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Richard Hankins, VMARS Archivist, Summer 2004

3rd TRADES TRAINING BN.
R. SIGNALS.

NOTES FOR

RADIO MECHANICS

PART 3.

Wireless Sets
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RECEPTION SETS R.107.

1. GENERAL.

The Reception Set R.107 is a receiver designed for C.W. & R.T. reception and it is usually employed in conjunction with Wireless Sets No 12 and 33.

The frequency range is 1.2 - 17.5 Mc/s covered in three overlapping bands thus :-

(I) 17.5 - 7 Mc/s
(II) 7.25 - 2.9 "
(III) 3.0 - 1.2 "

The set is designed for operation from a 12v. accumulator or alternatively from 100/250v. 50 ~ A.C. Change over from D.C. to A.C. operation is accomplished by means of a two-way switch in the power-chassis.

The complete apparatus comprises three separate chassis units i.e. R.F. IF/AF, and Power. These are mounted on a steel framework and a sheet steel panel carries the receiver controls. Connection between the three units is achieved by means of tagboards.

2. CIRCUIT DESCRIPTION.

A nine valve (eight plus rectifier) super-heterodyne circuit is employed. The valves are indirectly heated (6.3v. heaters) and are fitted with International Octal bases. There are four R.F.pentodes (ARP 34), four double-diode-triodes (AR21) and a full wave rectifying valve (6 x 5 G).

The circuit is arranged as follows :-

An R.F. stage is coupled by means of a band-pass filter to a mixer stage with separate 1st Local Oscillator, the intermediate frequency signal (465 Kc/s) thus produced is amplified by two I.F.stages which are followed by the combined signal detector - A.V.C. and A.F. stage. An output stage and Beat Frequency Oscillator complete the circuit.

(i) R.F. Amplifier.

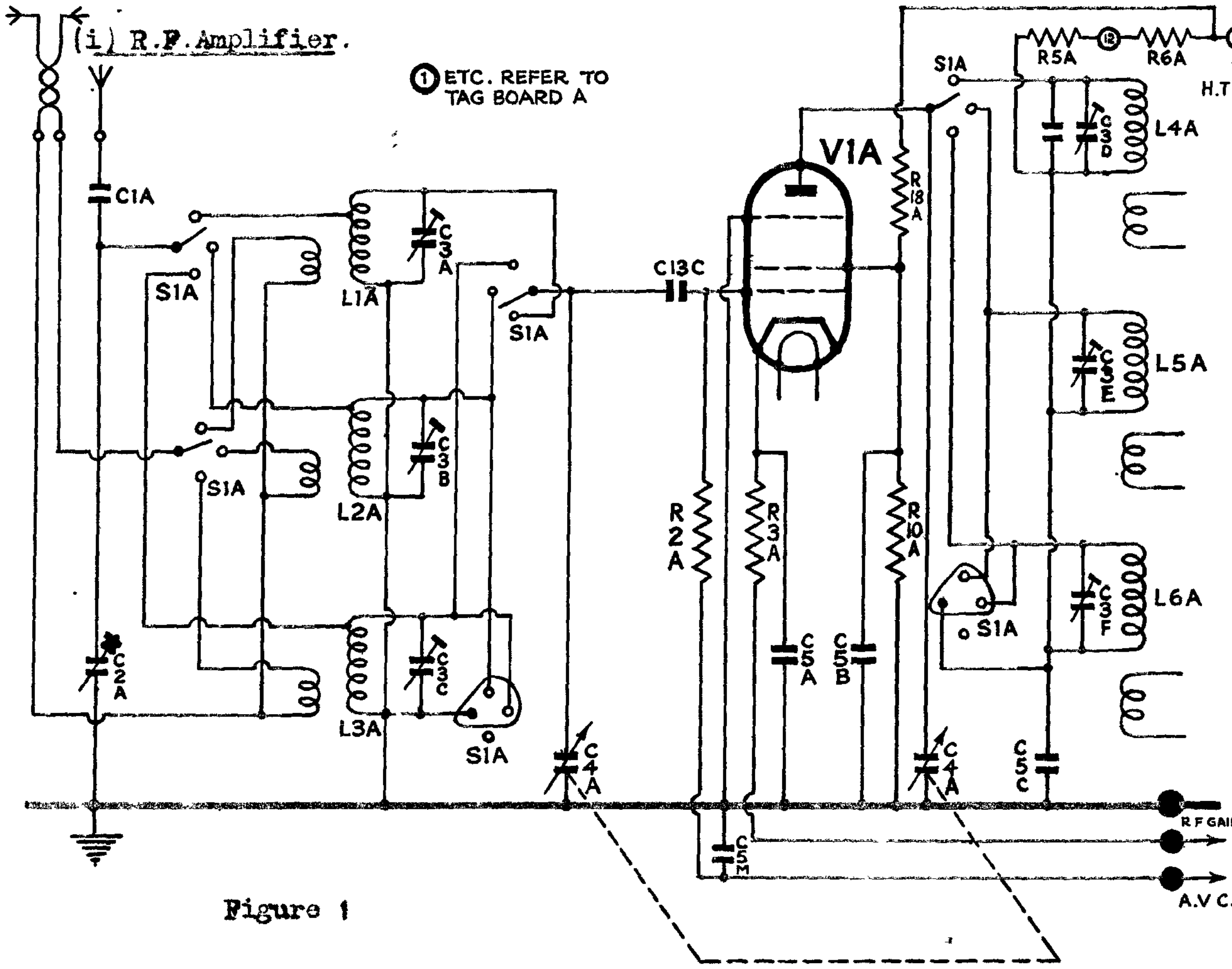


Figure 1

The signal from the open aerial is normally applied via the series condenser C1A(20$\mu\mu$F)to a tapping on the grid coil(L1A, L2A or L3A according to the frequency range selected by switch S1A), which is tuned by one section of a 4-gang variable condenser C4A(4 x .0003μF). Separate terminals on the front panel, connected via a section of S1A to a coil loosely coupled to the grid coil, enable a dipole aerial to be used. C3A-C(25$\mu\mu$F) are semi-variable trimming condensers associated with L1A, L2A and L3A respectively.

This tuned circuit is coupled to the grid of the R.F. pentode V1A via the grid condenser C13C (.0002μF)(Fig.12)H.T. to the anode of this valve is picked up from tag 1 of the tagboard A and applied via resistances R6A (3,000Ω) & R5A(5,000Ω) decoupled by C5C(.05μF) and the inductance L4A, L5A or L6A, according to the frequency range. Screen grid voltage for V1A is applied by means of the voltage divider comprising R18A(25,000Ω) top & R10A(20,000Ω) bottom. C5B(.05μF) is the screen decoupling condenser. Minimum bias on this stage is obtained in the usual manner from R3A (300Ω) in the cathode lead decoupled by C5A(.05μF). Extra cathode bias for R.F. gain control is provided by the variable resistance VR1A (4,000Ω) also in the cathode circuit.

A.V.C. decoupled by C5M(.05μF) is applied to the control grid from the A.V.C. line through the grid leak R2A(.25 MΩ).

Signals amplified at radio frequency are passed on to the frequency changer via the coupled circuits composed of L4A - B, L5A - B or L6A - B. (according to the position of the range switch S1A),which are tuned by the second and third sections of the 4-gang tuning condenser C4A.Link coupling is used between the separate tuned circuits.

The inclusion of three tuned circuits before frequency changing ensures adequate selectivity to prevent second channel interference.

(ii) Frequency Changer.

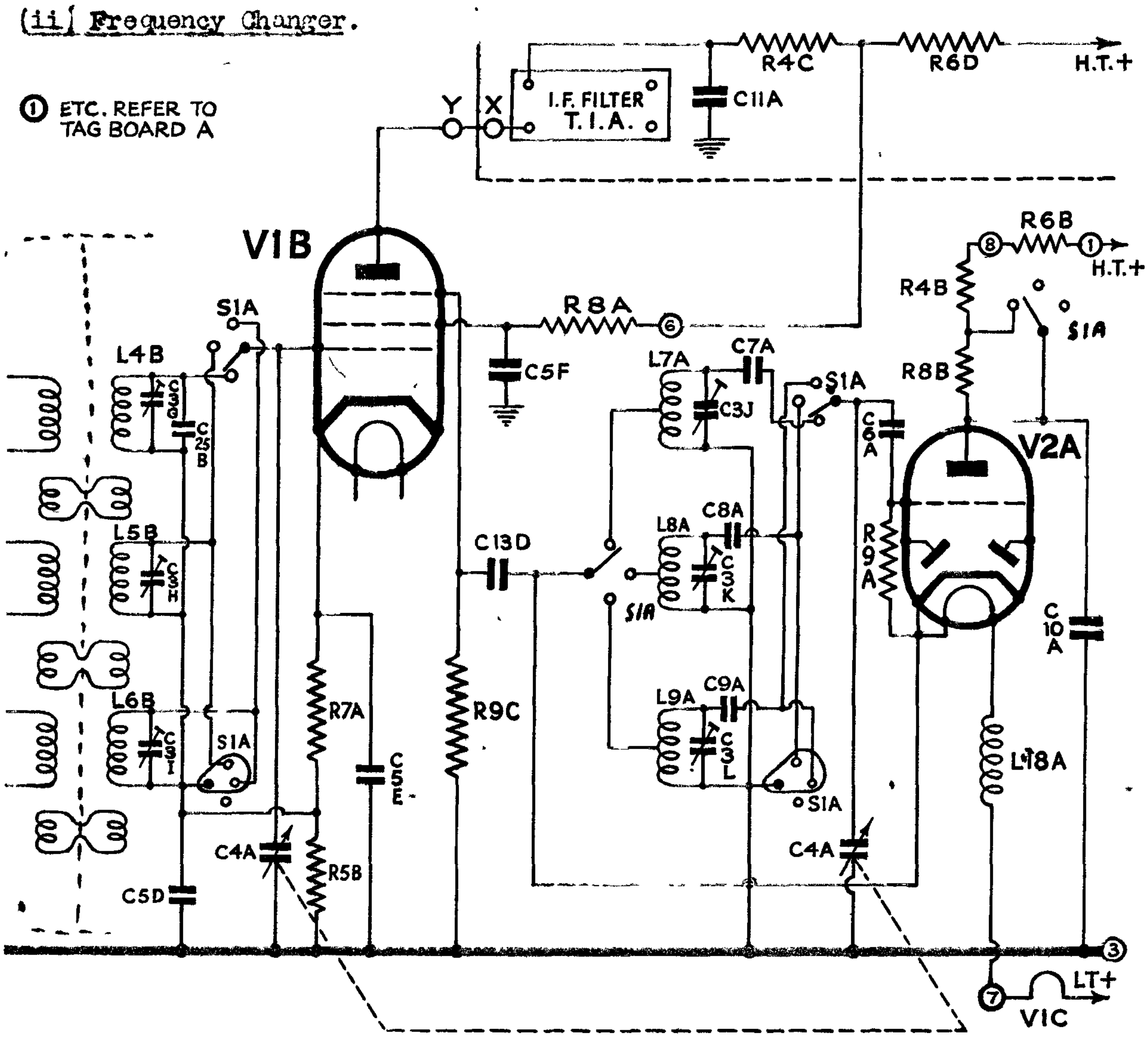


Figure 2

The output from the second of the circuits referred to above is applied direct to the control grid of the mixer V1B, an R.F. pentode type ARP 34.

The local oscillations are produced by V2A an AR 21, the triode portion only being used. The circuit of this oscillator is arranged in the form of a Hartley with the anode, instead of the cathode, at R.F. earth potential. The frequency of operation (i.e. signal + I.F.) is determined by the tuned circuit comprising L7A, L8A or L9A, tuned by the fourth section of C4A in series with the padder C7A (.005μF) on range 1, C8A (.00163μF) on range II and C9A (.00075μF) on range III. Trimming is carried out by means of the parallel trimmers C3J, C3K and C3L (25μμF) respectively.

All R.F. coils are fitted with inductance trimmers in the form of copper discs which can be screwed in and out of the coils longitudinally. Grid bias for V2A is obtained by means of the grid leak R9A (50,000Ω) and grid condenser C6A (80μμF). H.T. is fed to the anode through resistors R6B (3,000Ω), R4B (25,000Ω) and R8B (80,000Ω), the latter being shorted out on frequency Range 1. The anode is decoupled by C10A (.01μF).

In order to nullify the capacity effect between cathode and heater the latter is returned to earth via the tapping on the oscillator tuning inductance. L18A in the heater circuit offers a high impedance to oscillations on the cathode which would otherwise pass to earth via V1C and L.T. supply.

Suppressor grid injection is employed in V1B by coupling the cathode of the oscillator to the suppressor grid of the mixer valve via the condenser C13D (.0002μF). H.T. reaches this valve by way of the resistances R6D (3,000Ω) and R4C (25,000Ω) decoupled by C11A (.1μF) and the primary circuit of the I.F. filter T1A, the latter forming the anode load impedance. All these components are located in the IF/AF chassis unit. Screen H.T. is fed from R6D through R8A (80,000Ω) decoupled by C5F (.05μF).

A negative bias of one and a half volts is provided for the control grid by the resistance R7A (400Ω) in the cathode lead decoupled by C5E. (.05μF). The additional resistance R5B (5,000Ω) decoupled by C5D (.05μF) gives -20 volts bias on the suppressor grid. The suppressor grid leak has a resistance of 50,000Ω.

(iii) Intermediate Frequency Amplifiers.

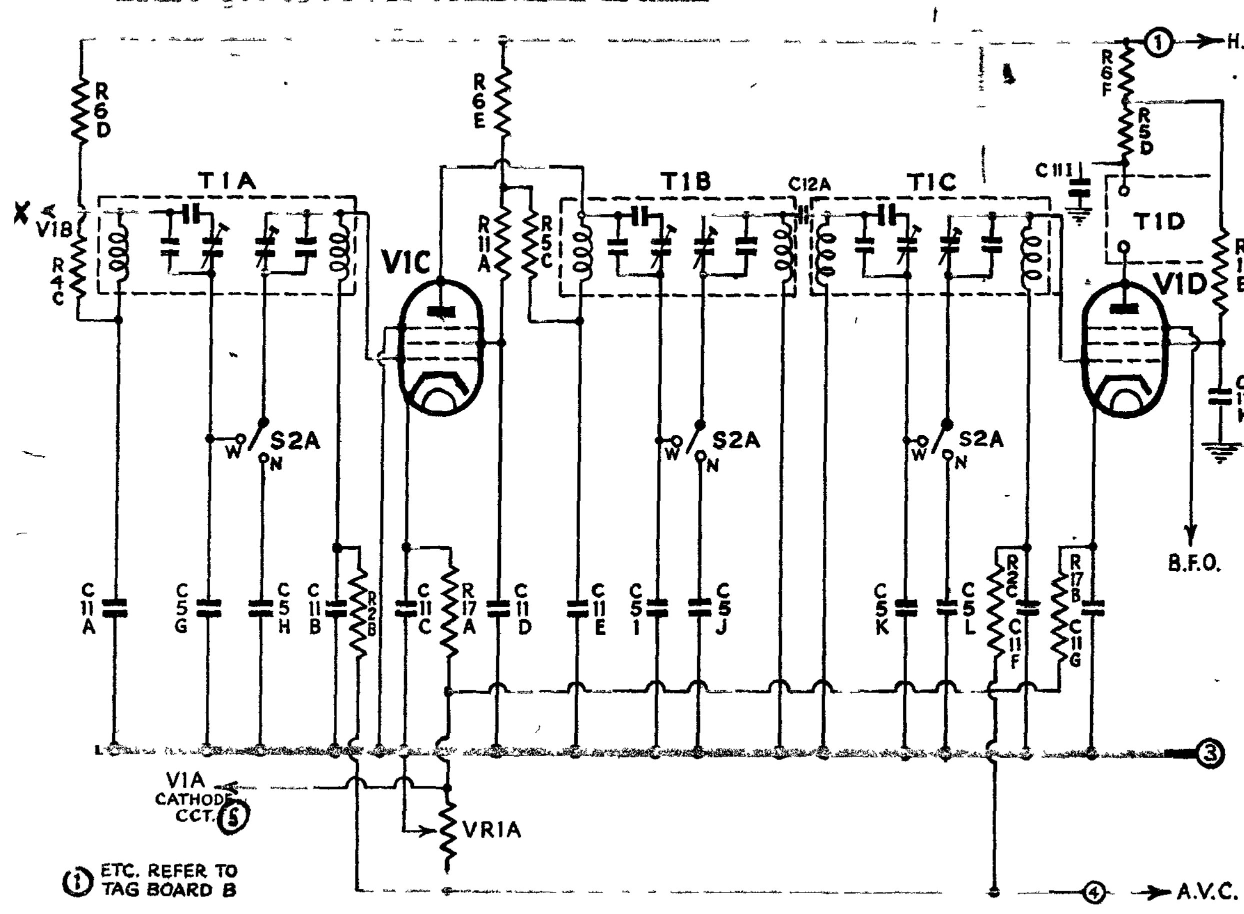


Figure 3

Two stages of intermediate frequency amplification are employed which give the necessary degree of sensitivity and adjacent channel selectivity. Each stage comprises an R.F. pentode, type A.R.P.34 (V1C & V1D), and band-pass filters.

The I.F output from V1B passes to V1C, the 1st I.F. stage via the band pass filter T1A. This latter consists of 2 inductances and their associated condensers contained in a metal screening box. Two degrees of selectivity are provided, - "Wide" and "Narrow", which can be selected by means of the switch S2A. On the "Narrow" setting the coupling between the tuned circuits is inductive, while in the alternative case additional coupling is provided by the condenser C5G (.05 μF), which is now common to both circuits.

Coupling between the 1st and 2nd stages is effected by means of two band-pass filters T1B and T1C, connected in series by means of C12A (2.2 μμF) which are similar in detail to T1A. The common capacitance in this case, on "Wide", is C5I and C5K (.05 μF respectively. A fourth filter T1D is employed between V1D and the signal detector V2B similar to the others except that the selectivity is not variable.

The I.F. response curve resulting from these filters drops 6dbs. for a band width of 3 Kc/s with an average cut-off slope of 15 dbs. per Kc/s on "Narrow". The corresponding figures in the "Wide" position are -6 dbs. when the bandpass is 7.5 Kc/s wide, with an average cut off slope of 12 dbs. per Kc/s.

(iv) Signal Detector.

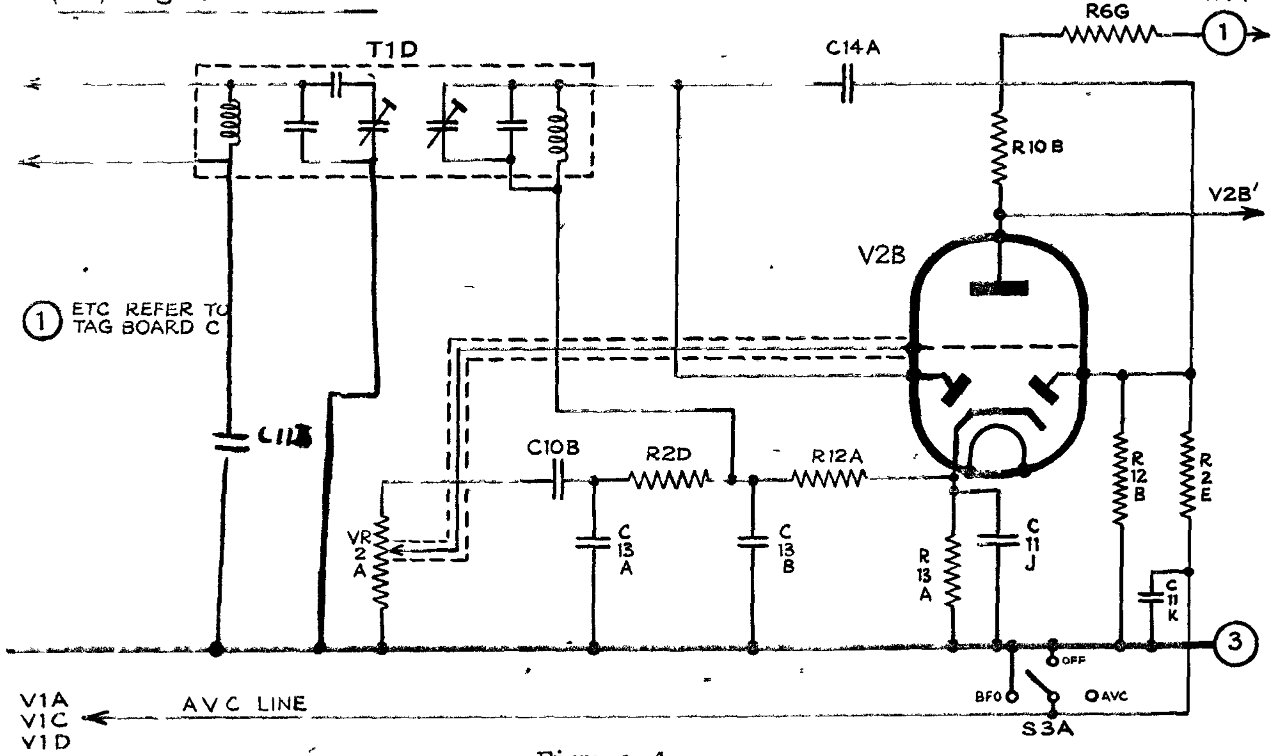


Figure 4.

Detection of the I.F. is performed by means of the first diode of V2B, a double-diode-triode W/T type A.R.21. R12A (.5 MΩ) is the series diode load resistance and C13B the diode condenser. R2D (.25 MΩ and C13A (.0002 μF) form an I.F. filter. A.F. passes through this and the coupling condenser C10B (.01 μF) to the audio gain control VR2A (.5 MΩ, and thence to the control grid of the triode section of V2B. C10B is included to isolate the control grid from the D.C. voltages produced by detection.

(v) Automatic Volume Control

A portion of the I.F. output from T1D is passed through C14A (.0001 μF) to the second diode of V2B. From this parallel diode circuit A.V.C. is obtained. The load resistance R12B (.5 MΩ) is returned to earth which is 3 volts negative with respect to the cathode due to the bias resistance R13A (1000 Ω) in the cathode lead. This provides an A.V.C. delay voltage of 3 volts. The negative potential developed across R12B, due to rectification of the incoming signal, is applied to the grid circuits of the controlled valves (V1A, V1C and V1D) via the filter resistance R2E (25 MΩ) decoupled by C11K (.1 μF).

In the "B.F.O." and 'OFF' positions of the BFO-AVC switch S3A the grid returns from the controlled valves are taken straight to earth.

(vi) Audio Frequency Amplifier.

The triode section of V2B functions as an amplifier of the audio frequency oscillations resulting from detection. H.T. is fed through the test resistance R6G (3000 Ω) and the anode load resistance R10B (20,000 Ω). Negative grid bias is obtained from the resistance R13A in the cathode lead decoupled by C11J (0 1 nF)

Resistance capacity coupling is employed between this and the output stage, the coupling condenser C10C having a value of 0 01 nF.

(vii) Output Stage

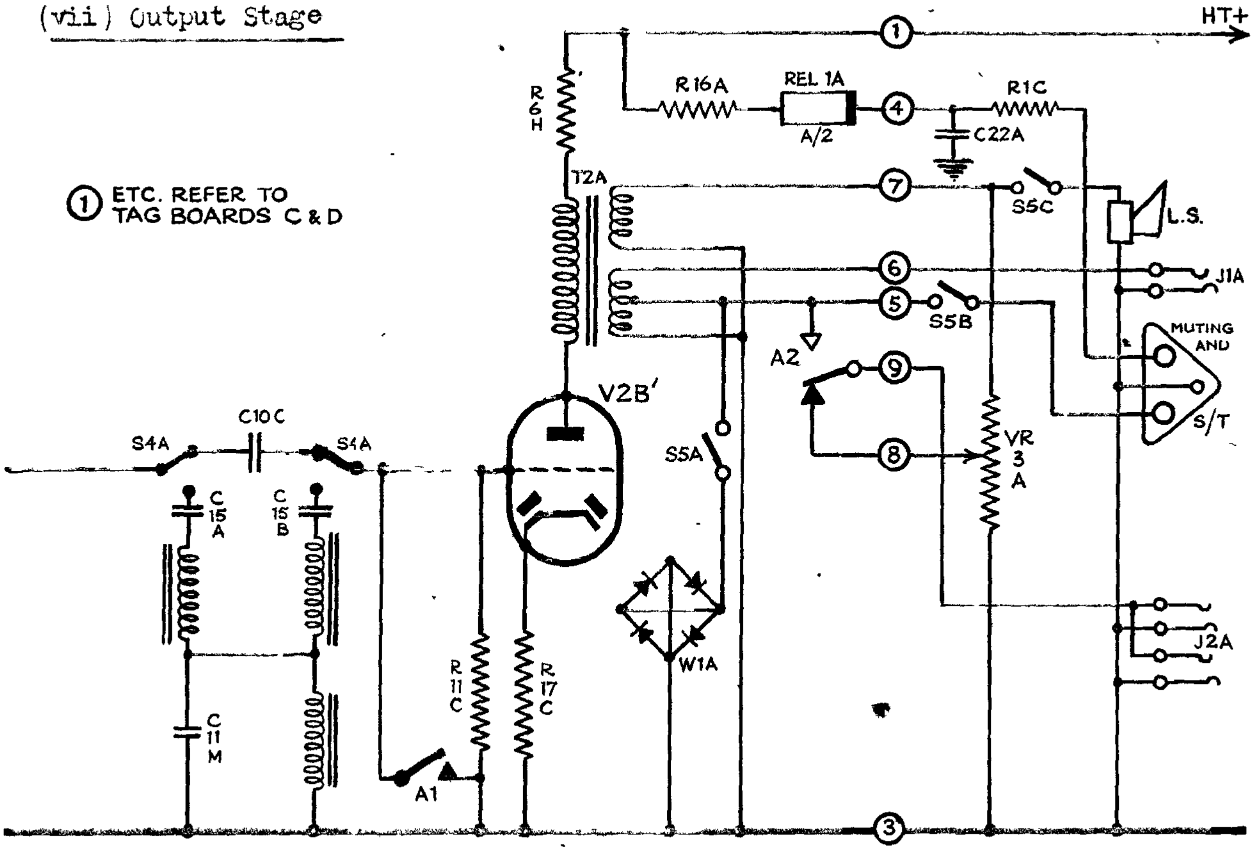


Figure 5.

V2B an AR21 with diode sections unconnected is used as a triode A.F. amplifier feeding into the output transformer T2A. Control grid bias is derived from the cathode resistance R17C (500 Ω).

An A.F. band pass filter, comprising one rejector and two acceptor ccts., which may be switched in or out of circuit by means of S4A is included between V2B and V2B'. This adds to the degree of selectivity obtainable on C.W. reception by allowing only a band of audio frequencies 300 ∿ wide at about 900 ∿ to pass to the output valve.

The component values of the tuned circuits are chosen to produce a resonant frequency of 900 ∿ If the B.F O. (next section) is adjusted to give a note of approximately this frequency on the wanted signal no loss will occur due to the filter and the A.F will be passed on to the output valve in the normal manner. Signals of other frequencies differing by more than 150 ∿, however, will produce notes differing by a similar amount. They will not reach the output valve owing to the filtering effect of the three tuned circuits.

The output transformer T2A is provided with two secondary windings, one of which is connected to the 'phone jacks J2A via the Audio gain potentiometer VR3A and the monitor loud-speaker. VR3A provides separate audio-control for the 'phones. The remaining secondary winding is wired to the Line jack J1A. The crash limiter W1A is switched across half the line secondary by means of S5A

(viii) Beat Frequency Oscillator.

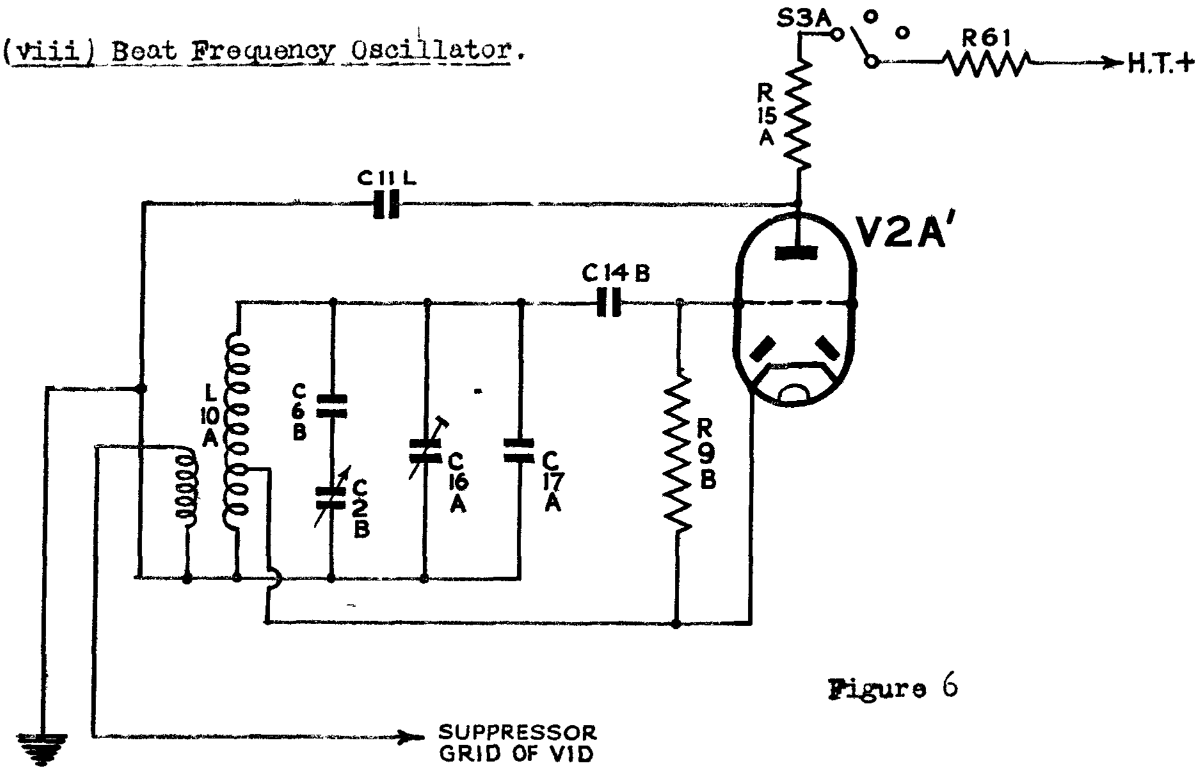


Figure 6

The Beat Frequency Oscillator V2A', a W/T type valve AR21 functions as an inverted Hartley Oscillator of similar type to V2A. The tuning circuit comprising the inductance L10A & condensers C17A(.001μF),trimmer C16A (.0001μF) & C6B (80$\mu\mu$F) in series with the B.F.O.Tuner C2B(50$\mu\mu$F) is adjusted to the intermediate frequency, 465 Kc/s, by C16A with the indicator at zero mark on the B.F.O.dial. The B.F.O. is inductively coupled to a coil in the suppressor grid circuit of the 2nd I.F. valve V1D, producing a beat note with the signal on detection.

3. THE POWER SUPPLY UNIT.

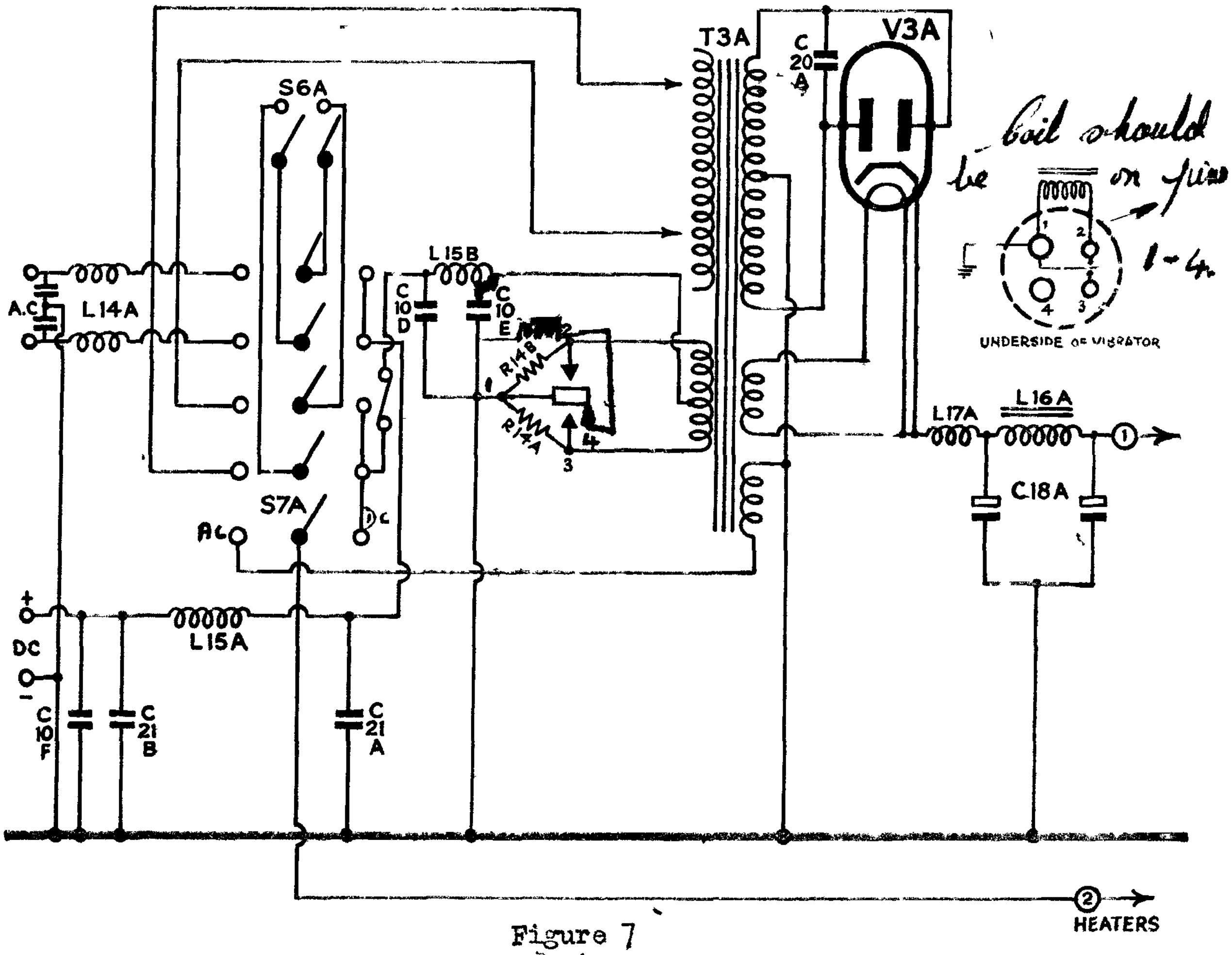


Figure 7

The components concerned with L.T. and H.T.supply to the receiver are located in the power chassis. They comprise the mains transformer T3A, the full wave rectifier V3A, L.T. & H.T. smoothing chokes & condensers.and the AC/DC change over switch S7A.

(i) A.C. Operation.

A.C.input from the 2-point plug No.3 is applied to the tapped primary of T3A via the change over switch referred to and the power switch S6A.Decoupling of the input is effected by means of the R.F.chokes L14A and condensers C23A-B (.001μF). The transformer primary tappings permit the use of any A.C. input voltage between 110 and 250 volts at 50 cycles/sec. Full wave rectification of the A.C. induced in the centre-tapped secondary is performed by V3A, an indirectly heated rectifier (6x5G). A separate low voltage (6.3v) winding is provided on T3A for the heater of V3A. Ripple in the output is smoothed out by means of the iron-cored choke L16A and the double electrolytic condenser C18A (8+8μF).Heater current for the receiver valves is obtained from 12v secondary winding provided for the purpose.

Receiver valve heaters are arranged in series-parallel as shewn in the figure below.

An R.F. filter consisting of L15C and C21C (1μF) is included in the heater circuit.

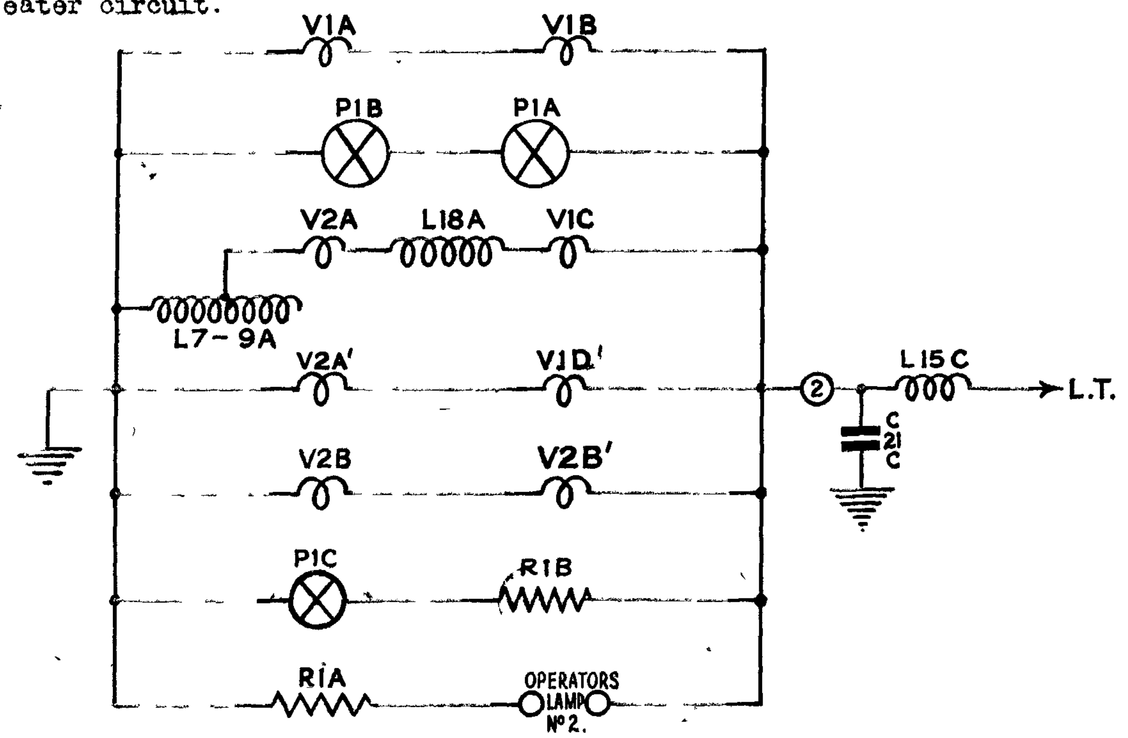


Figure 8

(ii) D.C. Operation.

The twelve volt input from accumulators is applied to a vibrator No.5 (Mallory type G650) & separate centre tapped primary on T3A via the change over switch S7A and the power switch S6A. The A.C.primary of T3A is open-circuited on D.C. Induced A.C. in the secondary is rectified and smoothed as for A.C. operation detailed above Heater current is obtained from the common L.T. input of 12v and not from the low voltage transformer secondary used on A.C.

4. MUTING AND SIDETONE.

When the R107 is used in conjunction with the No.12 or No.33 set the receiver can be muted and side tone fed to the loud speaker and 'phones on send merely by pressing the sender key or the microphone pressel switch. This is accomplished by means of the relay REL 1A located at the rear of the IF/AF chassis.

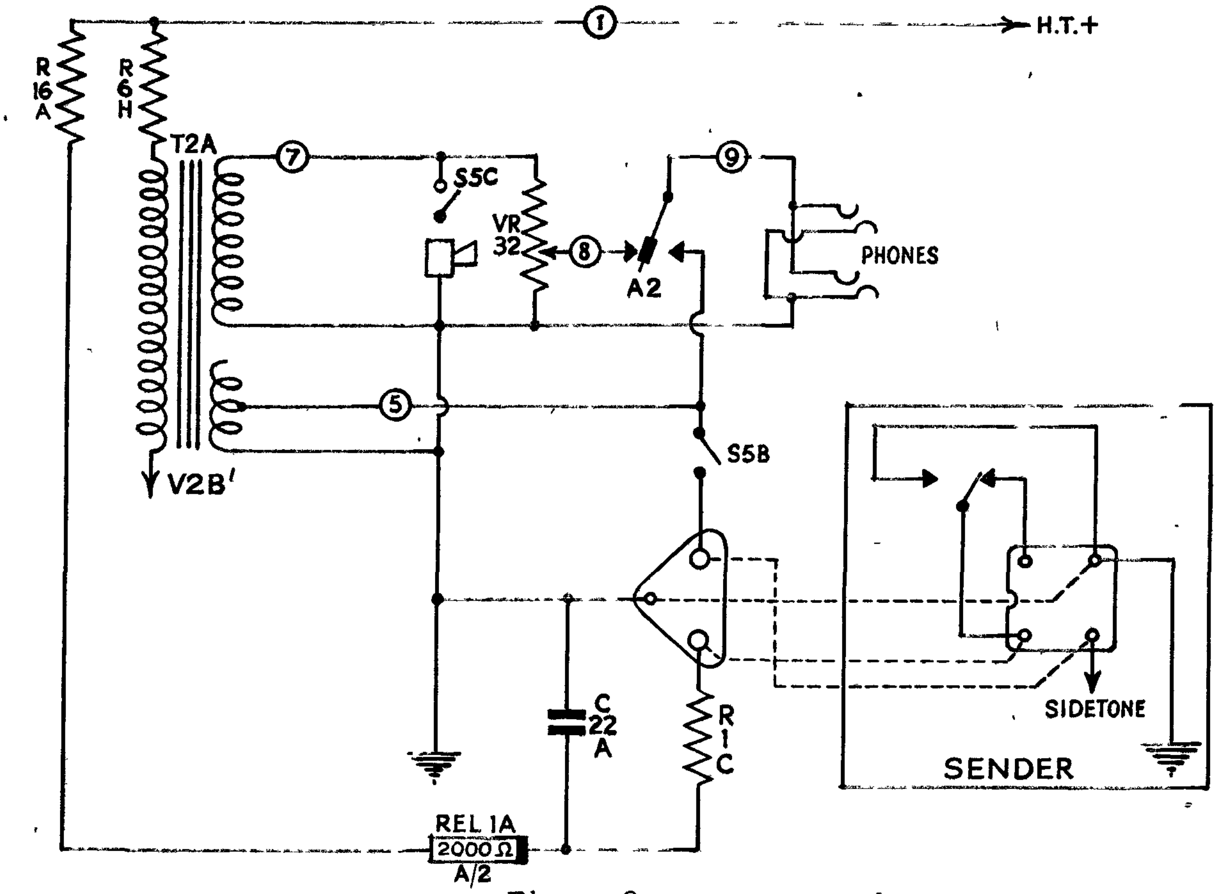


Figure 9

The relay armature operates two spring sets one of which comprises a simple make and break contact unit A1 and earths the control grid of the output valve V2B'. The other spring set consisting of a change over action simultaneously disconnects the 'phones from the receiver & applies sidetone to them from the sender via the side tone switch S5B & the 3-point plug.

Rel 1A is energised from the H.T. supply which is fed through the resistance R16A (15,000Ω), the circuit being completed via the 3-point plug and contacts on the 'muting' relay in the sender. Arcing at the contacts of the latter is minimised by the inclusion of condenser C22A(4μF) and resistance R1C (100Ω). (See Appendix)

5. LOCATION OF FAULTS ON RECEPTION SETS R.107.

Having made certain that the fault is not an external one, the valves should be tested. This can be done, without removing the set from its case with the aid of a voltmeter and the valve test panel located on the front panel. By this means the cathode current of each valve may be checked by measuring the voltage drop across a 3,000ΩR6 resistance in its H.T. supply.

A table of approximate readings is given below, taken with an Avometer Model 7 (resistance 500Ω/volt) using the 100v range. Readings obtained with other ranges or a meter with a different internal resistance maydiffer considerably from those given.

Valve	Type	Function	Approx: Reading		
V1A	A R P 34	R.F.Amp	15.0 volts		
V2A	A R 21	1st L.O.	11.0	"	Range I
			5 0	"	" II
			5.0	"	" III
V2A	"	B.F.O.	9 5	"	
V1B	A R P 34	Mixer	11.5	"	
V1C	"	1st I.F.	16.5	"	
V1D	"	2nd I.F.	16.5	"	
V2B	A R 21	1st A.F.	9.5	"	
V2B	"	Output	20.0	"	

Before taking valve readings always short aerial terminals(no signal), turn R.F. gain control fully clockwise and switch to B.F.O.

If an abnormal reading is obtained on any stage first try replacing with a valve of similar type from another stage.

The following points carefully noted will help towards an intelligent interpretation of readings obtained :-

1. The heater circuits are wired in series-parallel and therefore if the meter fails to read on one point only the fault will not lie in the heater circuit. On the other hand no readings at V1A & V1B, or V2A & V1C, or V2A′ & V1D or V2B & V2B′ will indicate a heater or heater circuit fault.

2. Complete absence of readings or low readings on all test points will probably indicate an L.T. or H.T. fault or both. The H.T. supply can be checked by reading between the + point on the test panel and chassis(250v) If the L.T. is correct 12 volts (A.C. or D.C. according to supply) should be obtained across the lamp sockets. In both cases the set need not be removed from its case.

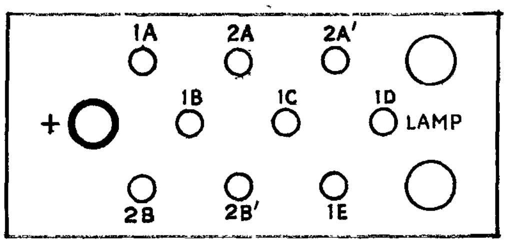


Figure 10

Valve Test Panel Connections (1E not used)

3. No reading at one point only after substituting a similar valve will indicate that the anode or screen supply is open-circuited. Remove the set from its case and apply voltage tests to the electrodes.

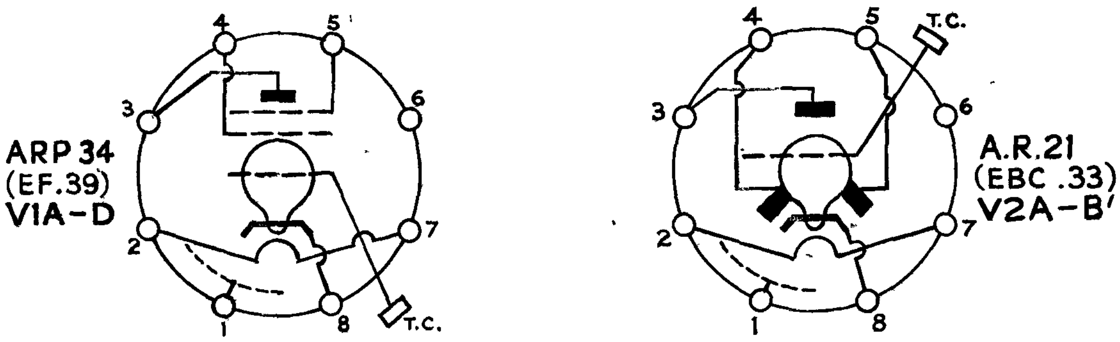


Figure 11. Valve Holders Viewed From Underside of Chassis.

Normal readings on the test panel will indicate that the valves and their anode, screen, heater and bias supply circuits are in order. The remainder can be tested stage by stage from output to aerial as follows:-

With the set switched on, the audio and R.F. gain controls at maximum and the crash limiter and audio filter off, touching the grid cap of each valve from the 2nd A.F.to the R.F.stage in turn should produce clicks in the 'phones. If a valve is encountered which produces no clicks, that stage, at least, is faulty, and the various components must be tested individually with an A.V.O.

When a fault is indicated in the R.F.stage it should be noted whether the trouble is experienced on all frequency ranges; if so, it may be assumed to exist in that part of the R.F. and 1st L.O. which is common to all ranges.

The wiring and components,which are accessible without dismantling the separate chassis units, can best be tested by standing the set on the handles of the front panel.

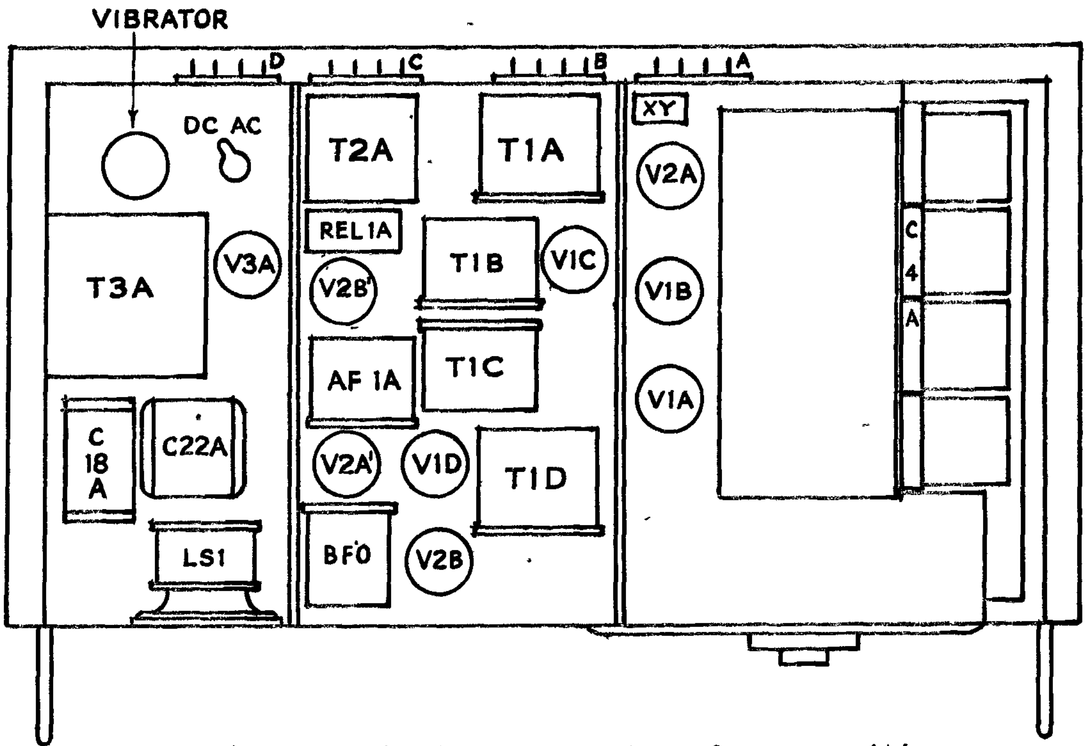


Figure 12. Plan showing valve & transformer positions.

<u>Appendix to section 4.</u>

<u>MUTING & SIDETONE.</u>

With Rel 1A normal (i.e., R107 switched off), sidetone is still obtained due to mutual coupling between the two secondaries of T2A.

NOTES ON RECEPTION SET R109.

1. GENERAL DESCRIPTION.

The Reception Set R109 is a general purpose wireless receiver suitable for use as a vehicle station or as a portable ground station. The inclusion of a beat frequency oscillator provides for the reception of C.W. signals as well as R/T and M.C.W.

The frequency range is 1.8 to 8.5 Mc/s covered in two bands. The set will therefore receive signals from any No.19 or 22 Set within range.

As a vehicle station the set, which is contained, complete with Power Unit, in a metal case, is mounted in a rubber suspended carrier which is bolted inside the vehicle. By releasing two catches the set may be removed from its carrier and set up as a ground station.

Those familiar with the No.21 Set will notice the similarity in construction and appearance between it and the set under discussion. Later, similarity in circuit details will be noted.

Aerials.

When operated as a vehicle station the set will be used with a vertical aerial comprising three 4' tapered rods which fit into one another (Antennae Rods F Sections 1, 2 and 3). The whole is mounted in a flexible rubber base (Aerial Base No.10) on the outside of the truck. Protection from overhead power lines is provided by a fixed condenser in the aerial lead, (Condenser X5, 5 KV Mk II). Four 4' rods may be used with a stationary vehicle. The receiver is earthed on the vehicle chassis by connecting one of the earth terminals to the carrier.

For ground station operation a self-supporting vertical aerial as described above may be used. Four sections, giving a total length of 16', are mounted in an Aerial Base No.11, the latter being clamped to a spike hammered into the ground. A counterprise earth should be used with this arrangement (Leads Counterprise No.2 Mk II). It may be noted, however, that in some circumstances satisfactory results may be obtained without an earth connection.

Two aerial terminals are provided marked 80 ohms and 500 ohms respectively. Aerials of the Marconi variety which are an odd number of 1/4 λ in length are connected to the low impedance (80 ohm) terminal on the set. The vertical aerials are connected to this terminal. The alternative terminal provides for matching the set to a high impedance Hertz type of aerial, the total length of which, i.e. horizontal portion + down lead, will be adjusted to 1/2 the wavelength of the received signal.

Power is derived from a 6 volt 40 A.H. accumulator, high-tension voltage being obtained by the use of a vibrator and selenium rectifier. L.T. current consumption is approximately 1.2 Amps.

The receiver employs an eight valve superheterodyne circuit consisting of an R.F. amplifier, mixer with separate local oscillator, two stages of I.F. amplification, combined signal detector A.V.C. diode and 1st A.F. amplifier followed by an output stage. A B.F.O. which may be switched on for the reception of C.W. signals completes the circuit.

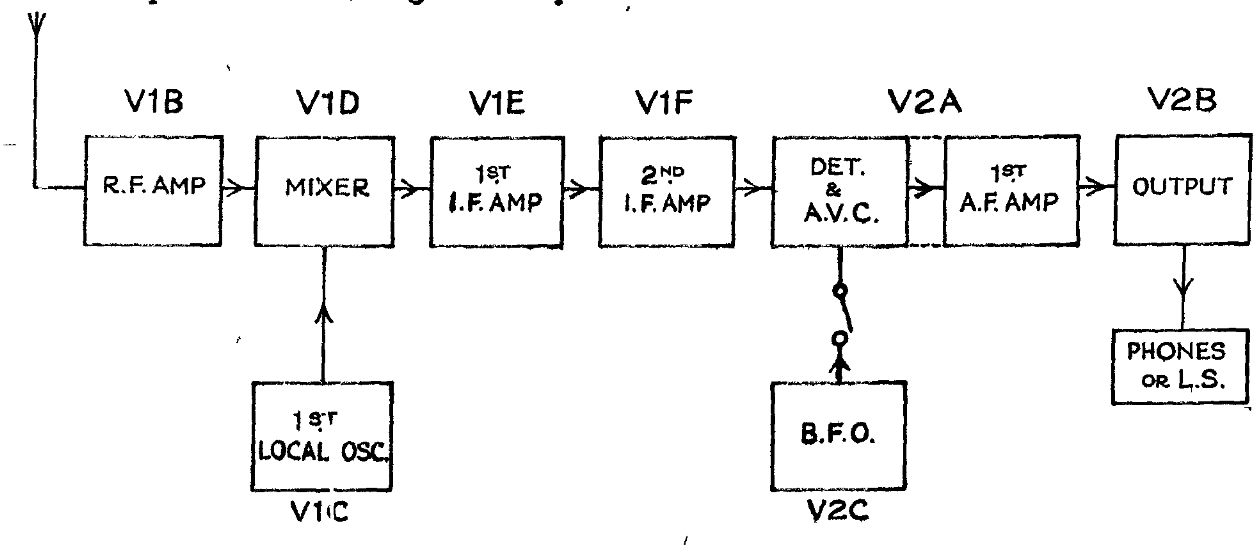


Figure 1. Block Diagram of R109.

2. DETAILED DESCRIPTION OF CIRCUITS.

(i) The R.F. Amplifier Stage.

The signal frequency R.F. valve V1B is a 2 volt directly heated R.F. pentode, type ARP12. The two tuned circuits associated with this valve provide sufficient selection before the frequency changer to prevent serious 2nd channel interference

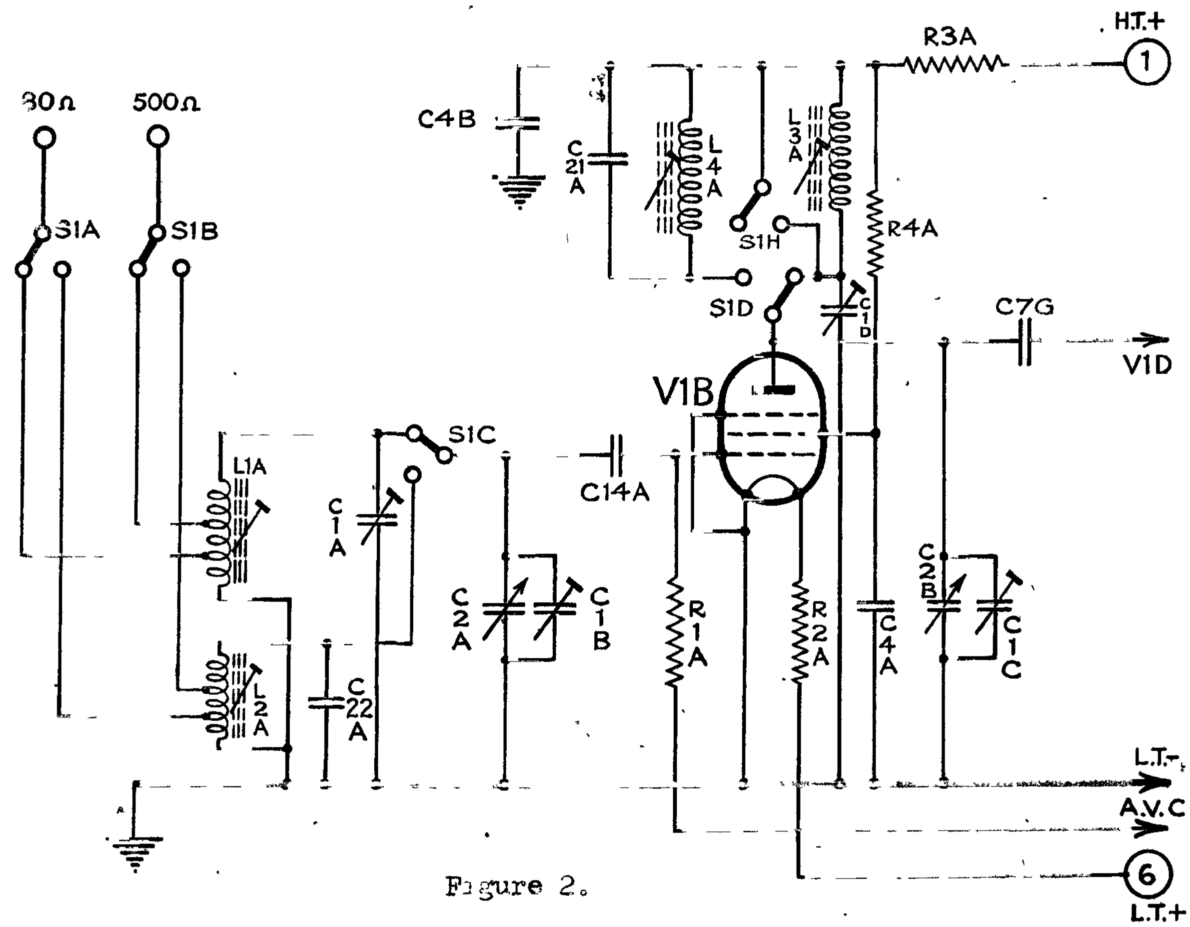


Figure 2.

The received signal is auto-coupled to the grid circuit comprising the dust iron cored inductance L1A or L2A tuned by C2A, one section of a 3-gang tuning condenser. C1B (5/35 μμF) is a trimming condenser located on the 3-gang assembly which in conjunction with C22A (22 μμF) enables the R.F. stage to be aligned on the 3.9/8.5 Mc/s band. C1A (5/35 μμF) is an additional trimmer operative on the 1.8/3.9 Mc/s band only.

The grid condenser C14A (.0003μF) enables grid bias of minimum value - 2.5V to be applied via the grid leak R1A (1 MΩ) and the A.V.C. line. Filament voltage is adjusted to its correct value by the filament resistance R2A (71Ω).

Tuned anode coupling is employed between this and the mixer stages. The dust-iron cored anode inductance L3A or L4A is tuned by C2B another section of the 3-gang condenser. Trimming on the higher frequency band is accomplished by C1C in conjunction with C21A. C1D is an additional trimmer for the other band. The anode circuit is decoupled by C4B (.01 μF) in conjunction with R3A (5000Ω) while R4A (.25 MΩ) and C4A serve a similar purpose for the screen grid of this stage.

R.F. output at signal frequency is taken from the anode to the control grid of the mixer V1D via the coupling condenser C7G (150 μμF).

(ii) The Mixer Stage and Local Oscillator.

Frequency changing is carried out by applying the output from the oscillator V1C to the suppressor grid of the mixer valve V1D. V1C is an R.F. pentode type ARP12 functioning as a tetrode in a series-fed tuned anode oscillator. Note that while screen grid and anode are strapped together the suppressor grid is earthed. This affords an increased R F. output. This is tuned to a frequency 465 Kc/s above that of the incoming signal by means of C2C the remaining section of the 3-gang tuning condenser. Minimum tracking error is maintained by means of the padders C5A (.0015 μF) and C6A (.002 μF) in series with the tuning inductances L5A (1.8/3.9 Mc/s) and L6A (3.9/8.5 Mc/s) respectively. Control grid bias for the valve is applied by means of the grid-leak and.

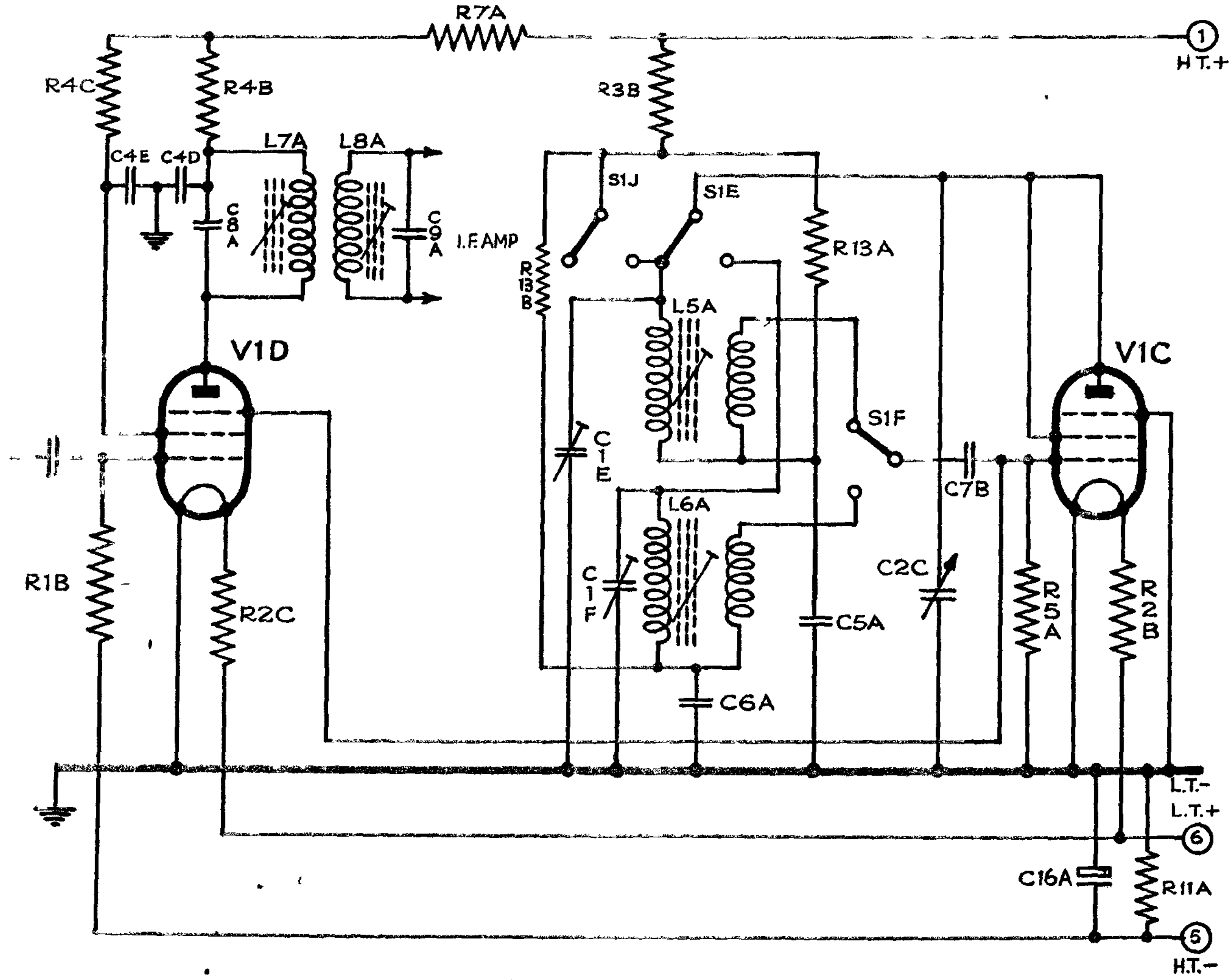


Figure 3.

condenser C7B and R5A (150$\mu\mu$F and 25,000Ω) respectively.

On the higher frequency band L5A is shorted by R13B, the anode feed resistance used on the other band. This is to prevent loss of efficiency on this frequency band due to absorption by the 1.8/3.9 Mc/s coil.

L7A, the primary winding of the 1st I.F. transformer, in conjunction with C8A (150$\mu\mu$F) form the anode load of the mixer valve V1D. This tuned circuit has a natural frequency of 465 Kc/s(I.F.) & selects this frequency difference between the incoming signal and the output from the local oscillator. Tuning adjustment to the I.F.coils is carried out by means of the movable slug inside each coil.

A steady negative bias of 2.5volts is applied to V1D by retuning the control grid via R1B (1 MΩ) to H.T.-.

R7A (10,000Ω) and R3B (5,000Ω) provide convenient means of testing the cathode current of V1D & V1C respectively by measuring the voltage drop across them.

(iii) The Intermediate Frequency Amplifier.

