1946

# NEW ZEALAND
# WIRELESS SET ZC.178
## DESCRIPTION & OPERATION
## PHOTOGRAPHS
## &
## PARTS LISTS

# WIRELESS SET 2C.178

## DESCRIPTION & OPERATION

Date of Issue
April 1946.

New Zealand Liaison Section
Radio Production Unit,
Woolwich Common,
London, S.E.18.

# WIRELESS SET ZC.178

## PART I

## General Description

### Contents

# STATION ZC.178 - GENERAL DESCRIPTION

## Introduction

1.01 Purpose. (1) Investigation of propagational and other characteristics of FM/AM signals over widely separated bands of the V.H.F. spectrum.

(2) To investigate the suitability of these higher frequencies for short range communication.

(3) To investigate the provision of V.H.F. equipment for use under tropical conditions.

1.02 Description.

Portable Station. Tropical.

Main Equipment. Sender.
Receiver.
Power Supply.
Antenna System.
Carrier.

1.03 Physical Data.

Weights and overall dimensions.

| | SENDER | | | | RECEIVER | | | |
|---|---|---|---|---|---|---|---|---|
| | Weight | Width | Depth | Height | Weight | Width | Depth | Height |
| Carrier | 6 lbs. | 16" | 19" | 17½" | 6 lbs. | 16" | 19" | 17½" |
| Power Supply | 20½ lbs. | 12⅛" | 10⅞" | 5¼" | 20½ lbs. | 12⅛" | 10⅞" | 5¼" |
| Aerial System (in Bag) | 3¼ lbs. | 3" dia | | 4' 3" | 3¼ lbs. | 3" dia | | 4' 3" |
| Unit | 13 lbs. | 12⅛" | 11½" | 6¼" | 9¼ lbs. | 12⅛" | 8½" | 5¼" |
| Satchel & Contents | 7½ lbs. | 12" | 6" | 8½" | 5 lbs. | 12" | 5" | 8½" |
| Total | 50¼ lbs. | | | | 44 lbs. | | | |

## DESCRIPTION OF RECEIVER ZC.178

2.01 Purpose

Receiver ZC.178 is designed to receive amplitude modulated signals, or frequency modulated signals, having a deviation approx. ±25 kc, on, or within 25 kc of the following spot frequencies:-

(1) 45 Mc/s - 0.05 Mc/s = 44.950 Mc/s
(2) 45 Mc/s + 0.050 Mc/s = 45.050 Mc/s
(3) 115 Mc/s - 0.10 Mc/s = 114.90 Mc/s
(4) 115 Mc/s + 0.10 Mc/s = 115.10 Mc/s
(5) 235 Mc/s - 0.15 Mc/s = 234.850 Mc/s
(6) 235 Mc/s + 0.15 Mc/s = 235.150 Mc/s

2.02 Power Supply

Receiver ZC.178 is normally used with Battery ZC.178. Supplies required are:-

L.T. 1.5 volts, at 0.75 amps.
H.T. 120 volts, at 32 mA.

The receiver will operate, with reduced performance, when the supply voltage falls to:-

L.T. 1.1 volts
H.T. 88 volts

In the Stand-By position filament drain is approx. 0.1 amp.

2.03 The receiver is designed to work into coaxial cables, or unbalanced lines, of 70 ohms.

2.04 Two connectors are provided for one or two pairs of Headphones, Type ITE or equivalent (150 ohms nominal impedance).

2.05 The battery cable is connected to the set by means of a 6 pin "Plessey" plug and socket.

2.06 Controls

System Switch: - (AM-FM)
Band Switch: - (See 2.01 for frequencies)
Battery Switch: - (OFF-ON)
Volume Control:
Meter Switch: - (See 2.09)
Aerial Trimmer:
Trim Tune: - (See 2.08. 2nd Oscillator)
Stand-by-ON Switch:

2.07 Circuit (To be read in conjunction with circuit Fig. 2 and Block diagram Fig. 1)

Receiver ZC.178 is a 13 valve superheterodyne receiver employing the double conversion system.

2.08 Analysis of Receiver Circuit

Crystal Section

To obtain stability as well as easy netting on all bands a crystal controlled frequency source is employed in the receiver as well as the transmitter.

The Valve V11, a hexode type 1R5, has, connected to its inner grid, via band selector switch S1D, one of two crystals, and in its screen circuit, (effectively the anode circuit of the crystal oscillator), a circuit, inductor L6 and capacitor C68, tuned to a nominal frequency of 5.83 Mc/s. In Position 1 of each of the three bands, 45 Mc/s, 115 Mc/s and 235 Mc/s, a 5.8292 Mc/s crystal is used, and in Position 2 a 5.8375 Mc/s crystal. Trimmers C63 and C64 allow the crystal frequencies to be varied by approx. 100 c/s without great decrease of output, for correction of errors in the crystals. The anode circuit of V11 is tuned to a mean frequency of 17.5 Mc/s and an interwound, but untuned secondary winding is used to couple to the first doubler V12. To aid the frequency tripling of V11 a tertiary winding is employed on T11 coupling back to the second control grid of V11. Phase and coupling are such that the 17.5 Mc/s output is increased without danger of parasitic oscillation.

The output of Valve V12, a type 1T4 pentode, is delivered to the tuned primary of T12 at a mean frequency of 35 Mc/s, exciting the second doubler stage Valve V13, a type 1T4, connected as a triode. Output from V13 at a mean frequency of 70 Mc/s is taken from the secondary of T13.

From this chain a heterodyning signal is obtained at 5.8292 x 12 = 69.950 Mc/s on all positions 1 of the band switch, and 5.8375 x 12 = 70.050 Mc/s in all positions 2. Bandwidths of circuits L6, T11, T12 and T13 are such that negligible change of power output results when changing from crystals 1 to 2.

1st Mixer

Valve V1, a type HY.114B triode, is used as a mixer with heterodyne signal injected into the filament circuit. The output of V1 is across the tuned circuit T5, at a frequency of 25 Mc/s. By "harmonic" operation of V1, operation on the bands 45 Mc/s, 115 Mc/s, 235 Mc/s, is obtained simply by selecting the input coils L1, L2 and L3, by means of S1A and S1B. S1C changes the anode voltage of V1 in order to obtain conversion at the best signal to noise ratio.

Received signal frequencies are:-

| | | | | | | |
|---|---|---|---|---|---|---|
| 45 Mc/s | 1 | = | 69.950 Mc/s - 25 Mc/s | = | 44.950 Mc/s |
| 45 Mc/s | 2 | = | 70.050 Mc/s - 25 Mc/s | = | 45.050 Mc/s |
| 115 Mc/s | 1 | = | 69.950 Mc/s x 2 - 25 Mc/s | = | 114.90 Mc/s |
| 115 Mc/s | 2 | = | 70.050 Mc/s x 2 - 25 Mc/s | = | 115.10 Mc/s |
| 235 Mc/s | 1 | = | 69.950 Mc/s x 3 + 25 Mc/s | = | 235.850 Mc/s |
| 235 Mc/s | 2 | = | 70.050 Mc/s x 3 + 25 Mc/s | = | 235.15 Mc/s |

25 Mc/s, I.F.

Valve V2, a type 1T4 pentode, amplifies the signal from mixer V1. This stage, by means of T5 and T6, effectively suppresses a spurious response 9.8 Mc/s below the desired received frequency.

2nd Mixer

Valve V3, a type 1T4 pentode, is used as a mixer with grid leak bias, and grid injection via C11. and converts the 25 Mc/s signal from T6 to 4.9 Mc/s.

2nd Oscillator

Valve V4, a type 1T4 pentode, is used in a "feed-back" type oscillator circuit. Circuit constants have been chosen so that good frequency stability is obtained under conditions of varying supply voltages. The nominal frequency of the oscillator is 20.1 Mc/s, but slight variation, approx. ±25 k/cs is effected by the control C14 (Trim Tune on the Front Panel), allowing for correction of errors in tuning due to imperfections in crystals or alignment, or for intentional mis-tuning.

In the "Stand By" position the filament of V4 (and also V11) is kept hot

I.F. Channel

The 4.9 Mc/s output of V3 across L4 is amplified by means of two stages V5 and V6 using type 1T4 pentodes and tuned by means of circuits L5 and T8.

V7 and V8 - Amplitude Modulation

When the receiver is switched to "A.M.", Valve V7, a type 1T4 pentode, functions as a 3rd I.F. amplifier. Bias and plate voltage being set to correct values by means of S2A and S2B. Valve V8 in the "A.M." position is operated as a diode. Screen voltage being removed and the grid acting as diode anode delivers its rectified output across resistor R27. Via filter networks a negative D.C. voltage is applied to V2, the 25 Mc/s I.F., and V5 and V6, the 4.9 Mc/s I.Fs., as A.V.C. voltage. The audio component of the signal is taken via blocking condenser C55 and switch S2F to the volume control R35.

V7 and V8 - Frequency Modulation

When the system switch is set to "F.M.", Valves V7 and V8, both type 1T4 pentodes, are operated with anode and screen potentials chosen so that very effective limiting results on any signal above approx. the input required to produce the standard quieting ratio. Output voltage from V8 is substantially flat for 45 Mc/s signals between 5 uV and up to at least 1 volt, and is approx. 5 volts. Time constants of the grid resistor and capacitor combinations R23, C33 and C37,R37 have been chosen to minimise "impulse" type interference.

Discriminator

The diodes of Valves V9 and V10, diode pentodes type 1S5, in conjunction with discriminator transformer T10 provide what is basically a Foster-Seely discriminator of the "quadrature" type. Voltages approx. 180° out of phase appear across the diode load resistors R52, and R53 during frequency modulation. To combine these in order to feed into the unbalanced audio input, a transformer T1 is used. It is fed via resistors R30 and R31 and blocking capacitors C48 and C50.

Audio Amplifier

This stage employs the pentode sections of V9 and V10 hooked up as triodes in a two stage circuit, and has its gain controlled by the control "Volume", on the front panel R35. V10 is used as the first stage and is resistance-capacitance coupled to V9, the output valve, which feeds either 1 or 2 pairs of 150 ohm phones via step-down transformer T2. A compromise is used to achieve satisfactory matching with one or two pairs of phones. Resistor R36A is used to equalise signal levels on F.M. and A.M.

Decoupling

Due to the relatively high gains employed and the possibilities of spurious responses with the double superheterodyne, comprehensive decoupling has been applied to supplies, anode, filament, screen, and grid, of most stages.

Bias

Rectified grid current of the second doubler valve V13, across R58, gives approx. 1.5 volts bias to the Audio Valves V9 and V10, and on F.M. to the I.F. Valves V2, V5 and V6, and on A.M. to I.F. Valve V7.

2.09 Metering

In order to check supply voltages, and certain internal circuits a meter and selector switch are fitted. The working positions of the switch are:-

| | |
|---|---|
| L.T. | Meter reading 7.5 = 1.5 volts at the receiver battery socket. |
| H.T. | Meter reading 7.5 = 120 volts at the receiver battery socket. |
| M.A. | Meter reading 7.5 = 30 mA. (Total H.T. current at 120 volts.) |
| Conv. M.A. | Meter reading 1 to 1.5 = 50 to 75 uA H.T. for first mixer V1. |
| Drive | Meter reading 3.0 = 150 uA grid current for the second doubler valve V13, checking operation of most of the crystal chain, and also D.C. bias voltage to the audio and I.F. valves. |

2.10 Physical Description

The Receiver ZC.178 is completely sealed, gaskets, etc. being employed to make the unit air and water-tight. Components have been tropic proofed and where possible sealed. Particular attention has been paid to transformers and paper condensers. Wiring with a P.V.C. covering has been used.

Case

This is made of corrosion-resistant Birmabright light-alloy, welding being used for fabrication. The front opening is flanged, to provide a large sealing surface to the front panel of the receiver when used with a rubber gasket. Sixteen 4 BA M.T. screws are placed round this flange to give rigid fastening of the front panel. At the rear of the case a smaller flange is fitted, with a threaded collar for the easy fitting of a large silica gel desiccator. This desiccator has a window and indicates the presence of internal moisture by changing from its normal blue to pink. It may be easily removed and replaced from the outside. The case is anodised and impregnated with a phenolic varnish before painting, as a measure against porosity.

Receiver Chassis

A flat chassis has been used in order that access to parts both above and below chassis shall be relatively easy for service and maintenance. A rigid, corrosion-resistant cast silicon aluminium panel has been used. This is also impregnated and anodised. All components coming through the front panel, control shafts, connectors, meter, mounting screws, are fitted with greased rubber gaskets. The control shafts are passed through glands and toggle switches covered with flexible rubber covers. Connectors are internally sealed and the meter is double sealed for the protection of the meter, or the set if the meter glass should be broken.

Components

Audio transformers are, after drying and vacuum impregnation, sealed into metal boxes, connections being made by glass to metal seals. Wire gauges have been limited to 44 S.W.G.

Valve sockets, variable trimmers and V.H.F. sections of the band switch use ceramic insulation; phenolic switch wafers and terminal parts have been suitably impregnated; the crystals are sealed in polythene; coils are wound on a high-grade plastic former and are thoroughly impregnated after drying; paper condensers are with two exceptions sealed by



/means

means of neoprene plugs or bands and are used well below their rated voltages; most tuned circuits are adjusted by means of iron core cores (i.e. all except the V.H.F. signal circuits); sealed ceramic condensers have been used throughout for small values, (i.e. below 2,000 pf); all metal work has been plated with the exception of the flexible drive, which is greased, and the toggle switch seals, which must be of unplated brass in order to effect a bond.

## RECEIVER TEST FIGURES

2.11 Overall Sensitivities

| | A.M. Input for 15 dB S/N Ratio | F.M. Input for 15 dB Quieting |
|---|---|---|
| 45 Mc/s | 4 uV | 4 uV |
| 115 " | 4 " | 4 " |
| 235 " | 10 " | 10 " |
| 25 " I.F. | 5 " | 5 " |

4.9 I.F.

Input required to give output of 2 mW into 120 ohm output meter - 12 to 15 uV.

Volume Control - Maximum.

Signal generator connected to V3 grid.

Selectivity

The selectivity of the I.F.channel shall be symmetrical (within 5 kc) and between 50 and 60 kc/s wide at 2 times the input required for standard S/N and Quieting measurements.

Image Frequency Rejection Ratio

The image frequency rejection ratio shall be greater than -

20 to 1 on 45 Mc/s
20 to 1 on 115 Mc/s
8 to 1 on 235 Mc/s

Intermediate Frequency Rejection Ratio

The intermediate frequency rejection ratio shall be greater than -

25 to 1 on 45 Mc/s
100 to 1 on 115 Mc/s
25 to 1 on 235 Mc/s

Audio Frequency Output

The maximum power output of the receiver shall be at least 10 mW at all frequencies between 250 and 2,500 cycles per second.

H.T. Current

H.T. Current on A.M. operation = 30 mA
" " " F.M. " = 32 mA

L.T. Current

## Alignment Information

### 4.9 Mc/s I.F. Channel

Volume Control - maximum
System Switch at A.M.
Signal Generator to 4.9 Mc/s
120 ohm output meter to phones outlet.
Dummy antenna fed through 0.01 mica condenser

(1) Connect signal generator through 0.01 condenser to V7 grid. Align T9 and lock for maximum output on meter. Input should not exceed 100,000 uV for 2 mW output.

(2) Connect signal generator to V6 grid. Align T8 and lock. Input should not exceed 5,000 uV for 2 mW output.

(3) Connect signal generator to V5 grid. Align L5 and lock. Input should not exceed 150 uV for 2 mW output.

(4) Connect signal generator to V3 grid. Align L4 and lock. Input should not exceed 15 uV for 2 mW output.

### 20.1 Mc/s Local Oscillator (T7, V4)

(1) The receiver should be switched on in the Stand-by condition for at least thirty minutes before aligning the 20.1 Mc/s oscillator.

(2) "Trim Tune" control to centre position.

Adjust T7 to bring the local oscillator accurately to 20.1 Mc/s. Lock adjustment. Care must be taken to avoid frequency shift as this locking nut is being tightened.

NOTE: The use of a separate communications receiver is recommended for this alignment, as follows:-

Set signal generator with C.W. signal to 20.1 Mc/s accurately.
Tune in this signal on the communications receiver.
Adjust T7 to 20.1 Mc/s, using the communications receiver to detect the zero beat between the signal generator and ZC.170 receiver local oscillator.

### 25 Mc/s I.F. Channel

Volume Control - maximum.
System switch on A.M.
Set Signal Generator to 25 Mc/s.
Connect 120 ohm output meter to phones outlet.
Connect Signal Generator through 0.01 mica condenser to V2 grid.
Align T6 for maximum output on meter.
Input should not exceed 3 uV for 2 mW output.
Disconnect V1 grid lead.
Connect 100K resistor from V1 grid to ground.
Tune T5 for maximum output on meter.
Input should not exceed 10 uV for a S/N ratio of 15 dB.

### 70 Mc/s Channel

(1) (a) Set meter switch to "Drive" position.
(b) Set Band switch to 45 Mc/s, Channel 1.

(2) Adjust L6 to produce optimum oscillation of both crystals.

(3) Adjust T11 for maximum reading on meter.

(4) Adjust T12 for maximum reading on meter.

(5) Switch Band switch from Channel 1 to Channel 2. If the meter reading is not constant for the two channels, then readjust T11 and/or L6 to give the same reading on both channels.

(6) Set Meter switch to Conv. M.A. position.

(7) Adjust T13 for maximum dip.

(8) Lock all adjustments.

Adjustment of Signal Frequency Stage

Coils L1, L2 and L3 are each individually adjusted after being wired into the set and should not require any further adjustment.

