NOTES ON WIRELESS SET NO. 12.

1. GENERAL DESCRIPTION.

The No.12 Set is a low-power sender with an R.F. output of about 25 watts on C.W., designed for use, in conjunction with Reception Set No. R 107, as a ground station. It can also be used to replace Wireless Set No 9 in 15 cwt.trucks.

The frequency band from 17.5 Mc/s - 1.2 Mc/s is covered in 4 overlapping ranges thus :-

Range	Frequencies in Mc/s
1	17.5 - 10
2	10.5 - 5.2
3	5.3 - 2.5
4	2.55 - 1.2

The set, complete with power pack, is built up on a steel chassis, which, with the front panel carrying the controls, is housed in a steel case measuring 24" x 12½" x 17½" with top,back and front covers in place. The total weight is 134 lbs.

The circuit is arranged for the transmission of R.T, M.C.W. or C.W. Facilities for remote control are provided, and the following types of aerial may be connected direct to the set :-

(a) Wyndom; (b) End-fed horizontal; (c) Half-wave dipole.

(a) & (b) may be used in conjunction with the Aerial Coupling Equipment and feeder cable provided.

A Dummy aerial is provided, which enables the sender cable to be correctly loaded to the feeder cable in the latter case. The sender aerial coupling control is first adjusted for correct loading with the Dummy aerial (100 ohms) connected.It is then disconnected and the feeder cable from the Aerial Coupling Equipment Unit F substituted, the latter being then adjusted for maximum aerial current.

Break-in working is provided on all types of transmission.

2. CIRCUIT DETAILS.

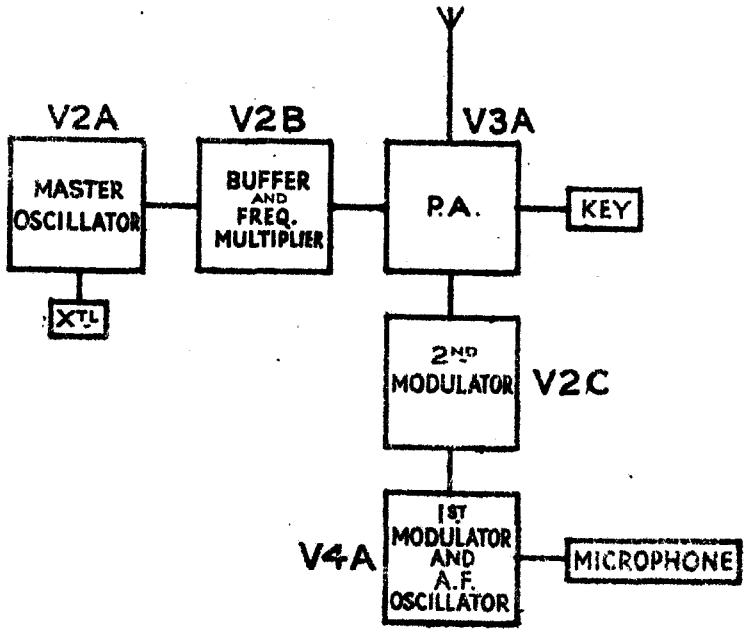


Figure 1. Block Diagram of No.12 Set.

Radio frequency oscillations are produced in the Master Oscillator stage, which may be crystal-controlled or self-excited.The output is fed into the Buffer Stage, which acts as an R.F.amplifier & frequency multiplier. This is followed by a Power Amplifier.

Suppressor grid modulation in the P/A stage,in conjunction with a two stage modulator, is employed.

Keying also takes place in the P/A suppressor grid circuit.

(i) R.F.Stages.

(a) Master Oscillator.

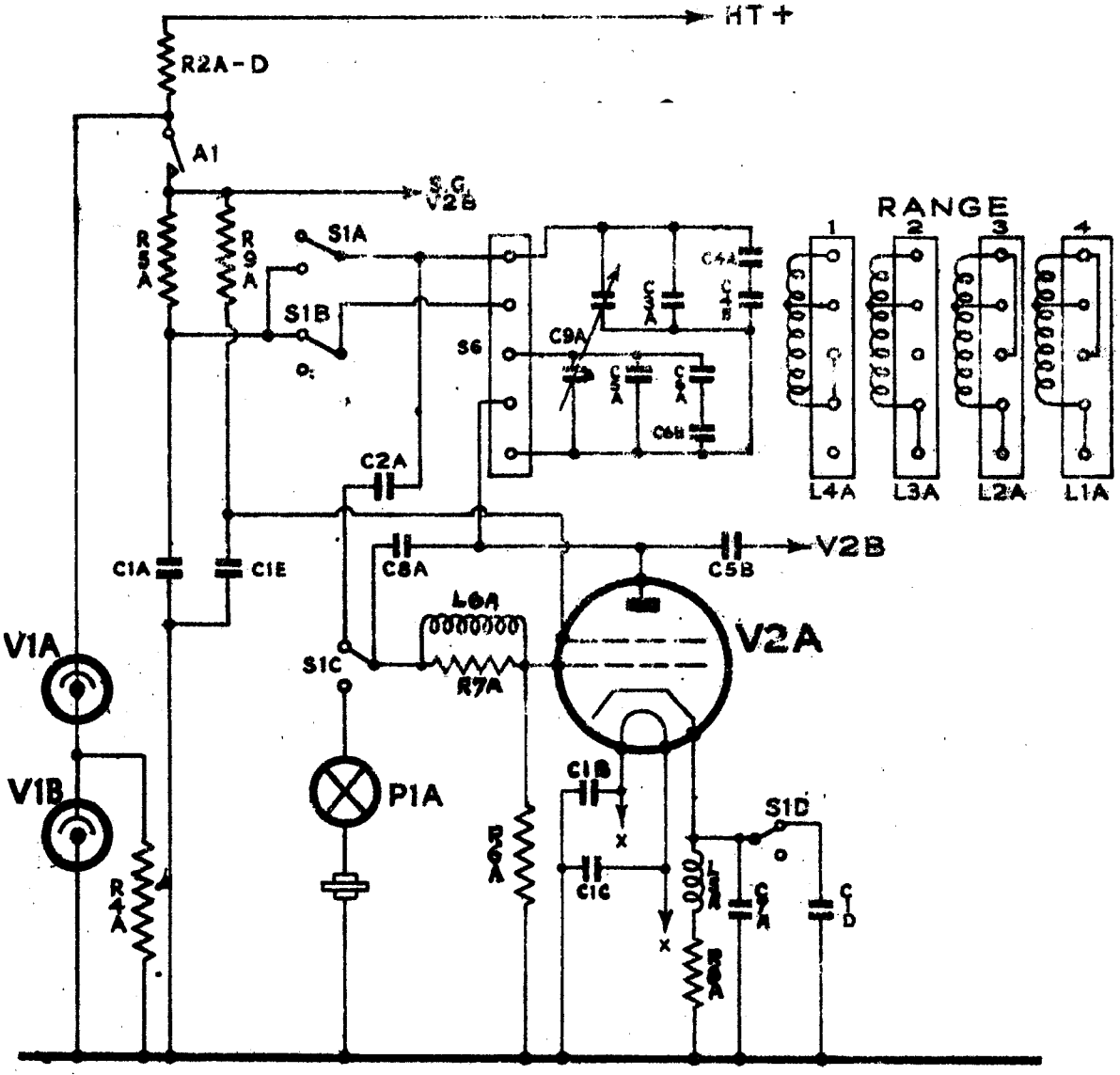


Figure 2. Master Oscillator.

