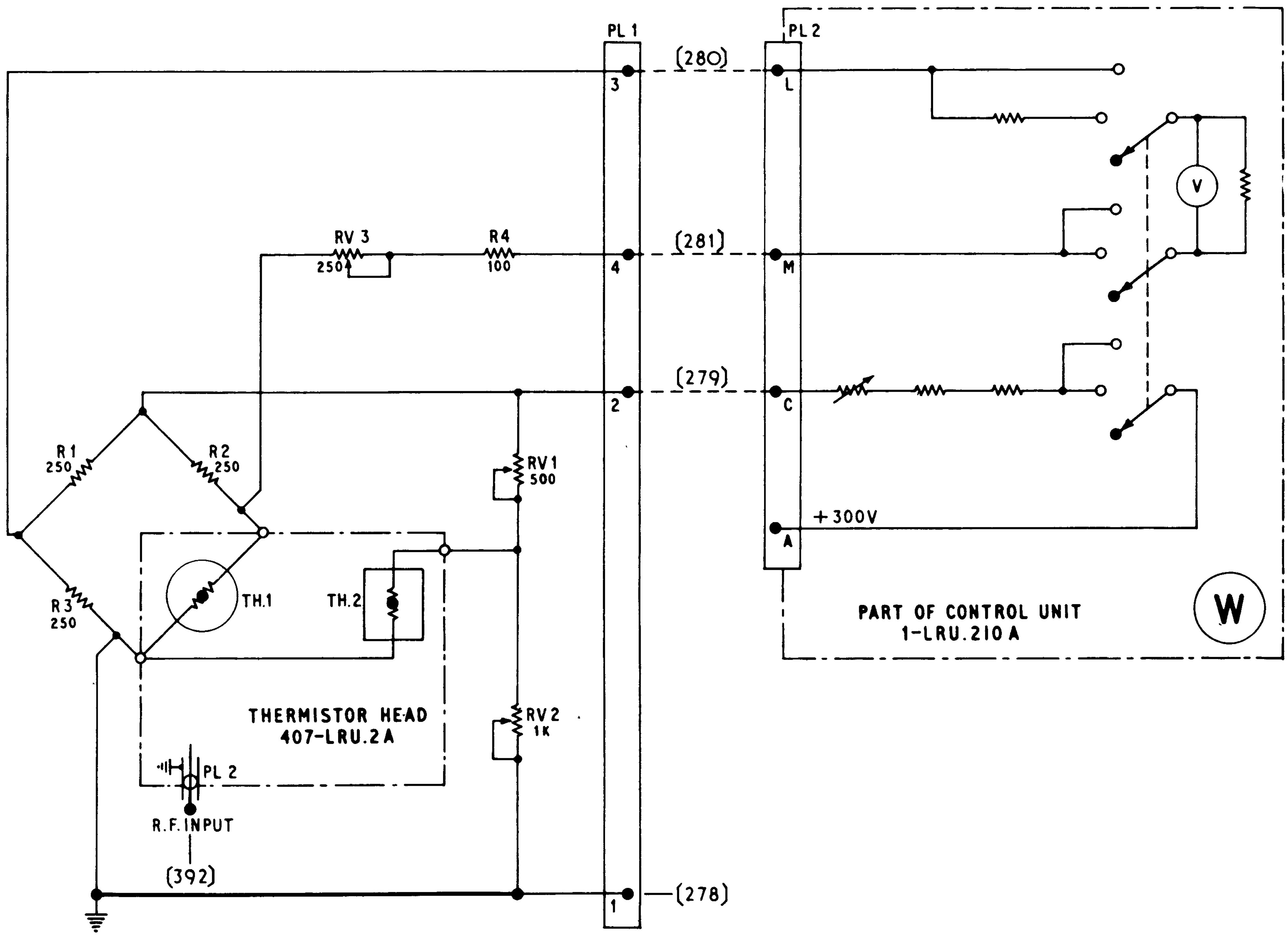
(b) A potentiometer network RV1 and RV2. The junction of RV1 and RV2 is connected to earth via TH2 which alters the value of H.T. fed to the bridge to compensate for ambient temperature changes.

The thermistor characteristics are:-

TH1. 2000 at 20°c. falling to 60 when 20 mW are dissipated across it.

TH2. 500 at 20°c falling to 50 at 80°C.