If the aerial trimmer ceases to peak very weak signals then the adjustment of C1A should be suspected. (C1A is set to a capacity of 3 pF before being wired into the set and the coils L1, L2 and L3 adjusted to suit.)

If the alignment of C1A is attempted the following procedure should be followed.

Feed a signal via 70 ohm coaxial cable to the set from a signal generator on 235 Mc/s. Attenuate the input until signal is very weak. Set aerial trimmer to almost minimum capacity position. Adjust C1A for maximum signal. The aerial trimmer should trim at a position near its minimum capacity if the adjustment of C1A is correct. Check on 115 Mc/s and 45 Mc/s bands. The Aerial Trimmer should trim on each of these bands without alteration of C1A.

Alignment of Discriminator Transformer T10, on F.M.

(a) Set up as for alignment of 4.9 Mc/s I.F. Channel.

(b) Set signal generator accurately to 4.9 Mc/s in unmodulated condition.

(c) Set system switch to F.M.

(d) Connect signal generator to grid of V3 and adjust input to 20 uV.

(e) While listening on phones to noise output from set adjust T10 Primary tuning (top adjustment) for maximum noise output.
Then adjust Secondary tuning (bottom adjustment) for minimum noise output. This adjustment will be found to be quite critical and care must be taken when locking the adjustment.
A check, using a D.C. V.T.V.M. connected between chassis and firstly to the bottom end of R30 and then secondly to the bottom end of R31 should show equal negative voltages developed at these points if the T10 adjustments have been made correctly. The voltage developed at these points with 20 uV to grid of V3 should exceed 1.0 V with the signal generator tuned to resonance (4.9 Mc/s).

## DESCRIPTION OF SENDER ZC 178.

3 .01 Purpose

Sender ZC 178 is designed to emit amplitude modulated signals, or frequency modulated signals having a deviation of approximately ± 25 Kc/s, on or within 25 Kc/s of the following spot frequencies:-

(1) 45 m/cs. - .05 m/cs. = 44.950 m/cs.
(2) 45 m/cs. + .05 m/cs. = 45.050 m/cs.
(3) 115 m/cs. - .10 m/cs. = 114.90 m/cs.
(4) 115 m/cs. + .10 m/cs. = 115.10 m/cs.
(5) 235 m/cs. - .150 m/cs. = 234.850 m/cs.
(6) 235 m/cs. + .150 m/cs. = 235.150 m/cs.

Provision is made for modulation by speech, or from an internal audio oscillator of about 1,000 c/s for MCW Signalling or as a continuous tone source.

.02 Power Supply.

Sender ZC 178 is normally used with Battery ZC 178, supplies required are:-

LT, 1.5 volts at between .77 amps on 45 m/cs. F.M. and 1.33 amps on 235 m/cs. A.M.

HT, 120 volts at between 55 m.amps on 45 m/cs. F.M. and 115 M.amps on 235 m/cs. A.M.

The transmitter will operate with reduced performance when the supply voltage falls to:-

LT. 1.1 volts.

HT. 88 volts.

In the "Stand-by" position filament drain is approximately:-

.1 amps and H.T. = 5 m.amps.

.03 The Sender is designed to work into a co-axial cable, or unbalanced line, of 70 ohms impedance.

.04 Two connectors are provided for a Microphone and a Key, these connectors are wired with similar contacts in parallel. The Microphone, type TE No.1. Mk.II, having a nominal impedance of 75 ohms and the Key, Sykes Type S.230 normally supplied, are wired so that they can be plugged into either connector and can be left connected when not in use. Closing the key when in the AMRT or FMRT position, does not affect the sender in any way.

.05 The Battery cable is connected to the set by means of a 6 pin "Plessey" miniature sealed plug and socket.

/.06 Controls.

.06 Controls.

System Switch:- AMCW (Amplitude Modulated CW for Keyed signals or as AM Tone source).

AMRT (Amplitude Modulator Radio Telephony).

FMRT (Frequency Modulated Radio Telephony).

FMCW (Frequency modulated CW for Keyed signals, or as FM Tone source).

Band Switch:- (see .01 for frequencies).

Battery Switch:- OFF - ON.

Send - Stand by Switch.

Trim Tune:- See .07

Netting Switch:- Net - Normal.

Meter Switch:- See .08 Metering.

.07 Circuit.

(To be read in conjunction with circuit Fig. 5. and block diagram Fig. 4.)

Sender ZC 178 is a 26 valve unit with carrier frequency controlled by a combination of crystal oscillator and reactor valve controlled oscillator, and developed by frequency multiplier and amplifier valves.

.08 Circuit Analysis.

Sender ZC 178 can be divided roughly into 8 electrical sections:-

(a) A 2.083 mc/s frequency generator capable of being frequency modulated up to several Kc/s. but usually modulating within the band ± 2.083 Kc/s. when the reactor valve is fed from its appropriate audio source.

(b) A Crystal Oscillator section giving two spot frequencies 5.8292 mc/s and 5.8375 mc/s.

(c) A microphone pre-amplifier or audio oscillator section.

(d) An amplitude modulator section.

(e) A section producing a signal at 45 mc. ± 50 Kc/s. by combining (a) and (b) and multiplying and amplifying.

(f) A section producing a signal at 115 mc/s ± 100 Kc/s. by combining (a) and (b) and amplifying and multiplying.



/ (g)

(g) A section producing a signal at 235 mc/s ± 150 Kc/s. by combining (a) and (b) and amplifying and multiplying.

(h) Switching systems.

The use of the combination of frequencies gives easy band switching and netting in combination with receiver ZC 178 and an F.M. signal of identical characteristics, on each band. (i.e. Deviation is F.M'd Oscillator deviation X12 on all bands).

"2.083 mc Section" Valve V1, a pentode valve type IT4, is used as "reactance valve" frequency modulator. By means of a phase shift network in the control grid circuit, and out-of-phase voltage is applied back to the tuned circuit T1. The valve assumes the character of a capacitive reactance and therefore, increasing, negative bias on V1 causes the frequency to increase, less bias causes a decrease in osc. frequency. Approximately 1 volt RMS. A.C. is required across C.4. for a deviation of ± 2.083 Kc/s. in the 2.083 mc/s Oscillator Section. This is equivalent to ± 25 Kc/s at the carrier frequencies 45 mc/s, 115 mc/s and 235 mc/s.

Valve $V_2$, a hexode valve type IR5 is used with its inner control grid and screen grid forming, in conjunction with transformer $T_1$, an oscillator circuit with a nominal frequency of 2.083 m/cs. Using an "electron coupled" arrangement, the output is developed across R.12.

The secondary of transformer $T_1$, is tuned by means of three capacitors $C_{10}$, $C_{11}$, $C_{12}$, $C_{10}$ is an 80 pf silver mica condenser having a very small positive temperature coefficient, $C_{11}$ is a 20 pf. ceramic condense having a considerable negative coefficient. This combination gives a tuned circuit having very low thermal frequency drift. $C_{12}$ is a small trimmer in parallel with $C_{10}$ and $C_{11}$ & is controlled on the front panel by the knob "Trim Tune". The carrier frequency can be shifted by approx. ± 25 Kc/s. for netting, correction of slight defects in crystals, misalignment, or where intentional mistuning may be required for tests.

In addition to the use of a relatively large tuning capacity and the dividing of valve capacities in the reactor valve across the two coils of $T_1$, in order to minimise frequency changes due to mechanical variation of $V_1$ and $V_2$, three precautions are taken against electrical variations. The source of the 2.083 mc/s signal, valves $V_1$ $V_2$ and Transformer $T_1$, is not called on to supply any considerable power to the mixer valves $V_5$, $V_{14}$, $V_{21}$. Electron coupling is used to take the output from $V_2$, developed across a resistor and not a tuned circuit, in order to eliminate any "pulling" of the oscillator circuit.

/Secondly,

Secondly, via. a divider and filter circuit, part of the bias voltage of $V_2$ is fed to the control grid of $V_1$, and is so proportioned that, when correctly adjusted by means of potentiometer R8, frequency change due to supply voltage variation over quite wide ranges, is reduced to a negligible amount. This minimises errors due to netting and/or ageing batteries. Thirdly, the circuit constants of the reactance section and the Oscillator transformers have been chosen so that the reactance valve does not produce a very great control on frequency. Although this requires a somewhat larger audio voltage to effect the requireddeviation, it makes electrode potentials of valve $V_1$, non-critical and facilitates the adjustment of R8.

In the "Stand-by" position Valves $V_1$ and $V_2$ are still operating under normal conditions, although the other valves of the set are turned off. Slow frequency drift for some seconds after switching to "Send" is thus reduced to a negligible amount.

Valve $V_3$, a type IT4 pentode is used as a buffer stage between $V_2$ and the mixer valves $V_5$, $V_{14}$ $V_{21}$. Its output, at 2.083 mc/s. across $L_1$, is sufficient to saturate the mixer valves so that limiting of spurious AM on the FM signal results.

Crystal Section.

Oscillator.

The pentode section of valve $V_4$, a type IS5 diode-pentode, is used with screen connected to anode to form a triode. In the control grid circuit switch $S_{1A}$ selects crystal $X_1$ of 5.8292 mc/s, on position 1 of the 45 mc/s, 115 mc/s, 235 mc/s. bands, and $X_2$ of 5.8375 mc/s on position 2. Trimmer $C_{51}$ and $C_{52}$ allow the crystal frequencies to be varied by approximately 100 c/s, for correction of errors in the crystals, without great decrease in output. Output across the anode tank circuit $L_2$, tuned to a nominal frequency of 5.83 mc/s. is fed to four other sections, $V_5$, $V_{13}$, $V_{20}$, and the diode of $V_4$.

Bias.

The diode of $V_4$ is coupled via. $C_{18}$ to the anode circuit of $V_4$ and its rectified D.C. output is used, via a decoupling and dividing network, as bias for valves $V_{10}$, $V_{11}$, $V_{12}$.

Audio Section.

Valve $V_{10}$. a type IT4 pentode is used as a Class A voltage amplifier when the system switch is in the AMRT or FMRT positions. Input from the microphone is applied via $T_3$ to the grid of $V_{10}$ and output is across $R_{49}$ and $R_{50}$. In the AMCW or FMCW positions the tapped secondary of transformer $T_3$ is used as the phase reversing medium, and the valve acts as an audio oscillator, frequency being controlled largely by $R_{46}$, $C_{54}$, and $R_{43}$, $C_{52}$. As the output of $V_{10}$ as an

pre-amplifier the output is reduced across the network $R_{49}$, $R_{50}$. In the FM positions the output of $V_{10}$ is fed via switch $S_2B$ to the reactance valve $V_1$. In the AM positions the output is transferred to $V_{11}$ via $S_2B$, which also grounds the input of $V_1$.

Valve $V_{11}$.

This valve a type IT4 pentode connected as triode, is used as a Class A driver valve for $V_{12}$, to which it is transformer coupled. It receives LT power in the AM positions only.

Valve $V_{12}$, a type 3A4 pentode is used as a Class A audio amplifier and is the amplitude modulator valve. Series inverse feed-back is applied by the network $R_{61}$, $C_{61}$, $R_{59}$.

In the 45 mc/s position the entire secondary of $T_5$ is used to match to the 45 mc/s P.A. valve $V_9$. In the 115 and 235 mc/s positions part of the secondary is used to match to the valves $V_{18}$, $V_{19}$ and $V_{24}$, $V_{25}$, $V_{26}$.

Band Switching. This is controlled by switch $S_1$ and is effected as much as possible by switching of the LT supply. Switch $S_1$ has four sections:-

$S_{1A}$ a section selecting the crystal $X_1$ or $X_2$ as required to produce the higher or lower channel in the desired bands; $B_{1B}$ which selects the LT supply; $S_{1C}$ which switches the modulated HT supply to the modulated stages; $S_{1D}$ connects the aerial output connector to the 45 mc/s, 115 mc/s or 235 mc/s, Circuits $T_2$, $T_7$ or $T_9$ as required.

45 mc/s. Operation

When LT etc. is switched to the 45 mc/s section; $V_5$, $V_6$, $V_7$, $V_8$, $V_9$, the operation is:-

45 mc/s. Mixer.

Valve $V_5$ a type IR5 hexode combines the outputs of the 2.083 and 5.83 mc sections. The resultant output appears across L3 in position 1 and on the 45 mc/s Band, the frequencies are:-

5.8392 - 2.083 mc/s = 3.7458 mc/s.

and on position 2, frequencies are:-

5.8375 - 2.083 mc/s = 3.7541 mc/s.

45 mc/s. Tripler.

Valve V6 a type IT4 pentode triples the output frequency of V5. Output at frequency 11.2375 mc/s. is obtained in position 1 and at frequency 11.2625 mc/s in position 2.

45 mc/s. Amplifier.

Valve V7 a type IT4 pentode, is used to amplify the output of V6, while Tuned Circuits L4 and L5 are used to discriminate against a number of spurious signals appearing from the mixer, principally the 2nd harmonic of the crystal oscillator at a mean frequency of 11.6 mc/s. and the fifth and sixth harmonics of the 2.083 mc. section.

1st 45 mc/s Doubler. One half of Valve V8 a type 3A5 double triode, is used to double the output frequency of V7, giving frequencies of 22.475 mc/s or 22.525 mc/s. This section is designated $V8_A$.

2nd 45 mc/s Doubler. The output frequency of $V8_A$ across L6 is again doubled by $V8_B$ and output at 44.950 mc/s or 45.050 mc/s is developed across L7.

45 mc/s PA Stage. Valve V9, a type 3A4 pentode, is used as Class C Amplifier at all times. On AM it is anode and screen modulated. Screening and by-passing have made neutralisation unnecessary. Output across the Tank Circuit $C_{45}$ and primary of T2 at 44.950 mc/s, in position 1 of the band switch, and 45.050 mc/s in position 2, is fed by means of a link, to the 70 ohm co-axial cable and switch $S1_D$ to the aerial connector.

The Bandwidth and conditions of valve excitation are such that effective compromise tuning is possible for the two spot frequencies. It should also be pointed out that the required bandwidth and deviation of the stage is in proportion to its relationship to the output frequency. Thus L3 at $\frac{\text{output frequency}}{12}$ has to pass an FM deviation of only 2.083 kc/s and a displacement of crystal frequency of only 8.3 Kc/s.

115 mc/s Operation.

Crystal Doubler. Valve $V_{13}$, a type IT4 pentode connected as triode, doubles the output frequency of V4, its output being across L8.

115 mc/s Mixer. Valve $V_{14}$ a type IR5 hexode, combines the outputs of $V_{13}$, and $V_3$, resultant output is developed across L9. The frequencies are:-

Position 1. 5.8292 mc/s x 2 - 2.083 mc/s = 9.575 mc/
Position 2. 5.8375 mc/s x 2 - 2.083 mc/s = 9.591 mc/

115 mc/s Tripler. Valve $V_{15}$ a type IT4 pentode, triples the output frequency of $V_{14}$, frequencies are:-

1 = 28.725 mc/s.
2 = 28.775 mc/s.

115 mc/s 1st Amplifier Valve $V_{16}$ a type IT4 pentode, is used to increase the power output of $V_{15}$, in order to drive $V_{17}$ satisfactorily, and tuned circuits $L_{10}$ and $L_{11}$ discriminate against spurious frequencies from the mixer.

115 mc/s. 1st Doubler. Valve $V_{17}$ a type 3A4 pentode doubles in frequency th output of $V_{16}$ across $L_{11}$, output across L12 being at frequency 57.45 mc/s in position 1 and 57.55 mc/s in position 2.

/115 mc/s. 2nd Amplifier.

115 mc/s. 2nd Amplifier

Valve $V_{18}$, a type 3A4, pentode amplifies the output of $V_{17}$ so that adequate drive is available to $V_{19}$. Circuit $L_{12}$, and the tuned primary and secondary of T6 discriminate against spurious signals. On AM, $V_{18}$, a class C amplifier is anode and screen modulated, as well as $V_{19}$, in order to obtain satisfactory modulation.

115 mc/s Doubler - PA.

Valve $V_{19}$, a type 3A5 double triode, is operated as a "push-push" doubler: that is operation with grids driven 180° out pf phase and plates paralleled. Output across the tuned primary of $T_7$ is at 114.90 mc/s in position 1 and 115.10 mc/s in position 2. The secondary link couples the output to the 70 ohm output circuit. On AM, modulation is applied to the HT supply of $V_{19}$, as well as $V_{18}$.

235 mc/s Operation

Crystal Tripler.

Valve $V_{20}$, a type IT4 pentode, triples the output frequency of the crystal oscillator $V_4$. Its output is across $L_{13}$.

235 mc/s Mixer.

Valve $V_{21}$, a type IR5 hexode, combines the outputs of $V_{20}$ and $V_3$, the resultant output is across $L_{14}$. The required frequencies are:-

Position 1 = 5.8292 mc/s x 3 - 2.083 mc/s = 19.5708 mc/s.
Position 2 = 5.8375 mc/s x 3 - 2.083 mc/s = 19.5958 mc/s.

235 mc/s 1st Amplifier

Valve $V_{22}$, a type IT4 pentode, amplifies the output of $V_{21}$. Circuits L14 and L15 discriminate against spurious signals from the mixer.

235 mc/s. Tripler.

Valve V23, a type 3A4 pentode, triples the output frequency of V23, its output frequency across L16 being:-

Position 1 = 58.7125 mc/s.
Position 2 = 58.7875 mc/s.

235 mc/s. 2nd Amplifier

Valve $V_{24}$, a type 3A4 pentode, amplifies the output of $V_{17}$, so that adequate drive is available to V25. Circuit $L_{16}$ and the primary and secondary of T8 discriminate against spurious signals. On AM, $V_{24}$, a Class C amplifier, is anode and screen modulated as well as as $V_{25}$ and $V_{26}$, in order to obtain satisfactory modulation.