The Master Oscillator valve V2A, which is a type 807, beam power tetrode (W/T Type A.T.S.25), can be crystal-controlled or self-excited, change over being accomplished by means of the oscillator switch S1. In the latter case it is employed in a series fed Hartley circuit.

When crystal-controlled, the tuning circuit is connected between H.T.+ and anode, and feed back from anode to grid is effected via the coupling condenser C8A (2.2$\mu\mu$F). L5A by-passed by C7 (450$\mu\mu$F), is to compensate for the change in the amount of feedback caused by the fact that the reactance of C8A varies with the frequency being transmitted, & works in the following manner:- The fluctuating anode current passing through L5A causes the voltage of the cathode to vary, and the variations are 180° out of phase with those fed back to the grid from the anode, and therefore increase the effect of the latter by producing a greater P.D. between grid and cathode. Now, when the reactance of C8A increases and the feedback through it consequently becomes less, the reactance of C7A also increases and consequently the voltage variations across L5A increase. Hence when the grid variations decrease those on the cathode increase & vice versa and the amplitude of oscillations remains constant.

Frequency range changing is effected by means of a switch S6 which rotates a coil turret and changes the tuning coil. Tuning is carried out by means of the 2-gang condenser C9A (.0005μF & .0005μF). These two sections, together with their associated padding condensers C3A, C4A-B and C5A, C6A - B are connected in parallel on ranges [illegible] and in series on

H.T. is fed to the anode of V2A via the dropping resistance R2A - D (4250Ω obtained by connecting two 5000Ω and two 3500Ω resistances in series-parallel), the relay contacts A1 and the resistance R5A (100Ω) decoupled by condenser C1A (0.01μF). Screen voltage is reduced by means of the dropping resistance R9A (20,000Ω) decoupled by C1E (0.01μF).

H.T.voltage to the M.O.and the screen of V2B is stabilized by means of two neon tubes V1A and V1B, W/T Type AW3. These two discharge tubes constitute a compensating parallel load which varies inversely as the external load on the H.T.supply.A constant load is thus maintained and the supply voltage remains constant. The resistance R4A (0.25 Mn) shunting V1B is included to facilitate "striking" when the supply is switched on.

When the M.O. is self-excited its frequency is half the radiated frequency, but the tuning dial is calibrated with the latter in Mc/s. On crystal control the stage is tuned to crystal frequency, resonance being indicated by the lamp P1A in series with the crystal. The oscillator tuning control will have to be set to approximately twice the fundamental frequency of the crystal.

A steady bias is applied to the indirectly heated cathode by means of the series resistance R8A (400Ω) decoupled by C1D (0.01μF) and C7A (450μμF) when working with self-excitation, and by C7A only on crystal control. Further bias is provided by means of the grid-leak R6A(50000Ω).

The heater is decoupled by condensers C1B & C1C (0.01μF). L6A shunted by R7A (500Ω) is a grid parasitic stopper.

(b) Buffer Stage.