This comprises two R.F. pentodes, type ARP12, employed in a two stage amplifier. The two valves V1E and V1F are coupled by I.F.bandpass transformers permeability tuned to the intermediate frequency 465Kc/s. Coupling to the signal diode detector stage is via another band-pass transformer.

The I.F.component of the output from V1D passes to the 1st I.F.valve V1E via the bandpass filter consisting of L7A & L8A with their associated condensers C8A (150$\mu\mu$F) and C9A (160$\mu\mu$F) respectively.

V1E is coupled to V1F by means of a similar filter consisting of L7B and L8B and their associated condensers C8B and C9B. Note. All complete circuit diagrams supplied with the set show an unused secondary winding in the 1st and 2nd I.F.transformers. These components were originally designed for the No.21 Set.

Anode and screen grid decoupling & control grid biasing arrangements are similar for both stages. Both suppressor grids are taken down to chassis. H.T. to anodes and screens is supplied by way of the test resistances R7B and R7C (10,000Ω) decoupled by C4H and C4L (.01μF) respectively. Further decoupling for the screens is provided by C4G and C4K (.01μF) in conjunction with the voltage dropping resistances R4D and R4E (.25 MΩ).

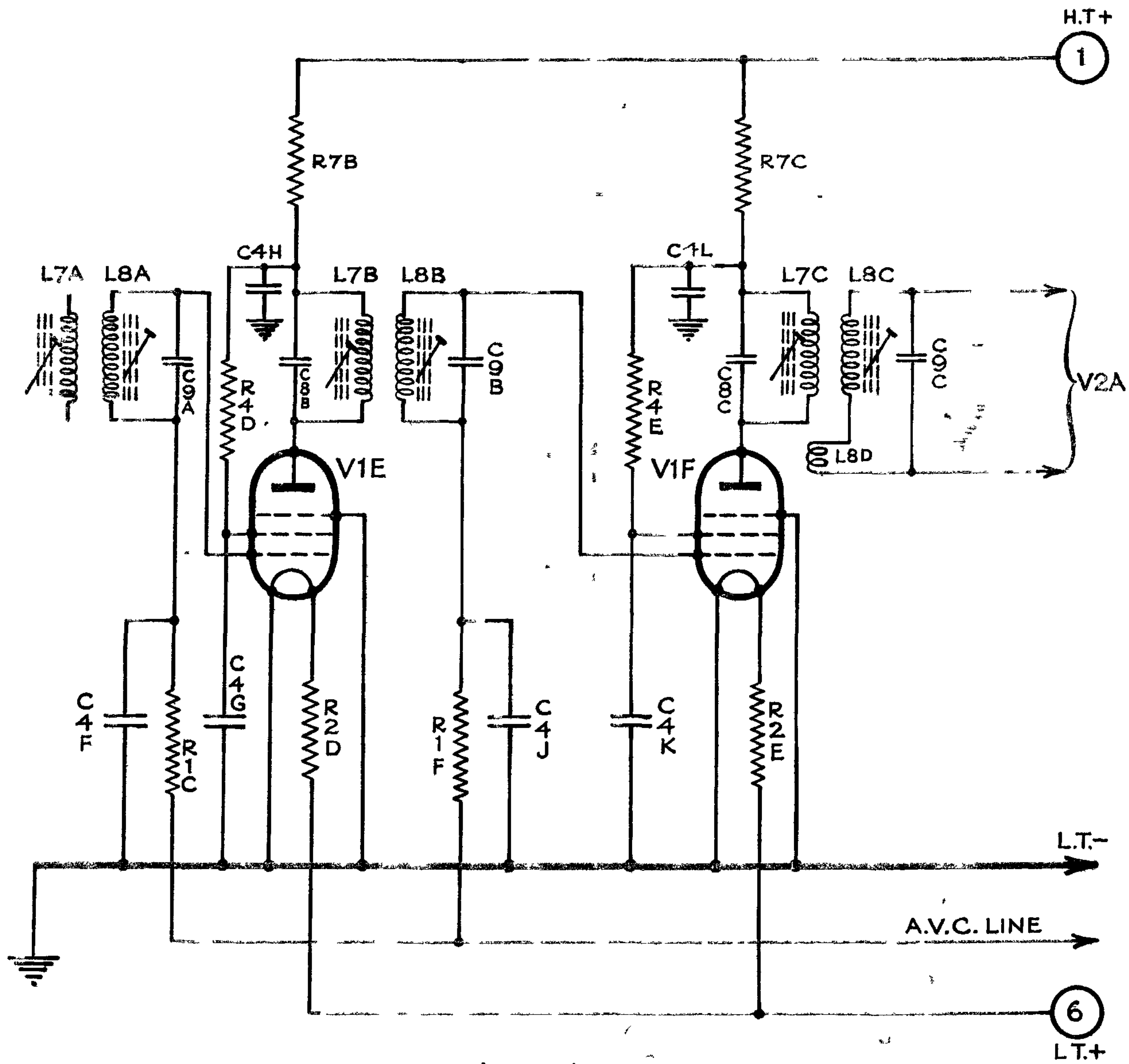


Figure 4.

Full A.V.C. is supplied to both valves by returning the control grid to the A.V.C. diode via the filter secondary and a 1 MΩ decoupling resistance (R1C and R1F) in each case. C4F and C4J (.01 μF) provide a low impedance path for I.F. between the earthy end of the filter secondaries and filament.

R2D and R2E are filament resistances.

The I.F. filter coupling V1F to the signal diode and comprising L7C, L8C, C8C and C9C is slightly modified by the inclusion of the extra coupling coil in series with the secondary. This provides a broader frequency response compared with that of the previous stages.

(iv) Signal Detector.

One diode of V2A, a double-diode triode valve, type AR8, functions as signal detector in a series diode circuit. R1D (1 MΩ) and C3B (100 μμF) are the load resistance and condenser respectively. R8A (.1 MΩ) in conjunction with C7D (150 μμF) and C3B form an I.F. filter. A.F. voltages across the load R1D are applied to the triode portion of V2A for amplification via the blocking condensers C11A (.002 μF).

(v) 1st Audio Frequency stage.

As inferred above the triode section of V2A functions as an A.F. amplifier. This stage is resistance capacity coupled to the output stage V2B, the anode load resistance being R9A (50,000 Ω) and the coupling condenser C11B (.002 μF). H.T. to the anode is decoupled by the electrolytic condenser C13A (2 μF) in conjunction with the test resistance R3C (5000 Ω).

A steady negative grid bias of 2.5 volts is applied by returning the control grid to H.T.- via the grid leak R1G (1 MΩ) and the decoupling resistance R1H (1 MΩ). C12A the decoupling condenser has a capacity of .1 μF. Note the I.F. stopper R4F (.25 MΩ) in the grid lead. The action of this component has been dealt with in Notes on W/S No.21.

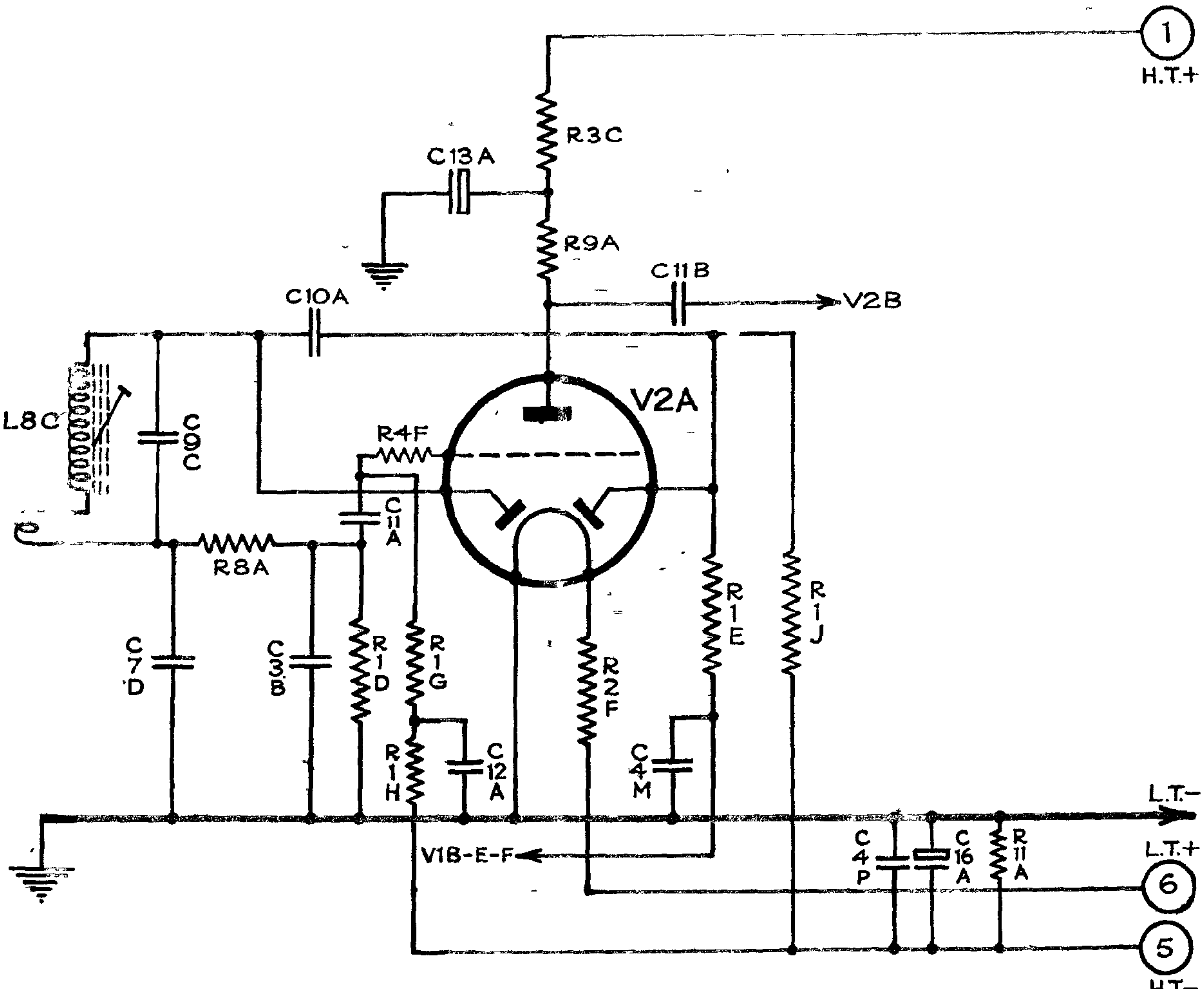


Figure 5.

(vi) Automatic volume control.

The remaining diode portion of V2A operates in a parallel diode circuit to provide extra grid bias on V1B - E - F when receiving strong signals. It should be noted that there is no R.F. gain control on this set.

I.F. input to this circuit is taken from the secondary of the last I.F. band-pass filter via the condenser C10A (200μμF). R1J (1 MΩ) between anode and H.T.- provides the load and the anode will of course receive a 2.5 volt negative bias due to R11A (250Ω) in the H.T.- lead. This bias acts as A.V.C. delay voltage so that the diode is inoperative on weak signals. The rectified signal causes a negative potential to develop at the anode proportional to the strength of the received carrier. This voltage is applied to the controlled valves as bias through the filter comprising R1E (1 MΩ) and C4M (.01μF).

(vii) The Output Stage.

The output stage comprises a double diode triode valve type AR8 functioning as a triode A.F. amplifier, the two diodes being strapped to filament. This valve works into an output transformer T1 which has two secondaries. One secondary is associated with two phone jacks while the other feeds a small loudspeaker. The switch S2A enables the receiver to be operated with either the loudspeaker OR phones.

The A.F. output from the previous stage is applied via the coupling condenser C11B to the receiver volume control R10A (1 MΩ variable). A.F. voltage is tapped off the latter and passed to the grid of V2B via the grid stopper R8B (.1 MΩ). Control grid bias is obtained by returning the volume control resistance to H.T.-. The anode circuit is decoupled by means of the electrolytic C13B (2μF) in conjunction with the test resistance R3D (5000Ω).

A crash limiter may be switched across the phone secondary of T1 by means of the switch S3A and consists of a metal rectifier unit W1A. This comprises two rectifiers in parallel but with polarities reversed the whole functioning as an A.C. resistance the value of which decreases rapidly with increase in applied voltage. The result is that for ordinary signal voltage, the resistance is high and has little effect, but on reception of transients such as atmospherics it becomes low and forms an effective short across the secondary winding of T1. C14B (.003μF) a condenser between anode and earth limits the high-note response of the set and overcomes shrillness in reproduction.

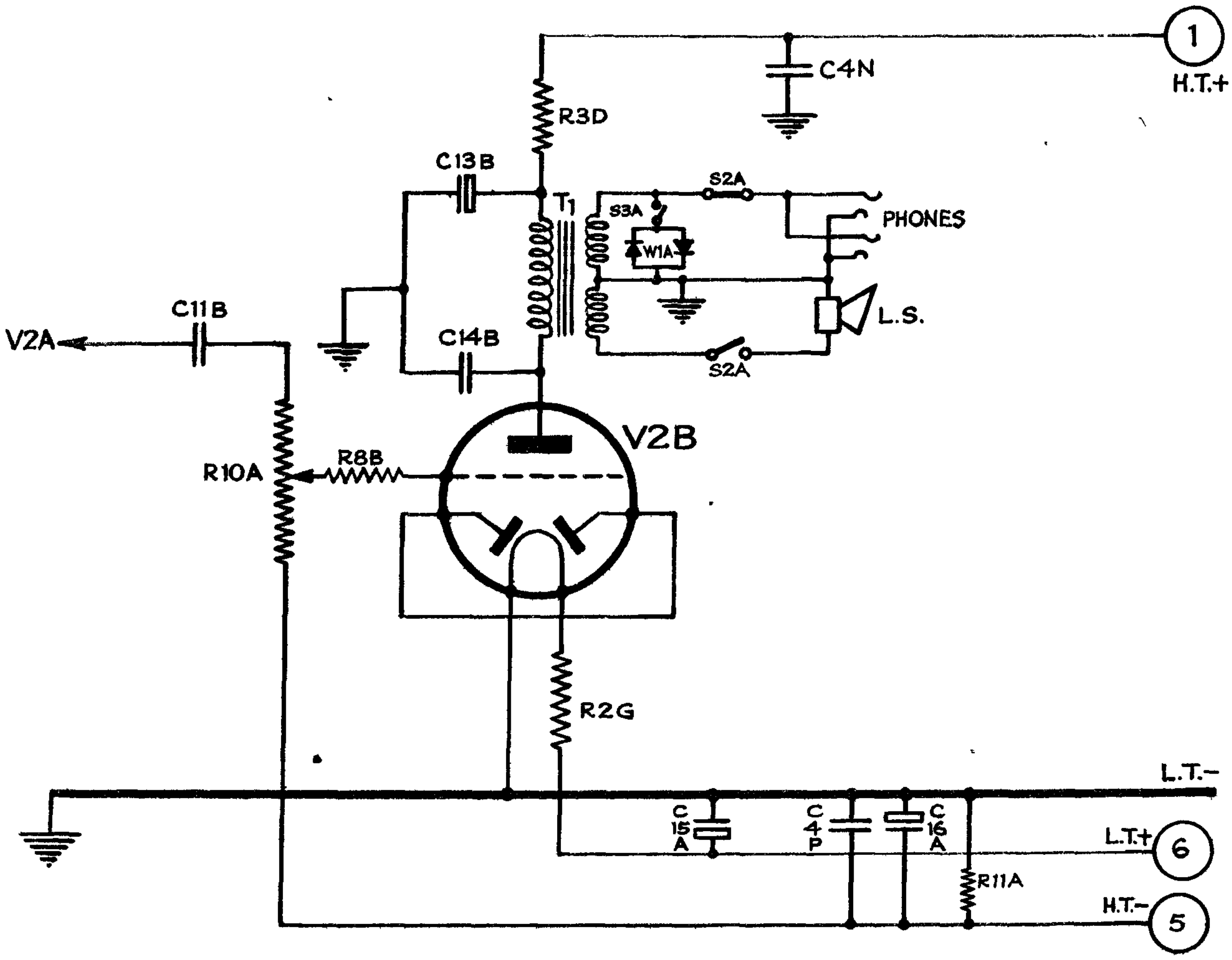


Figure 6.

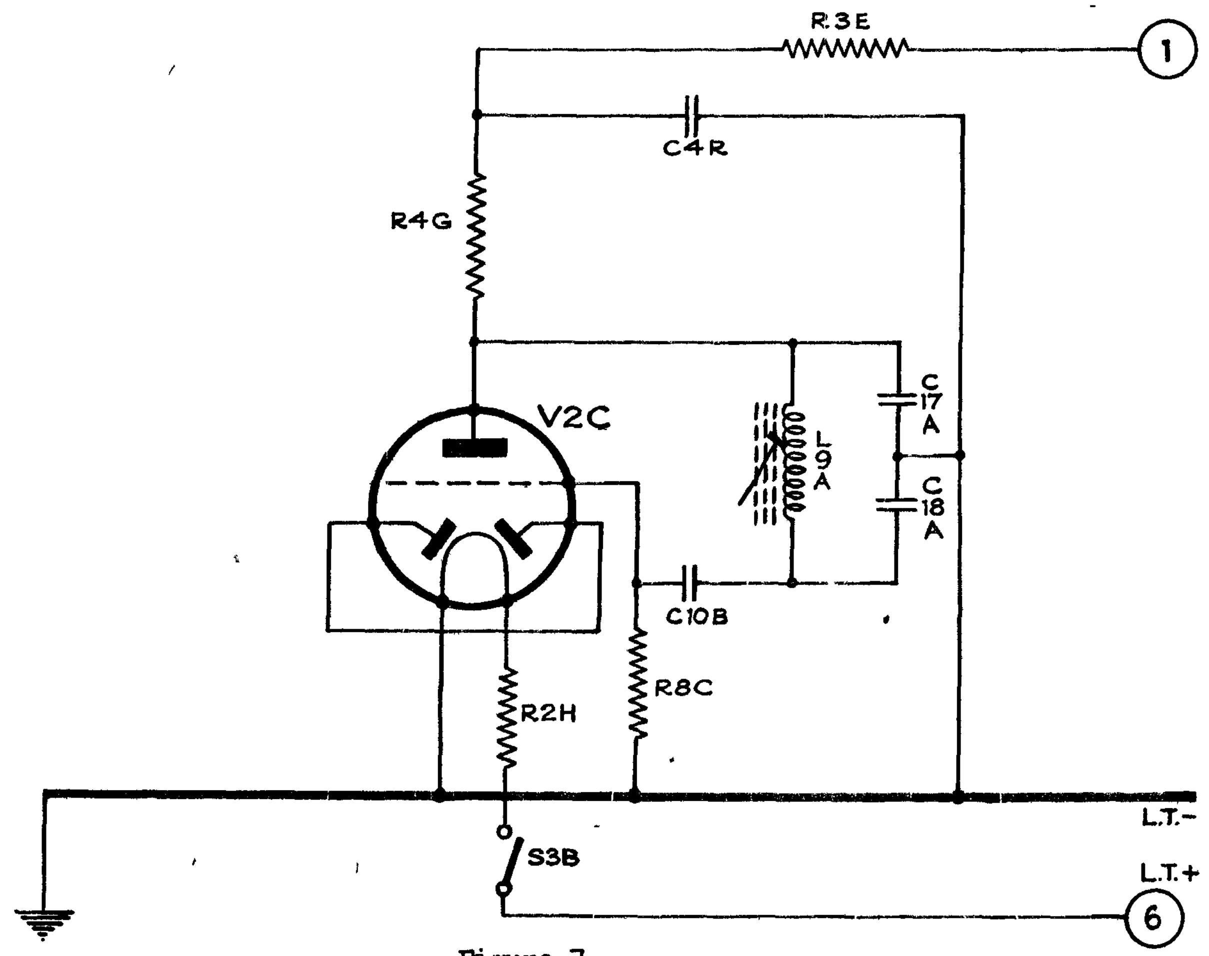


Figure 7.

(viii) Beat Frequency Oscillator.

The beat frequency oscillator V2C is a double diode triode with diode anodes strapped to filament as in V2B, operating as a triode in a parallel-fed Colpitts circuit. The oscillatory circuit consisting of the permeability tuned inductance L9A and the condensers C17A (.0004 μF) and C18A (.0012 μF) functions at approximately the intermediate frequency. Output is taken from the anode and applied to the signal detector via the small capacity of a short piece of twin flex. Self-bias is obtained from the grid leak R8C (1 MΩ) in conjunction with C10B (.0002 μF). H.T. to anode is supplied from the H.T. line via the test resistance R3E (5000 Ω) and the load R4G (.25 MΩ). The oscillator maybe switched on or off by means of the RT/CW switch S3B which breaks the filament cct. on R/T.

(ix) The Wave Change Switch.

Switching from one frequency band to the other is accomplished by means of a Yaxley type switch. This latter is a two position switch arranged in three banks which are mutually screened.

The rear bank (S1A - B & C) is associated with the aerial tuning inductances L1A and L2A, while the R.F.A. tuned anode inductances L3A and L4A are dealt with by the centre bank (S1D & H). The remaining disc (S1E, F & J) in front of the switch assembly selects the appropriate local oscillator coil L5A or L6A.'

3. TECHNICAL DESCRIPTION OF THE POWER SUPPLY UNIT.

H.T. and L.T. current is derived from the self-contained power pack located on the left side of the set, and energised by a 6 volt accumulator. The H.T. output is 160 volts at 10 mA.

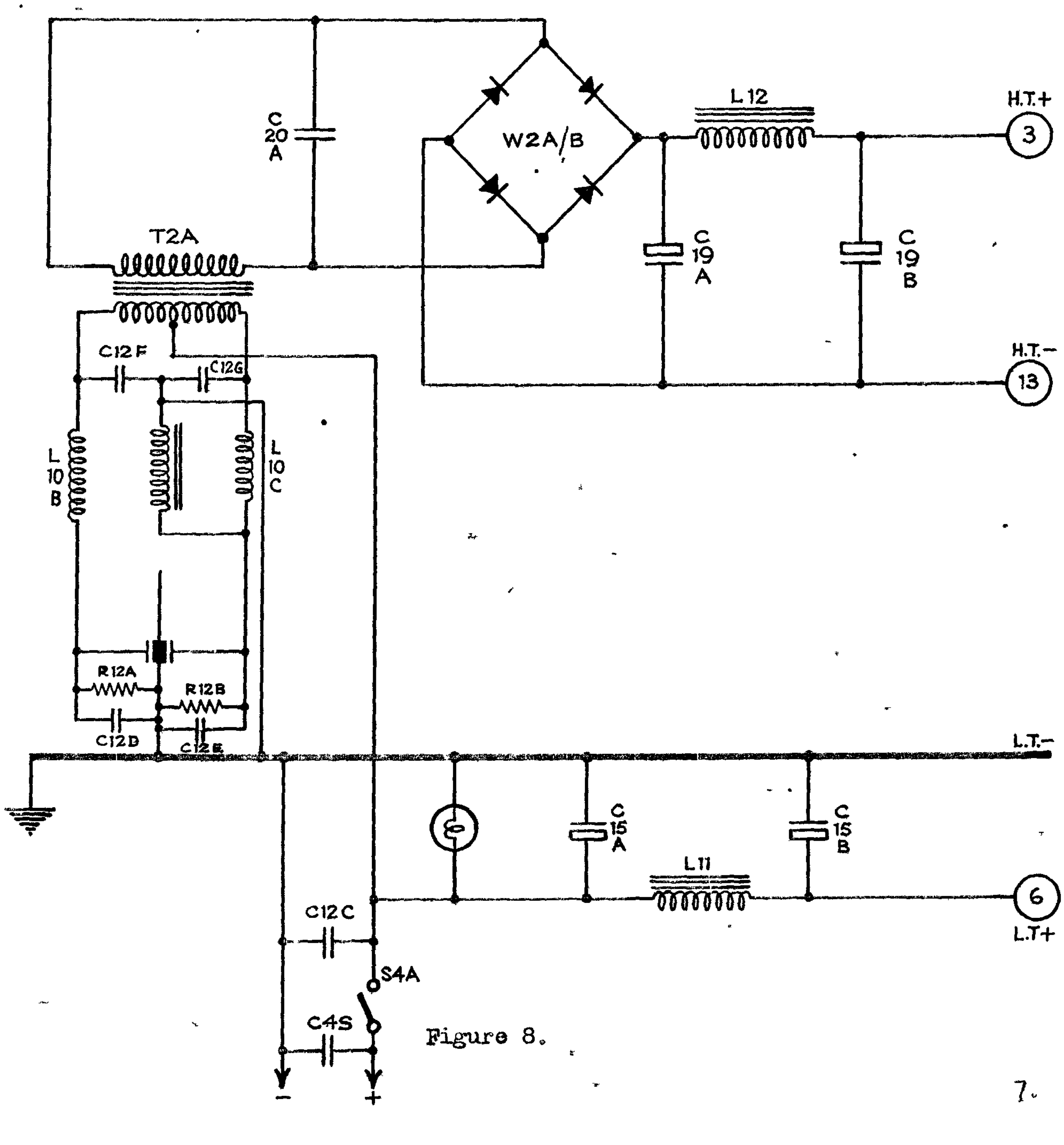


Figure 8.

The low voltage from the accumulator is stepped up by means of a Vibrator No.2 (Mallory Type 650) and a suitable iron-cored transformer T2A. The former is of the non-synchronous type and the transformer output is therefore applied to a separate bridge-connected selenium rectifier W2A/B. H.T. smoothing is accomplished by means of the choke L12 and condensers C19A & B (4μF).

Vibrator action is as follows:- When the battery is first switched on by means of S4A the vibrator reed is drawn over to the right by the electromagnet and a pulse of current traverses the right hand half of the primary winding of T2A. The magnet coil is now short-circuited by the right-hand vibrator contacts and becomes de-energized, the reed rebounding on to the left-hand contacts. A pulse will now pass through the remaining half of the primary of T2A. The electromagnet is again energised and the cycle of operations repeated. We thus obtain an A.C. input to T2A the frequency of which depends upon that of the vibrator reed.

C20A (.025μF) connected across the secondary of T2A absorbs surges of current in the latter, & thus forms a protection for the rectifier and smooths its input. The R.F. chokes L10B and L10C in conjunction with condensers C12F - G (1μF) form effective R.F. filters to prevent R.F. interference from reaching the receiver. Condensers C12D - E shunted by R12A - B (150Ω) across the vibrator contacts reduce arcing at these points. Smoothing in the filament circuits of the directly heated valves is provided by the choke L11 and condensers C15A - B (75μF).

Circuit Modifications.

To meet special requirements modified versions of the Reception Set R109 have been produced with a consequent improvement in C.W. reception and an extension in frequency range. A summary of these modifications follows.

Reception Set R109 A.

1. The ARP12 in the R.F. stage is replaced by a 6 volt indirectly heated pentode (V3A), type ARP36. A separate L.T. line from power pack to receiver has been included.
2. A.V.C. is not included but there is an I.F. gain control operated manually. V3A is biased by means of a cathode resistor R11B (270Ω) connected to H.T. -.
3. Bias for V1E and V1F is obtained from an additional rectifier circuit in the Supply Unit. See diagram below. Minimum bias is derived from R11A and control is obtained by means of a variable resistor R10A.

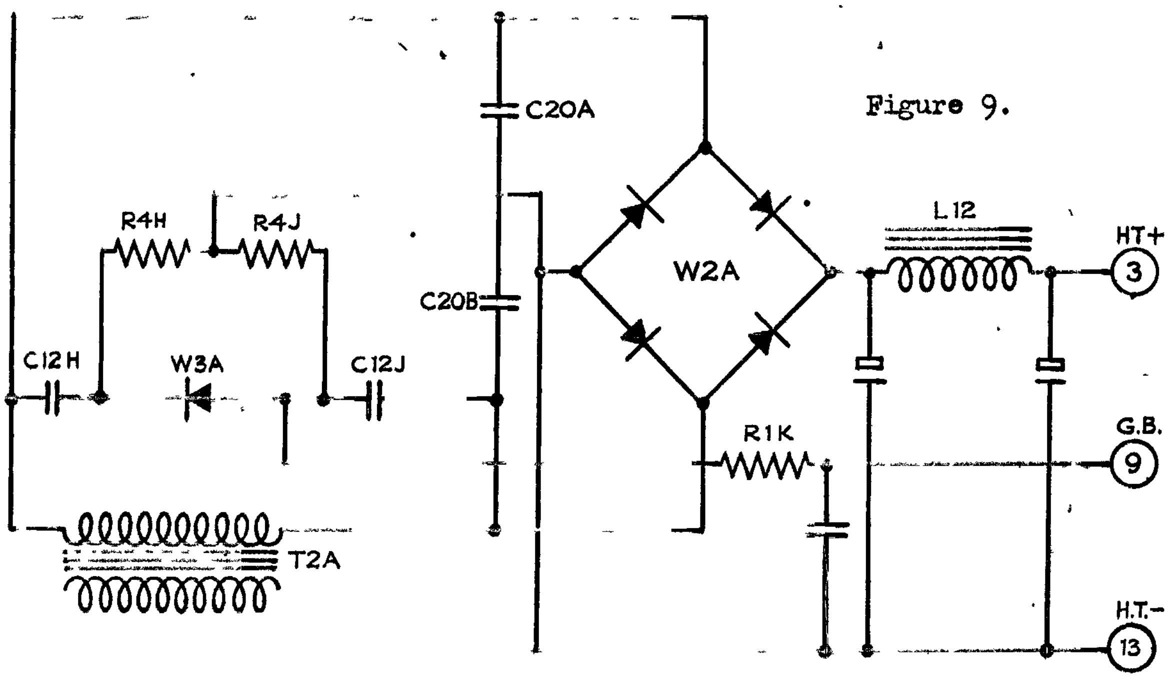


Figure 9.

4. Different values of variable condenser gangs and R.F. tuning coils have been used to give an extended frequency range, i.e. 2.0 - 4.9 Mc/s and 4.9 - 12.0 Mc/s.
5. Tuned secondary transformer coupling is used between V3A and V1D.

Reception Set R109 B.

Modifications as for R109A except that the frequency range covered is 2.5 - 5.5 Mc/s and 5.5 - 12 Mc/s, values of condenser gangs and tuning inductances being adjusted accordingly.

Reception Set R109 C.
These sets have been modified to improve C.W. reception only, the frequency range remaining as for R109.
1. A.V.C. is dispensed with & a manual control operates in the I.F. and R.F. stages.
2. Bias supply & control is provided by similar means to those detailed for R109 A & B.

4. FAULT FINDING.

To remove the chassis from its metal case, loosen the two captive fixing bolts marked ⊗ on the front panel and withdraw. Without further stripping tests may be made on all valves. A test tag panel located at the rear of the receiver chassis enables a rapid check on valve emission to be taken with a pocket voltmeter by measuring the voltage drops across the test resistances referred to in the text. The meter (Voltmeters pocket 250 V No.2) is connected between each of the points marked V1B etc. in turn and the point marked +. There is a separate + point for V2B.

The following table while typical of the readings obtainable is for illustration only, each set should have its own set of readings for comparison when faults appear.

VALVE.	PANEL ENGRAVING.	FUNCTION.	APPROX. VOLTS.
ARP 12	V1B	R.F. Amp.	4
"	V1C	1st L.O.	8.
"	V1D	MIXER	2.5
"	V1E	1st I F.A.	4.5
"	V1F	2nd I.F.A.	4.5
AR 8	V2A	Det A.V.C.& A.F.	1.5
"	V2B	OUTPUT	4
"	V2C	B.F.O.	1 Switch to C.W.

The following tests will be made if no valve readings are obtainable :-

(i) H.T. input to the set (160V) can be tested across tags 3 & 13 on the panel.

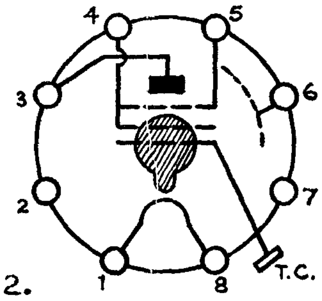
(ii) Testing across tag 5 and chassis will prove L.T. input.

(iii) The voltage between tag 3 & chassis should be slightly lower than in (i) - no reading here with (i) normal will indicate the bias resistor R114 dis.

Voltage tests at the valve holders can be made with the aid of the diagrams below. The readings given should prove a useful guide.

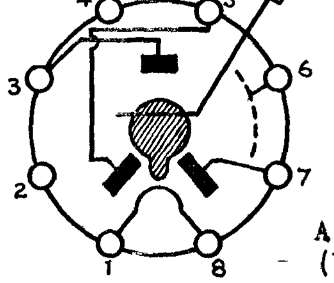
Readings obtained with an Avometer Model 7 (400 V range).

Between Chassis and	V1B	V1C	V1D	V1E	V1F	V2A	V2B	V2C
Anode	140	65	40	140	140	100	140	35
Screen	50	65	50	50	150	-	-	-



A.R.P.12.
(V1B-F)

Valve Base connections viewed from under side of Chassis



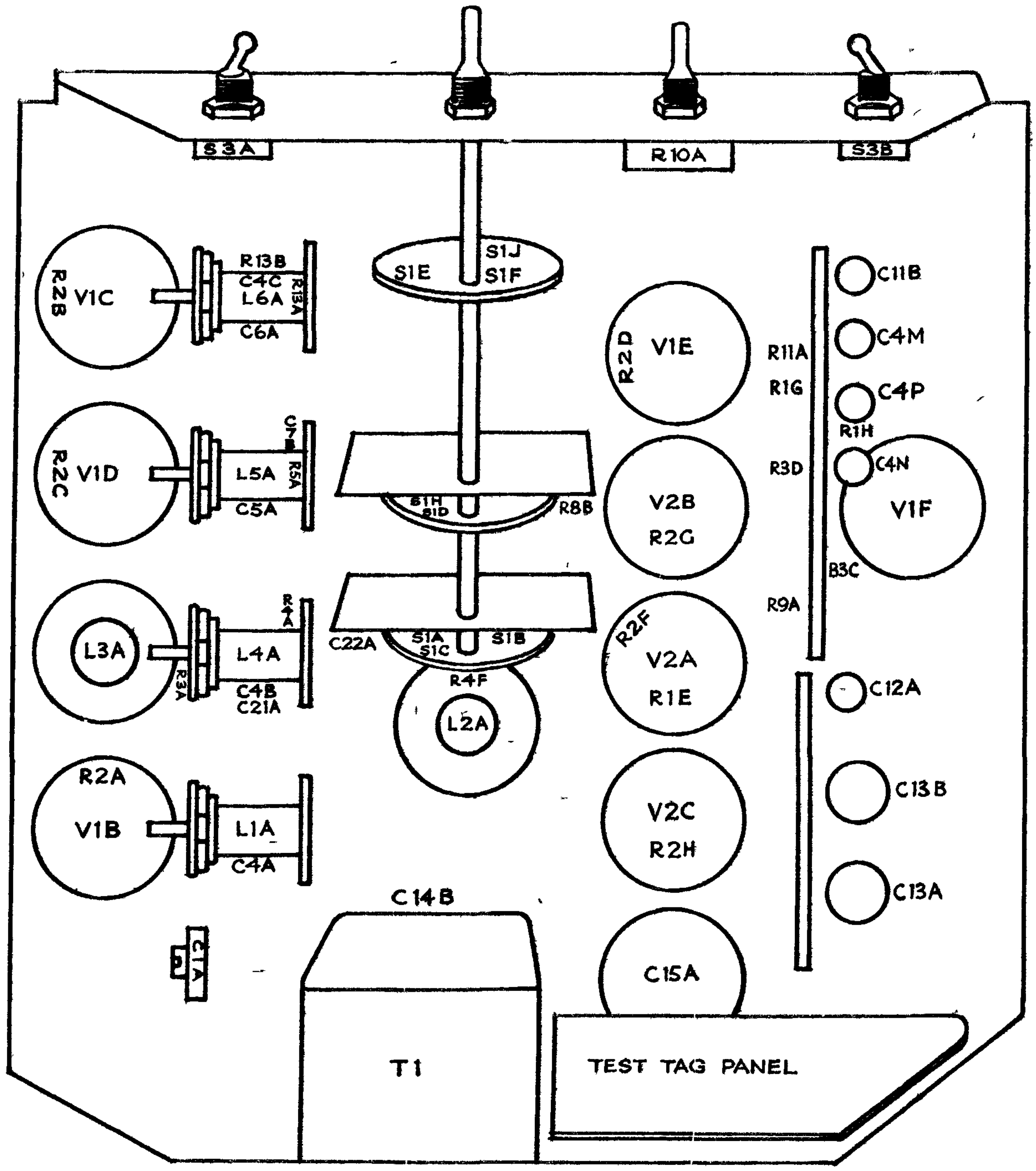
A.R.8.
(V2A-C)

Figure 10.

Figure 11.

DRAWING OF LEFT SIDE OF RECEIVER CHASSIS

SHOWING APPROX. LOCATION OF COMPONENTS.



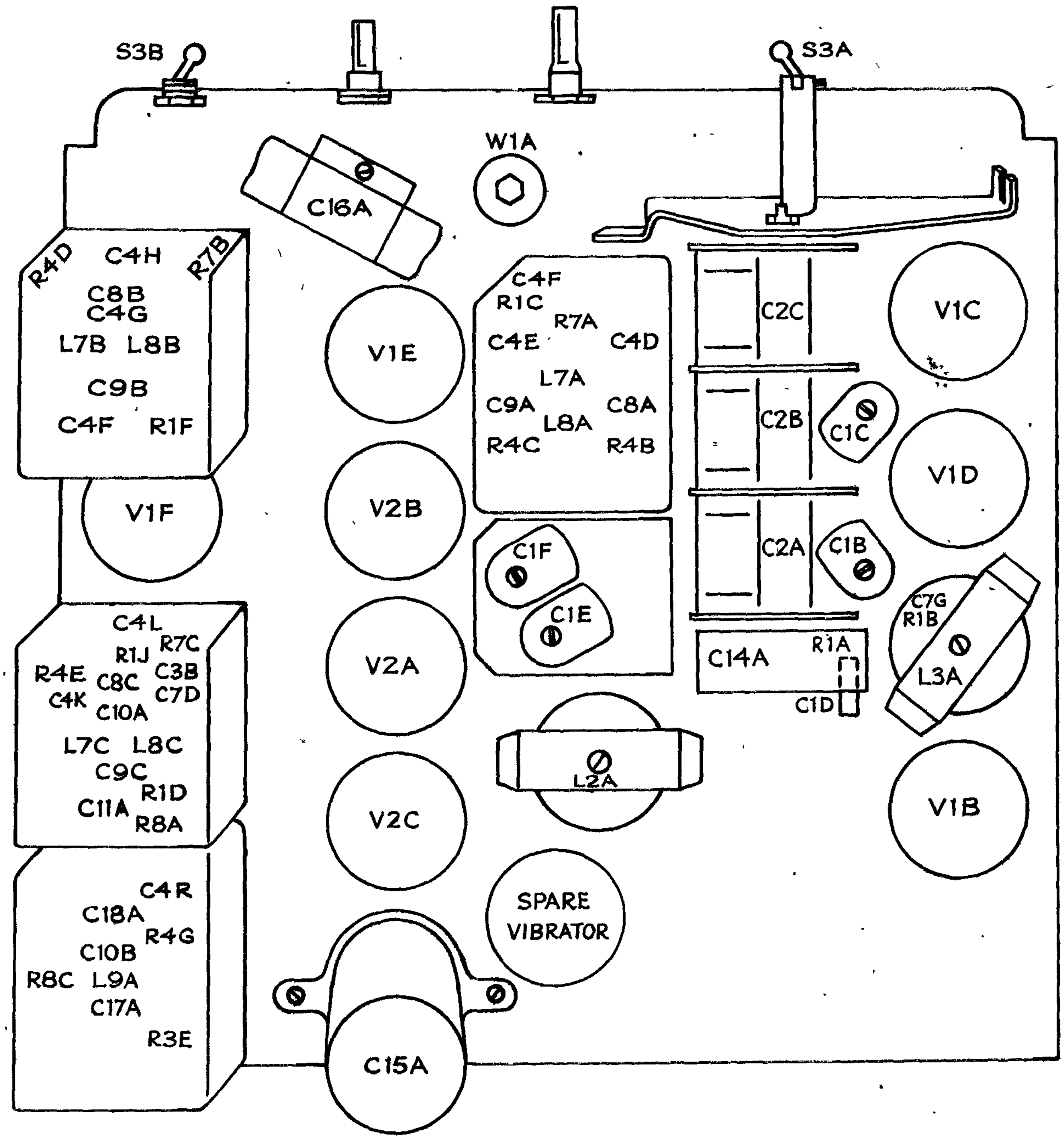
CONDENSERS

C1 5/35 μμF	C2 14/368 μμF	C4 .01 μF
C5 .0015 μF	C6 .002 μF	C7 150 μμF
C8 150 μμF	C9 160 μμF	C10 220 μμF
C11 .002 μF	C12 .1 μF	C13 2 μF
C14 300 μμF	C15 75 μF	C16 25 μF
C17 400 μμF	C18 .0012 μF	C19 4 μF
C20 .025 μF	C21 15 μμF	C22 20 μμF
	C25 100 μμF	

Figure 12.

DRAWING OF RIGHT SIDE OF RECEIVER CHASSIS

SHOWING APPROX. LOCATION OF COMPONENTS.



RESISTORS

R1 1 MEG OHM	R2 71 OHMS	R3 4,700 OHMS
R4 .22 MEG OHMS	R5 22,000 OHMS	R7 10,000 OHMS
R8 100,000 OHMS	R9 47,000 OHMS	R10 1 MEG OHM
R11 270 OHMS	R12 150 OHMS	

WIRELESS SET No.18, Mk I, II and III.

I. GENERAL DESCRIPTION.

The Wireless Set No.18 is a self-contained short-range sender & receiver designed for R/T and C.W. working (exdept the Mark I which operates on R/T only).

The set may be used as a ground station or as a pack set when it may be operated on the march

The frequency range is 6 - 9 Mc/s covered in one band. This affords sufficient overlap to allow operation with the No's 19 & 22 Sets. Send/Receive switching on R/T is carried out by means of the microphone pressel switch while on C.W. (Mk II & III Sets) a switch is embodied in the morse key for this purpose.

The range over which it is possible to work a No.18 Set is largely governed by the type of aerial used. A vertical rod aerial or a ground aerial are usually employed when ranges up to 5 and 3 miles respectively on R/T may be expected. For C.W. working double the ranges should be obtained.

The rod aerial referred to above, which incidentally is the only type which can be employed on the march, consists of a maximum of twelve 12" copper-plated tubes which fit into each other forming a self supporting aerial up to 11' high.

The ground aerial consisting of 25' of insulated wire, attached to the aerial socket of the set by means of a plug, is laid out straight along the ground in the direction of the station being worked. Although less efficient than the rod aerial this type has the advantages of easy concealment, directional properties and freedom from the screening effects of woods, buildings etc.

Ranges greater than those obtainable with either of the two aerials so far dealt with may be obtained by using an elevated ground aerial. This is erected with the aid of three or more sections of vertical rod & any convenient tree or other suitable support.

If very much greater ranges are required between two ground stations, one of the types of horizontal tuned aerial must be used, as for example (i) the Windom or (ii) the end-fed $\frac{1}{2}\lambda$ Hertz.

The trainee should be reminded that as the operation of this type of aerial at its extreme range depends upon the indirect ray, reception will be governed largely by the time of day and season.

Dimensions for the two types of aerial mentioned above are given below.

(i) The roof-length L of a Windom aerial is given by:-

$$L = \frac{433.4}{f}$$ feet where f is the carrier frequency in Mc/s.

The position of the feeder tapping-point from the end of the radiator is given by:-

$$l = \frac{162.5}{f} \text{ feet}$$

$$\text{Optimum feeder length} = \frac{123.1}{f} \text{ or } \frac{492.5}{f} \text{ feet.}$$

(ii) The total length of wire (radiator + feeder) L for a $\frac{1}{2}\lambda$ Hertz aerial is given by:-

$$L = \frac{467.8}{f} \text{ feet}$$

Power for the set is obtained from dry batteries. There are two types known as the "battle battery" and the "static battery".

The battle battery comprising 150 volts H.T., 12 volts G.B.& 3 volts L.T. in a single block fits into a compartment in the set. A five-way cable from the sender terminates in a 5-point plug which plugs into the battery-block. Battery supplies for the receiver are distributed from a socket on the sender front panel by way of a further 5-way cable.

The static battery which is larger and of higher capacity is housed in an external battery box and is connected to the set by means of a Connector 5-pt No.6.

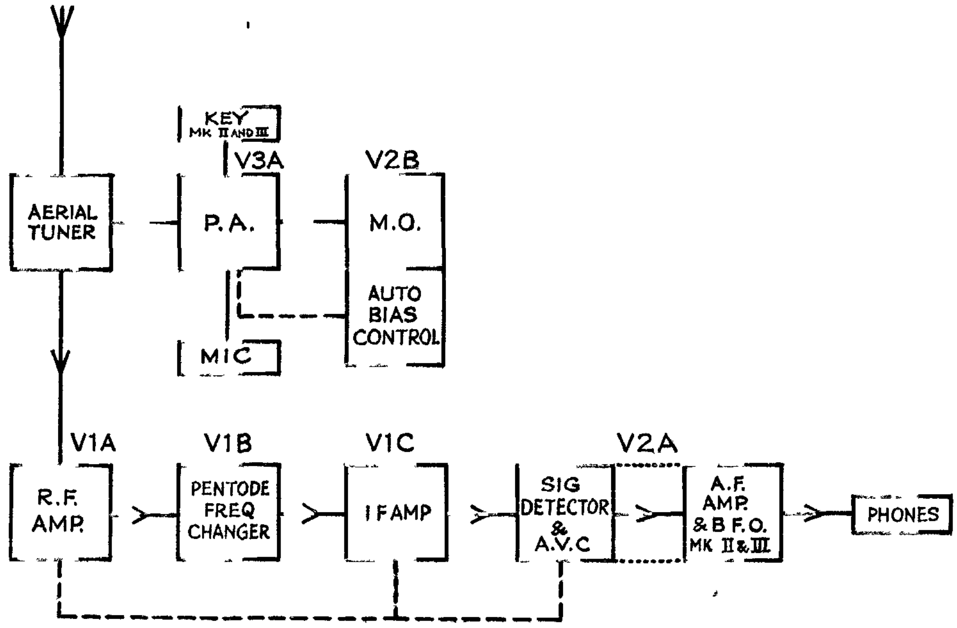


Figure 1.
Complete Block Diagram of No.18 Set

The box contains the following items:-
2 60 volts dry batteries
3 12 volt " "
2 1 5 volt " "
The output voltages are 144V for H.T , 12 for G.B., and 3V for L.T.

II. CIRCUIT SUMMARY.

The No.18 Set comprises a separate sender and receiver, the aerial tuning circuit being common to both. The sender consists of a triode Master Oscillator valve followed by a single pentode Power Amplifier stage Control Grid modulation is employed on R/T Mk II and III sets are keyed in the P/A screen circuit for C W. transmission. Mk I sets are not equipped for C.W. operation.

The receiver is a straight forward 4 valve superheterodyne consisting of an R.F amplifier, frequency changer, a single stage of I.F amplification and combined signal detector A.V.C , and A F. amplifier stages. On Mk II and III sets the A.F. stage also operates as a Beat Frequency Oscillator for C W. reception.

A netting device consisting of a plunger type switch is provided to enable the sender frequency to be adjusted accurately to the frequency of any received signal. The netting switch causes the M.O. to function while the receiver is operating The M.O. frequency can then be adjusted until a beat note is heard in the headphones due to the M.O. output heterodyning the incoming signal. Further adjustment to zero beat tunes the M.O. to the received signal frequency.

III. DETAILS OF SENDER CIRCUIT

(a) Master Oscillator and Automatic Bias Control

These circuits employ a directly-heated double-diode-triode valve V2B type AR8.

The triode portion of this valve operated in a series fed tuned anode oscillator the frequency of which is determined by the tuned circuit consisting of the inductance L4A tuned by C21A (150 $\mu\mu$ F) the M O. TUNING control. This circuit is trimmed by means of C22A (10 $\mu\mu$ F fixed) in parallel with C15C (15 $\mu\mu$ F max.). H.T at 150 volts is applied to the anode via R12A (10.2 Ω) and R2C (1000 Ω) decoupled by C11C (.025 μF).

The grid coil L4B is inductively coupled to L4A to provide feed-back Bias is provided by the grid-leak R4B (50,000 Ω) in conjunction with C12A (30 $\mu\mu$ F).

R.F. output from the anode is applied as drive to the grid of the P/A valve via the coupling condensers C15F (15 $\mu\mu$ F max.) and C22B (10 $\mu\mu$ F). C15F

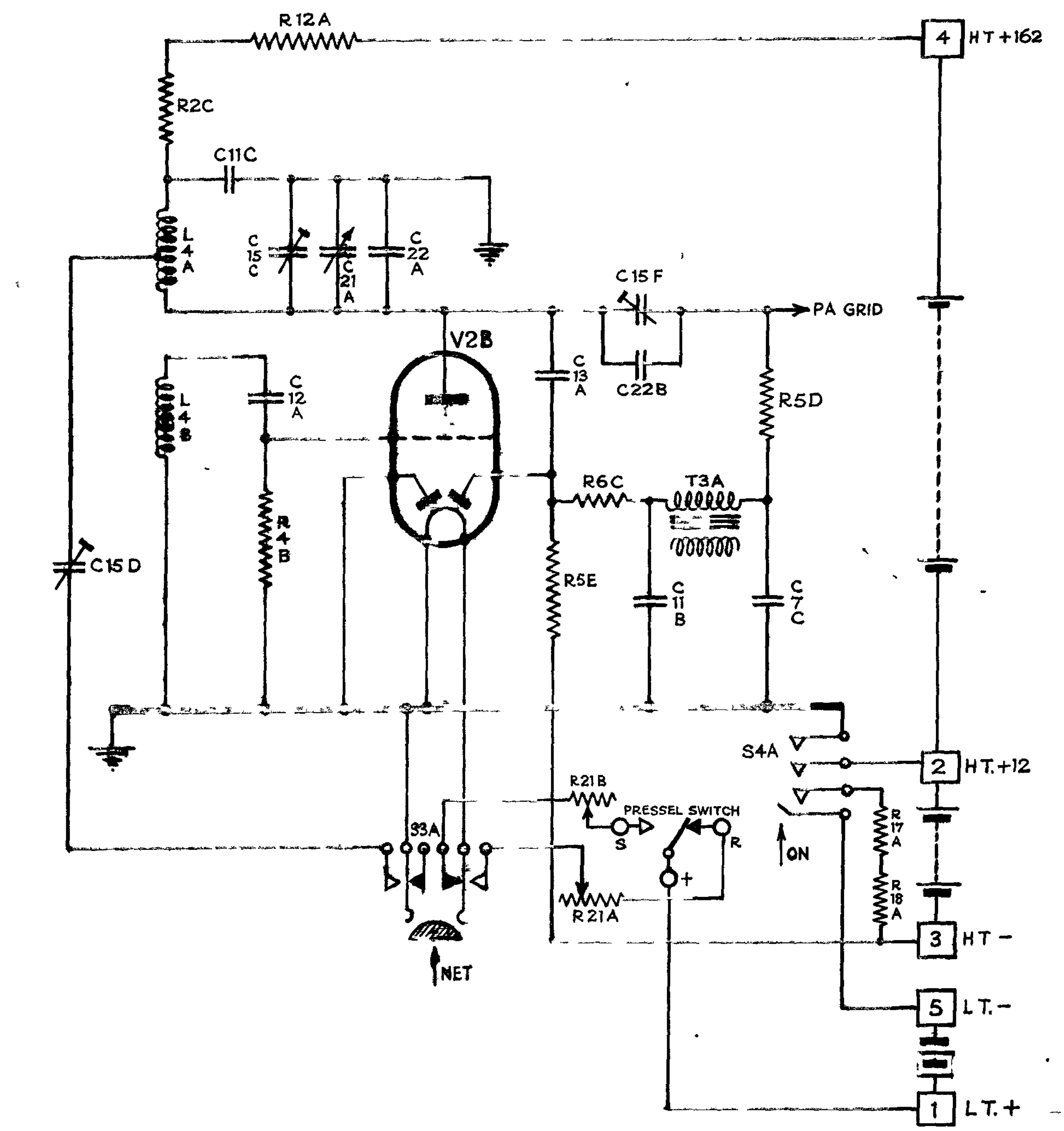


Figure 2

is adjustable and enables the amplitude of the drive to be regulated within limits.

The 2-volt filament is heated from the 3V battery normally via the microphone pressel switch, R21B the filament rheostat and the NET switch S3A. R21B (6 Ω max.) is adjustable from the front panel of the sender unit and is used to ensure correct filament voltage for V2B and the P/A valve.

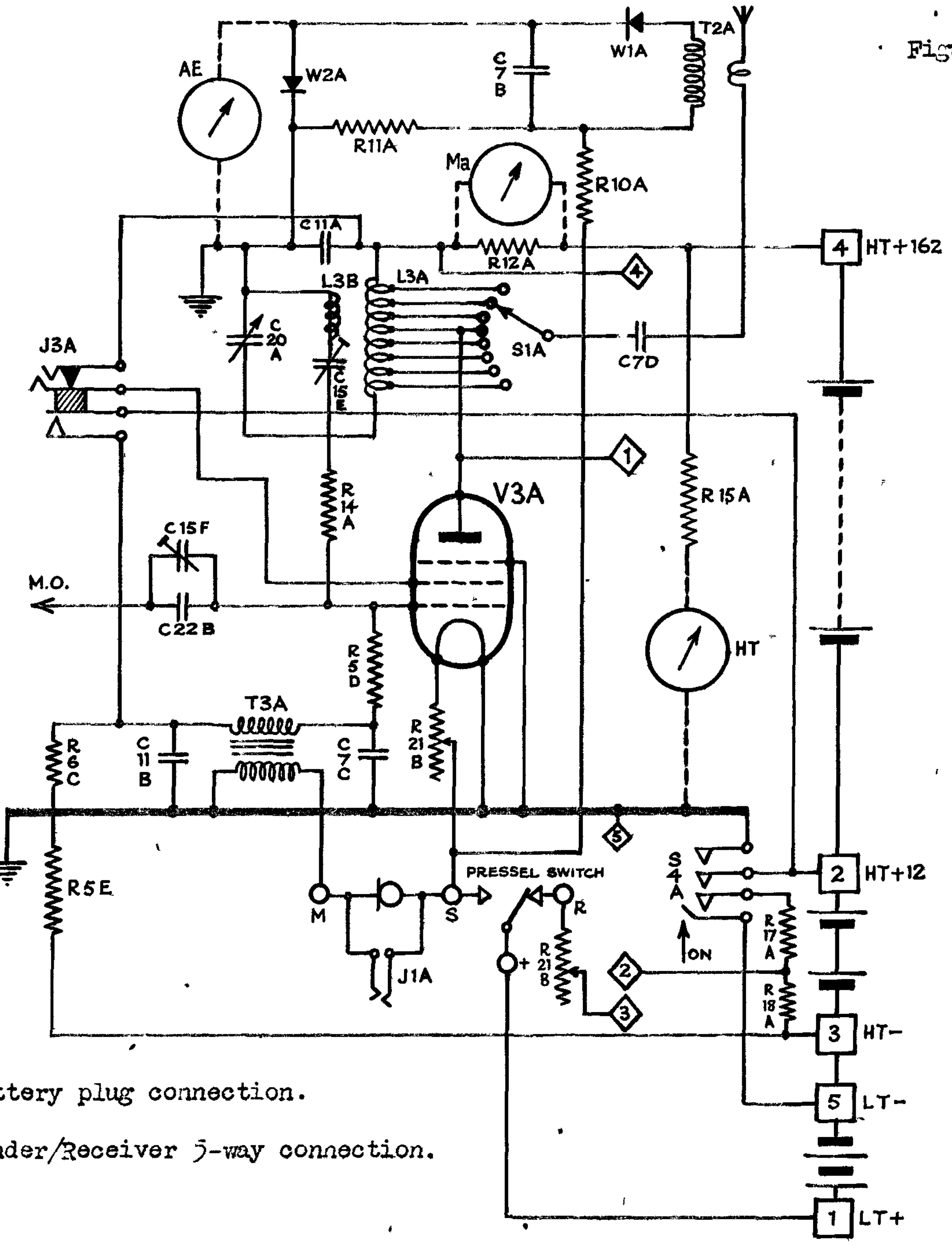
With S3A in the NET position, the filament current is supplied via R21A, the receiver valve rheostat and the pressel switch now, of course, in the receive position.

In Mk I and II sets R21A and R21B are omitted and the sender valves have individual filament resistors.

On NET the M.O. operates without the P/A load and the M.O. frequency will therefore differ from that obtaining under normal send conditions. This is compensated for by the condenser C15D (15 $\mu\mu$F max.) which is effectively in parallel with part of L4A when the NET button is pressed.

A portion of the M.O. output is applied to one diode of V2B for the purpose of providing extra bias to the P/A control grid. This section of V2B operates in a parallel diode circuit R5E (500,000 Ω) and C13A (5 $\mu\mu$F) being the diode load and condenser respectively. A delay voltage of 12 V from the bias battery (between [2] and [3] Fig.3) is applied to the anode and the drive

Figure 3.



[4] Battery plug connection.

◇(2) Sender/Receiver 5-way connection.

normally overcomes this and causes the diode to conduct. The consequent voltage developed across the load is applied to the P/A grid via R6C(100,000 Ω), the secondary of the microphone transformer T3A and R5D (500,000 Ω). C11B (.025 μF) in conjunction with R6C forms an R.F. filter to ensure that only the D.C. component is applied to the P/A grid. This will cause the P/A working point to vary with the magnitude of the drive and tend to maintain the drive at the grid constant. Ref. Drive Control on W/S No.22.

(b) <u>Power Amplifier.</u>

The power amplifier valve V3A is a double power pentode strapped internally, type ATP4, and operates under class B conditions on R/T (Control grid modulation being employed) with 140-150 volts anode and screen potentials. Bias for this stage is derived as follows:-

(i) From the 12 volt grid bias battery.

(ii) Rectification of the drive due to grid current in R5D, R6C and R5E.

(iii) Automatic bias from the drive control diode in V2B; this has been dealt with in (a).

H.T. to anode is fed via the common feed resistor R12A (10.2 Ω) and the tapped anode inductance L3A. R12A provides a convenient means of indicating H.T. consumption on send and receive, as in the "Ma" position of the meter switch the meter shunts this resistor. L3A, in conjunction with C20A, (127 $\mu\mu$F max.), forms the tuned anode circuit. This circuit tuned to the carrier frequency forms the anode load of V3A, correct impedance matching being attained by tapping the anode on to L3A. Correct aerial matching is carried out by means of a variable tap selected by S1A. H.T. is isolated from the aerial by means of C7D (.0005 μF).

The stage is neutralized by feeding back voltage, in antiphase, from the anode circuit to the grid. This is achieved by means of the coil L3B which is magnetically coupled to L3A and connected between control grid & filament via the semi-fixed neutralizing condenser C15E (15 μμF max.) and R14A (100 Ω).

Modulation.

As noted in the summary the carrier is modulated at the control grid of the P/A. This takes place, without A.F. amplification from a carbon microphone used in conjunction with the microphone transformer T3A. On pressing the pressel switch T3A primary circuit is completed, the microphone being enegised from the L.T. battery. A.F. output from the secondary of T3A is applied to the grid via R5D (.5 MΩ). C7C (500 μμF) in conjunction with R5D decouples T3A. There is no provision for controlling depth of modulation, but full modulation is obtained at normal voice level. C11B as well as its function noted in para. (a) offers a low impedance path to A.F. from the earthy end of T3A secondary.

C.W. Working.

When operating on C.W. the microphone plug is removed and the four-point plug on the morse key is substituted. The remaining plug attached to the key is plugged into the key jack J3A. In this way the microphone pressel switch is replaced by the Send/Receive switch on the key & the key contacts are in the P/A screen lead. It should be noted also that on C.W. the P/A grid bias is reduced by returning R5D to earth via T3A secondary, J3A and S4A. The P/A output is thus increased by operating the valve Class A, self-bias being produced by R5D only.

Aerial current meter.

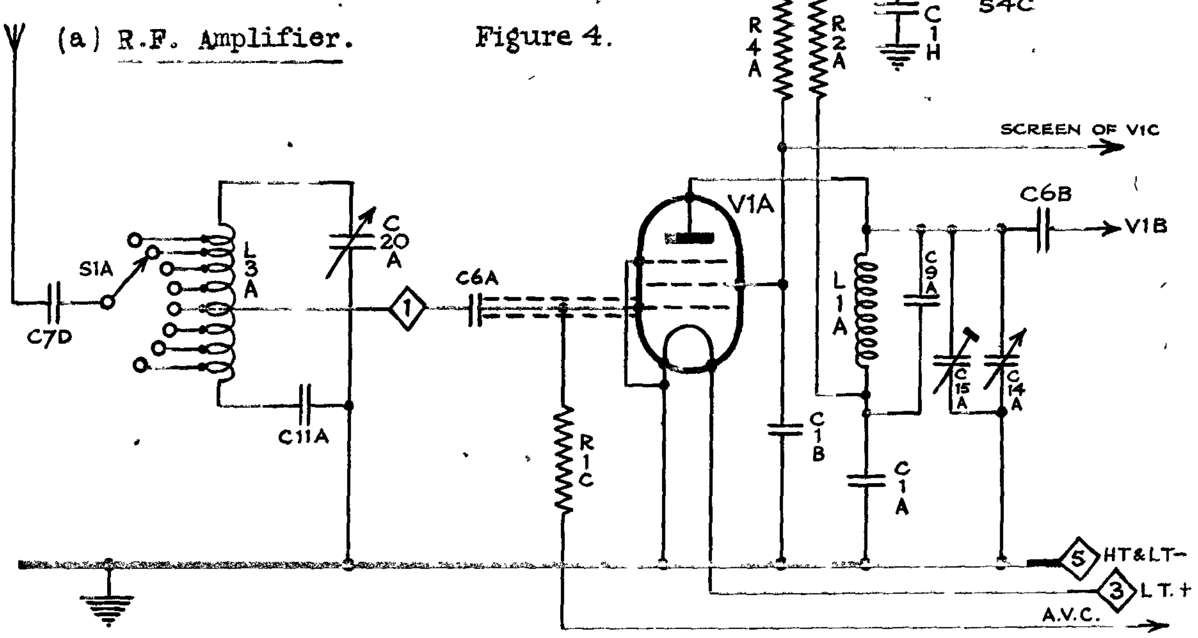
Aerial current is indicated by means of an R.F. rectifier circuit in conjunction with the set meter. The transformer T2A of which the aerial lead itself comprises the primary has a Westector, W1A in the secondary circuit. C7B (.0005 μF), and the meter in series with R11A (25 Ω) form the condenser and load of this circuit respectively. Rectified R.F. in the load will cause a meter deflection dependant upon the current in the primary of T2A, i.e., in the aerial.

On "send" R11A (25 Ω) and R10A (400 Ω) form a potential divider across the L.T. battery and the voltage across R11A is applied as positive bias to W1A thus adjusting its working point to the commencement of the straight part of the characteristic. This, coupled with the fact that a very small standing D.C. will flow through the meter, thus helping to overcome the inertia of the latter when rectified current flows, increases the sensitivity of the device.

W2A is a selenium rectifier shunting the meter. This acts as a safety device against excessive current and depends for its operation on the fact that for normal voltages its impedance is high but this decreases very rapidly on overload, when it acts as a virtual short-circuit.

IV. DETAILS OF RECEIVER CIRCUIT.

(a) R.F. Amplifier. Figure 4.



The R.F. valve V1A is a directly heated R.F. pentode type ARP12 which receives its input from the aerial via the tuned circuit associated with the P/A stage and consisting of L3A and C20A. The necessary connection between Sender and Receiver unit's is made by means of the 5-core Sender/Receiver interconnecting cable.

H.T. to the anode of this valve is applied through R22A (5000 Ω), R2A (1000 Ω) decoupled by C1A (.1 μF) and the tuning inductance L1A which forms part of a tuned anode circuit. Screen current is taken through R22A and the separate dropping resistance R4A (50000 Ω) which is decoupled by C1B (.1μF). R22A which is common to anode and screen circuits of all receiver valves on Mk III sets, is shunted by the H.T. economy switch S4C. The latter is operated in the LOW or open position for the reception of strong signals thus effecting a saving in H.T. R22A is decoupled by C1H (.1 μF). R4A also feeds the screen of V1C.

A minimum grid bias of -2 volts is provided from the battery via the grid leak R1C (1 MΩ) and the A.V.C. network, as well as extra A.V.C. bias on strong signals. This will be understood better after reading section (d).

L1A in the anode circuit is tuned by C14A (one section of a two-gang variable condenser). The decoupler C1A also allows the moving plates of the ganged condenser to be earthed. This circuit is trimmed by C15A (15 μμF max.) R.F. output to the frequency changer stage being taken from the anode via the coupling condenser C6B (100 μμF).

