TRANSMITTER 4T
FREQUENCY MULTIPLIER UNIT

Note:- The identity numbers of components used in these notes are the same as those used in Section RS pages 2 - 19 to which reference should be made for details not given here.

1. INTRODUCTION.

Transmitter 4T has been modified by the addition of a Patt. W6260 Frequency Multiplier Unit. This unit has been designed to meet the requirements for Crystal Frequency Control of Transmitter 4T on the higher frequencies and to obviate the use of crystals cut to frequencies higher than 7,000 kc/s.

The unit is capable of operating in three alternative modes:-

I. Variable frequency control over the whole frequency range of Transmitter 4T (100 - 17,000 kc/s).

II. Fundamental crystal frequency control between 1930 and 7,000 kc/s.

III. Doubling or trebling (up to 17,000 kc/s) the frequency of a crystal having a fundamental frequency between 2,400 and 7,000 kc/s.).

The output power of the Transmitter 4T remains approximately the same for V.F.O. crystal fundamental and crystal doubling, but some slight reduction of power will be experienced when trebling the crystal frequency.

2. CONSTRUCTION.

The Frequency Multiplier Unit is fitted on the front of the Transmitter 4T, replacing the door of the valve compartment. Access to the master valve is now obtained by removing the cover of the unit. While the remaining valves are accessible by swinging the unit down on its hinges. The safety interlock arrangements formerly fitted to the valve access door of Transmitter 4T, which ensures that this door could not be opened unless the H.T. supply was broken, are not fitted to the frequency multiplier unit and in consequence it is IMPORTANT to ensure that the MAIN SWITCH IS BROKEN BEFORE THE COVER OF THE UNIT IS REMOVED OR THE UNIT IS SWUNG DOWN ON ITS HINGES.

In addition it should be noted that in cases where the transmitter is fed from an A.C. supply, if the unit be removed or hinged downward with the filament supplies "ON", the filament voltage on the remaining valves in the transmitter will rise to about 6 volts, instead of the correct value of 4 volts.

Connections between the unit and the existing circuit of the Transmitter 4T are made by means of five knife contacts at the rear of the unit, which engage with sockets mounted at the front of the space in which the master valve was previously fitted. A four-pin adaptor is placed in the old master valve socket and connections are made from this to the knife contacts and to earth.

3. CIRCUITS.

The Frequency Multiplier Unit contains an indirectly heated beam tetrode, NT75B with its beam plates externally connected to the screen. The heater takes approximately 30 seconds to warm up and this time should be allowed to elapse after switching on before pressing the morse key.

This valve acts as the master oscillator of the Transmitter 4T and as it takes more current than the old master valve, an additional 20,000 ohm resistance (200) is fitted in parallel with the H.T. dropping resistance (32), in order to obtain the correct operating voltages.

The valve may operate as a normal variable frequency oscillator, as a crystal-controlled oscillator working on the fundamental crystal frequency, or as a crystal controlled oscillator working on the second or third harmonic of the crystal frequency i.e. a frequency doubler or trebler.

The conditions of operation are chosen by means of a switch (201) having five positions, V.F.O., crystal fundamental and three different frequency bands of crystal controlled frequency multiplying.

The unit has only two controls, the switch mentioned above and a cathode tuning condenser (214). This latter control is only operative when frequency multiplication is being used, i.e., when the switch is in position 3, 4 or 5.

The complete circuit of the multiplier unit is shown in Fig. [illegible], while Figs. U, V and W are simplified diagrams of the circuit in the V.F.O., crystal fundamental and frequency multiplying conditions. Fig. y is a simplified diagram of the keying circuit.

The circuit of the master oscillator valve (213) is controlled by means of a four-pole, five-way switch (201). The five positions of this switch are:-

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SIMPLIFIED DIAGRAMS

VARIABLE FREQUENCY CONTROL

SWITCH POSITION 1.

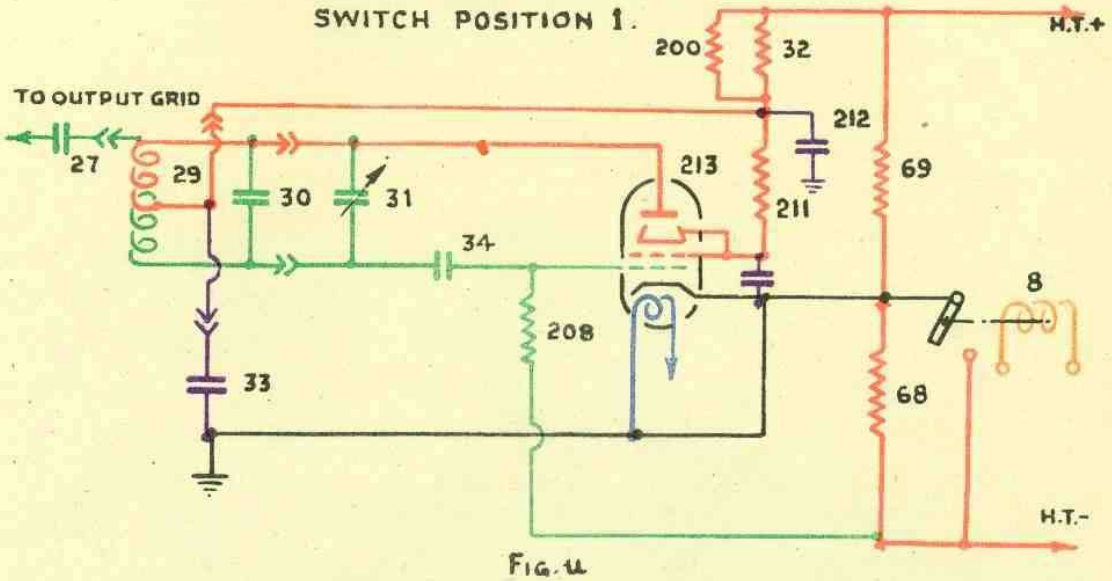

FIG. U.

FUNDAMENTAL CRYSTAL CONTROL

SWITCH POSITION 2.

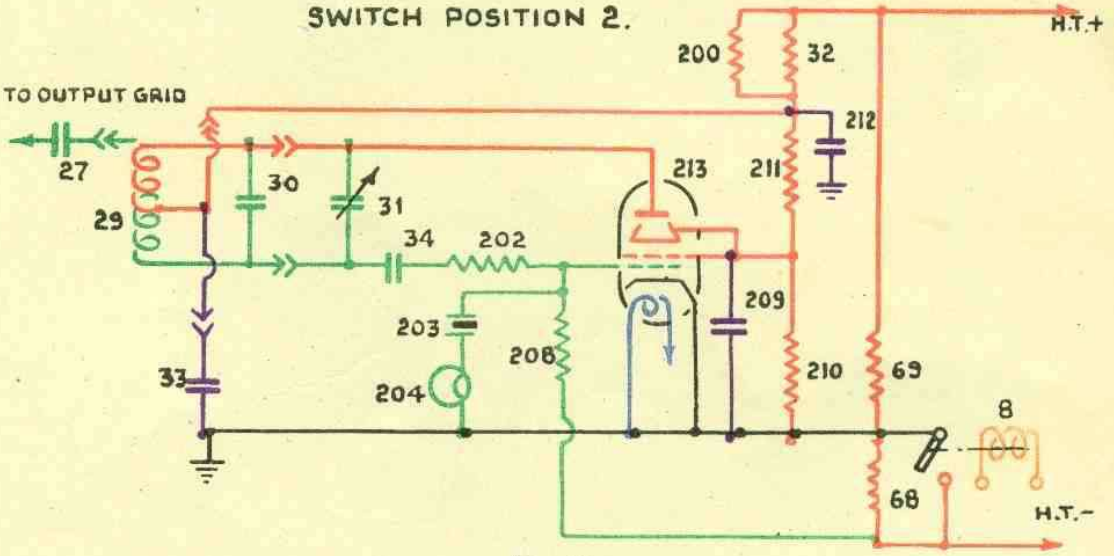

FIG. V.

CRYSTAL DOUBLE OR TREBLE

SWITCH POSITIONS 3,4 & 5.