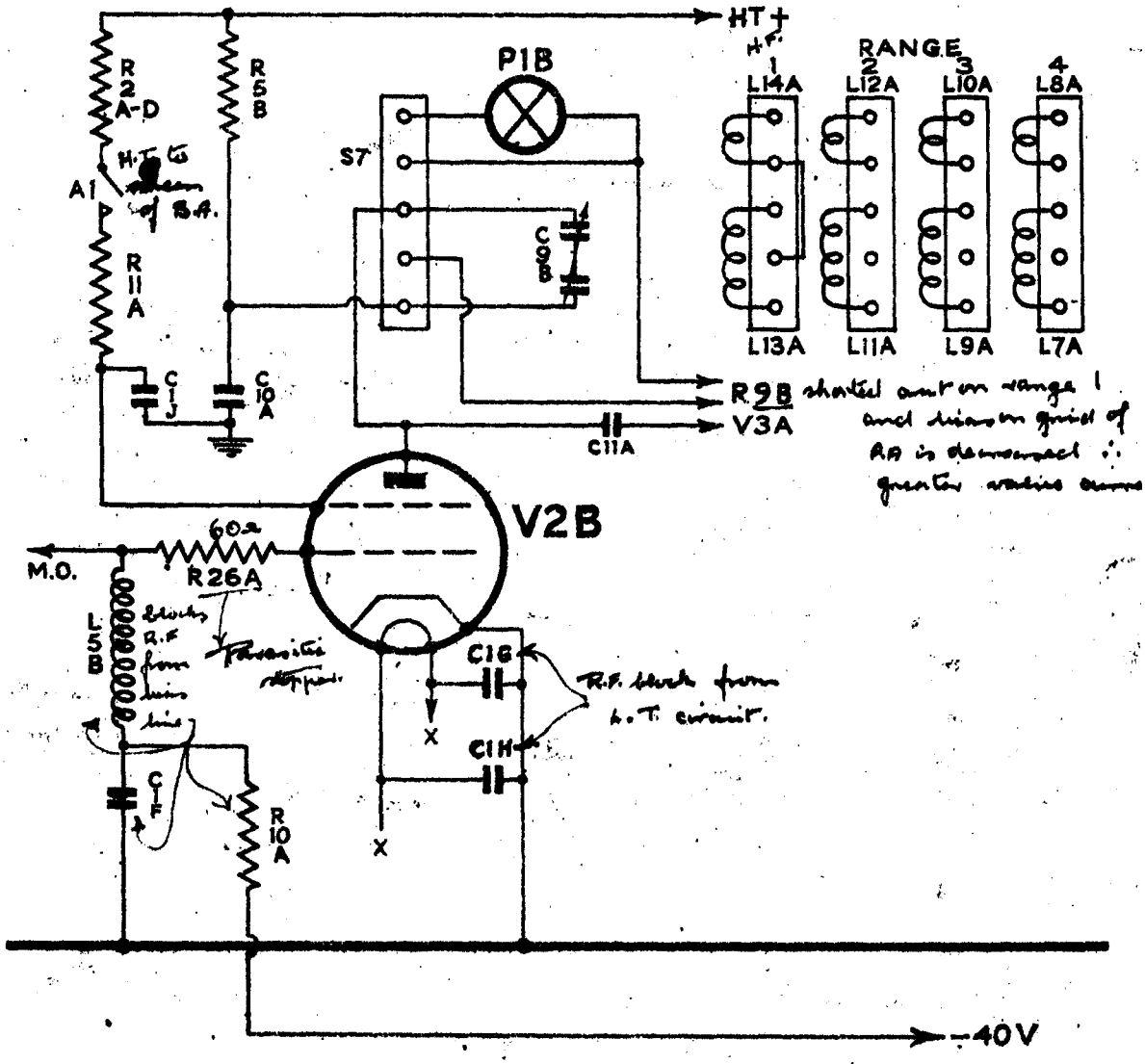


Figure 3. Buffer Stage.

In this stage V2B, a W/T type ATS 25, operates as a radio frequency

inductances, L7A, L9A, L11A, and L13A and the variable condenser C9B. The latter is a 2-gang assembly with its sections connected in series. This circuit is usually tuned to the second harmonic of the oscillator frequency. When crystal-control is being used, tuning may be adjusted to any harmonic within the frequency band of the sender. Frequency range switching is accomplished by means of the switch S7 which rotates a second coil turret carrying the four inter-changeable inductances. Resonance is indicated by the lamp P1B, energised from a winding, loosely coupled to the anode coil.

H.T. is fed to the anode via the resistance R5B (100Ω) decoupled by C10A (0.01μF) and the anode inductance.

A fixed grid-bias of -40 volts is applied to the control grid by returning the latter via the gridchoke L5B & grid leak R10A (150,000Ω) decoupled by C1F (0.01μF) to the grid bias potential-divider on the power pack. C1G and C1H decouple the heater circuit.

Output is taken from the anode via C11A (50μμF).

(c) Power Amplifier.

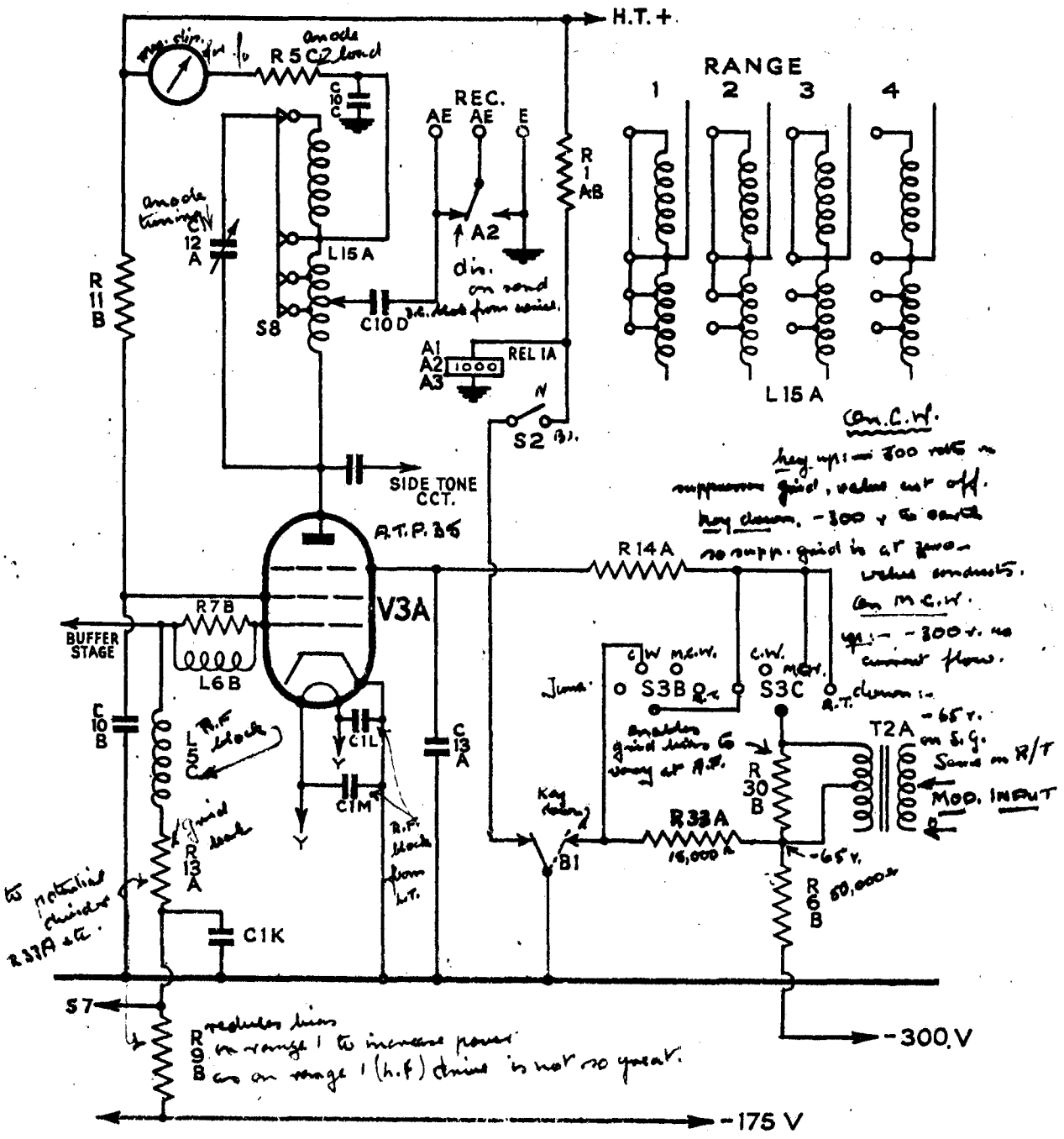


Figure 4. Power Amplifier.

This stage, which employs an indirectly-heated pentode valve W/T type

a negative bias of -175volts is applied to the control grid which reduces the D.C. anode current practically to zero when the drive is removed.