(b) <u>The Frequency Changer Stage.</u>

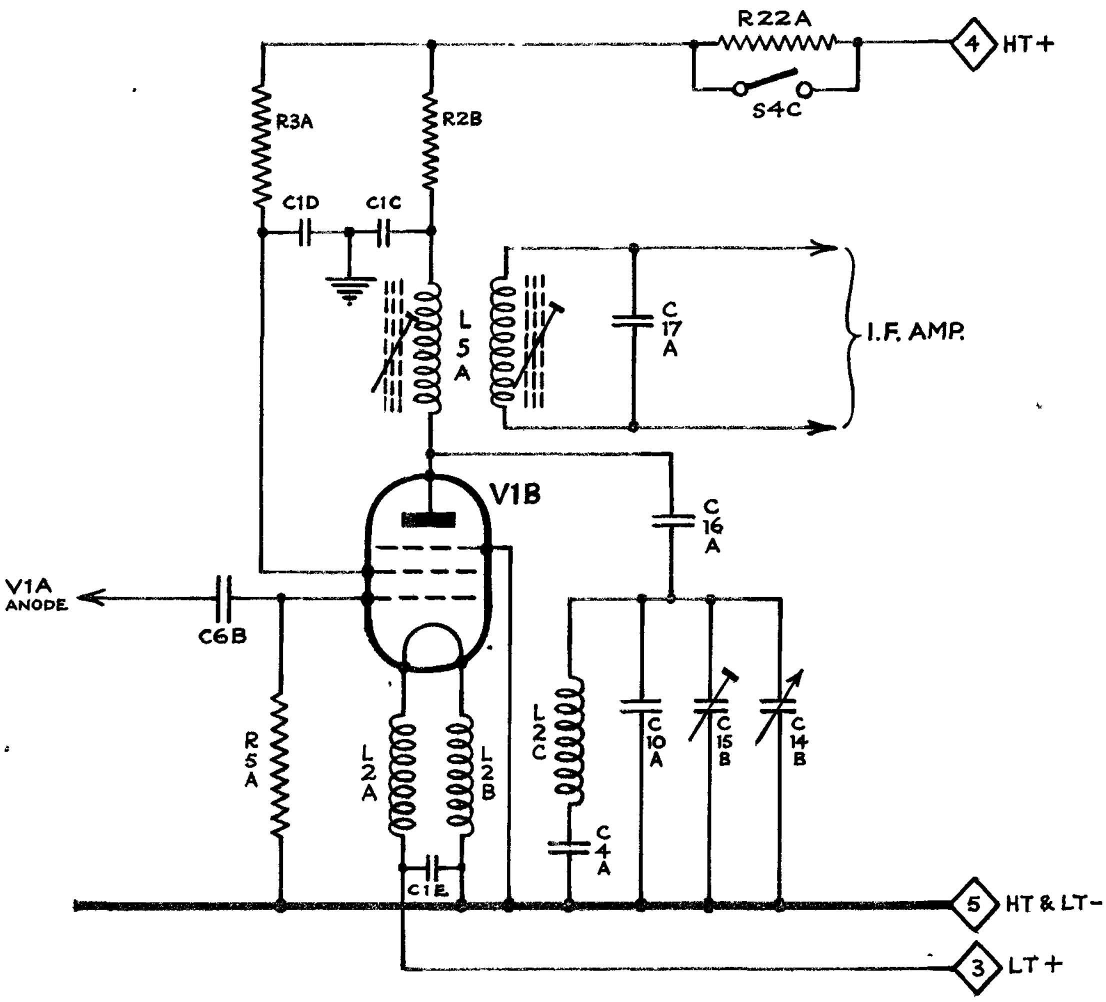


Figure 5.

The No.18 Set employs a single R.F.pentode V1B, type ARP12, as frequency changer, the valve functioning both as local oscillator and mixer. Signal and oscillator voltages are applied in series between the control grid and filament of this valve which operates as a detector. Oscillator & detector coupling is achieved by cathode injection. The resulting difference frequency 465 kc/s, is selected by means of a resonant circuit tuned to I.F. and coupled to the anode circuit.

We will now consider the two portions of the circuit in detail. The oscillator section is composed essentially of the oscillator tuning inductance L2C tuned to signal frequency + I.F. by C14B, and the two cathode coils L2A & L2B. The oscillatory circuit L2C and C14B is parallel-fed by connecting it between anode & chassis. The primary of the I.F. transformer L5A and C16A are the anode load and coupling condenser respectively. Grid exciting voltage is fed into the grid-filament circuit by inductive coupling between L2C and L2A and L2B to maintain self-oscillation. Note that L2A and L2B are common to both oscillator and signal input circuits.

Signal input from the R.F. amplifier is applied between the grid of V1B and chassis via the grid condenser C6B whilst oscillator input is developed between filaments and chassis across L2A and L2B. C1E (.1μF) connects the cathode coils virtually in parallel & at the same time keeps R.F. out of the L.T. supply. The control grid receives negative bias due to oscillator grid current through the grid leak R5A (.5 MΩ).

C14B is the remaining section of the 2-gang condenser noted in section (a) and forms the Receiver Tuning control. C16A (80 μμF) is an H.T. blocking condenser of sufficient reactance to prevent shunting of the I.F. component. C4A (.005μF) is the series padder, while C10A (50 μμF fixed) and C15B (15 μμF semi-fixed) are the parallel trimmers.

H.T. to anode and screen of V1B is fed via R2B (1000 Ω) decoupled by C1C (.1μF) and R3A (70,000 Ω) decoupled by C1D (.1μF) respectively. Coupling to the next stage is effected by means of the tuned secondary I.F. transformer L5A.

(c) I.F. Amplifier.

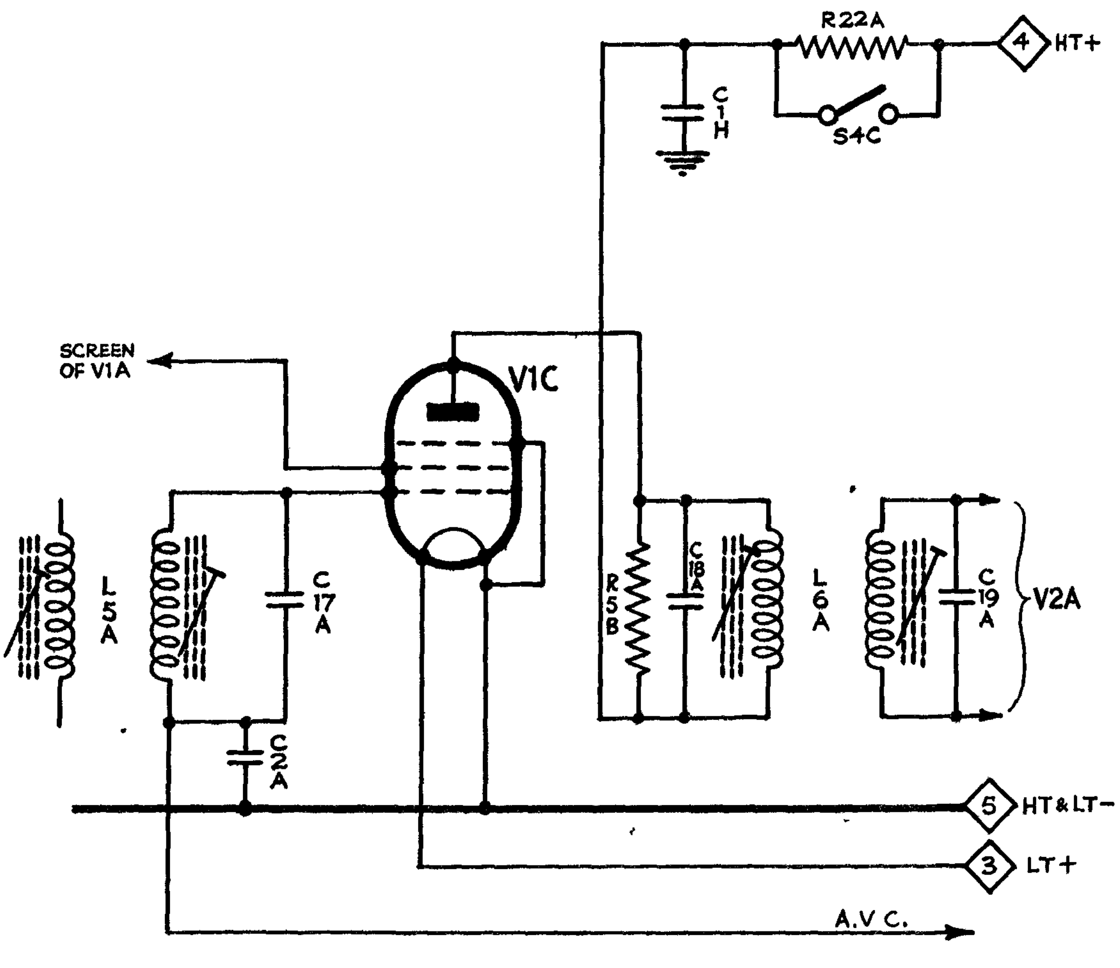


Figure 6.

A single stage of intermediate frequency amplification is employed, the valve V1C being similar to that used in the R.F. stage namely an ARP12. Input is derived from the tuned secondary of L5A and output is applied to the detector stage by means of a bandpass transformer L6A.

H.T. to the anode of V1C is applied through R22A and the primary of L6A while screen voltage is picked up from the screen of V1A as already noted.

The valve receives a minimum bias of -2 volts and A.V.C. bias from the A.V.C. network.

The input tuned circuit comprising the secondary of L5A and the fixed condenser C17A (90 μμ F) is adjusted to 465 Kc/s by means of the movable slug inside the coil.

Similar adjustments are carried out on the primary & secondary circuits of L6A. Primary and secondary coils are tuned by C18A and C19A (130 μμ F and 140 μμ F) respectively. The desired bandwidth is obtained by shunting the primary with a .1 MΩ resistor R5B and suitably adjusting the coupling

(d) Signal Detector.

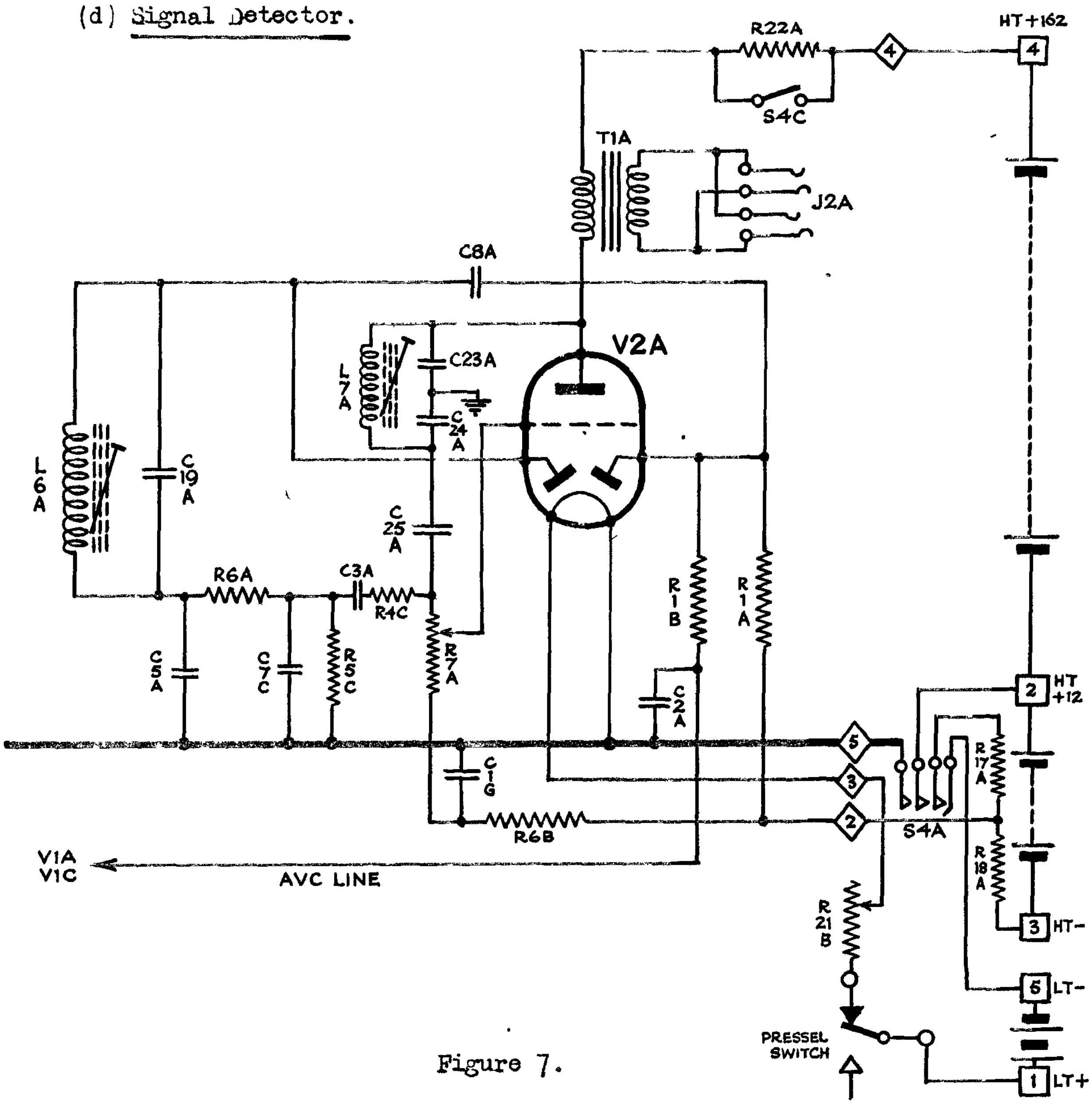


Figure 7.

The final valve V2A is a double diode triode, type AR8, and operates as a combined signal detector, A V.C. diode and A.F. amplifier. In addition, on Mk II & III Sets there is a B.F.O. circuit associated with this valve.

I.F. output from the secondary of L6A is applied to the signal detector section which is operating in a series diode circuit. R5C (.5 MΩ) and C7A (500 μμ F) are the diode resistance and condenser respectively. R6A (.1 MΩ) and C5A (100 μμ F) provide additional I.F. filtering. The A.F. component of voltages developed across the load is applied to the grid of the triode section through the D.C. blocking condenser C3A (.002 μF) and the potentiometer volume control R7A (1 MΩ).

(e) A.V.C.

The A.V.C. diode which operates in a parallel circuit receives part of the I.F. through the condenser C8A (20 μμ F). The negative potential developed by the signal across the load R1A (1 MΩ) and (in the sender) R17A and R18A in parallel is applied as A.V.C. bias to the control grids of V1A and V1C through the filter resistance R1B (1 MΩ). C2A (.05 μF) is the A.F. filter condenser.

A delay voltage of 2 volts is obtained by returning the load resistance R1A to the junction of R17A & R18A which form a voltage divider across the bias battery. It will be seen now that this same voltage is applied to the controlled valves as minimum negative bias

(f) A.F. Stage.

The triode section of V2A which functions as an A.F.amplifier receive H.T. for its anode via R22A and the primary of the phones transformer T1A. The control grid is biased 2 volts negatively by returning the volume control element to the bias voltage divider through R6B (.1 MΩ) decoupled by C1G (.1μF).

(g) B.F.O.

In Mk II & III sets the triode section also operates as a Colpitt's oscillator when the volume control is turned sufficiently clockwise.The oscillatory circuit comprising the variable inductance L7A,C23A(.001μF) & C24A(110 μμF) oscillates at approximately intermediate frequency. The primary of T1A acts as the anode load, while C25A (3 μμF) and the bottom part of R7A in conjunction with R6B are the grid condenser and leak. C25A is given a small value of capacity to prevent A.F. feedback to the grid. With the volume control only partly advanced sufficient resistance is included in the series with the grid to prevent the circuit from oscillating. R4C (50,000Ω) prevents C3A and C7C. from acting as a shunt to I.F.

Coupling to the signal detector anode is effected by means of the interelectrode capacity of V2A.

Note on Sidetone.

The sidetone obtained when sending R/T is explained as follows:-

Modulation causes the H.T. current from the battery to vary at A.F. and owing to the internal resistance of the latter slight H.T. voltage variations will occur. A.F. is induced into the primary of T1A due to stray coupling and sidetone is heard in the phones.

V. FAULT FINDING.

(a) The correct method of dealing with a faulty set is to apply the standard tests enumerated below in the order given. These tests, which proceed in a logical sequence, will reveal possible elementary faults which might otherwise be missed by concentrating, too soon, on the internal parts of the set.

Preliminary. Plug a microphone, hand, No.4 into the mic.socket, a pair of phones into one of the phones sockets and switch the battery switch ON (H.T. economy switch to HIGH in the case of Mk III).

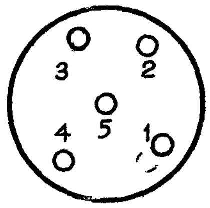
Power Supply. Turn meter switch to H.T. and meter should read, at least to red line. No reading indicates a flat battery or faulty connection to batt.

Turn meter switch to L.T. or L.T.R. in the case of a Mk III set. Meter should read to the red line in the former case or 2 volts (180-195μA) in the latter. No reading in most cases will be found due to a flat battery or faulty battery connection, although in the case of Mk III sets a defective microphone, cord or socket may show this symptom. The possible reasons for a low reading vary with the mark although in all cases a battery near exhaustion may be suspected. In the case of Mk II and some Mk I sets see that the battery switch at the rear of the sender chassis is to L.On Mk III sets the R screw should be tried for readjustment.

(On Mk III sets only,turn meter switch to L.T.S.and press pressel switch. A reading below 2 volts can usually be corrected by means of the S screw. A high reading may be similarly cured but can also be due to a filament circuit fault in the sender).

Valve testing. With meter switched to mA and pressel switch normal,meter should read 240 - 340μA. If no reading or reading below 240 is obtained,first suspect the connection between sender and receiver units.Testing with an A.V.O. at the 5-pt socket on the sender chassis should yield the following results:-

Test between	Volts
H.T. +(4) and H.T. -(5)	140 - 150
R.F. (1) and H.T. -(5)	140 - 150
L.T. +(3) and L.T. -(5)	2.8 - 3.0
H.T. -(5) and G.B. -(2)	1.8 - 2.0



Front view of socket.

If the above proves correct but meter reading is still low one or more receiver valves may be defective. Test by substitution.

To test the M.O.valve press the NET button, when the meter reading should increase by 30 or more.

Release the NET button and press pressel switch. Meter should now read 340 - 440 μA. If the reading is below 340 try replacing the P/A valve.

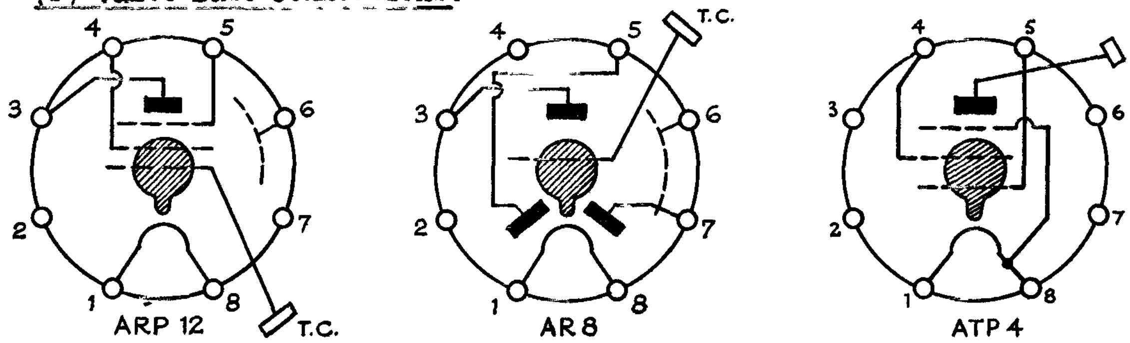
Sender. Insert one aerial rod and switch the meter to AE. Set the M.O. control to 9 Mc/s and pressing the pressel switch adjust controls for maximum aerial current. The reading obtained should be 180-300. Modulation is proved by speaking loudly into the microphone when the needle should kick upwards.

Mk II and Mk III sets are tested on W/T as follows:- Remove the mic-plug and inset the key and plug assembly No.8. Switch to send and press key. AE current should now read about 100 more than on R/T.

Receiver. Release pressel switch, switch meter to mA and turning gain control fully clockwise tune in a strong R/T station. The meter reading should dip on tuning through the station, and a heterodyne whistle in Mk II and III sets, proves the B.F.O. and A.V.C. In the absence of a strong signal, with the M.O. and Receiver Tuning controls at 9 Mc/s press the NET button and rock the Receiver Tuning control. A whistle should be heard and mA reading should dip as above.

The following data will be found useful in more detailed testing of the various stages.

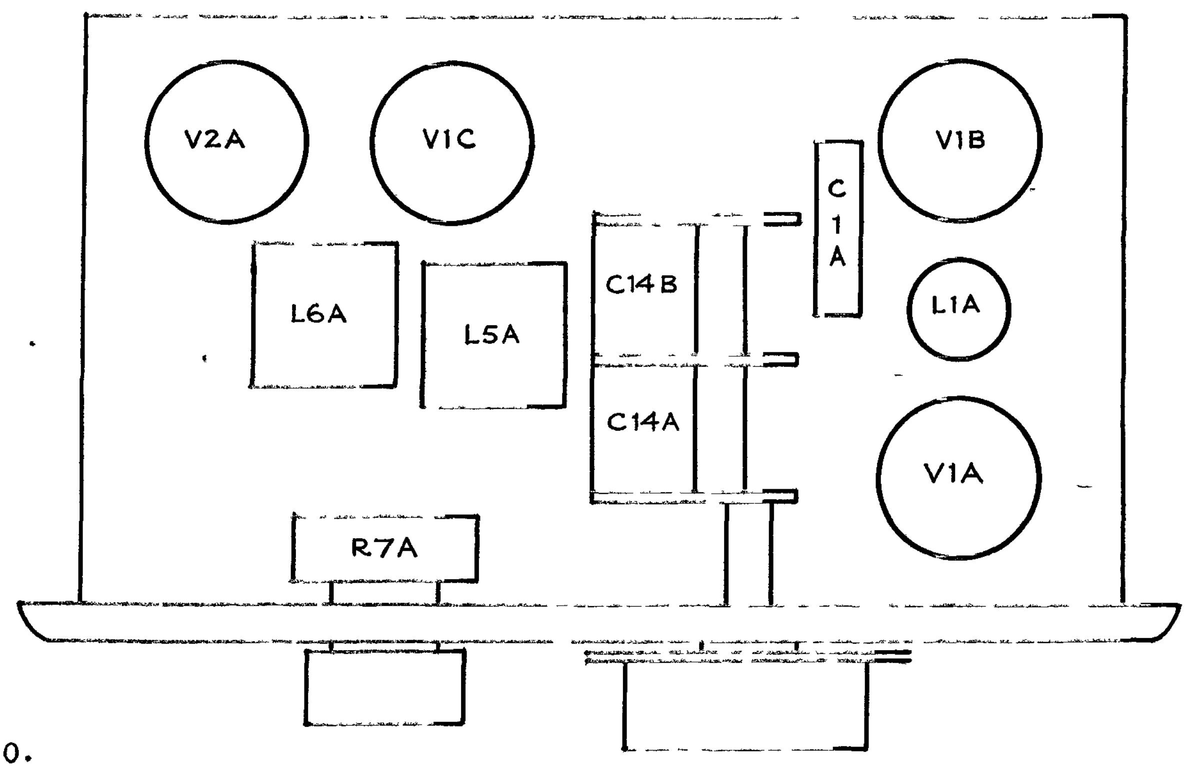
(b) Valve Base Connections.



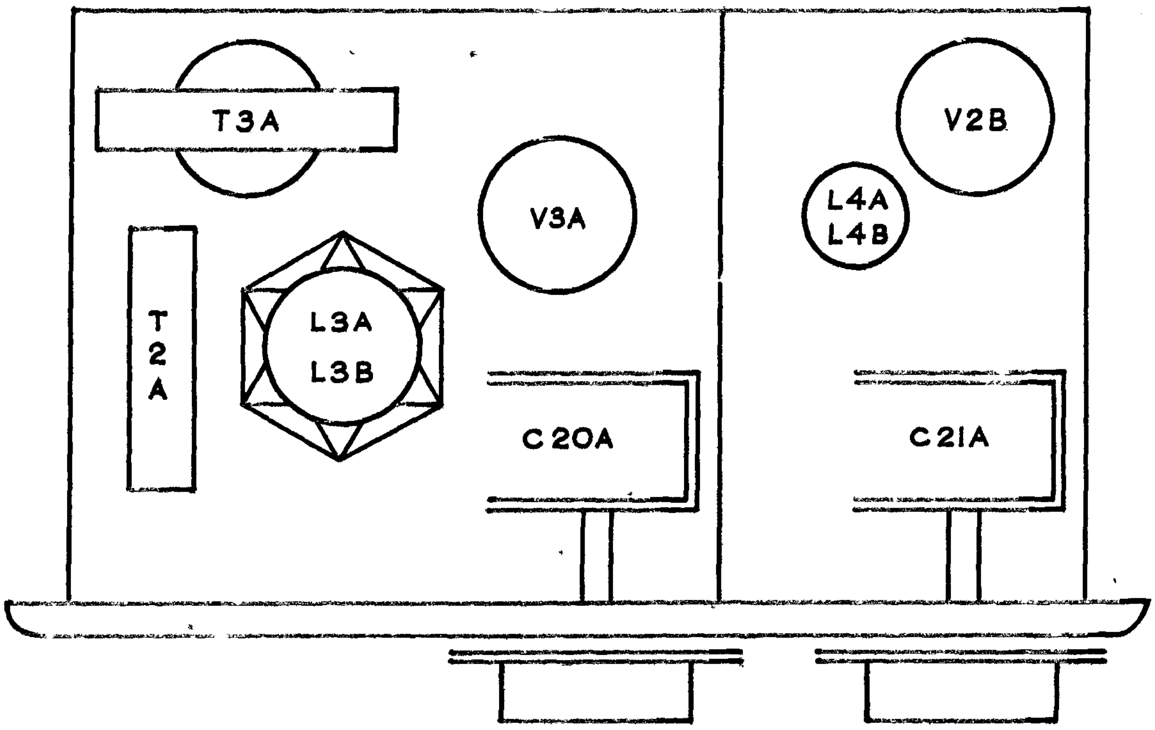
(c) Table of Valve voltages between valve socket and chassis.

	Valve Type & Function		Anode Volts	Screen Volts
V1A	ARP12	R.F. Amp.	140 - 150	70 - 75
V1B	"	Freq.Chgr.	140 - 150	70 - 75
V1C	"	I.F. Amp.	140 - 150	70 - 75
V2A	AR 8	A.F. Amp.	140 - 150	-
V2B	"	M.O.	140 - 150	-
V3A	ATP 4	P.A.	140 - 150	140 - 150

(d) PLAN OF MK III RECEIVER SHOWING POSITION OF VALVES.



(e) PLAN OF MK III SENDER.



VI. SOME ADJUSTMENTS TO THE W/S NO.18.

(a) Neutralization.

Tune the set to 9 Mc/s on SEND and receive the signal on another set with the B.F.O. on. Adjust this receiver until a beat note is heard. Adjust C15E until no change in the pitch of the beat note is heard when the AERIAL TUNING control is moved either side of the position of maximum aerial current.

(b) P.A. Drive.

Tune the set for maximum aerial current at 9 Mc/s on SEND. Switch to mA and adjust C15F to indicate 380μA on the meter.

(c) Netting Compensation.

Couple the M.O. loosely to a wavemeter. Tune the sender to 9 Mc/s and pick up the signal on the wavemeter adjusting the latter for zero beat.

Release the pressel switch and press the NET button. Adjust C15D for zero beat again. Check the adjustment for other points on the scale and readjust for minimum error throughout.

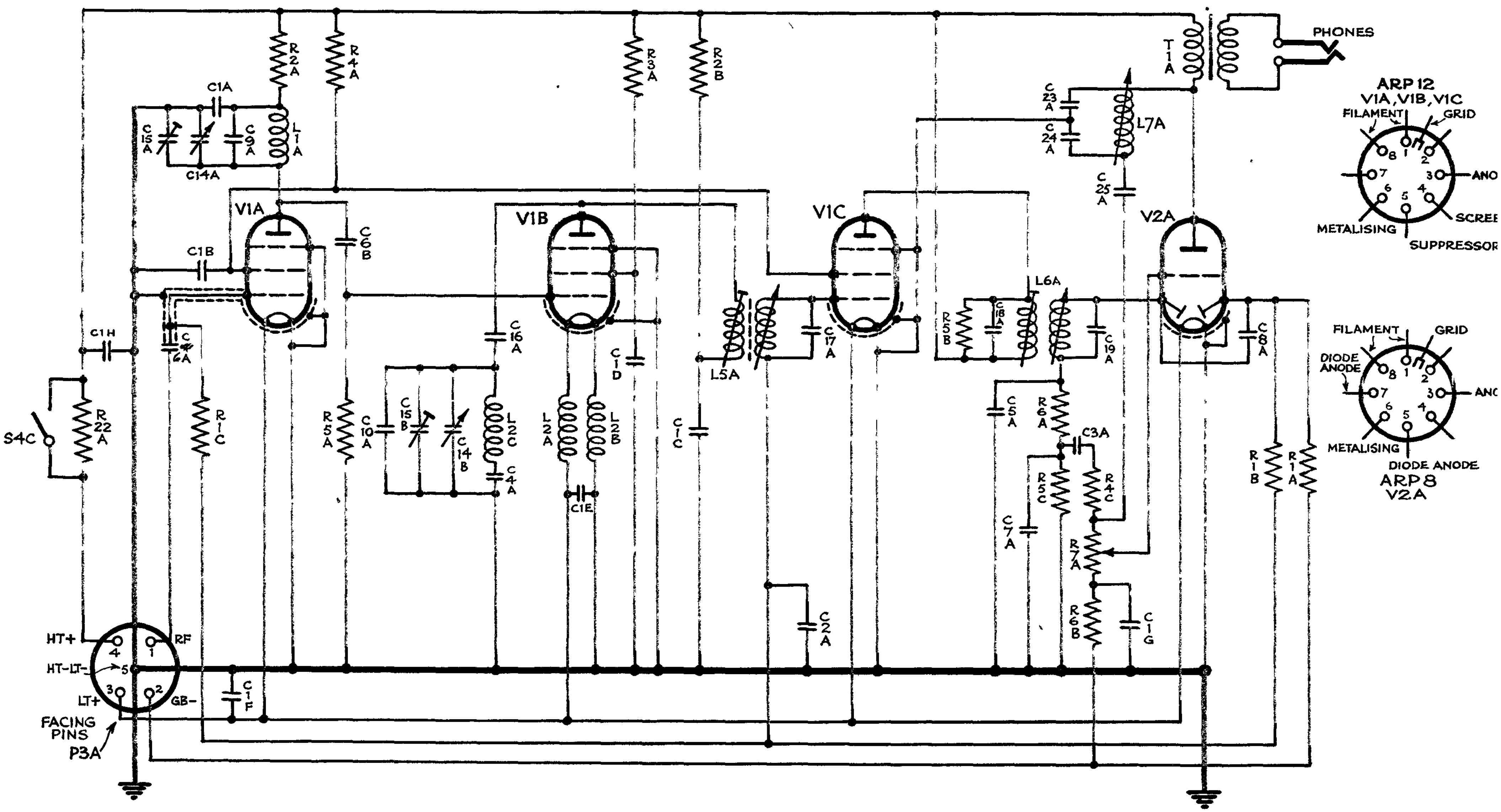
W/S NO.68.

Wireless Sets No.68 are practically identical in circuit detail with the W/S No.18 Mk III, except that different frequency bands are covered as follows:-

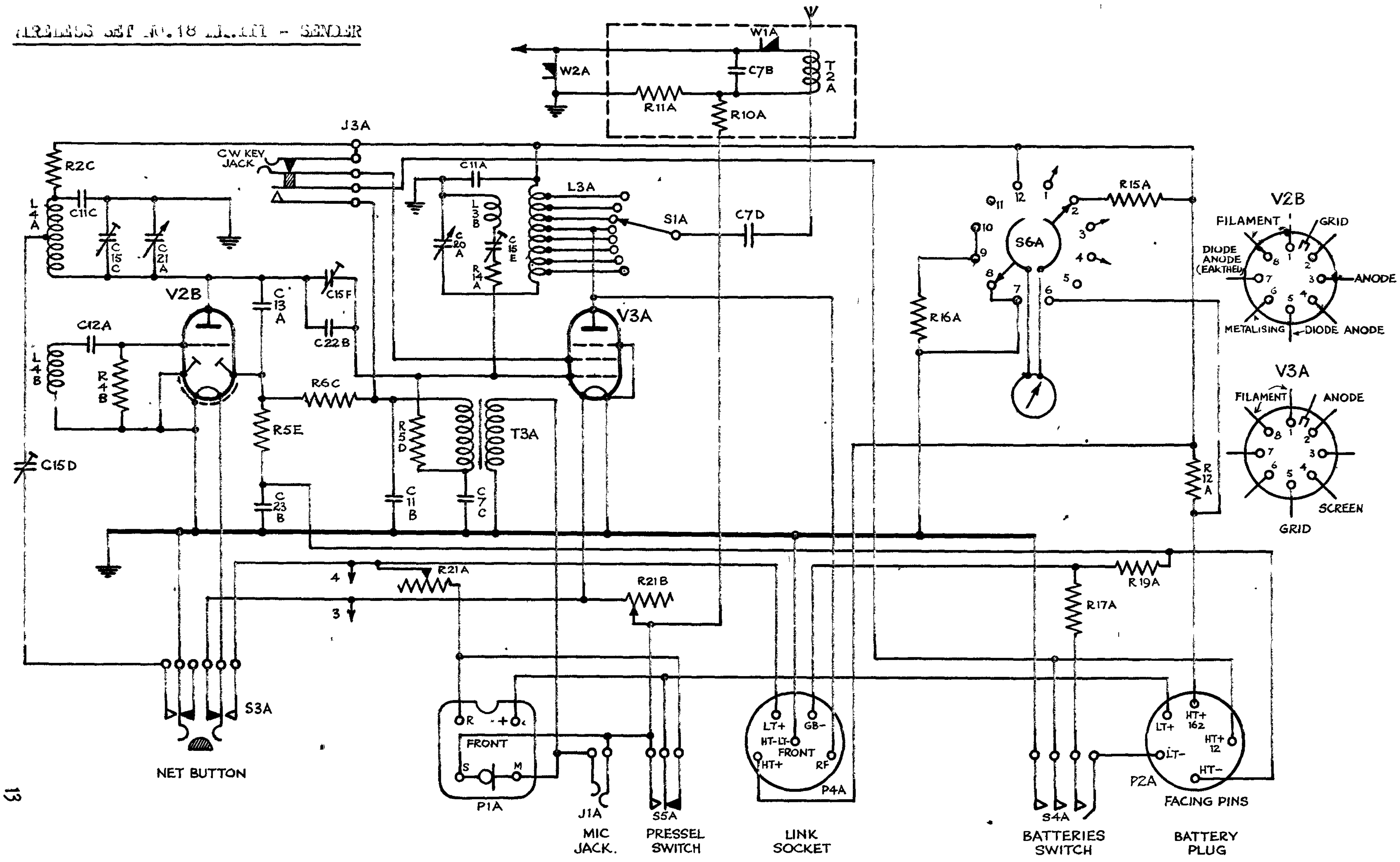
W/S No.68 P 1.5 - 3 Mc/s
W/S No.68 Q)
W/S No.68 R) 3 - 5.2 Mc/s
W/S No.68 T 1.5 - 3 Mc/s

In addition to the above alterations No.68 P & R are equipped with provision for Crystal Control on send. The crystal is plugged into the sockets located on the sender panel above the M.O. tuning dial. This added facility necessitates slight additions to the existing M.O. circuit.

WIRELESS SET NO.18. RECEIVER MK.III.



WIRELESS SET No.18 MK.III - SENDER



WIRELESS SET NO.19 MK III.

In the following notes the differences between Mk II & Mk III sets are duly noted in the appropriate sections. A summary of principal differences between Mk I, II and III is given at the end.

1. GENERAL DESCRIPTION.

(a) Purpose and general features.

The No.19 Set is designed primarily to provide a complete communication system for armoured fighting vehicles. The apparatus also forms the signal equipment in A.C.V's and L.3.C's (mobile headquarters), when increased range is obtained by using a specially designed R.F.Amplifier in conjunction with the 19 A Set. It is also used as a ground station in which case remote control facilities are available, working over ½ mile of line using Remote Control Unit "E".

The following facilities are provided.

(i) The "A" Set.

This is used for communication on R/T, M.C.W. and C.W. On R/T and M.C.W. a range of about 10 miles may be expected while the use of C.W. will increase the range to about 20 miles. The frequency range is 2-8 Mc/s, covered in two overlapping bands. (The range for the Mk I is 2.5-6.25 Mc/s in one band).

(ii) The "B" Set.

This is a U.H.F.transceiver providing R/T working only, between vehicles up to a distance of half a mile. The frequency used is approximately 235 Mc/s.

(iii) The I-C Amplifier.

For communication between members of the crew in armoured formations and between members of the staff in mobile headquarters.

Power for the combined apparatus is derived from a 12v accumulator which drives two rotary transformers, one of which runs on send only, contained in a Supply Unit No.1 Mk III. Maximum battery consumption is 10.7 Amps on send and 7.1 Amps on receive. Note. If an Amplifier R.F. No.2 is used there will be an additional drain of about 24 Amps on send.

The Microphone & Receiver Headgear No.1 or No.2 used with the apparatus is connected to the sets via separate control units located at convenient points in the vehicle and the facilities required are selected by means of a three-position ("A", "B" and "I-C") switch on the front of each unit.

Switching over from "Receive" to "Send" is accomplished on R/T by means of the microphone pressel switch and on W/T by inserting the Key Plug.

(b) Aerials.

The A set uses a rod aerial for ground wave communication. A.F.V's carry a 12' rod consisting of three 4' sections mounted in a flexible rubber base on the outside of the vehicle turret. Mobile headquarters vehicles use a V aerial with the H.P. set consisting of two rods mounted in a V adaptor. Stationary vehicles may be operated with vertical aerials up to 34' in height or, for sky wave communication with an end-fed horizontal aerial of which six different lengths are issued. A more convenient form, however, is the Aerials Horizontal All Wave "A" consisting of a 100' length of stranded copper wire joined to the variometer through a coupling unit which can be constructed from ordinary spares. See Figure 1. The 50 $\mu\mu$F condenser is not normally in circuit but is switched-in should the variometer tuning point come on the red band. The switch must be well insulated.

The B set aerial is a half-wave rod 20" in length and is connected direct to the set by means of a screened feeder, a multiple of one half wavelength in length.

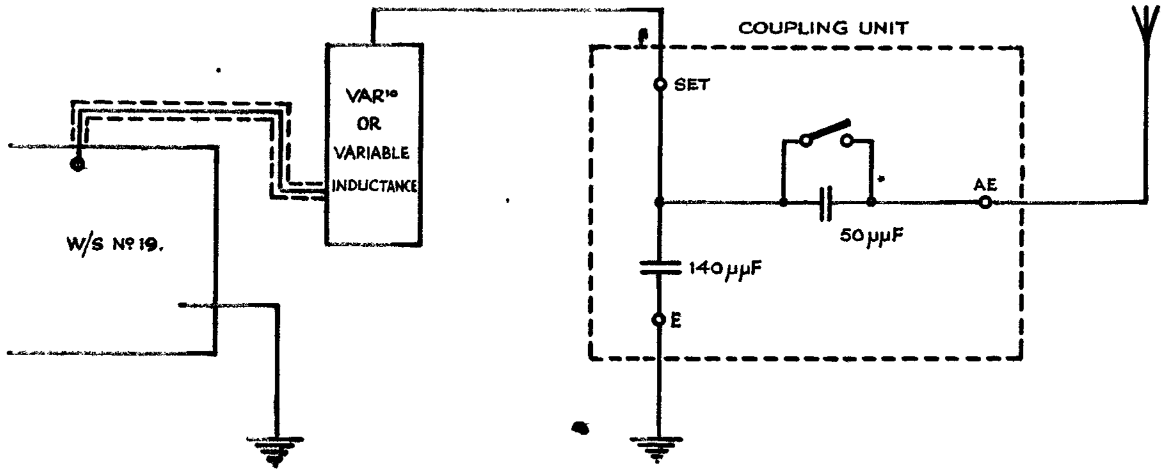


Figure 1.

2. THE "A" SET.

(a) General Circuit Considerations.

The "A" Set circuit is so designed that when it is tuned to any incoming signal within its frequency range, exactly the same frequency will be radiated without the adjustment of a separate Master Oscillator. Netting is thus automatically achieved, provided the receiver is tuned accurately.

The principles employed are shown in the accompanying block diagram.

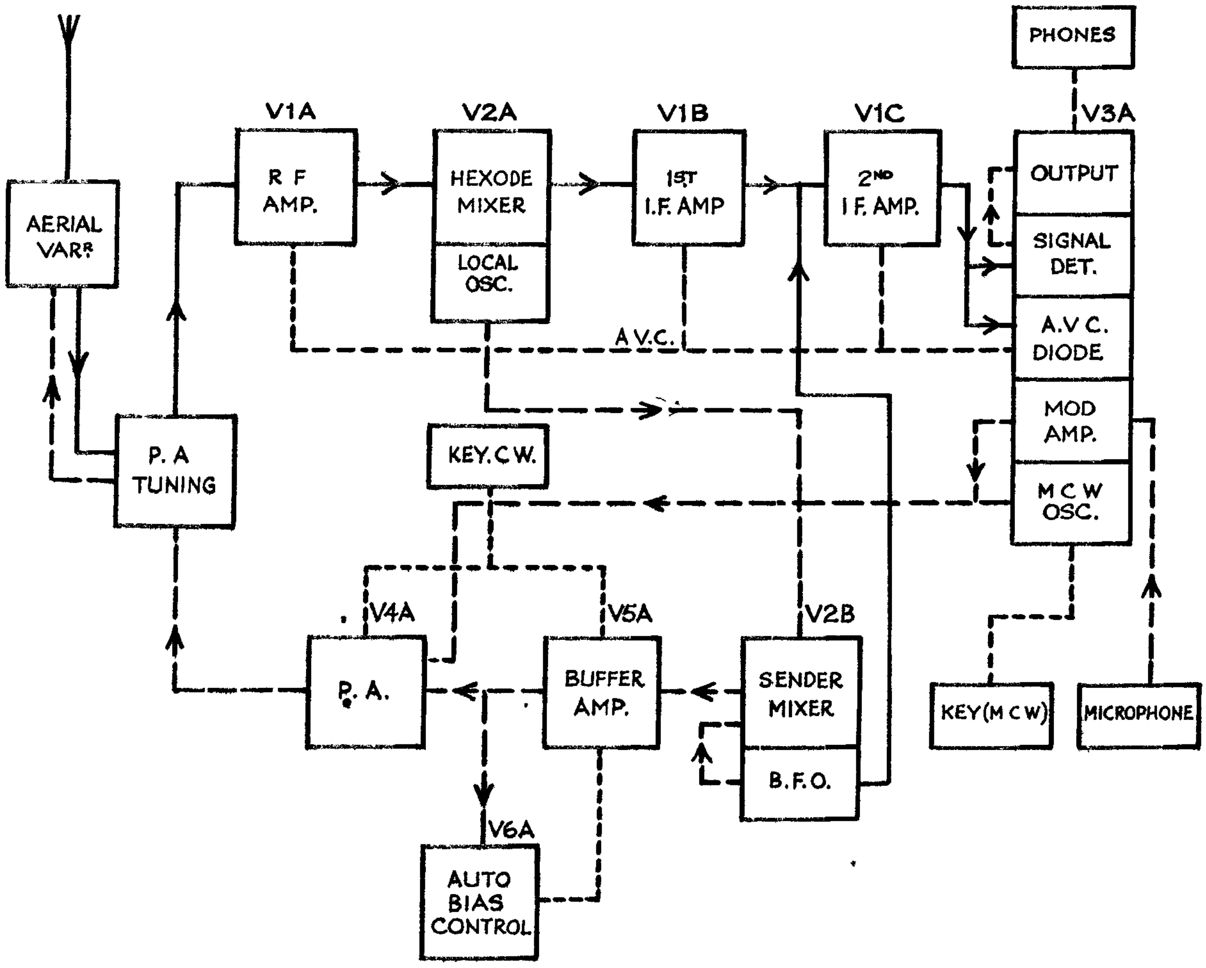


Figure 2. Complete Block Diagram of "A" Set.

The complete set employs 9 valves, 3 of which are used on both "send" and "receive".

For reception a superheterodyne circuit with automatic volume control is used and the sender signal frequency is controlled by the tuning of the receiver 1st Local Oscillator and Beat Frequency Oscillator.

(b) The Flick Frequency.

This set is equipped with a mechanical flick frequency arrangement which permits the pre-selection of any two frequencies in the band, change over from one to the other being accomplished by the simple movement of each of the two tuning dials.

The flick mechanism consists essentially of 2 circular plates each of which is locked to the main condenser shaft by means of 2 clamping screws. When these latter are slackened by one half-turn the condenser shaft can rotate independently. Each plate has a V aperture cut in the periphery, into which a spring-loaded locating arm can engage. The latter also operates a flag, thus providing visual indication for each frequency. A three-position flick lever in the "tune" position disengages the flick mechanism and brings the slow motion drive into operation. In the "set" position both flick and slow motion mechanisms are in operation and the tuning dial may be set for "flick". In the "flick" position the slow motion drive is disconnected and the flick mechanism is operating.

(c) Receiver - Technical Description.

The receiver employs a 6 valve superheterodyne circuit comprising one stage of R.F. amplification, frequency changer, two I.F. amplifier stages (465 Kc/s) followed by a combined signal detector, A.V.C. and output stage. A separate Beat Frequency Oscillator used for C.W. reception may also be operated at exactly the intermediate frequency by means of a toggle switch. Tuning to zero beat with the aid of this will ensure correct adjustment and accurate netting.

(i) R.F. Amplifier.

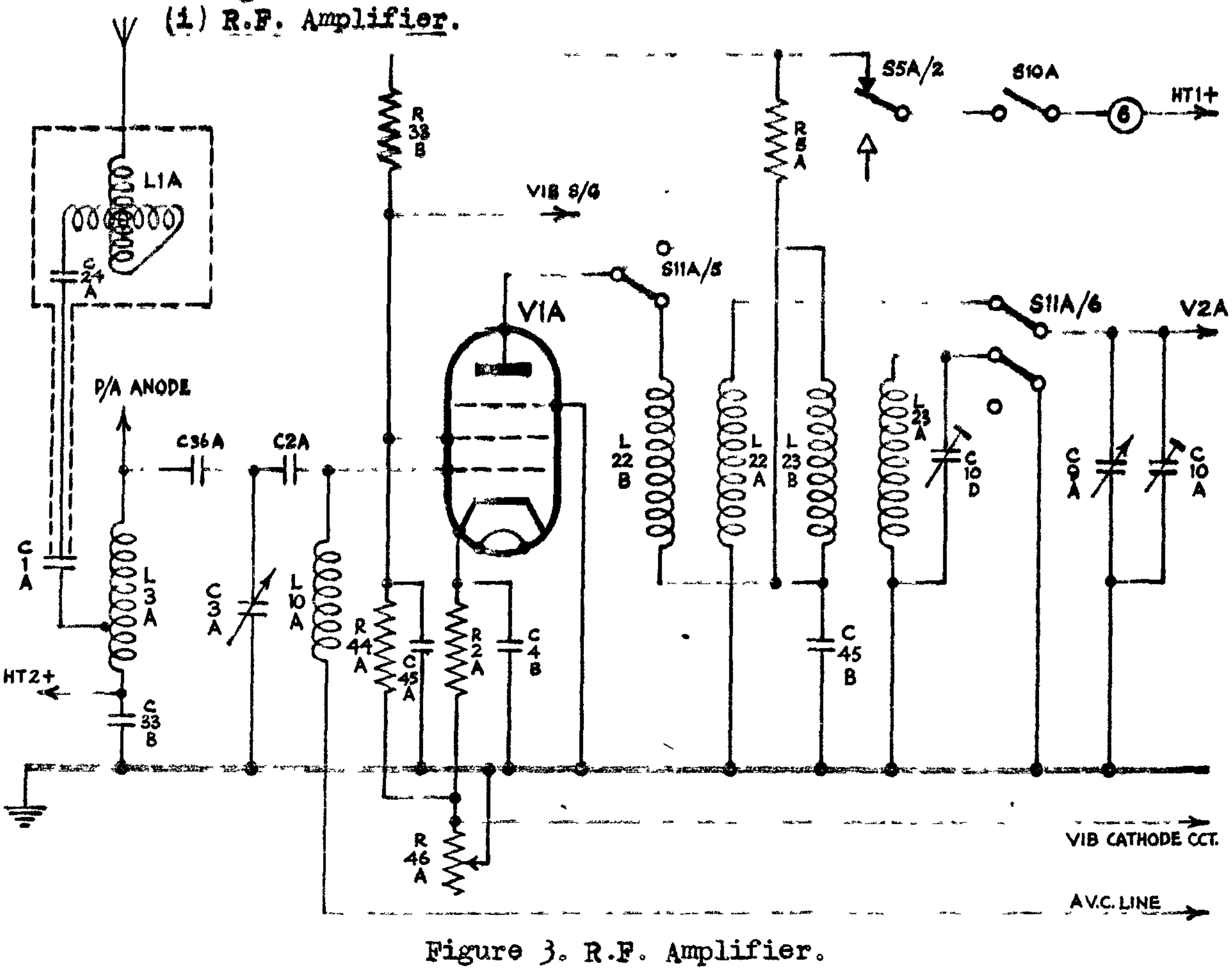


Figure 3. R.F. Amplifier.

The signal from the aerial, which is tuned to resonance by the variometer L1A and condenser C24A (.001μF) in series, is applied to the aerial tuning circuit comprising L3A tuned by C3A (.00054μF) through a tapping on L3A. The latter is connected to the control grid of V1A, an R.F. variable-mu pentode, type 6K7G, via the condenser C2A (.0001μF).

C33B (.1μF) and C36A (.01μF) isolate the P/A H.T. which is applied to L3A on send. V1A is self-biassed by means of R2A (220Ω) decoupled by C4B (.1μF). Extra cathode bias for R.F. gain control is provided by R46A (10 KΩ) also in the cathode circuit. [The Mk II is not provided with R.F. gain control]

A.V.C. bias is applied via L10A the purpose of which is to prevent loss of signal input to chassis via the bias circuit.

The anode load impedance is the primary of the R.F. transformer L22A and B (H.F.) or L23A and B (L.F.). H.T. to anode is applied via the resistor R5A (2.2 KΩ) decoupled by C45B (.05µF or .1µF). The screen grid, in common with the screen of V1B, the 1st I.F. valve, receives H.T. from a potential divider consisting of R33B top (27 KΩ) and R44A (82 KΩ) and R46A, bottom. C45A (.05µF or .1µF) is the screen decoupling condenser. [In Mk II Sets the potential divider is replaced by a 39000Ω feed resistor] .

C9A, one section of a 4 gang assembly, tunes the transformer secondary to the signal frequency and C10A is the trimmer for this circuit. C10D, a further trimmer, is necessary on the L.F. band.

(ii) Frequency-changer.

The R.F. amplifier output is taken to the hexode control grid of V2A, a triode hexode, Type 6K8G. The triode section of this valve acts as the local oscillator of tuned anode feed-back variety, and is parallel fed. It works on a frequency, 465 Kc/s above the signal frequency, determined by the resonant frequency of the tuned circuit comprising the coil L24A (H.F.) or L24A and L24C (L.F.) and C9B another section of the 4 gang tuning condenser.

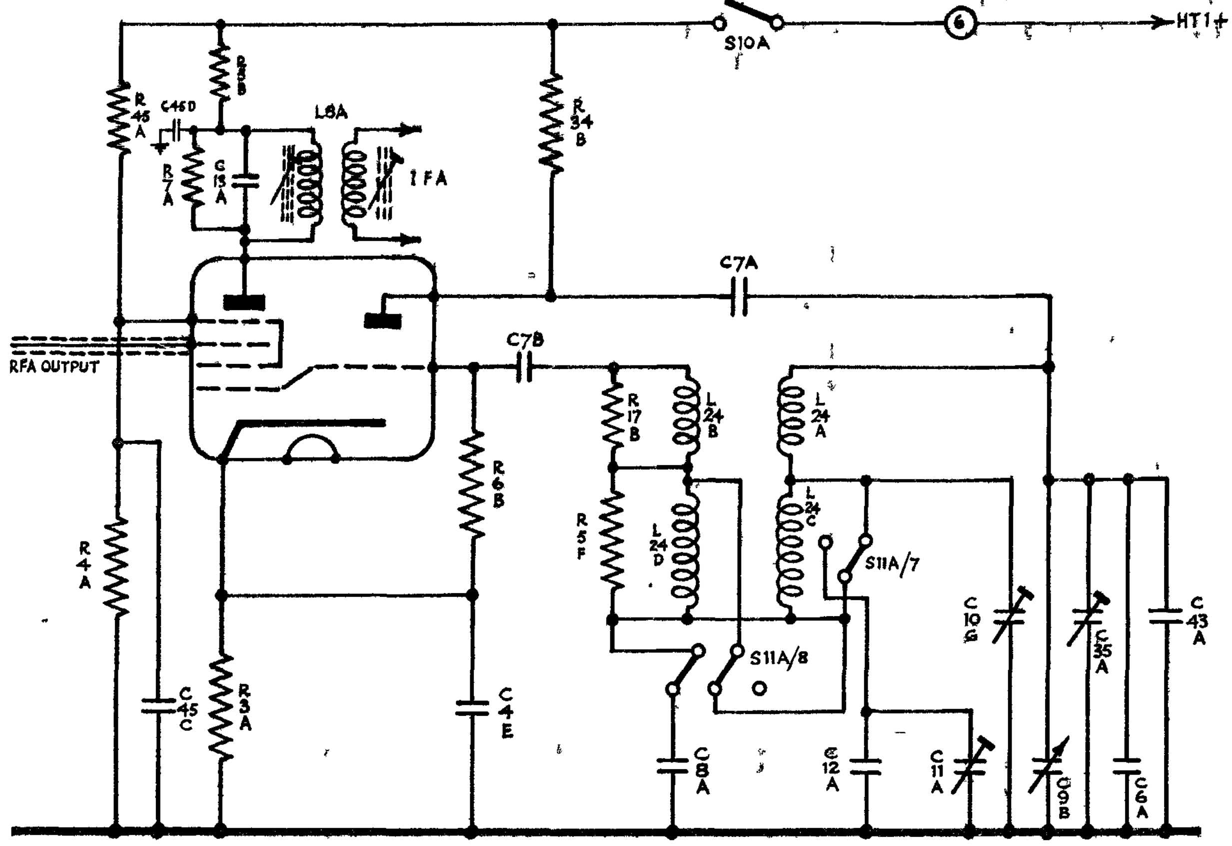


Figure 4. Frequency Changer.

Feedback is provided by the coupling coils L24B(H.F.) or L24B and L24D (L.F.). These coils are shunted by R17B (3.9 KΩ) and R5F (2.2 KΩ) respectively to stabilise oscillator output by preventing resonance in the grid circuit.

C8A (.005µF) and C12A (.002µF) in parallel with C11A (750µµF semi-variable) are the padders on the H.F. and L.F. bands respectively. C10G, C35A, C43A and C6A are parallel trimmers, the latter being a special ceramic condenser with negative temperature coefficient to correct frequency drift. Self bias is provided by the grid leak R6B (47 KΩ) and condenser C7B (50µµF).

The triode grid of V2A is connected internally to the injector grid of the hexode section which functions as the mixer. Control grid bias is provided by the usual resistor R3A (270Ω) in the cathode lead decoupled by C4E (.1µF). A.V.C. is not applied to this stage to maintain maximum conversion conductance.

The I.F. component of the output from V2A is selected by the primary of the I.F. transformer L8A and passed on, to the control grid of the 1st I.F. valve V1B. L8A is permeability tuned and R7A (100 KΩ) shunting the primary assists in providing the desired response curve.

[The Mk II L.O. circuit adopts a slightly different method of band switching and is more subject to frequency drift].

(iii) I.F. Amplifier.

There are two stages of I.F. amplification. The input to each of the I.F. valves V1B and V1C (Type 6K7G) is taken from the secondary of the previous I.F. transformer. These form band-pass filters which are permeability tuned to the intermediate frequency (465 Kc/s). V1B is self-biassed by means of R9A (1 KΩ) and also receives bias from the R.F. gain control R46A. V1C is biassed by R3B (270Ω) only in the cathode lead. Each valve receives full A.V.C. bias through the secondary of its I.F. transformer. On C.W. however, V1C does not receive A.V.C. bias. [This does not apply to Mk II Sets.]

Note that when the Send/Receive relay is in the "send" position it disconnects the screen-grids of V1A, B and C but not the anodes.

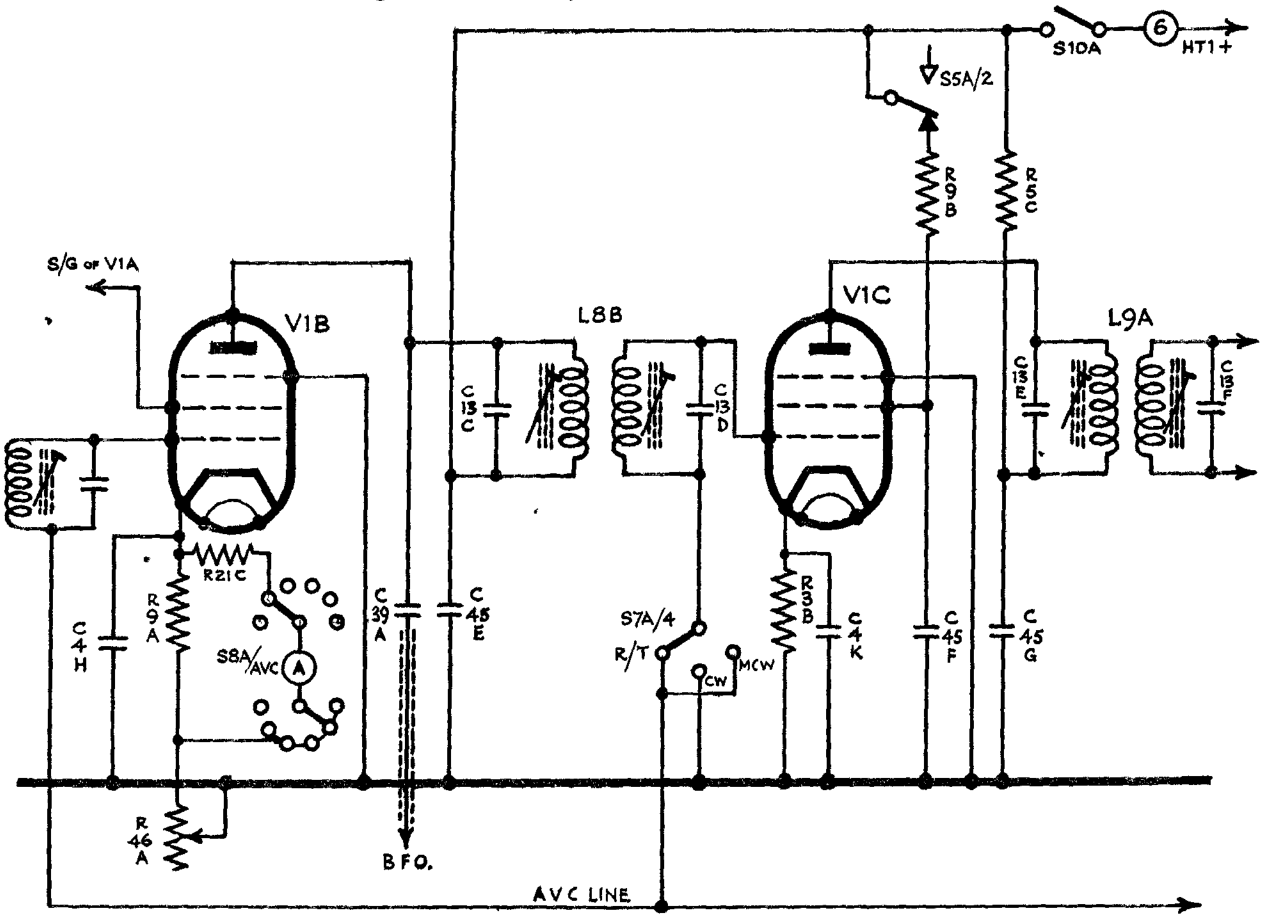


Figure 5. I.F. Amplifiers.

(iv) Signal Detector, A.V.C. and Output Stage.

V3A is a double-diode pentode, Type 6B8G. One diode acts as the signal detector the other diode as the A.V.C. detector and the pentode section as the A.F. amplifier.

Signal Detector.

The signal detector section of V3A operates in a series diode circuit, the load resistance being R1B (470 KΩ). R7C (100 KΩ) together with C14A (.0001μF) and C15A (.0005μF) form an I.F. filter. A.F. is fed through the blocking condenser C17A (.002μF) to the A.F. volume control R13A (1 MΩ) which is connected by a screened lead through the system switch and contacts on the send/receive relay to the control grid of the pentode section of V3A.

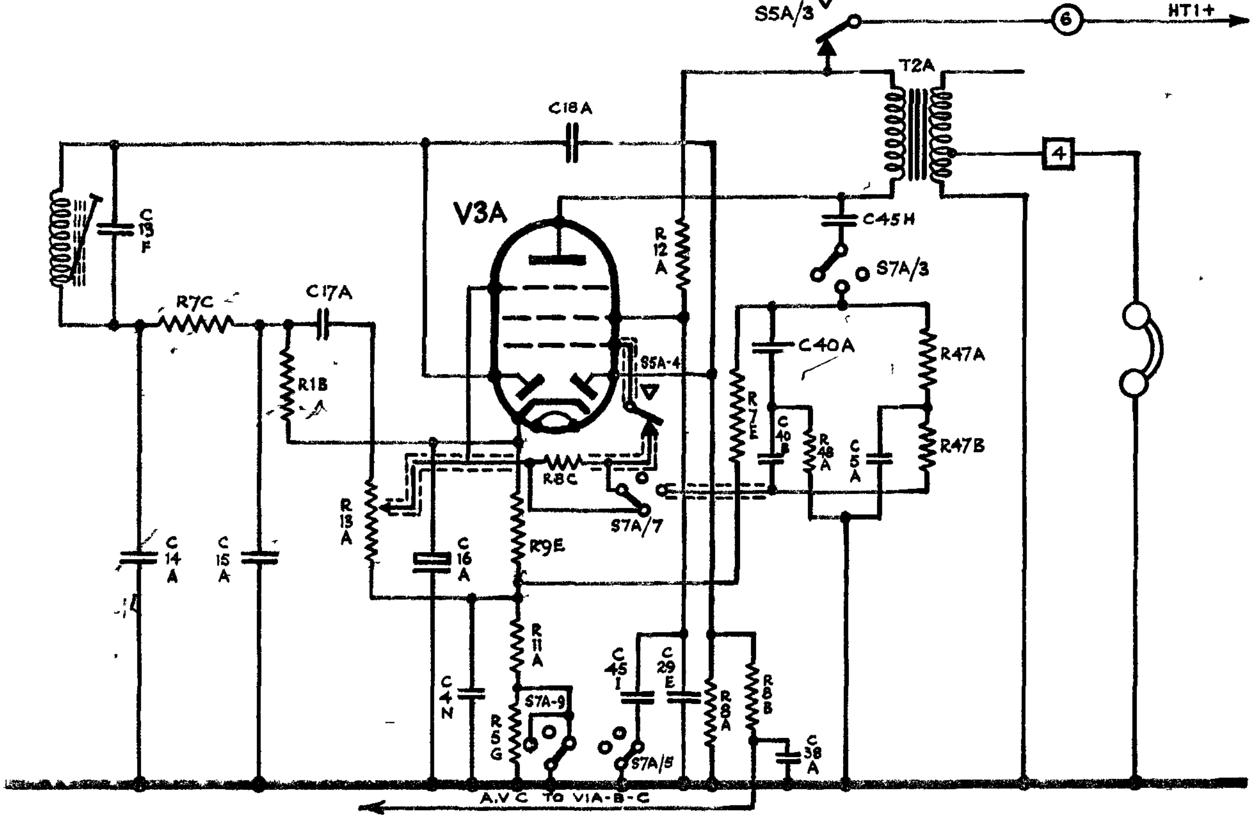
Automatic Volume Control.

The A.V.C. diode receives I.F. via the condenser C18A (20μμF). This diode operates in a parallel diode circuit, R8A (1 MΩ) and C18A being the diode load resistance and condenser respectively. Rectified current through the former develops voltage which is applied as negative bias through the filter circuit R8B (1 MΩ) and C38A (.1μF) to the controlled valves. As R8A is returned straight to earth, a negative delay bias is applied to the A.V.C. diode anode equal to the voltage (-30) across the cathode resistors R9E (1 KΩ) and R11A (3.3 KΩ) (and R5G 2.2 KΩ on C.W. only).

Output stage.

The pentode section of V3A is biassed by the cathode resistance R9E decoupled by C16A (12μF). Its anode load impedance consists of the primary of the output transformer T2A, the secondary of which goes to the phones.

Figure 6. Detector, A.V.C. & Output.



Both anode & screen grid receive H.T. through the S/R relay contact S5A/3 while on receive.

Selectivity on C.W. is assisted by the inclusion of an A.F. filter consisting of a network of resistances and condensers R7E (100 K), R47A & B (1 MΩ), R48A (150 KΩ), C5A (.005μF) and C40A & B (.00025μF). The filter provides voltage negative feedback except over a band of frequencies around 1000~ and a note of this pitch will therefore receive more amplification than others.

The performance on W/T is further improved by restricting the frequency response of the output stage in order to reduce noise and interference. The reduction in the value of screen decoupling condenser (C29E .01μF) provides base attenuation on C.W. and M.C.W. while the response to the higher audio frequencies is reduced by the grid filter consisting of R8C (1 MΩ) and the shunt capacity of the screened leads. [In Mk II Sets the C.W. filter and arrangements for bass and top cut are not included].

(v) Beat Frequency Oscillator.