235 mc/s 1st Doubler.

Valve $V_{25}$, a type 3A5 double triode, is operated as a "push-push" doubler. Voltages 180° out of phase are obtained from the tuned secondary of T8 and applied to the grids. Output from $V_{25}$ is developed in the circuit $L_{17}$, which is basically a pi network using the output capacities of $V_{25}$ and the input capacity of $V_{26}$ as circuit elements. Output frequencies of $V_{25}$ are:-

Position 1 = 117.425 mc/s.

235 mc/s
2nd Doubler/PA

Valve $V_{26}$ is a type 3A5 double triode, one half of which is used. It doubles the output frequency of $V_{25}$ and output is taken at 235 mc/s by means of a series "tank" circuit, the primary of $T_9$, the condenser $C_{113}$, the output capacity of $V_{26}$ completing the circuit. The secondary link couples the output to the 70 ohm output system. Output frequencies are :-

Position 1 = 234.850 mc/s.
Position 2 = 235.150 mc/s.

On A.M. $V_{26}$ is anode modulated in conjunction with $V_{24}$ and $V_{25}$.

Switching Systems.

In addition to the Band switch $S_1$, already described five other switches are used.

System Switch S2.

This is a wafer switch whose main functions are:- the changing of the pre-amplifier valve, $V_{10}$, from an audio oscillator in the AMCW and FMCW position to a microphone pre-amplifier, switching the output of $V_{10}$ to either the FM modulator or to the AM modulator, and turning off the AM modulator section by removal of LT supply when the set is used on FM.

Battery Switch.

$S_5$ a double-pole single throw toggle switch breaks both HT and LT supplies in the "OFF" position.

Stand-by Switch.

$S_4$, also a double-pole single-throw toggle switch operates with sections paralleled, to break the LT supply to all valves except $V_1$ and $V_2$ when in the "Stand-by" position.

Netting Switch.

$S_3$ is a wafer type switch. In the "Net" position, HT supply to the final amplifier valve and sections of the multiplier channel of the band used is reduced to provide a small netting signal for the local receiver. Should $S_4$ be in the "Stand-by" position, one section of $S_3$ in parallel brings on the LT supply without re-setting of $S_4$.

Metering Switch and Metering.

To assist in the operation of the set a meter and switch are built into the sender. With this it is possible to check rapidly.

(a) Combined plate and screen currents of the modulated stage or stages in the Ip P.A. setting

(b) H.T. supply voltage; H.T.

(c) L.T. " " L.T.

(d) P.A. stage grid current; Ig P.A.

(e) Crystal Oscillator operation; and Audio bias supply; C.O.

(f) Aerial feeder voltage; Aer.

Position 1 = 234.850 mc/s.
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Battery Switch.

$S_5$ a double-pole single throw toggle switch breaks both HT and LT supplies in the "OFF" position.

Stand-by Switch.

$S_4$, also a double-pole single-throw toggle switch operates with sections paralleled, to break the LT supply to all valves except $V_1$ and $V_2$ when in the "Stand-by" position.

Netting Switch.

$S_3$ is a wafer type switch. In the "Net" position, HT supply to the final amplifier valve and sections of the multiplier channel of the band used is reduced to provide a small netting signal for the local receiver Should $S_4$ be in the "Stand-by" position, one section of $S_3$ in parallel brings on the LT supply without re-setting of $S_4$.

Metering Switch and Metering.

To assist in the operation of the set a meter and switch are built into the sender. With this it is possible to check rapidly.

(a) Combined plate and screen currents of the modulated stage or stages in the Ip P.A. setting

(b) H.T. supply voltage; H.T.

(c) L.T. " " L.T.

(d) P.A. stage grid current; Ig P.A.

(e) Crystal Oscillator operation; and Audio bias supply; C.O.

(f) Aerial feeder voltage; Aer.

In this position, the meter reading does not depend solely on feeder voltage. Circuit elements $C_{47}$, $R_{41}$, $C_{48}$ and RFC3 are proportioned so that the 235 mc/s. output is favoured, in order that meter readings of similar magnitudes shall be obtained on each band. Resistor R68 is made variable so that correction may be made for the variations in the silicon crystal rectifier

.09 Physical Description.

The Sender ZC 178 is completely sealed, gaskets, etc. being employed to make the unit air and water tight. Components have been tropic-proofed and where possible sealed. Particular attention has been paid to transformers and paper condensers. Wiring with a P.V.C. covering has been used.

Case.

This is made of corrosion-resistant Birmabright Light Alloy, welding being used for fabrication. The front opening is flanged, to provide a large sealing surface to the front panel of the receiver when used with a rubber gasket. 16 - 4 B.A. M.T. Screws are placed round the flange to give rigid fastening to the front panel. At the top of the case a smaller flange is fitted, with a threaded collar for the easy fitting of a large silica gel desiccator. The desiccator has a window and indicates the presence of internal moisture by changing from its normal blue to pink. It may be easily removed and replaced from the outside. The case is anodised and impregnated.

Sender Chassis.

In order to simplify construction and testing, two chassis have been used in Sender ZC 178. The front chassis, (i.e. near the panel), carries the crystal oscillator, 2.083 mc/s section, Audio section, (pre-amplifier and AM modulator), 45 mc/s section and all switching. It thus constitutes a complete 45 mc/s sender. The rear section carries the complete 115 mc/s and 235 mc/s sections. Both chassis are shallow in order that easy access is given to parts above and below for ease of servicing and maintenance. A rigid, corrosion-resistant aluminium panel has been used. All components passing through the front panel, control shafts, connectors, meter, mounting screws, are fitted with greased rubber gaskets. The control shafts are passed through glands and the toggle switches are covered with flexible rubber covers. Connectors are internally sealed and the meter is double sealed, for the protection of the meter, or the set, if meter glass should be broken.

Components.

Audio transformers are, after drying and vacuum impregnation, sealed into metal boxes, connectors being made by glass to metal seals. Wire gauges have been limited to 44 S.W.G.

Valve sockets, variable trimmers, and V.H.F. sections of the band switch, use ceramic insulation. Phenolic switch wafers and terminal panels have been suitable impregnated; crystals are sealed in polythene; coils are wound one a high-grade plastic former and are thoroughly impregnated after drying; paper condensers are with but three exceptions,

(sealed

sealed by means of neoprene sleeves or plugs and are used well below their rated voltages; most tuned circuits are adjusted by means of iron cores (i.e. all except most of the V.H.F. circuits); sealed ceramic condensers have been used throughout for small values, (i.e. below 2,000 pf); all metal has been plated except the toggle switch seals, which must be unplated brass in order to effect a bond.

3.10 Alignment Procedure, Sender ZC 178.

(1) Set Controls.

Band Switch to 45 mc/s Position 1.

System Switch to FMCW.

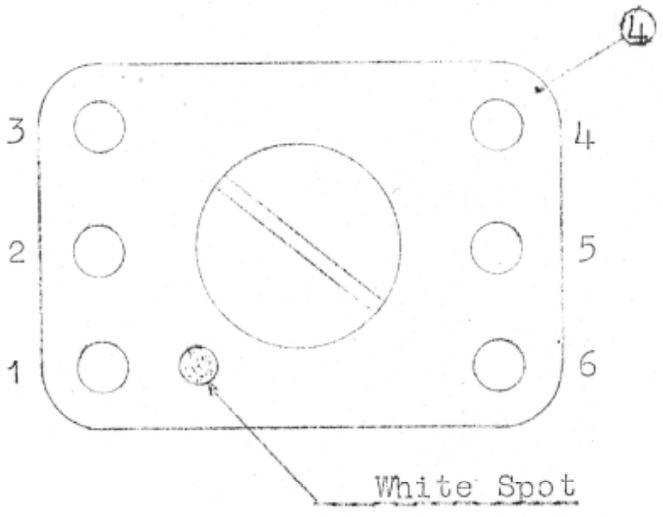
Meter Switch to CO.

Stand-by Switch : ON.

Net Switch : Net.

Trim Tune : Top centre.

(2) Connect Battery, Fit 70 ohm Dummy Aerial and output indicator. Connect the positive terminal of a 0-500 micro amp. meter to chassis. Connect the negative terminal to Lug 4 of L2. (That is across resistor $R_{20}$).




VIEW OF COIL CONNECTIONS

(3) Switch Sender Battery ON.

V4 (4) Adjust the iron core position of L2 for maximum meter reading. The meter on the Sender should be giving a reading of approx. 5; it should not be less than 4. Check that comparable readings are obtained on 45 Mc/s position 2. Lock adjustment by means of nut.

V1 V2 (5) Using an accurate heterodyne wavemeter, or calibrator-receiver combination, set adjustment of T1 to 2.083 Mc/s. Carefully lock adjustment by means of nut. Check that locking has not shifted the frequency substantially.

V3 (6) Check meter reading across R14. Connect meter to Lug 4 of L1. Adjust L1 for maximum meter reading and lock adjustment.

45 Mc/s Section

V5 (7) With meter to Lug 4 of L3, adjust for maximum reading. Lock.

V6 (8) With meter to Lug 4 of L4, adjust for maximum reading. Lock.

V7 (9) With meter to Lug 4 of L5, adjust for maximum reading. Lock.

V8A (10) Switch from NET to NORMAL position.

(11) With meter to Lug 4 of L6, adjust for maximum reading. Lock.

V8B (12) With meter to Lug 4 of L7, adjust for maximum reading.

V9 (13) Remove meter, adjust C45 for maximum output to the Dummy Aerial.
Switch the Sender Meter to $I_gPA$. Check that L7 is set for best reading, approx. 3.0.
Check $I_pPA$, reading should be approx. 3.0. Lock trimmer by means of collar.

"Aer" Metering (14) Turn potentiometer R68 to maximum resistance position (anti-clockwise). Switch Sender Meter to "Aer.". Set R68 for reading of 9.0.

115 Mc/s Section

(15) Set Band switch to 115 Mc/s, position 1; net switch to NET.

V13 (16) With meter connected to Lug 4 of L8, adjust for maximum reading. Lock.

(17) Check meter reading across R20 (See 4 for connection).

V14 (18) Check meter reading across R17 (See 6 for connection).

(19) With meter connected to Lug 4 of L9, adjust for maximum reading. Lock.

V15 (20) With meter connected to Lug 4 of L10 adjust for maximum meter reading. Lock.

V16 (21) With meter connected to Lug 4 of L11, adjust for maximum meter reading. Lock.

NORMAL. Adjust L12 for maximum reading. Lock.

V18 (23) With Sender Meter set to $I_g$PA, adjust the iron core of the primary of T6 and, using a low-capacity screwdriver, adjust the trimming capacitor C85 across the secondary. When the circuit is tuned readings of $I_g$PA should be approx. 4.0.

V19 (24) Adjust C87 for maximum output. Meter reading on "Aer" should be approx. 9.0, $I_p$PA 6.5. Lock the trimmer by means of the threaded collar.

(25) Check tuning of T6 for maximum $I_g$PA reading. Lock

235 Mc/s Section

(26) Set Band Switch to 235 Mc/s, position 1; Net switch to NET.

V20 (27) With meter connected to Lug 4 of L13, adjust for maximum meter reading. Lock.

(28) Check meter reading across R20 (See 4 for connection).

V21 (29) Check meter reading across R17 (See 6 for connection)

(30) With meter across R102, adjust L14 for maximum reading. Lock. (Care must be taken to tune to the heterodyne frequency approx. 19.58 Mc/s, and not the crystal channel frequency at approx. 17.5 Mc/s.)

V22 (31) With meter across R106, adjust L15 for maximum reading. Lock.

V23 (32) With meter across R110, switch to NORMAL. Adjust L16 for maximum reading.

V24 (33) With meter connect BY MEANS OF A SERIES 47 K RESISTOR across R114, adjust the primary and secondary of T8, by means of the iron core in the primary and the trimmer C109 across the secondary for maximum meter reading.

V25 (34) Switch Sender Meter to $I_g$PA. With a low-capacity insulated screwdriver adjust C111 for maximum reading.

V26 (35) Adjust C113 for maximum output.

(36) Remove meter connection from R114. Check that adjustments of T8, L17, C113 are all optimum. Lock adjustments.

(37) Sender Meter readings should be approx., $I_p$PA = 9.0; $I_g$PA = 5.5; Aer. = 2.5.

(38) Check plate current of V1. This should be 0.8 mA. Adjustment is by means of R8.

For critical setting of frequency, the above alignment process should be carried out and then the set allowed to run in the F.M. C.W. 45 Mc/s, position 1 for approximately a quarter of an hour.

Crystal frequencies should be adjusted only if a very accurate frequency standard is available. Changes of about 100 c/s at the crystal frequency can be reasonably effected by means of C52 for X1 and C51 for X2.

With the "Trim Tune" control in the top centre position, operation 5 should be repeated carefully.

## SENDER GRID CURRENTS

| Tube | Type | Grid Current | Remarks |
|---|---|---|---|
| V2 | IR5 | 300 uA | F.M. osc. Across botton 4.7 K |
| V3 | IT4 | 20 " | |
| V4 | IS5 | 200 " | Crystal oscillator. |
| V5 | IR5 2.083 | 400 " | |
| | 5.8 | 100 " | |
| V6 | IT4 | 100 " | |
| V7 | IT4 | 90 " | |
| V8 | 3A5 A | 160 " | |
| | B | 400 " | |
| V9 | | 100 " | Across 2 K to earth. |
| V13 | IT4 | 100 " | |
| V14 | IR5 5.8 | 100 " | |
| | 2.08 | 400 " | |
| V15 | IT4 | 75 " | |
| V16 | IT4 | 50 " | |
| V17 | 3A4 | 40 " | |
| V18 | 3A4 | 220 " | |
| V19 | 3A5 | 200 " | |
| V20 | IT4 | 100 " | |
| V21 | IR5 5.8 | 100 " | |
| | 2.08 | 400 " | |
| V22 | IT4 | 100 " | |
| V23 | 3A4 | 70 " | |
| V24 | 3A4 | 100 " | |
| V25 | 3A5 | 110 " | Meter through 4.7 K. |
| V26 | 3A5 | 300 " | |

## SENDER METER READINGS

| | | |
|---|---|---|
| Aer. | 45 Mc/s | 8.0 |
| | 115 Mc/s | 9.0 |
| | 235 Mc/s | 3.0/2.5 |
| C/O | | 5.0 |
| $I_g$mA | 45 Mc/s | 3.0 |
| | 115 Mc/s | 4.0 |
| | 235 Mc/s | 5.5 |
| H.T. | | 7.5 |
| L.T. | | 7.5 |
| $I_p$mA | 45 Mc/s | 3.0 |
| | 115 Mc/s | 6.5 |
| | 235 Mc/s | 9.0 |

/4.01. Description of Battery.

## DESCRIPTION OF BATTERY ZC.178.

4.01 Battery ZC.178 is intended for use with either Receiver ZC.178 or Sender ZC.178.

It provides power at the two required voltages. 1.5 volts L.T. and 120 volts H.T.

L.T. supply is derived from two No.6 cells in parallel, H.T. is obtained normally from eleven 12 volt blocks, each containing 8 type Eveready U11 cells, (U.S. No.935) internally connected and sealed with a low-leakage insulating material. The H.T. supply is built up in this way to lower internal battery leakage and deterioration.

Connection between H.T. blocks is obtained by using a moulded connector block. A 250 mA fuse is included in the negative lead as a precaution against short-circuits from H.T. battery to case as well as low resistance short-circuits in the sender or receiver or supply cables.

Connections are made to the unit by means of a 6 pin "Plessey" miniature sealed socket.

The case is similar in size to the sender case, It is fitted with a similar flange at the front, but has no desiccator. 8 Studs are fitted for attaching the front panel. The case is fabricated from Birmabright Light Alloy sheet and anodised and impregnated before painting.

The front Panel is cast silicon aluminium, 8 No.2 B.A. Wing Nuts are used to secure the Front Panel to the studs.

The unit is not completely sealed, although quite secure from ordinary rain etc. This is necessary in order to allow the battery to "breathe".

Although the output voltage from 88 cells is nominally 132 volts, this voltage is obtained for a short period only, quickly falling under load. To prolong battery life by extending working on the more stable part of the discharge curve, the Sender and Receiver are operated with slightly excessive H.T. voltage during initial operation with a new battery

## WORKING LIFE OF BATTERY ZC.178.

4.02

| | |
|---|---|
| Receiver only, ON continuously | 20 hours |
| " " ON 8 hours, OFF 16 hours | 25 " |
| Sender only, ON continuously, 45 mc/s. F.M. | 12 " |
| " " ON 8 hours, OFF 16 hours, 45 mc/c. F.M. | 16 " |
| " " ON continuously 235 mc/s. A.M. | 8 " |
| " " ON 8 hours, OFF 16 hours, 235 mc/s. A.M. | 10 " |

Average Working life.

| | |
|---|---|
| Receiver and Sender Combined Supply 1.3 S.R. ratio, Average drain = L.T. 1 Amp. H.T. 60 m.Amps. | 10 hours. |
| Receiver and Sender Separate Supply 1.3 S.R. ratio. | 30 hours. |

The Separate Sender and Receiver Supply life may be extended by exchanging Batteries at periods of about eight hours in order to equalise battery life.

Where Sender and Receiver are operated close together, particularly when the Sender is to be used for long continuous periods, best Battery life is obtained by paralleling Sender and Receiver Batteries by means of the long Battery Cable and alternative Sockets on the Battery Unit.

Best battery life is obtained on F.M. and the 45 mc/s. band.