The anode is tuned by means of the variable condenser C12A (0.0005 μF) connected in parallel with the anode coil L15A. Range switching is accomplished by means of S8 which shorts out a suitable number of turns on L15A. Resonance is indicated by maximum dip in the reading of the P.A. anode current meter which is connected between H.T.+ and the anode resistance R5C (100Ω) decoupled by C10C (0.01μF). The aerial is coupled to L15A via C10D (0.01μF) by means of a continuously variable tap.

H.T. to the screen is applied via R11B (10,000Ω) decoupled by C10B (0.01μF).

Standing bias on the control grid is obtained by returning the latter via the grid parasitic stopper R7B (500Ω) shunted by L6B, the grid choke L5C and grid leaks R13A (10,000Ω) and R9B (20,000Ω) to the grid bias potential divider. R9B is shorted-out by the switch S7 on range 1.

The suppressor grid circuit.

(a) With system switch to R.T.

When the pressel switch is pressed Relay 3A is operated and R6B (50,000Ω) and R33A (15,000Ω) are connected, by means of the contactB1 across the grid bias supply, forming a potential divider. The suppressor grid of V3A is biassed to approx: -65 v. by returning it to the junction of R6B and R33A via the blocking resistance R14A(100Ω) decoupled by C13A (.002μF), the switch S3C, and the secondary of T2A.

(b) On M.C.W.

With the key up a bias of -300 v. is applied via R6B, T2A, S3C & R14A. When the key is pressed Relay 3A operates and the bias is reduced to -65v applied as in (a) above.

(c) On C.W.

Before the key is pressed the full negative bias of -300v is applied via R6B, R33A & S3B. With the key down & relay 3A operated, the suppressor grid is earthed by means of contacts B1.

(d) In the 'Tune' position.

The suppressor grid circuit is the same as for R.T. & M.C.W. with the key pressed.

(ii) The Modulator.

The No.12 Set incorporates a 2-stage modulator employing an indirectly heated pentode V4A, W/T type ARP 34, followed by a beam power tetrode V2C W/T type ATS 25.

V4A functions as an amplifier on R/T and an A.F.oscillator on M.C.W. H.T. is taken from the 300v. line through the dropping resistances R19A-C (7,500Ω) decoupled by C15A (4μF) and the anode load resistance R21A (50,000Ω). The working anode voltage is 70v. Screen voltage is applied by means of the potential divider comprising R18A & R18B (each 100000Ω). C16A the screen by-pass condenser has a capacity of 0.1μF.

The microphone transformer T3A has separate primary windings for the microphone circuit and remote control working. Depth of modulation on R/T is controlled by means of the potentiometer R23A shunting the secondary of T3A. Grid bias on R/T is provided by R22A & R22B(each 300Ω)in series with the cathode.

For M.C.W. working V4A functions as an A.F. oscillator in a parallel fed Hartley circuit, tuned to oscillate at 900 c/s. The A/F tuned circuit comprises the choke L16A and condenser C19A (0.04μF). C18A (0.02μF) is the anode blocking condenser. Steady grid bias is afforded by the cathode resistor R22B, and further bias is provided by the grid condenser C20A (0.01μF) and leak R15B (50,000Ω).

The output from V4A is resistance capacity coupled via C10E (0.01μF) to V2C. This valve is transformer-coupled to the suppressor grid circuit of the P.A. valve V3A. It operates with an anode voltage of 200v. and is biassed by means of the resistance R17A (500Ω) in the cathode lead.

The A.F. input on M.C.W. is reduced by connecting the control grid of V2C via the grid stopper R32A (100Ω) to the junction of the grid resistances R27A (15,000Ω) and R28A (35,000Ω).