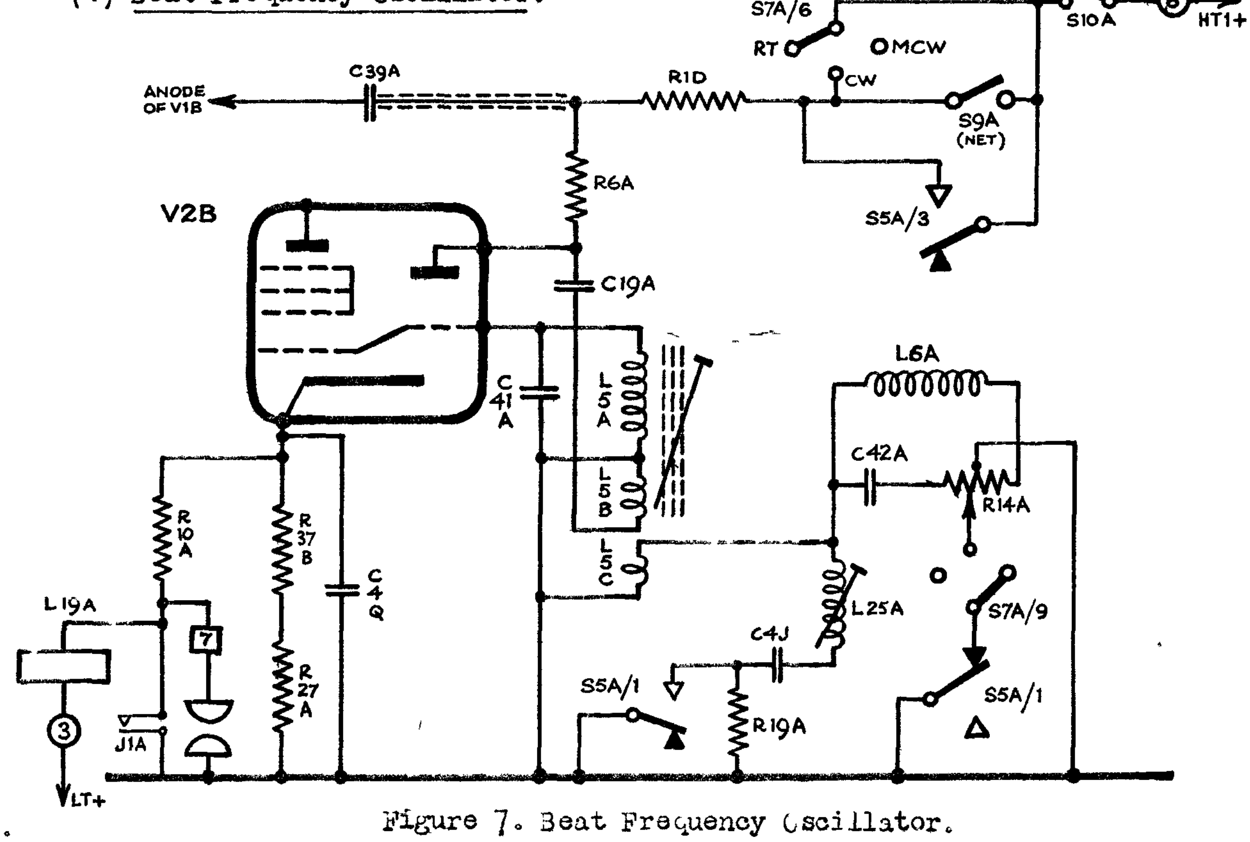


Figure 7. Beat Frequency Oscillator.

The triode section of V2B operates as the B.F.O. in a parallel-fed Meissner circuit. The oscillatory circuit consists of L5A tuned by C41A (.0002μF) to the intermediate frequency (465 Kc/s). Feedback is provided by L5B, and the valve is biassed by means of the voltage drop across R37B (390Ω) and R27A (470Ω) which, in series with R10A (4.5 KΩ) and L19A, are across the L.T. supply. C4Q (.1μF) is the bias decoupling condenser.

Oscillator frequency is varied within audible limits of the I.F. by means of the coupling coil L5C which is shunted by the rejector circuit L6A, C42A (.05μF) and R14A (20Ω C.T. and variable). The latter circuit is tuned to the I.F. when R14A (HET.TONE control) is in the centre position. Variation of R14A either way changes the reactance of this rejector circuit which in turn varies the load on the B.F.O. oscillatory circuit and, of course, its frequency.

The output voltage developed across part (R1D) of the anode load R6A (47 KΩ) and R1D (470 KΩ) is fed to the primary of L8B via C39A (2μμF).

For best C.W. reception the HET.TONE control is adjusted so that the pitch of the wanted signal coincides with the peak frequency of the filter in the output valve circuit.

When the netting switch S9A is pressed, the B.F.O. operates at the intermediate frequency (465 Kc/s) and the set is accurately tuned by adjusting the tuning control for zero beat.

[Mk II's use a Colpitt's oscillator, the frequency of which may be varied slightly by means of a variable resistance which shunts a coil coupled to the oscillatory circuit. The output is coupled to the I.F. amplifier via the interelectrode capacity of V2B and the grid of the L.O].

(d) The Sender.

(i) General.

When the "A" set is operating on "send" the output of the 1st local oscillator V2A (signal + 465 Kc/s) and the B.F.O. output (465 Kc/s) are combined in the hexode section of V2B. The difference frequency, i.e., signal frequency, is selected by a tuned circuit and after amplification in the buffer stage, V5A, it is applied to a power amplifier stage. On R/T and M.C.W. grid modulation of the P/A is employed while on C.W. the screen of the P/A valve and anode and screen of the Buffer valve are keyed.

(ii) Master Oscillator.

This is the triode section of the receiver frequency changer valve V2A, which oscillates at a frequency 465 Kc/s above that of the carrier. No circuit changes take place on this stage when switching from receive to send. Coupling to the hexode control grid of V2B is obtained by means of the potentiometer comprising C21A (5μμF), R42C (10 KΩ) and R7L (100 KΩ).

(iii) Sender Frequency-changer.

The triode section of the triode hexode valve V2B oscillates at exactly 465 Kc/s. Oscillator frequency is independent of the HET.TONE control (R14A) by making the slider o/c on send. A slight variation in frequency on applying H.T. to the hexode screen on send is compensated by means of the adjustable coil L25A in series with C4J and shunting L5C. On receive the shunting effect is reduced to a negligible quantity by C17B (.002μF). The output is mixed with that from the master oscillator in the hexode section of this valve since the oscillator grid of the 6K8G also forms the 1st grid of the mixer. The output load is the primary of a transformer L7A & B (H.F.) or L21A & B (L.F.) the secondary being tuned to the difference or signal frequency by C9D another section of the main tuning condenser.

[Mk II sets employ a tuned anode circuit in this stage].

The screen grid voltage is applied by means of a potential divider R45B and R4D similar to that used for V2A. Control grid bias is obtained from the cathode resistors R37B (390Ω) and R27A (470Ω) in series, with R10A (1.5 KΩ) in parallel. The hexode grid receives bias developed across R37B only.

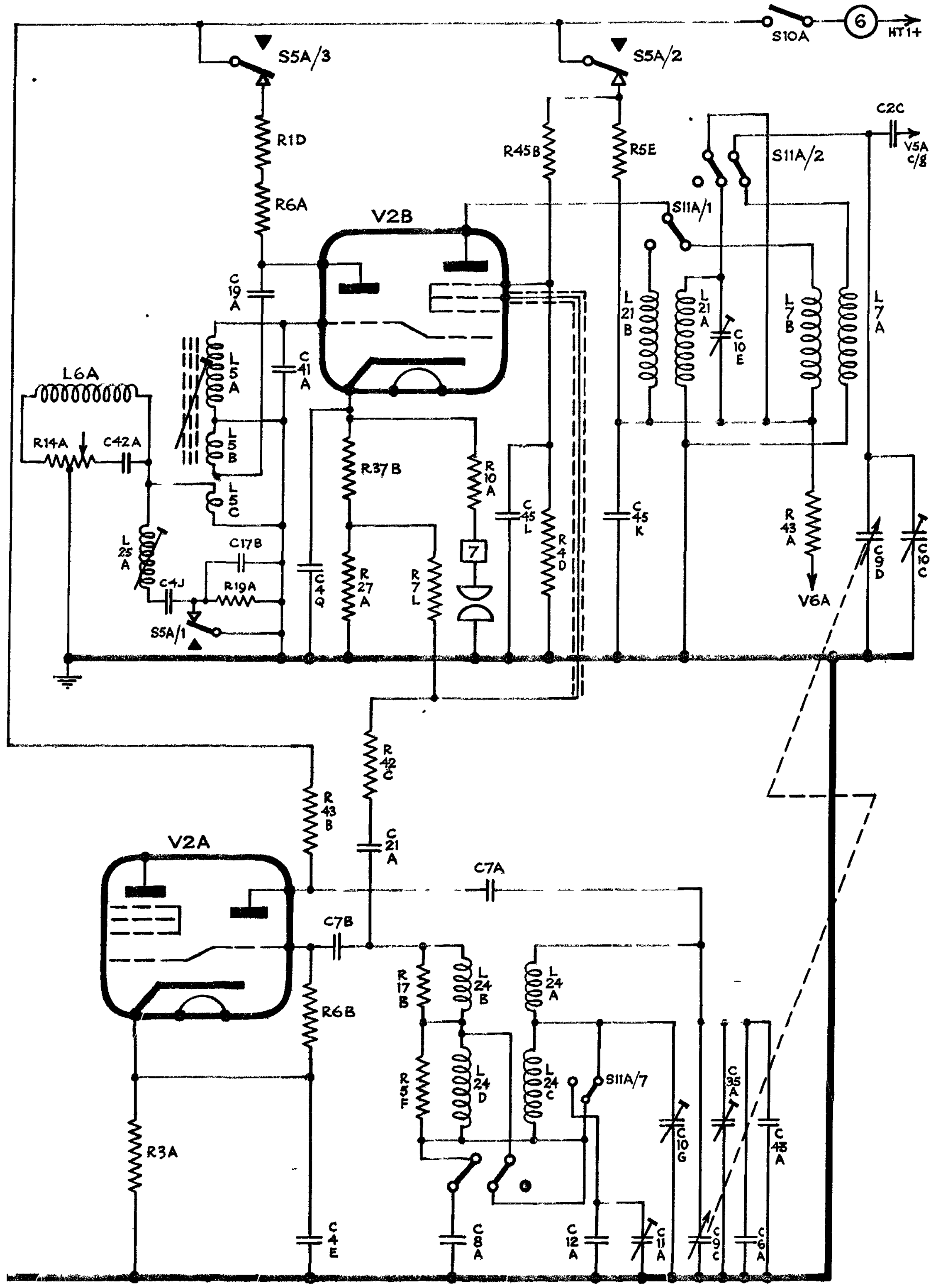


Figure 8. Sender Frequency Changer.

(iv) Buffer Amplifier.

This stage is included to amplify the drive voltage before it is applied to the power amplifier valve. It is designed round a high-μ R.F. pentode valve V5A (A.R.P.35). The output is tuned to carrier frequency by the transformer L4A & B (H.F.) or L4C & D (L.F.) and C9C, a section of the 4-gang condenser. [A tuned anode circuit is used in Mk II Sets]. Coupling to the P/A grid is via the fixed condenser C2D (.0001μF) and the preset condenser C34A. Screen voltage is applied via the resistance R17A (3.9 KΩ) decoupled by C20B (.002μF). Minimum bias is provided by the cathode resistor R20B (100Ω) decoupled by C45 (.1μF).

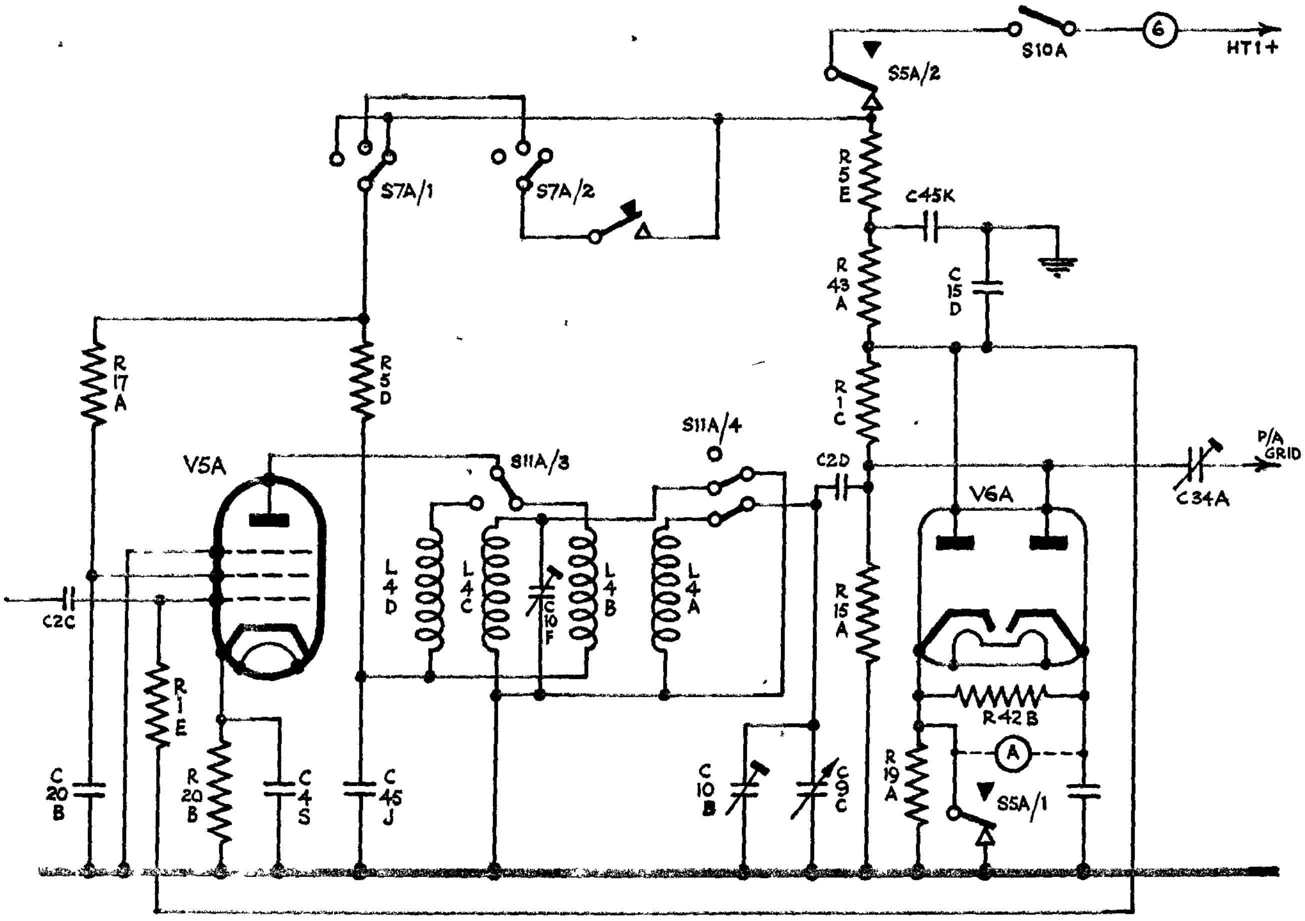


Figure 9. Buffer Amplifier & Bias Control.

(v) Double Diode Bias Control.

The control grid of V5A receives further negative bias in the form of automatic gain control voltage from V6A, an indirectly heated double-diode valve, type ARDD5. This control voltage which is delayed is used to maintain a constant pre-determined drive to the grid of the P/A valve.

One diode (right hand in figure) of V6A operating in a parallel diode circuit receives R.F. input through C2D and the voltage developed across the load resistance R15A (220 KΩ) is applied as control bias, to the grid of V5A through the filter consisting of R1C (470 KΩ) and C15D (500μμF) and the grid leak R1E (470 KΩ). Control voltage is delayed by the other diode which shunts the A.G.C. line, to an extent determined by the positive bias provided by the potential divider R5E (2.2 KΩ), R43A (3.3 MΩ), R1C and R15A across the H.T. supply. The actual drive to the P/A grid is adjusted by C34A. [In Mk II sets the two diodes provide separate control bias for V5A & V4A. Delay voltage on the buffer bias control diode is provided by a potentiometer across the H.T. supply and is adjustable].

(vi) Power Amplifier.

The P/A valve V4A is a beam tetrode, type ATS25, operating with an anode voltage of 450v from the high voltage rotary transformer & 260v on the screen from the lower voltage machine. Grid bias on R/T & M.C.W. is obtained from the voltage drop across R16A (1.8 KΩ) in the H.T.2- line. R16A is de-coupled by C16C (12μF electrolytic) and is short-circuited on C.W. when V4A is self-biassed by the grid current in the grid leak R7D (100 KΩ).

When switched to receive a large positive bias is applied to the cathode by means of the potential divider R18B (270 KΩ) and R19A (82 KΩ). This is sufficient to render the valve inoperative. On send R19A is shorted.

The output is tuned by the inductance L3A & C3A the P/A TUNING condenser, and is fed from a low impedance tap on L3A through screened feeder to the variometer L1A which tunes the aerial.

[The Mk II P/A is biassed on R/T and M.C.W. by means of V6A and also by rectification of the drive in the grid circuit].

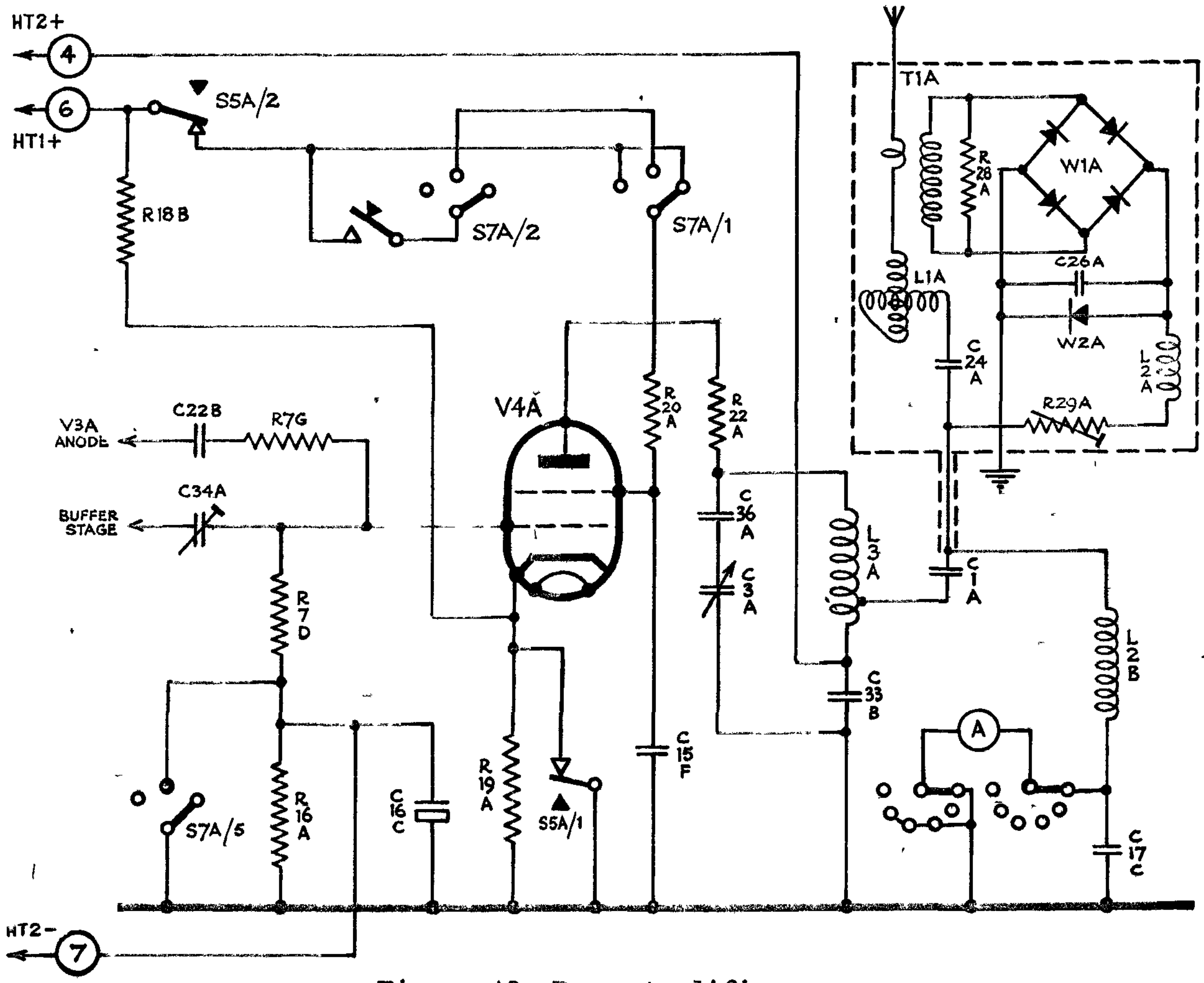


Figure 10. Power Amplifier.

(vii) Modulation.

On R/T working the pentode section of V3A is used as a modulation amplifier. Input from the moving-coil microphone comes through the secondary of the microphone transformer T3A to the control grid which is self-biassed by R9E in the cathode lead. The A.F. output is choke-capacity coupled to the grid of the P/A valve, the choke being the primary of the phone transformer T2A. Sidetone is taken from the secondary of T2A.

On M.C.W. V3A is employed as an A.F. oscillator the primary and secondary of T2A functioning as reaction and grid coil respectively. Keying takes place in the anode and screen circuits (T.T.K.M.).

(viii) Continuous Wave Working.

Keying of the carrier for C.W. is effected by connecting the key in the following H.T. circuits :-

(a) Screen grid of V4A.

(b) Anode and screen of V5A.

[In Mk II Set the anode and screen of V2B (hexode section) are also keyed.]

(ix) Send/Receive Switching.

The changeover from receive to send is accomplished by means of the microphone pressel switch. When the pressel switch is closed the relay energising coil L19A and L27A (in Supply Unit) are connected to 12V L.T., and the relays operate. The high voltage rotary transformer starts and the following circuit changes take place:

1. The microphone transformer secondary circuit is completed on R/T.

2. The anode and screen voltage to V1A and the screen voltage to V1B and V1C are removed. H.T. is applied to anodes and screens of V2B, V5A and V4A.

3. Anode and screen voltage to V3A is removed on C.W.

4. The large positive bias on the cathode of V4A and V6A is removed.

For C.W. and M.C.W. working the changeover is effected when the key plug is pushed into its jack, this action closing a switch and thus earthing one side of L19A.

Figure 11. Modulator.

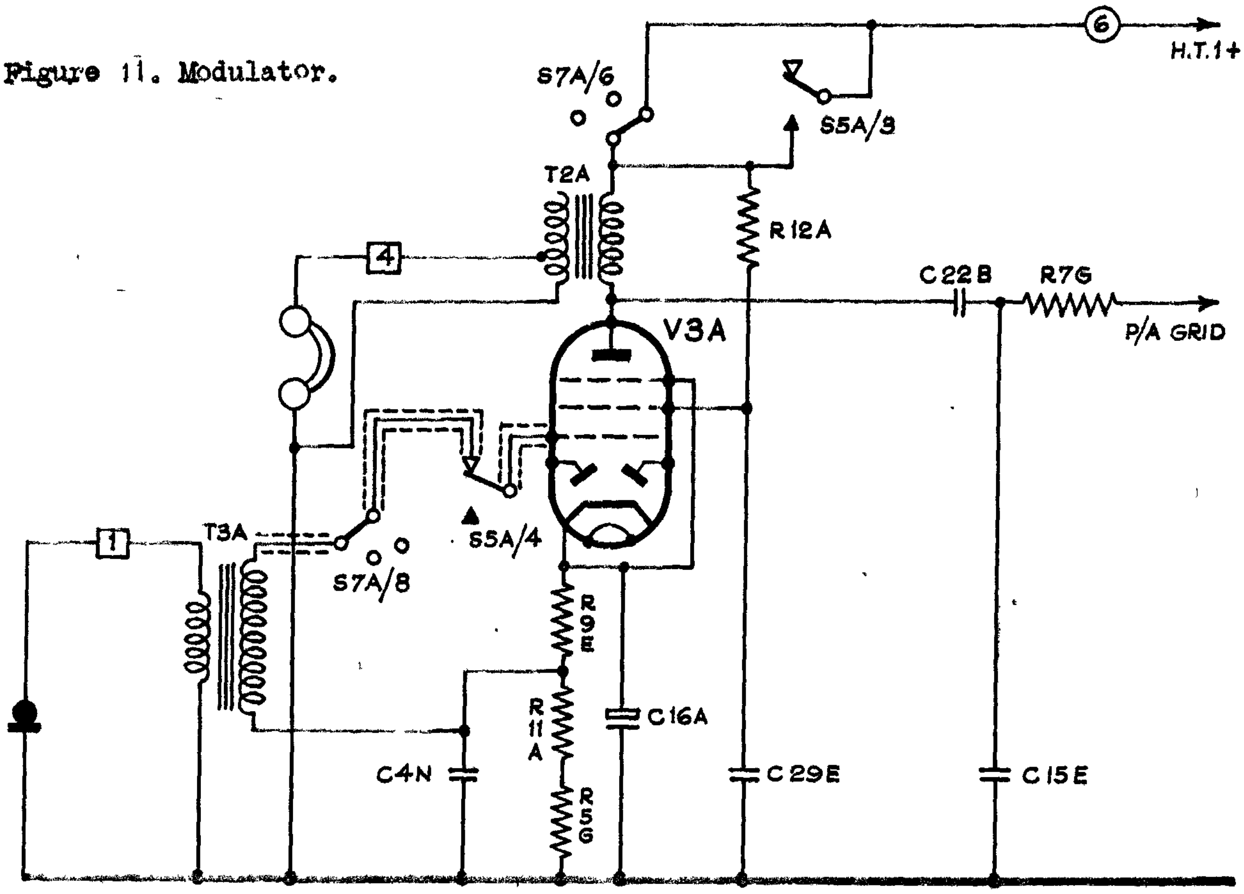
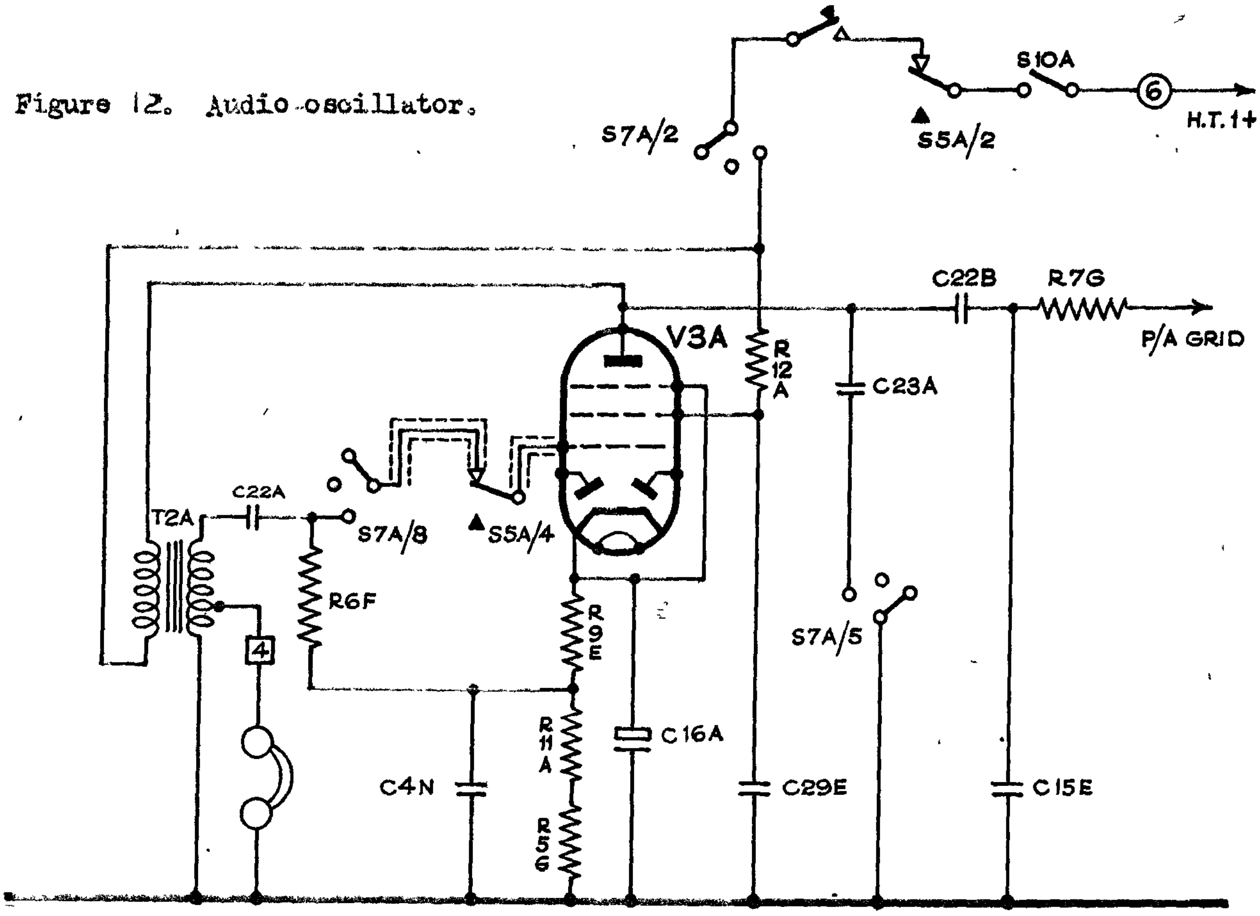


Figure 12. Audio-oscillator.



(x) The Meter.

The test meter on the front panel is a 0-500μA microammeter, and by means of a 6 position rotary switch the following indications are available:-

1. AERIAL CURRENT.

R.F. from the transformer T1A in the variometer is applied to the bridge rectifier W1A. D.C. output is taken to the meter via L2A, R29A (750Ω), the screened aerial lead L2B.

2. A.V.C.

In this position the meter, in series with R21C (27 KΩ) shunts the cathode resistor R9A in the 1st I F. stage. The deflection obtained will depend upon the cathode current of V1B which in turn will be affected by changes in bias The meter reading should therefore dip when the set is tuned through a strong signal. Compare this with W/S No.22.

3. L.T.

The meter in series with R26A (29.5 KΩ) functions as a voltmeter across L.T. input.

4. H.T.1.

The meter indicates H.T.1 input voltage. R24A (1.2 MΩ) is the series resistor.

5 H.T.2

In series with R25A(1.2 MΩ)the meter is connected as a voltmeter between H.T.2+ and chassis giving an indication of the P/A anode voltage.

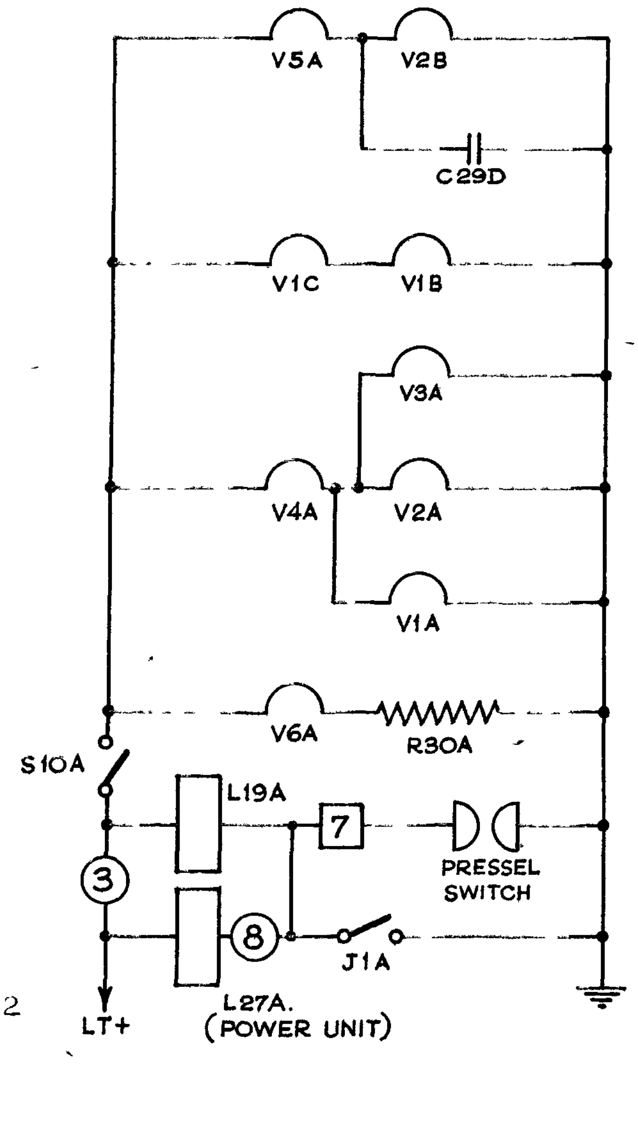
6. DRIVE.

In the Drive position the meter is connected across R42B (10 KΩ) in the cathode of the A.G.C diode. As the current in the latter will be proportional to the drive applied to the P/A grid, this and any variation in drive will be indicated by the meter deflection.

(xi) Variometer.

The variometer which tunes the aerial comprises a rotor & stator which can be connected either in series or in parallel by means of switches operated by the rotor spindle.

Between 0 and 100 on the scale the coils are in series and between 100 and 200 they are in parallel. Switch changeover positions are indicated by red bands on the scale & the component should not be used in these positions. To increase the inductance from minimum to maximum the dial must be rotated first from 100-200 and then from 100-0.



[7] = POINT ON 12 PT PLUG. (SET - CONTROL UNIT)

(3) ETC = POINT ON 12 PT PLUG. (POWER UNIT - SET)

Figure 13. Valve Heater and Send /Receive Relay Operating Circuits.

3. THE "B" SET.

(a) General.

The "B" set is a U.H.F. combined sender and receiver operating on R/T only, with a frequency range of approximately 229-241 Mc/s. Four indirectly heated valves are employed and power is derived from the common supply unit. On "receive" a four valve super-regenerative circuit is used embodying a separate quench oscillator, the latter operating on a frequency between 158 & 228 Kc/s. When used as a sender, three valves only are connected in an anode-modulated oscillator circuit.

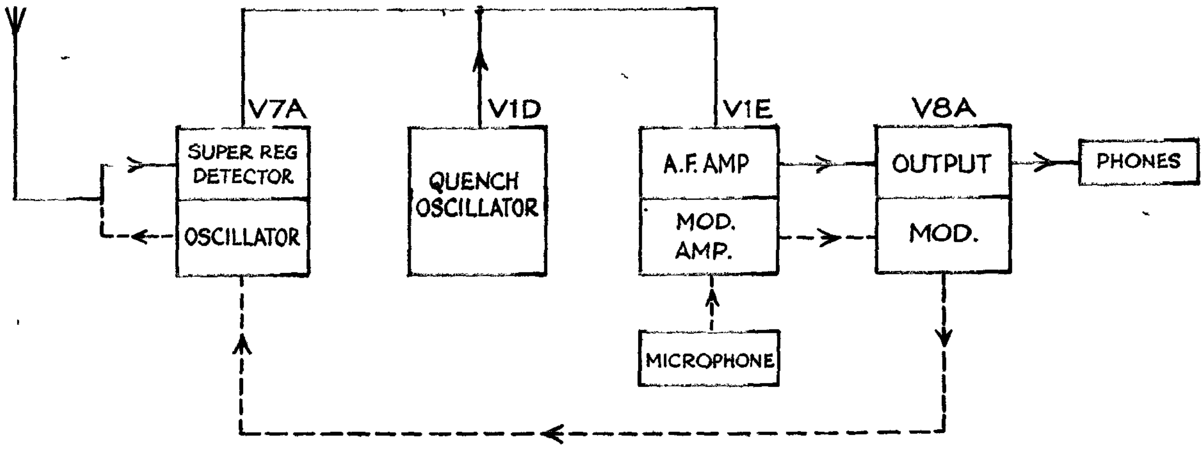


Figure 14. Complete Block Diagram of "B" Set.

OPERATION.

Purpose of Controls.

(i) "B" On/Off switch.

A double-pole on-off toggle switch S10B in the H.T. and heater leads enables the "B" set to be switched off while leaving the remainder of the equipment operative.

(ii) Tuning B.

Adjusts the split stator condenser C25A and varies the frequency of the set between 229 Mc/s and 241 Mc/s. It is not calibrated but the dial is marked with 10 divisions enabling resetting to be carried out.

(iii) Gain B.

Operates a 0.1 MΩ potentiometer R35A controlling the A.F. gain of the "B" set only.

(iv) Quench.

Is used on receive only and is a permeability tuning adjustment associated with L14A which determines the quench frequency. It enables this frequency to be adjusted to avoid interference between sets in a net due to the beating of their quench frequencies or their harmonics.

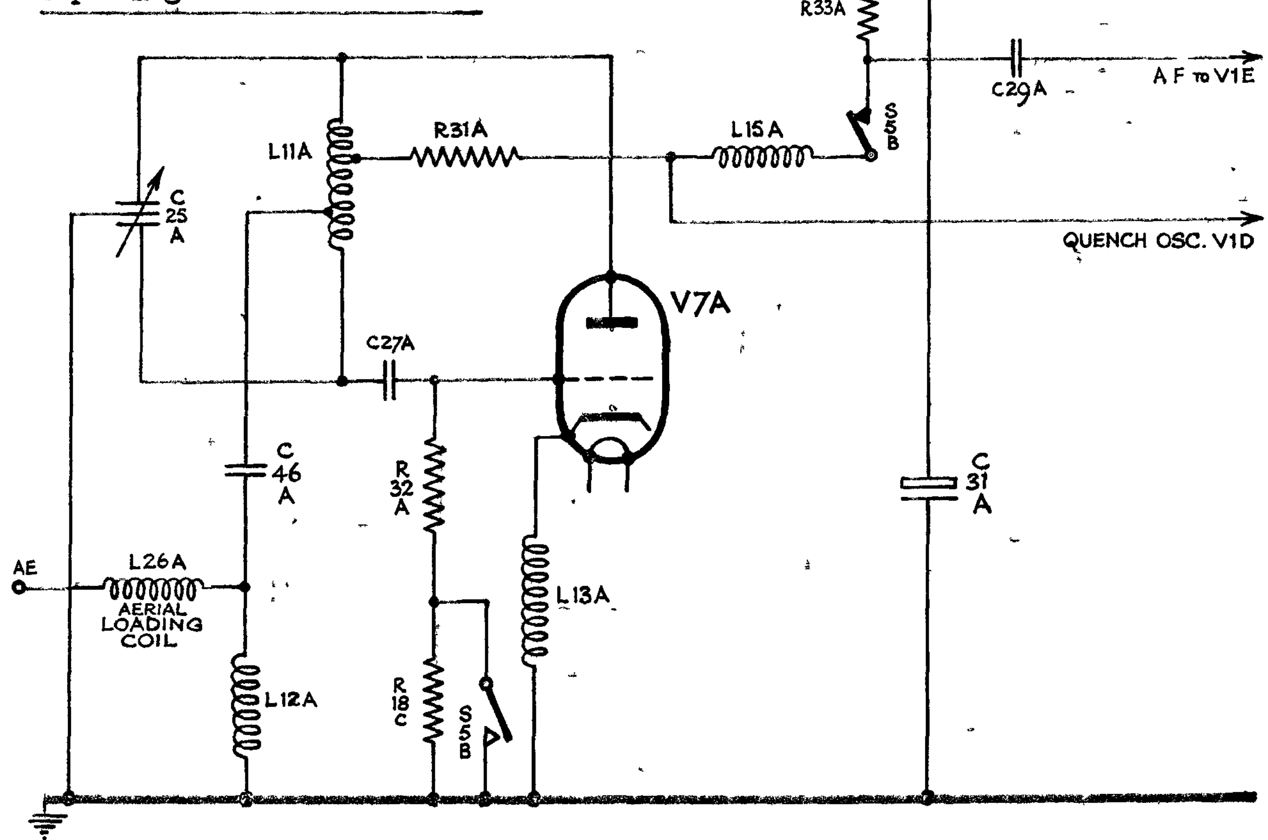
Note on Super-regenerative receivers. In this type of receiver the incoming signal is applied to a cumulative grid detector valve circuit with reaction, maintained in a state of high sensitivity by increasing the reaction beyond the oscillating point. The heterodyning of the carrier which normally results is prevented by varying the anode voltage of the detector at a supersonic frequency. Thus the detector ceases to oscillate every negative half-cycle of the latter frequency. This action is accomplished by means of another valve oscillator known as the "quench oscillator".

(b) Detailed Description of Receiver Circuit.

(i) The Super Regenerative Detector Stage.

The oscillating detector valve V7A is a special low capacity indirectly heated triode, type CV6, the grid and anode leads being brought out to top caps on the valve envelope. This stage forms a self-excited Colpitts oscillator, the oscillatory circuit comprising L11A and the split stator variable condenser C25A. The latter enables the value of the split capacity to be varied for the purpose of tuning the circuit to the signal frequency. Cumulative grid detection is obtained by means of C27A (20 μμF) and the grid leak R32A (15,000Ω) and R18C (270,000Ω).

Figure 15.
Super Regenerative Detector.



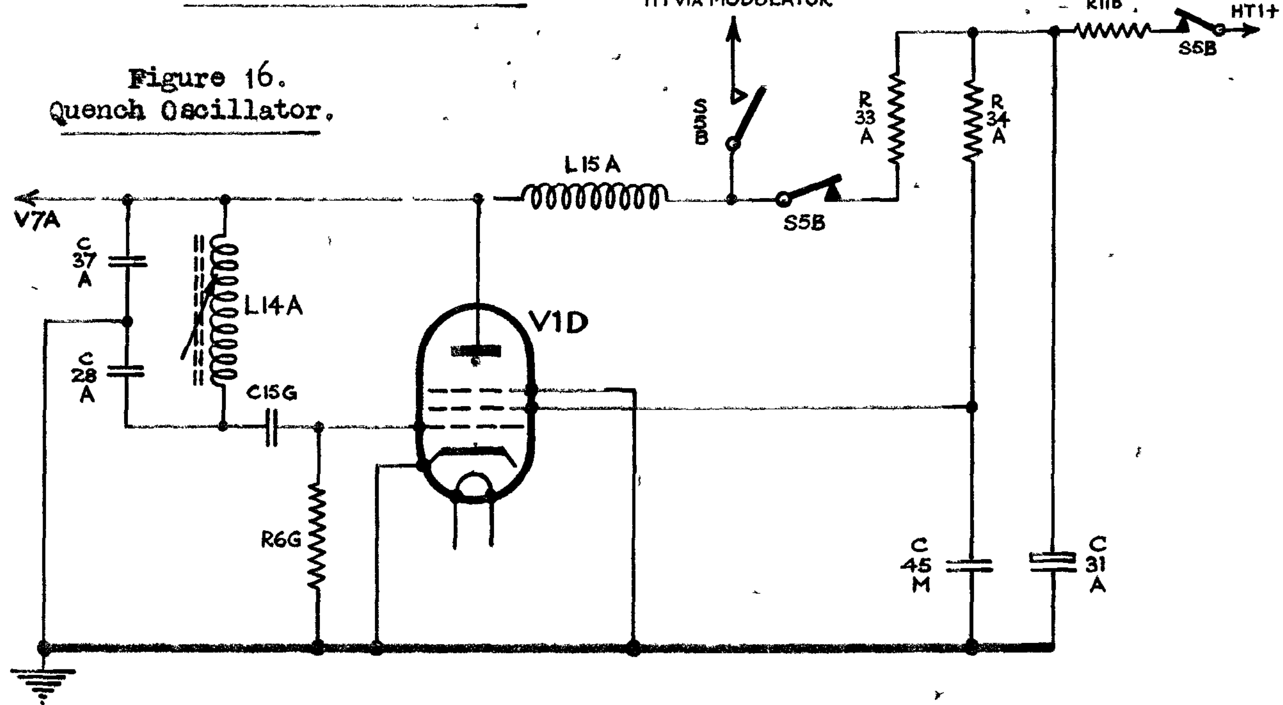
This stage is also used as the U.H.F. oscillator on send when the grid leak is reduced in value to 15,000Ω by short-circuiting R18C via a pair of contacts on the relay S5B.

The R.F. input developed across L12A is fed to the detector via C46A (5μμF) and a tapping on L11A. The inclusion of the cathode choke L13A prevents negative feedback, thus increasing the oscillator efficiency on the high frequencies employed.

H.T. voltage applied to the anode is picked up from the H.T.1+ line via switch S10B, relay S5B, anode dropping resistance R11B (3300Ω) decoupled by C31A (2μF), the load resistance R33A (10,000Ω), the quench anode choke L15A and the resistance R31A (2200Ω). A.F. voltages developed across R33A are applied to the A.F. stages through the coupling condenser C29A (.01μF). L12A and C46A form a filter to keep spurious oscillations out of the aerial which cause interference on the A set.

(ii) The Quench Oscillator.

Figure 16.
Quench Oscillator.



In this stage an indirectly heated variable-μ R.F. pentode V1D type 6K7G is employed in a parallel fed Colpitts oscillator circuit tuned to the quench frequency by L14A, C28A and C37A. This frequency may be varied between the limits of 158 Kc/s and 228 Kc/s by means of the variable inductance L14A (see notes on Operation).

H.T. to the anode of V1D is applied via its anode load impedance L15A which, we have seen, is also included in the anode cct. of detector V7A. Variations in potential at the quench frequency are thus applied to the anode of the detector, the average potential of which has been adjusted so that oscillation ceases every other half-cycle.

Screen - grid H.T. is fed via R34A, decoupled by C45M (.1μF) from the anode resistor R11B. Anode and screen resistors R33A, R11B and R34A are open-circuited on send, thereby increasing H.T. on the oscillator anode (V7A) and rendering the quench oscillator inoperative.

(iii) 1st A.F. Amplifier.

The detector stage is resistance capacity coupled to the 1st A.F. amplifier V1E, an R.F. pentode type 6K7G. An input filter comprising C30A & B (.001μF) and R6H (47,000Ω) is included to keep oscillations at quench frequency out of the A.F. stages. The A.F. voltage applied to the grid of this amplifier via grid stopper R23B is governed by the potentiometer R35A (Gain B).

H.T. to the anode is fed through resistances R23C (22,000Ω) and R7J (100,000Ω), the load. R1A (470,000Ω) decoupled by C45N (.1μF) feeds the screen grid. Fixed negative grid bias is provided by the cathode resistor R9B (1000Ω) Note the absence of a decoupling condenser here. This gives negative current feedback owing to the fact that R9B is common to both input and output circuits.

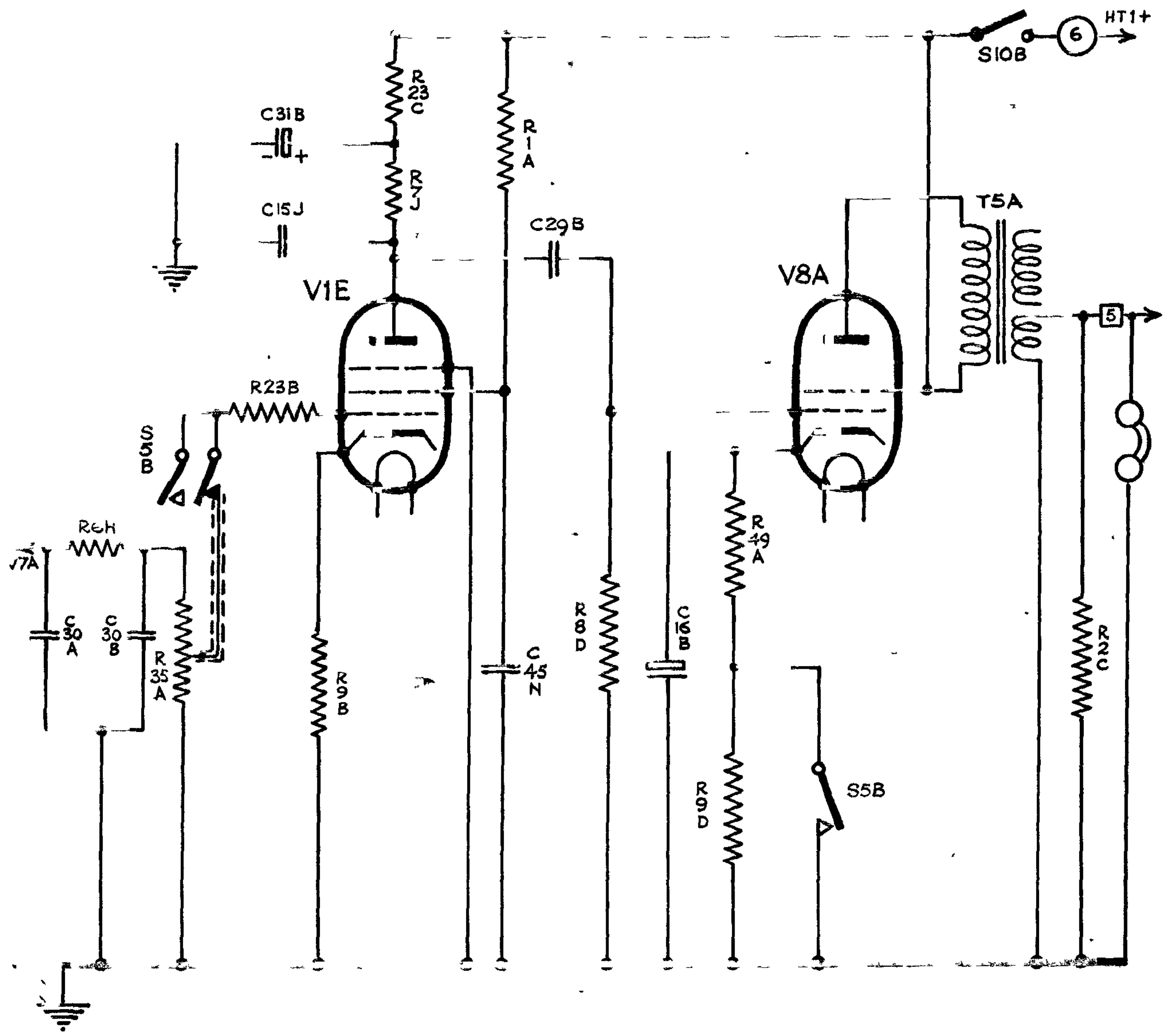


Figure 17 1st and 2nd A.F. Amplifiers.

As the control grid becomes more negative anode current decreases and the potential drop across R9B decreases; as the grid becomes less negative anode current increases and the potential drop across R9B increases. This means that the feed-back voltage is out of phase with the signal input to the grid, i.e. the overall amplification is reduced, with a consequent increase in stability. This same result could be achieved by:- (a) reducing H.T. on the anode, or (b) increasing grid bias.
The particular advantage of negative feedback, however, is that it reduces 3 kinds of distortion common in A.F. amplifiers, namely, frequency, harmonic and phase distortion.

(iv) Output Stage.

The output stage consists of a resistance capacity coupled beam tetrode V8A Type 6V6G. Automatic grid bias is provided by the cathode resistors R37A (390Ω) and R9D (1000Ω) in series & decoupled by the electrolytic condenser C16B (12μF). Note that on send, when the valve is used as a modulator, R9D is shorted by means of a pair of contacts on the relay S5B. The anode load impedance consists of the primary of output transformer T5A, one secondary of which is connected to chassis and No.5 pin on the 12-pt. output plug on the set, and so to the control units and phones. R2C corrects response of T5A.

(c) Detailed Description of Sender Circuits.

(i) Modulation Amplifier.

Due to the very low audio output from the moving coil microphone used, a 'pre-amplifier' is necessary between microphone and modulator valve. Output from the microphone is taken via microphone transformer T4A to the control grid of V1E which functions in the same manner as on "receive". The output is again fed through the coupling condenser C29B to the control grid of the modulator valve V8A.

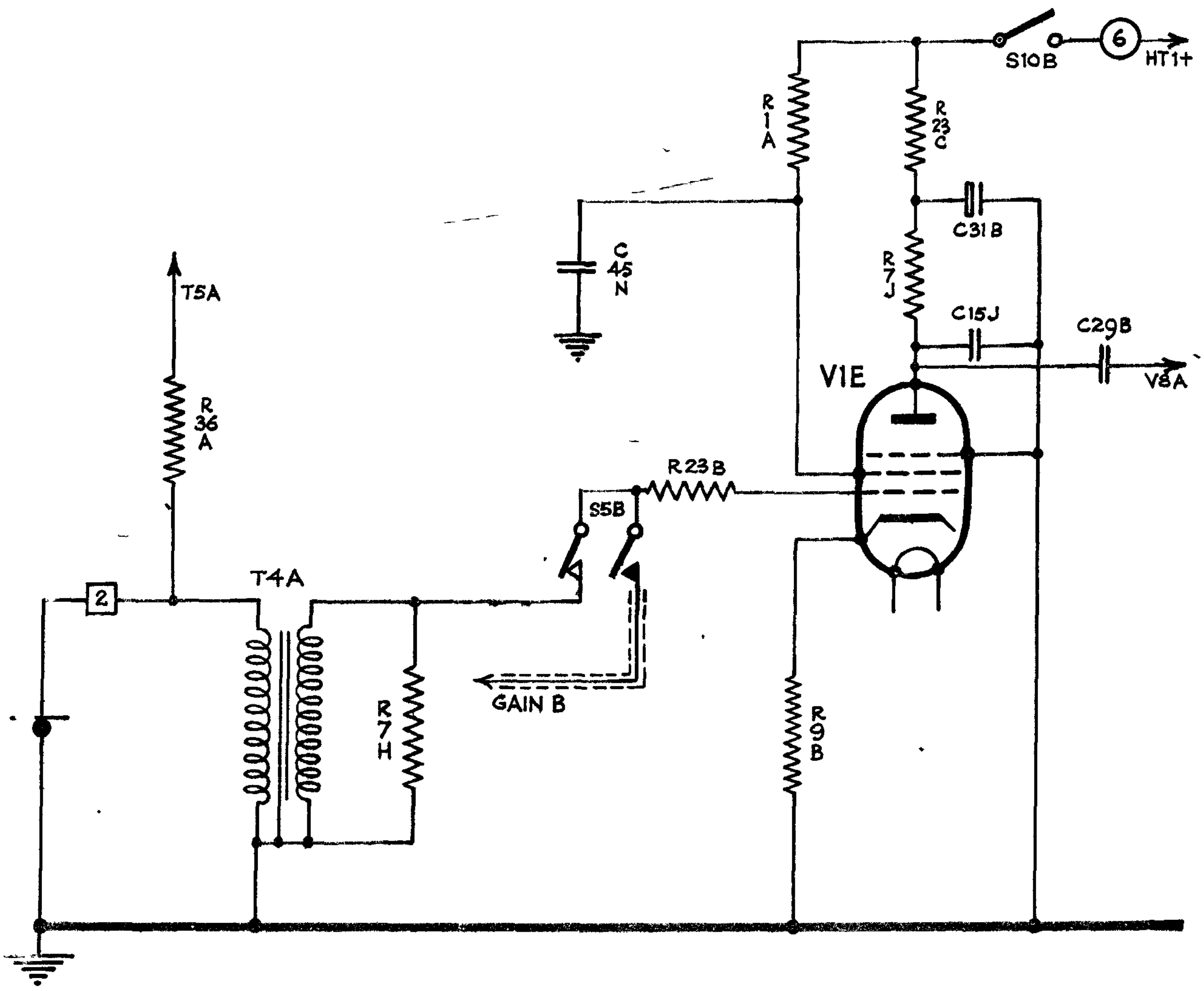


Figure 18. Modulation Amplifier.

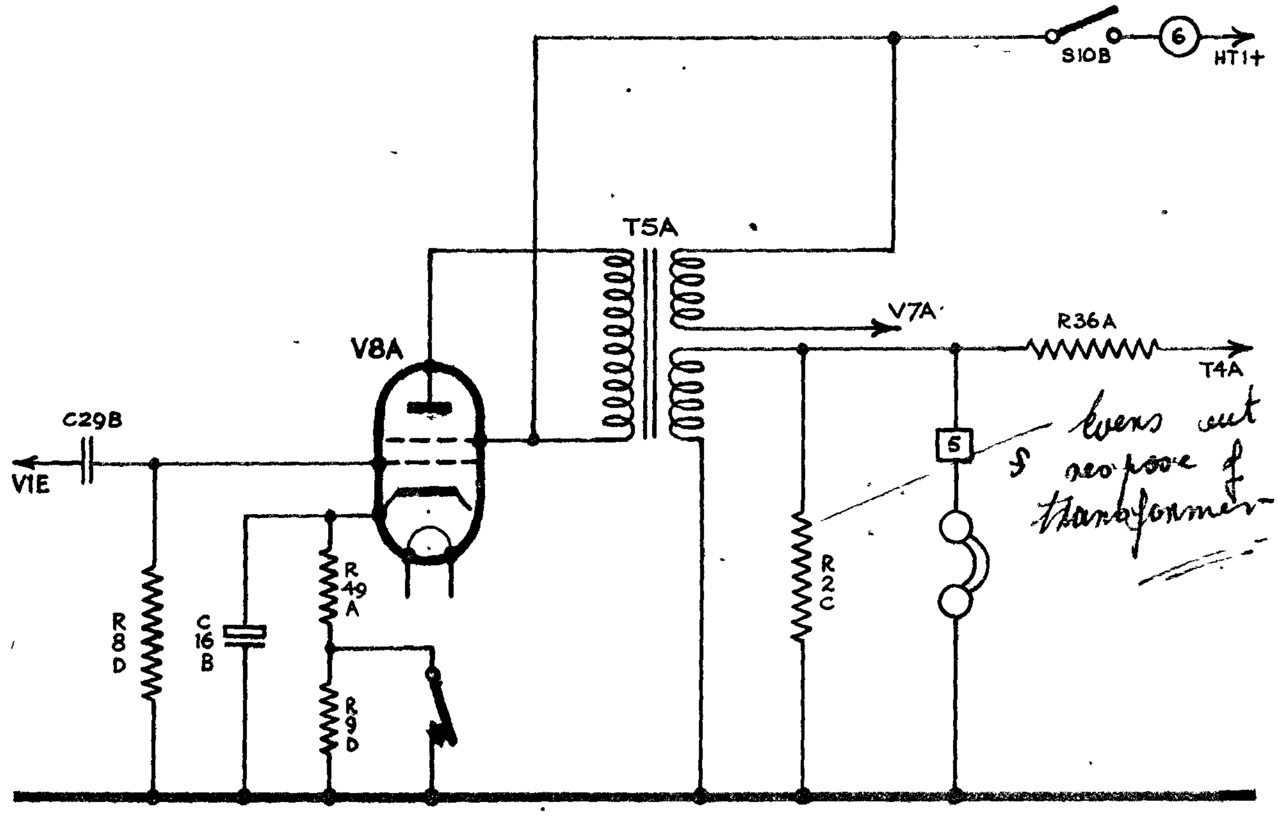


Figure 19. Modulator.

(ii) Modulator.

The beam tetrode power valve V8A operates as a class A amplifier and is biassed by the cathode resistor R37A. The output from this valve is taken from a second winding on the output transformer T5A which is included in the anode circuit of the oscillator V7A. Negative feedback is taken from the 'phone winding of T5A and applied to the primary winding of T4A. Sidetone is also taken from the phone winding of T5A.

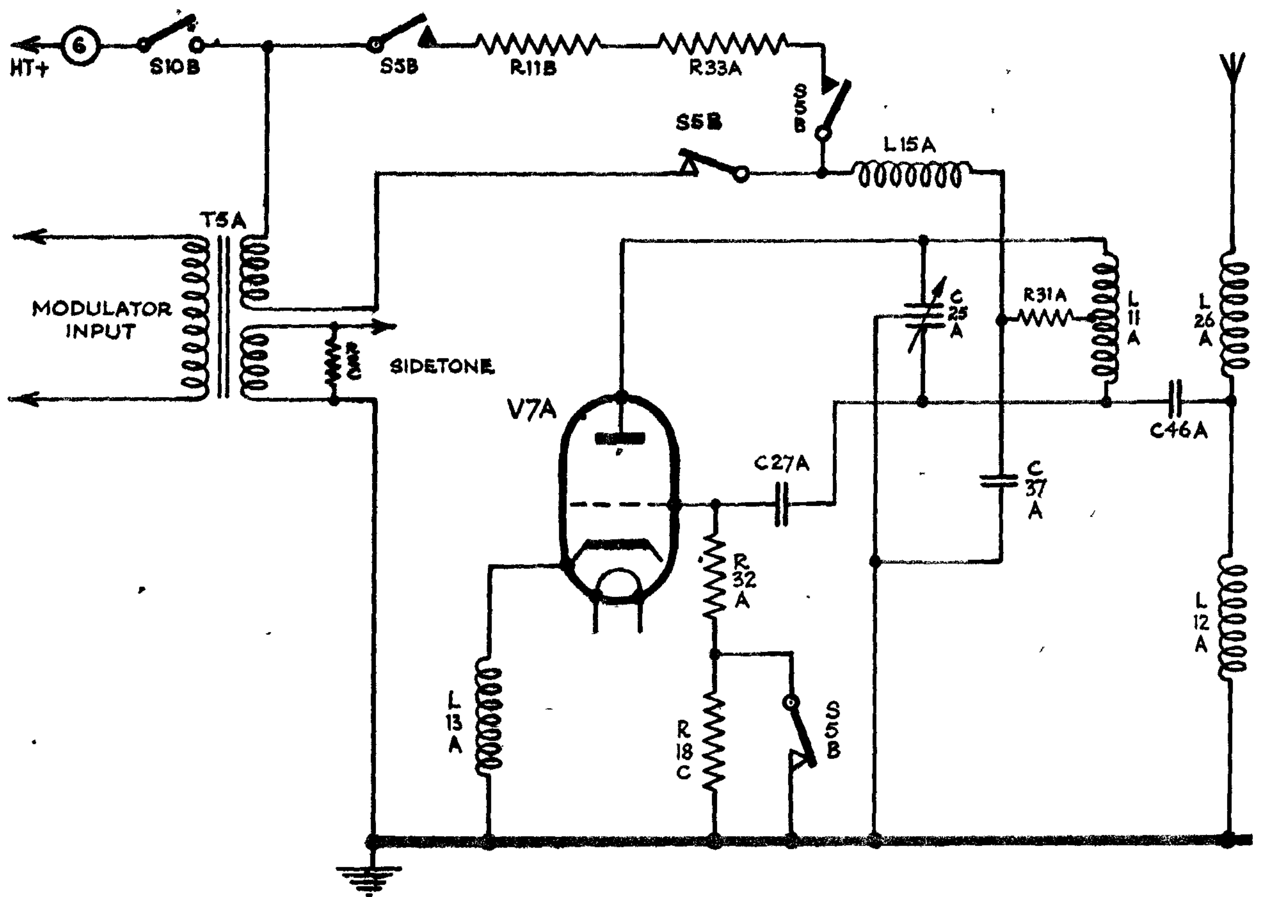


Figure 20. U.H.F. Oscillator.

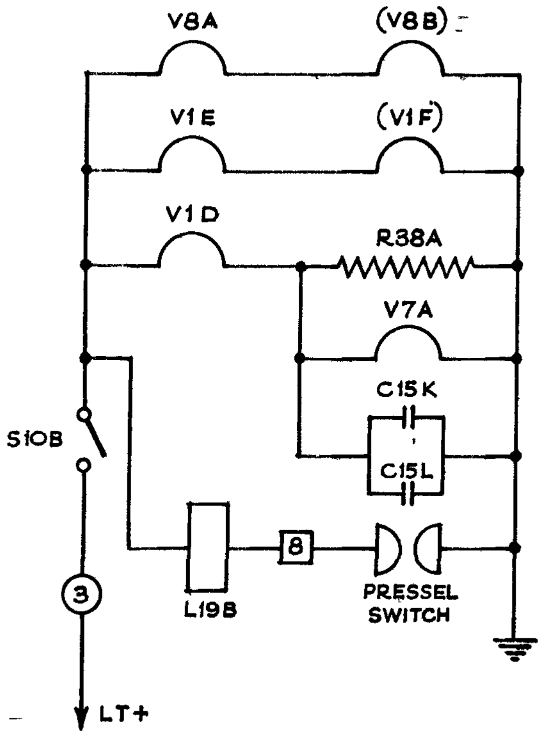
(iii) Oscillator.

The valve V7A acts as a U.H.F. oscillator producing the sender carrier. H.T. is then supplied through the secondary of T5A enabling anode modulation to take place.

A half-wave aerial is connected to a tap on the inductance L11A by means of a screened lead in series with the condenser C46A

(d) Send-Receive Switching.

Change over from receive to send is performed by the pressel switch on the Microphone and Receiver Headgear No.1. which actuates the relay S5B. When the pressel switch is closed one side of the relay operating coil L19B is earthed (pin 8 12-pt plug). The other side has a standing voltage of 12v when the switch S10B is ON, and the relay therefore operates.



I/C Valve Heaters shown in brackets,

Figure 21. Valve Heater & Send/Receive Relay Operating Circuits.

4. INTER-COMMUNICATION AMPLIFIER.

This is a two stage resistance capacity coupled amplifier comprising a pentode V1F type 6K7G followed by a beam tetrode V8B type 6V6G. Negative feed back is employed.

The purpose of this amplifier is to enable members of the tank crew to communicate one with the other when the control units are switched to "I-C". In this position signals received by both the A & B sets can be heard as side tone and depression of the pressel switch does not operate the S/R relay.

The output from the moving coil microphone is applied via the microphone transformer T4B to the 1st amplifying valve V1F. A.F. voltages produced across the anode load resistance R7K (0.1 MΩ) are fed through the coupling condenser C29C (.01μF) to the control grid of the 2nd amplifying valve V8B. The output reaches the 'phones through the 'phone transformer T6A. Fixed grid bias is provided for V1F and V8B by means of the cathode resistors R9C (1000Ω) and R39A (820Ω) respectively. The absence of by-pass condensers in these cathode circuits results in the application of series negative feed-back. Further negative feed-back is taken from the secondary of T6A and applied via R21B (27,000Ω) to the primary of T4B.

The resistors R2D & R2E (220Ω) across the windings of T4B and T6A modify the frequency response curve. Further tone compensation is provided by the filter consisting of C14B (.0001μF) and R23D (22,000Ω).