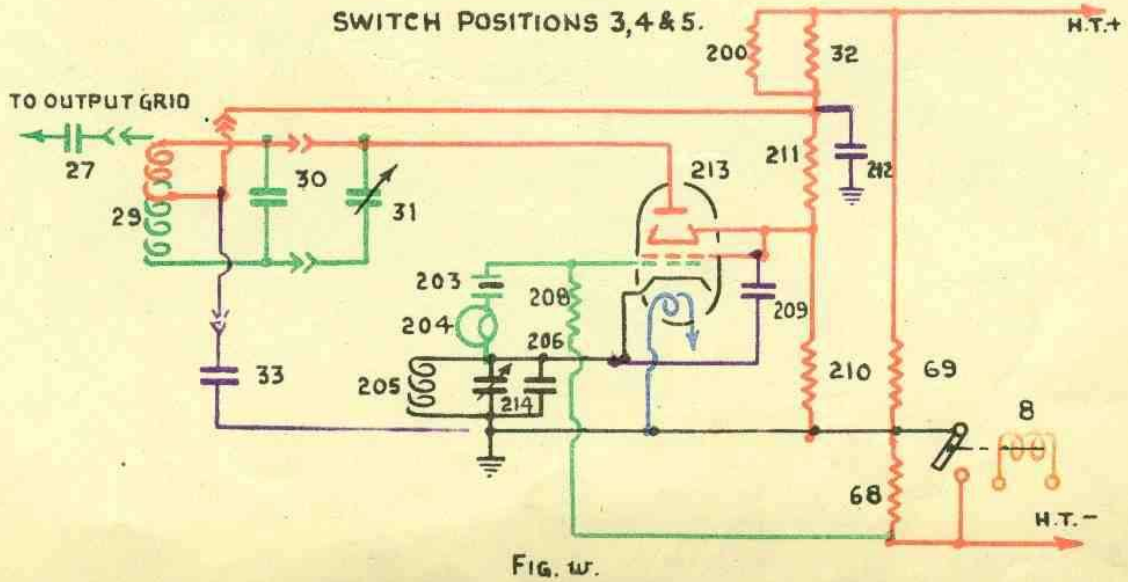

FIG. W.

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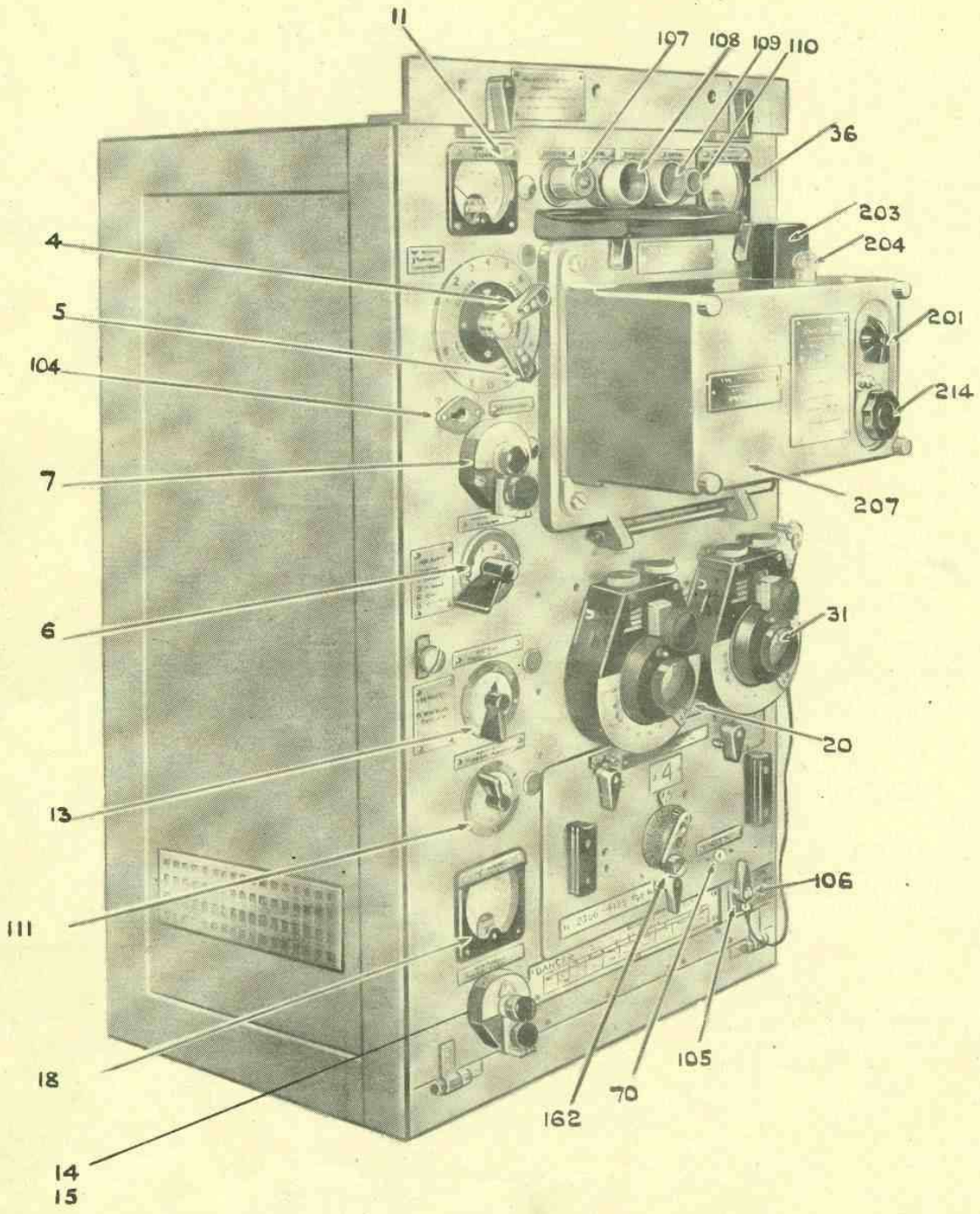

FIG. x

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1. Variable frequency control. Master valve connected in normal Hartley oscillator circuit and tuned by the normal master oscillator tuned circuit in the range unit. (See Admiralty Handbook of W/T (1938) Vol. II, Para K7).

2. Crystal fundamental. The grid of the master valve is connected to the cathode of the valve via the crystal and to the tuned circuit through a resistance (202).

3.) Crystal Doubling or Trebling. For frequency multiplication the master valve has a tuned circuit connected
4.) between the cathode and earth, while the crystal is connected between the grid and cathode in series
5.) with its indicating lamp. The only difference between the three positions of the switch marked "Crystal Doubling and Trebling" is the amount of cathode tuning inductance (205) in circuit.

4. CRYSTAL.

The crystals employed are contained in plug-in holders which fit into a socket at the top of the multiplier unit. A 4 volt 0.5 watt lamp (204) is connected inseries with the crystal (203) and indicates when an excessive current is passing through the crystal.

This lamp is provided both as a fuse and an indicating device. When using the crystal on the fundamental frequency the crystal current is so small that the lamp does not glow. The crystal current increases when doubling or trebling and the lamp will glow fairly brightly on the higher frequencies when the cathode circuit is tuned to the crystal frequency. If the crystal current is too high the cathode circuit should be detuned towards a higher frequency (clockwise) until the lamp barely glows. The aim should be to maintain effective control by the crystal with a minimum of crystal current.

Under certain conditions the lamp will glow when the crystal is not oscillating and for this reason the lamp should NOT be used as a Cathode tuning indicator.

Both the crystal and the indicating lamp must be removed before the cover of the multiplier unit is removed.

5. VARIABLE FREQUENCY CONTROL CIRCUIT.

When the master oscillator switch (201) is set to position 1 the master oscillator valve (213) is connected as a normal Hartley oscillator as shown in Fig. U.

The cathode of the VT75B master oscillator valve is earthed through one contact of the switch (201). Another contact of the switch disconnects the lower end of the screen potentiometer resistance (210) from earth, thus raising the screen voltage to the value required for satisfactory operation.