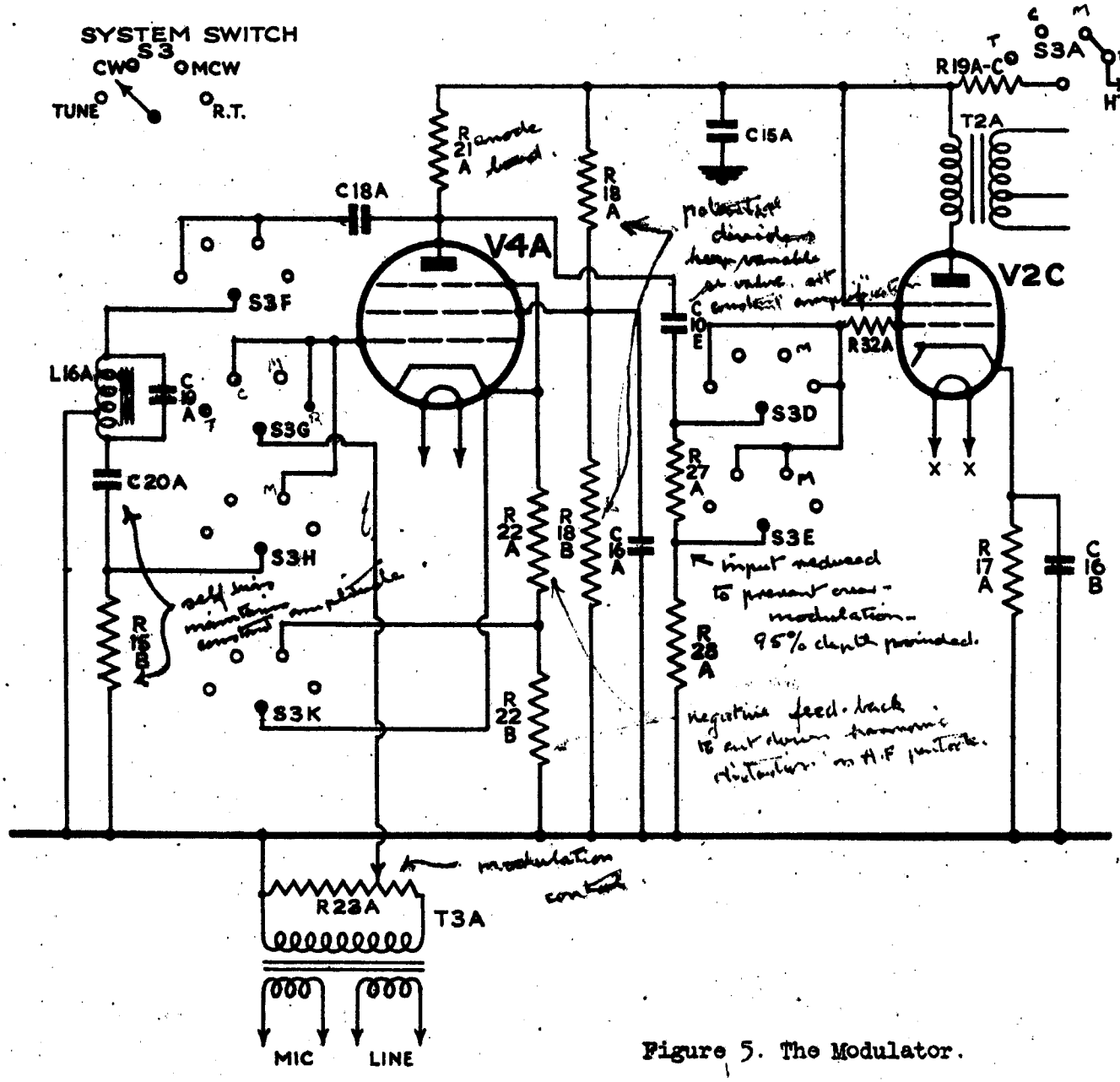
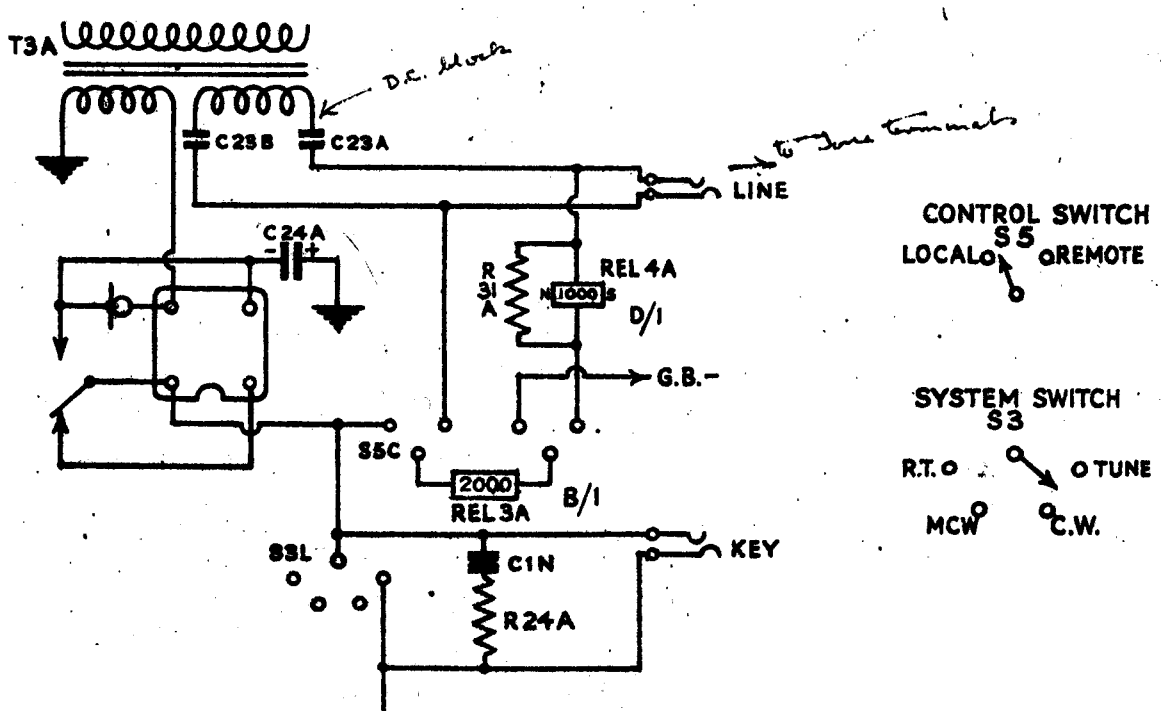


Figure 5. The Modulator.



(iii) The Audio Equipment.

A Microphone Hand No.4 is employed, the pressel switch of which embodies a change-over action, serving the purpose of the send / receive switch on R/T when using "break-in" i.e. S2 closed. On pressing pressel switch, the microphone inset and the relay Rel.3A in series with it are energised from the G.B. supply. Current variations at A.F. are set up in the microphone primary of T3A which is also in the circuit. The microphone smoothing condenser C24A has a capacity of 25μF. The contacts B1 associated with Rel. 3A now remove the short on the coil of the change-over relay Rel.1A, thus applying H.T. to the M.O., connecting the aerial and muting the receiver.

On C.W.or M.C.W. a path from G.B.- to earth through the relay Rel.3A is provided whenever the key is pressed and the former operates. In the "tune" position S3L provides a short circuit on the key jack.

(iv) Power Supply.

The power supply components are situated on the rear half of the chassis. They comprise,in order from left to right, the mains contractor relay Rel. 2A and transformer T4A, the remote control relay Rel. 4A, the selenium full-wave bridge rectifier for bias supply W2A - B which is mounted on top of the mains transformer T5A, the full- wave rectifying valve V5A Type FW 4/500 (W/T Type A.V.1.) and the H.T. & G.B. smoothing chokes L17A and L18A respectively. Bias potentiometer resistances are mounted on top of L17A.The smoothing condensers C21A & B(8μF,1000v D.C) for H.T. and C25A & B (4μF,400 v.D.C.)for G.B. are fixed underneath the chassis.