RESISTORS	R1 R3	R2		RV3		R4 RV1 RV2		
MISCELLANEOUS		PL 2	TH 1		TH 2		PL 1	



SRI.18118, FGRI.181191 – thermistor unit (U)

Fig.3

(A.L.19, Jan.59)

AIR DIAGRAM 6264AB/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

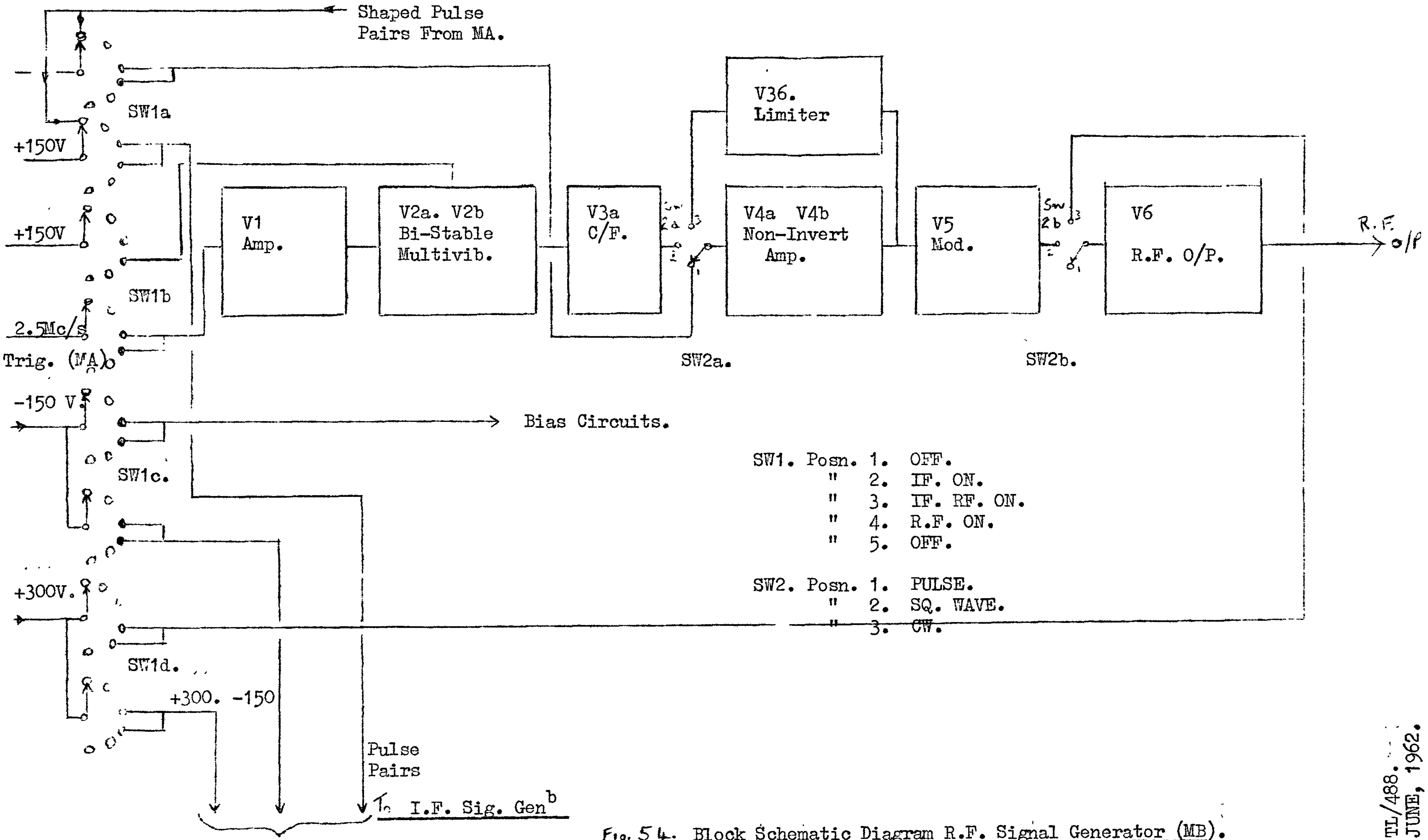
8596 355171 2/59 630+500 C.B.&S. Ltd GP 924

286. <u>R.f. Signal Generator MB</u>. This unit is mounted on the left hand inner door and is used to:-

(a) Generate R.F. signals tunable over the band 962 to 1213 Mc/s

(b) Modulate the R.F. output for c.w., square wave or pulse generation.

(c) Control H.T. and bias supplies to the IF. Signal generator.



SW1. Posn. 1. OFF.
" 2. IF. ON.
" 3. IF. RF. ON.
" 4. R.F. ON.
" 5. OFF.