Owing to the additional length of lead to the anode of the master oscillator valve, a small capacity has, in effect, been added in parallel with the tuned circuit capacity. The effect of this is not appreciable on frequencies covered by range units 0 to 6 and makes very little difference on the lower frequencies of the remaining ranges. Range Units 7 and 8 will still cover their nominal frequency bands, but Range Unit 9 now has an upper limit of 17,000 kc/s, when using variable frequency control, although 17,200 kc/s, can still be reached when using the crystal multiplier.

6. CRYSTAL FUNDAMENTAL CIRCUIT.

When the switch (201) is set to position 2 the master oscillator valve is connected to operate as a crystal-controlled oscillator operating at the fundamental frequency of the crystal. The circuit is shown in Fig. V.

The grid of the master oscillator valve (213) is now connected to the master tuned circuit via a 20,000 ohm resistance (202) and the condenser (34) in the normal Transmitter 4T circuit. The crystal is connected between the grid of the valve and the cathode which is earthed. The resistance (202) prevents the circuit becoming self-oscillatory and at the same time permits sufficient potential to reach the grid to energise the crystal and so set the tuned circuit (29)(30)(31) into oscillation when it is brought into resonance with the crystal.

The voltage on the screen of the valve is maintained at approximately the same value as for V.F.O. control by one contact of the switch (201), which earths the lower end of the screen potentiometer resistance (210).

The value of the resistance (202) which is connected between the grid of the master oscillator valve (213) and the isolating condenser (34) is chosen to give satisfactory operation with crystals having frequencies between 1930 and 7000 kc/s. Should it become necessary to employ crystals having frequencies below 1930 kc/s, the value of this resistance may have to be increased to prevent the circuit becoming self-oscillatory at some frequency other than that to which the crystal is cut.

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7 CRYSTAL DOUBLING OR TREBLING CIRCUIT.

When the switch (20¹) is set to position 3, 4 or 5 the circuit is arranged for multiplication of the crystal frequency. The only difference in the circuit given by the three positions is that in positions 4 and 5 increasing portions of the cathode circuit inductance are short-circuited. (Fig. W).

When the switch is in any of these positions the following circuit changes are effected:-

(a) The grid of the master valve (213) is disconnected from the condenser (34).

(b) A circuit tuned to the fundamental frequency of the crystal is inserted in the cathode lead of the valve.

(c) The crystal is connected between grid and cathode.

(d) The lower end of the screen grid potentiometer resistance (210) is connected to earth.

Excitation of the crystal is obtained by tuning the cathode circuit to the same frequency as that of the crystal. The master circuit is then tuned to the second or third harmonic of the crystal frequency giving a transmitted frequency of twice or three times that of the crystal.

The cathode circuit comprises a small coil (205), the whole of which is in circuit when the switch (20¹) is in position 3. When the switch is in positions 4 or 5 portions of the coil are short circuited. The coil is tuned to the crystal frequency by a small variable condenser (214), of 160 mmfd. maximum capacity, in parallel with which is connected to a fixed condenser (206) of 100 mmfd. capacity. This latter condenser is provided to ensure that the L/C ratio of the tuned circuit does not become unduly high and thus cause an excessive crystal current.

The frequency bands covered by the cathode circuit when frequency doubling are indicated on the front of the multiplier unit. When trebling, the bands will shift slightly downwards, e.g. when doubling, the cathode circuit will tune to 3000 kc/s on ranges 3 and 4, but when trebling this frequency can be obtained only on range 3. When it is possible to tune the circuit to a crystal frequency on either of two ranges, the higher range should be chosen; this will result in a lower crystal current.

When doubling or trebling the crystal frequency, receivers in the same compartment as the Transmitter 4T will be able to receive the fundamental frequency at some strength while the key is pressed, depending upon the screening of the receiver and its aerial connection.

8 KEYING CIRCUIT.

The keying of the Transmitter 4T is unchanged. The grids of the output and master valves are connected to H.T. negative and the operation of the magnetic key connects H.T. negative to filament negative. The keying circuit is shown in Fig. Y. (Page RS27).

For convenience in wiring the cathode of the master valve (213) is connected to earth and the H.T. return circuit is completed by a lead from the filament negative pin of the adaptor in the old master valve holder to earth.

During "spacing" conditions the grids of the master and output valves are about 250 volts negative with respect to cathode and filament respectively and the valves are completely "shut down". When the morse key is pressed the grids are returned to earth and the valves operate normally.

As the keying bias of 250 volts is applied to one socket of the crystal holder during "spacing" when the switch (20¹) is in any position but "1", the safety switch on the front of the Transmitter 4T should be broken before changing crystals.

OPERATION.

9 PRECAUTIONS TO BE OBSERVED WHEN USING THE FREQUENCY MULTIPLIER UNIT.

IT IS MOST IMPORTANT THAT THE FOLLOWING PRECAUTIONS BE OBSERVED WHEN OPERATING A TRANSMITTER 4T FITTED WITH A FREQUENCY MULTIPLIER UNIT.

(a) ALWAYS BREAK THE SUPPLIES TO THE TRANSMITTER BEFORE REMOVING THE COVER OF THE MULTIPLIER UNIT OR LOWERING THE UNIT ON ITS HINGES TO GAIN ACCESS TO THE VALVES.

(b) ALWAYS BREAK THE H.T. SUPPLY BY MEANS OF THE SAFETY SWITCH BEFORE CHANGING CRYSTALS.

(c) ALL TUNING SHOULD BE CARRIED OUT ON M.C.W. SINCE, IF THE OUTPUT CIRCUIT IS NOT IN TUNE, THE FEED CURRENT ON C.W. MAY BECOME HIGH ENOUGH TO DAMAGE THE OUTPUT VALVES.

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10. TUNING - VARIABLE FREQUENCY CONTROL.

The procedure for tuning the Transmitter 4T using variable frequency control is as follows:-

(a) See that the safety switch (106) is set to "OFF".

(b) Set the modulation control switch (74) to "M.C.W."

(c) Set the switch (201) on the Multiplier Unit to position "1".

(d) Insert the appropriate range unit for the desired frequency in the transmitter. See that the latches are vertical.

(e) Set the aerial coupling control on the range unit to "0".

(f) Set the safety switch to "ON".

(g) Press the morse key and tune the master circuit to the required frequency by wavemeter.

(h) Adjust the output tuning control (20) to give minimum reading on the output valve anode milliammeter (36).

(j) Adjust aerial tuning for a rise in the reading of the output valve anode milliammeter. This should coincide with a reading on the aerial ammeter.

(k) Increase the aerial coupling and readjust aerial fine tuning until maximum aerial current is reached.

11. TUNING - CRYSTAL FUNDAMENTAL CONTROL.

The procedure for tuning the transmitter when fundamental crystal control is to be used is as follows:-

(a) See that the safety switch (106) is set to "OFF".

(b) Set the modulation control switch (74) to "M.C.W."

(c) Set the switch (201) on the multiplier unit to position "2".

(d) Plug the crystal to be used into the socket at the rear of the top of the multiplier unit.

(e) Insert in the transmitter the range unit covering the crystal frequency.

(f) Set the coupling control on the front of the range unit to '0'.

(g) Set the safety switch to "ON".

(h) Press the morse key and tune the master circuit for a slight decrease in the reading of the anode current ammeter (36). (The approximate position at which the dip should occur may be found by reference to the book of "Typical Master Tuning Curves" supplied with Transmitter 4T).

(j) Adjust output tuning control for minimum reading of the anode meter (36).

(k) Adjust aerial circuit for a rise in the reading of the anode current meter, which should coincide with a reading on the aerial ammeter.

(l) Increase the aerial coupling and readjust aerial fine tuning control until maximum aerial current is obtained.

(m) Readjust master tuning condenser for maximum aerial current, taking care not to approach too closely to the point at which the crystal stops oscillating.

(n) Set the modulation switch to the type of modulation required.

12. TUNING - DOUBLING OF TREBLING CRYSTAL FREQUENCY.

The procedure to be followed when tuning to a multiple of the crystal frequency is as follows:-

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(a) See that the safety switch (106) is set to "OFF".