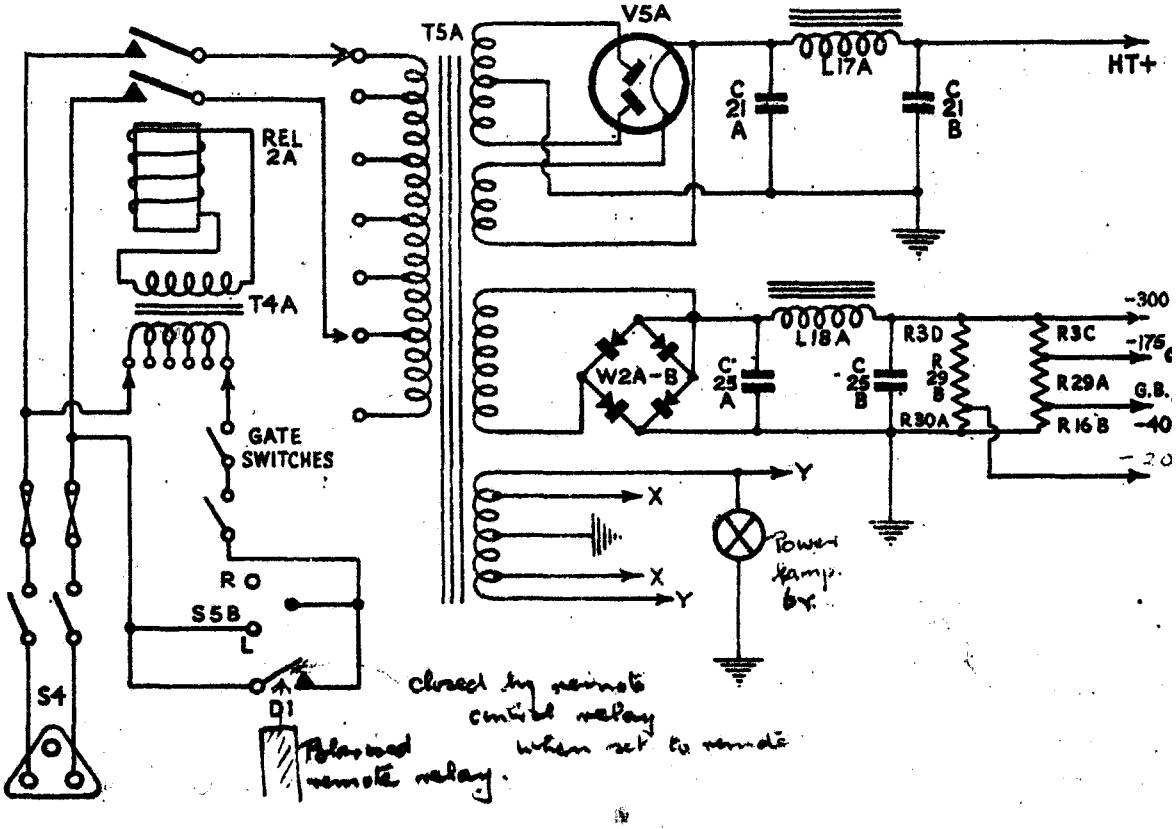


Figure 7. Power Supply.

The mains transformer has four separate secondary windings, two high voltage for H.T. and G.B. supplies, one low voltage for the rectifying valve filament and one for the heaters of the remaining valves. Input to the tapped primary (adjustable for voltages between 100 & 250) is controlled by the contractor relay Rel. 2A operated on 100v by means of the transformer T4A. Input to T4A is controlled by the contacts D1 on the

the switch S2B provides a short on D1.2 gate switches in series are also included in the primary circuit of T4A. S4 the main on/off switch provides a master control to the primaries of both T4A and T5A.

Full wave rectification is provided by V5A which works with 500v on each anode and produces a D.C.output of about 550v. The filament voltage is 4v. Adequate smoothing is supplied by C21A & B and L17A.

The output from the G.B. rectifier bridge is smoothed by L18A in conjunction with C25A & B and the output of about 300v D.C.is applied to the two potential dividers comprising R3D, R29B & R30A, and R3C, R29A & R16B.

The pilot lamp P1C is connected between one side of the P.A. valve heater and earth (6 volts).

(v) Receiver Muting and Side Tone.

A small proportion of the R.F. output is tapped off the P/A anode through the condenser C8B(2.2 P) and rectified in the detector circuit containing a diode valve V6A (or Westector W1A) and transformer T1A.One side of the secondary of T1A is taken to a pin on the Receiver Muting & S/T 4-pin connector; the remaining side is earthed. The remaining three pins on the connector are taken to the spring contacts A3 on the change-over relay Rel.1A. Three leads are taken from the 4-pin connector on the sender to the receiver,a sidetone line, a muting line and an earth link. When the change-over relay Rel.1A is operated the muting line is shorted to earth by contacts A3.Side tone reaches the receiver via the side tone line and earth link.

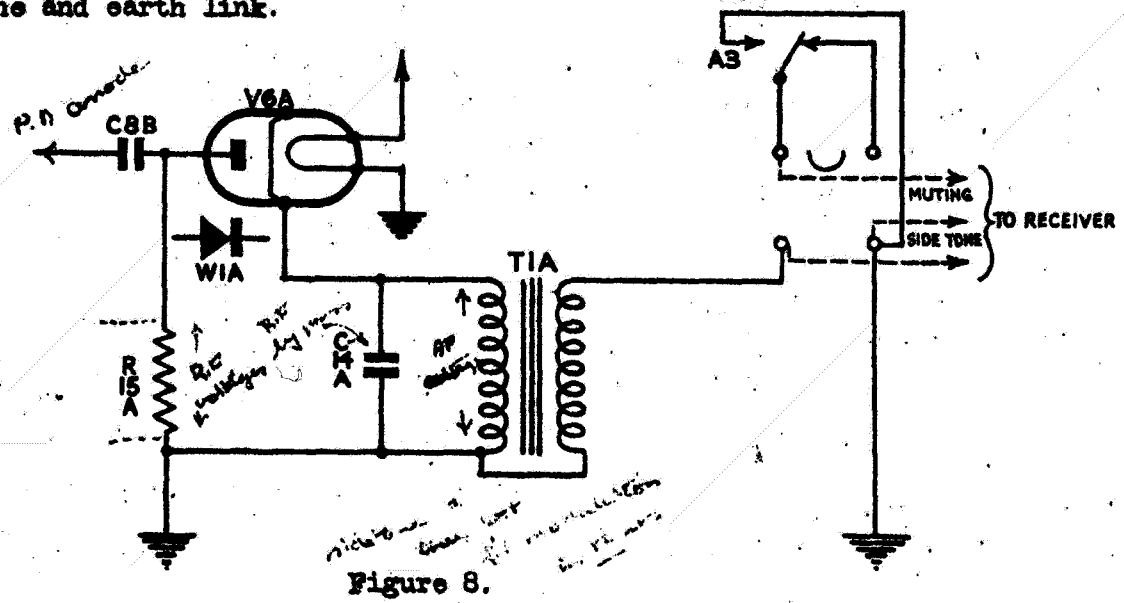


Figure 8.

(vi) Wireless Remote Control Unit C.

This apparatus enables the Wireless Set No.12 to be switched off, keyed on C.W. or M.C.W. and modulated by any V.F. system from a remote point. The unit which,together with a Reception set R107, is located at the point from which remote control is to be effected, is connected to the Sender by Cable,Electric D8 Twisted,terminating in an adapterplugged into the line jack on the set.

The unit consists of the following :-

(a) A P.O.type key switch S1, for switching the Sender on or off.
(b) A high-speed relay Rel.1A.
(c) Switch S2 for normal or break-in working.
(d) Switch S3 for keying the sender by morse key or wheatstone transmitter.
(e) A morse key jack.
(f) A four-pin socket for connection to the receiver muting pins.
(g) Terminals for connection to Teleprinter, Wheatstone Transmitter, line and extra calls.