SW2. Posn. 1. PULSE.
" 2. SQ. WAVE.
" 3. CW.

Fig. 54. Block Schematic Diagram R.F. Signal Generator (MB).

TL/488.
JUNE, 1962.

287. Switch Functions. SW1 selects the operating conditions as follows

Pos. 1 Off.

Pos. 2 I.F. On. Signals from Unit MA are fed via SW1a to the i.f. signal generator unit MC. Power supplies for unit MC are fed from monitor unit L via SW1c in this position.

Pos. 3 I.F. and R.F. On. Signals from unit MA are fed to both signal generators and power supplies to both via SW1 segments c and d.

Pos. 4 R.F. On. Signals and power supplies fed to R.F. signal generator only.

Pos. 5 Off.

SW. 2 selects the form of modulation.

Pos. 1 Pulse. The R.F. output valve is fed with pulsed H.T. which is controlled by the signal pulses from unit MA. This is the normal working condition.

Pos. 2 Square Wave. V6 H.T. is modulated by a 1.1 square wave form from a bi-stable multivibrator which is fired by trigger pulses from unit MA. Used when checking the beacon signal to noise ratio.

Pos. 3 C.W. +300V H.T. is connected directly to V6 anode and the stage produces continuous oscillations.

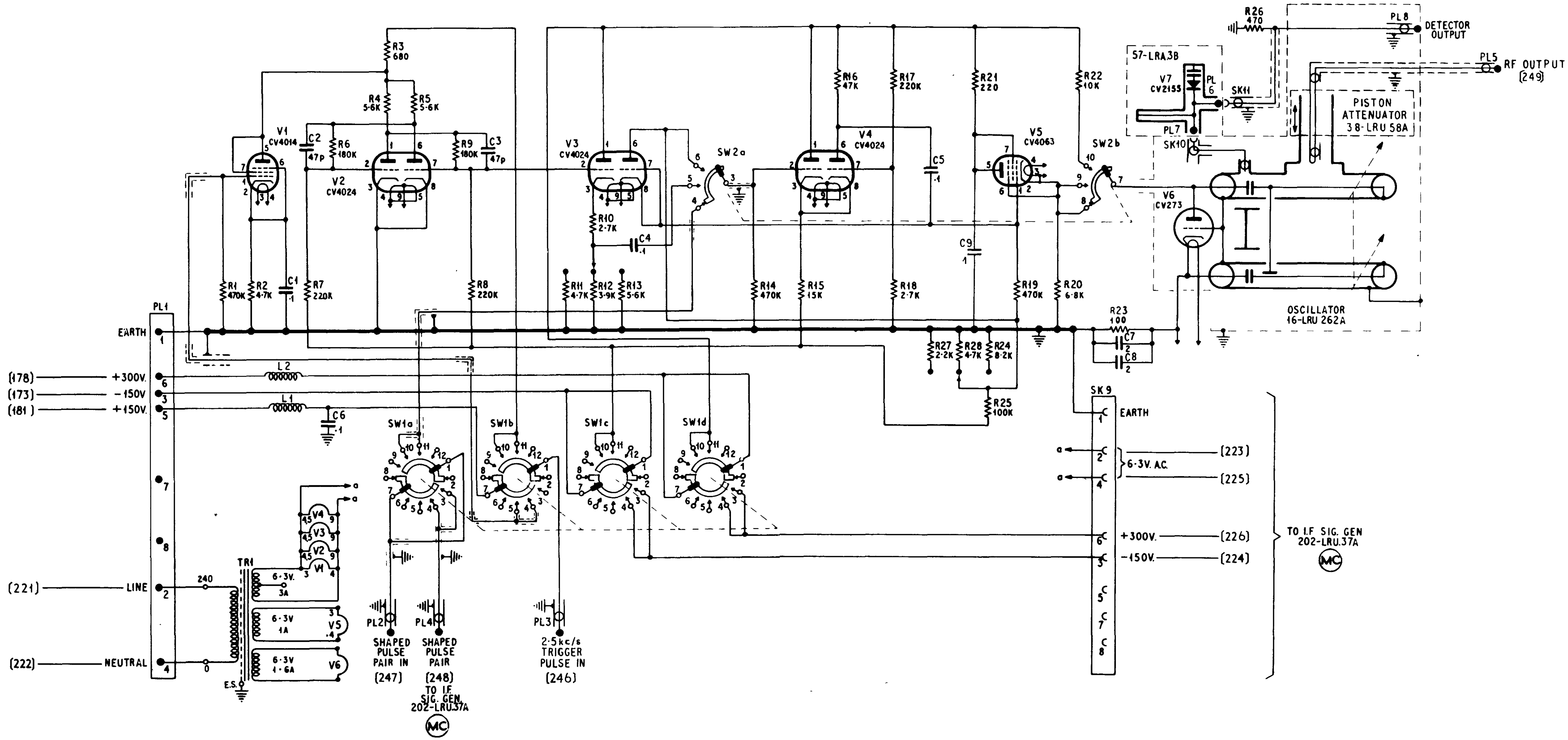
288. Modulation Circuits. The 2.5 Kc/s trigger pulses from unit MA are fed via PL.3 and SW1b to the grid of V1, an amplifier inverter. V1 and V2, a bistable multivibrator share a common anode load R3. and the trigger pulses are coupled via this and the grid circuit connections to the grids of V2. V2 output is a symmetrical square wave at half the P.R.F. of the input triggers. This waveform is cathode followed by V3a to V4a and V4b. These two valves form a non-inverting amplifier stage and the waveform is fed to V5 grid. V5 is normally cut off by the negative potential produced by R19, R125 and selected resistor R24, R28, R27. The input waveform positively D.C. restored by V3b cuts on V5 and the resultant voltage developed across R20, cathode load, is the H.T. for oscillator valve V6. When the unit is used for pulse modulation V1 and V2a are switched out of circuit and the pulses from unit MA are connected via SW2a to the non-inverting amplifier V4, thence to the modulator V5.