(b) Set the switch (201) on the multiplier unit to position "3", "4" or "5", according to the frequency of the crystal to be used:-

Crystal Frequency.	Switch Position.
2400 - 3000 kc/s.	3
3400 - 4740 kc/s.	4
4740 - 7000 kc/s.	5

(c) Plug the crystal into the sockets on top of the multiplier unit.

(d) Insert in the transmitter the range unit which will cover the required frequency i.e., twice or three times the crystal frequency.

(e) Set the master and output tuning condensers to the approximate frequency.

(f) Set the safety switch to "ON".

(g) Press the morse key and adjust the cathode tuning condenser (214) for minimum reading on the anode meter (36).

(h) Tune the master circuit for minimum anode current in anode meter (36).

(j) Adjust output tuning condenser for minimum anode current in anode meter (36).

(k) Adjust aerial tuning for a rise in anode current, which should coincide with a reading on the aerial ammeter.

(l) Increase aerial coupling and adjust aerial fine tuning control for maximum aerial current.

(m) Readjust cathode tuning condenser for maximum aerial current consistent with low crystal current (indicated by lamp on multiplier unit).

NOTE 1: On no account must the master circuit be tuned to the fundamental crystal frequency when the switch (201) is in positions "3", "4" or "5", as this will produce an excessive crystal current.

NOTE 2: If the decrease in anode current when tuning the cathode circuit is not visible, set the cathode tuning condenser (214) a few divisions higher than the setting shown in the typical tuning sheet and proceed with the next operation.

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KEYING CIRCUIT – SIMPLIFIED DIAGRAM

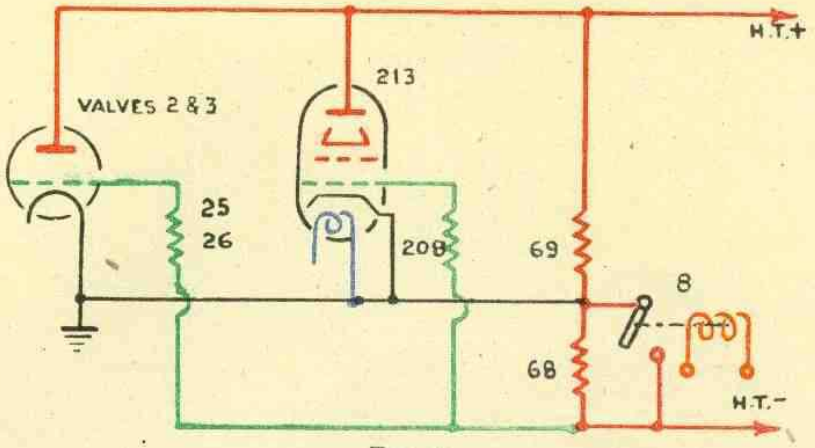


FIG. 4.