## REPLACEMENT OF H.T. AND L.T. BATTERIES.

4.03 When replacing H.T. and L.T. batteries reference should be made to Fig.7 and PLATES 25, 26, 27, 28 and 29. H.T. batteries (11 x 12 volt blocks) are connected in series commencing with the bottom left hand block, the positive lead of which goes to the "+" terminal of the connector strip and finishing with the negative lead from the top right hand battery connected to the "-" terminal of the connector strip. Intermediate battery junctions are commoned and clamped in sequence along the connector strip. The L.T. battery (2 x No.6 Dry Cells in parallel) are connected by the "Red" jumper lead bridging the positive terminals and the "Black" jumper lead bridging the negative terminals. It is advisable to check voltage and connections. Place the rubber packing in position before securing the case lid by means of wing nuts.

It is important that discharged batteries be not left in the battery case.

## AERIAL SYSTEMS.

5.01 The input impedance of Receiver ZC.178 and the output impedance of Sender ZC.178 are both nominally 70 ohms. They are suitable for use with unbalanced lines only. The Pye sealed Co-axial Connector, used on both units, is designed to be used in conjunction with Uniradio 32 Cable, or equivalent.

Three Aerial systems are provided for both Receiver and Sender ZC.178 when used as a portable station:-

(a) 45 mc/s Whip aerial sections, and a coupling unit. (3 sections, 2 x 4', 1 x 2' approx. Total 10')

(b) 115 mc/s Whip aerial section and a matching stub. (1 x 4' section)

(c) 235 mc/s combined Whip aerial and matching stub.

The radiating section of each system is one half wavelength long.

## ADJUSTMENT OF 45 Mc/s. AERIAL MATCHING UNIT.

5.02 This unit should not need re-adjustment. If it should be necessary:-

(1) Set up Sender ZC.178 on open ground.

(2) Remove bottom cover of Matching Unit and replace with a dummy unit with hole for insertion of a box spanner, for adjustment of the trimmer.

(3) Fit the appropriate aerial rods (10 feet).

(4) Connect Matching Unit to Sender by means of the short co-axial cable.

(5) Set Sender switches to give an unmodulated 45 Mc/s. Signal and meter showing "Aer."

(6) Adjust trimmer for maximum reduction of "Aer." reading.

(7) Seal Trimmer.

(8) Replace bottom cover of Matching Unit and screw down, making sure that the Gasket is in position.

## PORTABLE OPERATION

### 6.01 Introduction

Sender and Receiver ZC.178 are each provided with an Everest Type Carrier. On this can be carried and mounted:-

One Receiver or one Sender ZC.178.
One Power Supply ZC.178.
One 45 Mc/s., 115 Mc/s., or 235 Mc/s. Aerial System as required.

Spare valves etc. are carried in a Spare Valves Box which, along with the Microphone and Key, is normally carried in the Sender Signals Satchel. Headphones etc. are carried in the Receiver Signals Satchel.

One complete Aerial System per Sender and one per Receiver are carried in separate aerial bags.

### 6.02 Receiver ZC.178 operation with power supply ZC.178; carrier, everest, modified, and whip aerial system.

**Setting up station**

.01 Check that battery switch is in OFF posn.
.02 Fit battery connector (short).
.03 Fit one or two pairs of headsets ITE, No.1 Mk.II.
.04 Fit aerial bracket.
.05 Fit aerial system for required band (45, 115 or 235 M/c.)
.06 Connect aerial system to receiver with short co-axial connector.

**Setting up controls**

.07 Set system switch (A.M.-F.M.) and band switch as required.
.08 Set volume control to maximum (fully clockwise) position.
.09 Set trim tune and aerial trim controls to top centre position.
.10 Set stand by switch in ON position.

**Operation**

.11 Turn battery switch ON.
.12 Check L.T. 7.5, H.T. 7.5, M.A. 7.5, Conv. M.A. 1 to 1.5, Drive 3.0
.13 Tune in signal by means of trim tune.
.14 Adjust trim aerial for best reception.
.15 Adjust volume control for required loudness.

**Stand by**

.16 In the interest of battery economy, and the prevention of accoustic feedback, switch the receiver to stand by when the local sender ZC.178 is ON. No damage results if the receiver is left ON. It may be used occasionally for monitoring the local sender.

**Changing Band**

.17 If a new band is selected, the aerial system must be changed accordingly. When changing channel or band, under good signal conditions, normally no resetting of controls is required. For weak signals slight adjustments of trim tune, trim aerial and volume may be necessary.

**Changing System**

.18 When changing from F.M. to A.M. normally no adjustment of controls is required. With weak signals some re-adjustment of volume and trim tune may be necessary, particularly if signals have not been accurately tuned in.

Switch set off when not in use.

6.03 Sender ZC.178 operation with power supply ZC.178: carrier, everest, modified, and whip aerial system.

**Setting up station**

.01 Check that battery switch is in OFF position.
.02 Fit battery connector (short).
.03 Fit microphone.
.04 Fit key.
.05 Fit aerial bracket.
.06 Fit aerial system for required band (45, 115, or 235 M/C.)
.07 Connect aerial system to sender with short co-axial connector.

**Setting up controls**

.08 Set system switch and band switch as required.
.09 Set trim tune control to top centre position.
.10 Set net/normal switch in normal position.
.11 Set stand by switch in stand by position.

**Operation R.T. (A.M. or F.M.)**

.12 Switch battery ON.
.13 Change stand by switch to ON position to send.
.14 Speak into microphone at ordinary conversation level, and with microphone 2 to 3 inches from mouth.
.15 Switch back to stand by position when receiving.

**Operation M.C.W. (A.M. or F.M.)**

.16 As for R.T. except .14, key may be used for morse signalling or for controlling of M.C.W. oscillator as a tone source.

/Checking operation

**Checking operation**

.17 Meter readings H.T. 7.5, L.T. 7.5, C.O. 5.0 $I_p$PA. 45 M/c 3.0, 115 M/c 6.5, 235 M/c 9.0. $I_g$PA. 45 M/c 3.0, 115 M/c 4.0, 235 M/c 5.5. Aerial with appropriate aerial system (approx.) 45 M/c 8.0, 115 M/c 9.0, 235 M/c 2.5/3.0

.18 Listen to sender on local receiver.

**Changing system**

.19 Normally no change to control settings other than the system switch is required.

**Changing channel or band**

.20 Normally no change other than band switching is required. When working as a "net", it may be desirable to check netting.

**Netting**

.21 Out-stations tune receivers to control stations sender signal. Senders at out--stations being set up as in .01 to .11 When the signal to net is given, out--stations turn the net/normal switch to net and adjust the sender trim tune for zero-beat. The netting signal given by the sender is sufficient for operation under normal signal conditions when receiver and sender are separated by not more than about 10 yards.

**Battery consumption**

.22 A.M. requires more H.T. and L.T. power than F.M. Consumption increases with frequency 45 M/c F.M. is therefore the most economical usage.

Switch set off when not in use.

TESTS OF WIRELESS SET ZC.178 carried out by

the NATIONAL PHYSICAL LABORATORY, TEDDINGTON,

26 April 1946.

Measured power radiated from half-wave aerial systems

| | | |
|---|---|---|
| 235 Mc/s. | = | 120 milliwatts. |
| 115 Mc/s. | = | 480 " |
| 45 Mc/s. | = | 720 " |

Measured sensitivity (A.M.) to half-wave aerial system for S = N

| | | |
|---|---|---|
| 235 Mc/s. | = | 4.4 micro-V/m. |
| 115 Mc/s. | = | 0.76 " |
| 45 Mc/s. | = | 1.4 " |

The sensitivity on 45 Mc/s. is shown lower than 115 Mc/s. Considerable interference from automobile ignition was experienced which created an abnormally high noise level on 45 Mc/s.

# TABLE OF COMPONENT VALUES FOR RECEIVER ZC.178

## RESISTORS

| Circuit Ref. | Value in ohms | Type | Wattage | Tolerance + or - | Function |
|---|---|---|---|---|---|
| R1 | 10 meg. | Erie or Morgan insulated carbon | 1/10 | 10% | V1 grid resistor (S1) |
| R2 | 68,000 | " " " | 1/10 | " | V1 plate dropping |
| R2A | 15,000 | " " " | 1/10 | " | V1 " " deviding |
| R3 | 47,000 | " | 1/10 | " | V1 plate devider (S1) |
| R4 | 27,000 | " " " | 1/10 | " | V1 " " (S1) |
| R5 | 1,000 | " " " | 1/10 | " | V1 metering |
| R6 | 470,000 | " " " | 1/10 | " | V2 grid resistor (T5) |
| R7 | 47,000 | " " " | 1/10 | " | V2 screen dropping |
| R8 | 15,000 | " " " | 1/16 | " | V2 plate dropping (T6) |
| R9 | 4.7 meg. | " " " | 1/16 | " | V3 grid resistor (T6) |
| R10 | 27,000 | " " " | 1/10 | " | V4 " " (T7) |
| R11 | 47,000 | " " " | 1/10 | " | V4 screen dropping |
| R12 | 15,000 | " " " | 1/10 | " | V4 plate " |
| R13 | 27,000 | " " " | 1/10 | " | V3 plate dropping (L4) |
| R13A | 10,000 | " " " | 1/10 | " | V3 " " devider |
| R14 | 100,000 | " " " | 1/10 | " | V5 grid resistor (L4) |
| R15 | 100,000 | " " " | 1/10 | " | V5 A.V.C. feed resistor |
| R16 | 47,000 | " " " | 1/10 | " | V5 screen dropping |
| R17 | 15,000 | " " " | 1/10 | " | V5 plate " (L5) |
| R18 | 470,000 | " " " | 1/10 | " | V6 grid resistor (L5) |
| R19 | 100,000 | " " " | 1/10 | " | V6, A.V.C., feed resistor |
| R20 | 1 meg. | " " " | 1/10 | " | A.V.C. filter resistance |
| R21 | 47,000 | " " " | 1/10 | " | V6 screen dropping |
| R22 | 15,000 | " " " | 1/10 | " | V6 plate dropping |
| R23 | 47,000 | " " " | 1/10 | " | V7 grid resistor (T8) |
| R24 | 6,800 | " " " | 1/10 | " | V7 plate dropping (T9) |
| R25 | 47,000 | " " " | 1/10 | " | V7 " " |
| R26 | 27,000 | " " " | 1/10 | " | V8 grid resistor (T9) |
| R27 | 470,000 | " " " | 1/10 | " | V8 diode load (T9) |
| R28 | 100,000 | " " " | 1/10 | " | V8 screen dropping |
| R29 | 68,000 | " " " | 1/10 | " | V8 plate dropping |
| R30 | 47,000 | " " " | 1/10 | " | V10 diode R.F. filter |
| R31 | 47,000 | " " " | 1/10 | " | V9 " " " |
| R32 | 100,000 | " " " | 1/10 | " | V9 " load |
| R33 | 100,000 | " " " | 1/10 | " | V10 " " |
| R34 | 68,000 | " " " | 1/10 | " | V7 screen dropping resis. |
| R35 | 1 meg. | Pot. Morgan, B.J. | | | Volume control |
| R36 | 1.5 meg. | " " | 1/10 | " | V10 grid resistor |
| R36A | 2.2 meg. | " " | 1/10 | " | FM-AM equaliser resistor (S2) |
| R37 | 470,000 | " " | 1/10 | " | V10 plate resistance |
| R38 | 1 meg. | " " | 1/10 | " | V9 grid " |
| R39 | 10,000 | " " | 1/10 | " | V9 plate dropping |
| R40 | 1.9 ohms | " " | 1/4 | " | Ip. shunt resistor |
| R41 | 220,000 | Erie or Morgan insulated carbon | 1/10 | " | Standby H.T. dropping |
| R42 | 3,900 | " " " | 1/10 | " | L.T. metering |
| R43 | 180,000 | " " " | 1/10 | " | H.T. " |
| R43A | 180,000 | " " " | 1/10 | " | H.T. " |
| R44 | 15 | " " " | 1/10 | " | Meter series resis. for Ip |
| R45 | 100,000 | " " " | 1/10 | " | V11 grid resistor |
| R46 | 15,000 | " " " | 1/10 | " | V11 screen dropping (L6) |

/R47

TABLE OF COMPONENT VALUES FOR RECEIVER ZC.178

RESISTORS (Contd.)

| Circuit Ref. | Value in ohms | Type | Wattage | Tolerance + or - | Function |
|---|---|---|---|---|---|
| R47 | 22,000 | Erie or Morgan insulated carbon | 1/10 | 10% | V11 plate dropping |
| R48 | 270,000 | " " " | 1/10 | " | V12 grid resistor |
| R49 | 47,000 | " " " | 1/10 | " | V12 screen dropping |
| R50 | 15,000 | " " " | 1/10 | " | V12 plate " |
| R51 | 100,000 | " " " | 1/10 | " | V13 grid resistor |
| R52 | 4,700 | " " " | 1/10 | " | V13 plate dropping |
| R53 | 10,000 | " " " | 1/10 | " | V13 bias network |
| R54 | 2,200 | " " " | 1/10 | " | V13 metering (drive) |

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WOOLWICH COMMON,
LONDON, S.E.18.
15th April, 1946.
PBA/JS

TABLE OF COMPONENT VALUES FOR RECEIVER ZC.178 (Contd.)

CONDENSERS

| Circuit Ref. | Value | Type | Volt. Rating | Tol. + or - | Function |
|---|---|---|---|---|---|
| C 1 | 18.5 pf max | Ingersoll 130B. Var. | - | - | Aerial Trimmer (32 TPI Bush) |
| C 1A | 1-7 pf | Ingersoll 153. Var. | - | - | Aerial series trimmer |
| C 2 | 51 pf | Erie N750K ceramic | - | 2% | V1 grid condenser |
| C 3 | 5.6 pf | " " " | - | 10% | V1 plate tuning (T5) |
| C 4 | .05 mfd | Dubilier Type 142 | 250 | - | V1 plate bypass |
| C 5 | 20 pf | Erie N750K ceramic | - | 2% | V2 grid coupling (T5) |
| C 6 | .1 mfd | Dubilier Type 412 | 150 | - | V2 filament bypass |
| C 7 | .05 mfd | " " " | 250 | - | V2 screen bypass |
| C 8 | 20 pf | Erie N750K ceramic | - | 2% | V2 plate tuning (T6) |
| C 9 | .05 mfd | Dubilier Type 412 | 250 | - | V2 plate bypass |
| C10 | 51 pf | Erie N750K ceramic | - | 2% | V3 grid coupling (T6) |
| C11 | 5.6 pf | " " " | - | 10% | V3 oscillator coupling |
| C12 | 51 pf | " " " | - | 2% | V4 grid condenser (T7) |
| C13 | 51 pf | " " " | - | 2% | V4 plate tuning (T7) |
| C14 | c.2pf max | Ingersoll 130B. Var. | - | - | Oscillator trimmer |
| C15 | 1000 pf | Erie K1200L ceramic | - | 5% | V4 plate bypass |
| C16 | .05 mfd | Dubilier Type 412 | 250 | - | V4 screen " |
| C17 | .1 mfd | " " " | 150 | - | V4 filament " |
| C18 | .1 mfd | " " " | 150 | - | V3 " " |
| C19 | .05 mfd | " " " | 250 | - | V3 plate " |
| C20 | 20 pf | Erie N750K ceramic | - | 2% | V3 plate tuning (L4) |
| C21 | 51 pf | " " " | | 2% | V5 grid coupling (L4) |
| C22 | .05 mfd | Dubilier Type 412 | 250 | - | V5 A.V.C. bypass |
| C23 | .1 mfd | " " " | 150 | - | V5 filament " |
| C24 | .05 mfd | " " " | 250 | - | V5 screen " |
| C25 | 20 pf | Erie N750K ceramic | - | 2% | V5 plate tuning (L5) |
| C26 | 51 pf | " " " | - | 2% | V6 grid coupling (L5) |
| C27 | .05 mfd | Dubilier Type 412 | 250 | - | V5 plate bypass |
| C28 | .05 mfd | " " " | 250 | - | V6 A.V.C. bypass |
| C29 | .1 mfd | " " " | 150 | - | V6 filament " |
| C30 | .05 mfd | " " " | 250 | - | V6 screen " |
| C31 | .05 mfd | " " " | 250 | - | V6 plate " |
| C32 | 20 pf | Erie N750K ceramic | - | 2% | V6 plate tuning (T8) |
| C33 | 51 pf | " " " | - | 2% | V7 grid bypass (T8) |
| C34 | .1 mfd | Dubilier Type 412 | 150 | - | V7 filament " |
| C35 | .05 mfd | " " " | 250 | - | V7 plate " |
| C36 | 51 pf | Erie N750K ceramic | - | 2% | V7 plate tuning (T9) |
| C36A | 10 pf | " " " | - | 10% | V7 plate tuning (additional) (T9) |
| C37 | 51 pf | " " " | - | 2% | V8 diode load R.F. bypass (T9) |
| C38 | 1000 pf | Erie K1200L " | - | 5% | V8 Audio filter |
| C39 | .1 mfd | Dubilier Type 412 | 150 | - | V8 filament bypass |
| C40 | .05 mfd | " " " | 250 | - | V8 screen " |
| C41 | 100 pf | Erie N750K ceramic | - | 5% | V8 plate tuning (T10) |
| C42 | 100 pf | " " " | - | 5% | T10 tuning, secondary (T10) |
| C43 | 100 pf | " " " | - | 5% | T10 " " (T10) |
| C44 | 100 pf | " " " | - | 5% | T10 pri-secy. coupling (T10) |
| C45 | .05 mfd | Dubilier Type 412 | 250 | - | V8 plate bypass |
| C46 | 51 pf | Erie N750K ceramic | - | 2% | V10 diode coupling |
| C47 | 51 pf | " " " | - | 2% | V9 " " |

CONDENSERS (Contd.)