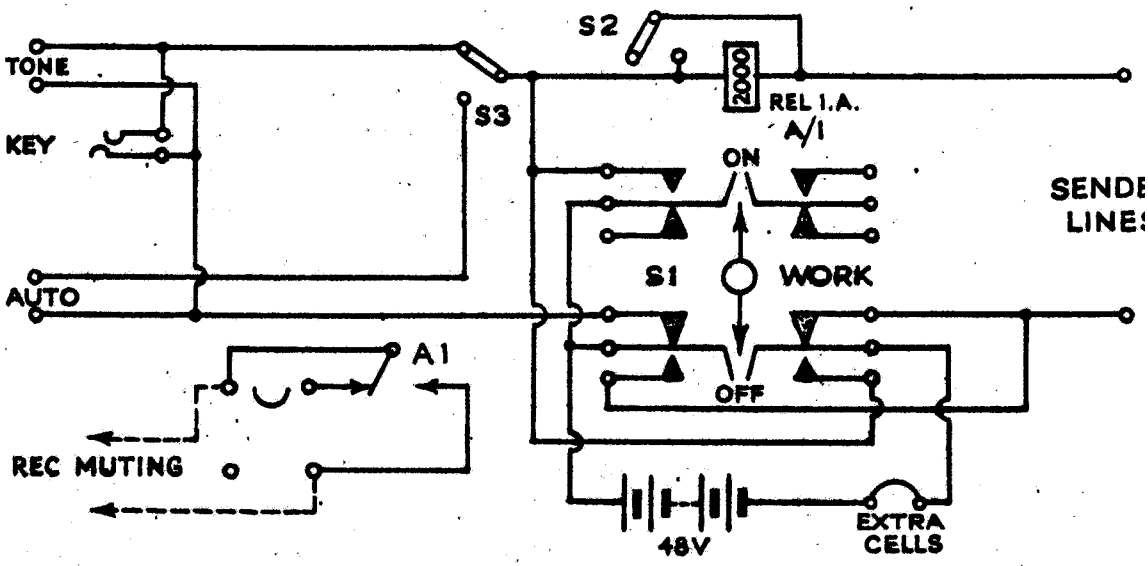


Figure 9.

The complete circuit is shewn above. By operating the switch S1 impulses of current in either direction can be sent out to line, which operate the polarised relay Rel. 4A in the sender, thus switching the latter on or off. With S3 in the "key" position the internal battery will operate the relay Rel.3A in the sender when the morse key is pressed. If the line voltage is too low additional cells must be connected to the "extra cells" terminals, which are normally short-circuited. In the "break -in" position of S2 a short is removed from Rel.1A in the unit and it will operate when the Morse key is pressed. The relay contacts connect the muting leads together. For high speed keying S2 should be at 'normal' as the relay coil is in series with the line.

3. FAULT FINDING ON THE NO. 12 SET.

After applying routine tests to the set in order that all the symptons may be noted, the normal procedure in logical fault-finding should be adopted. After ensuring that the fault is not an external one, try to localise it as far as possible before testing individual components.

(i) Power Supply.

If, when properly connected-up and switched on, the set is dead, the power supply apparatus may be suspected. See that the contactor relay Rel.2A works when switching on. If it does not, check the primary cct: of T4A including gate-switches, fuses and switch S5B. H.T. output may be checked with an AVO meter between L17A and earth. This is normally 550v. A similar test on the G.B. supply (between L18A and earth) should give 300 volts negative.

(ii) R.F. Stages.

Keep a careful check on the range switch positions and it should be ascertained from the start whether the fault is peculiar to all or only one range. In this connection it may be remembered that the buffer stage works as a frequency multiplier and therefore use can sometimes be made of the other range coils.

(iii) The Power Amplifier.

With the Buffer Tuning Lamp lighting and therefore indicating that the P/A valve should be receiving grid drive, the following approximate readings should be obtained on the P.A. Anode Current Meter :-

Range	P.A. Anode Current (System switch to 'tune' Anode circuit unloaded. see Col.iv)		Position of Aerial Coupling control for zero coupling.
	Anode circuit untuned	Anode circuit tuned	
(i)	(ii)	(iii)	(iv)
1	80 mA	25 mA	13.1
2	80 mA	15 mA	9.1
3	80 mA	10 mA	0
4	80 mA	30 mA	0

(iv) Voltage readings on R.F. Stages.

The following are the normal voltage readings obtained on the P.A. valve:-

Anode Voltage measured at the anode cap, with oscillator out of action, switch to C.W. and key down = 580-650 volts.

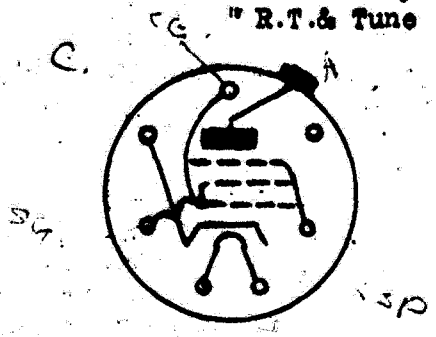
Screen Voltage under similar conditions:-

Off tune = 390 volts approx: Tuned = 325 volts approx:

Control Grid Voltage obtained, with rectifier V5A removed, in any position of system switch = -150 to -175 volts.

Suppressor Grid Bias with V5A removed =

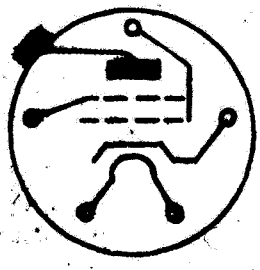
On C.W. key up -270 to -300 volts
" " key down 0 volts
" M.C.W. key up -270 to -300 volts
" " key down -58 to -65 "
" R.T.& Tune -58 to -65 "



Valve Base of A.T.P.35 viewed from below chassis.

The Buffer Stage.

Valve Voltages.
Anode 580-650 volts.
Control grid bias -40 volts.
Screen 250 volts off tune, 220 volts tuned.



Valve Base of A.T.S.25 (807)

Master Oscillator.

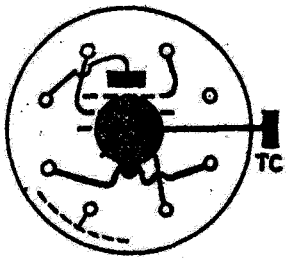
Voltage measurement at the anode of V2A with the oscillator out of action should give 255-275 volts.

(v) The Modulator.

If the sender works satisfactorily on C.W. but not on R.T. and/or M.C.W. the suppressor grid bias circuit should first be tested by switching to 'Tune'. Abnormal P/A anode current will indicate a fault in the potentiometer resistance network. Assuming that the sender operates on

Modulator valve voltages - With AVO: Model 7 400v. range.