MULTIPLIER UNIT – COMPLETE CIRCUIT DIAGRAM

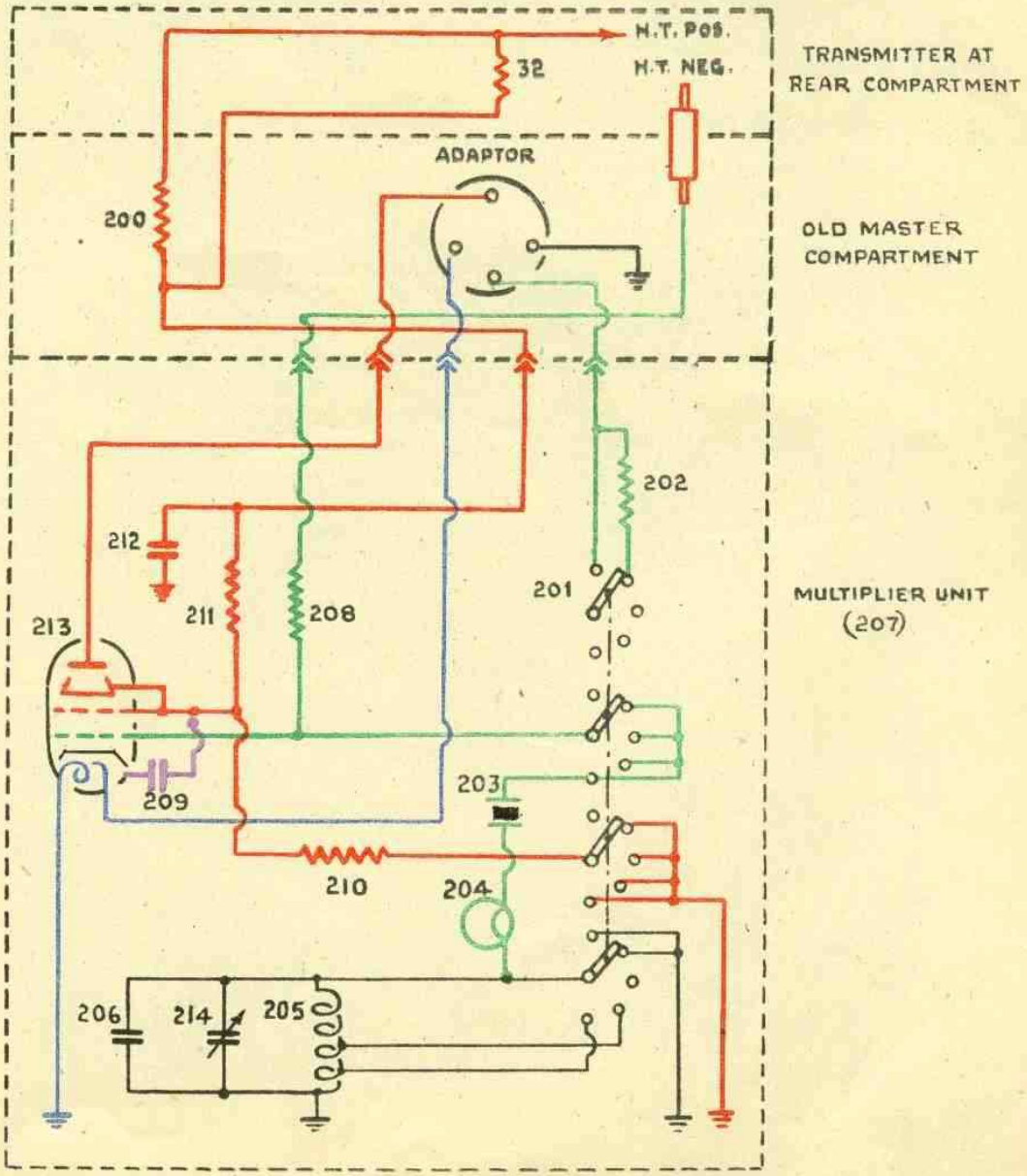


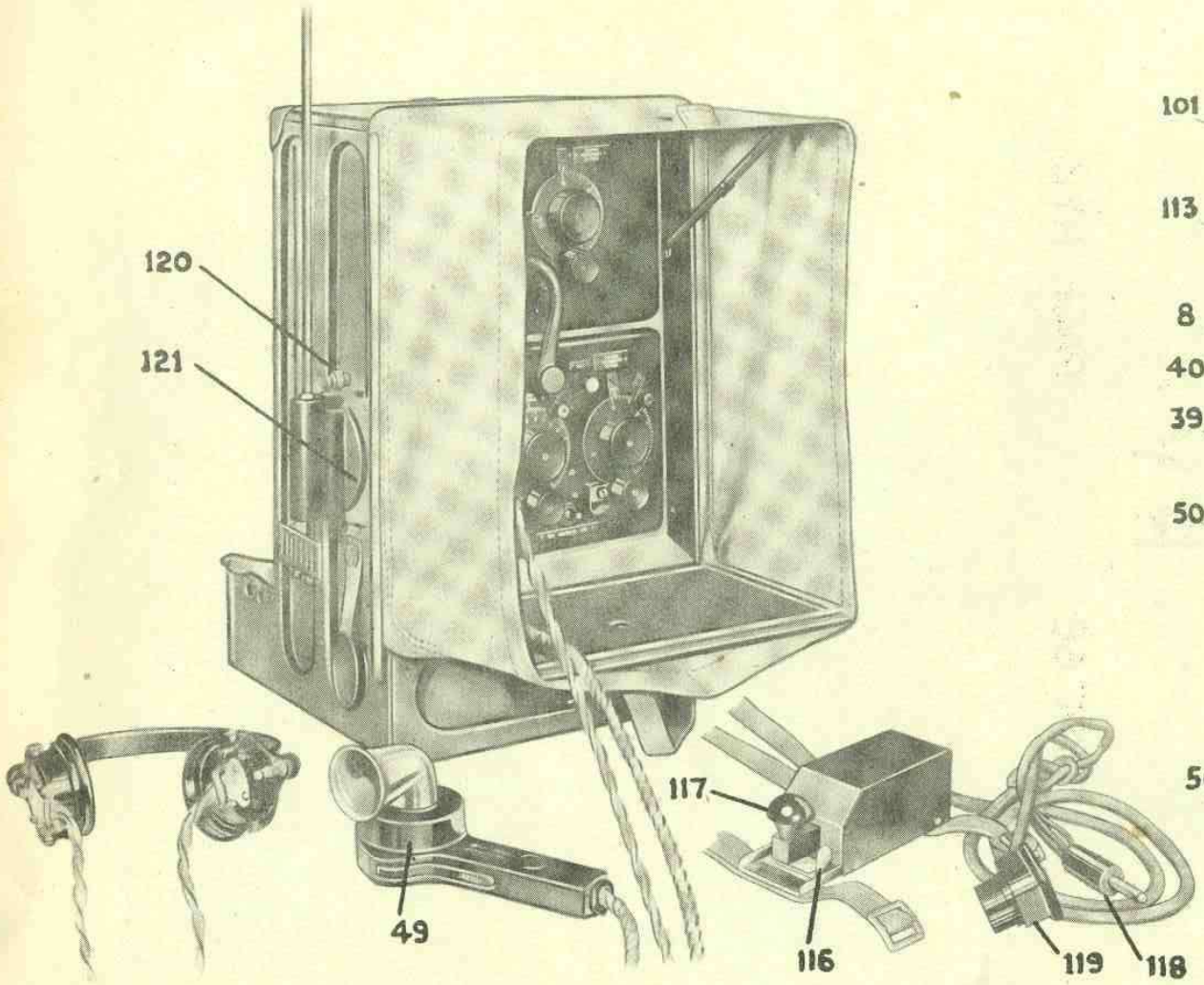
FIG. 3.

SUB - SECTION

R V

TYPE 66 PAGE RV2

COMPLETE EQUIPMENT



FRONT VIEW

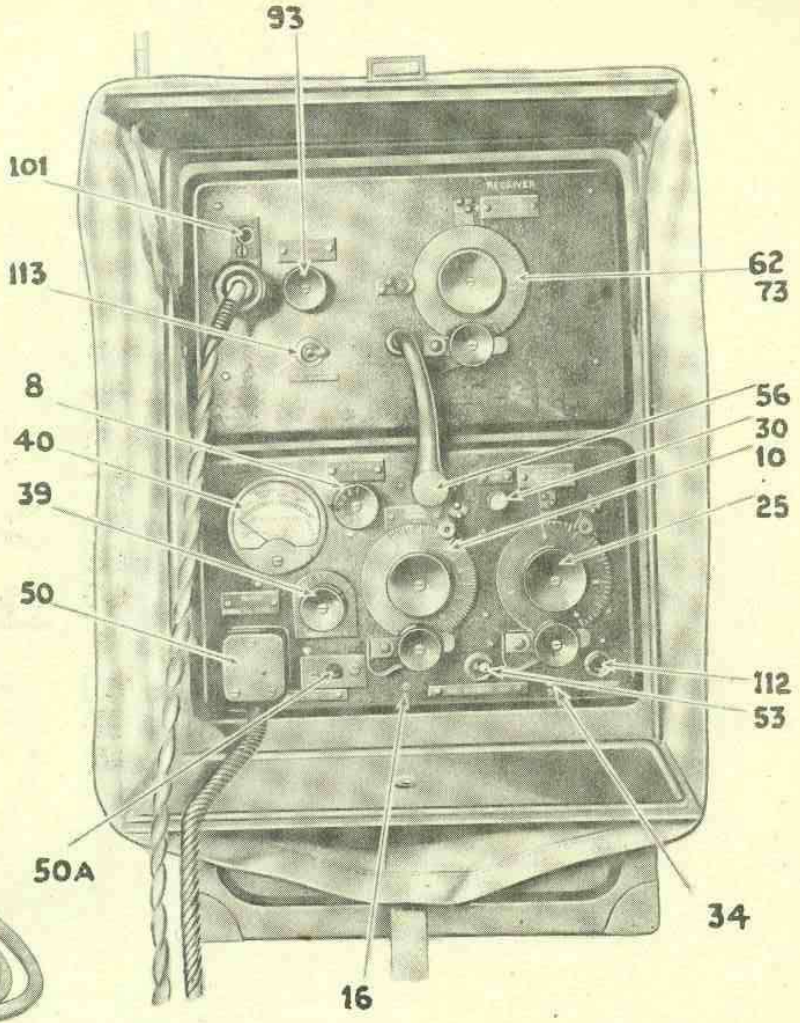


FIG. a.

GENERAL DESCRIPTION.

1. Type 66 (Portable Set A2, using Army Wireless Set No.18) is a portable transmitting and receiving set with a frequency range of 6 - 9 Mc/s, and a working range which varies with the type of aerial used between 2 and 16 miles on C.W. On R/T the range will be about half that obtainable on C.W. The set uses either a rod aerial or a ground aerial for portable use of a short aerial supported by the mast when fitted in combined operations craft.

Type 66 consists of a pressed steel case embodying a rucksack frame and containing the transmitter, receiver and batteries. Approximate overall dimensions are 8 ins. x 10 ins. x 17 ins. and the complete equipment weighs 34 lbs.

The front of the case is closed by hinged metal flaps and canvas hood, which gives protection to the controls of the set when it is being operated in bad weather. The canvas may easily be detached for decontamination.

The transmitter slides into the lower portion of the case and the receiver into the upper. Both are held in position by securing screws at the back of the case and may easily be withdrawn for inspection.

A rod aerial consisting of twelve 1 ft. lengths of copper-plated ¼-in. steel tube is carried in a rack at the side of the set and is mounted for use on a rotating plug (121) fitted on the side of the case. The aerial sections are spigotted and may be firmly joined together to form an aerial of up to 10 ft. in height.

Connection between battery and transmitter unit and between transmitter and receiver is by cables terminating in suitable plugs.

A satchel is provided with the set, containing the telephones, microphone, ground aerial and key and plug assembly.

The set includes a "Netting" device by means of which both the receiver and the Master Oscillator Stage in the transmitter may be switched on together, thus enabling the Master Oscillator to be tuned to the frequency of another station by the reception method. This facility is provided as it is frequently necessary to operate a number of Type 66 sets on a common frequency.

A test meter is included in the transmitter and shows the H.T. voltage, the voltages supplied to the transmitter and receiver filaments, the total anode current or the aerial current, according to the setting of a selector switch.

The power supplies for both transmitter and receiver are taken from batteries carried in the set when it is to be used as a portable set or from the batteries supplying Receiver Outfit CDB when the set is installed in Combined Operations Craft. When using its own batteries about 8 - 12 hours of continuous operation is possible, assuming a ratio of transmission to reception time of 1 : 3.

2. Controls and Fittings.

When reading this section the item numbers quoted should be identified on the photograph on page RV2.

Name and Item Number.	Description and Use.
Transmitter (Lower) Panel.	
Batteries ON/OFF Switch (53).	A tumbler switch which makes and breaks the power supplies to the set.
Meter Switch (39).	A five-position switch which is used to connect the milliammeter (40) in various circuits.
Milliammeter (40)	A test meter by means of which the following test readings can be made :- (i) Aerial Current (An indication only). ("AE" position). (ii) H.T. Voltage. ("H.T." position). (iii) Receiver Filament Voltage ("L.T.R." position). (iv) Transmitter Filament Voltage ("L.T.S." position). (v) Total Anode Current Load ("mA" position).