| Circuit Ref. | Value | Type | Volt. Rating | Tol. + or - | Function |
|---|---|---|---|---|---|
| C48 | .05 mfd | Dubilier Type 412 | 250 | - | T1 coupling |
| C49 | .002 mfd | Hunts tubular | 350 | - | V9 R.F. filter |
| C50 | .05 mfd | Dubilier Type 412 | 250 | - | T1 coupling |
| C51 | .002 mfd | Hunts tubular | 350 | - | V10 R.F. filter |
| C52 | .1 mfd | Dubilier Type 412 | 150 | - | V9 Filament bypass |
| C53 | .1 mfd | " " " | 150 | - | V10 " " |
| C54 | .05 mfd | " " " | 250 | - | V7 screen " |
| C55 | .05 mfd | " " " | 250 | - | T1 to vol. control coupling |
| C56 | .05 mfd | " " " | 250 | - | Vol. control to S2G |
| C57 | .05 mfd | " " " | 250 | - | V9 grid coupling |
| C58 | 100 pf | Erie N750L ceramic | - | 5% | V10 plate R.F. bypass |
| C59 | 2 mfd | TCC Picopack electroly. | | - | V9 plate filter |
| C60 | .05 mfd | Dubilier Type 412 | 250 | - | B+ line bypass |
| C61 | .05 mfd | " " " | 250 | - | V13 bias network bypass |
| C62 | .05 mfd | " " " | 250 | - | Filament line bypass |
| C63 | 3-30 pf | Mullard concentric | - | - | Crystal trimmer (S1) |
| C64 | 3-30 pf | " " | - | - | " " (S1) |
| C65 | .1 mfd | Dubilier Type 412 | 150 | - | V11 filament bypass |
| C66 | .05 mfd | " " " | 250 | - | V11 screen " |
| C67 | 20 pf | Erie N750K ceramic | - | 2% | V11 plate tuning |
| C68 | 51 pf | " " " | - | 2% | V11 screen " |
| C69 | 51 pf | " " " | - | 2% | V12 grid condenser |
| C70 | .1 mfd | Dubilier Type 412 | 150 | - | V12 filament bypass |
| C71 | .05 mfd | " " " | 250 | - | V12 screen " |
| C72 | .05 mfd | " " " | 250 | - | V12 plate " |
| C73 | 5.6 pf | Erie N750K ceramic | - | 10% | V12 plate tuning |
| C74 | 51 pf | " " " | - | 2% | V13 grid condenser |
| C75 | .1 mfd | Dubilier Type 412 | 150 | - | V13 filament bypass |
| C76 | .05 mfd | " " " | 250 | - | V13 plate " |
| C77 | 5.6 pf | Erie N750K ceramic | - | 10% | V11 plate tuning |

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15th April, 1946.
PBA/BF.

Inductances.

| Circuit Reference. | Description | Function |
|---|---|---|
| L1 | Aerial 45 m/c. | |
| L2 | " 115 m/c. | |
| L3 | " 235 m/c. | |
| L4 | I.F. 4.9 m/c. | V3 plate to V5 grid. |
| L5 | I.F. 4.9 m/c. | V5 plate to V6 grid. |
| L6 | Inductance, crystal 5.829 m/c. | Crystal Osc. V11 screen. |
| RFC. | Chokes, filament. (10) | |

Transformers.

| Circuit Reference | Description | Function |
|---|---|---|
| T1 | Transformer, Discriminator, Audio. | Discriminator to first A.F. grid. |
| T2 | " Audio output. | 2nd Audio plate to phones. |
| T3 | Deleted. | |
| T4 | Deleted. | |
| T5 | Transformer I.F. 25 m/c. | V1 plate to V2 grid. |
| T6 | " I.F. 25 m/c. | V2 plate to V3 grid. |
| T7 | " Oscillator 20.1 m/c. | |
| T8 | " I.F. 4.9 m/c. | V6 plate to V7 grid. |
| T9 | " I.F. 4.9 m/c. | V7 plate to V8 grid. |
| T10 | " Discriminator 4.9 m/c. | V8 plate to V9 & V10 diodes. |
| T11 | " 17.5 m/c. | V11 plate to V12 grid. |
| T12 | " 35 m/c. | V12 plate to V13 grid. |
| T13 | " 70 m/c. | V13 plate to link. |

Crystals.

| Circuit Reference | Description | Function |
|---|---|---|
| X1 | Crystal Polythene mounted 5829.2 k/c. (LF) | ± 100 cps max. |
| X2 | Crystal Polythene mounted 5837.5 k/c. (HF) | ± 100 cps max. |

Switches.

| Circuit Reference | Description | Type |
|---|---|---|
| S1 | Band switch. | Frequency selector. |
| S2 | System Switch. | AM - FM selector. |
| S3 | Toggle switch, stand-by. | Arrow DPST. |
| S4 | " " battery ON-OFF. | " " " |
| S5 | Switch meter range. | Minibank, 2 pole, 6 posn. |

Meters.

| Circuit Reference | Description | Type |
|---|---|---|
| M | Meter .5 mA sealed. | Nalder Bros. & Thompson ZA 24968. |

Valves.

| Circuit Reference | Type. | Function |
|---|---|---|
| V1 | Valve, Type HY 114B. | 1st Convertor. |
| V2 | " " IT4 | 25 m/c I.F. Amp. |
| V3 | " " IT4 | 2nd Convertor. |
| V4 | " " IT4 | 20.14 m/c Oscillator. |
| V5 | " " IT4 | 1st I.F. M/c Amplifier. |
| V6 | " " IT4 | 2nd I.F. M/c " |
| V7 | " " IT4 | 1st Limiter, I.F. |
| V8 | " " IT4 | 2nd Limiter/Detector. |
| V9 | " " IS5 | Discriminator diode/1st AF. |
| V10 | " " IS5 | " " /2nd " |
| V11 | " IR5 | Crystal Oscillator 5.829 m/c. |
| V12 | " " IT4 | Doubler 17/35 m/c. |
| V13 | " " IT4 | " 35/70 m/c. |

# TABLE OF COMPONENT VALUES FOR SENDER ZC.178

## RESISTORS

| Circuit Ref. | Value in ohms | Type | Wattage | Tolerance + or - | Function |
|---|---|---|---|---|---|
| R1 | 2,200 | Erie, or Morgan insulated | 1/10 | 10% | V4 grid metering |
| R2 | 47,000 | " " " | 1/16 | 10% | V4 grid coupling |
| R3 | 27,000 | " " " | ¼ | 10% | V1 screen dropping |
| R4 | 22,000 | " " " | ¼ | 10% | V1 plate decoupling |
| R5 | 68,000 | " " " | 1/10 | 10% | V1 grid coupling |
| R6 | 100,000 | " " " | 1/10 | 10% | V1 grid decoupling |
| R7 | 100,000 | " " " | 1/10 | 10% | V1 grid decoupling |
| R8 | 25,000 | Potentiometer, Morgan, B.J. | - | - | V2 Bias control |
| R8A | 47,000 | Erie or Morgan insulated | 1/10 | 10% | F.M. mod. bias network |
| R9 | 27,000 | " " " | 1/10 | 10% | Part of phasing network V2 grid. |
| R10 | 22,000 | " " " | 1/10 | 10% | V2 grid decoupling |
| R11 | 47,000 | " " " | 1/10 | 10% | V1 bias network |
| R12 | 22,000 | " " " | ¼ | 10% | V2 plate load |
| R13 | 220,000 | " " " | 1/10 | 10% | V3 grid coupling |
| R14 | 2,200 | " " " | 1/10 | 10% | V3 grid metering |
| R15 | 47,000 | " " " | ¼ | 10% | V3 screen dropping |
| R16 | 15,000 | " " " | 1/10 | 10% | V3 plate decoupling |
| R17 | 2,200 | " " " | 1/16 | 10% | V5 grid metering |
| R18 | 100,000 | " " " | 1/16 | 10% | V5 grid decoupling |
| R19 | 15,000 | " " " | 1/10 | 10% | V4 plate decoupling |
| R20 | 2,200 | " " " | 1/16 | 10% | V5 grid metering |
| R21 | 100,000 | " " " | 1/16 | 10% | Mixers grid resistor, V13,20,5. |
| R22 | 22,000 | " " " | ¼ | 10% | V5 screen dropping |
| R23 | 22,000 | " " " | 1/10 | 10% | V5 plate decoupling |
| R24 | 2,200 | " " " | 1/16 | 10% | V6 grid metering |
| R25 | 220,000 | " " " | 1/16 | 10% | V6 grid coupling |
| R26 | 47,000 | " " " | ¼ | 10% | V6 screen dropping |
| R27 | 15,000 | " " " | 1/10 | 10% | V6 plate decoupling |
| R28 | 2,200 | " " " | 1/16 | 10% | V7 grid metering |
| R29 | 220,000 | " " " | 1/16 | 10% | V7 grid coupling |
| R30 | 47,000 | " " " | ¼ | 10% | V7 screen dropping |
| R31 | 15,000 | " " " | 1/10 | 10% | V7 plate decoupling |
| R32 | 2,200 | " " " | 1/16 | 10% | V7 grid metering |
| R33 | 220,000 | " " " | 1/16 | 10% | V8 grid (1) coupling |
| R34 | 220 | " " " | 1/10 | 10% | V8 plate (1) decoupling |
| R35 | 2,200 | " " " | 1/16 | 10% | V8 grid metering |
| R36 | 100,000 | " " " | 1/16 | 10% | V8 grid (2) coupling |
| R37 | 220 | " " " | 1/10 | 10% | V8 plate (2) decoupling |
| R38 | 150,000 | " " " | 1/16 | 10% | V9 grid coupling |
| R39 | 3,300 | " " " | ¼ | 10% | V9 screen dropping |
| R40 | 220 | " " " | ¼ | 10% | V9 plate decoupling |
| R41 | 3,300 | " " " | 1/10 | 10% | Aerial metering cct. |
| R42 | 22,000 | " " " | 1/10 | 10% | Keying network |
| R43 | 100,000 | " " " | 1/10 | 10% | M.C.W. freq. control network. |
| R44 | 3,900 | " " " | 1/10 | 10% | M.C.W. stabiliser |
| R45 | 100,000 | " " " | 1/10 | 10% | Pre-amp. bias dividing net. |
| R46 | 47,000 | " " " | 1/10 | 10% | M.C.W. freq. control net. |
| R47 | 330,000 | " " " | 1/10 | 10% | M.C.W. stabiliser |
| R48 | 2.2 meg. | " " " | 1/10 | 10% | V10 screen dropping |
| R49 | 220,000 | " " " | 1/10 | 10% | V10 plate load |
| R50 | 100,000 | " " " | 1/10 | 10% | Pre-amp. output divider. |

## TABLE OF COMPONENT VALUES FOR SENDER ZC.178

RESISTORS (Contd.)

| Circuit Ref. | Value in ohms | Type | Wattage | Tolerance + or - | Function |
|---|---|---|---|---|---|
| R50A | 27,000 | Erie, or Morgan insulated | 1/10 | 10% | V10 plate filter |
| R51 | 1 meg. | " " " | 1/10 | 10% | Pre-amp. bias divider |
| R52 | 220,000 | " " " | 1/10 | 10% | Reactance tube audio alternator |
| R53 | 1 meg. | " " " | 1/10 | 10% | V11 grid coupling |
| R54 | 100,000 | " " " | 1/10 | 10% | A.M. driver bias decoupling |
| R55 | 12,000 | " " " | 1/10 | 10% | A.M. driver bias divider |
| R56 | 4,700 | " " " | 1/10 | 10% | A.M. driver bias divider |
| R57 | 220 | " " " | 1/10 | 10% | Bias metering shunt |
| R58 | 10,000 | " " " | ¼ | 10% | V1 plate decoupling |
| R59 | 12,000 | " " " | 1/10 | 10% | V12 plate series resist. |
| R60 | 220,000 | " " " | 1/10 | 10% | Netting resistor |
| R61 | 220,000 | " " " | 1/10 | 10% | V12 feed-back network |
| R62 | 6,800 | " " " | ¼ | 10% | V12 screen dropping |
| R63 | Deleted | | | | |
| R64 | 180,000 | " " " | ¼ | 10% | H.T. metering multiplier |
| R65 | 3,900 | " " " | ¼ | 10% | L.T. metering multiplier |
| R66 | 180,000 | " " " | ¼ | 10% | H.T. " " |
| R67 | 1.27 | " " " | 1/10 | 10% | Mod. stages plate current shunt. |
| R68 | 10,000 | Morgan B.J.Potentiometer | - | - | Aerial metering adjustment. |
| R69 | Deleted | | | | |
| R70 | 15,000 | " " " | 1/10 | 10% | V13 plate |
| R71 | 2,200 | " " " | 1/16 | 10% | V14 grid metering |
| R72 | 100,000 | " " " | 1/16 | 10% | V14 grid coupling |
| R73 | 22,000 | " " " | 1/10 | 10% | V14 plate decoupling |
| R74 | 2,200 | " " " | 1/16 | 10% | V15 grid metering |
| R75 | 220,000 | " " " | 1/16 | 10% | V15 grid coupling |
| R76 | 47,000 | " " " | 1/10 | 10% | V15 screen dropping |
| R77 | 15,000 | " " " | 1/10 | 10% | V15 plate decoupling |
| R78 | 2,200 | " " " | 1/16 | 10% | V16 grid metering |
| R79 | 220,000 | " " " | 1/16 | 10% | V16 grid coupling |
| R80 | 47,000 | " " " | 1/10 | 10% | V16 screen dropping |
| R81 | 15,000 | " " " | 1/10 | 10% | V16 plate decoupling |
| R82 | 2,200 | " " " | 1/16 | 10% | V17 grid metering |
| R83 | 1 meg. | " " " | 1/10 | 10% | V17 grid coupling |
| R84 | 4,700 | " " " | 1/10 | 10% | V17 screen dropping |
| R85 | 470 | " " " | ¼ | 10% | V17 plate decoupling |
| R86 | 220,000 | " " " | 1/10 | 10% | V18 grid coupling |
| R87 | 2,200 | " " " | 1/10 | 10% | V18 grid metering |
| R88 | 4,700 | " " " | 1/10 | 10% | V18 screen dropping |
| R89 | 470 | " " " | ¼ | 10% | V18 plate decoupling |
| R90 | 27,000 | " " " | 1/10 | 10% | V19 bias filter |
| R91 | 220 | Erie, or Morgan insulated | 1/10 | 10% | P.A. grid metering network |
| R92 | 680 | " " " | 1/10 | 10% | " " " " |
| R93 | 1,500 | " " " | 1/10 | 10% | " " " " |
| R94 | 220 | " " " | ¼ | 10% | V19 plate decoupling |
| R95 | 47,000 | " " " | 1/10 | 10% | V20 screen dropping |
| R96 | 15,000 | " " " | 1/10 | 10% | V20 plate decoupling |
| R97 | 2,200 | " " " | 1/16 | 10% | V21 grid metering |
| R98 | 100,000 | " " " | 1/16 | 10% | V21 grid coupling |
| R99 | 22,000 | " " " | 1/10 | 10% | V21 screen dropping |

TABLE OF COMPONENT VALUES FOR SENDER ZC.178

RESISTORS (Contd.)

| Circuit Ref. | Value in ohms | Type | Wattage | Tolerance + or - | Function |
|---|---|---|---|---|---|
| R100 | 22,000 | Erie, or Morgan insulated | 1/10 | 10% | V21 plate decoupling |
| R101 | 270,000 | " " " | 1/10 | 10% | V22 grid coupling |
| R102 | 2,200 | " " " | 1/10 | 10% | V22 grid metering |
| R103 | 47,000 | " " " | 1/10 | 10% | V22 screen dropping |
| R104 | 15,000 | " " " | 1/10 | 10% | V22 plate decoupling |
| R105 | 1 meg. | " " " | 1/10 | 10% | V23 grid coupling |
| R106 | 2,200 | " " " | 1/10 | 10% | V23 grid metering |
| R107 | 4,700 | " " " | ¼ | 10% | V23 screen dropping |
| R108 | 470 | " " " | ¼ | 10% | V23 plate decoupling |
| R109 | 220,000 | " " " | 1/10 | 10% | V24 grid coupling |
| R110 | 2,200 | " " " | 1/10 | 10% | V24 grid metering |
| R111 | 4,700 | " " " | ¼ | 10% | V24 screen dropping |
| R112 | 470 | " " " | ¼ | 10% | V24 plate decoupling |
| R113 | 27,000 | " " " | 1/10 | 10% | V25 grid leak |
| R114 | 2,200 | " " " | 1/10 | 10% | V26 grid metering |
| R115 | 47,000 | " " " | 1/10 | 10% | V26 grid coupling |

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11th April, 1946.
BPA/JS

TABLE OF COMPONENT VALUES FOR SENDER ZC. 178 (Contd.)