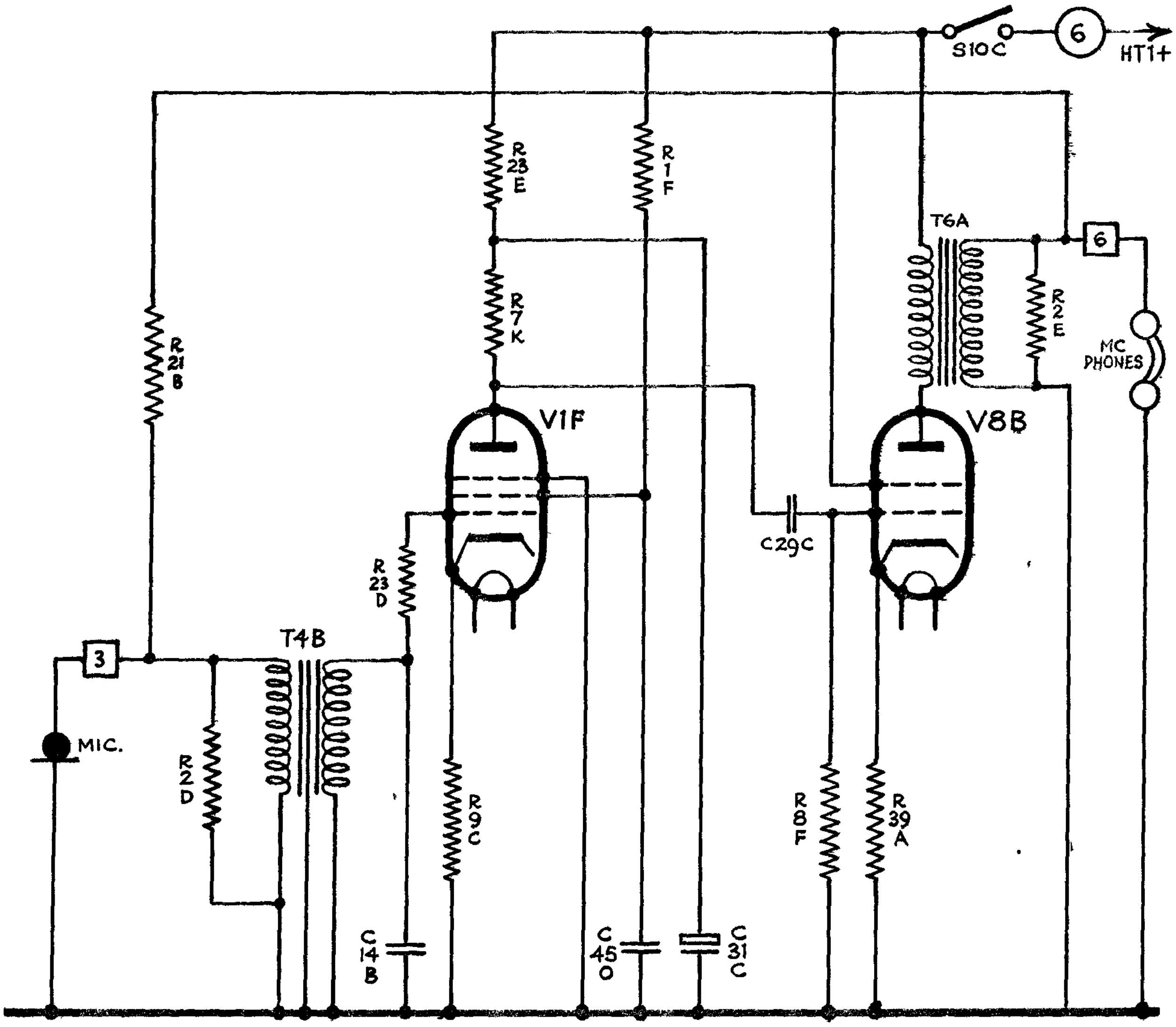


Figure 22. Inter-Communication Amplifier.

5. TECHNICAL DESCRIPTION OF AUDIO EQUIPMENT.

(i) Microphone & Receiver Headgear No.1.

This comprises a Microphone Hand No.7 and a pair of moving coil headphones which are together connected to the control units by means of a 5-way cord and "snatch plug & socket".

The moving coil units employed in the headphones and microphone are basically the same in construction. They give a wide audio frequency response which is a considerable advantage under noisy working conditions. A moving coil microphone is also relatively insensitive to external mechanical vibration and requires no polarising current. A unit is shown diagramatically in Figure 23.

Drawn twice actual size

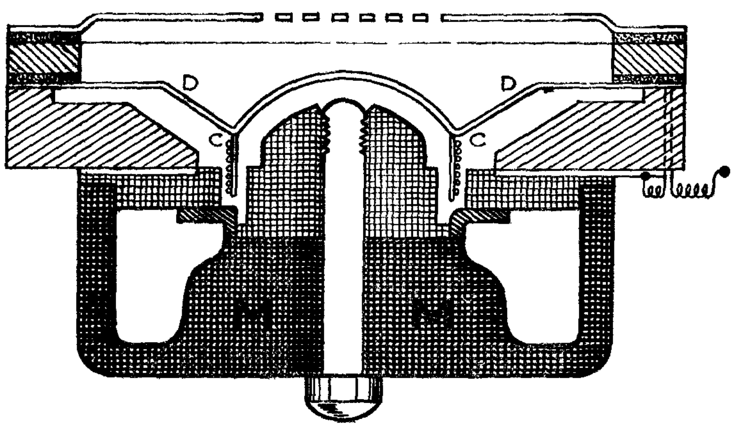


Figure 23. Section through moving coil unit.

A small light speech coil C, attached to a paper diaphragm D, is capable of a piston-like movement in an intense magnetic field produced by the pot magnet M. This field is radial i.e. it is at right angles to the coil at every point. If speech currents are fed into the coil the latter and its attached diaphragm will be set in vibratory motion at a similar frequency & amplitude. Conversely if sound waves fall upon the diaphragm the speech coil will travel backwards and forwards in the direction of its axis so that variable E.M.F's at speech frequency will be generated in it.

The microphone pressel switch actuates two separate make & break contacts one of which closes the microphone circuit while the othef operates the send-receive relay.

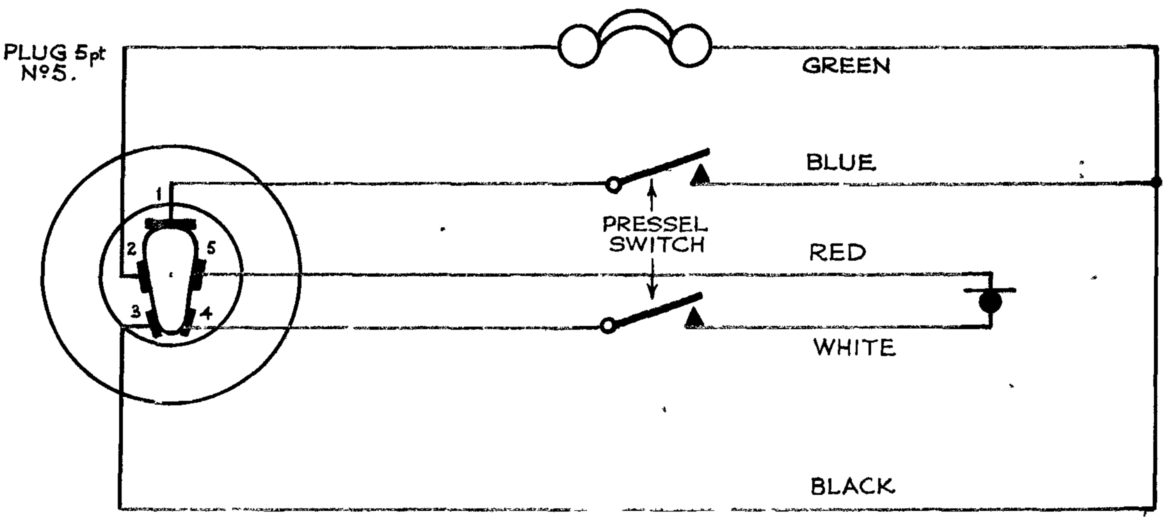


Figure 24. Snatch plug connections, (looking into plug showing contacts).

(ii) The Morse Key.

For the transmission of M.C.W. & C.W. a Key & Plug Assembly No.9 is employed. This comprises a Key W/T 8 Amp No.2. Mk II the contacts and terminals of which are enclosed by a metal cover secured to the base by means of 4 round-headed screws. The key is connected to the set by means of a twin cord terminating in a key-plug, which, when inserted into the key jack J1A, automatically actuates the S/R relay. The action of half withdrawing the plug restores the relay to normal, i.e. switches the "A" set to "receive".

6. TECHNICAL DESCRIPTION OF POWER SUPPLY.

Supply Unit No.1 Mk III.

Economy in battery current is obtained (i) by using a power unit which includes two separate rotary transformers, one of which only runs on send, (ii) by providing a separate ON/OFF switch for each service so that those not required may be switched off.

The unit provides H.T. for the whole set from two shunt-wound rotary transformers which step up the 12 volt input to 275 and 550 volts. The higher voltage machine which supplies the A set P/A anode and bias voltages is started by the relay L27A when the pressel switch is pressed or the key is plugged in.

H.T.1 output is filtered by C38B (.1μF) for R.F. and by C32A (30μF) for hum. H.T.2 output is filtered by C44A (1μF) and L18A, the negative side being by-passed by C4CP (.1μF). R7F (100 KΩ) shunting C4CP prevents damage to the latter if the machine is run on open circuit C22C (.025μF) and L17A filter the L.T. line to the valve heaters.

The low voltage input is taken via a 6 pt plug/socket connector and connection to the set is effected by means of a 12 pt. connector. [Mk II sets are used with Power Supply Units Mk I and I* which employ a single 3 commutator rotary transformer to supply both H.T. voltages simultaneously. In this case connection to the set is made with a 6-pt connector].

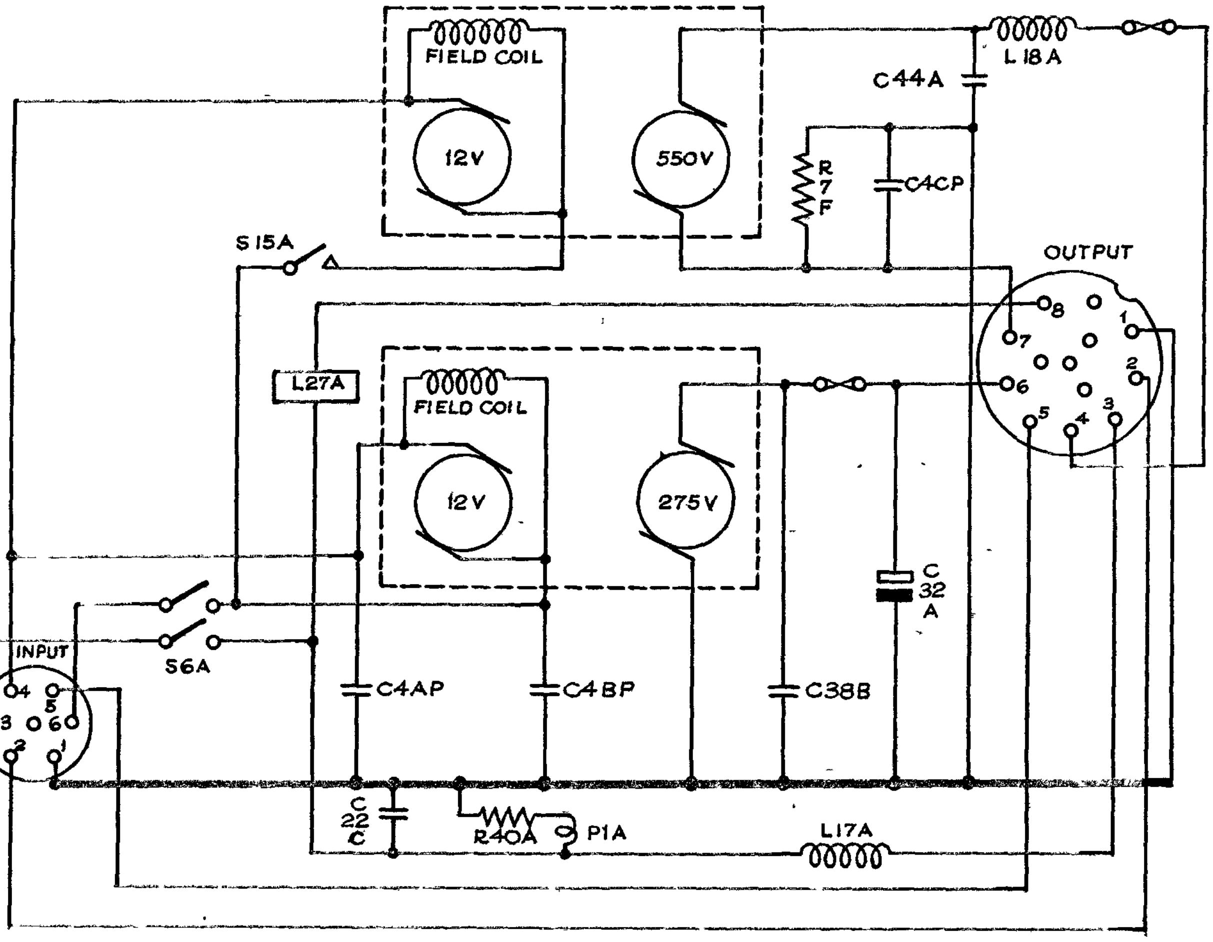


Figure 25.

7. CONTROL SYSTEM.

Owing to the number of different types of vehicle in which the No.19 Set may be installed, a variety of control systems is employed. The installations, however, differ only in detail. A typical installation is shown in Figure 26. The set is connected by a 12-pt connector to a Control Unit No.2 Mk II which is fitted with a single drop lead and snatch plug to take one headset. The control unit is fitted with two switches, one of which enables the user to speak or listen on the "A" set, "B" set or I.C. The other switch which has two positions Normal (N) and Rebroadcast (R), in the latter position permits the relaying of signals in the A net of a headquarters vehicle to the B sets of other vehicles. The switches will be to "R" and A - B. To change the direction of communication the switches must be to "R" and B - A.

An output plug affords the means of connection to a Control Unit No.1. Mk II through another 12-pt connector. This unit carries two drop leads for the headsets, one of which can be switched to A, I.C. or B, while the other is permanently on I.C. There is also a 4-way terminal strip to enable connections to be made to the I.C. amplifier circuits.

A warning lamp P1 in the Control Unit No.2 lights when both switches are at B indicating that the A set is unattended.

CONTROL UNIT NO.10.

This is used in all L3C's and A.C.V's and is known as the "high-mod." box. It incorporates a 3 position switch labelled "Normal" "High Mod.1" and "High Mod.2".

In the normal positions the microphone output is fed straight into the A Set as usual.

In position High Mod.1 the mike output is first fed into the i/c amplifier and then through a dropping resistance network into the "A" set.

In High Mod.2 position the modulation is attenuated less before being fed into the A set, giving greater sensitivity.

The box therefore enables members of the Staff to speak in a normal voice without shouting into the microphone.

Colour coding of Connectors.

All leads from connector pins and sockets are colour-coded for easy identification. This is done by using different coloured leads with coloured sleeves.

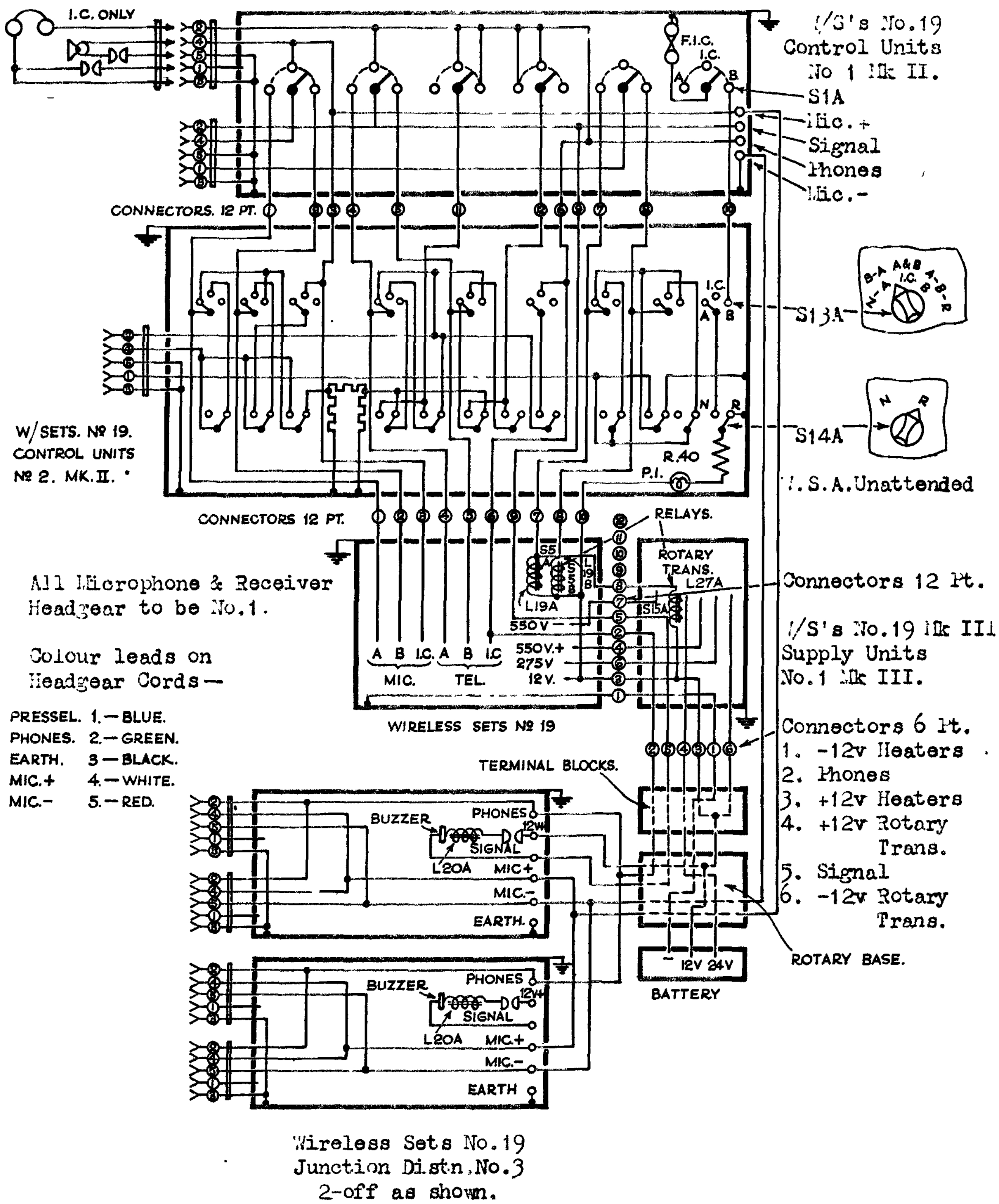


Figure 26. **Typical Installation wiring diagram.**

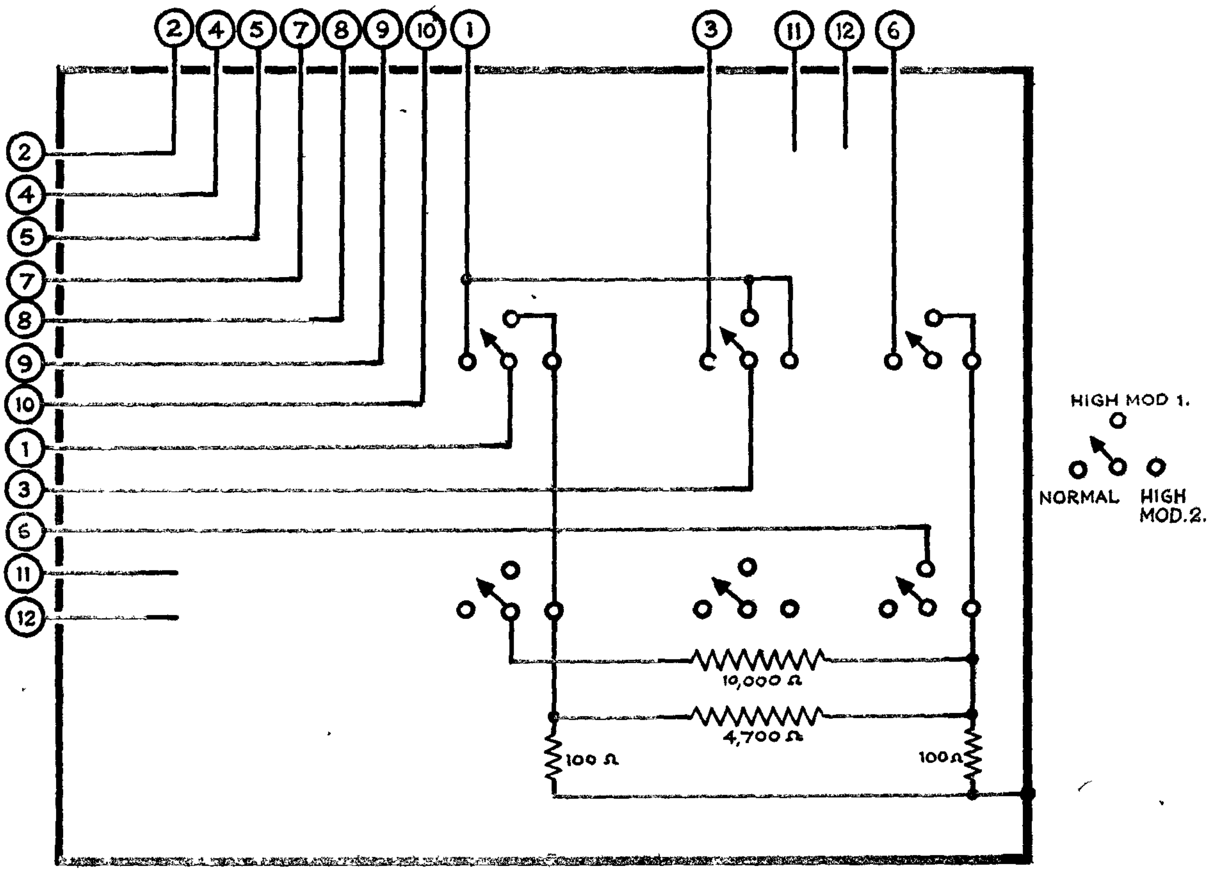


Figure 27. Control Unit No.10.

Lead function	Lead colour	Sleeve colour	Wire number: 12-pt. connector.	Wire number: Power input 6-pt connector.	Wire number: Unit-set 6-or 12-pt. connector.
Microphone "A"	White	Mauve	1	-	-
" "B"	"	Grey	2	-	-
" "IC"	"	Orange	3	-	-
Headphones "A"	Green	Mauve	4	-	-
" "B"	"	Grey	5	-	-
" "IC"	"	Orange	6	2	2
Relay "A"	Blue	Mauve	7	-	8
" "B"	"	Grey	8	-	-
Driver's signal	Green	White	9	5	5
Lamp, "A" unattended	Brown	Brown	10	-	-
Headphone stand by, "A"	Green	Red	11	-	-
Headphone, stand by, "B"	"	Brown	12	-	-
Heaters 12 V -	Black	Black	-	1	1
" 12 V +	Red	Red	-	3	3
Rotary transformer 12 V +	"	"	-	4	-
Rotary transformer 12 V -	Black	Black	-	6	-
H.T. + 1	Red	Yellow	-	-	6
H.T. + 2	"	Green	-	-	4
H.T. - 2	Blue	Green	-	-	7

Figure 28. Connections and colour-coding of control harness.

8. FAULT FINDING ON THE NO.19 SET MK III.

It cannot be over-emphasised that for successful fault finding on this set, a logical test procedure must be adopted in order to localise the faults. Indiscriminate searching will probably introduce more faults than are cleared. The following tests should be carried out in the order given. If any of the tests enumerated fail, look first for external faults (including control settings) before internal faults.

(a) Power Supply.

With the set correctly connected for operation, and the OFF-ON "IC" "B" and "A" switches to ON, switch on the power. The red lamp should light and one machine should run steadily. If not, examine batteries, connector, switch and L.T. commutator and brushes in that order. Switching the set meter to L.T. should give a reading of 11 - 12v, otherwise the battery may be flat or the unit/set 12-pt connector faulty (lines 1 & 3).

H.T. + 1 supply is tested by means of the set meter (275 V). If there is no reading first check the fuse, the 12-pt connector (line 6) & the commutator and brushes. The possibility of a faulty meter or meter circuit should not be overlooked. If a new fuse blows immediately, localise the cause by removing the connector and plugging into the supply unit only. If the fault is obviously in the Supply Unit C32A may be down.

To test H.T. + 2 switch control unit to A and system switch to R/T and press pressel switch and the second machine should run. Failure to do so may be due to a faulty pressel switch, 12-pt connector (line 8) or faulty relay in supply unit. Switching the meter switch to H.T.2. should show about 500volts on the meter. If there is no reading, check the fuse and the 12-pt connector (lines 4 & 7), the commutator and brushes.

(b) I-C Amplifier.

With all control units switched to I-C and the OFF-ON "IC" switch to ON press pressel switch and speak, when the voice should be clearly audible in all headsets. Time may be saved in tracing microphone and headphone faults by substituting a headset known to be correct. A faulty control system can be detected by means of a "test control box". Lines 3 & 6 in the 12-pt connectors should also be examined.

To localise an internal fault on the amplifier proceed as follows :-

Remove the set from its case, re-connect and switch on. Note whether V1F and V8B heaters are working by testing the valve envelopes for warmth. Remember that V1F and V8B heaters are in series with V1E and V8A respectively.

Assuming heater circuits correct the H.T. voltages should be taken. Readings obtained vary from set to set & depend on the state of the battery, so that results must be compared with those obtained during the regular routine tests. Typical readings are as follows :-

Valve	Anode to chassis	Screen grid to chassis	Cathode to chassis
V1F	60v	40v	1.5v
V8B	260v	265v	18v

Assuming that the valves are working correctly try to obtain clicks in the headphones by earthing the grid of V8B. Failure to obtain clicks will indicate a fault in the primary or secondary circuits of T6A. If the output stage is tested O.K. apply similar test to V1F. No clicks will indicate a faulty coupling condenser C29C or primary or secondary circuits of T4B open or shorted.

(c) "A" Set.

(i) Receiver on R/T.

Switching the control units to "A", the system switch to R/T and the meter to A.V.C., turn R.F. GAIN fully clockwise and tune in a strong R/T signal. The meter should give normal A.V.C. reading and dip when tuning through the station. If the "dip" is obtained but the set is "dead" the latter may be assumed correct up to the final stage. Check the headset and control apparatus as in (b). If the "A" set functions on "send" V3A may be checked as an amplifier by switching to "send" and testing for AE current variation on loud speech. If this occurs inspect the signal diode cct., the coupling condenser C17A and the gain control R13A. If touching the control grid of V3A does not produce a click in the headphones examine the lead to pin 4 on the 12-pt connector. If the AE current reading does not change on speech proceed as above but first check voltages on V3A (see below).

Set dead and no A.V.C. reading on panel meter.

Remove the set from its case and, after noting that all the receiver valves are warm, take valve readings. Remember that a faulty heater in V4A will put V1A, V2A and V3A out of action, also that V1B and V1C have heaters in series. Typical valve readings are given below (see previous note).

Valve	Anode to chassis	Screen grid to chassis	Cathode to chassis
V1A	240v	130v	2.8v
V2A (hexode section)	250v	80v	
(triode ")	85v		2.4v
V1B	260	130	6
V1C	250	85	2.4
V3A	260	150	30
V2B (triode section)	100	-	-

Substitute any valve giving an abnormal reading and examine D.C. circuits when a cure is not effected.

Assuming that all valves are functioning normally the receiver must be tested stage by stage from V3A-V1A. Where a signal generator is not available earth the grid of each stage in turn. A loud click in the 'phones indicates that all stages between that point and the 'phones are working. Failure to obtain a click means a fault between that point and the last to give a click.

If the set sounds "alive" but no signals are heard notice whether the background noise is reduced when the triode grid of V2A is earthed. No change being noted, change valve and then examine oscillator circuit. Where oscillator tests O.K., i.e. reduction in "mush" on earthing grid, fault probably lies in the aerial circuit or variometer.

When signals are satisfactory on the 2-4.5 Mc/s range and absent on the other range, check L22A & B, L24A & B, and the wave change switch S11A. If the 4.5-8 Mc/s range only is good check L23A & B, L24C & D, and S11A.

Beat Frequency Oscillator.

Tune the set to a strong signal using "Net" switch. Where no whistle results check voltages on V2B triode section. Remember that V2B & V5A heaters are in series. If a whistle is obtained on C.W. check System and Net switches.

(ii) Sender.

Radiation. No aerial current reading obtainable with switch to R/T and pressel switch pressed.

(a) If no click is heard in the set when the pressel switch is used, see that the S/R relay is operating. If not, change headset and examine control system before testing relay operating circuit internally.

(b) Drive meter reading normal. Check voltages on V4A and meter circuit.

(c) Drive meter reading varies with frequency. Try changing V5A, V2A & V2B in turn; also check voltages on V5A.

(d) No reading on drive meter. Check valve voltages as in (c). Examine L4A, L6A, L7A & L21A for open circuits and look for faulty switch contacts on S11A. Meter circuit may be faulty, i.e. R42B s/c.

Valve	Anode to chassis	Screen grid to chassis	Cathode to chassis
V4A	500v	290v	-
V5A	275	285	0.5
V2B (hexode section)	285	100	4

Modulation. Aerial current meter reading should vary when speaking into the microphone and sidetone should be heard in the headphones.

(a) AE meter reading steady and no sidetone. First test headset by switching to I-C. Check line 1 in 12-pt connector. Test microphone transformer T3A and check circuit through S7A, S5A to No. 1 pin of 12-pt socket.

(b) AE meter reading steady, sidetone O.K. Look for internal fault, probably C22B or R7G o/c.

Keying. Switch set to C.W. plug in key and press. A steady aerial current reading should be obtained; if the set continues to receive, examine jack spring. If the set stops receiving but the meter reads zero, first test key and plug by substitution if possible, then the key jack and finally the key circuits inside the set.

Switch set to M.C.W. and press key. If sidetone is not heard examine keying circuits.

(d) The 'B' Set.

When the 'B' set is on "receive" with the gain turned up, a loud hiss should be heard in the 'phones. If the set is dead, check line 5 in 12-pt connectors. To locate fault internally check valve voltages and then test for clicks by earthing the grid of V8A and then V1E.

Assuming the two A.F. stages correct, check the quench oscillator circuit, also C29A, C45E, C27A and R38A for o/c. Examine relay contacts. Finally try replacing V7A VERY CAREFULLY. The relative positions of wires in this section must not be altered or performance will be impaired.

For weak signals proceed as above, paying particular attention to C16B, R23B and C46A for o/c.

An open grid circuit in V1D may cause instability, i.e. set howls.

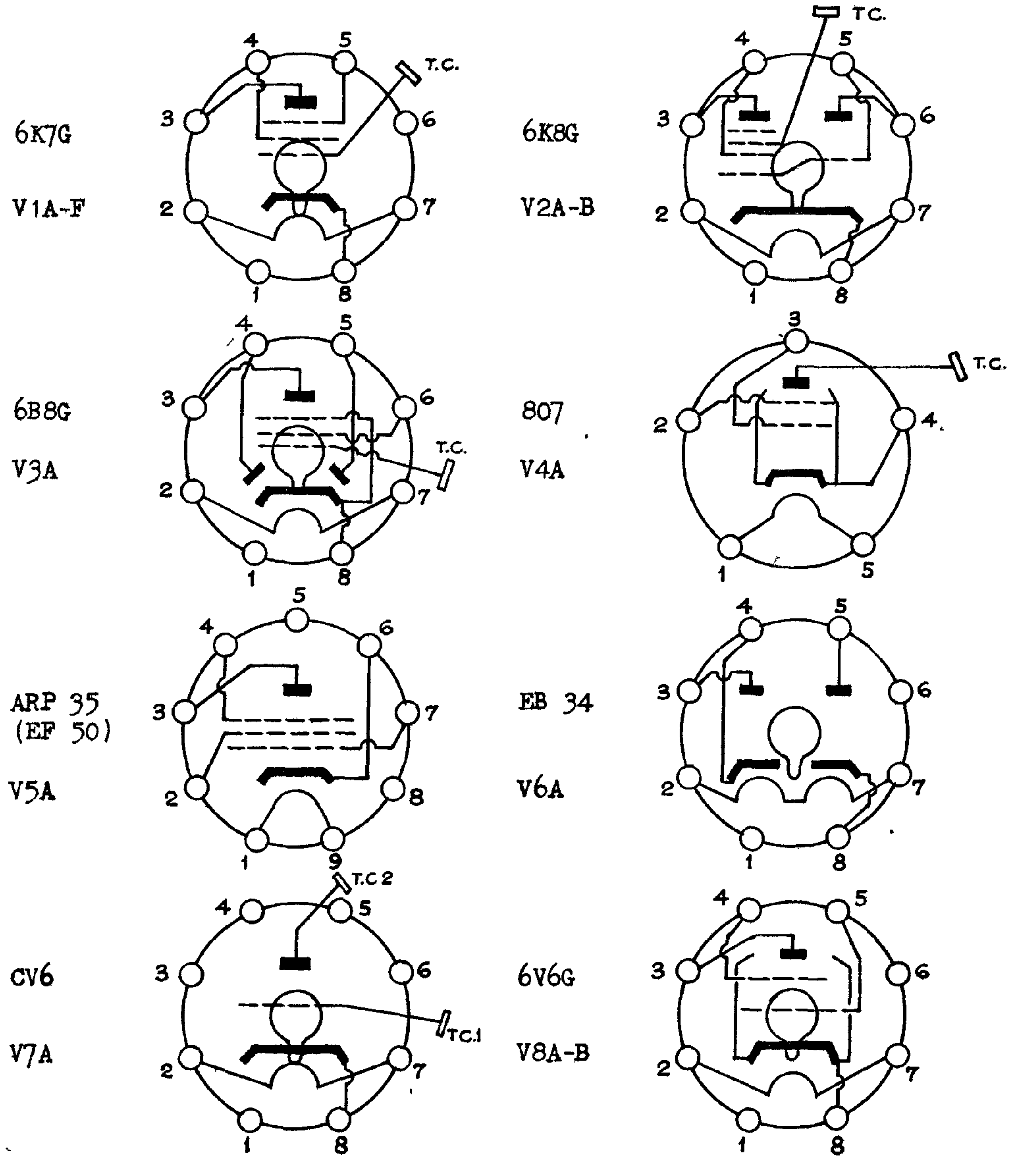


Figure 29. Valve holders - Viewed from underside of chassis.

When the pressel switch is pressed the background hiss should cease with sidetone in 'phones. If not, look for external fault in headset and control apparatus before examining S/R relay S3B.

If the hiss ceases but sidetone is unobtainable examine the microphone circuit externally, then internally.

Modulation can only be checked by listening on another set. No modulation indicates an internal fault. Check relay contacts and sender secondary of T3A for o/c.

Valve		Anode to chassis	Screen grid to chassis	Cathode to chassis
V7A	send	180v.	-	-
	receive	45	-	-
V1D	receive	75	100v	-
V1E		35	30	1.8v
V8A	send	250	260	14.
	receive	260	265	21.

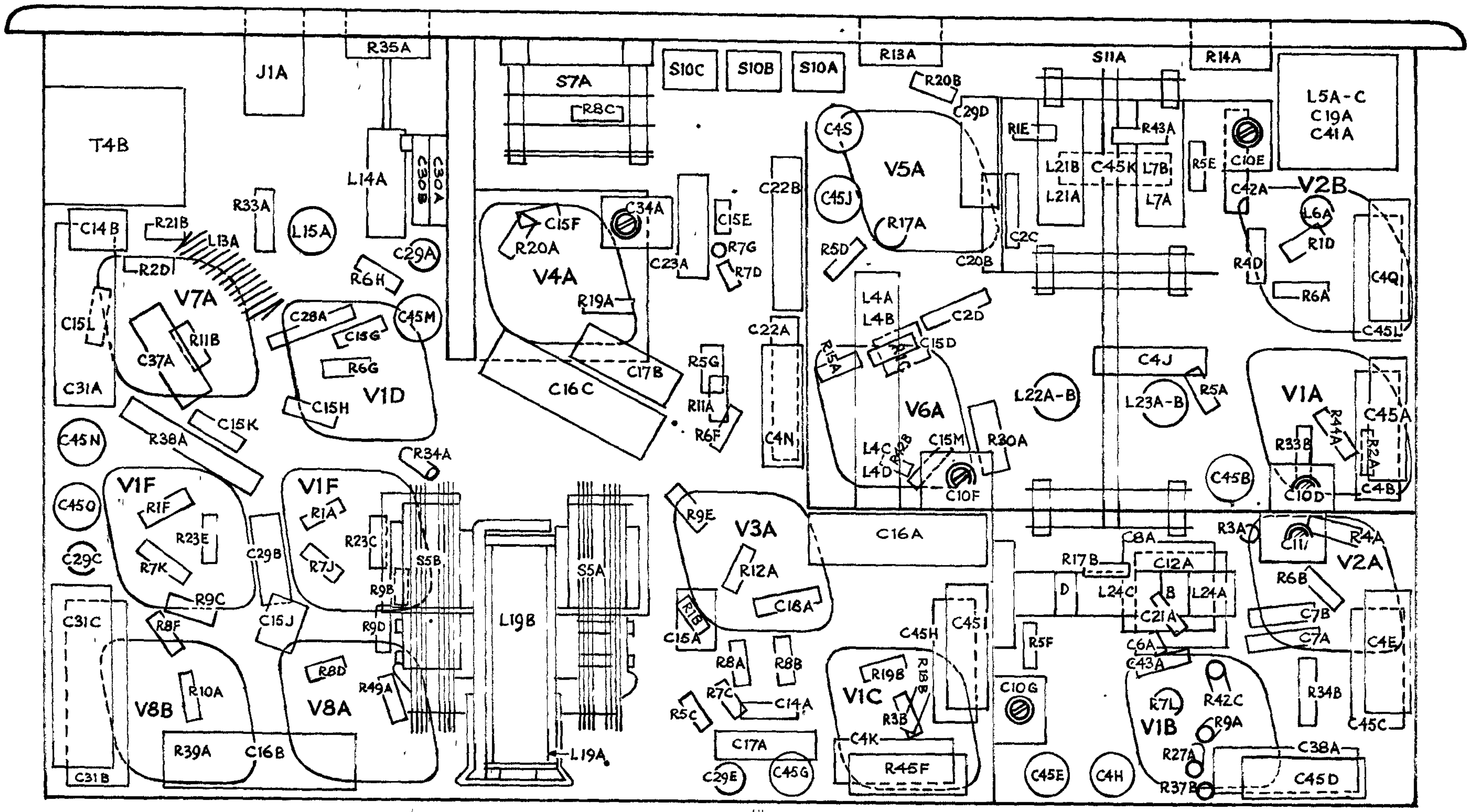


Figure 30· UNDERNEATH PLAN OF CHASSIS

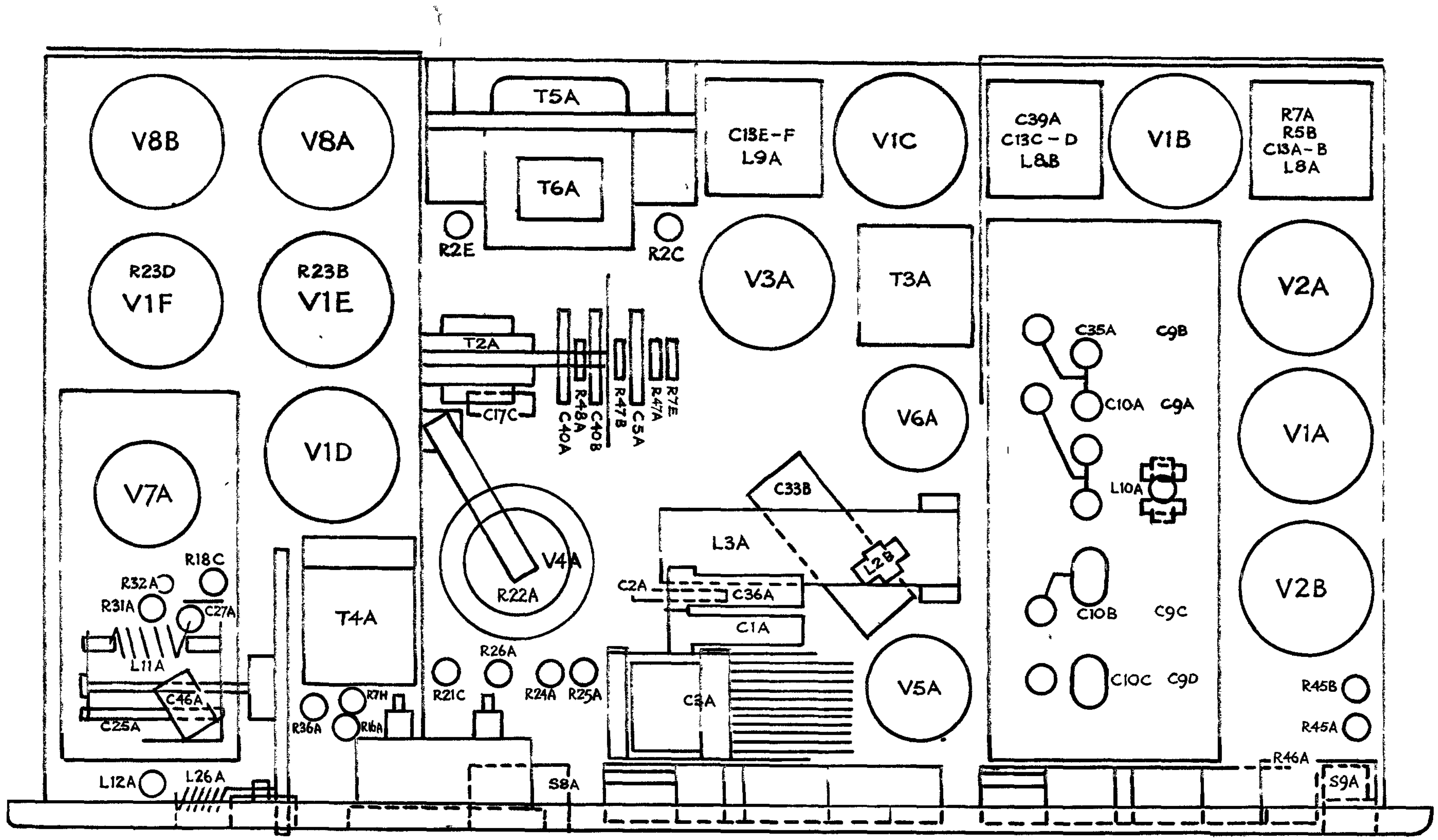


Figure 31. TOP PLAN OF CHASSIS

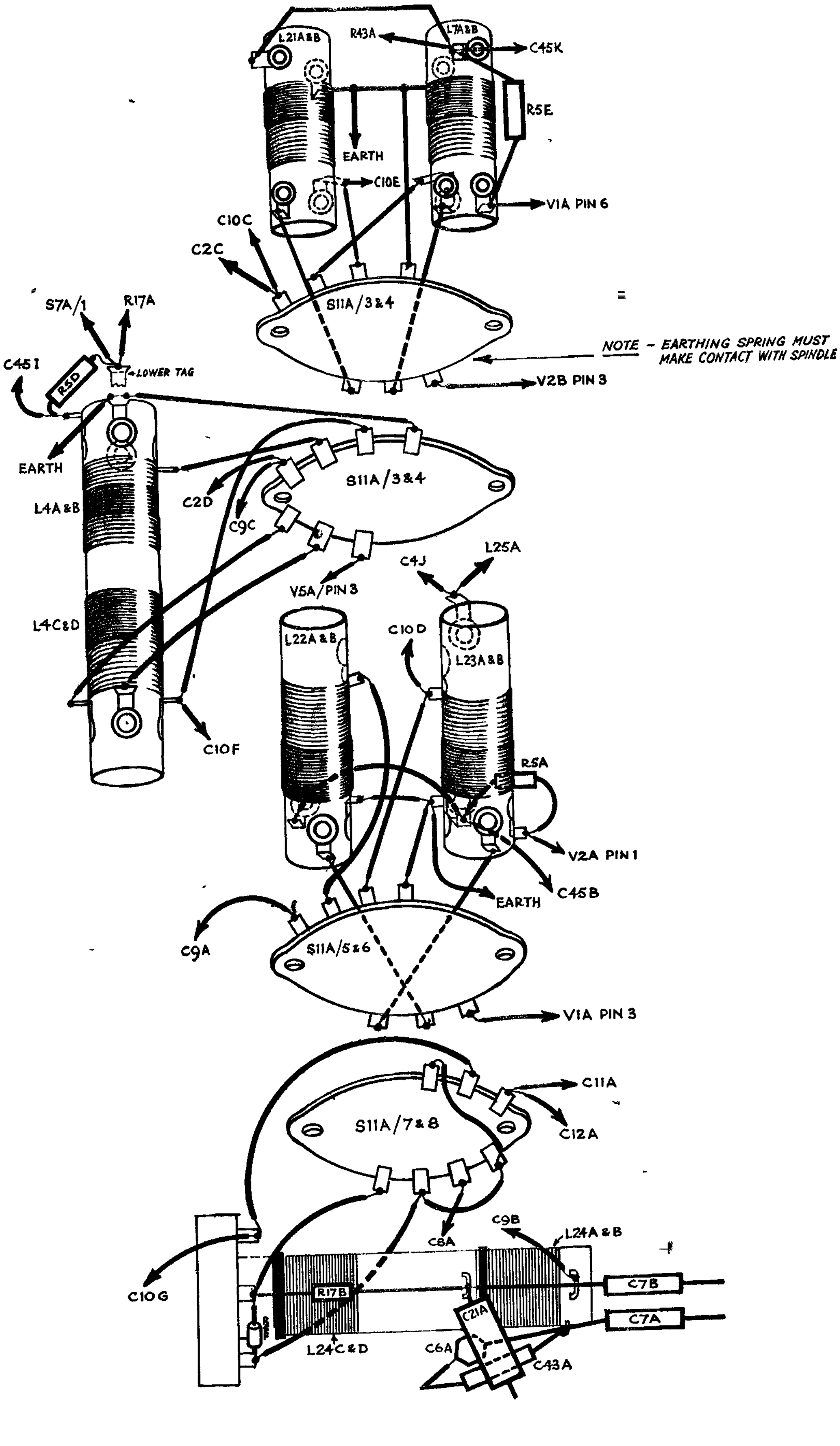


Figure 32. R.F.coils and switching.

UNDER-CHASSIS DRAWING OF W/S NO. 19 MK III. SHOWING LOCATION OF TAG STRIPS AND SPARE PINS ON VALVE BASES.

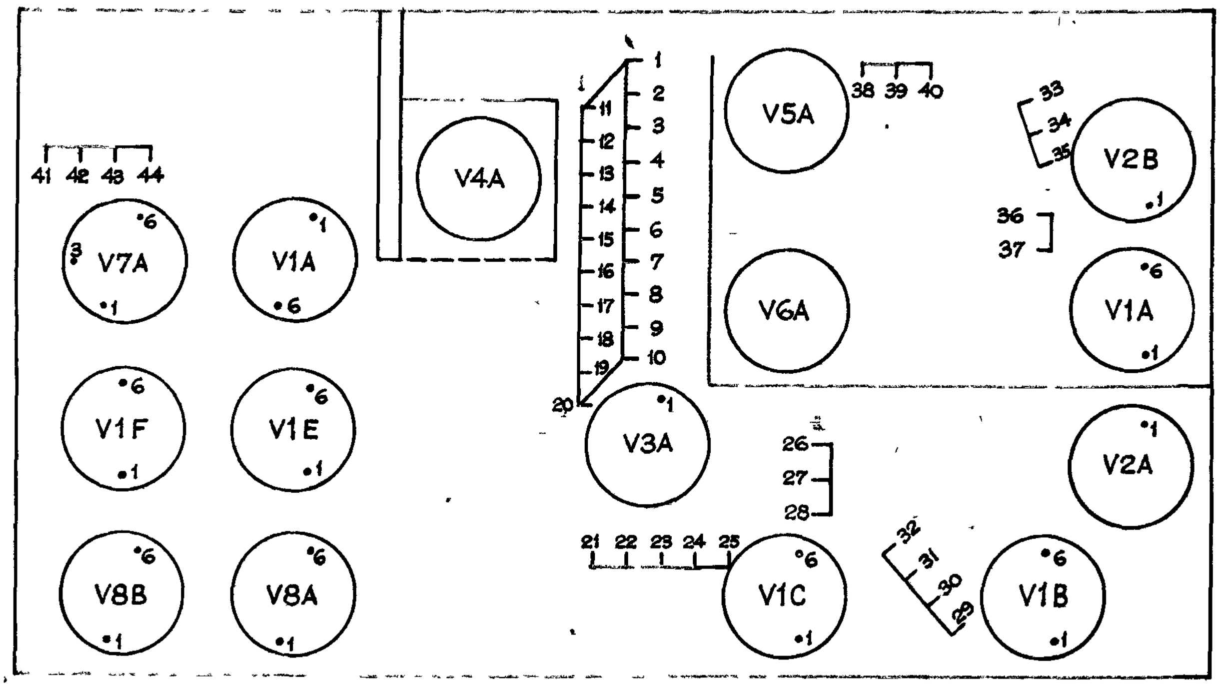


Figure 33.

CONNECTIONS TO TAG STRIPS.

1. C23A (Anode V3A) Pink flex to S7A.
2. Blank.
3. C15E (Anode V3A) Black flex to S7A (earth).
4. C34A (Grid P.A.) R7D, R7G (Anode V3A).
5. T2A (Blue) C22B, C23A. Cable form No.9 pink to V3A pin 3 (anode).
6. R7D, R16A, C16C (all in P A. Grid cct.). Cable form No.4 brown to S7A (Tag 10). Mauve wire to meter tag plate.
7. R5G, R11A (Cathode V3A) orange flex to S7A (Tag 5).
8. R16A, C4N, C17B, R5G. Earth point.
9. Cable form No.4 Red to S7A (Tag 14). Cable form No.9 Red to S10A. Red wire to 5 way Tag plate L9A (I.F. trans). Red wire to relay (S5A/2C & 3C).
10. R6F (M.C.W. osc) R9E, R11A, C4N, T3A. Cable form No.8 Brown to C.W. filter. Cable form No.9 Brown to R13A.
11. Black flex to S10C Black wire to L19. Black wire to meter tag plate, (L.T.+).
12. Red flex to S10C Red wire to meter tag plate (H.T.+).
13. Blank Tag.
14. C15E, C22B, R7G.
15. Blank Tag.
16. C22A, T2A.
17. T2A (White) Red wire to V3A pin 1. Red wire to Relay (S5A/3R). Cable form No.4 yellow to S7A (Tag 23).
18. Blank Tag.
19. R6F, C22A. Cable form No.4 Green to S7A (Tag 3).
20. Cable form No 0 Green to S8A. Brown wire to Relay (S5A/1S). Brown wire to V4A pin 4 Brown wire to V6A pin 4. Brown wire to V1C pin 1.
21. R5C. Red wire to Meter Tag Bd from H T + line and other Red wire to Anode V1B.
22. R1B and R7C wire to C17A. C15A to earth.
23. R8A. Conn to E.
24. R8B. Conn to C38A and A V.C. lines to various Control Grids.
25. C17A and conn to R13A (A F. gain control).
26. C45L. Lead to System Sw. S7A/5.
27. Earth point C16A connected here.
28. C45H to system sw S7A/3.
29. R7L, R27A, R37B.
30. R37B (to Tag 29) Lead to cathode V2B and lead to R10A and Relay.

31. Earth point R27A.
32. R9A. To meter cct. and to R44A.
33. L6A (B.F.O.) Lead to Het. Control.
34. Earth point C10E earthed.
35. L6A and L25A lead to L5C.
36. R6A Conn. to C39A. R1D.
37. Earthpoint R4D.
38. C2C conn. to C.G. V5A and to R1E.
39. R43A conn to Diode Anode V6A.
40. Blank earth tag.
41. C14B. Conn. to C.G. V1E.
42. Earth from C14B and R2D.
43. Conn from Pin 3. 12 pt conn. R21B.
44. Conn from Pin 6. 12 pt conn. R21B.

CONNECTIONS TO SPARE PINS ON VALVE HOLDERS.

V1A. 1. R2A, R44A (to S.G. V1A). Lead to R46A (R.F. gain control). Lead to Cathode R9A of V1B.
6. Conn to System Sw. S7A (C6). Conn to top of R5E. Conn to R45B.
V1B. 1. Blank.
6. Connection to C.G. Hexode V2B. R7L and R42C.
V1C. 1. R18B. Conn to Relay (Tag No.7) S5A/2R. Conn to Cathode of P.A.
6. R18B. R19B Conn to L8B. Conn from H.T. line.
V1D 1. C15G and R6G. Conn from C.G. (top cap).
6. H.T. from B ON/OFF Sw. Conn to V1E Pin 6.
V1E 1. R23C, C31B, R7J.
6. R23C. H.T. from Pin 6 V1D. R1A to pin 4. Conn. to screen V8A pin 4
V1F. 1. R7K to Pin 3. R23E from Pin 6.
6. H.T. from S10C (IC ON/OFF Sw). Conn to Screen Pin 4 V8A. Screen Res. to Pin 4 R1F. R23E to Pin 1.
V2A. 1. H.T. 1 point. Conn to L23A bottom Tag. Conn from Pin 6 V3A and eventually from H.T.1 point Tag No.12.
V2B. 1. R1D. Conn to S9A (Net Sw). Conn to System Sw (S7A B2) and to Relay.
V3A 1. R12A. Conn from 16 way Board Tag No.17.
V5A. 5. Earth. Conn for C20B. Conn for C29B.
8. Earth.
V6A. 1. Conn for C10B to earth.
6. R1C. Conn to R43A. Conn to Pin 3 V6A. C15D.
V7A. 1. R11B. Conn to Relay.
3. Blank.
6. R11B. C31A. Conn to R33A.
V8A. 1. Blank.
6. R49A. R9D. Conn to Relay S5B.
V8B. 1. R10A to Pin 6 V8A. Conn from Pin 8 V2B.
6. R10A from Pin 1. Conn to key Jack. Conn to Pin 8 Power 12pt conn.

CONNECTIONS TO TAG STRIPS ABOVE CHASSIS.

45. From R.F. Gain. R46A.
46. R45A. H.T. from point on primary of L8A. Lead to Pin 4 V2A.
47. R45B. H.T. from Pin 6. V1H. Lead to Pin 4 V2B.
48. Conn from C2A. Conn to C.G. V1A. L10A.
49. Blank earth Tag.
50. L10A Conn to R8B via tag on L8A.
51. Earth.
52. Conn from C.G. V2B. Conn to Pin 6 V1B.
53. Conn to 12 pt conn. Pin 1 and conn to primary Mike Trans.
54. Earth and one side of Prim. Mike Trans.
55. Secondary Mike Trans V, connection to R9E. Tag No.10.
56. Components in C.W. Filter cct.
57. R21C. Conn to K of V1B, and to Sw. Meter.
58. R26A. Conn to Pin 3 12 pt Power Socket and to Meter Sw.

59. Earth.
60. R24A. Conn to Pin 6 H.T.1. Conn to Meter Sw.
61. R25A. Conn to Pin 4 H.T.2. Conn to Meter Sw.
62. R31A. Conn to L15A.
63. Conn to Grid V7A.
64. R32A.
65. R18C to earth.

PLAN SHOWING TAG STRIPS ABOVE CHASSIS.

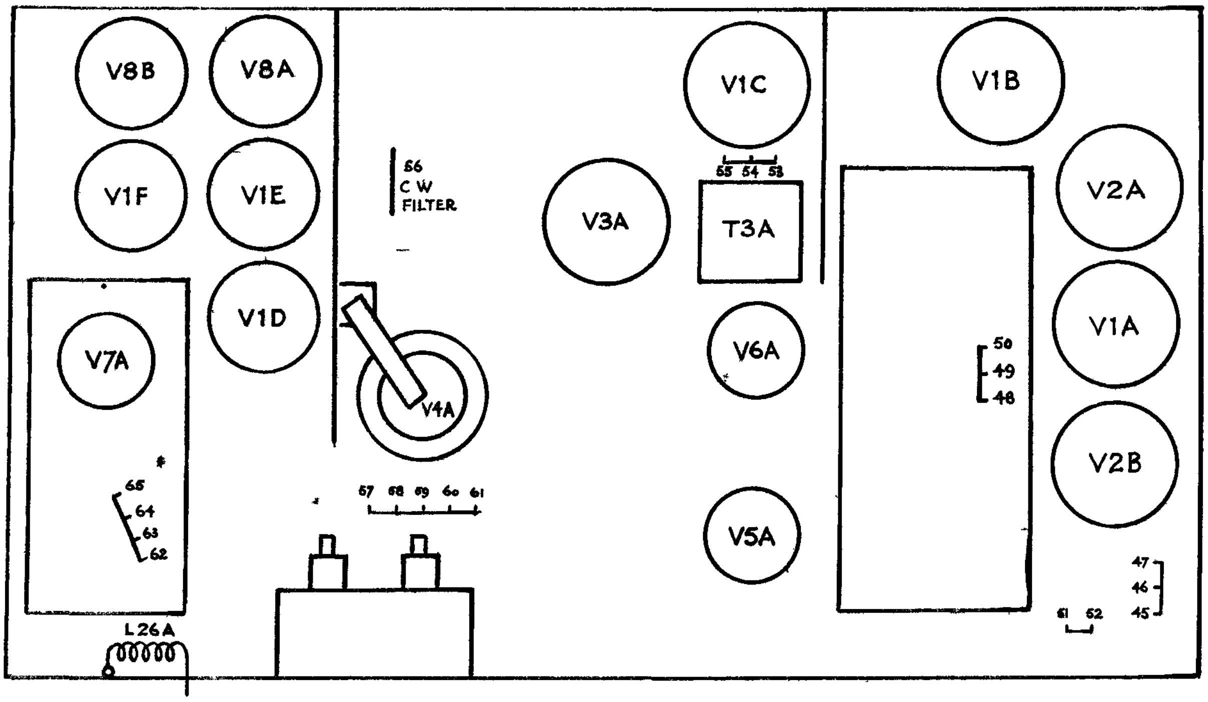


Figure 34.

DIFFERENCES BETWEEN MARKS I, II & III.

"A" SET RECEIVER.

(a) R.F. gain control fitted in Mk III, not in Mk II.

(b) "A" on-off switch fitted in Mk III in place of "A only-all" switch in Mk II.

(c) Toggle-switch for netting in Mk III in place of push-button in Mk II.

(d) Two-speed slow-motion drive for frequency control in Mk III; single-speed only in Mk II.

(e) Het. tone control range from 600 to 2000 c/s, single-sided, no zero, in Mk II; range approx. 3000-0-3000 c/s, double-sided, centre zero, in Mk III.

(f) CW filter in A.F. amplifier in Mk III, not in Mk II.

(g) On CW, beat oscillator injection via capacities of V2B and V2A in Mk II; via direct coupling to I.F. amplifier in Mk III.

(h) Local oscillator circuit different. Frequency drift is less in Mk III.

(i) Different design of all R.F. coils.

"A" SET SENDER.

(a) Master oscillator circuit different. Frequency drift reduced in Mk III.

(b) Beat oscillator circuit and coil different. Spurious radiations from aerial less in Mk III due to this.

(c) Drive circuit coils of different design.

(d) Drive A.G.C. circuit and P.A. bias circuit different.

(e) P.A. coil of different design; frequency coverage slightly wider in Mk III.

(f) Aerial meter transformer different.

"B" SET.

No essential change, except "B" on-off switch controls H.T. only in Mk II, and both H.T. and L.T. in Mk III.

"IC" AMPLIFIER.

No essential change, except "IC" on-off switch is fitted in Mk III; "A only-all" switch is used instead in Mk II.

POWER SUPPLY UNIT.

Mks I and I* are similar. They employ a single 3-commutator rotary transformer to supply both H.T.voltages simultaneously. Mk III employs two separate small rotary transformers. H.T.2 being switched on by a relay only when the"A" set is switched to send. The filter circuits are different in the three types. Connection to the set is made with a 6-point connector on Mks I and I* units, used with Mks I and II sets, and with a 12-point connector on Mk III unit, used with Mk III set. The overall dimensions are the same for all types.

VARIOMETER.

This is the same in all marks, except that

(a) the meter transformer is similar in Mks I and II, but different in Mk III.

(b) R29A is contained in the set in Mk I and in the variometer in Mks II and III.

INTERCHANGEABILITY.

(a) Power supply unit. Mks I & I* are interchangeable and can be used with Mks I and II sets,but not with Mk III. Mk III unit can be used only with Mk III set.

(b) Variometer. Mk I can be used only with Mk I sets. Mks II and III can be used with Mk I sets if R29A in the set is short-circuited. Mk III can be used with Mk II sets. Mk II can be used with Mk III sets in an emergency, but R29A may need readjustment to prevent meter going off scale when measuring aerial current.

(c) Control units, harness, aerials, etc., are completely interchangeable with any mark of set.

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1. General Description.

The Amplifier R.F. No.2 is designed to amplify the modulated R.F. output from the W/S No.19 and thus to increase the range of the latter. It employs four A.T.S. 25 valves in parallel which operate under Class A conditions.

On R/T and M.C.W. send/receive switching is carried out in the normal way from the W/S No.19. When sending C.W., however, a separate S/R switch on the amplifier unit is used.

The No.19 Set variometer is replaced by a variable inductance (Inductance Aerial Tuning No.1) which tunes the aerial to a quarter wavelength. When the amplifier is switched OFF the No.19 set works normally without any reconnection.

The amplifier tunes from 2.1 Mc/s - 7.5 Mc/s in two bands and over this frequency range full gain is obtained. Operation between 2 & 2.1 Mc/s and between 7.5 and 8 Mc/s is possible on any No.19 set but full gain is not generally obtained.

2. Power Supply.

Power is derived from the No.19 Set 12 volt accumulator which supplies heater current for the four A.T.S. 25 valves, connected in series-parallel, as well as input to a rotary transformer contained in the unit. The rotary transformer which supplies H.T. to anodes and screens has an output of approximately 600 V at 240 mA. Accumulator current consumption for the amplifier alone is about 24 amps on send and 2.5 amps on receive.

All Mk II Amplifiers are fitted with a cooling fan and they may be run continuously on send. Mk I amplifiers without fans must NOT be run continuously for more than 15 minutes in each hour.

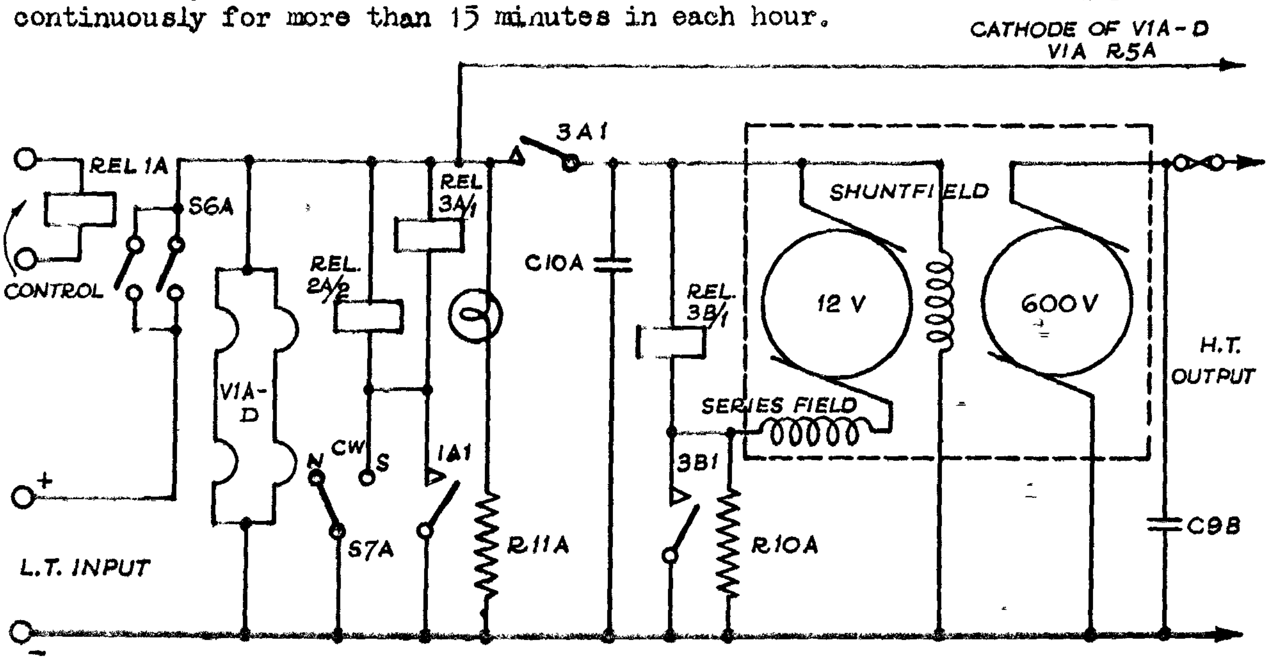


Figure 1.

The 12 volt input to the amplifier unit is taken via a twin lead and connector, while the control of the send/receive relays from the No.19 set is provided by a further twin lead and connector which forms part of the special connector between the No.19 set and its power unit. Rel 1A is now in the H.T. + 550 line of the A set and this relay will be operated by the P/A anode current, i.e., when the pressel switch is pressed or the key is plugged in on M.C.W. With Rel 1A operated L.T. is applied to the contactor relay Rel 3A which then operates, starting the rotary transformer. Rel 3B operates and shorts out the starting resistance R10A. On C.W. the control relay Rel 1A is not used because H.T. to the P/A only flows when the key is pressed. In this case the contactor relay Rel 3A is operated by the C.W./Send switch S7A and the sequence of events is as before.