Master Oscillator Tuning Control (25).	The large graduated dial on the right hand side of the panel. This dial controls the M.O. circuit tuning condenser. The dial is graduated in megacycles.
Aerial Tapping Switch (8)	An eight-position switch which selects tapping points on the aerial tuning inductance (9).
Aerial Tuning Control (10)	The large graduated dial in the centre of the panel. This controls the aerial tuning condenser and, in conjunction with the Aerial Tapping Switch (8), is used to tune the aerial circuit for both transmitter and receiver.
Netting Switch (30)	A spring-loaded "push" switch marked "NET" which is used to switch on the Master Oscillator valve whilst the receiver is in use in order to tune the transmitter to the frequency of another station. The oscillations generated by the M.O. beat with the signal being received and by tuning the M.O. to the zero beat position the Master Circuit is brought accurately into tune with the transmitting station (See para.4).
Microphone Plug (50)	This plug is attached to the microphone and fits into the socket in the bottom left hand corner of the panel.
Microphone Jack (50A)	This jack is situated on the left hand side of the panel close to the microphone plug socket and is for use with a gas mask microphone.
C.W. Key Break - Jack (112)	The plug (118) on the morse key unit is plugged into this jack when transmitting morse. The jack is in the right hand bottom corner of the panel and is marked "C.W. Key". A plug (119) similar to the Microphone Plug (50) is also attached to the morse key unit and is plugged into the microphone plug socket to complete the circuit from the Send-Receive Switch (116).
Transmitter Filament Rheostat (34).	A preset control marked "S" situated immediately below the M.O. Tuning Control. It is operated by a screwdriver and is used to adjust the transmitter filament volts to 2V. (See para. 11).
Receiver Filament Rheostat (16).	The preset control marked "R" immediately below the Aerial Tuning Control (10). It is adjusted in the same manner as the Transmitter Filament Rheostat. (See para. 13).
Receiver Power Supplies Plug (56).	This plug connects the battery supplies to the receiver (See para. 11) and also connects the receiver to the common aerial circuit.
Receiver (Upper) Panel.	
Receiver Tuning Control (62)(73)	This is the main tuning control of the receiver. The dial, which is graduated in megacycles, adjusts two ganged condensers. One tunes the R/F stage and the other the oscillator in the frequency changer stage.
A/F Gain Control (93).	The receiver Volume Control. When turned fully clockwise it also causes the output stage to oscillate and so act as a local oscillator for use when receiving C.W. signals (See para. 12).
Receiver H.T. Current Switch (113).	A tumbler switch which by short circuiting a series resistance, enables the H.T. to the receiver to be increased when necessary, as for example, when a very weak signal is being received. The receiver should normally be operated with the switch in the "LOW" position (see para. 13).

Send-Receive Arrangements.

Send-Receive switching is effected by transferring the filament supplies from receiver to transmitter when it is desired to transmit. The receiver, therefore, is switched off during transmission. Switching is controlled by the Press-to-Speak switch (48) on the microphone for R/T Transmissions and by the Send-Receive Switch (116) on the base of the key unit for morse transmissions.

3. OPERATION AND TUNING.

(a) Transmitter.

(i) Make the "BATTERIES" switch (53).

(ii) Set the "METER" switch (39) to "AE".

(iii) Set the master oscillator tuning dial (25) to the required frequency and lock the adjustment by tightening the locking nut. (See note (i) below).

(iv) Press the "Press-to-Speak" switch (48) and keep it pressed

(v) Tune the output and aerial circuit by varying the positions of the aerial tapping switch (8) and aerial tuning control (10) alternately until the maximum aerial current is indicated on the test meter (40).

(vi) Speak into the microphone in a normal voice, with the instrument held close to the lips. "Kicks" on the test meter will indicate that speech is being transmitted.

(vii) Release the "Press-to-Speak" Switch.

The transmitter is now ready for operation.

(b) Receiver.

It is assumed that the "BATTERIES" switch is "ON" and that the "Press-to-Speak" switch in the handset is released:

(i) Set the receiver tuning dial to the frequency of the wanted station. Turn the A/F gain control (93) clockwise to its stop. (See note (ii) below).

(ii) Slowly rotate the receiver tuning control a little either side of the calibration mark until the required signal is heard, then adjust this control carefully for maximum signal strength. If necessary, reduce the setting of the A/F gain control to permit the tuning control to be set accurately. When a C.W. signal is required the A.F. Gain Control should be turned clockwise until the output valve just oscillates, but for R/T reception the Gain Control should be turned anticlockwise until oscillations cease and then adjusted to give the required volume.

(iii) Lock the receiver tuning control by tightening the knurled nut at the end of the dial.

Note:- (i) Great care should be exercised when locking the dials. There is a tendency to tighten the lock so much that the pressure on the moving dial varies the frequency setting.

(ii) If it is desired to tune the receiver before the transmitter is tuned, the Aerial Tuning Control (10) and the Aerial Tapping Switch (8) should be adjusted for maximum signal strength, in addition to the operations detailed above.

4. Netting.

The term "netting" means the adjustment of a group of stations to a common frequency, so that all stations in the group can intercommunicate freely without the necessity for retuning. In practice, one station, usually the headquarters station, becomes the "Control Station", establishing the group frequency.

All the remaining stations in the group net on (i.e. tune to) the control station.

The procedure which should be adopted is as follows:-

(a) The control station transmitter is tuned to the group frequency in accordance with the instructions given in para. 3(a) above.

(b) After a preliminary call the control station radiates C.W. (i.e. unmodulated carrier) for 30 seconds

During this period the outstations in group each proceed as follows:-

(c) During the preliminary call the receiver is tuned to the control station in accordance with para. 3(b) above.

(d) The netting switch is now fully depressed and the master oscillator tuning control (25) is tuned to the dead space and locked.

Note:- If the signal from the control station is weak a whistle may not be heard unless the receiver volume control is turned fully clockwise.

(e) Release the "Netting" switch and await the announcement of the cessation of the netting signal from the control station. (This is important. No outstation must radiate during the netting signal, otherwise interference with other outstations will occur).

(f) Press the "Press-to-Speak" Switch in the microphone and tune the aerial circuit of the transmitter as indicated in para. 3. No alteration in the setting of the master oscillator tuning control must be made after the outstation has been netted with the control station.

The outstations are now netted with the control station. The control station receiver is not, however, tuned to the group frequency.

(h) The control station operator now tunes his receiver to the group frequency by one of the following methods:-

(i) The control station operator asks for a transmission from one of the outstations and tunes his receiver to this transmission.

OR (ii) With the control station receiver operating (i.e. "Press-to-Speak" switch in the microphone released) the meter switch (39) is set to "mA", the netting switch (30) is pressed and the receiver tuning control is adjusted until a dip in the meter reading is observed. The tuning control is then adjusted for a minimum reading on the meter.

NOTES:-

(i) Once the net is established, the control station operator must on no account alter the setting of the transmitter tuning control, otherwise the whole net will be destroyed. The operator may, however, adjust his aerial tuning controls when necessary.

(ii) Any operator, other than the control station operator, should check the netting of his transmitter if communication with other stations is unsatisfactory. This is done by pressing the netting switch and listening to the control station. If the whistle heard has a high pitch the transmitter tuning control (25) should be re-tuned to the dead space. It will not be necessary to readjust the remaining transmitter tuning controls.

(iii) As an alternative to tuning to zero beat, the receivers may be netted on very strong or very weak signals by setting the meter switch to the "mA" position and tuning for minimum on the meter, care being taken to check by listening on the telephones that netting is being done on the Control Station and not on neighbouring interference. This method is not so accurate as the dead space method.

5. Send-Receive Switching.

Having made the "Batteries" switch (53) and tuned both transmitter and receiver as indicated above, Send-Receive switching is effected entirely by pressing or releasing the "Press-to-Speak" switch (48) on the microphone. When the switch is pressed the transmitter operates, while releasing the switch operates the receiver.

It is important to allow one or two seconds to elapse after pressing the "Press-to-Speak" switch before speaking, as otherwise the valve filament may not have warmed up, in which case the first words of the message may be lost.

BEFORE CLOSING DOWN AFTER USE, MAKE SURE THAT THE "BATTERIES" SWITCH IS IN THE "OFF" POSITION.