CONDENSERS

| Circuit Ref. | Value | Type | Volt. Rating | Tol. + or - | Function |
|---|---|---|---|---|---|
| C 1 | .05 mfd | Dubilier Type 412 | 250 | - | V1 screen bypass |
| C 2 | .05 " | " " " | 250 | - | V1 plate decoupling |
| C 3 | 10 pf | Erie N750K | | 2% | V1 plate, $V_2$ grid. |
| C 4 | 20 pf | " " | | 10% | V1 grid decoupling network |
| C 5 | .05 mfd | Dubilier Type 412 | 250 | - | V1 grid decoupling |
| C 6 | 20 pf | Erie N750K | | 2% | V1 grid coupling |
| C 7 | .002 mfd | Hunts tubular | 350 | - | V1 audio grid coupling from V11 |
| C 8 | 100 pf | Erie N750K | | 5% | V2 grid decoupling |
| C 9 | .05 mfd | Dubilier Type 412 | 250 | - | V2 grid decoupling |
| C10 | 80 pf | Lemco, silver mica | | 2% | V2 grid tuning (T1) |
| C11 | 20 pf | Erie N750K | | 2% | V2 grid tuning (T1) |
| C12 | 2 pf max | Ingersoll 130B | - | - | EM: osc. (V2) grid tuning |
| C13 | 100 pf | Erie N750K | | 10% | V2 plate to V3 grid coupling |
| C14 | .05 mfd | Dubilier Type 412 | 250 | - | V3 screen bypass |
| C15 | 51 pf | Erie N750K | | 2% | V3 plate tuning (L1) |
| C16 | .05 mfd | Dubilier Type 412 | 250 | - | V3 plate decoupling (L1) |
| C17 | 100 pf | Erie N750K | | 10% | V3 plate to V5 grid coupling (L1) |
| C18 | 5.6 pf | Erie N750K ceramic | | 10% | V4 diode to V4 plate coupling |
| C19 | 51 pf | " " " | | 2% | V4 plate tuning (L2) |
| C20 | .05 mfd | Dubilier Type 412 | 250 | - | V4 plate decoupling (L2) |
| C21 | 100 pf | Erie N750K | | 10% | V4 plate to V5 grid coupling (L2) |
| C22 | .05 mfd | Dubilier Type 412 | 250 | - | V4 diode decoupling |
| C23 | 5 mfd | T.C.C. Picopack electro. | 50 | - | V4 diode decoupling (Audio) |
| C24 | .05 mfd | Dubilier Type 412 | 250 | - | V5 screen bypass |
| C25 | 51 pf | Erie N750K | | 2% | V5 plate tuning (L3) |
| C26 | .05 mfd | Dubilier Type 412 | 250 | - | V5 plate decoupling (L3) |
| C27 | 100 pf | Erie N750K | | 10% | V5 plate to V6 grid coupling (L3) |
| C28 | .05 mfd | Dubilier Type 412 | 250 | - | V6 screen bypass |
| C29 | 20 pf | Erie N750K | | 2% | V6 plate tuning (L4) |
| C30 | .05 mfd | Dubilier Type 412 | 250 | - | V6 plate decoupling (L4) |
| C31 | 100 pf | Erie N750K | | 10% | V6 plate to V7 grid coupling (L4) |
| C32 | .05 mfd | Dubilier Type 412 | 250 | - | V7 screen bypass |
| C33 | 20 pf | Erie N750K | | 2% | V7 plate tuning (L5) |
| C34 | .05 mfd | Dubilier Type 412 | 250 | - | V7 plate decoupling (L5) |
| C35 | 100 pf | Erie N750K | | 10% | V7 plate to V8 grid (1) coupling (L5) |
| C36 | 10 pf | Erie N750K | | 2% | V8 plate (1) tuning (L6) |
| C37 | .05 mfd | Dubilier Type 412 | 250 | - | V8 plate (1) decoupling (L6) |
| C38 | 100 pf | Erie N750K | | 10% | V8 plate (1) to V8 grid (2) coupling (L6) |
| C39 | 10 pf | Erie N750K | | 2% | V8 plate (2) tuning (L7) |
| C40 | .05 mfd | Dubilier Type 412 | 250 | - | V8 plate (2) decoupling (L7) |
| C41 | 10 pf | Erie N750K | | 2% | V8 plate (2) to V9 grid coupling (L7) |

CONDENSERS (Contd.)

| Circuit Ref. | Value | Type | Volt. Rating | Tol. + or - | Function |
|---|---|---|---|---|---|
| C42 | 1000 pf | Erie K1200L | | 20% | V9 RF grid filter |
| C43 | 1000 pf | " " | | 20% | V9 RF filament bypass |
| C44 | 1000 pf | " " | | 20% | V9 screen bypass |
| C45 | 27 pf max | Polar Cat. No.2602 | - | - | V9 tank tuning |
| C46 | 100 pf | Erie N750K | | 10% | V9 plate decoupling |
| C47 | 1 pf | Erie N750K ceramic | | 25% | Aer. metering cct. coupling |
| C48 | 1 pf | " " " | | 25% | Aer. metering equaliser |
| C49 | 1000 pf | Erie K1200L | | 20% | Aer. metering cct. decoupling |
| C50 | 3-30 pf | Mullard concentric | - | - | Crystal trimmer No. 1 |
| C51 | 3-30 pf | " " | - | - | " " No. 2 |
| C52 | .002 mfd | Hunts tubular | 350 | - | M.C.W. network |
| C53 | .05 mfd | Dubilier Type 412 | 250 | - | M.C.W. network |
| C54 | .003 to .005 mfd | Hunts tubular | 350 | - | " " |
| C55 | 20 pf | Erie N750K | | 10% | V10 grid bypass |
| C56 | .05 mfd | Dubilier Type 412 | 250 | - | V10 Filament bypass |
| C57 | .05 mfd | " " " | 250 | - | V10 Screen bypass |
| C57A | .05 mfd | " " " | 250 | - | V10 plate decoupling |
| C58 | .002 mfd | Hunts tubular | 350 | - | V11 grid coupling |
| C59 | .05 mfd | Dubilier Type 412 | 250 | - | V11 grid decoupling |
| C60 | 2 mfd | T.C.C. Picopack electrolytic | 150 | - | V11 plate decoupling |
| C61 | .05 mfd | Dubilier Type 412 | 250 | - | V12 inverse feedback coupling |
| C62 | 2 mfd | T.C.C. Picopack electrolytic | 150 | - | V12 screen bypass |
| C63 | 20 pf | Erie N750K | | 2% | V13 plate tuning (L8) |
| C64 | .05 mfd | Dubilier Type 412 | 250 | - | V13 plate decoupling (L8) |
| C65 | 51 pf | Erie N750K | | 10% | V14 grid coupling (L8) |
| C66 | 20 pf | Erie N750K | | 2% | V14 plate tuning (L9) |
| C67 | .05 mfd | Dubilier Type 412 | 250 | - | V14 plate decoupling (L9) |
| C68 | 51 pf | Erie N750K | | 10% | V15 grid coupling (L9) |
| C69 | .05 mfd | Dubilier Type 412 | 250 | - | V15 screen bypass |
| C70 | 10 pf | Erie N750K | | 2% | V15 plate tuning |
| C71 | .05 mfd | Dubilier Type 412 | 250 | - | V15 plate decoupling (L10) |
| C72 | 51 pf | Erie N750K | | 10% | V16 grid coupling (L10) |
| C73 | .05 mfd | Dubilier Type 412 | 250 | - | V16 screen bypass |
| C74 | 10 pf | Erie N750K | | 2% | V16 plate tuning |
| C75 | .05 mfd | Dubilier Type 412 | 250 | - | V16 plate decoupling (L11) |
| C76 | 51 pf | Erie N750K | | 10% | V17 grid coupling (L11) |
| C77 | 1000 pf | Erie K1200L | | 20% | V17 screen bypass |
| C78 | Deleted | - | - | - | - |
| C79 | 1000 pf | Erie K1200L | | 20% | V17 plate decoupling |
| C80 | 10 pf | Erie N750K | | 10% | V18 grid coupling |
| C81 | 1000 pf | Erie K1200L | | 20% | V18 screen bypass |
| C82 | 2.2 pf | Erie N750K ceramic | - | 10% | V18 plate tuning (T6) |
| C83 | 1000 pf | Erie K1200L | | 20% | V18 plate decoupling |
| C84 | 2.2 pf | Erie N750K ceramic | - | 10% | V19 grid tuning (T6) |
| C85 | 1-7 pf | Ingersoll Type 153 | - | - | V19 grid tuning (T6) |
| C86 | 1000 pf | Erie K1200L | | 20% | V19 plate decoupling |
| C87 | 3-12 pf | Polar. Cat. No.5032 | - | - | V19 plate tuning |
| C88 | .05 mfd | Dubilier Type 412 | 250 | - | V20 screen bypass |
| C89 | 20 pf | Erie N750K | | 2% | V20 plate tuning (L13) |
| C90 | .05 mfd | Dubilier Type 412 | 250 | - | V20 plate decoupling (L13) |
| C91 | 51 pf | Erie N750K | | 10% | V21 grid coupling (L13) |
| C92 | 10 pf | Erie N750K | | 2% | V20 plate bypass |
| C93 | .05 mfd | Dubilier Type 412 | 250 | - | V21 screen bypass |
| C94 | .05 mfd | " " " | 250 | - | V21 plate decoupling |
| C95 | 5.6 pf | Erie N750K ceramic | - | 10% | V21 plate tuning (L14) |



/C96

CONDENSERS (Contd.)

| Circuit Ref. | Value | Type | Volt. Rating | Tol. + or - | Function | |
|---|---|---|---|---|---|---|
| C96 | 51 pf | Erie N750K | | 10% | V22 grid coupling | |
| C97 | .05 mfd | Dubilier Type 412 | 250 | - | V22 screen bypass | |
| C98 | .05 mfd | " " " | 250 | - | V22 plate decoupling | |
| C99 | 5.6 pf | Erie N750K ceramic | | 10% | V22 plate tuning | (L15) |
| C100 | 51 pf | " " " | | 10% | V23 grid coupling | |
| C101 | 1000 pf | Erie K1200L " | | 20% | V23 screen bypass | |
| C102 | 1000 pf | Erie K1200L " | | 20% | V23 plate decoupling | |
| C103 | 1 pf | Erie N750K ceramic | | 25% | V23 plate tuning | (L16) |
| C104 | 10 pf | " " " | | 10% | V24 grid coupling | |
| C105 | 1000 pf | Erie K1200L | | 20% | V24 screen bypass | |
| C106 | 1000 pf | " " | | 20% | V24 plate decoupling | |
| C107 | 2.2 pf | Erie N750K ceramic | | 10% | V24 plate tuning | (T8) |
| C108 | 2.2 pf | " " " | | 10% | V25 grid tuning | (T8) |
| C109 | 1-7 pf | Ingersoll Type 153 | - | - | V25 grid tuning | (T8) |
| C110 | 5.6 pf | Erie N750K | | 10% | V25 plate bypass | |
| C111 | 3-12 pf | Polar Cat. No.5032 | - | - | V25 plate tuning | |
| C112 | 51 pf | Erie N750K | | 10% | V26 grid coupling | |
| C113 | 3-12 pf | Polar Cat. No.5032 | - | - | V26 plate tuning | |

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TABLE OF COMPONENT VALUES FOR SENDER ZC.178.(Contd).

Inductances.

| Circuit Reference. | Description. | Function. |
|---|---|---|
| L1 | Coil, FM, Buffer tank 2.083 m/c. | V3 plate. |
| L2 | " , crystal oscillator tank 5.83 m/c. | V4 plate. |
| L3 | " , 3.75 m/c. mixer tank. | V5 plate. |
| L4 | " , tripler tank 11.25 m/c. | V6 plate. |
| L5 | " , Amplifier plate tank 11.25 m/c. | V7 plate. |
| L6 | " , doubler plate tank 22.5 m/c. | V8A plate. |
| L7 | " , doubler plate tank 45 m/c. | V8B plate. |
| L8 | " , 11.6 m/c.crystal multiplier tank. | V13 plate. |
| L9 | " , 9.583 m/c mixer tank. | V14 plate. |
| L10 | " , tank 28.75 m/c. | V15 plate. |
| L11 | " , tank 28.75 m/c. | V16 plate. |
| L12 | " , tank 57.5 m/c. | V17 plate. |
| L13 | " , tank 17.5 m/c. | V20 plate. |
| L14 | " , tank 19.583 m/c. | V21 plate. |
| L15 | " , tank 19.583 m/c. | V22 plate. |
| L16 | " , tank 58.75 m/c. | V23 plate. |
| L17 | " , doubler tank 117.5 m/c. | V25 plate. |
| RFC.1A | Choke RF, 3 pie. | V1 plate. |
| RFC.1B. | " " " | V4 diode. |
| RFC.1C. | " " " | V25 plate. |
| RFC.2 | Choke RF, 235 m/c. plate. | V26 plate. |
| RFC.3 | Choke RF, aerial. | Aerial metering circuit. |

Transformers.

| Circuit Reference. | Description. | Function. |
|---|---|---|
| T1 | Transformer, FM Oscillator 2.083 m/c. | |
| T2 | " ,45 m/c. P.A. tank. | |
| T3 | " ,microphone & M.C.W. osc. | Audio. |
| T4 | " ,A.M. driver. | Audio. |
| T5 | " ,modulation (A.M.) | Audio. |
| T6 | " ,RF, 57.5 m/c. | V18 to V19 coupling. |
| T7 | " ,115 m/c. P.A. tank. | |
| T8 | " ,RF, 58.75 m/c. | V24 to V25 coupling. |
| T9 | " ,235 m/c. P.A. tank. | |

## TABLE OF COMPONENT VALUES FOR SENDER ZC.178.(Contd).

### Crystals.

| Circuit Reference. | Description. | Function. |
|---|---|---|
| X1 | Crystal, polythene mounted, (LF) 5829.2 K/c. | ± 100 cps.max. |
| X2 | Crystal, polythene mounted, (HF) 5837.5 K/c. | ± 100 cps.max. |

### Switches.

| Circuit Reference. | Description. | Function. |
|---|---|---|
| S1 | Sub-assembly band switch. | 6-way, 4 deck. |
| S2 | " " system switch. | 8 pole, 2-way, 2 deck. |
| S3 | Switch netting. | 2 pole,2 position, single deck. |
| S4 | Switch,toggle stand-by. | Arrow DPST. |
| S5 | Switch,toggle,battery ON-OFF. | " " |
| S6 | Switch, meter range. | Minibank, 2 pole,6 pos. |

### Meters.

| Circuit Reference. | Description. | Type. |
|---|---|---|
| Meter. | Meter, .5 ma. sealed. | Walder Bros.& Thompson. ZA.24968. |

### Valves.

| Circuit Reference. | Type. | Function. |
|---|---|---|
| V1 | IT4. | FM. reactor. |
| V2 | IR5. | FM. oscillator. |
| V3 | IT4. | FM. buffer. |
| V4 | IS5. | Crystal oscillator. |
| V5 | IR5. | Mixer 45 m/c. channel. |
| V6 | IT4. | Tripler. |
| V7 | IT4. | Amplifier. |
| V8 | 3A5. | Doubler-doubler. |
| V9 | 3A4. | P.A. 45 m/c. |
| V10 | IT4. | Mic. Amp/MCW. osc. |
| V11. | IT4. | Driver AM. |
| V12 | 3A4. | Modulator AM. |
| V13 | IT4 | Crystal doubler, 115 m/c. channel |

Valves.

| Circuit Reference. | Type. | Function. |
|---|---|---|
| V14 | IR5. | Mixer, 115 m/c. channel. |
| V15 | IT4 | Tripler. |
| V16 | IT4. | Amplifier. |
| V17 | 3A4. | Tripler. |
| V18 | 3A4. | Amplifier. |
| V19 | 3A5. | Doubler P.A. |
| V20 | IT4. | Crystal tripler, 235 m/c. channel. |
| V21 | IR5. | Mixer, 235 m/c. channel. |
| V22 | IT4. | Amplifier. |
| V23 | 3A4. | Tripler. |
| V24 | 3A4. | Amplifier. |
| V25 | 3A5. | Doubler. |
| V26 | 3A5. | Doubler P.A. |
| Silicon Crystal. | CV.103. | Aerial metering. |