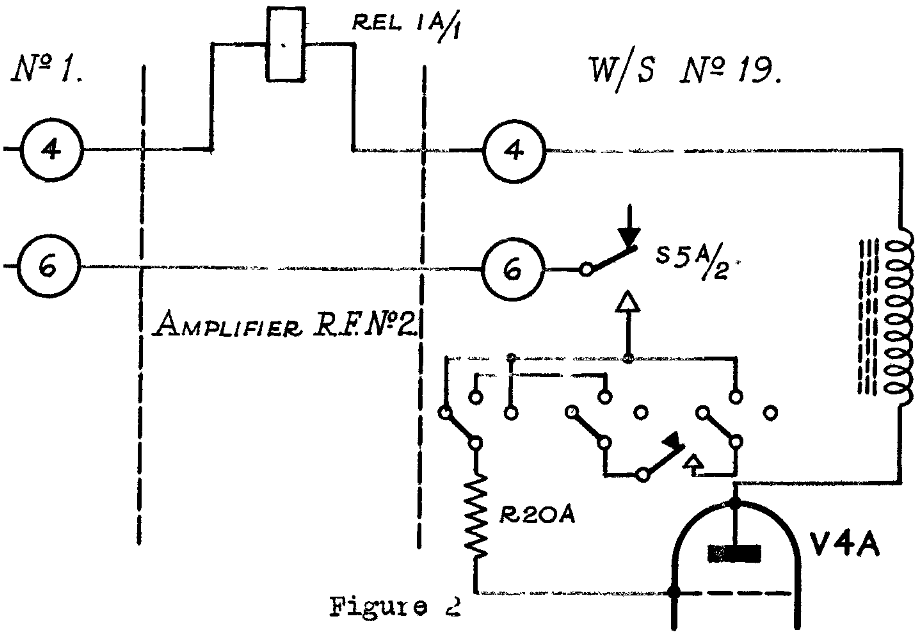


Figure 2

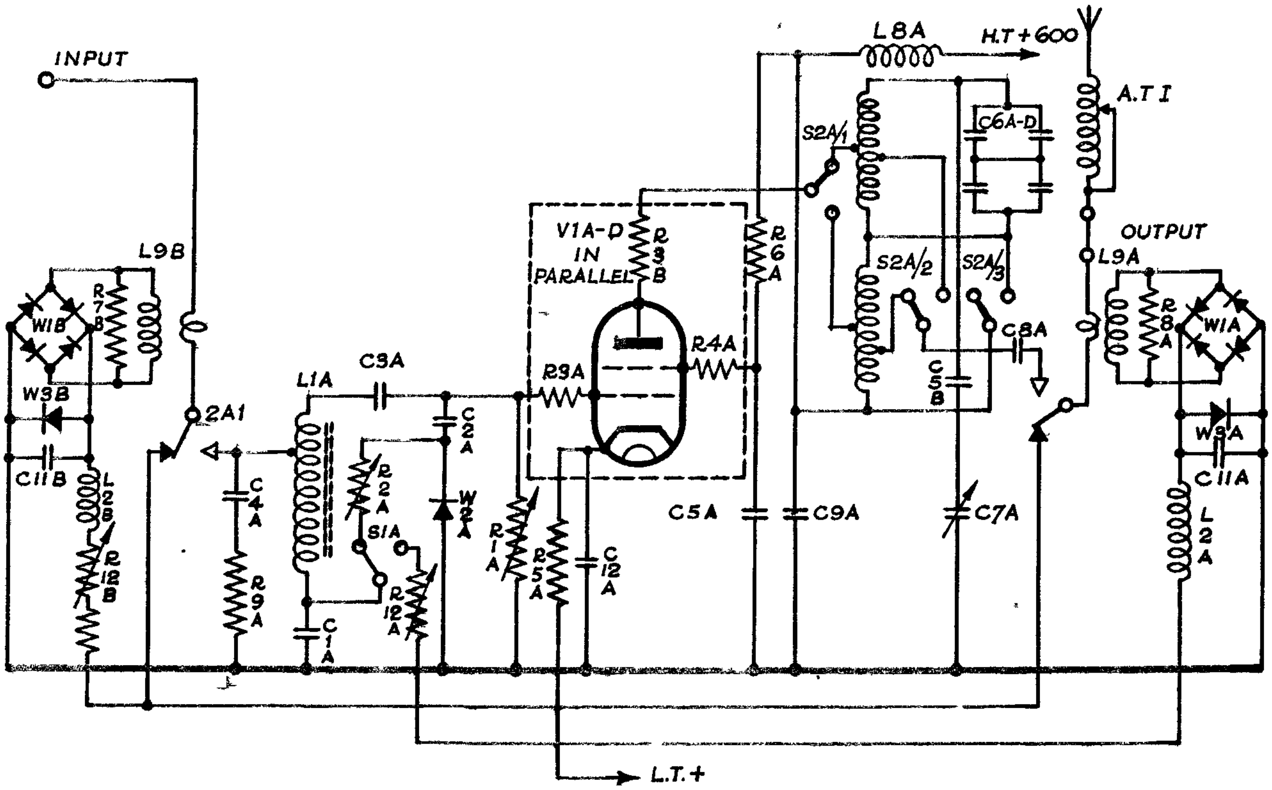


Figure 3.

3. Power Amplifier Section.

The four power amplifier valves V1A - D (type ATS25) which are connected in parallel receive modulated R.F. grid excitation from the W/S No.19 Set via a screened feeder between the "A" aerial plug on the No.19 Set and the amplifier INPUT plug; R.F. input is fed to the grids via the primary of the meter transformer L9B, the relay contacts 2A1 and an impedance matching device comprising the tapped inductance L1A, C1A, C4A and R9A (12Ω). Drive is regulated by the variable swamping resistance R1A (250Ω)

The output load comprises the tuned anode circuit L5A and/or L4A (according to the frequency range) tuned to the carrier frequency by the variable condenser C7A - the Amplifier Frequency Dial. The aerial which is adjusted to an odd number of $\frac{1}{4}\lambda$'s is coupled to a tapping on the tank coil L4A or L5A via the primary of the meter transformer L9A, the relay contacts 2A2 and the coupling condenser C8A.

V1A-D operate with approximately 600V on the anodes fed through the tank coil - L4A or L5A from the rotary transformer. Voltage is dropped to 300V for the screen grids by means of R6A (15000Ω) decoupled by C5A. The valves are biased to 22 volts negative by means of the common cathode resistor R5A (47Ω).

4. Meter Circuits.

Circuit arrangements are such that the meter on the No.19 Set, switched to AE, will indicate the following :-

1. Aerial current when the A set is working as a Low Power set, i.e., with amplifier switched OFF.
2. Aerial current when working on High Power.
3. Drive to the P/A valve grids.

The relay changeover contacts 2A1 & 2 are operated by the relay Rel 2A/2 which shunts the contactor relay Rel 3A/1. In the normal position, i.e., amplifier OFF, the A set output is applied direct to the A.T.I and aerial. In this case aerial current is indicated by the meter due to rectified R.F. from the meter circuit associated with L9B.

When H.P. is in use Rel 2A/2 is operated and by switching S1A to AMP DRIVE an indication of drive to the P/A grids is given by the rectified R.F., from W2A, which reaches the meter via R2A, S1A, L1A and the input plug.

Switching S1A to AE will give aerial current indication due to the rectified R.F. from the meter circuit associated with L9A. In this case the D.C. to operate the meter traverses R12A, S1A and then the path enumerated in the previous paragraph.

5. Component Values.

Resistors				Condensers			
R1	250Ω	R6	15000Ω	C1	.005μF	C6A-D	24 P.F.
R3	47Ω	R9	12Ω	C2	.0001μF	C8	.01μF
R4	100Ω	R11	22Ω	C3	.01μF	C9	.1μF
R5	47Ω	R12	750Ω	C4	.001μF	C10	.1μF
				C5	.004μF	C12	.01μF

1. GENERAL DESCRIPTION.

The No. 22 Set can be used as a vehicle station and as a ground station on removal from the vehicle. Facilities are also provided for the set to be transported in three loads as a "manpack" if necessary. *

The set is designed to provide communication on R/T, C.W. and M.C.W. (TTKM) over a frequency range identical with that of the No. 19 set Mks. II and III. i.e. 2 - 8 Mc/s in two bands. Break-in working is available when using the key, that is, the set is switched from receive to send by pressing the morse key. During gaps in the keying the receiver becomes operative again, and the operator at the other station can break-in with a message if he wishes. Send-receive switching on R/T is accomplished by means of the microphone pressel switch.

Remote control up to a distance of ½ mile using D3 cable is possible when operating the set in conjunction with Remote-control Units F Nos. 1 & 2. These units, in addition to the usual remote control facilities, provide for the re-broadcast, on the 22 Set., of signals received on a separate receiver while signals from the 22 Set receiver can be re-broadcast on another sender.

The range over which communication is possible varies considerably with the type of aerial used, the system of transmission and general conditions. However, some idea of the ranges obtainable is given in the following table:-

Type of Aerial.	Range in miles on:— R/T	M.C.W.	C.W.
12' Rod on move.	15 - 30	25 - 35	30 and upwards
34' Rod stationary	30 - 40	35 and upwards	35 and upwards
¾ wave wire	50 and upwards	50 and upwards	50 and upwards

The set operates from a 12 volt 75 A.H. battery when worked in a vehicle or as a ground station and from a 12 volt 25 A.H. battery when used as a man-pack ground station. The battery supplies current for the valve filaments and heaters and also provides input to the vibrator. The latter develops a maximum H.T. output of 325 volts at 80 mA. The maximum battery consumption is 3.7 A.

The sender/receiver is built on a single chassis housed in a metal case. The Power Supply Unit is contained in a separate case. When used in a vehicle, both units are secured in a Set Carrier fitted inside the truck.

The No. 22 Set is used primarily with vertical aerials, which provide communication by means of the ground ray only. Normally with this type of aerial the lowest possible frequency will be used.

The vehicle aerial comprises three 4' tapered sections (Antennae Rods F Sections 1, 2, and 3) mounted in a flexible rubber base on the outside of the truck. A fixed condenser in the aerial lead and tested to 5000 v provides protection in the event of the aerial rods making contact with overhead power lines. Less than three sections (12') should not be used, owing to the difficulty of tuning the aerial at the low frequency end of the scale. A stationary vehicle may use four sections (16').

When operating as a ground station the sixteen-foot aerial described above may be used. This aerial mounted on a rigid insulated base attached to a stake in the ground is self-supporting. A more efficient rod aerial consists of six 3' sections of ⅞" rod mounted in an Insulator W/T. B. To the top section is attached an adaptor carrying the 16' fishing rod aerial already described, thus giving a 34' mast. The latter is held steady by means of a stay plate inserted beneath the adaptor.

To obtain ranges in excess of those obtainable with the rod aerials, a ¾ λ aerial may be used. This, arranged as an inverted L with the horizontal portion thirty feet from the ground, will give good results. The optimum frequency, and hence length of aerial, will depend upon the time of day or night and also the season. Below are listed six lengths of wire which will cover the entire range of the set. Tuning to ¾ λ is performed by means of the set aerial tuner.

* See Appendix.

Length in feet.	Frequency in Mc/s.
250	2 - 2.65
185	2.6 - 3.5
150	3.45 - 4.5
110	4.45 - 5.6
90	5.55 - 6.65
70	6.6 - 8

The set may be operated from cover at distances up to 100' from the aerial by using Remote Unit J.

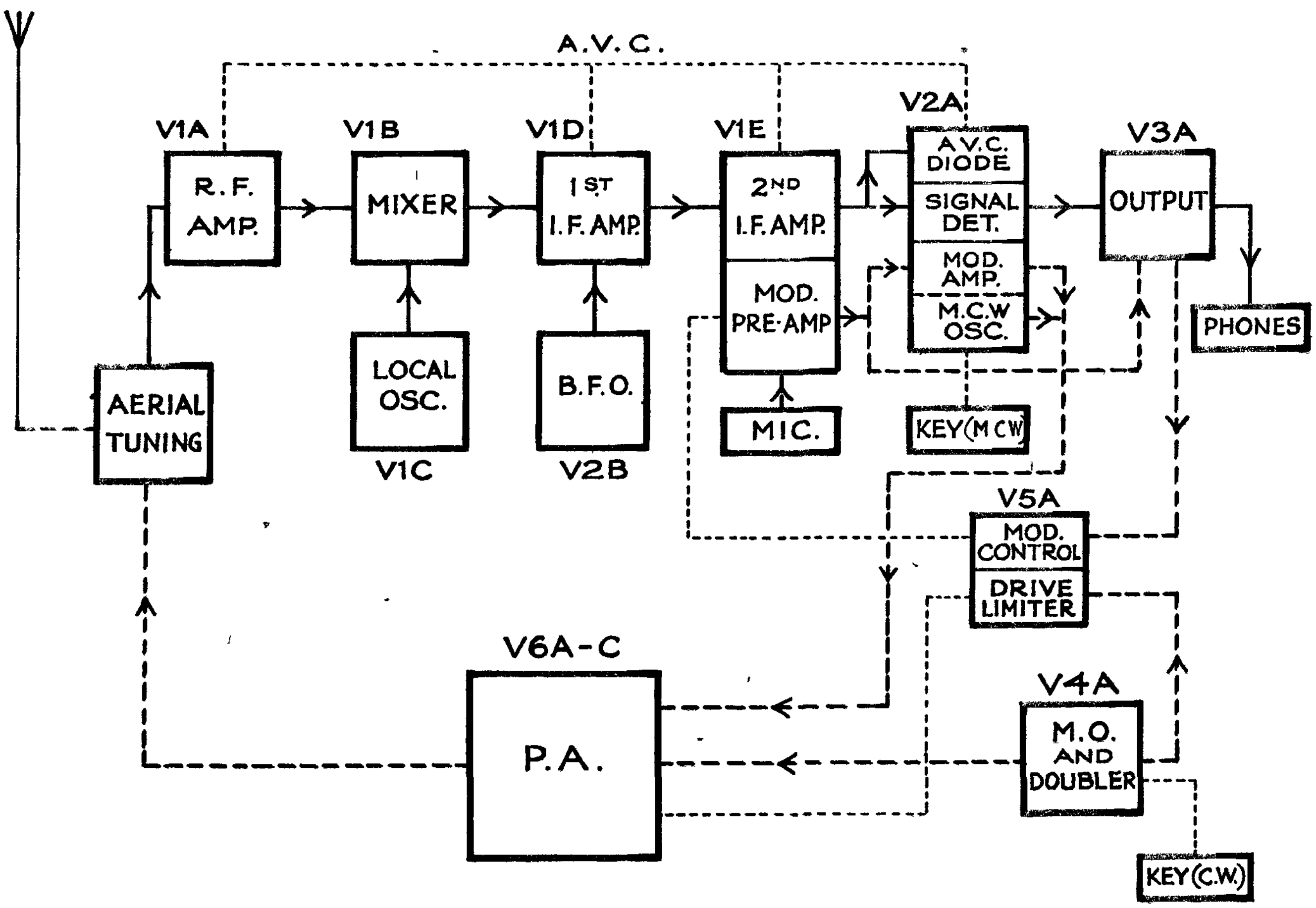


Figure I. COMPLETE BLOCK DIAGRAM OF W.S. NO. 22

2. SUMMARY OF TECHNICAL DETAILS.

The set employs 13 valves, three of which are common to sender and receiver circuits. The sender and receiver R.F. circuits are electrically independent but are tuned together by a 4-gang condenser (FREQUENCY MC/S) so that sender and receiver frequencies are always approximately the same. In this way netting is simplified, small errors due to stray capacity being corrected by the NETTING TRIMMER. The aerial circuit common to both sender and receiver is tuned by an independent AERIAL TUNING control. The sender output is matched to the aerial circuit impedance by means of a matching condenser (AERIAL COUPLING).

The receiver is a conventional 8 valve superheterodyne comprising a signal frequency stage, frequency changer with separate local oscillator, two I.F. stages followed by signal detector and A.V.C. diode, and one stage of A.F. amplification. A B.F.O. is included for C.W. reception. A high order of sensitivity is obtained (better than 2μV for an output of 50 mW on all frequencies).

Sender frequency stability is ensured by employing a master oscillator valve working at half carrier frequency and frequency - doubling in this stage. The M.O. output is applied as drive, maintained constant by a limiting device, to the P/A stage. The latter consisting of three pentodes in parallel is grid modulated on R/T and M.C.W. Depth of modulation is automatically controlled.

3. DETAILED DESCRIPTION OF RECEIVER CIRCUITS

Filament and Relay operating circuits (indirectly heated valves underlined).

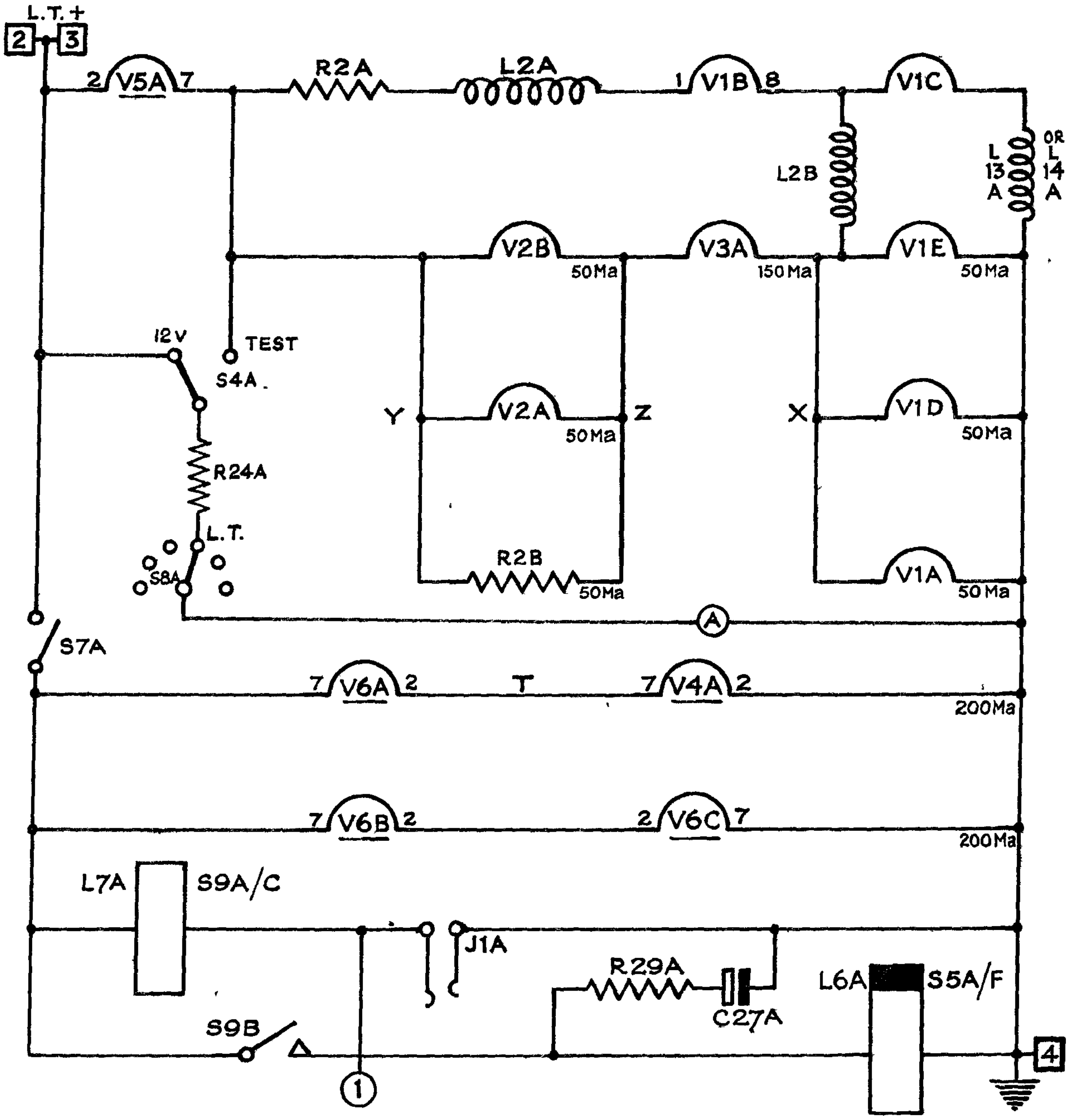


Figure 2.

(a) Filament Circuits.

The eight receiver valves have 2 volt filaments and the remaining five sender valves are indirectly heated. Filaments and heaters are arranged in series-parallel across the 12v L.T. supply as shown in the accompanying diagram. The 39 Ω resistors R2A-B are included in the receiver valve circuit for correct filament voltage distribution. The choke L2B between V1C and V1E etc. serves the same purpose. It should be noted at this stage that the filaments of V1B and V3A are 2v positive with respect to chassis or L.T. - and those of V2A and V2B 4v positive. This fact will be referred to when considering the bias to these stages.

(b) R.F. Amplifier.

The signal frequency R.F. amplifier valve V1A is a 2-volt directly heated R.F. pentode, Army type RP12. The inclusion of this stage permits frequency changing at a high signal level thus improving signal/noise ratio.

The signal, received by the aerial tuned to resonance by the variable inductance L4A and the variable condenser C8A, is applied between control grid and filament via the grid condenser C17H (140μμF) and the by-pass condenser C10M (.1μF). The grid is returned to earth through the choke L5B, the A.V.C. line and the R.F. gain control R15A (100,000Ω). The latter provides a variable bias of 2 - 20 volts for volume control.

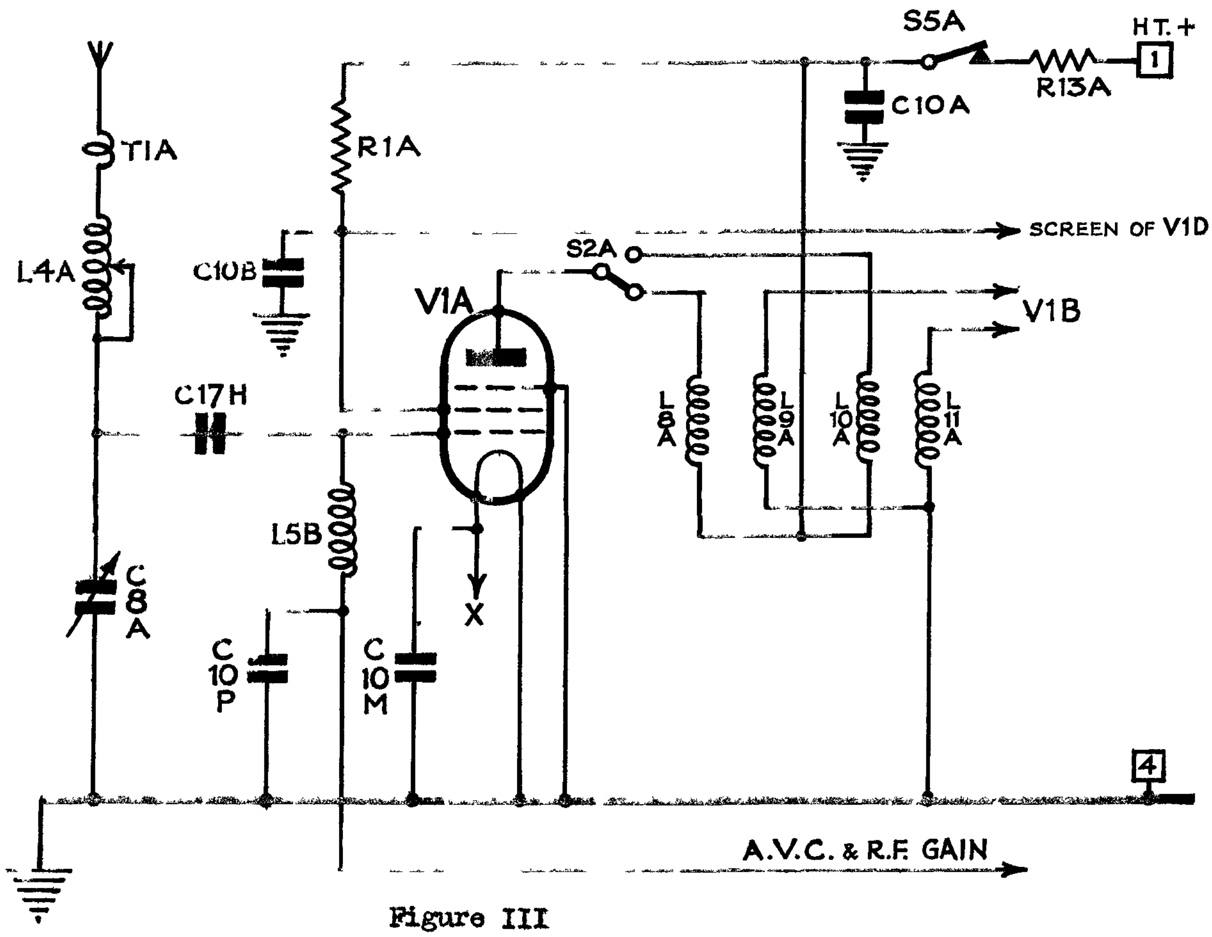


Figure III

Coupling to the mixer stage is provided by the tuned secondary R.F. transformer L8A, L9A or L10A, L11A according to the position of the range switch S2A. H. T. at 120v is applied to the anode via the common dropping resistance R13A (20,000Ω) decoupled by C10A (.1μF), the change-over relay contact S5A and the coupling transformer primary L8A or L10A. Screen volts to this valve and also V1D are reduced to 60 by means of R1A (47,000Ω) decoupled by C10B (.1μF).

(c) Frequency Changing Stage

The secondary of the inter-valve transformer, i.e. L9A or L11A (depending on the frequency range) is tuned to signal frequency by C1A one section of the four-gang tuning condenser. C2B (3 - 30μμF) is the associated trimmer, and is located on the top of the condenser assembly. The R.F. output is applied between the grid of the mixer valve V1B, type ARP. 12, and earth. A negative grid bias of 2 volts is provided by the filament circuit (see diagram).

H.T. at 90 volts is supplied to the anode through R3A (10,000Ω), decoupled by C10D (·1μF), and the primary of the I.F. transformer L12A. R1B (47000Ω) decoupled by C10C (·1μF) feeds the screen grid.

Frequency changing is achieved by cathode injection, the local oscillator output being applied between the filament of the mixer valve and earth. L2A in the filament circuit offers a high shunt impedance to the input while the D.C. resistance is kept low.

The local oscillator valve V1C is a pentode of similar type (ARP12) which is used as a triode by strapping anode and screen grid together. This valve oscillates in a Hartley type of oscillator circuit, the anode of which is at earth R.F. potential. The oscillator frequency is determined by the setting of C1B, a section of the 4 - gang condenser, already referred to, which tunes the tapped inductance L13A or L14A. C4A is the trimmer associated with C1B.

The oscillator output is maintained at 465 KC/S above signal frequency by means of the padding condensers C14A (.0016μF) and C15A (.0013μF) in parallel with C3A (150 - 600μμF) associated with L13A and L14A respectively. C13A (50μμF), C12A (30μμF) and C3A (3 - 30μμF) are added to facilitate trimming on both frequency ranges. Grid bias is provided by the grid leak and condenser R1C (47000Ω) and C17C (140μμF) respectively. H.T. is fed to anode and screen by R3B (1000Ω) decoupled by C10E (.1μF). Output is taken between the filament and earth and applied to the mixer as already described. L2B offers a high impedance path to earth for R.F.

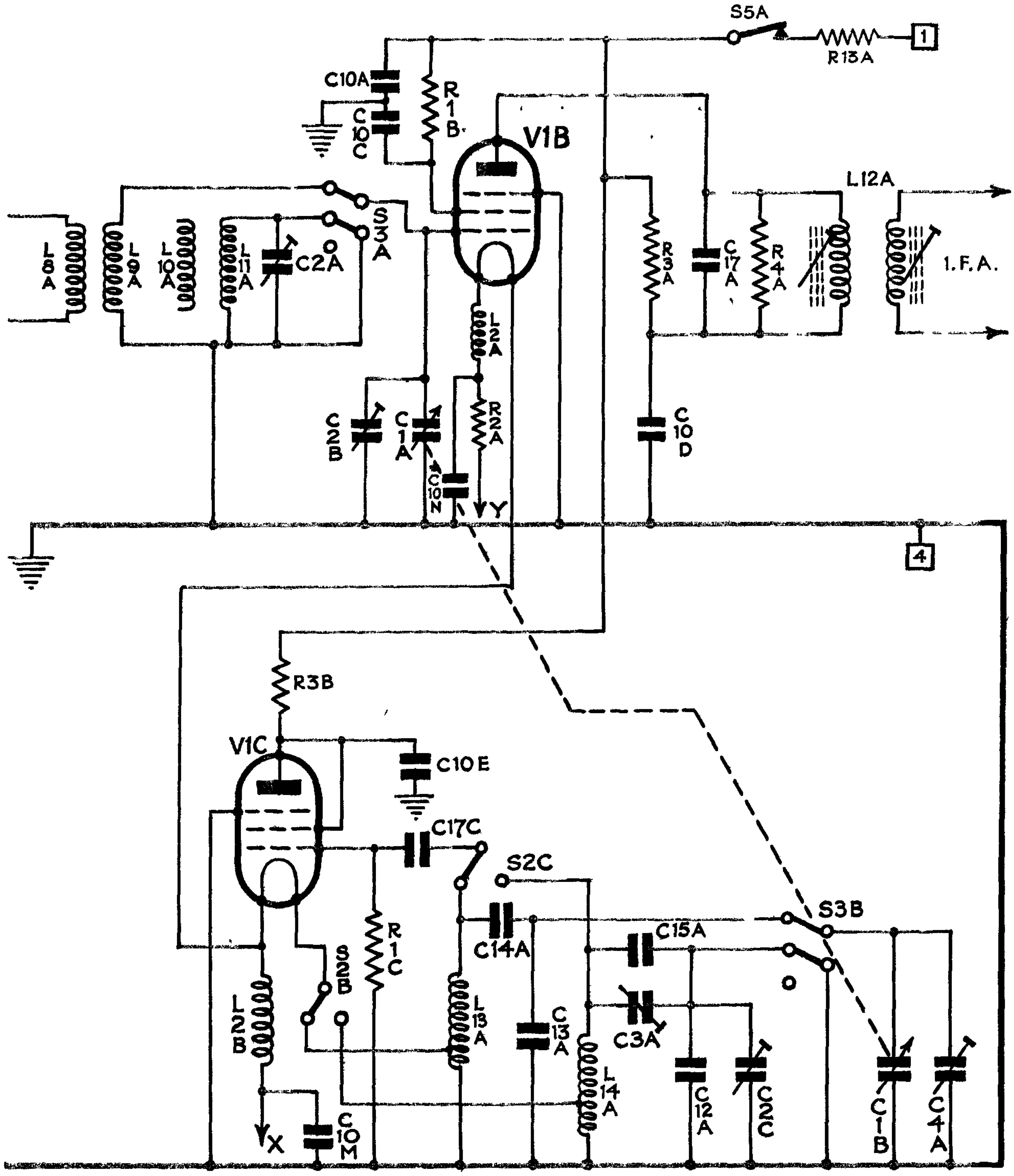


Figure 4.

We then have the mixer control grid varying at signal frequency, the cathode at oscillator frequency and the valve biassed negatively. The valve will therefore operate as an anode bend detector, the R.F. oscillations appearing in the anode circuit together with sum and difference frequencies. The difference between the signal and oscillator frequencies, i. e. 465 KC/S, is selected by the tuned primary of L12A.

NOTE.

In later sets the Local Oscillator stage has been modified by the addition of the feed back coils L30A and L31A shown in Figure 5 below. Notice also the change in the position of the fixed condenser C12A.

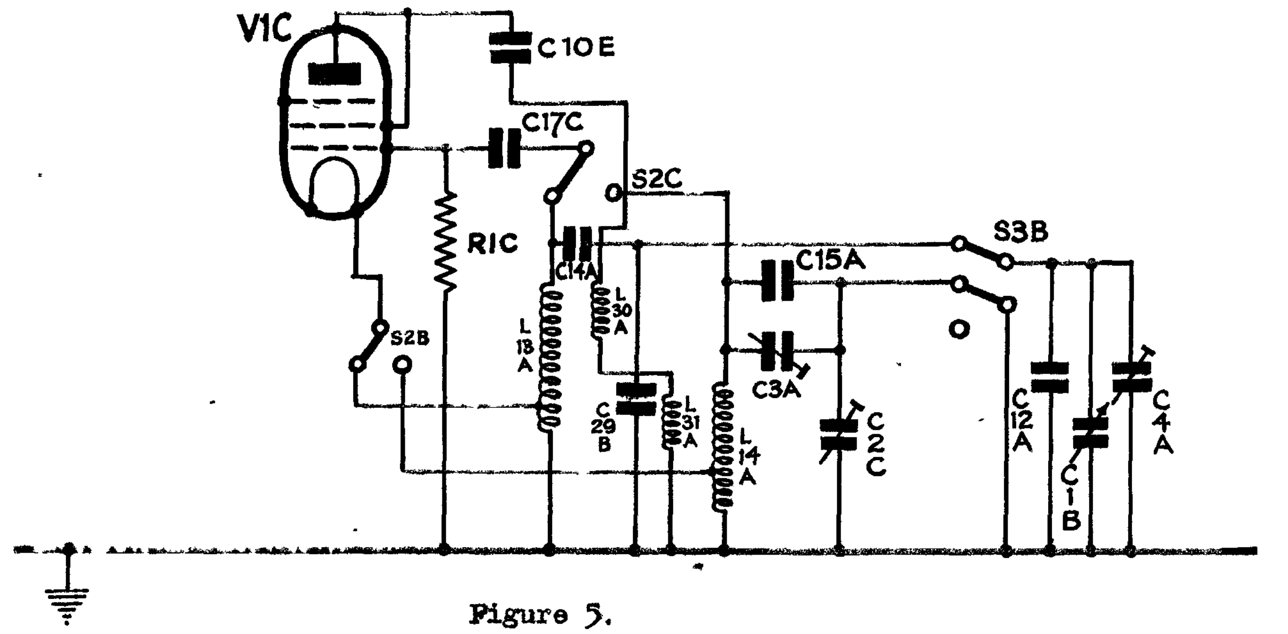


Figure 5.

(d) The I.F. Amplifier.

There are two I.F. amplifier valves V1D and V1E (type ARP12) coupled by permeability tuned transformers L12A and L12B employed as band pass filters. The intermediate frequency is 465 KC/S. The output from these stages is applied to the detector via a band-pass filter L15A. L12A and L12B are arranged for optumim coupling and their primaries shunted by R4A and R4B (100,000Ω) respectively to give the desired band-width (5 - 8 KC/S). H.T. to the anode is applied through the dropping resistance R13A and relay contacts S5A. The latter open on send thus disconnecting H.T. to V1A-D. The screen feed to V1D is common to V1A as already noted. Anode and screen voltage for V1E is picked up direct from the H.T. line and fed through R21A (68000Ω) decoupled by C21B (2μF), R8A (22000Ω) and the primary of L15A to the anode. Screen volts are applied by means of the potentiometer comprising R4C (100,000Ω) R7A (470,000Ω) and R6A (3300Ω).

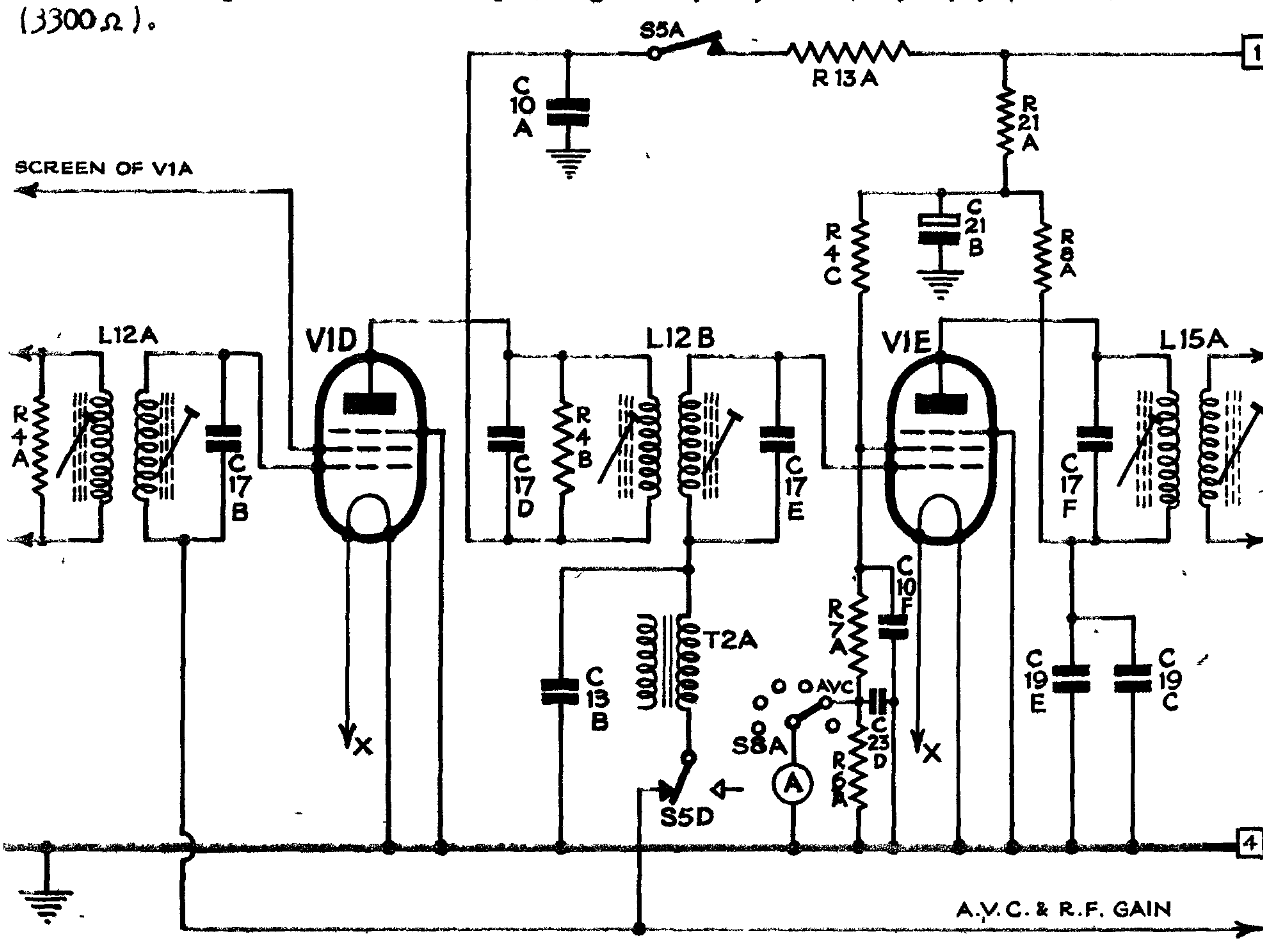


Figure 6.

Control grids are returned to chassis via the A.V.C. line so that bias is obtained from the R.F. gain control and the A.V.C. diode.

When the meter switch S8A is switched to A.V.C. the test meter is connected across R6A and any change in potentimeter current will be indicated. Now the total cathode current of V1E depends upon the grid bias applied, this in turn is determined by the strength of the input, due to the extra A.V.C. bias. Reduced cathode current will cause a reduction in potential drop across R21A and hence a larger current in the potentiometer. This will result in an increased deflection on the test meter. Thus the receiver is always tuned for maximum meter reading with the switch to A.V.C.

(e) Signal Detector

The output from the secondary of the I.F. bandpass filter L15A is applied to the signal detector portion of V2A a double-diode triode, type AR8. This is connected in a series diode circuit, the potentiometer R9A (1MΩ) and C19A (.0005 μF) being the effective diode resistance and condenser respectively. R4E (100,000Ω) and C18A (.0001 μF) form an I.F. filter. A.F. voltages produced across R9A are tapped off by means of the potentiometer slider (L.F. gain control) and applied to the output stage.

(f) A.V.C.

The second diode of V2A operates in a parallel diode circuit the load resistance of which is R10A (1MΩ) and the diode condenser is C11A (20μμF).

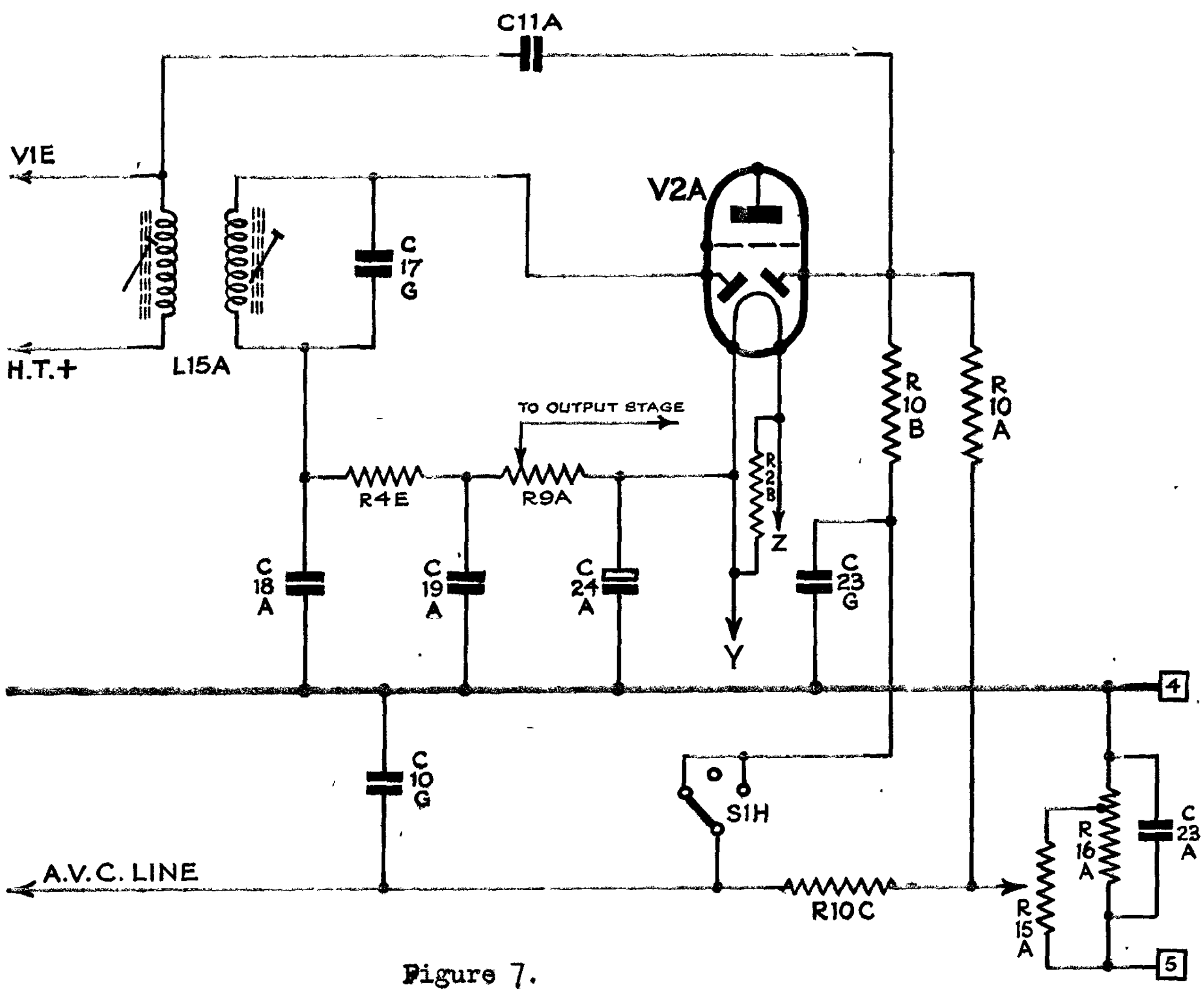


Figure 7.

The I.F. input is taken from the primary of L15A, thus giving a higher voltage on the diode anode and reducing distortion and sideband screech when the set is mistuned from a station. The potential developed by the signal across R10A is applied as negative bias to the controlled valves V1A, V1D and V1E on R/T and M.C.W. via the filter circuit comprising R10B (1MΩ) C23G (.001μF) and C10G (.1μF).

Delay bias is obtained by returning R10A to chassis via the R. F. gain potentiometer R15A and the bias resistor R16A (860Ω) tapped at 100 Ohms. This arrangement gives 2 volts minimum delay due to the latter in addition to 4 volts from the filament circuit network (see diagram). This delay bias is also applied via R10C (1MΩ) as minimum bias to the three controlled valves.

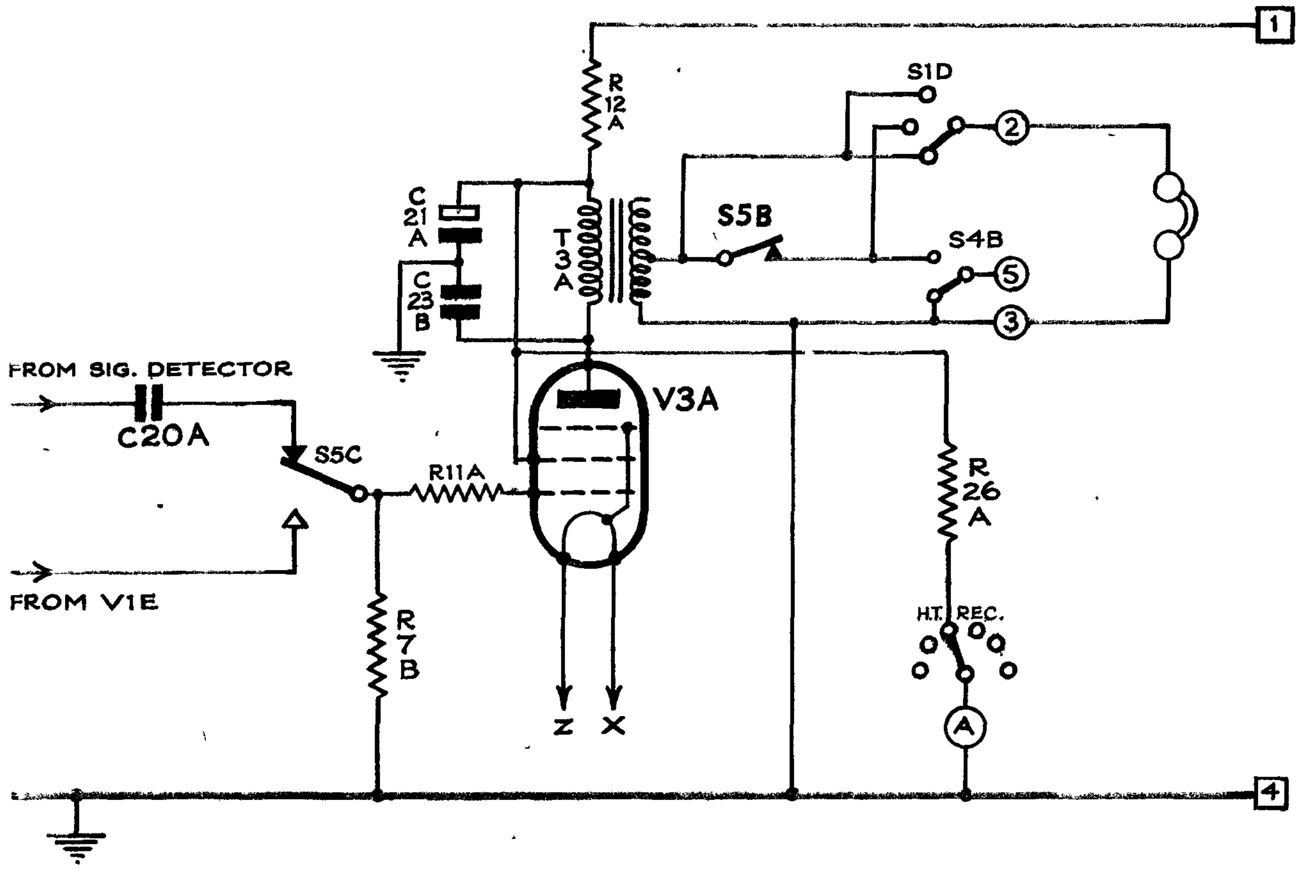


Figure 8

(g) Output Stage.

The final stage is an A.F. amplifier employing a 2 volt directly heated output pentode typePEN25(Army type CV65). This works into the output transformer T3A and H.T. to anode and screen is fed direct from the H.T.+ve line through R12A (47000Ω) decoupled by C21A (2μF). A.F. input is taken from the L.F. gain control R9A to the grid via the coupling condenser C20A (.002μF), the slugged relay contacts S5C and the I.F. stopper R11A (15000Ω). A.D.C. path from grid to earth is obtained by way of R7B (470,000Ω) and as the filament is 2 volt positive with respect to earth V3A receives a steady control grid bias of 2 volts negative. The anode and screen voltage applied is approximately 100, and it is this voltage which is indicated by the test meter with the switch to H.T. Rec.

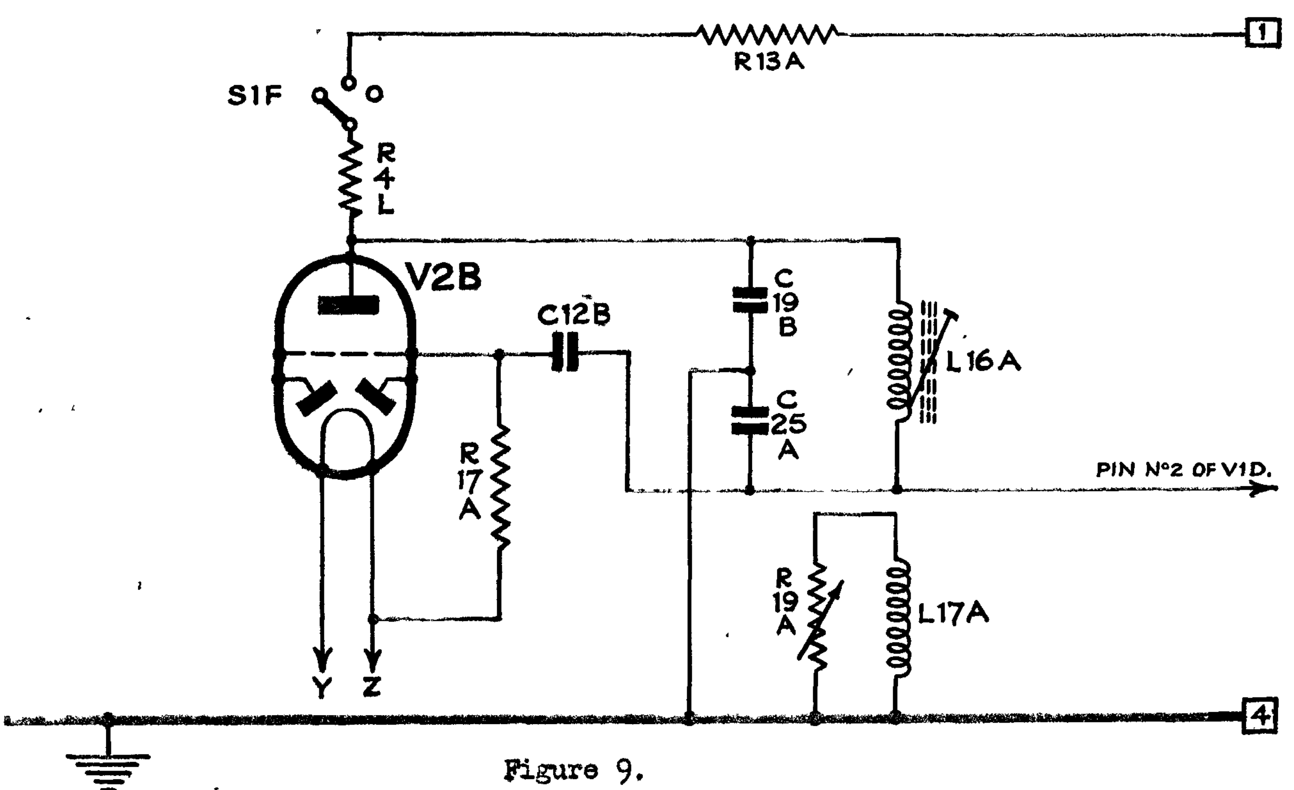


Figure 9.

(h) Beat Frequency Oscillator.

V2B is a double diode triode type AR8 functioning as a triode only in a Colpitts oscillator circuit. The latter is tuned to within an audible frequency of the intermediate frequency by means of the Het Tone control R19A. This shunts the coupling coil L17A thus providing a variable load on the oscillator coil L16A. A section of the system switch S1F is included in the anode circuit so that the B.F.O. will only function on C.W. Coupling to the I.F. amplifier is achieved by connecting the grid end of L16A to a spare pin on valve V1D.

4. TECHNICAL DESCRIPTION OF SENDER

(a) The Master Oscillator

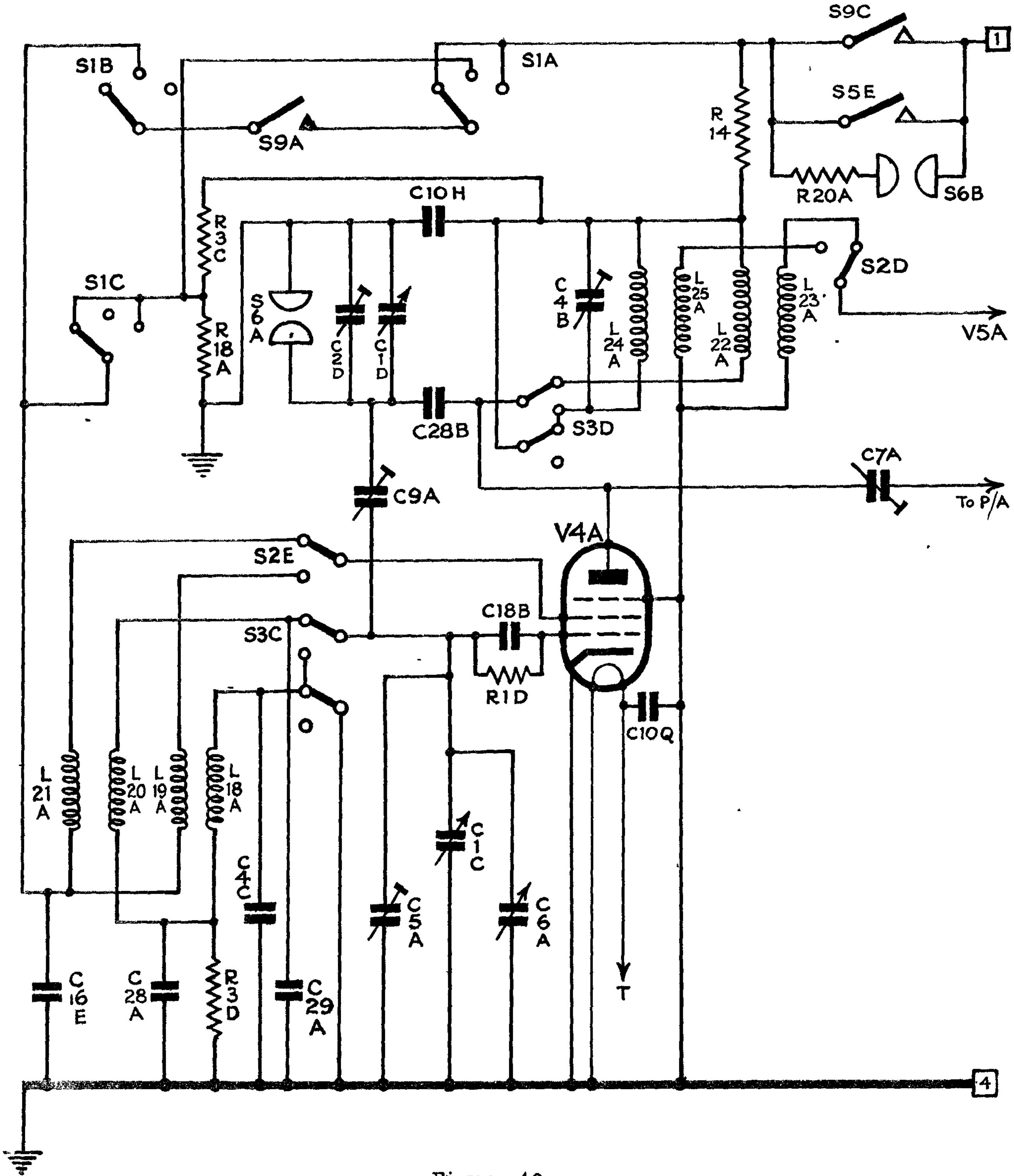


Figure 10.

Diagram showing circuit of Master Oscillator

The M.O., a simplified version of which is given below, consists of an electron coupled oscillator employing frequency doubling.

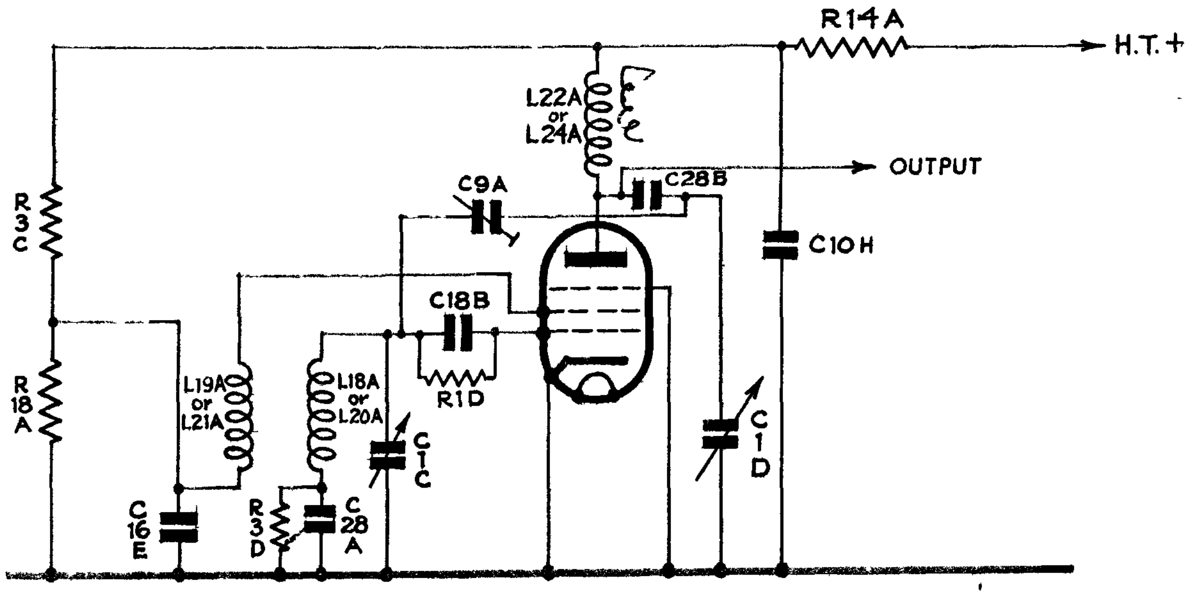


Figure 11.

The valve V4A, type ARP34, is an indirectly heated R.F. pentode with approximately 230V and 60V on anode and screen respectively. The screen grid, control grid, and cathode operate in a series feed - back oscillator of the Meissner variety. Coupling to the tuned anode circuit, tuned to double the oscillator frequency, is via the electron stream of the valve. Drive for the P/A stage is taken direct from the anode through the preset condenser C7A(4-80μμF).

The grid oscillatory circuit consists of L18A or L20A tuned by C1C, one section of the main tuning condenser. C5A (3-50μμF) is a trimmer associated with C1C while C4C (1-15μμF) and C29A (10μμF) are additional trimmers for the lower frequency range. L19A and L21A are the feed back coils for the 2-4.5 Mc/s and 4.5-8 Mc/s ranges respectively. The valve is biassed by means of the grid leak and condenser R1D (47000Ω) and C18B (.0001μF).

The tuned anode circuit comprises the inductance L24A (or L22A on the higher frequency range) tuned by C1D the remaining section of the 4-gang tuning condenser. C2D is the associated trimmer and C4B the counterpart of C4C above. L23A and L25A are coupling coils associated with the drive limiter circuit to be dealt with later.

H.T. to anode is fed by way of the relay contacts S9C and S5E, the dropping resistance R14A (4700Ω) decoupled by C10H (.1μF) and the anode coil L24A (or L22A). Screen voltage is applied by means of the potentiometer comprising R3C (10,000Ω) and R18A (39,000Ω) through the switch S1C and the feed-back coil on R.T. and M.C.W. When working C.W. the screen circuit is completed via S1A, S1B and the high speed relay contacts S9A. Coupling between anode and oscillator circuits due to capacity between anode and screen is neutralized by means of C9A (1 - 7.5μμF).

Netting.

We have already seen that owing to the mechanical arrangements adopted, the M.O. will always be adjusted to approximately the same frequency as that of the receiver. Netting is accomplished by adjusting the M.O. to give a zero beat with the incoming signal by means of an extra trimmer operated from the front panel.

The control station is tuned in as accurately as possible and the Net Switch S6A-B closed. This applies H.T. to V4A and adjustment to the netting Trimmer C6A (2.8-10μμF) in the grid circuit will result in a beat note being produced in the headphones. C6A is tuned to the zero beat position and S6A returned to normal. Sender and receiver are now netted for the received frequency. S6A shunts out drive to the P/A thus preventing a carrier being emitted as the P/A is in operation on Net. Note the D.C. blocking condenser C28B (.005μF) and its counterpart C28A in the grid circuit to ensure correct tracking.

(b) Power Amplifier.

The P/A stage consisting of three indirectly heated pentodes, V6A - C. in parallel (Type VT52), operates with an anode voltage of 290V and 280 volts on the screen grids. The 6V heaters are supplied from the 12 volt L.T. supply (see diagram). Grid bias for this stage is derived as follows:-

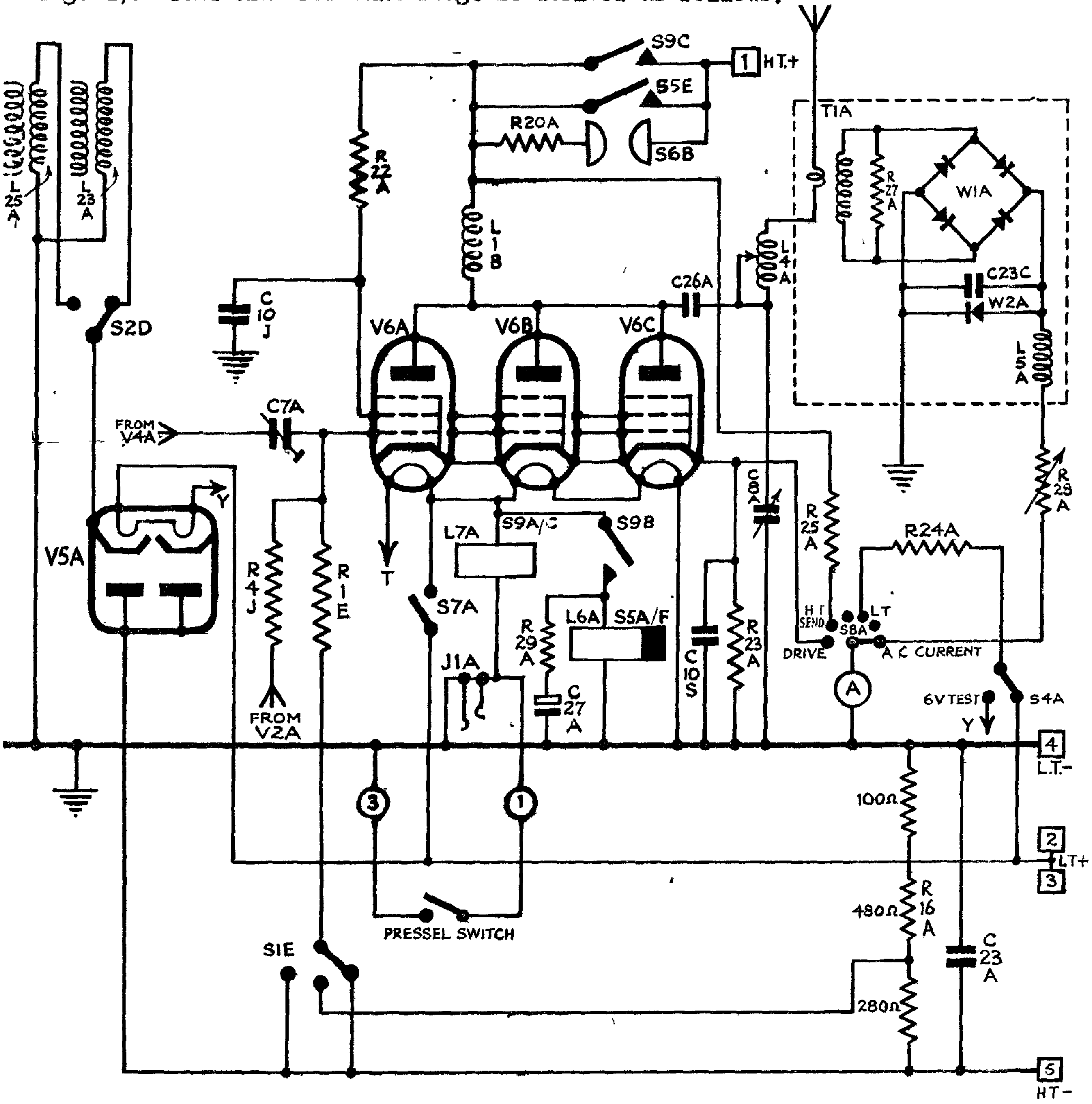


Figure 12

(i) By returning the control grids via R1E (47,000Ω) and S1E to R16A (860Ω tapped at 580 Ω from the earth end for C.W.) a steady negative bias of 45 volts on R/T and M.C.W. and 35 volts on C.W., is obtained.

(ii) One section of an indirectly heated double-diode V5A, Type ARDD5 is used to provide extra bias on R/T & M.C.W. when the drive exceeds the steady voltage due to R16A. By this means the R.F. drive at the P/A grids is maintained constant, although M.O. output may vary, and operation will be more uniform. It is achieved by means of a series diode circuit, the load resistance and condenser of which are R16A & C23A respectively. R.F. input to the diode is provided by the coupling coil (L25A or L23A) and the delay of 45 volts is obtained from R16A.

Drive to the P/A valve grids is applied by means of the preset condenser C7A (4 - 80μμF). Parallel feed is used, the H.T. being fed through the R.F. choke L1B to the anodes. The R.F. output is coupled to the aerial circuit by means of the isolating condenser C26A (.004μF).