	Anode	Screen	Cathode
V4A	80v	70v	2.5v
V2C	250v	250v	20v



Valve Base of A.R.P.34

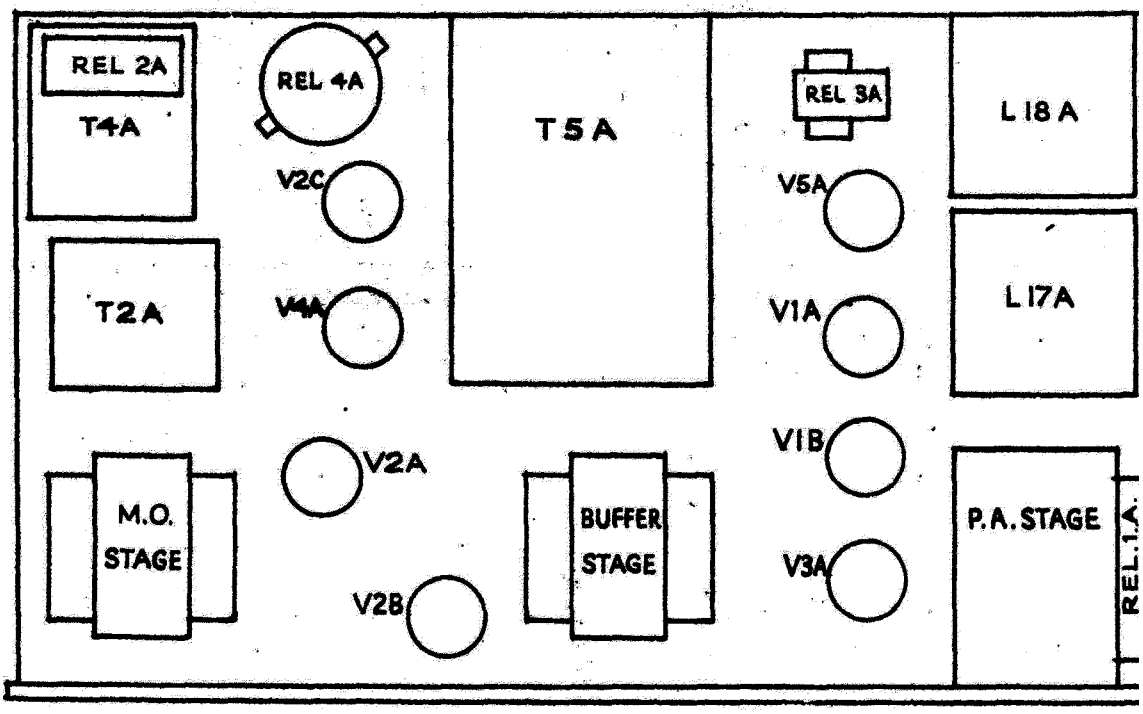


Figure 10. Plan shewing valve positions.

4. AERIAL COUPLING EQUIPMENT F.

The aerial coupling equipment comprises the Aerial Unit F, the Se Unit F and the Connectors Twin No.56. Aerial Unit F, which is connecte to the sender by means of the feeder cable(Connectors Twin No.56)and th set unit, enables any normal aerial to be matched to the feeder witho loss of range and efficiency. It consists essentially of a coil L1A sim ilar to that in the anode circuit of the P/A valve, tuned by a variable condenser C1A,(.0005 F),a tuning indicator lamp P1A, an aerial curren indicator containing the meter M1A and 3 controls governing frequenc range (S3), feeder coupling (S2) and aerial coupling. S2 & S3 are set t the same range as the sender P.A. range switch. On range 4 they are se to position 4B first. S3 which short-circuits suitable portions of L1 allows the circuit L1A,C1A to be tuned to the sender frequency, the lam P1A which is coupled to L1A by means of L2A lighting at resonance. S gives correct feeder coupling to L1A at the sender frequency. On al ranges the aerial coupling is adjusted by means of a continuously vari able tap. However, on ranges 1 and 2 part of the coil covered by the ta falls within the unused portion of the tuning coil.

Below are given the useful taps for the various frequency ranges

Range	Aerial Coupling Control
1	12.8 - 16.9 turns
2	9.8 - 16.9 "
3	
4a	0 - 16.9 "

With S2 and S3 switched to the correct range the circuit is tuned for the point of maximum brilliance of P1A,S1 being pressed if necessary. The optimum aerial coupling is obtained by reference to the meter which will then show a maximum.

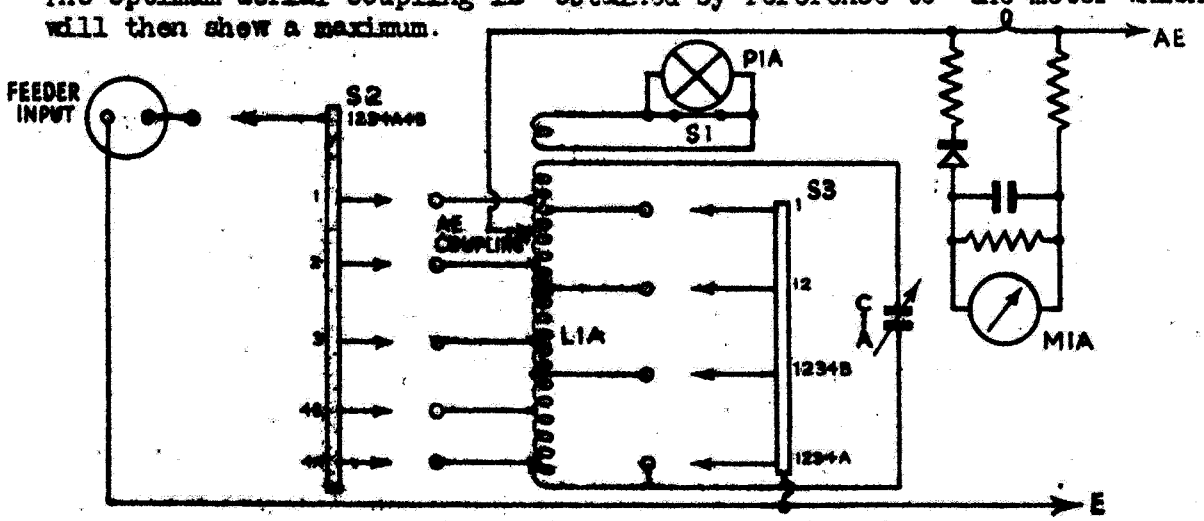


Figure 11. Aerial Coupling Equipment F.

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