6. Instructions for Mobile Working.

When operation on the move is required the following procedure is adopted:-

The set is tuned and netted in the manner described above whilst on the ground. The bottom door flap is then closed, and the microphone and telephone receiver leads are passed over the top of this flap at the right-hand side of the set. The top door is then closed on top of these leads and the retaining straps are fastened across the door flaps. The set may then be carried on the operator's back and operated in the normal manner. It will be necessary to open the front of the set to switch "OFF" and withdraw the microphone and telephone receivers. The Morse Key is provided with straps and for mobile C.W. working the key is strapped to the operator's leg.

It may be noted that after a relatively long period of working on the move signal strength may fall, due to drifting of the oscillator. This can be remedied by renetting, either by a second operator, whilst the set is still on the first operator's back, or by removing the set from the shoulders and netting with the set on the ground in the normal manner.

If the operator is compelled to assume a prone position, it may be found that there is a serious fall in signal strength. An increase in signal strength can be effected by restoring the aerial to a vertical position. The aerial is held by the lowest section and rotated towards the vertical until it locks.

7. Choice of Site for Stationary Working.

If tactical and other considerations permit, the site chosen should be on high ground, and as far away from trees and telephone wires, etc., as possible. For stationary working the wire supplied for the ground aerial may with advantage be used to make a larger aerial than the rods alone provide. A counterpoise earth connected to the earth terminal (120) on the left hand side of the set, may be used if desired.

8. BRIEF TECHNICAL DETAILS.

Frequency Range:- 6000 - 9000 Kc/s.

Power Supply:- H.T. - Patt. 3773 66 volt dry battery.
L.T. - Patt. 8856A 2 volt 21 ampere - hour accumulator

OR

H.T. and L.T. from an Army "STATIC" battery as supplied for Army W/T set No. 18.

Valves used:- Transmitter.

Master Oscillator	AR8
Output Stage	ATP4
Receiver - 3	ARP12
1	AR8

Approximate range in miles:- C.W. 2 - 16 miles.
R/T 1 - 8 miles.

(According to aerial used and local conditions).

Aerial used:- Sectional rod aerial 10 feet long,

OR

In Combined Operations Craft a short aerial supported by the mast.

A ground aerial consisting of a length of insulated wire trailed on the ground in the direction of the station with which it is desired to work, may also be used for mobile use when circumstances prevent the rigging of rod or mast aerials.

Type of Transmission :- C.W. or R/T.

9. TRANSMITTER.

Wave Form	Method of Producing Oscillations	Nature of Circuit		Grid Excitation		Feed		Aerial Excitation.
		Master	Main	Master	Main	Master	Main	
C.W. or R/T.	Master Controlled.	Tuned Circuit between Anode and fila-ment.	Tuned Circuit between Anode and fila-ment.	Mutual induc-tive.	Induct-ive from Master Circuit	Series	Series	Direct.

The transmitter comprises a two stage master-controlled circuit, using the triode portion of a duo-diode triode as a master-oscillator and a neutralised pentode in the output stage.

Simplified diagrams of the transmitter are given in Figs. B and C.

For C.W. Transmission the Morse Key (117) is connected in the screen grid lead of the output valve (1) by means of a plug (118) inserted in the break-jack (112). Transmit-receive switching is arranged by means of a switch (116) on the base of the key unit. This switch performs a similar function to the "Press-to-Speak" Switch on the microphone in that it transfers the filament supply from the receiver to the transmitter valves. The switch is connected to a plug (119) which is inserted in lieu of the microphone plug (50). When the "Netting Switch" is in the "Net." position (pressed), the Master Oscillator valve filament only is switched on, but if the "Press-to-Speak" switch also is operated the filament circuit to the Master Oscillator valve will be broken.

For R/T Transmission the microphone plug (50) is plugged into the microphone socket and the "Press-to-Speak" switch (48) on the microphone (49) is pressed when it is desired to transmit.

When the switch (48) is pressed the microphone is connected across the L.T. supply in series with the primary winding of the microphone transformer (23), and the filament L.T.+ lead is disconnected from the receiver valves and connected to the transmitter valves. Speech made into the microphone results in A/F potentials being applied to the grid of the output valve in addition to the carrier frequency generated by the master oscillator.

An automatic bias circuit which varies the mean D.C. potential of the grid of the output valve in accordance with the amplitude of the carrier voltage generated by the master oscillator stage is provided by one of the diodes in the Master valve and the resistance (21).

10. TEST METER CIRCUITS.

The test meter (40) has five conditions of operation, which are selected by means of the meter switch (39). These five conditions are as follows :-

TABLE I.

Switch Position.	Test Condition.	Reading to be expected.
"AE CURRENT".	Test meter connected to aerial current rectifier circuit (42 - 47) to indicate aerial current.	-
"H.T."	Test meter connected across H.T. supply in series with 500,000 ohm resistance (37) to indicate H.T. voltage.	At least up to the full red line.
"L.T.R."	Test meter connected across receiver filaments in series with 9,500 ohm resistance (30) to indicate L.T. voltage.	The number of divisions marked on a plate above the meter as corresponding to two volts.
"L.T.S."	Test meter connected across transmitter filaments in series with 9,500 ohm resistance (38) to indicate L.T. voltage.	
"M.A."	Test meter connected across 10.2 ohm resistance (35) in series with H.T. supply lead to indicate total anode current.	See below.

With the switch in the M.A. position the readings should be as follows :-

Receiver Emission current	240 - 270 microamps.
Transmitter " " (Press-to-Speak switch (48) depressed).	340 - 440 "
Receiver Emission Current plus M.O. Emission Current (Netting Switch (30) depressed).	310 - 370 "

When transmitting on R/T a "kick" will be observed in the aerial current reading if the carrier is being modulated, i.e. if speech is being transmitted.

The meter scale is graduated in microamperes but these graduations are not an indication of the actual current flowing. The meter should read as indicated above.

11. POWER SUPPLIES.

When the set is supplied for portable use the H.T. filament and grid bias supplies are taken from a Battle Battery for Army W/T Set No. 18 which comprises a 162-volt H.T. battery, tapped at 12 volts for the grid bias supply, and a 3-volt filament battery contained in a single pack. A short cable terminated in a plug connects the transmitter to the battery, which is carried in the lower part of the case of the Type 66.

When the set is fitted in Combined Operations craft fitted with receiver outfit CDB or D/F outfit R.A.3 the H.T. supply is taken from two Batt. 3773 H.T. batteries connected in series. The grid bias supply is taken from a tapping at 9 volts from the negative end of the battery. The filament supply is taken from a Batt. 8856A accumulator. These batteries are fitted as part of the receiver outfit or D/F outfit.