289. R.F. Circuit. V6 is a grounded grid triode. The anode-grid circuit is a $\frac{3}{4}\lambda$ lecher line and the cathode circuit is a $\lambda/4$ line. Feedback between anode and grid circuits is by means of a capacitive couple between the lines. V6 grid is at earth potential and R23, C7, C8 produce the cathode bias. A detector probe is coupled into the anode/grid cavity to feed V7, a detector, whose output is fed to PL8 on the front of the unit for monitoring. Both lecher lines are ganged and tune together. The R.F. output is loop coupled from the anode/grid cavity and attenuation is controlled by the depth of the loop in the cavity.

RESISTORS R1 R2 R7 R6 R3 R4 R5 R9 R8 R11 R10 R12 R13 R14 R15 R16 R17 R18 R27 R28 R21 R24 R25 R19 R20 R22 R23 R26

CAPACITORS C1 C2 C6 C3 C4 C5 C9 C7 C8

MISCELLANEOUS PL1 TR1 V1 L2 L1 PL2 V2 SW1a PL4 SW1b PL3 V3 SW1c SW2a SW1d V4 V5 SW2b SK9 V7 PL7 SK10 V6 PL6 SK11 PL5 PL8



AIR DIAGRAM 6264W/MIN.

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SRI. 18118, FGRI. 18119 – RF signa generator (MB) – circuit