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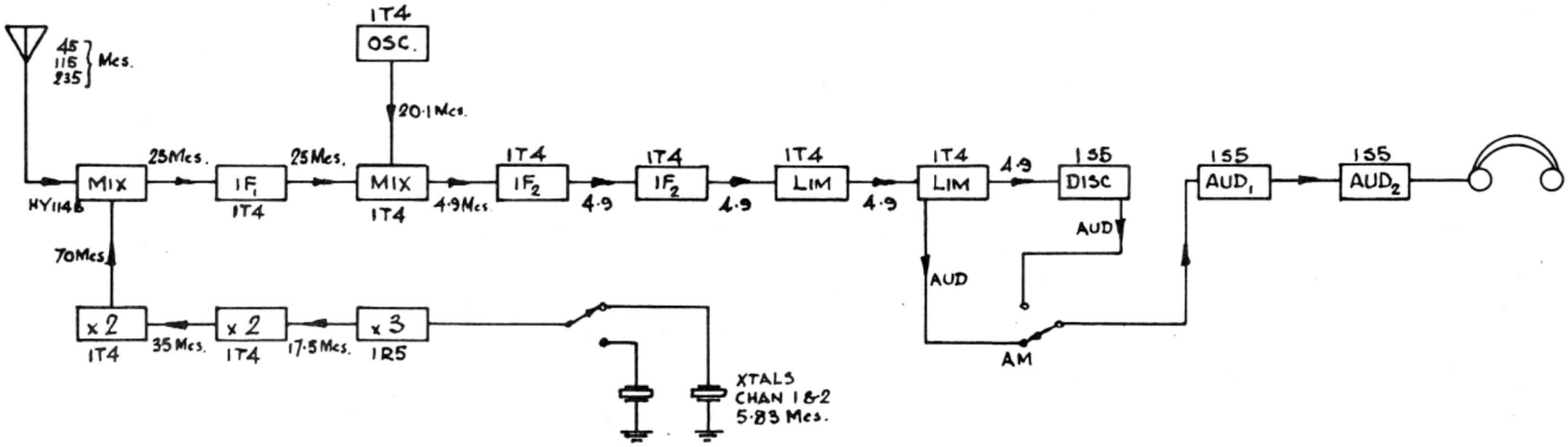
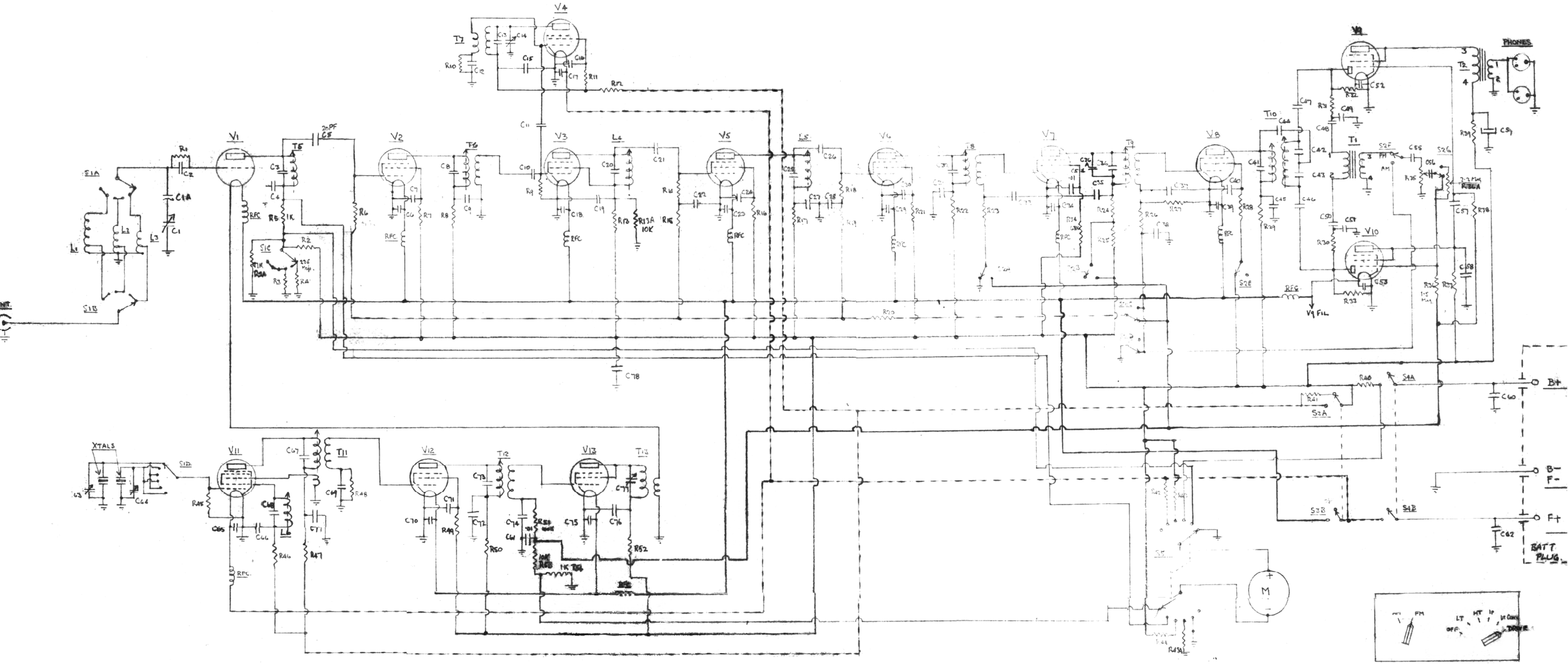
PBA/MT.

A/4C.

# RECEIVER ZC.178 — BLOCK DIAGRAM — Fig 1.




NOTE! FREQUENCIES OF AERIAL CIRCUIT & CRYSTAL CHANNEL ARE MEAN FREQUENCIES. FOR EXACT FREQUENCIES SEE RECEIVER DESCRIPTION.




RIECEIVER CIRCUIT. ZC/178.

VALVE LAYOUT RECEIVER ZC.178 TOP OF CHASSIS WIRELESS SET ZC.178

REAR

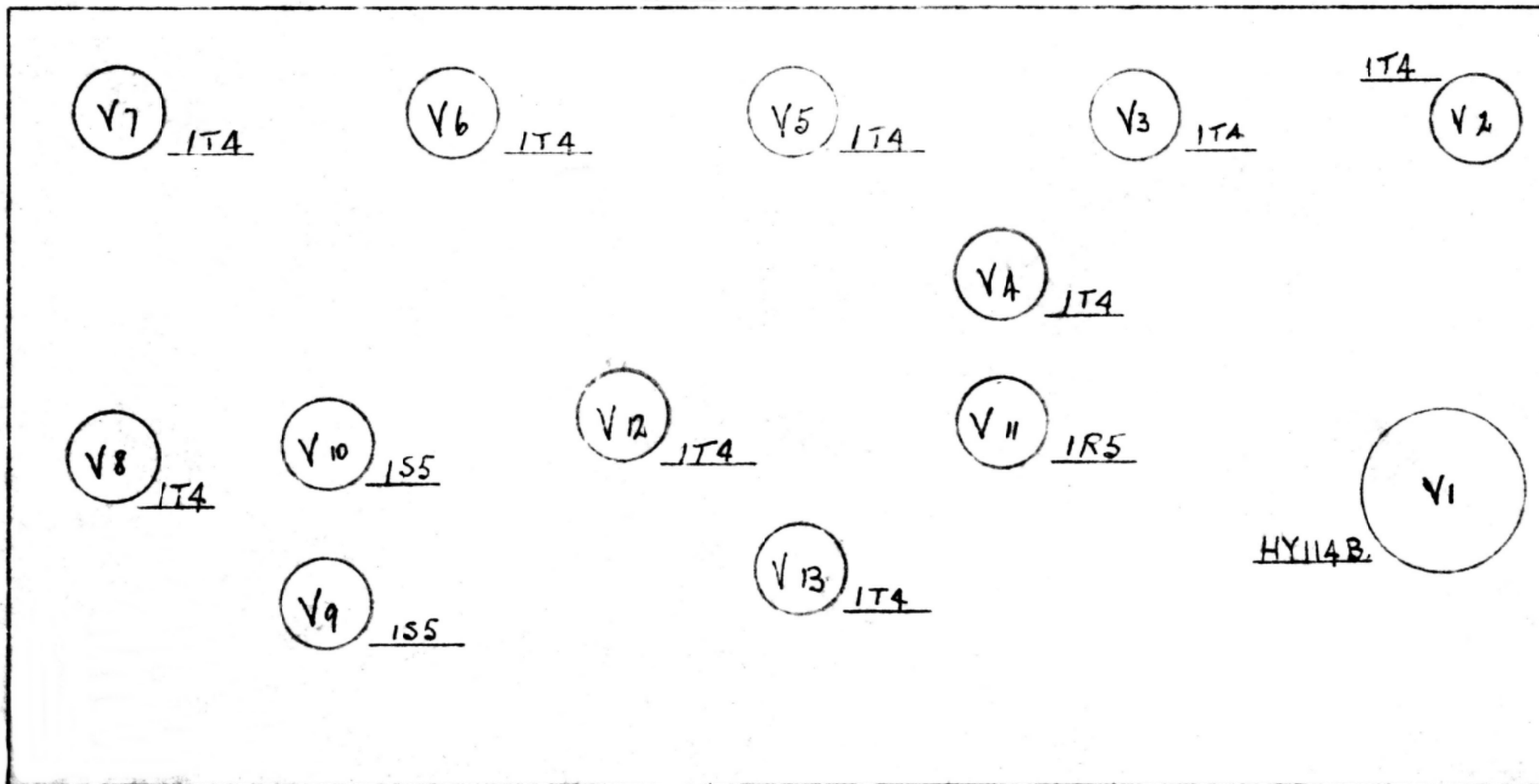


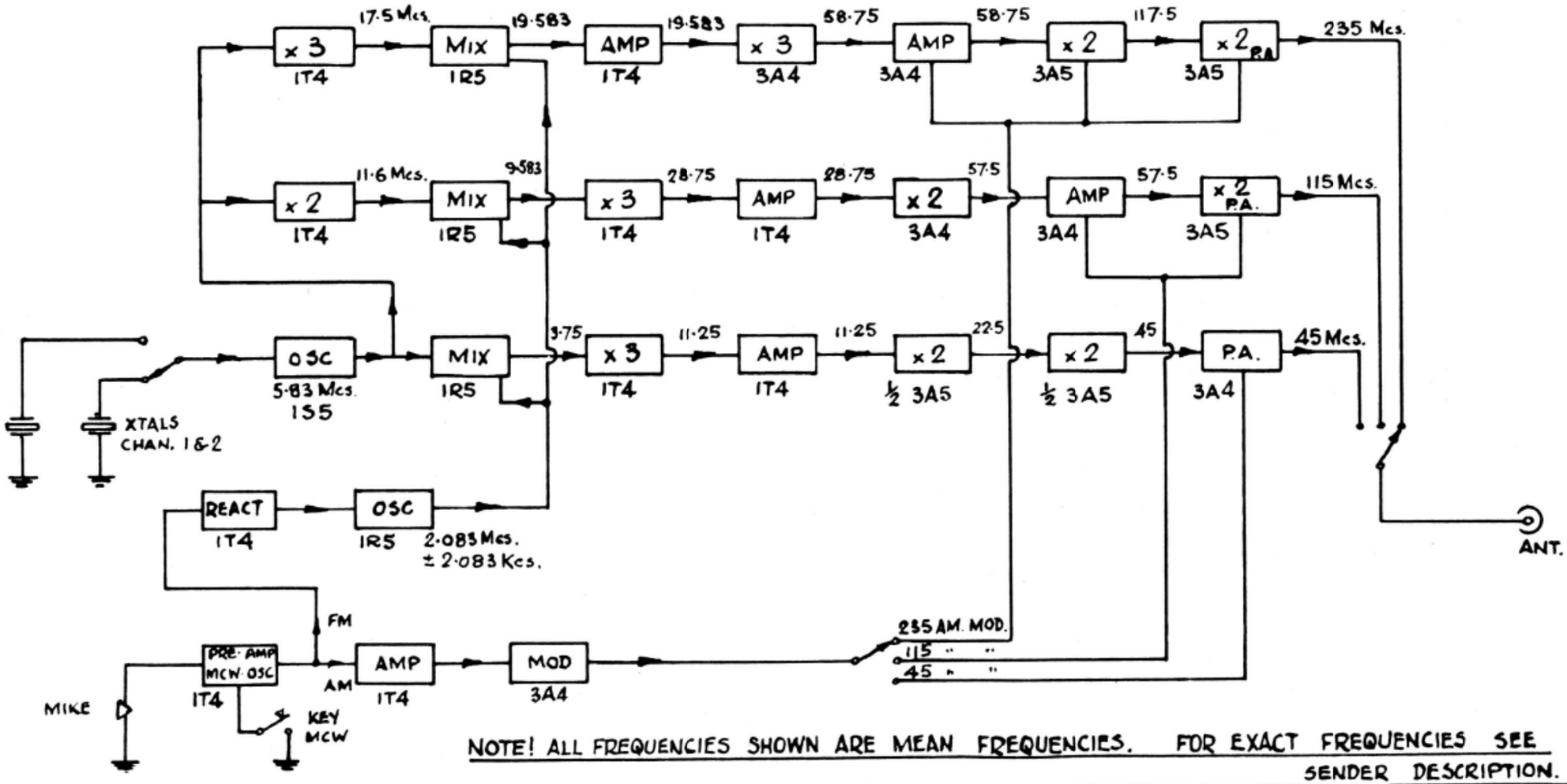

FIGURE 3

FRONT

# SENDER ZC 178

## BLOCK DIAGRAM

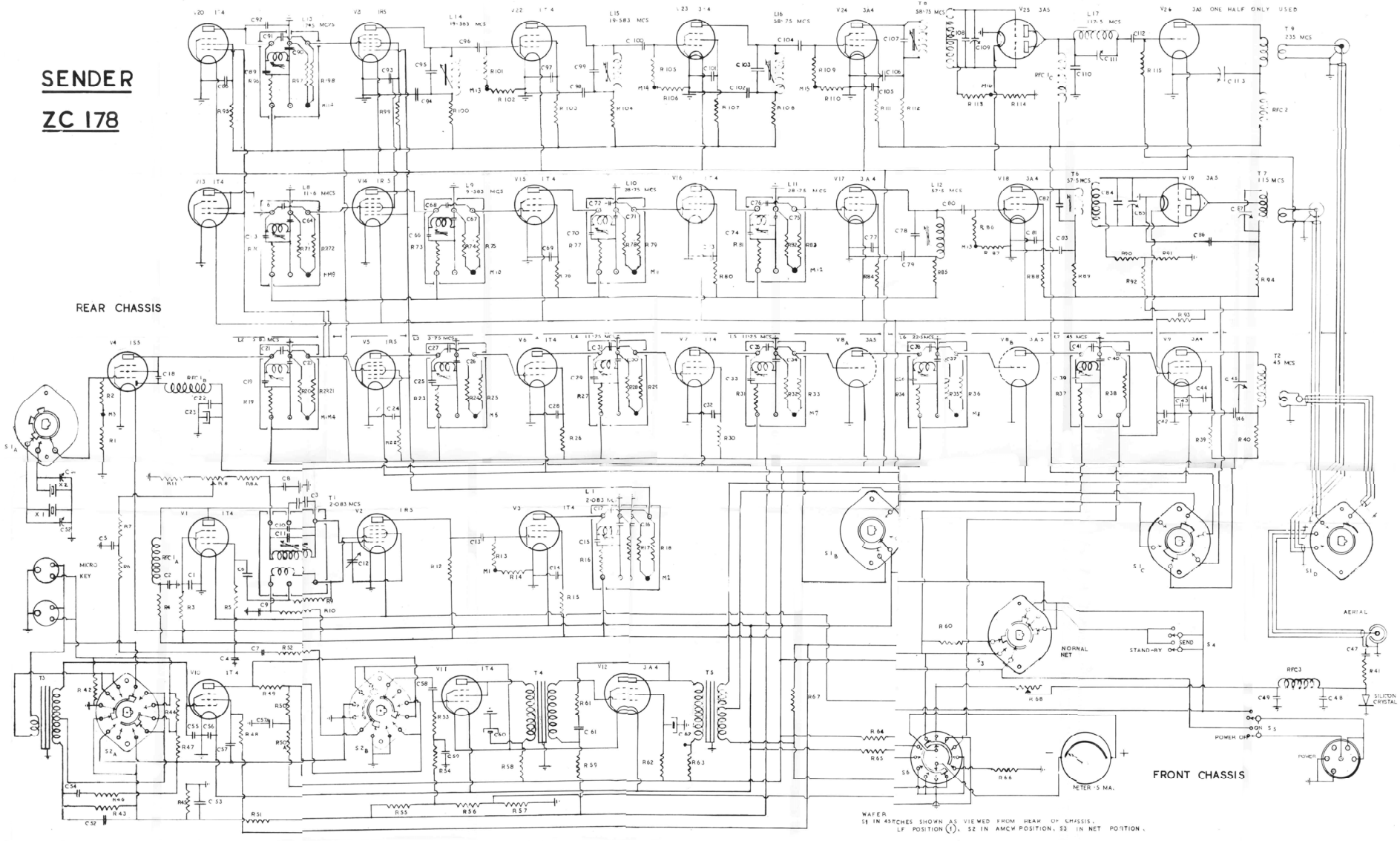
Fig. 4




NOTE! ALL FREQUENCIES SHOWN ARE MEAN FREQUENCIES. FOR EXACT FREQUENCIES SEE SENDER DESCRIPTION.