TYPE 66 TRANSMITTER

RV9

SIMPLIFIED CIRCUIT DIAGRAM SHOWING TRANSMITTER IN R/T POSITION & METER SWITCH IN Æ POSITION

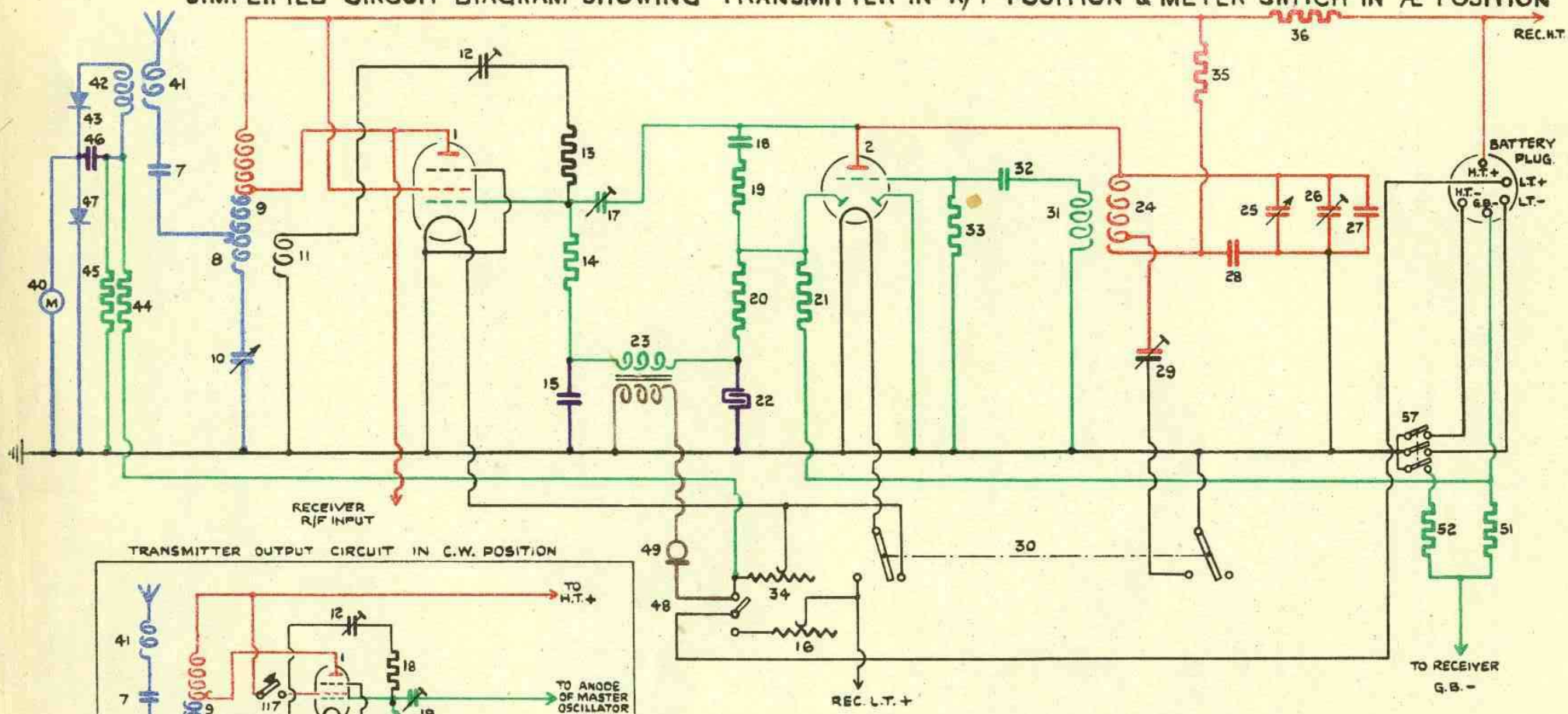


FIG. b

TRANSMITTER OUTPUT CIRCUIT IN C.W. POSITION

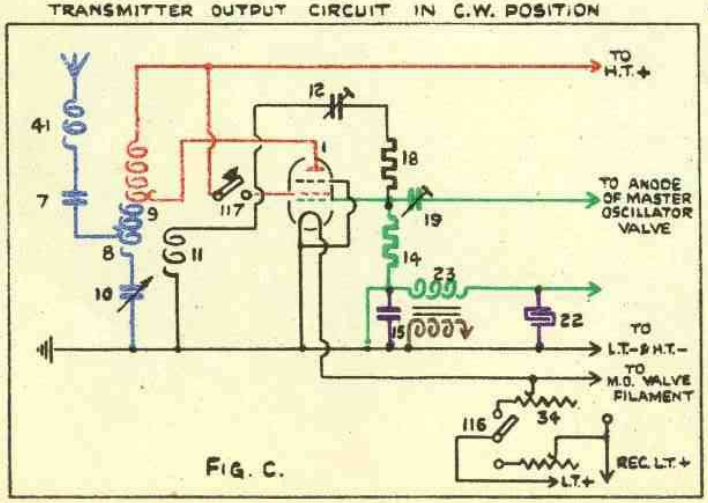


FIG. C.

TYPE 66

When the set is fitted in Combined Operations craft which are not fitted with receiver outfit CDB or D/F outfit R.A.3 the H.T. supply is taken from two Patt. 3773 H.T. batteries connected in series and the filament supply from a Pattern 8856A accumulator, as before, but in this case the batteries are fitted as part of the Type 66.

The L.T. consumption is 0.35 amps when transmitting and 0.2 amps when receiving, while the H.T. consumption is 18-20 m.A. when transmitting and 15 m.A. when receiving. Assuming a ratio of transmission to reception time of 1 : 3 about 8 - 12 hours continuous operation of the set is possible without changing batteries. In more intermittent working the useful life of the batteries is greatly increased.

As the filament voltage required by the valves in the set is 2.0 volts while the filament battery gives 3 volts, a filament rheostat (34) is included in the transmitter filament circuit. This rheostat is adjusted by a screw driver control marked "3" on the front panel of the set. It should be set so that the test meter reads the number of divisions marked on the panel as corresponding to 2.0 volts. (The meter switch is set to "L.T.S.")

When type 66 is fitted in Combined Operations craft it takes its power supplies from the batteries fitted as part of receiver outfit CDB. The battery plug is disconnected from the battery and brought out of the case of the Type 66 through the aperture provided. It is then connected through a lead (Type ZA2783) to a socket provided in a convenient position adjacent to the set. In this case the filament battery is a 2-volt accumulator and the filament rheostat must be adjusted accordingly.

If a Type 66 is removed from a Combined Operations Craft for portable use the filament rheostat must be re-adjusted for the increased filament battery voltage before putting the set in use.

12. RECEIVER.

The receiver is a superheterodyne model, having one R/F stage, frequency changer, I/F stage, diode second detector, A/F amplifier and A.V.C. rectifier. The detector and A.V.C. diodes and the A/F amplifier are combined in a single double-diode-triode valve. A simplified diagram of the receiver is given in Fig. D.

Valves and method of coupling :-

R/F Stage (3) ARP 12		Tuned Anode Capacity.
Frequency Changer (4) ARP 12		Transformer-Tuned Secondary.
I/F Stage (5) ARP 12		Tuned Transformer.
Combined Detector (Diode)		Telephone Transformer
Detection and AVC, Second)	(6) AR8	in output stage
Heterodyne and Output Stage)		

The set uses an intermediate frequency of 465 kc/s, which is produced by means of the frequency changer valve (4). This valve has the incoming R/F signals applied to its grid and a circuit arranged to oscillate at a frequency 465 kc/s below that of the received signal is connected between the anode of the valve and earth. The filament of the valve is connected to the supply via the double-wound reaction winding (78) which provides the necessary feedback to cause the valve to oscillate.

When the A/F gain control (93) is turned to maximum (fully clockwise) the amplifier stage is made to oscillate and so function as a second heterodyne oscillator. The valve (6) oscillates at a frequency of approximately 464 kc/s and a voltage at this frequency is mixed with the 465 kc/s signal supplied to the detector diode from the I/F stage, producing a 1,000 c/s beat note in the telephones.

This oscillating condition of the receiver is used during "netting" or when it is desired to receive a C.W. signal. For R/T reception the A/F gain control (93) must be turned back from its maximum position.

13. POWER SUPPLIES.

The receiver power supplies are taken from the batteries which supply the transmitter as follows :- The H.T. supply is taken from the transmitter H.T. line through a 5,000 ohm resistance (114) which may be short circuited by a switch (113) on the front panel of the receiver if it is desired to increase the receiver H.T. voltage, as for example when a very weak signal is being received.

The filament supply for the receiver valves is taken from the 3-volt filament battery contained in the battery pack (or from the 2-volt accumulator when the set is fitted in Combined Operations Craft) through a rheostat (16) which is adjusted by means of a screwdriver control marked R. on the front panel of the transmitter. To adjust this rheostat the meter switch on the transmitter is set to "L.T.R." and the control is adjusted until the meter reads the number of divisions marked on the panel as corresponding to 2.0 volts. Should the set be used at the limit of its useful range, or difficulty be experienced with the netting procedure, it is occasionally desirable to increase the receiver filament voltage to 2.2 volts, i.e. one scale division on the meter above the value indicated for 2.0 volts.

The grid bias supply for the receiver is obtained from the output of a fixed potentiometer consisting of a 680-ohm resistance (51) and a 130-ohm resistance (52) connected across the grid bias portion of the H.T. battery. These resistances are contained in the transmitter unit.