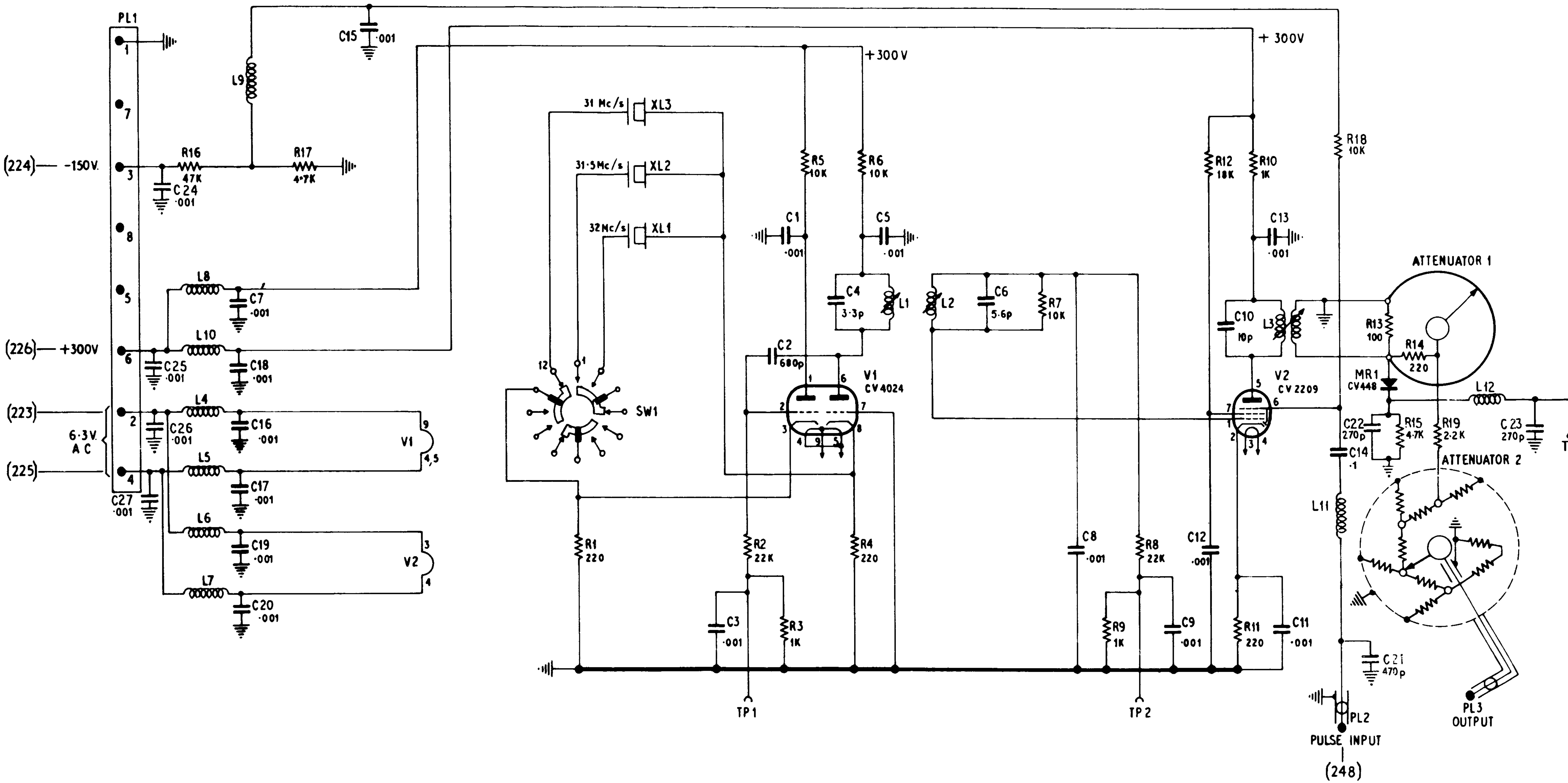
Fig.2

290. <u>I.F. Signal Generator MC</u>. The purpose of the Unit is to produce modulated I.F. signals at 62, 63 and 64 Mc/s carrier frequency for checking the efficiency of the I.F. Stages and the ferris discriminator. It is mounted on the left hand inner door.

291. <u>Circuit details</u>. V1 is a cathode coupled crystal oscillator. SW1 selects one of three crystals The crystals are connected between the cathodes of the two triodes and are used in a series mode of oscillator. Overtone mode crystals are used to produce oscillator frequencies of 31, 31.5 and 32 mc/s. The output coupling transformer is tuned to the fundamental frequency of 31.5 mc/s (L1 C4). The secondary is damped by R7 to produce a broad band pass circuit. The signal is fed to doubler/amplifier V2 whose tuned anode load is adjusted to produce the transmitted frequencies 62, 63 and 64 mc/s. V2 output is fed via fine and coarse resistive attenuators to the output terminal PL3. V2 is normally cut off by the negative potential at the junction of R16, R17. (L9, C15 prevent pulses being fed back to the D.C. supply line) which is fed to the suppressor. Positive pulses from unit MA, fed via unit MB, lift the suppressor bias thus producing the required modulated output.

MR1, C22, R15, L12, C23 form a detector and filter network whose output is fed to TP13 for monitoring.

RESISTORS R16 R17 R1 R2 R3 R5 R4 R6 R7 R9 R8 R12 R11 R10 R18 R13 R14 R15 R19
CAPACITORS C24 C25 C26 C27 C7 C18 C16 C17 C19 C20 C15 C3 C2 C1 C4 C5 C6 C8 C9 C12 C10 C13 C11 C14 C21 C22 C23
MICSELLANEOUS PL1 L8 L10 L4 L5 L6 L7 L9 SW1 XL1 XL2 XL3 TP1 V1 L1 L2 TP2 V2 L3 PL2 L11 MR1 ATT.1 ATT 2 PL3 L12 TP3



SRI. 18118, FGRI. 18119 — IF signal generator (MC) - circuit

Fig.4

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