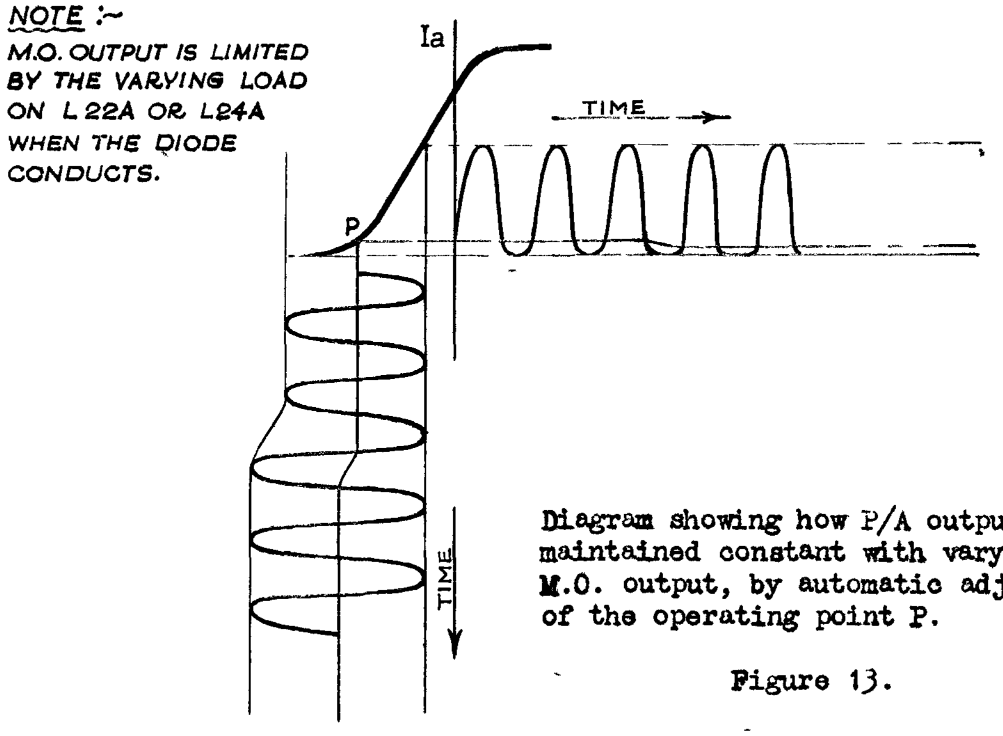


Diagram showing how P/A output is maintained constant with varying M.O. output, by automatic adjustment of the operating point P.

Figure 13.

The aerial circuit common to sender and receiver is composed of the variable loading inductance L4A and the matching condenser C8A the latter being connected from the anode end of L4A to earth. The aerial is tuned to resonance by means of L4A and the resulting impedance is matched to that of the output stage by means of C8A. Optimum load conditions are indicated by maximum aerial current resulting from the combined adjustment of L4A and C8A. The theory of the Reactance Transformer embodied here is considered at the end of this section.

The Meter.

On "send" the test meter, a 0 - 0.5 M.A.D.C. milliammeter associated with a 6-position rotary switch S8A, is used to provide the following indications:-

(i) Aerial Current

The R.F. output from the transformer T1A in the aerial lead, is rectified by means of the bridge rectifier W1A, and the D.C. output from the latter is applied through L5A and R28A to the meter. R27A (47Ω) shunting the secondary of T1A is included to damp down resonances and maintain output independant of frequency. L5A in conjunction with C23C (.001μF) comprises an R.F. filter. W2A limits the D.C. output from the bridge rectifier and prevents overloading the meter. R28A a preset resistance of 530Ω located on the chassis is to provide a suitable meter deflection.

(ii) Drive.

In this position of the switch S8A the panel meter is shunting R23A (2.5Ω) in the cathode lead and gives a deflection proportional to the cathode current. As the P/A valves are biassed back to work under Class B conditions the cathode current will be held back until the drive is applied when it will be released to an extent proportional to the drive.

(iii) H.T. Send.

The meter connected in series with R25A (1.2MΩ) functions as a voltmeter and indicates the voltage applied to the anodes of V6A - C.

(iv) L.T.

The meter in series with R24A (29,500Ω) operates in conjunction with S4A as an L.T. voltmeter. In the "normal" position of S4A the L.T. voltage applied to the set is indicated, while in the "Test" position a check is provided on the voltage distribution to the receiver valve filaments.

(c) Modulation Pre-Amplifier.

The output from the moving-coil microphone is given a stage of amplification before the modulator. This is accomplished by means of the receiver 2nd I.F. amplifier now operating as a resistance capacity coupled A.F. amplifier. Microphone output is applied to the control grid of V1E via the microphone transformer T2A.

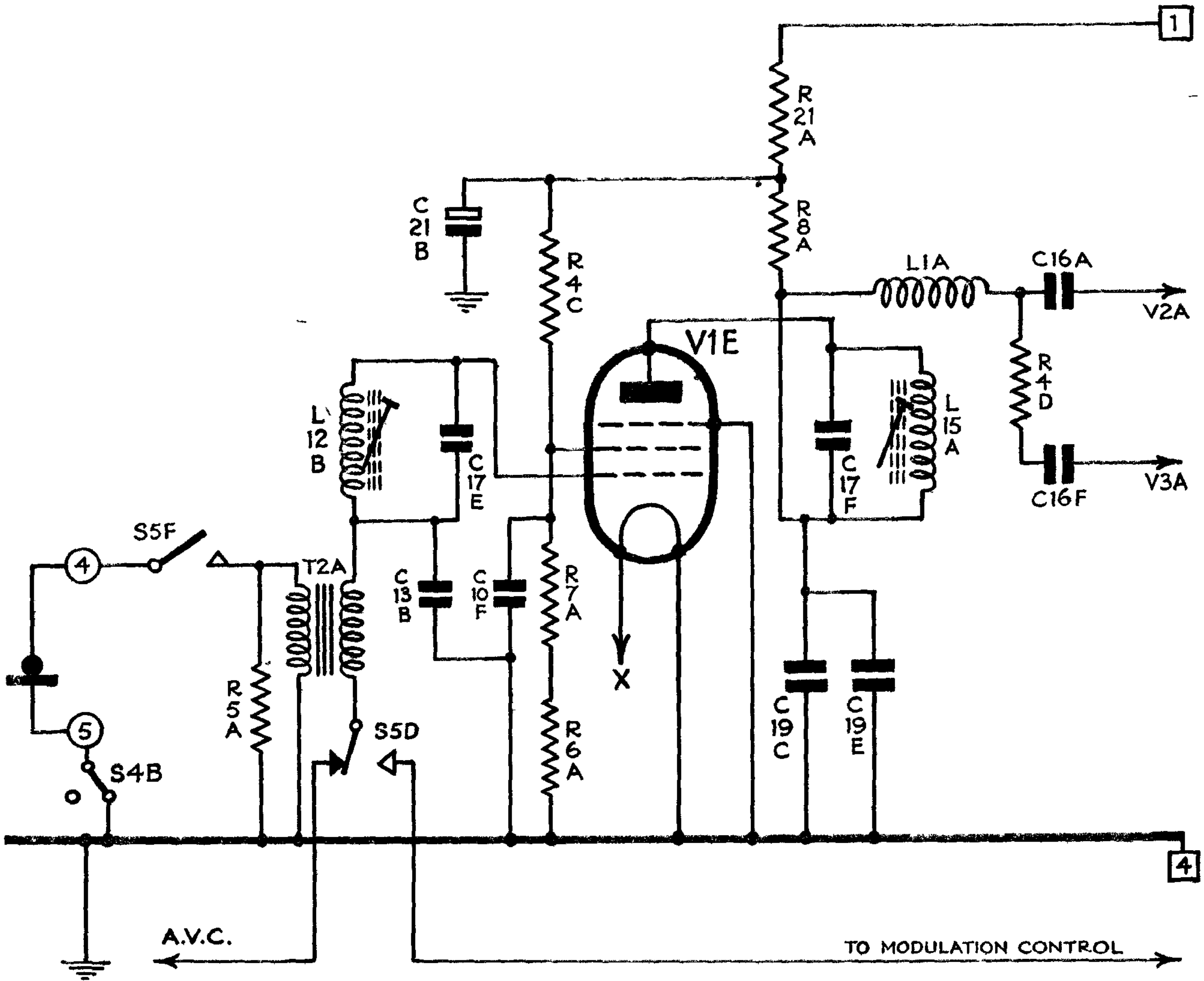


Figure 14.

Anode and screen feeds are the same as for receive, the anode load impedance now being R8A (22,000Ω). Coupling to the Modulator is via the R.F. choke L1A and the coupling condenser C16A (.01μF). L1A in conjunction with the condensers C19C and C19E (each .0005μF) form an I.F.filter for the purpose of preventing instability on receive due to I.F.on the control grid of V2A. Grid bias for the stage is derived from the automatic modulation control which feeds back a negative voltage proportional to the microphone output. This achieves a degree of volume compression and maintains a good depth of modulation without distortion.

(d) The Modulator.

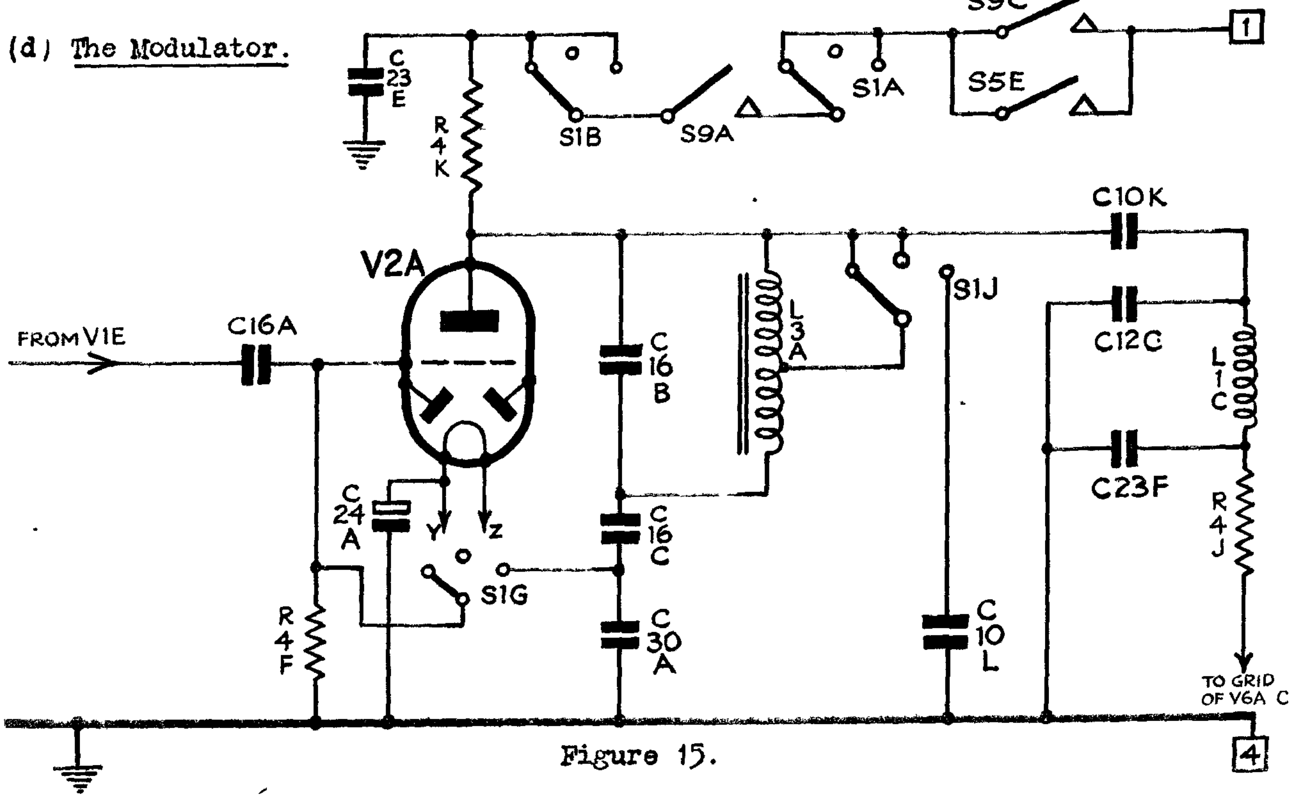


Figure 15.

The modulator valve is the triode section of V2A the two diodes remaining out of use on, send.H.T. from the H.T.+ve line is applied to the anode via the relay contacts S9A and C, S5E, the system switch S1A and B and the anode load resistance R4K. The voltage at the anode is 150V. A steady bias of 4 volts negative is derived from the filament circuit as previously mentioned.

On R/T amplified A.F. output from the microphone is applied between the grid and filament of V2A and appears as modulating voltage developed across the load resistance R4K (100,000Ω). This output is taken to the P/A grids via the filter comprising L1C, C12C (30μμF) and C23F (.001μF) and the resistance R4J (100,000Ω).

* For the transmission of M.C.W. the triode section of V2A operates as a parallel-fed Hartley A.F. oscillator, the tuned circuit of which consists of the tapped choke L3A in parallel with C16B (.01μF). A.F. output is taken from the anode to the P/A stage as before.

(e) Sidetone and Automatic Modulation Control.

Audio frequency output from the modulation preamplifier is taken through R4D (100,000Ω) and C16F (.01μF) to the receiver output valve V3A where it is further amplified for sidetone on R/T. Sidetone on M.C W. is picked up from the modulator grid and fed to V3A via C16A, R4D and C16F.

Depth of modulation is controlled by the means of the grid bias and therefore the gain of V1E. This is accomplished by applying A.F. output from the anode of V3A, via C16D (.01μF) and R8B (22,000Ω) to the second diode circuit associated with V5A. Rectified current in the load R4H will set up a voltage drop which is applied as bias to V1E via the filter, comprising R4C and C22A, and the relay contacts S5D. This diode is given a delay of 12V by connecting the cathode to L.T.+.

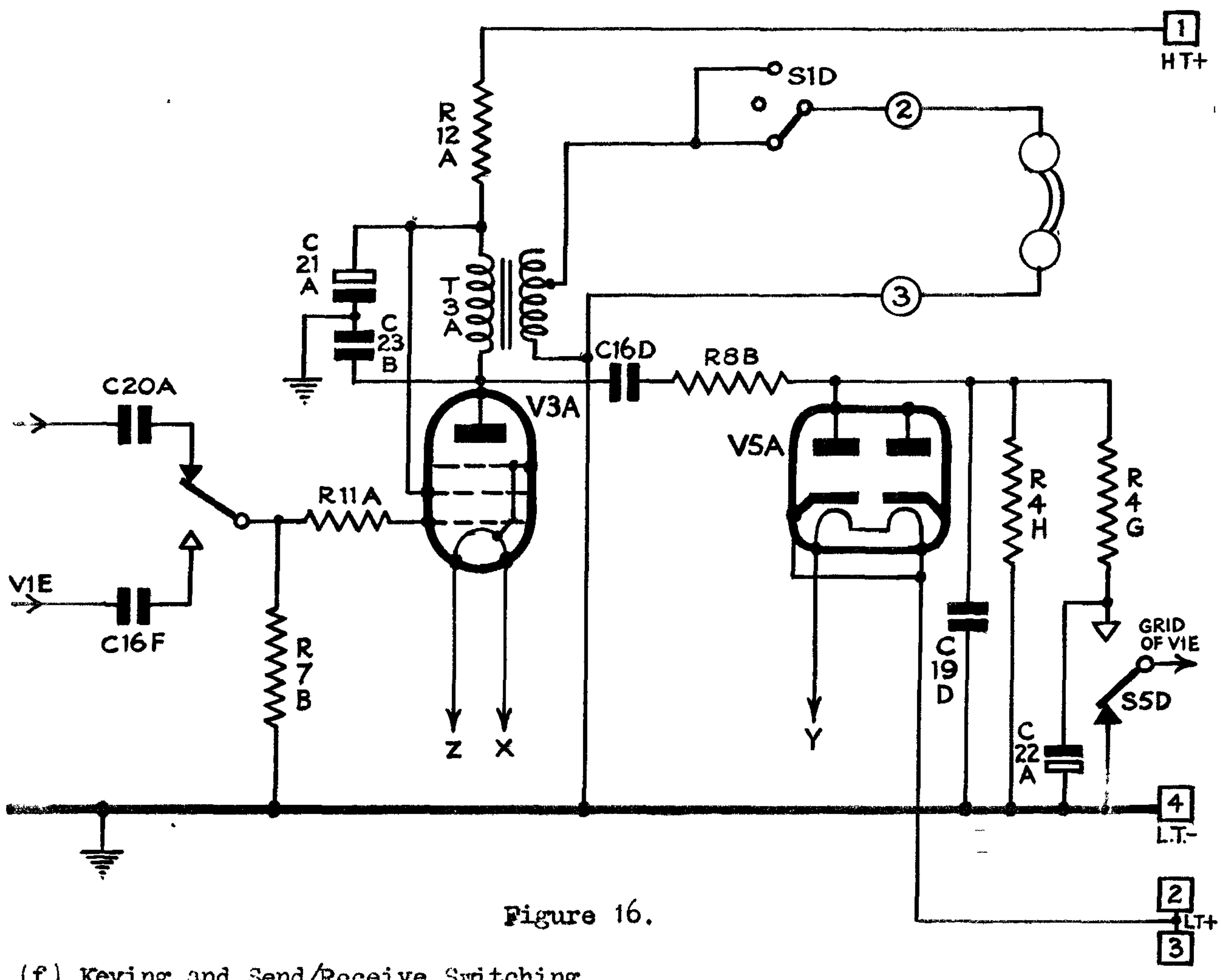


Figure 16.

(f) Keying and Send/Receive Switching.

The change over from receive to send is achieved by means of two relays operated by the microphone pressel switch on R/T and the morse key on C.W. and M.C.W. The relays are so arranged that during gaps in keying the receiver becomes operative and the receiving station can "break in."

When either pressel switch or key is pressed the high-speed relay L7A operates, applying H.T. to the P.A., M.O. and modulator valves. In addition it

* See Appendix

operates the slugged relay L6A which is slow to release. The latter relay performs the following circuit changes:-

1. Provides a path for H.T. to the P.A. valves and M.O. anode when using the key on C.W. so that only the M.O. screen is keyed. On M.C.W. it permits the modulator anode only to be keyed.

2. Breaks the H.T. circuit to valves V1A - D.

3. Cuts out sidetone on C.W.

4. Switches the grid of V3A from the receiver signal detector to V1E for sidetone.

5. Disconnects the grid return of V1E from the A.V.C. line and connects it to the modulator control.

6. Closes microphone circuit.

Note on Reactance Transformer.

In order to get the maximum energy transferred from the P/A stage to the aerial the latter must be matched to the A.C. resistance of the P/A valves. This is achieved by arranging that the last named should present a resistance to the aerial equal to the total aerial resistance.

The 22 set aerial circuit may be represented as follows:-

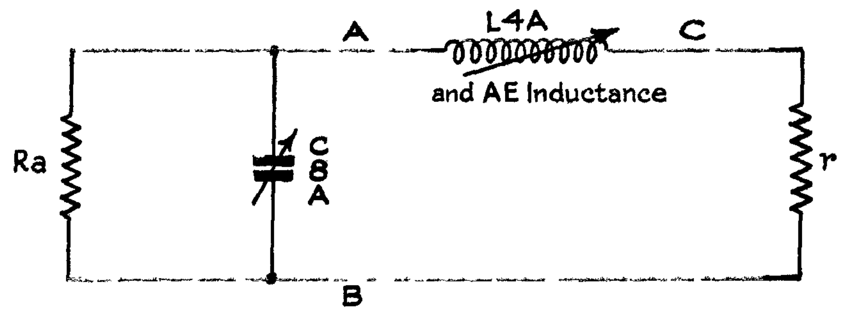


Figure 17.

Where Ra is the effective anode characteristic impedance of V6A - C, C8A is the aerial matching condenser, r the total aerial resistance and L4A the total inductance of the aerial including that of the variable inductor.

The impedance of the circuit Ra and C8A in parallel is equivalent to a smaller resistance r and a smaller capacitative reactance x in series. By adjusting C8A so that x is equal numerically to the inductive reactance due to L4A and the aerial inductance, the two reactances will neutralize and the impedance across A & B will be equal to r.

The advantage of this method of matching is the wide range of load ratio covered within comparatively small limits of component values.

5 AUDIO EQUIPMENT.

The No. 22 Set employs Microphone and Receiver Headgear No. 1. which comprises a pair of moving coil telephones and a moving coil microphone wired in a common head harness and connected to the set by means of a 5-way cord and snatch plug and socket. A detailed description of this apparatus has been given in the No. 19. set notes, but for convenience a diagram showing snatch plug connections is given here.

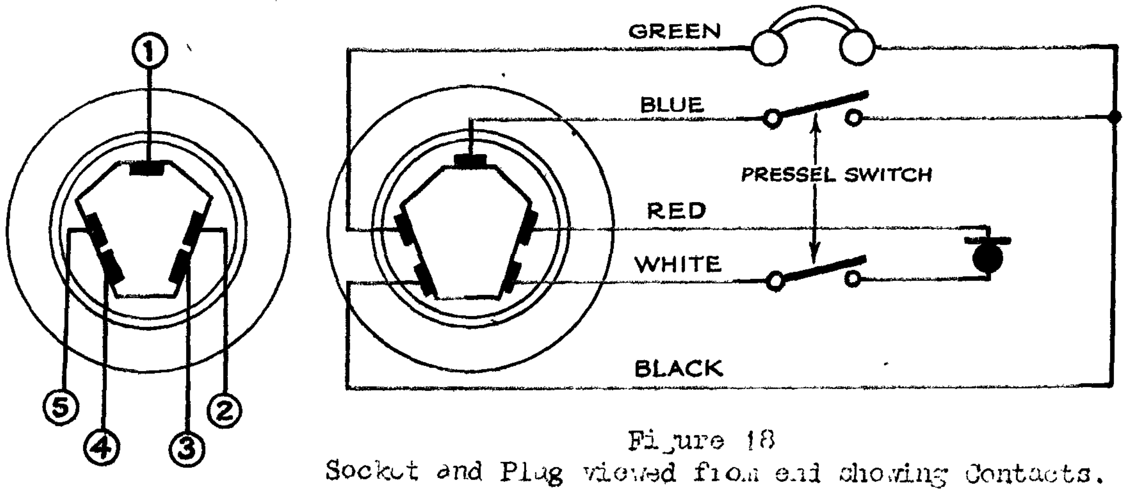


Figure 18
Socket and Plug viewed from end showing Contacts.

6. TECHNICAL DESCRIPTION OF POWER SUPPLY UNIT

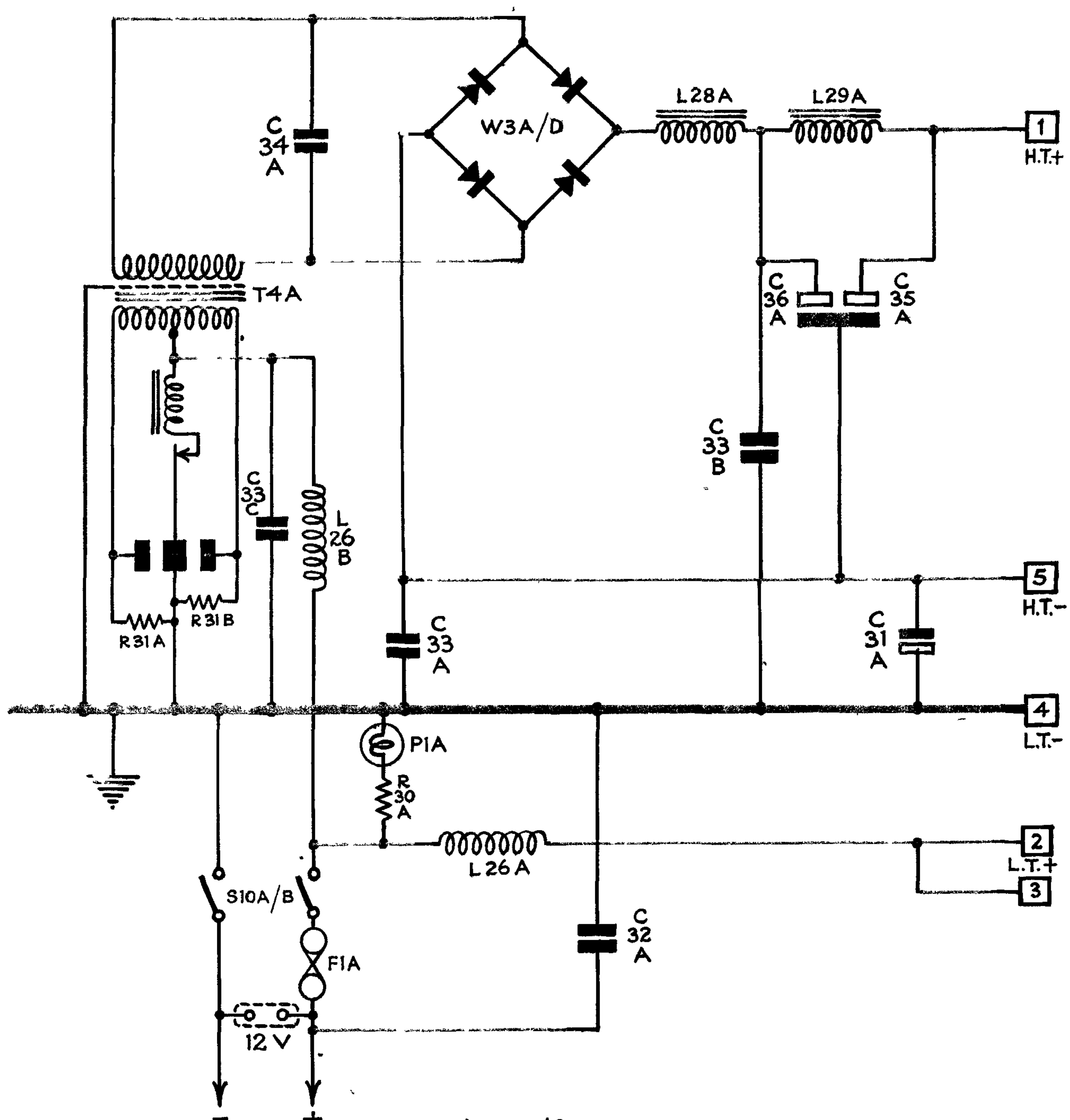


Figure 19.

H.T. & L.T. supplies for the No.22 Set are obtained from a Supply Unit No.1. This is of the vibrator type and operates from a 12 volt battery. The maximum output developed is 325 volts at 80 M.A.

Energising current for a Vibrator No.5 is taken from the 12V supply via the on/off switch and input filter consisting of L26B and C33C (.1 μF). The vibrator output is stepped up by T4A and rectified by the full - wave selenium bridge W3A/D. C34A(.01 μF) across the secondary of T4A is an R/F by pass condenser.

Smoothing is carried out by means of the low-pass filter employing choke input. The first element in this filter is the "swinging choke" L28A, the inductance of which decreases with the current in the load. This limits the charging pulses to C36A to a reasonable value and ensures good regulation, i.e. H.T. output voltage will be nearly constant for currents up to full load. The low-pass filter consists of the choke L29A and the electrolytic C35A and C36A (24+8 μF). C33A and C33B(.1 μF) are R.F. bypass condensers necessitated by the inductive reactances set up by electrolytics C31A & C36A respectively.

L.T. for the valve filaments and heaters is taken direct off the 12V input and the R.F. filter L26A & C32A (.005 μF) is included in the L.T.+ lead. Connection with the set is effected by means of a five point snatch plug & socket similar to that employed for the Microphone & Receiver Headgear No.1.

7. FAULT FINDING.

The purpose of this section is rather to supply useful data for the location and clearing of faults than a reiteration of the principles of fault finding.

A. Preliminary Test.

The following preliminary tests, carried out in the order given, will assist in ascertaining symptoms before removing the set from its case.

(i) Power Supply.

Connect up the set ready for operation with the microphone switch to "normal" and the sender switch in the "on" position. Switch on power supply. The red lamp on the supply unit should light and a slight hum from the vibrator should be detected. If the unit is dead the L.T.input can be checked by inserting the operator's lamp in the inspection lamp socket.

Switch the set meter to L.T. and a reading of 11-12 volts should be obtained. During this operation the test switch inside the set must be at normal. A low reading will indicate a run-down battery. If no voltage is indicated, examine the power drop-cords and connectors.

H.T. input to the set is checked by switching the set meter to H.T. Rec. and noting that the meter reads 90 volts approx.

(ii) Receiver.

With system switch to R/T and meter switch to A.V.C. turn both gain controls fully clockwise and tune in a strong R/T station. The A.V.C. reading should increase when tuning through the station. Try this on both frequency bands. If this happens but the set is "dead" the receiver may be assumed correct as far as, and including the 2nd I.F. stage.

Check the R.F. & A.F. gain controls and see that they work.

Switch to C.W. when a whistle should result, the pitch varying with the Het. Tone setting.

Press the Net Switch and adjust the netting trimmer (system switch to R/T again). A whistle should be heard which can be adjusted for zero beat.

(iii) Sender.

(a) Radiation.

Switch the set to R/T, put meter switch to H.T. send and press the pressel switch. A reading of about 260V should be indicated. If there is no reading see that the high speed relay is operating. If not, change the headset.

Turn meter switch to "Aerial" and adjust "Aerial Tuning" and "Aerial Coupling" for highest possible meter reading.

If aerial current is unobtainable, switch to "Drive" and see that reading is normal. A quick check on the M.O. is to press the Net Button and note that Drive reading falls to half normal value.

(b) Modulation

Switch meter switch to A.V.C. and speak loudly into the microphone. The meter should kick upwards and sidetone should be heard.

(c) Transmission of C.W. & M.C.W.

Switch to "Aerial" and "C.W." and plug in key. On depressing the key aerial current should be indicated, if not check key, lead and plug first.

Put system switch to M.C.W. and again press key. Aerial current and sidetone should be obtained.

B. Valve Base Connections.

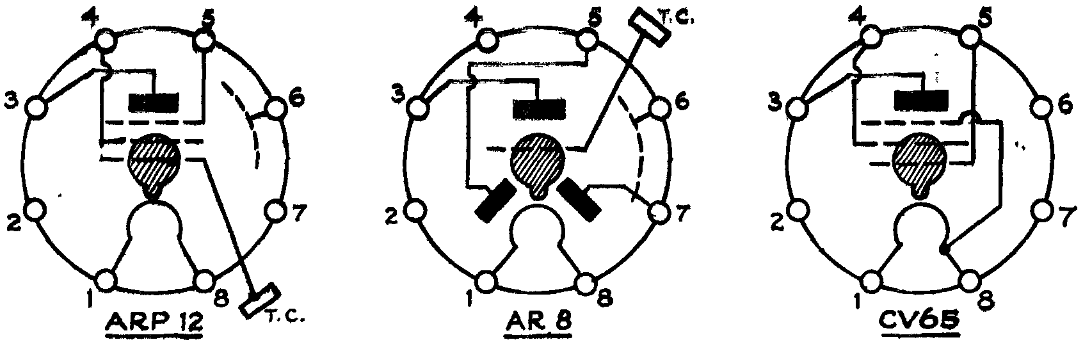


Figure 20. (a) *(Viewed from underside of chassis)*

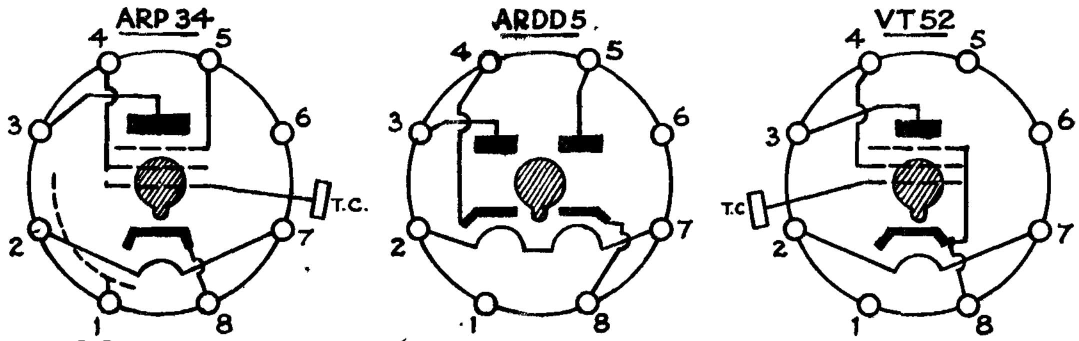


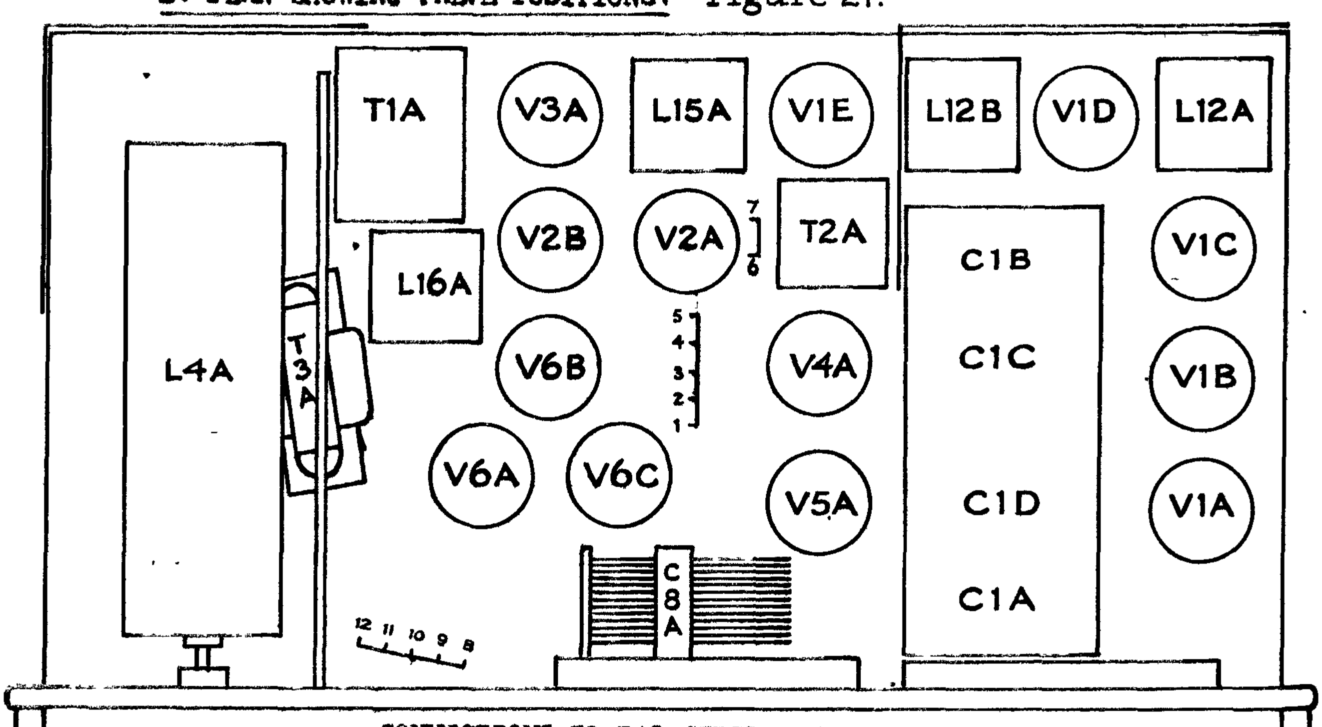
Figure 20 (b). *(Viewed from underside of chassis)*

C. TABLE OF VALVE VOLTAGES TAKEN BETWEEN VALVE SOCKET AND CHASSIS.

VALVE	TYPE & FUNCTION		ANODE VOLTS RECEIVE.	SEND.	SCREEN VOLTS RECEIVE.	SEND.
V1A	ARP12	R.F.A.	130	-	70	-
V1B	"	MIXER	104	-	80	-
V1C	"	1st L.O.	83	-	83	-
V1D	"	1st I.F.A.	125	-	70	-
V1E	"	2nd I.F.A. & MOD.AMP.	118	80	78	48
V2A	AR8	SIG.DET. A.V.C.& MOD.		180	-	-
V2B	"	B.F.O.	45	-	-	-
V3A	CV65	OUTPUT & SIDETONE.	90	80	95	85
V4A	ARP34	M.O.	-	235	-	168
V6A-C	VT52	P.A.	-	290	-	282

NOTE: R/F GAIN FULLY CLOCKWISE, SENDER SWITCHED ON AND SYSTEM SWITCH TO R/T EXCEPT FOR V2B.

D. PLAN SHOWING VALVE POSITIONS. Figure 21.



CONNECTIONS TO TAG STRIPS AS FOLLOWS:-

1. To S5C and C16F
2. To C16F & R4D
3. To R4F & chassis
4. To R4F, grid of V2A & C16A
5. To C16A & L1A & R4D
6. L1A, C19E anode V1E
7. C19E and chassis
8. R25A and Pin 6 of V6C
9. R26A and tag 14
10. Chassis and meter
11. R25A and S8A
12. R26A and S8A

E. UNDER-CHASSIS DRAWING OF No.22 SET SHOWING LOCATION OF TAG-STRIPS AND SPARE PINS ON VALVE BASES.

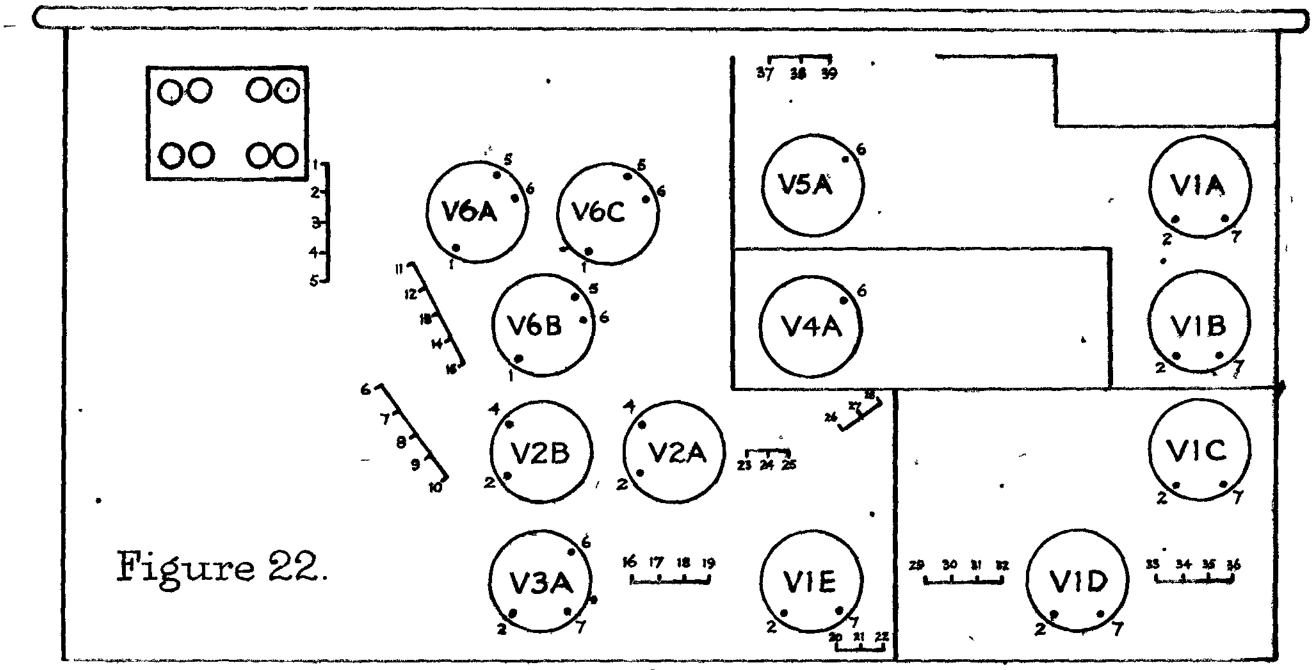


Figure 22.

CONNECTIONS TO TAG STRIPS.

1. Junction of C22A (lead to R4G) and to relay S5D (open on rec).
2. Black lead to T3A, White to relay S5B(closed on rec).Red & black to S1D.
3. Earth.
4. To C10L and M.C.W. contact on S1J.
5. H.T.+ to junction of R12A and R13A.
6. To tap on R16A (100 Ω), mauve lead to R.F. gain control.
7. Junction of R12A, C21A, R26A and screen feed to V3A.
8. Earth and one side C23A.
9. Junction of R4L and contact 4 of S1F.
10. Junction of centre tap of M.C.W. choke and contact 4 of S1J.
11. Junction of R13A, relay S5A, and S1F (C.W. only).
12. Junction of R20A and R14A (to netting button).
13. To R8B and pink lead to diode (MOD) V5A.
14. R12A and S.G. of V3A.
15. Earth and C23E.
16. Signal diode and Sec. of L15A.
17. R8A and pink lead to L1A.
18. Junction of R4E and C18A.
19. C11A and direct lead to anode of V1E.
20. R21A and Main H.T.+.
21. Earth and C18A.
22. Junction C20A and lead to relay S5C (made on rec.)
23. Junction R4E and C19E and screened lead to R9A (L.F. Gain.)
24. Earth, C10G and R5A.
25. R5A, lead to T2A, mauve lead to relay S5F.
26. Junction of C20A and lead to moving contact of R9A.
27. Earth.
28. C10K, and green lead to tag 6 on V6B (L1C and C12C).
29. Blank.
30. H.T. side of Primary of L12B and R4B.
31. L12B sec. and C13B.
32. R4B and anode of V1D.
33. Junction of R1C and C17C and lead to control grid of V1C.
34. Junction of R4A, R3A and C10D.
35. Sec. L12A to A.V.C.
36. R4A and lead to anode of V1B.
37. R4G and lead to tag 1.
38. Earth (anchor for R4H and C19D).
39. Junction of lead to diode (Drive limiter), lead to R.F. gain and H.T. −

CONNECTIONS TO SPARE PINS ON VALVE HOLDERS

V1A 2. None
7. Relay side of R1A

V1B 2. Junction of L2A & C10N, white lead to pin 6 V5A
7. Distribution point for H.T. (connected direct to relay S5A).

V1C 2. Junction of C10A and R3A
7. None

V1D 2. To pin 4 on V2B
7. C17C (L O. grid condenser) green lead to switch S2C

V1E 2. Junction of R6A, R7A and C23D
7. Junction of R21A and R4C and red lead to pin 7 of V3A

V2A 2. Black and white lead to T2A, and lead to Relay S5D.
4. Junction of yellow lead to Sec. L12A, C10G, brown lead to contact 4 S1H, and brown lead to Relay S5D

V3A 2. None
6. Junction of R11A and R7B.
7. Red lead to Pin 7 on V1E, lead to C21B, R8A.

V2B 2. R17A, lead to control grid of V2B, lead to C12B.
4. C12B, green lead to Pin 2 of V1D.

V4A 6. To netting button and R20A
V5A 6. White lead to pin 2 V1B, lead to R2A.

V6A 1. Junction of R14A and R3C, and red lead to S3D
5. R1E and green lead to S1E.
6. Junction of L1B, R20A and R14A, and to Relay S9C, lead to Pin 6 V6C.

V6B 1. Junction of R1E, control grids of P.A's, and Drive Condenser C7A & R4J.
5. Junction of C23E and R4K.
6. Junction of L1C and C12C, green lead to C10K.

V6C 1. Junction of L1C and C23F and R4J
5. Junction of R18A and R3C and leads to S1A and S1C
6. Junction of lead to R25A and R22A. Pink lead to S1A, lead to Pin 6 V6A.

F. W/S Nº22. Drop Cord Connections.

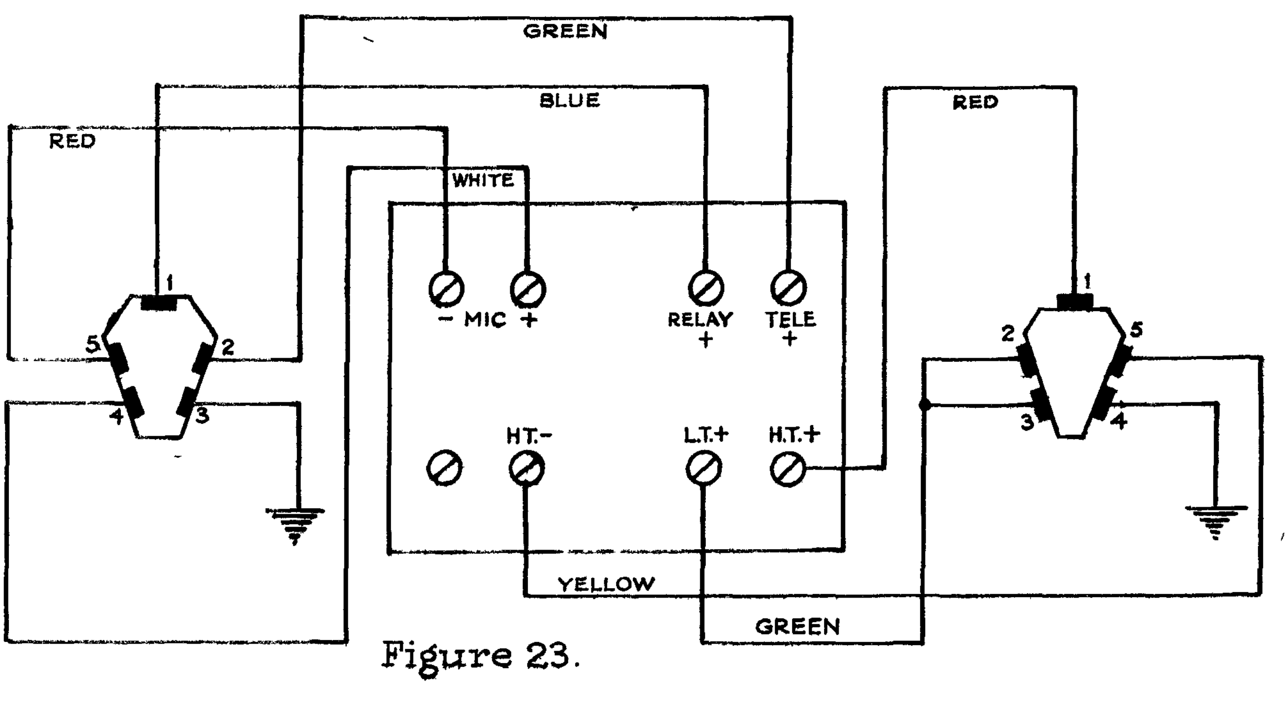
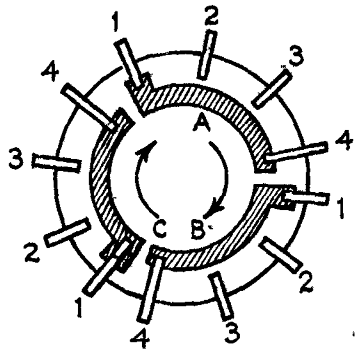


Figure 23.

G. SYSTEM SWITCH DIAGRAM.

FRONT PANEL

S1A - B - C



ROTOR MAKES CONTACT WITH 1 ON R/T.
" " " " 2 " C.W.
" " " " 3 " M.C.W.

S1D - E - F

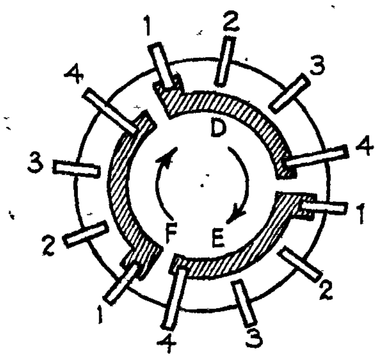
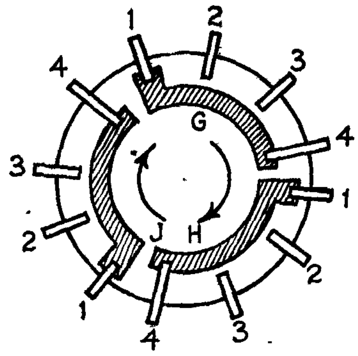


Figure 24.

S1G - H - J



CONNECTIONS

S1A 1. To junction of R14A & R20A (HT feed).
2. To junction of R18A & R3C (HT feed), and 1 & 3 of S1C.
3. As 1.
4. To S9A.

S1B 1. To R4K & C23E (HT feed to V2A)
2. To 4 of S1C, L19A & L21A.
3. As 1.
4. To S9A.

S1C 1. To 2 of S1A & junction of R18A & R3C.
2. -
3. As 1.
4. To 2 of S1B.

S1D 1. To secondary of T3A & S5B.
2. To S5B.
3. As 1.
4. Tele +

S1E 1. To H.T. & R16A.
2. To tapping on R16A 580Ω from chassis.
3. As 1.
4. To R1E.

S1F. 1. -
2. To R13A.
3. -
4. To R4L.

S1G 1. -
2. -
3. To C16C and C30A.
4. Grid of V2A and R4F.

S1H 1. To R10B & C23G.
2. -
3. As 1.
4. To A.V.C.line & R10C & C10G.

S1J 1.)
2.) To R4K, L3A and anode of V2A
3. To C10L.
4. To Centre tap of L3A.

H. WAVE CHANGE SWITCH DIAGRAM.

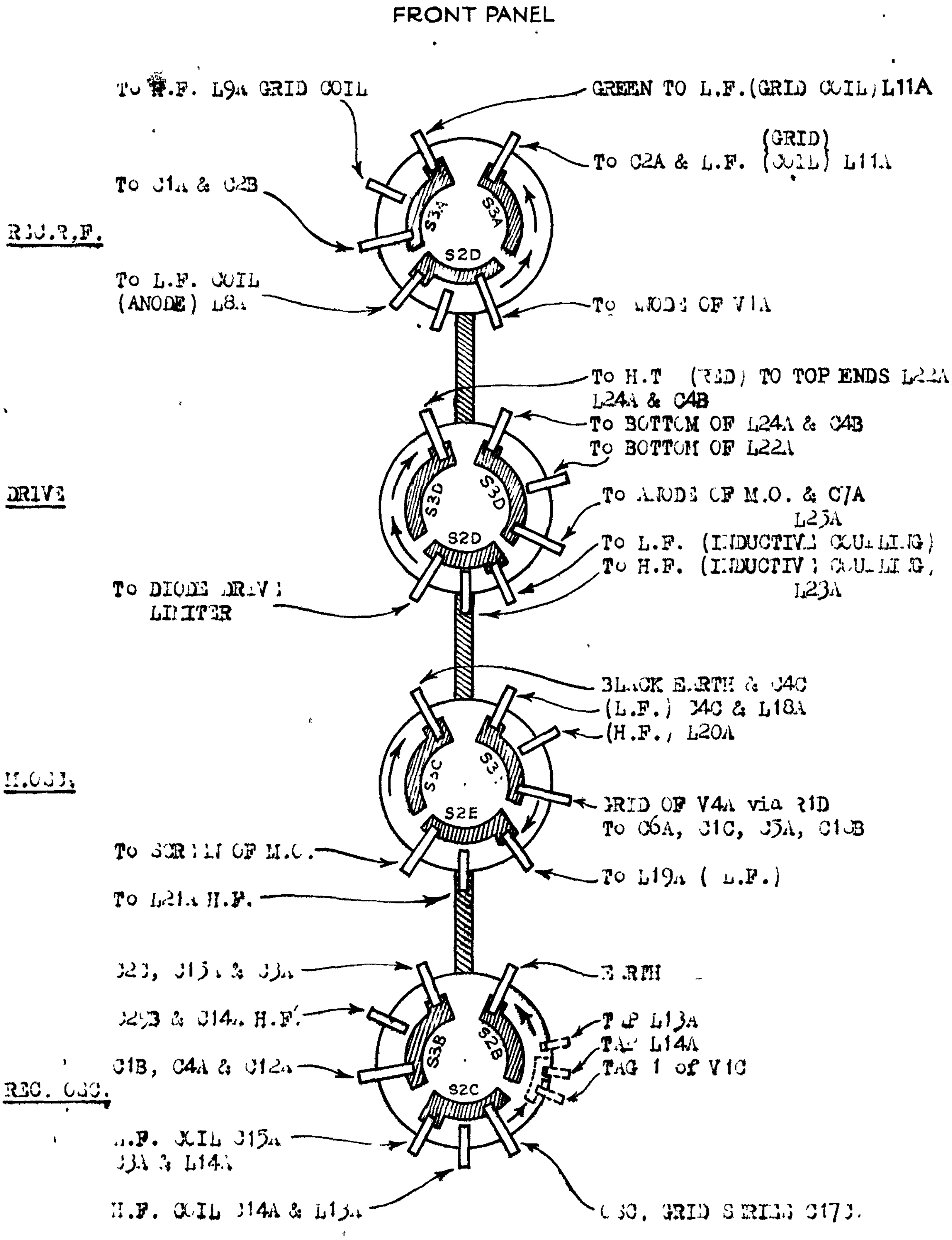


Figure 23.

J Relay Diagram

Contacts shown in normal (receive) position.

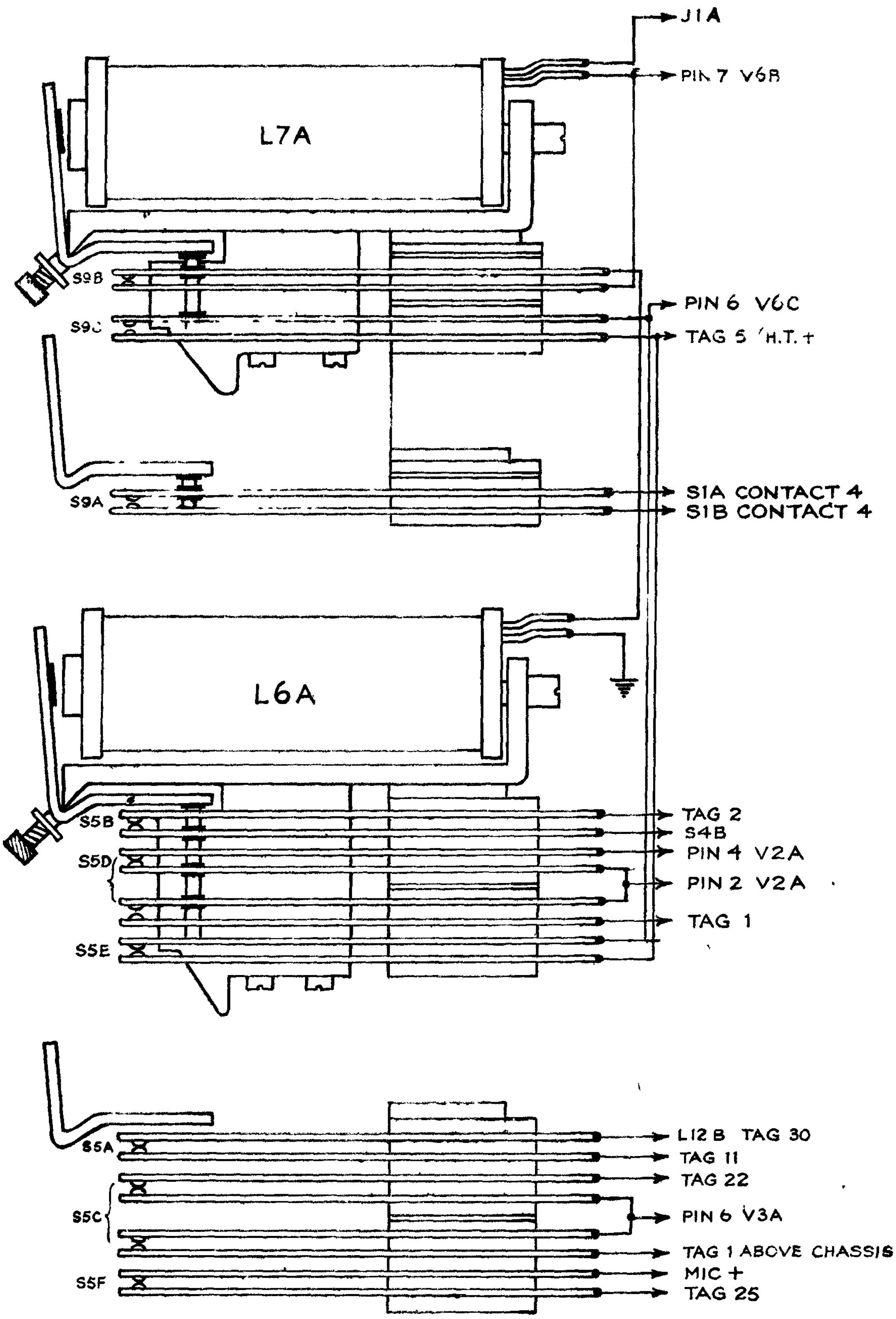
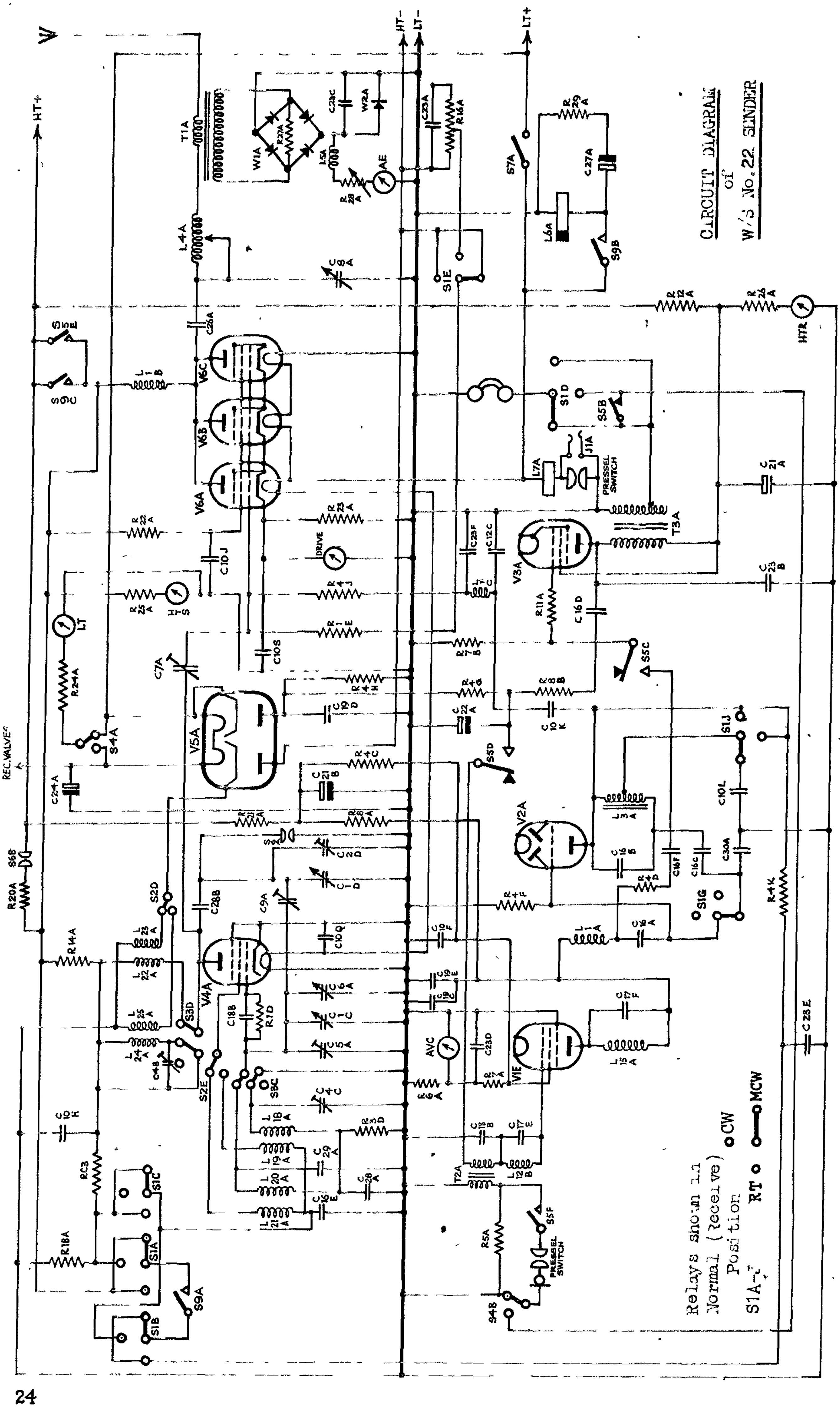
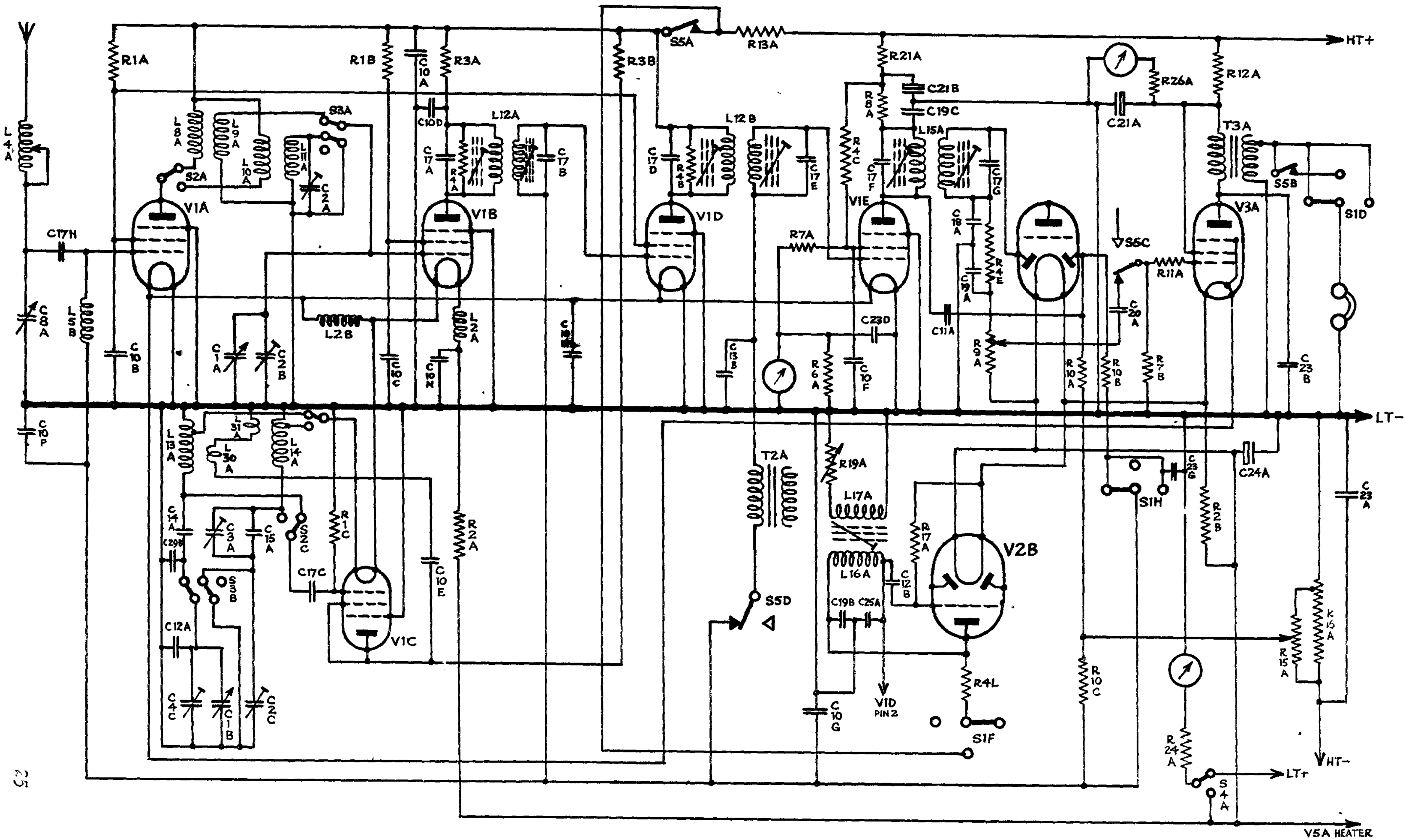


Figure 26


CIRCUIT DIAGRAM of W/S No.22 SENDER
Relays shown in Normal (Receive) Position S1A-J
CW
RT
MCW

CIRCUIT DIAGRAM OF [illegible] RECEIVER

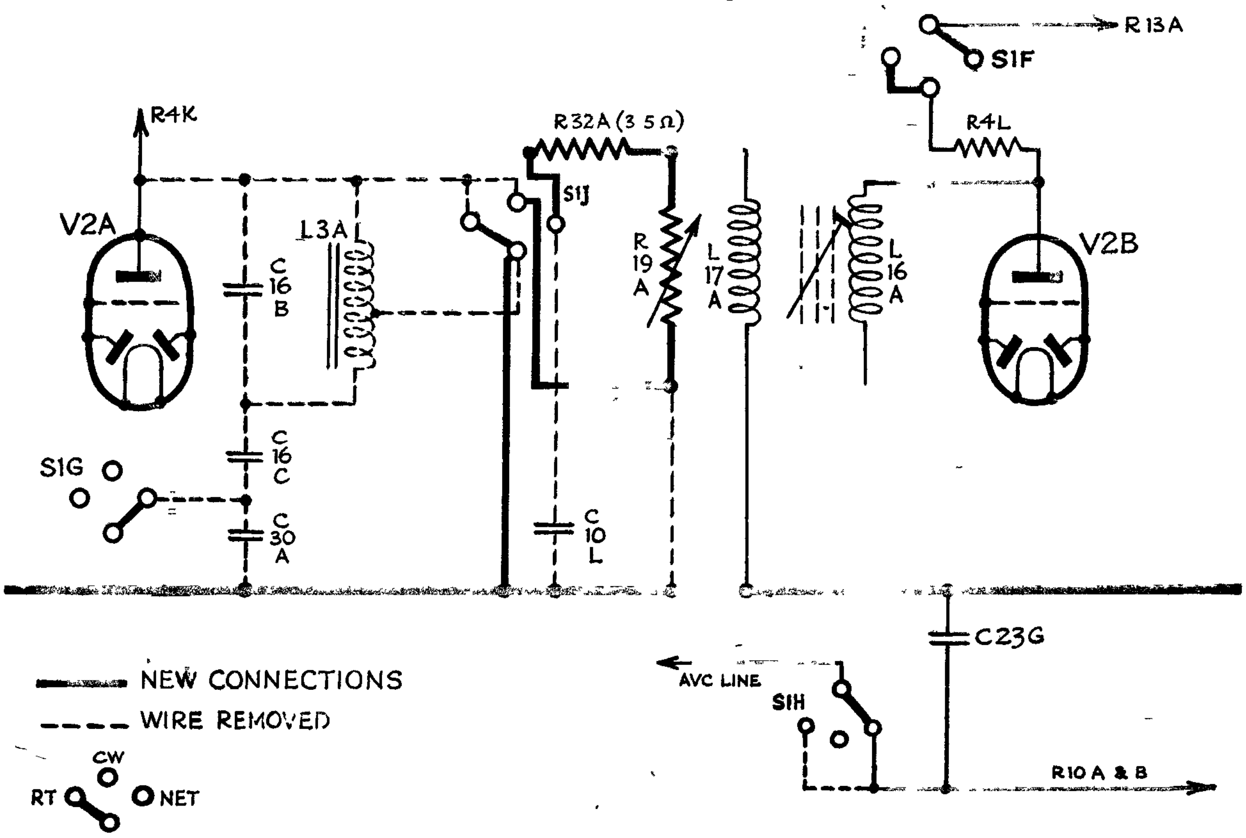


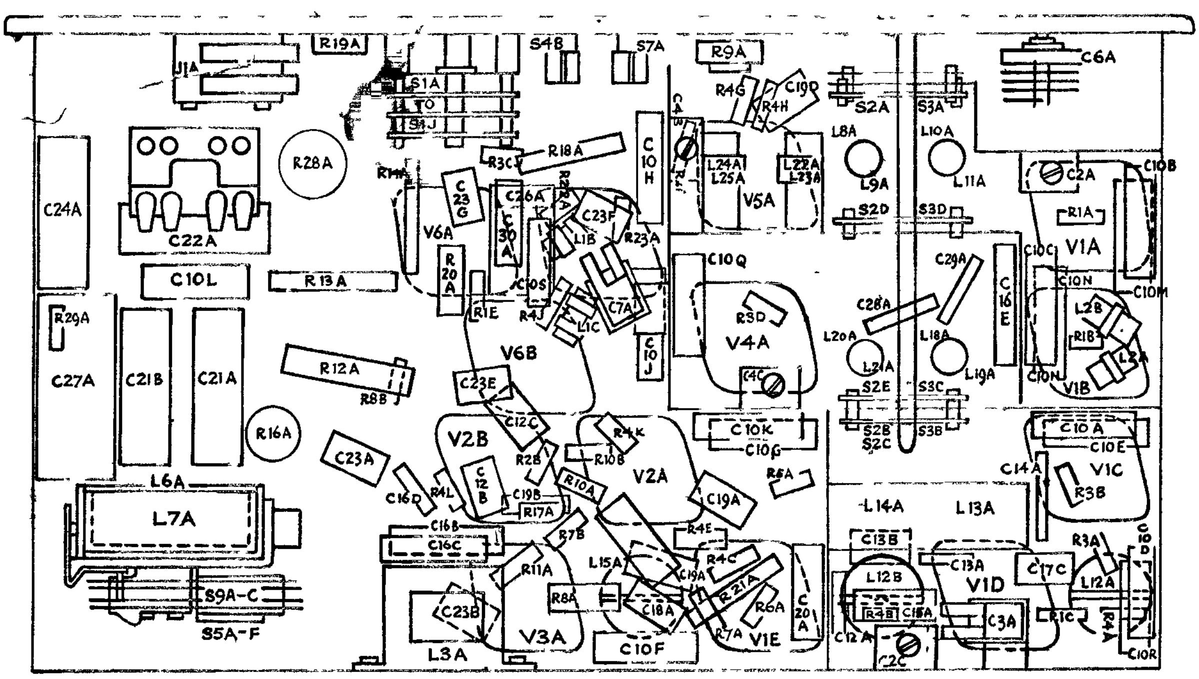
APPENDIX

The following circuit modifications have been or will be carried out on all W/S No.22 :-

The M.C.W. facility is eliminated and when the system switch is in this position the B.F.O. operates exactly at the intermediate frequency. Accurate receiver tuning is then easily effected by adjusting the tuning control for zero beat in the phones. Sender netting is carried out in the usual manner.

The circuit & component changes entailed can be seen from the following diagram which should be compared with Figures 7, 9 & 15.





UNDER-CHASSIS LAY-OUT

1. General Description.

The No.38 Set is a light-weight portable sender and receiver designed for short range R/T working. The frequency band covered is approximately 7.3 Mc/s to 8.8 Mc/s obtained in a single range on a calibrated tuning control common to both sender and receiver. Sender and receiver are automatically adjusted to the same frequency thereby simplifying netting.

The set is carried on the left breast next to the respirator and the supporting sling is secured to the webbing equipment by means of a brace hook and ring. A body belt, also fastened by means of a hook and ring secures the set at the lower end.

Mk II and Mk II* sets can be used in infantry tanks for short range communication between the tanks and supporting infantry. In this case they are used in conjunction with the W/S No.19 Inter-com-amplifier, a special control unit being fitted for the purpose.

The aerial used consists of a single vertical rod comprising one or three Antennae rods "F" sections. The maximum range obtainable using one 4' rod is approximately 2 miles over flat open country, while up to 5 miles range may be expected with the full 12' aerial.

The power supply is derived from dry batteries. All valve filaments are heated by means of a 3 volt dry battery and a 150 V layer type provides the H.T. Both batteries are housed in a single pack (Battery Dry HT/LT 150/3 volts).

L.T. Consumption in Receive .23 A on Send .45 A.
H.T. " " " 9 mA " " .14 mA.

Five valves are employed two of which are common to both sender and receiver circuits. The set which is built up on a single chassis is housed together with the HT/LT battery, in the case of Mk I Sets, in a light metal case. The battery for Mk II and Mk II* sets is carried in a haversack on the operator's back. In the latter case a battery of somewhat larger capacity may be used.

Two aerial sockets, the tuning control, and a combined send/receive on/off switch are located on the top panel. The 'phones and throat microphone are connected to the set via a junction box which, in the case of a Mk I set, is attached to it by means of a 4 way flexible cable. For Mk II & Mk II* sets a modified junction box is supplied which is carried in the haversack with the battery. Connection between the junction box and battery is made by means of a four point plug, while a 6-core cable terminating in a plug connects the battery and audio equipment to the set.

2. Circuit Description.

On receive the set employs four R.F. pentodes (ARP12) in a superheterodyne circuit comprising R.F. amplifier, mixer and separate local oscillator, and a reflexed I.F. and A.F. amplifier. Signal detection and A.V.C. are carried out by means of a Westector Type W X 6.

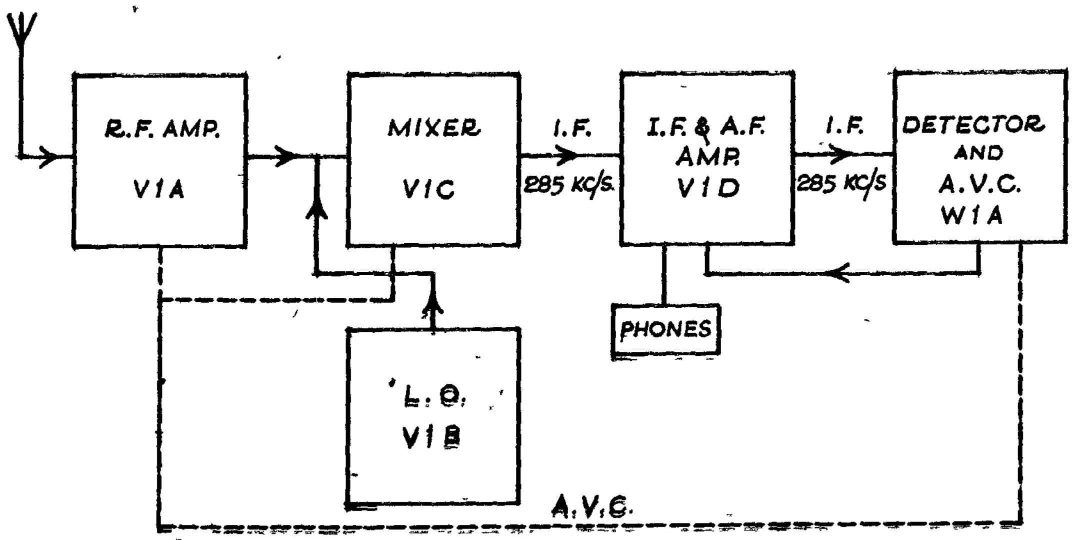


Figure 1.
Block Diagram of No.38 Set on "Receive".

When functioning as a sender the signal frequency is produced by the local oscillator stage which is followed by a single power amplifier. The latter is grid modulated by the output from the A.F. amplifier now functioning as a modulator stage.

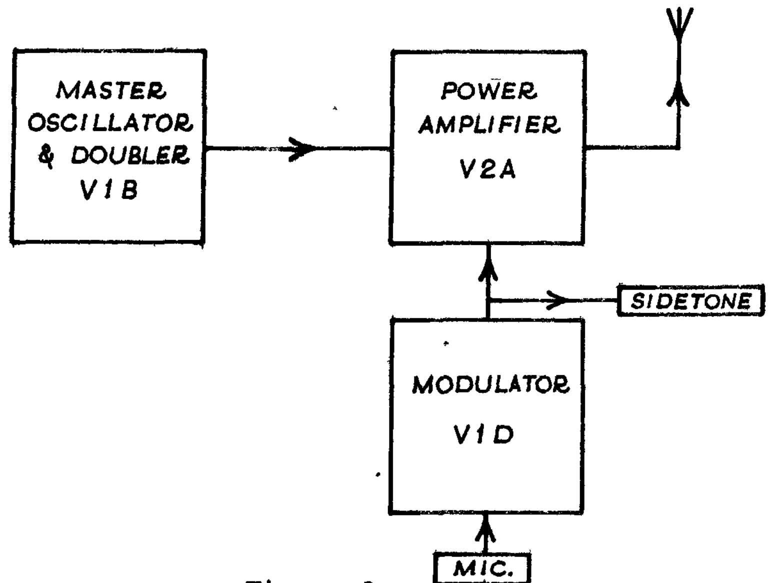


Figure 2.
Block Diagram of No.38 Set on "Send".

(a) The Sender.

(i) M.O. and Doubler Stage.

V1B an ARP 12 operates as an electron coupled oscillator in a frequency doubling circuit. The screen control grid and filament functioning as an inverted Hartley oscillator in conjunction with the inductance coil L5 tuned by C4B produce oscillations at half the carrier frequency. The tuned anode circuit consisting of L3 tuned to the second harmonic of the grid circuit frequency by C4A provides drive for the P/A stage at carrier frequency via the coupling condenser C5E. C4A and B are two sections of a three-gang variable condenser (TUNING Mc/s control). L3 and L5 have dust-iron cores which are adjustable for trimming purposes, and their associated tuned circuits include the parallel trimmers C1C and C1D respectively.

H.T. to anode is fed direct from H.T. + 150 via S1F a section of the ON/OFF, SEND/RECEIVE switch and L3. C13A (4μF) shunted by C6E (.01μF) decouples the H.T. Screen voltage is reduced to approx.40 V by means of the feed resistor R4B (.1 MΩ) decoupled by C6C (.01μF). R1A is shorted out on send. Self-bias is provided by C5C (100μμF) and R5A (50,000Ω).

(ii) Power Amplifier.

The P/A valve V2A is a double pentode with electrodes strapped internally, type A.T.P.4. The output circuit consists of an anode coil L1 tuned to carrier frequency by C3A, the 3rd section of the 3-gang assembly, and the parallel trimmer C1B.

H.T. is applied to the anode via S1F, S1B, R2A (600Ω) decoupled by C15A (.01 F) and L1. The anode of V2A is tapped up the coil L1 for impedance matching. The screen is supplied with H.T. direct from R2A. The control grid is biased back to the bottom-bend by means of the resistor R10A in the H.T.- lead which provides a standing bias of 16 volts negative.

Neutralization is carried out by means of the few extra turns on L1 which are coupled to the grid of V2A via C2A and C5E.

(iii) Modulator Stage.

The audio frequency output from the throat microphone is amplified by the valve V1D type ARP12 operating as an A.F. amplifier (modulator) before application to the P/A grid for modulation. The microphone output is applied to the grid of V1D via the microphone transformer T1. The primary of T2 forms the A.F. load in this stage and output is taken to the grid of the P/A valve via C6F (.01μF), S1E and the modulation choke L10.

The tuned circuits L7B and C7B in the grid and L7C, L8 and C7C in the anode have negligible effect on the operation of V1D on send as they tune to 285 Kc/s and therefore offer a low impedance to audio frequencies. Sidetone is derived from the A.F. voltages induced in the secondary of T2.

(b) The Receiver.

(i) R.F. Stages.

The received signal is amplified before frequency changing by V1A, an ARP12, operating in a tuned anode R.F. amplifier. The aerial is coupled to the tuned grid circuit via C5A. This circuit, which forms the P/A tuning circuit on send, comprises L1, C3A, C1B and C15A.

H.T. to V1A anode is fed via S1F and the anode coil L3. The latter, we have already seen, is tuned to signal frequency by C4A. Screen voltage at approximately 45 V is applied via R4A decoupled by C6A.

The control grid is isolated from the H.T. on the grid coil L1 by the grid condenser C3B. Grid return to filament is through the leak R3A and the A.V.C. network.

V1B on receive functions as the local oscillator the output of which must be signal frequency + I.F. i.e., S + 285 Kc/s. This increase in frequency when switching from send to receive is accomplished by shunting the oscillator tuned circuit with a tracking coil L6 and the compensating condensers C16A, C2B and C9A. In the case of Mk I & II sets the grid circuit of V1B oscillates at half the output frequency i.e. $\frac{1}{2}$ (S + I.F.) but in Mk II* sets the values of the components in the compensating network are such that oscillations are produced at output frequency (See Fig.IV).

The oscillator output is developed across the tuned circuit L3, C4A etc. which we have seen is common to the R.F. amplifier output & is tuned to signal frequency. This common load will therefore supply two separate inputs to the mixer valve V1C, i.e., signal frequency from V1A and signal + I.F. from V1B. This is only possible with a low value of I.F.

Screen voltage on V1B is reduced to approx. 20V on receive by removing the short on R1A.

Oscillator and R.F. amplifier outputs are applied to the mixer valve V1C which functions as a detector. The resultant difference frequency is selected by the tuned primary of the I.F. transformer L7A.

(ii) Reflex Amplifier, Signal Detector and A.V.C.

The valve V1D, an ARP12, operating in a reflex circuit on receive, amplifies both I.F. output from the 1st detector or mixer and A.F. output from the signal detector.

I.F. output from the mixer stage is applied to the grid circuit of V1D via the 1st I.F. transformer secondary L7B. The anode load in this case is the tuned circuit comprising the primary of the 2nd I.F. transformer L7C, L8 and C7C.

The secondary of the I.F. transformer is associated with a series diode detector circuit in which a metal rectifier W1, type W X 6, is used. R6B (47000Ω) and C5F (100μμF) are the diode load and condenser respectively.

The A.F. voltage developed across R6B is re-applied to the grid of V1D by way of the voltage divider consisting of R7C, R5B and R7B. R4C, C8A and C8B from an I.F. filter. The A.F. signal is handled by this stage in similar fashion to the microphone output as already detailed, the amplified signal appearing in the secondary of T2 and operating the phones. C8D is the anode I.F. decoupling condenser.

The D.C. component of the signal detector output is applied as A.V.C. voltage to V1A and V1C via the filter circuit comprising R7D and C6B. As there is no D.C. blocking condenser in the A.F. input circuit of V1D, the D.C. component will be applied as partial A.V.C. voltage to this valve.

H.T. to the anode of V1D is applied from the H.T.+ line through S1F, the primary of T2, L8 and L7C. Screen volts are dropped to approximately 30 volts by the feed resistor R1B (.18 MΩ) decoupled by C10A (1μF).

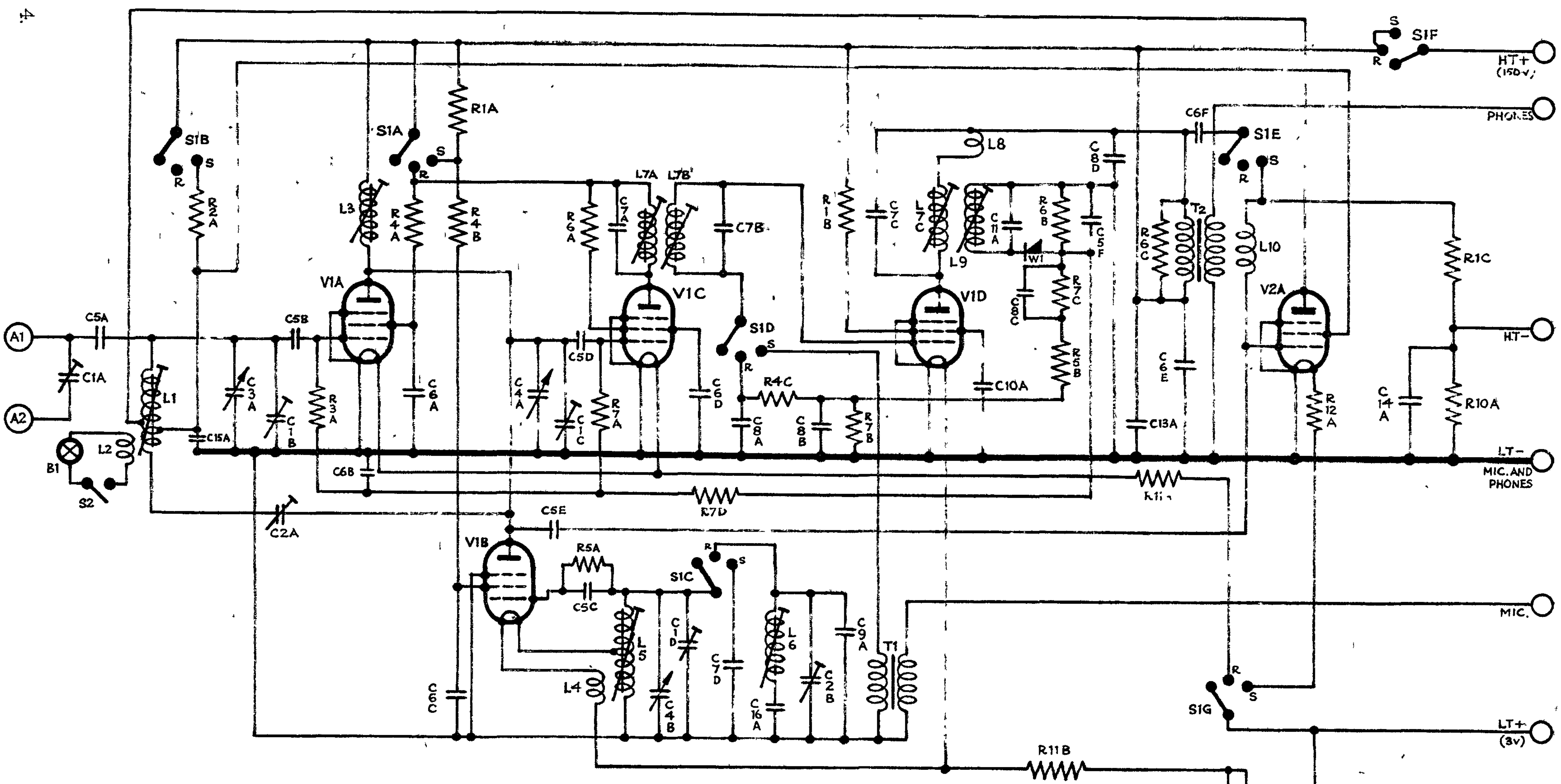


Figure III

CIRCUIT DIAGRAM OF WIRELESS SET No. 38 Mk. II and Mk. II*

CIRCUIT OF OSCILLATOR IN W/S NO 38 MK II*

Figure 4.

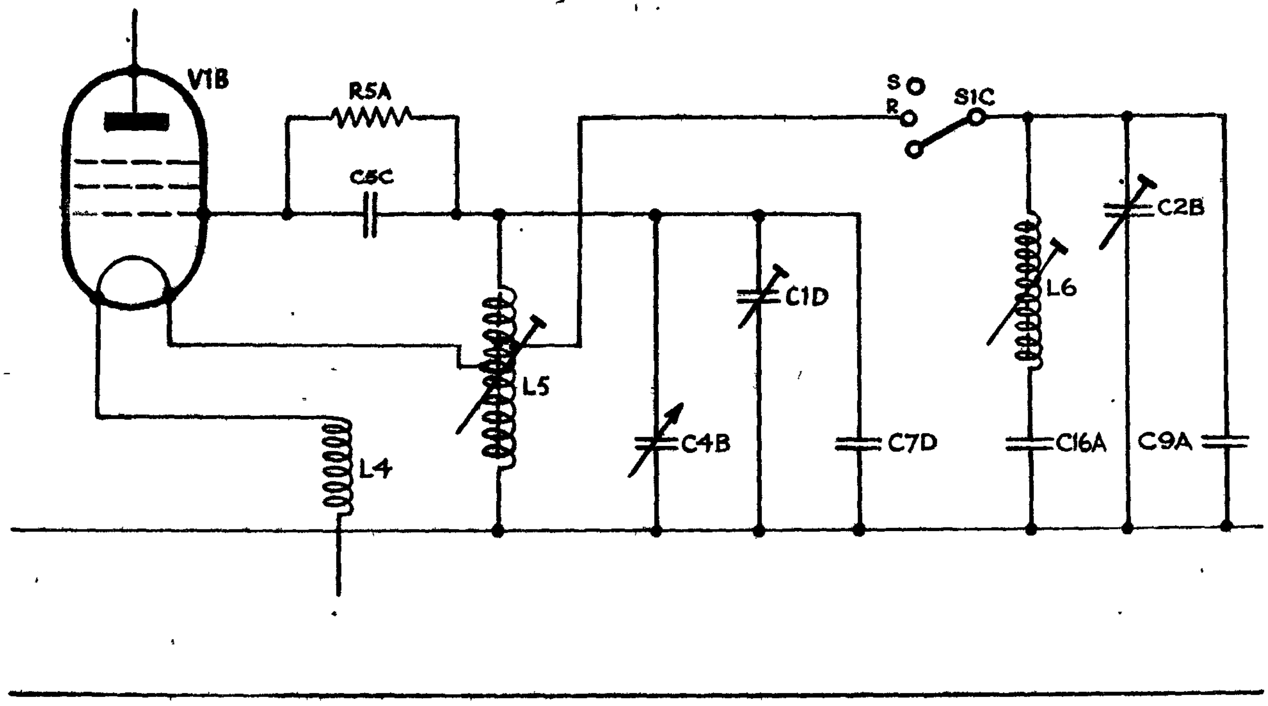
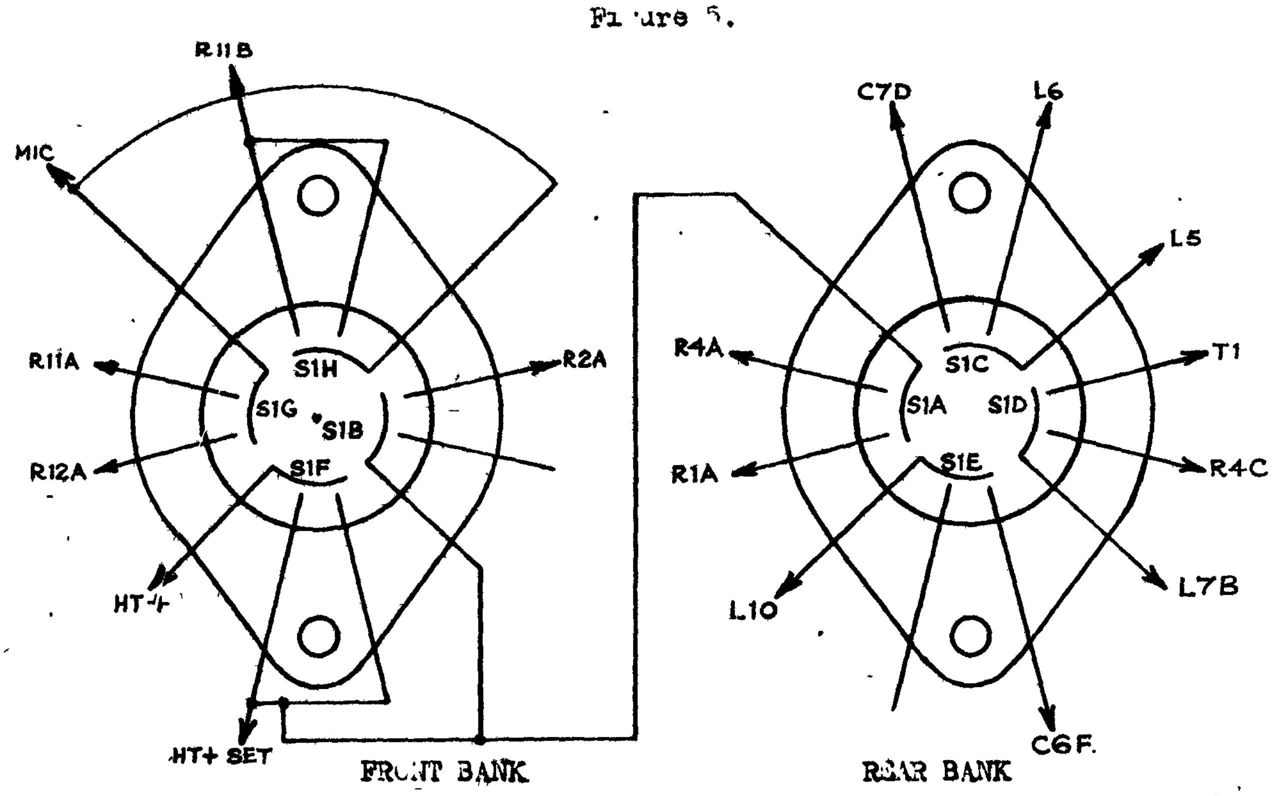


Figure 5.



OFF-RECEIVE-SEND SWITCH S1A-H
REAR VIEW.

GENERAL DESCRIPTION.

The No.46 Set is a portable sender-receiver which is normally transported as a man-pack.

Facilities for R/T and M.C.W. communication on three fixed, and crystal - controlled, frequency channels are provided. Change-over from one channel to the other is accomplished by means of a channel switch; in this way tuning & netting are eliminated.

The following frequency bands are covered :-

3.6 - 4.3 Mc/s
5.0 - 6.0 "
6.4 - 7.6 "
7.9 - 9.1 "

Communication on any three frequencies in one of these bands is obtained by plugging in the appropriate band coil and sender and receiver crystals. Adjustment to three preset trimmers is also necessary when changing the frequency channels. This latter operation is normally carried out by I.M.'s or specially qualified persons only. Change-over from Receive to Send is carried out by means of a Press To Send switch which is also used for slow morse transmission (M.C.W.).

Power Supply.

H.T. and L.T. supplies are derived from a combined 150v H.T., 12v G.B. and 3v L.T. primary battery which is the familiar battle battery used in the No.18 Set.

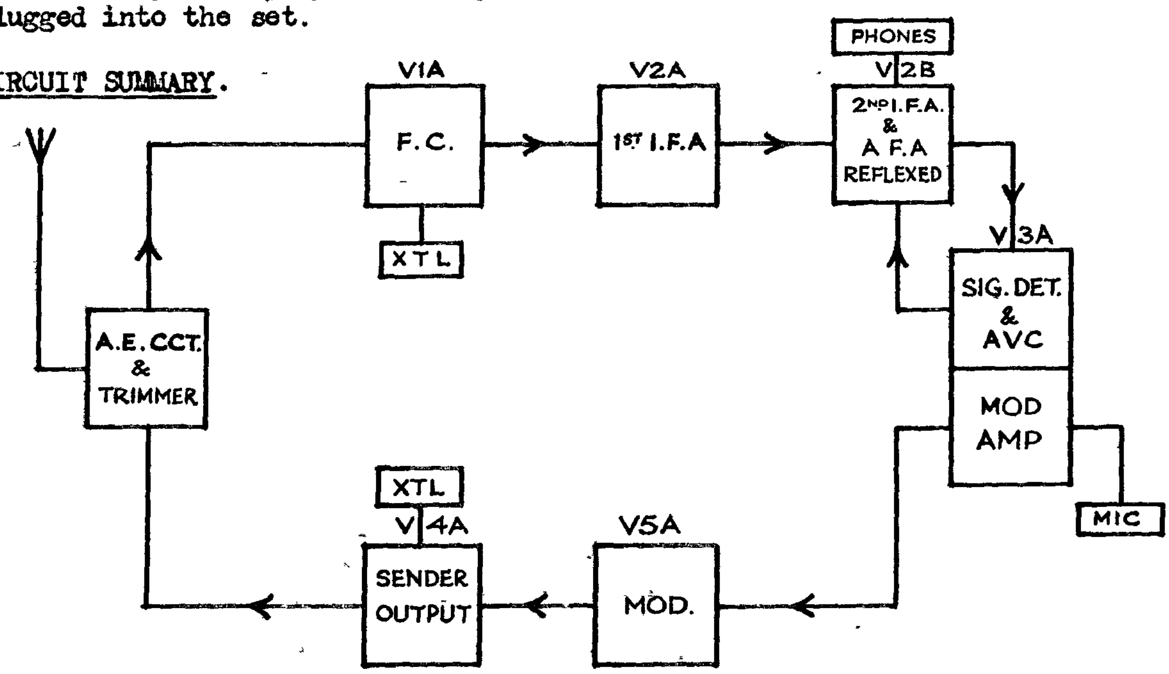
Current consumption is as follows :-

		L.T.	H.T.
Receiver	R/T	.35 A	10 mA
	M.C.W.	.85 A	10 mA
Send	R/T	.55 A	28 mA
	M.C.W.	.55 A	37 mA

Aerials.

The set is normally used with 8 sections of copper-plated steel tube (Antennae Rods "B") which are plugged direct into an aerial socket on the set. When the set is used as a fixed ground station a 16' aerial made up of Antennae Rods "F" may be employed in conjunction with an Aerial Adapter Unit which is plugged into the set.

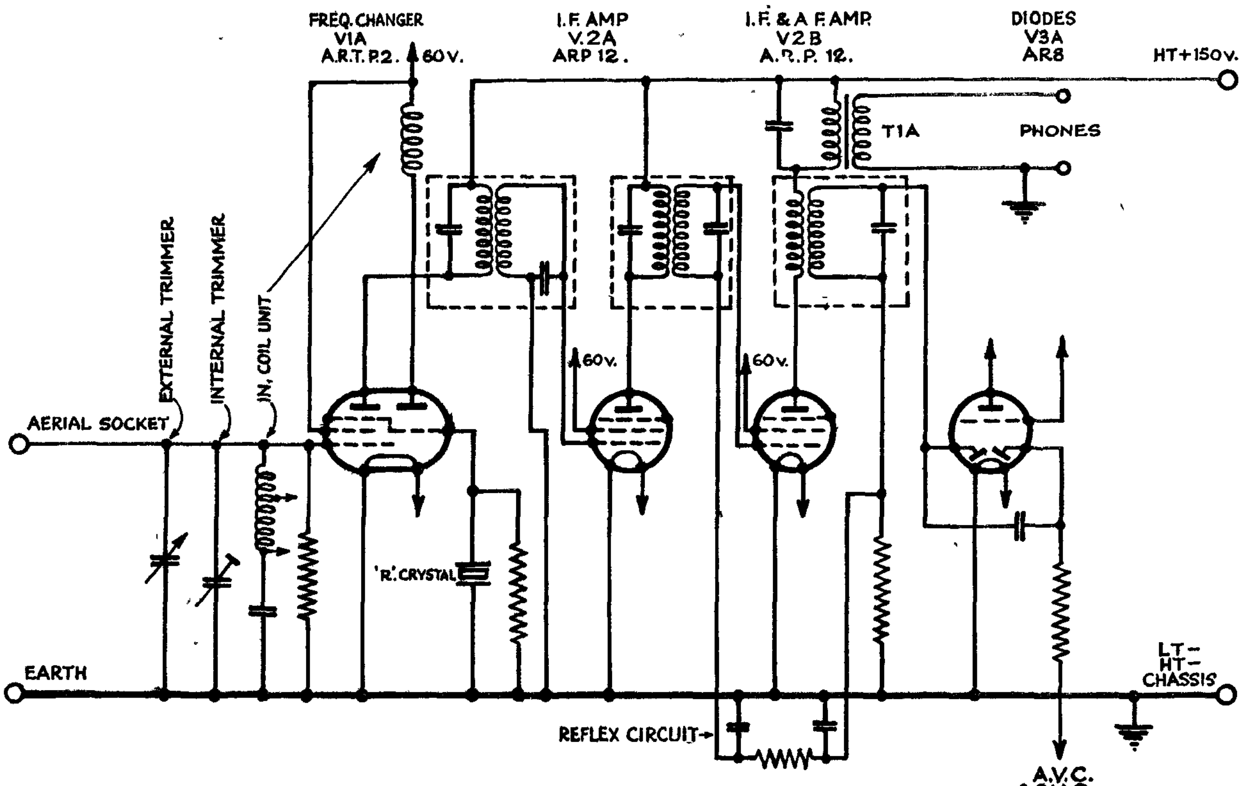
CIRCUIT SUMMARY.



Complete Block Diagram of W/S No.46.

The Receiver Circuit.

The receiver employs 4 of the 6 valves in a superhet circuit comprising frequency changer stage followed by two stages of I.F. amplification, a signal detector and A.V.C. stage and an A.F. amplifier. The second stage of I.F. amplification and the A.F.amplification are accomplished by one pentode valve operating in a reflex circuit.



Simplified Receiver Cct.

The frequency changer valve V1A is a triode pentode, directly heated, type ARTP2. The triode portion operates as the local oscillator the frequency of which is fixed at $S \mp$ I.F. by the receiver crystal. The anode plug-in coil will permit oscillation at any crystal frequency within a given waveband without retuning. The oscillator frequency is 1550 kc/s below the signal frequency on the 7.9 - 9.1, 6.4 - 7.6 and 5.0 - 6.0 Mc/s bands, and is 1550 kc/s above signal frequency on the 3.6 - 4.3 Mc/s band.

Input to the pentode portion of V1A is taken from an aerial tuning circuit which is common to sender and receiver. This tuned circuit consists of an inductance, interchangable for different wavebands, an external aerial trimming condenser and three individual internal trimmers switched in by the channel switch.

The I.F. output (1550 kc/s) from V1A is amplified by 2 ARP12's V2A and V2B operating in a two stage transformer coupled I.F. amplifier.

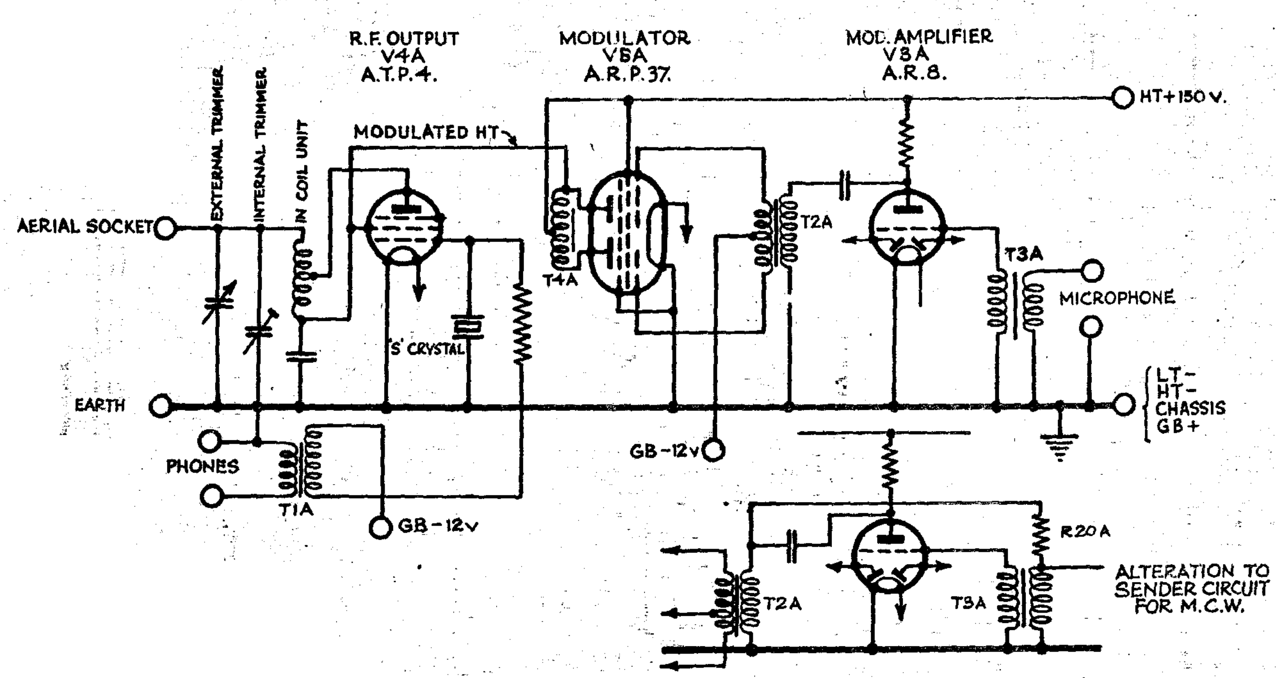
Signal detection is carried out by one diode of a double-diode triode valve V3A, type A.R.8, which functions as a straightforward series diode detector. The A.F.output is applied, via a filter, to V2B which affords A.F. amplification and operates the phones through the phones transformer in the anode circuit.

The second diode of V3A supplies AVC bias to V1A, V2A, and V2B. The triode section of V3A is not used on receive.

The Sender Circuit.

The carrier frequency is produced by V4A an ATP4 which operates as a pentode crystal oscillator. The anode circuit of the oscillator is the aerial tuning circuit already described and is tuned to a frequency slightly higher than that of the crystal.

Modulation takes place on the anode and screen of V4A. On R/T the output from the throat microphone is amplified by the triode section of V3A which is transformer coupled to the modulator V5A. V5A, an ARP37, operates in a QPP amplifier, and is biased so that with no A.F. input the anode current is approx. 5 mA. The A.F.output is applied to the oscillator V4A via the centre tapped modulation transformer T4A.

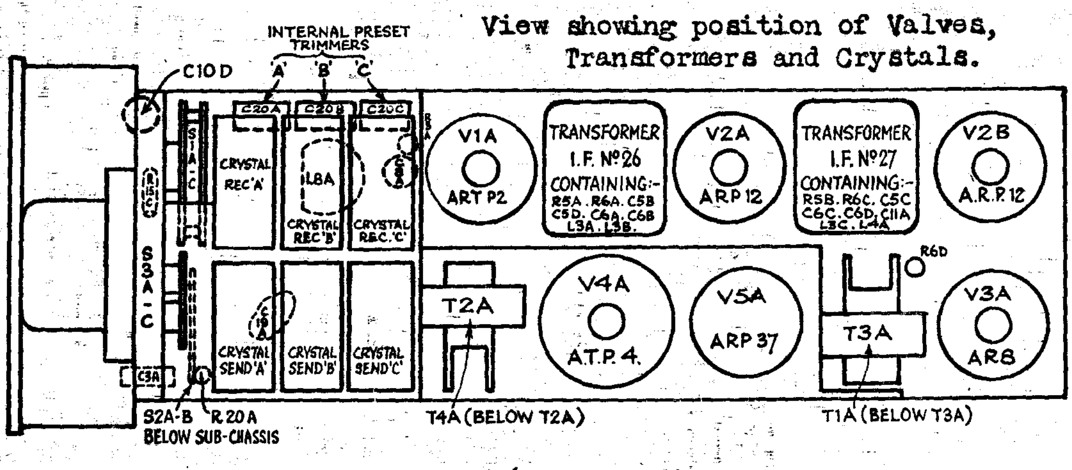


Simplified Send Cct. Diagram.

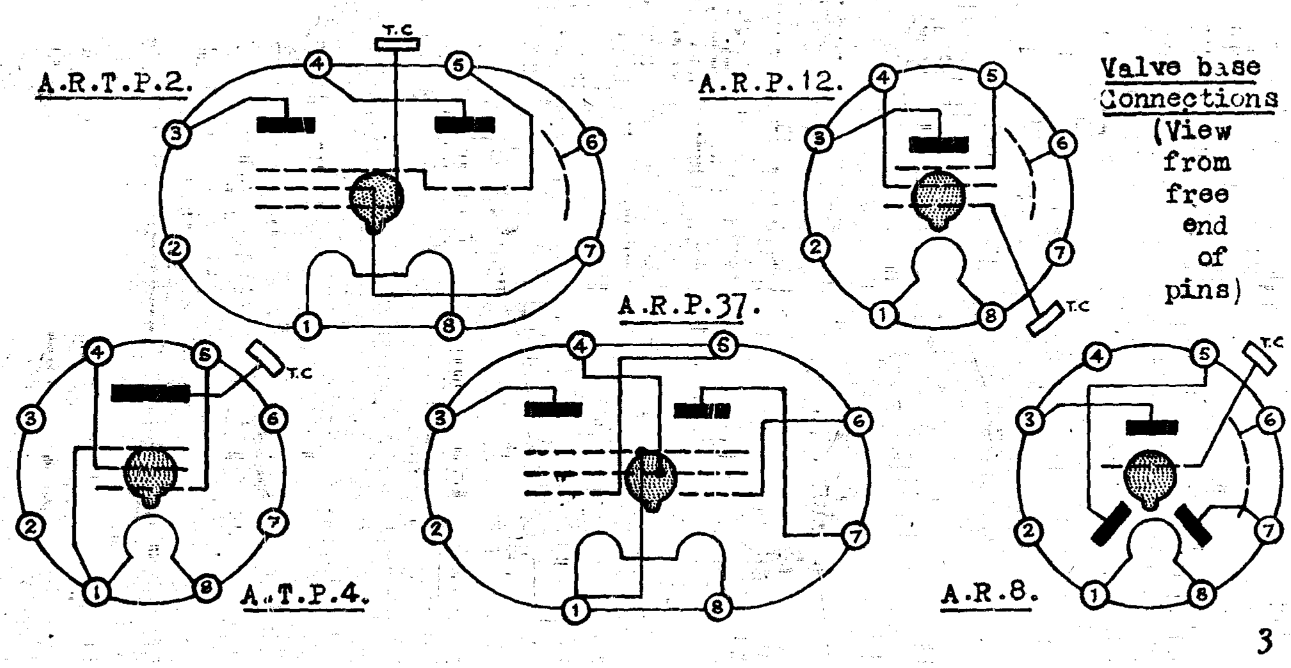
For M.C.W. working the triode section of V3A operates as an A.F. oscillator at 1000 - 1500 c/s. The A.F. voltage developed across the anode load resistance is parallel fed to the modulator as in the case of R/T.

Sidetone is obtained by connecting a winding on the phones transformer T1A in series with the grid leak of V4A. The grid current of the sender output valve V4A will vary with the modulation voltage and the modulation will be audible in the phones.

View showing position of Valves, Transformers and Crystals.

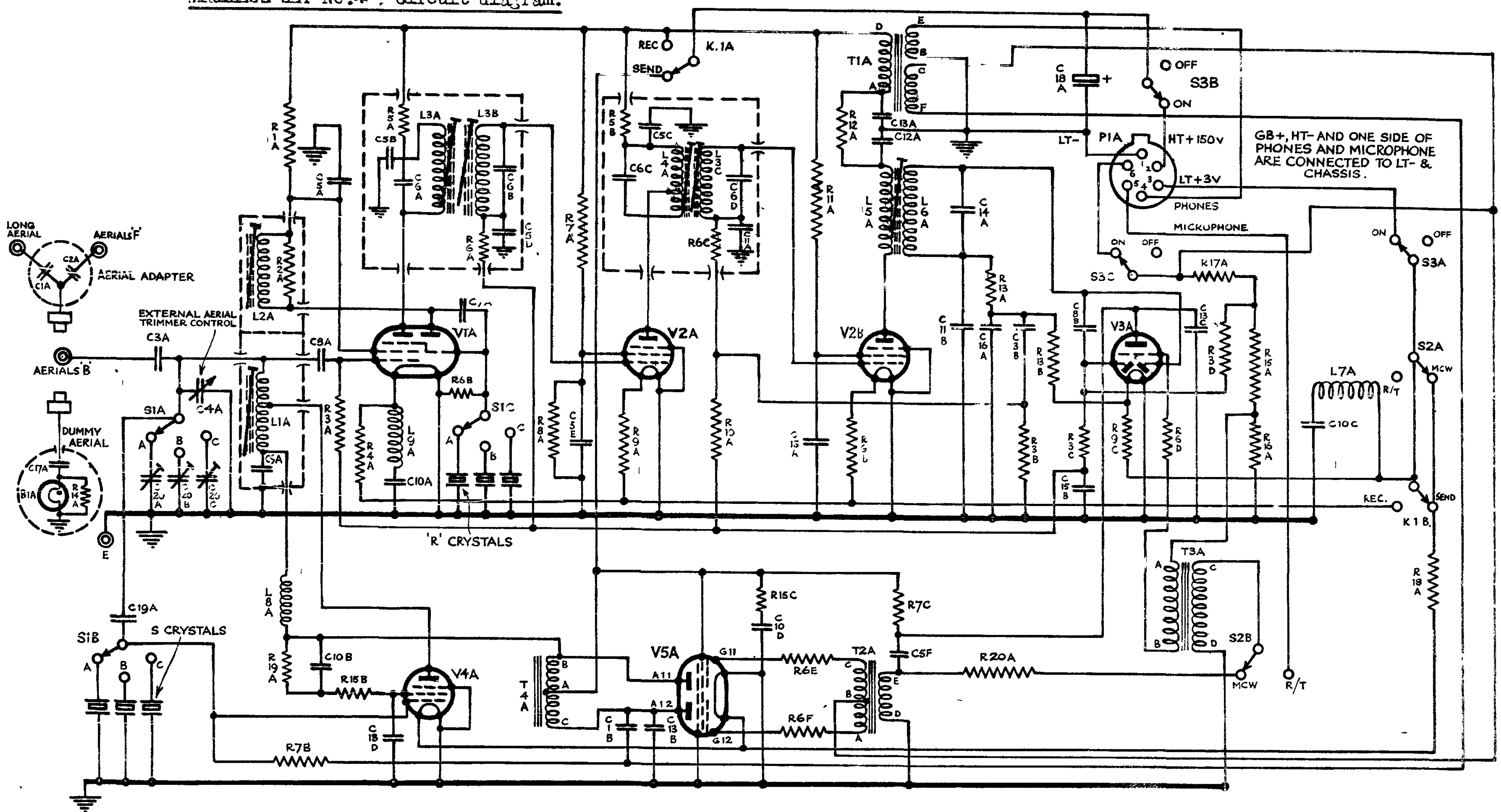


Wireless Set No. 46. Top plan of chassis.



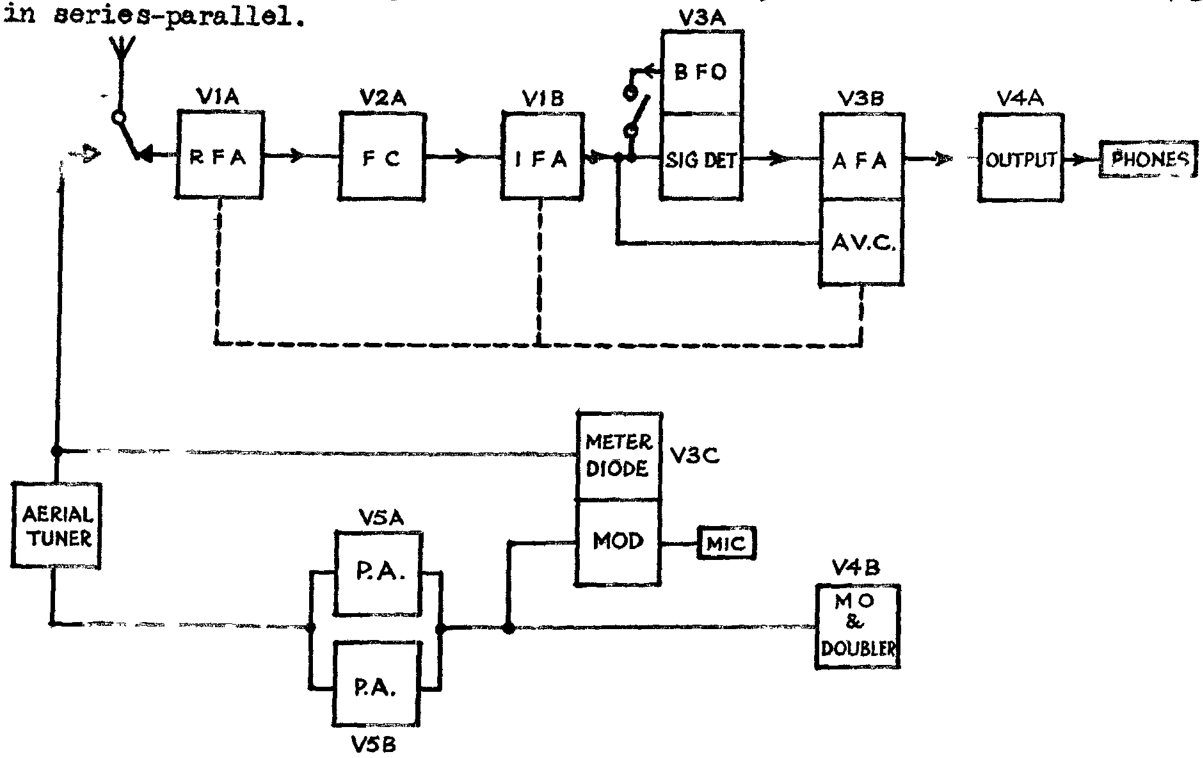
Valve base Connections (View from free end of pins)

WIRELESS SET NO.4. Circuit diagram.



This set is essentially an American version of the W/S No.18. The frequency range covered remains the same at 6-9 Mc/s. When used as a pack set the H.T. and L.T. supplies are obtained from an 18 set battle battery. A hand generator may be used in place of the battery when operating the set as a ground station.

The complete set employs 10 valves with 1.5V filaments which are arranged in series-parallel.



Complete Block Diagram of W/S No.48.

The Sender.

On send four valves are used. V4B, a directly heated pentode type 1A5GT operates as the M.O. in an electron coupled oscillator circuit employing frequency doubling. The anode and grid tuning condensers are ganged together and controlled by the M.O. TUNING dial on the sender panel.

M.O. output at signal frequency is applied as drive to two P/A valves in parallel, type 1299, feeding into a tuned anode circuit consisting of a tapped inductance and the AERIAL TUNING condenser. The P/A stage is neutralized by means of a small coil coupled to the anode coil. The valves are self biased by rectification of the drive, a suitable negative voltage being developed across the grid leak R6B.

On R/T modulation takes place on the screen grids of the power amplifier valves. Microphone output is amplified by the pentode section of a diode pentode valve V3C, type ILD5, operating in a single audio amplifier circuit with negative feedback.

Keying, on C.W., takes place in the H.T.- line.

Changeover from receive to send is accomplished by means of a relay operated from the 12v battery supply by pressing the pressel switch or the switch on the key and plug assembly. Operating this relay changes the aerial from receiver to sender and also changes over the filament battery from the receiver to the sender valves.

Function Switch.

In the NET position of the function switch, the M.O. and modulator valve filaments are connected to the battery when on receive. This enables the M.O. frequency to be adjusted to zero beat with the incoming signal when netting. Note that the M.O. now functions as a triode oscillator as the anode is not connected to H.T.

With the function switch in the CAL position the circuit is similar to the above except that the modulator valve V4B now functions as a 1 Mc/s crystal oscillator which can be used to check the megacycle points on the M.O. TUNING dial.

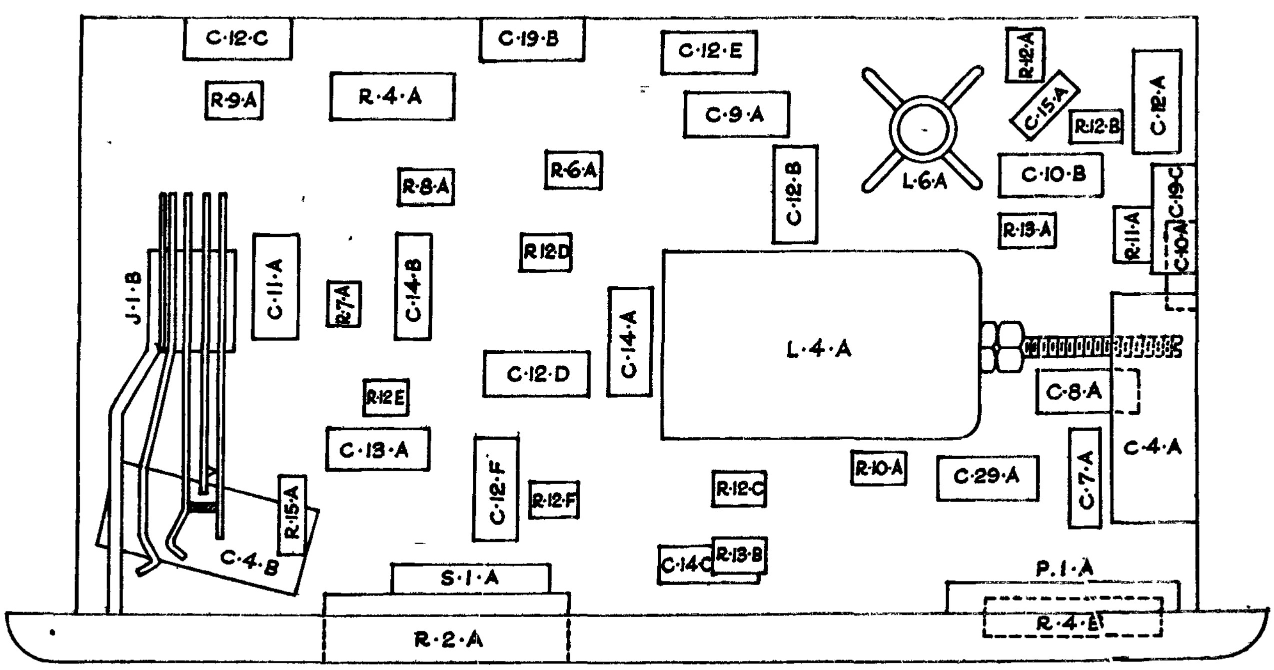
The Receiver.

The receiver employs 6 valves in a straightforward superhet circuit consisting of one R.F. stage, pentagrid frequency changer, a single I.F. amplifying stage, signal detector and two A.F. stages. A.V.C. on the R.F. and I.F. valves is provided and also a B.F.O. for C.W. reception.

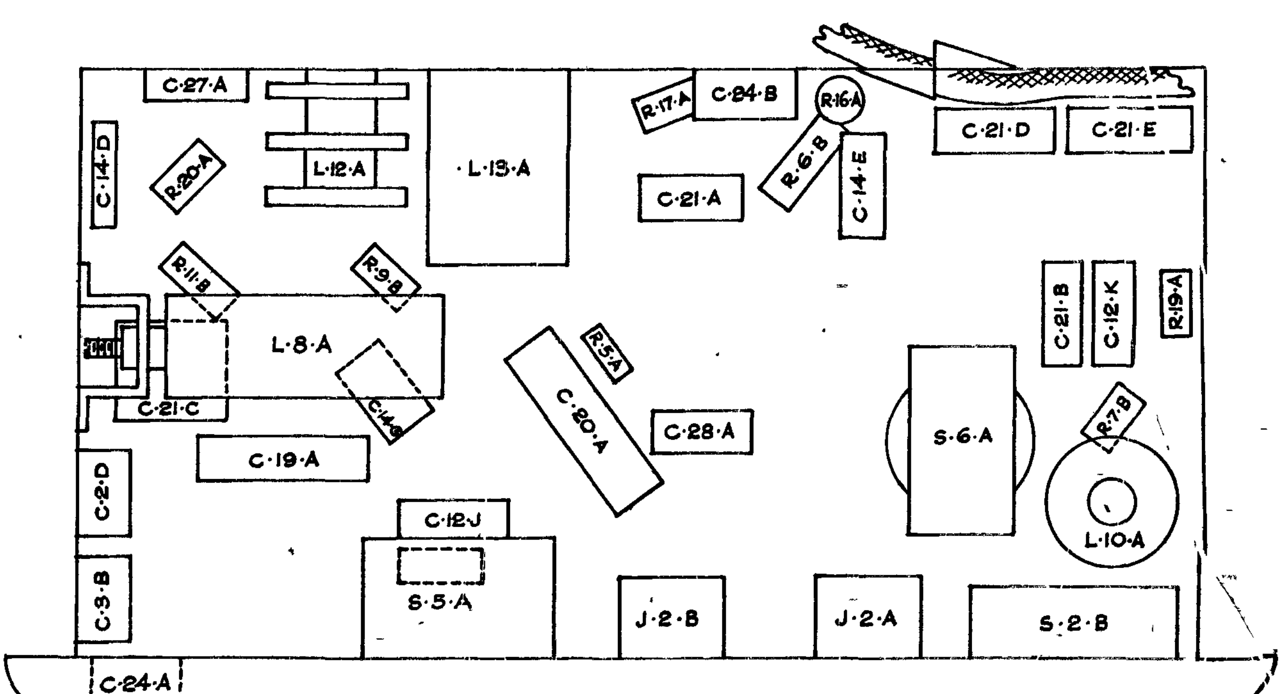
The valves used are as follows :-

Valve	Type	Description	Function
V1A	ILN5	R.F. Pen.	R.F. Amp.
V2A	ILA6	Pentagrid	Freq.changer
V1B	ILN5	R.F. Pen.	I.F. Amp.
V3A	ILD5	Diode pentode	Sig.det. & B.F.O.
V3B	ILD5	- do -	1st A.F.Amp.&A.V.C.
V4A	IA5GT	Output pen.	Output.

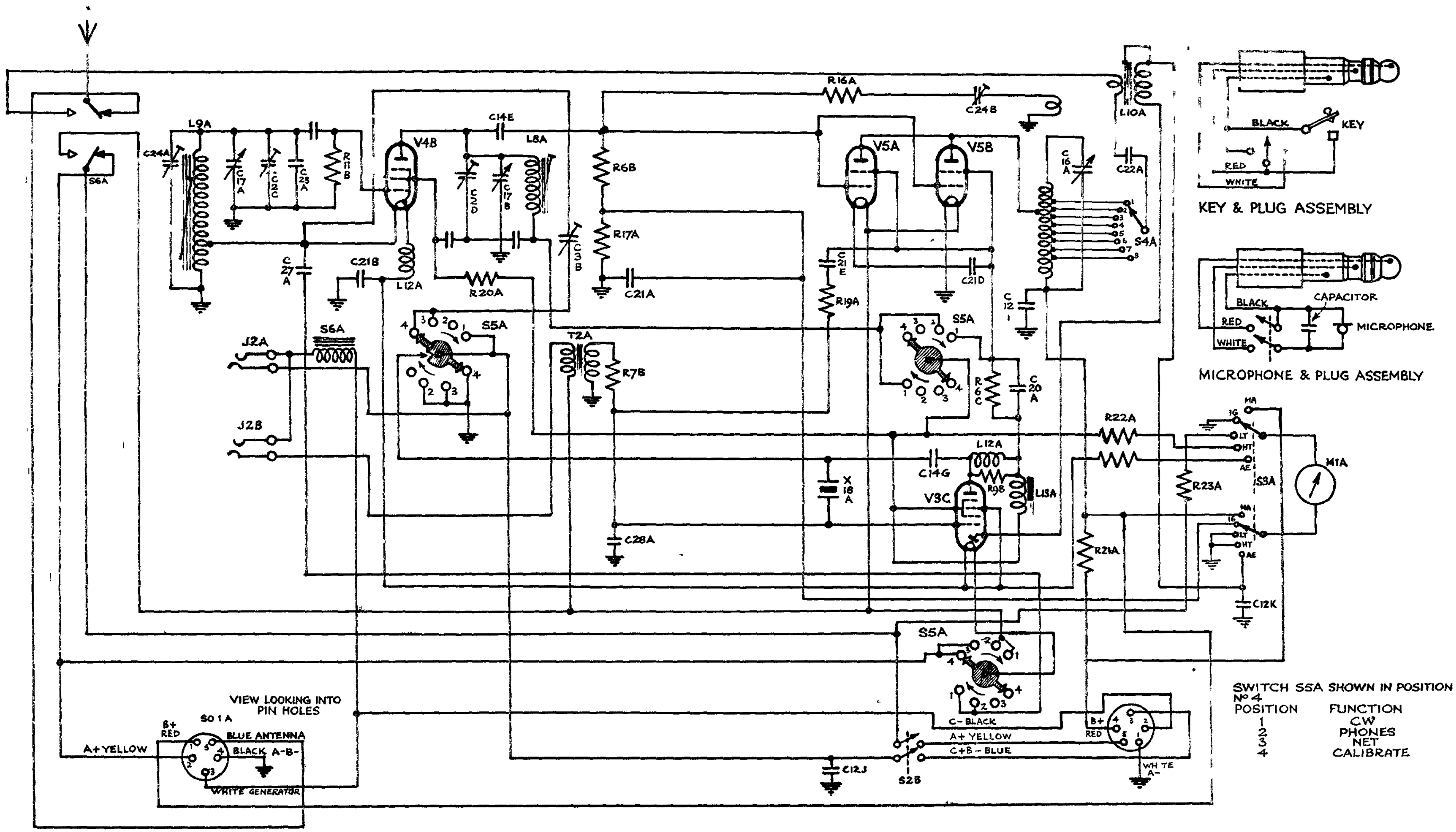
Intermediate frequency = 455 Kc/s



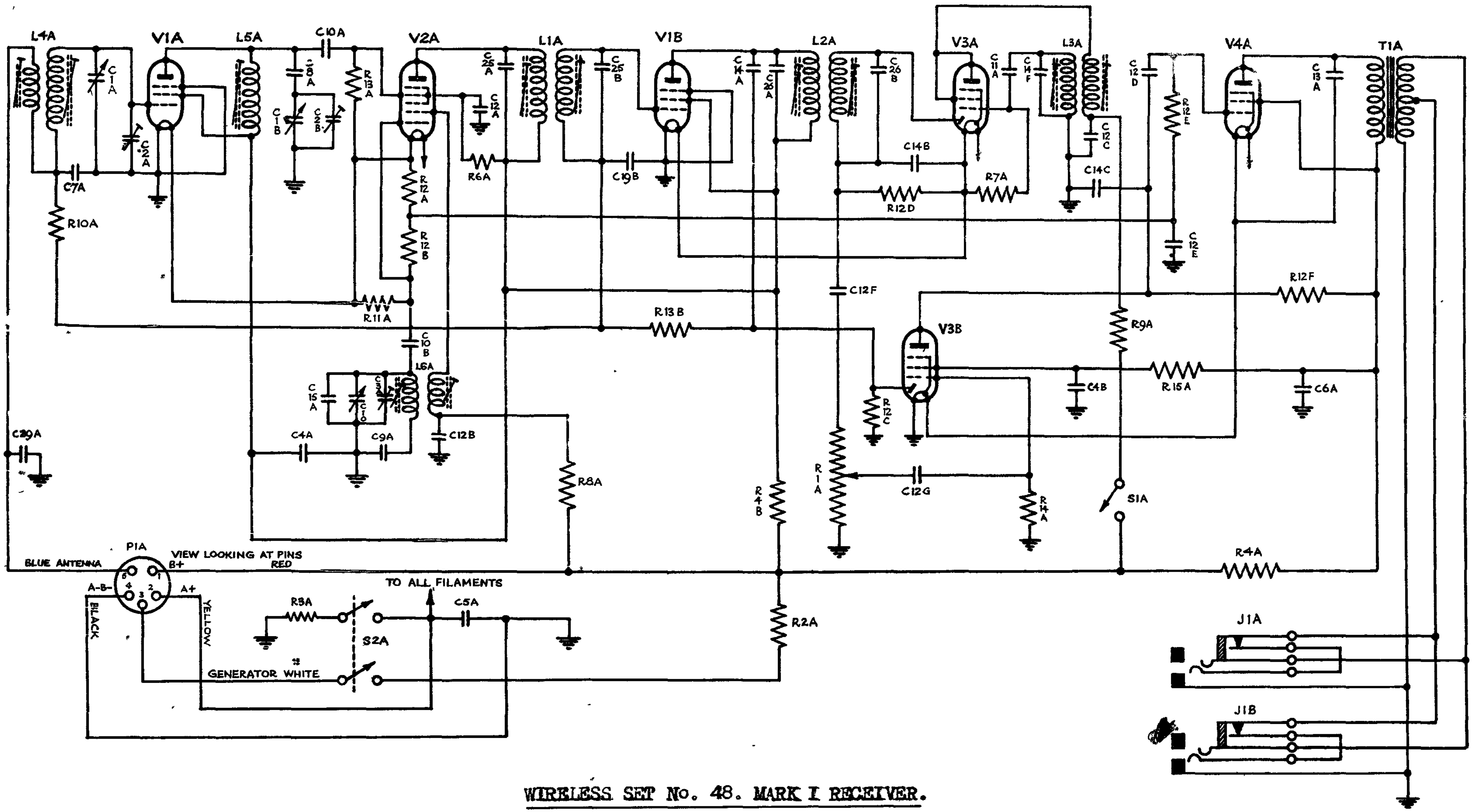
Underside View of Receiver.



Underside View of Sender.



WIRELESS SET No. 48. MARK I. SENDER.



WIRELESS SET No. 48. MARK I RECEIVER.