# SENDER

# ZC 178

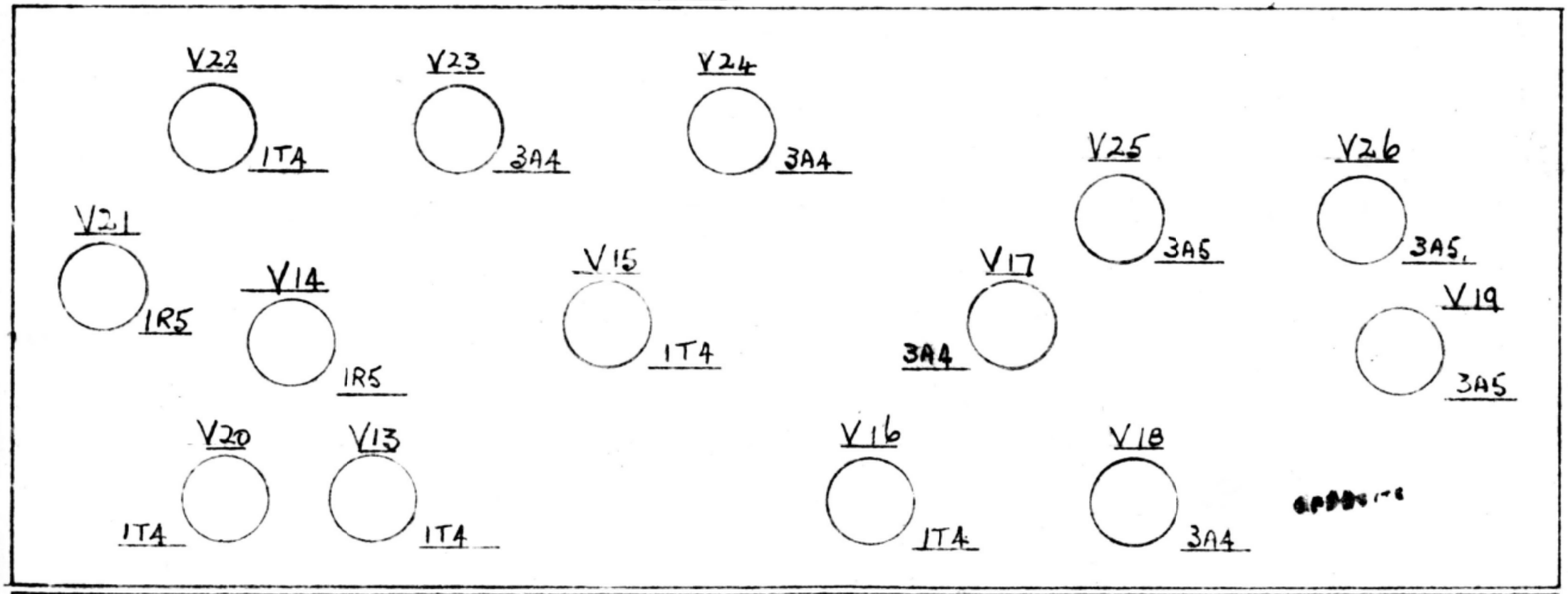


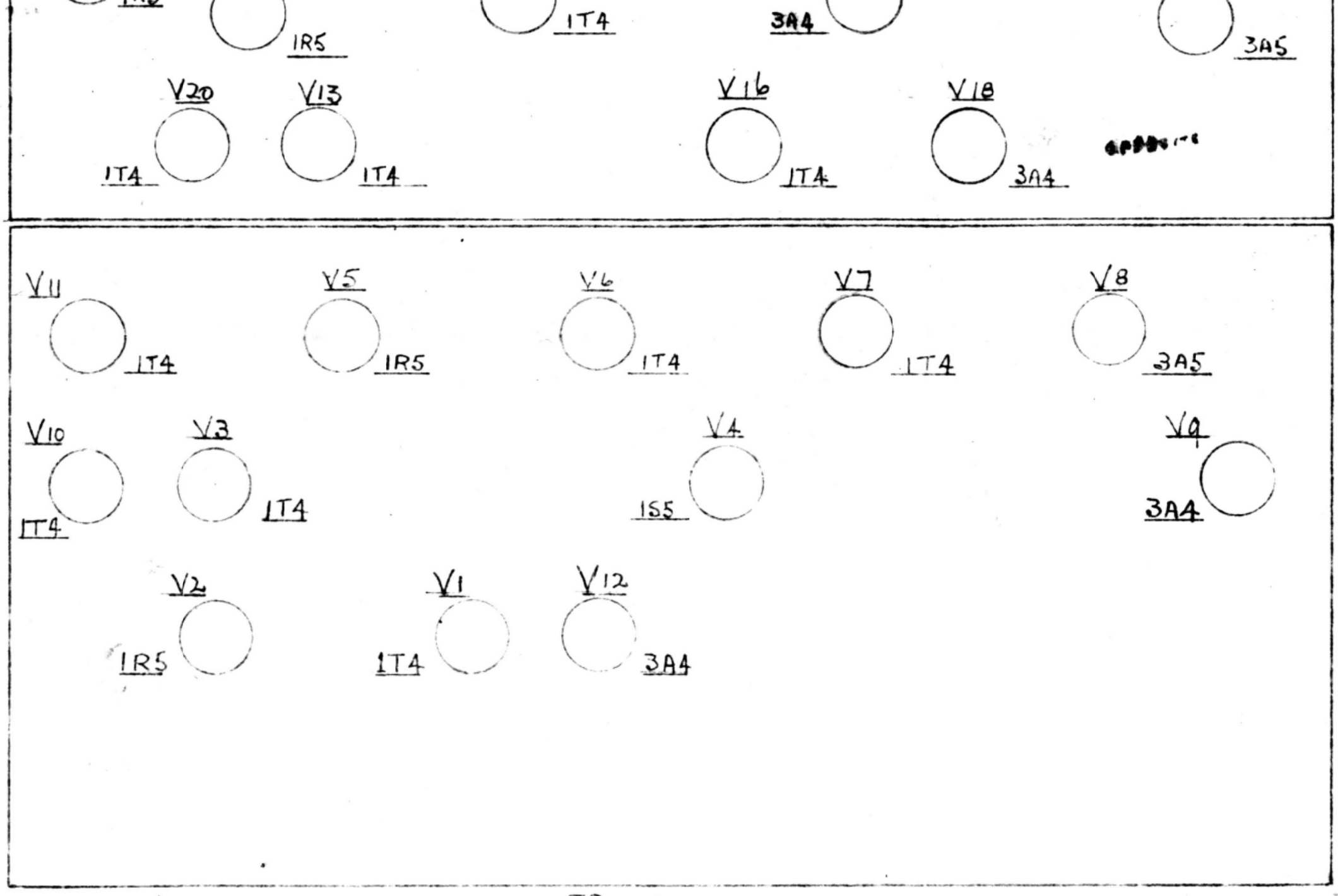
# VALVE LAYOUT - SENDER ZC.178

# WIRELESS SET ZC.178

TOP OF CHASSIS

REAR.






FRONT.

FIGURE 6

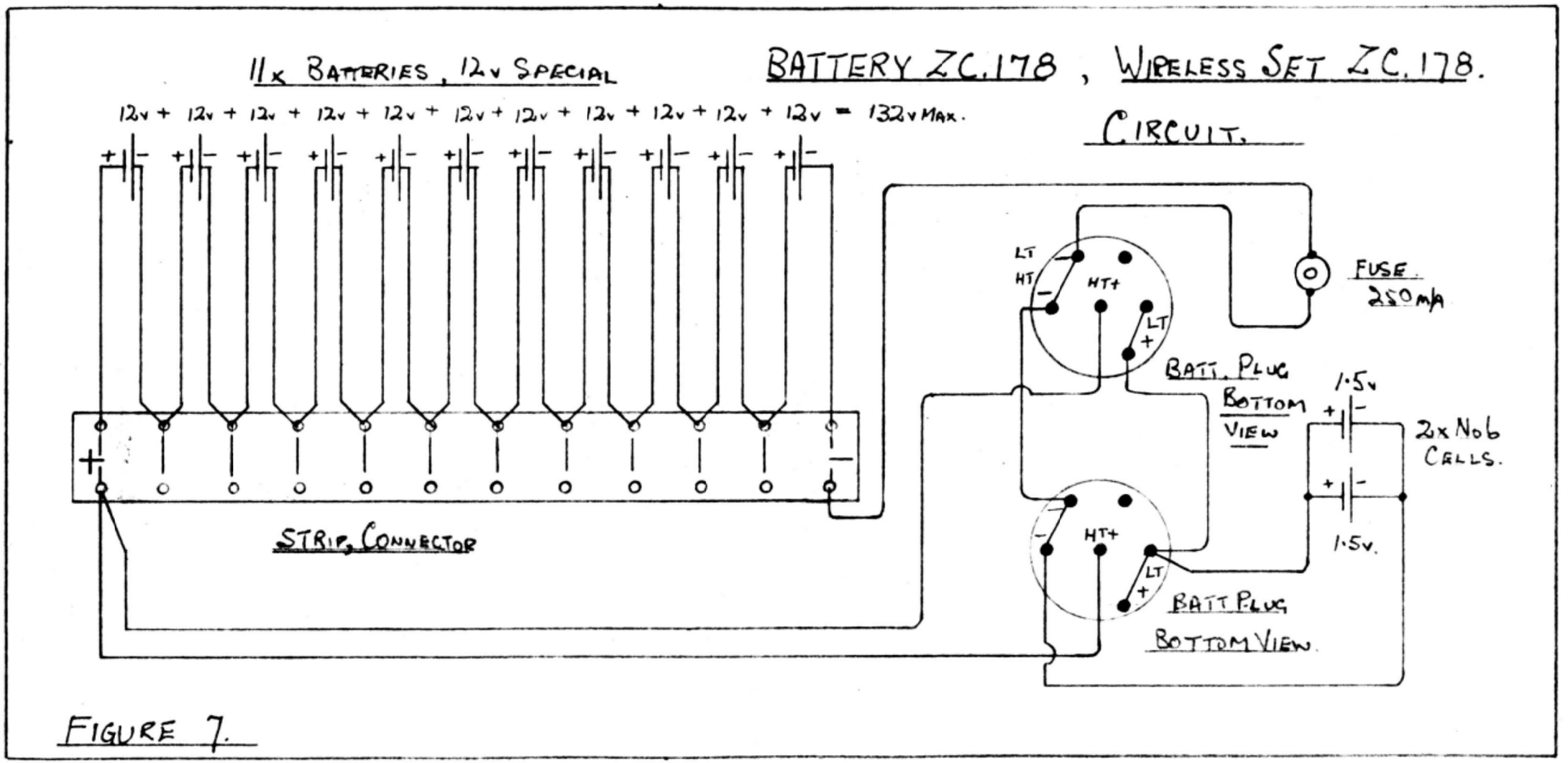

11x BATTERIES, 12v SPECIAL
BATTERY ZC.178, WIRELESS SET ZC.178.
12v + 12v + 12v + 12v + 12v + 12v + 12v + 12v + 12v + 12v + 12v = 132v MAX.
CIRCUIT.
STRIP, CONNECTOR
LT
HT
HT+
LT
+
FUSE.
250 m/A
BATT. PLUG
BOTTOM
VIEW
1.5v
2x No6
CELLS.
1.5v.
HT+
LT
+
BATT PLUG
BOTTOM VIEW.

FIGURE 7.

CIRCUIT - 45 Mc/s AERIAL MATCHING UNIT. WIRELESS SET Z.C. 178.

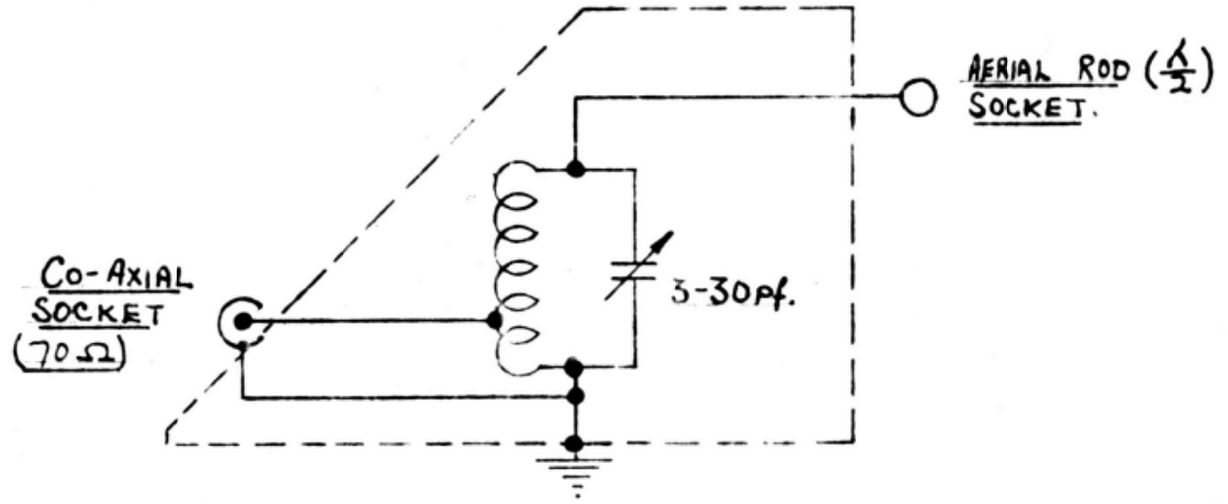
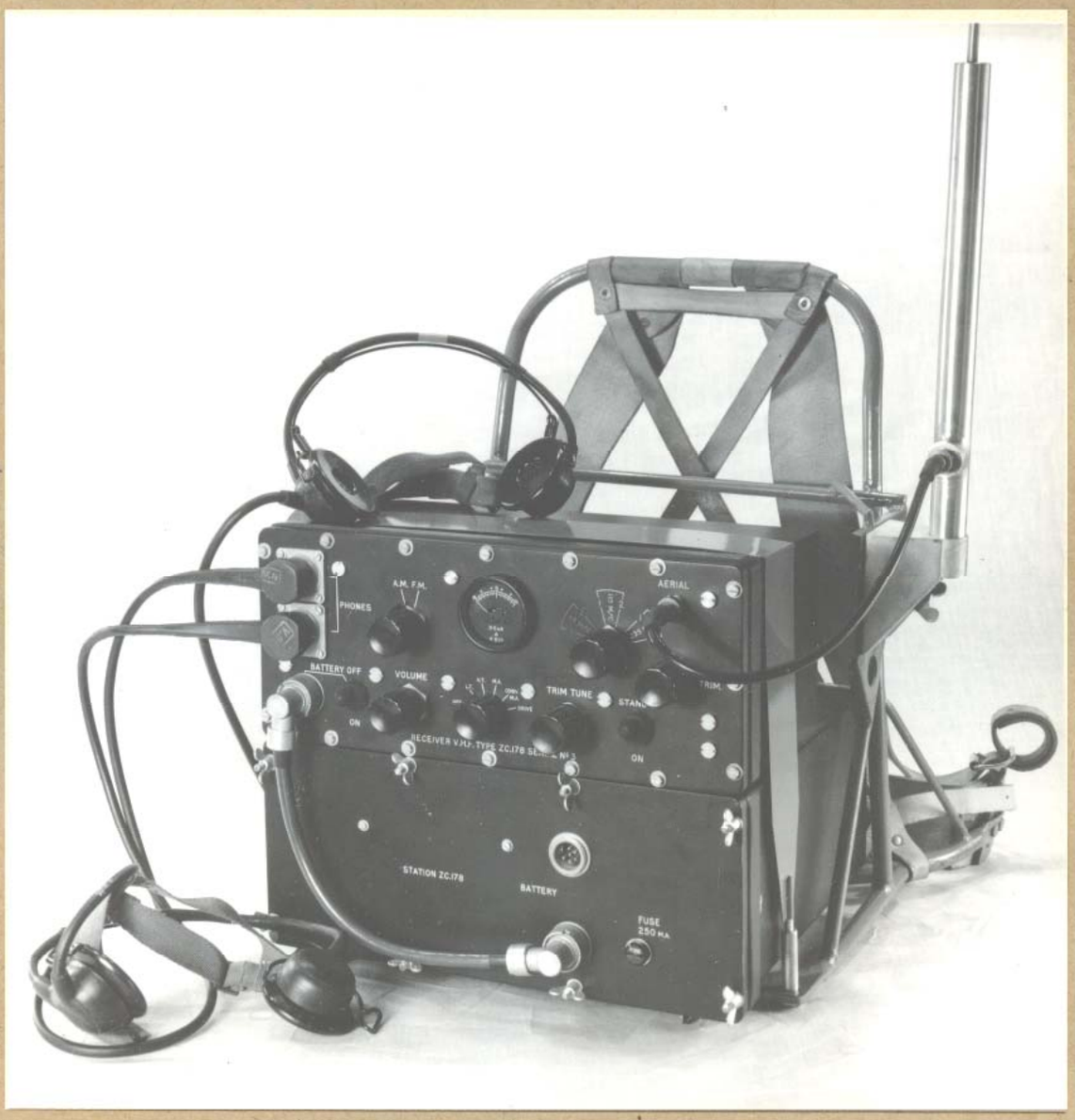



FIGURE 8.

RECEIVER IN CARRYING POSITION.

SENDER IN CARRYING POSITION.



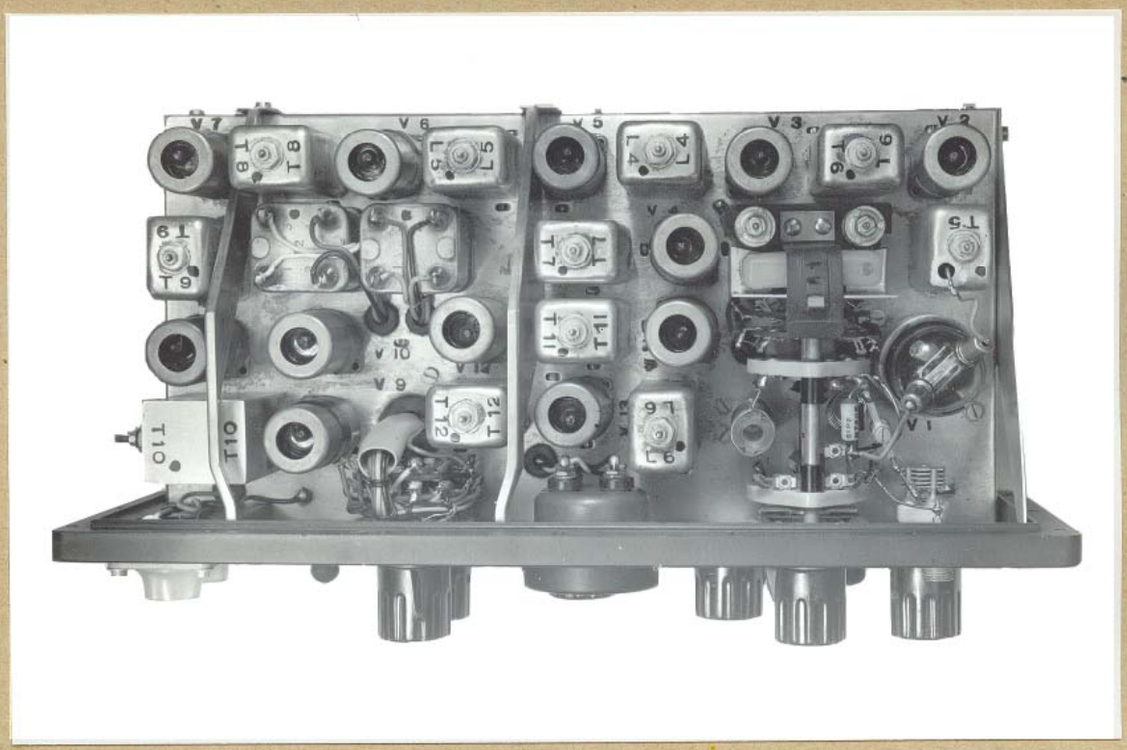

RECEIVER

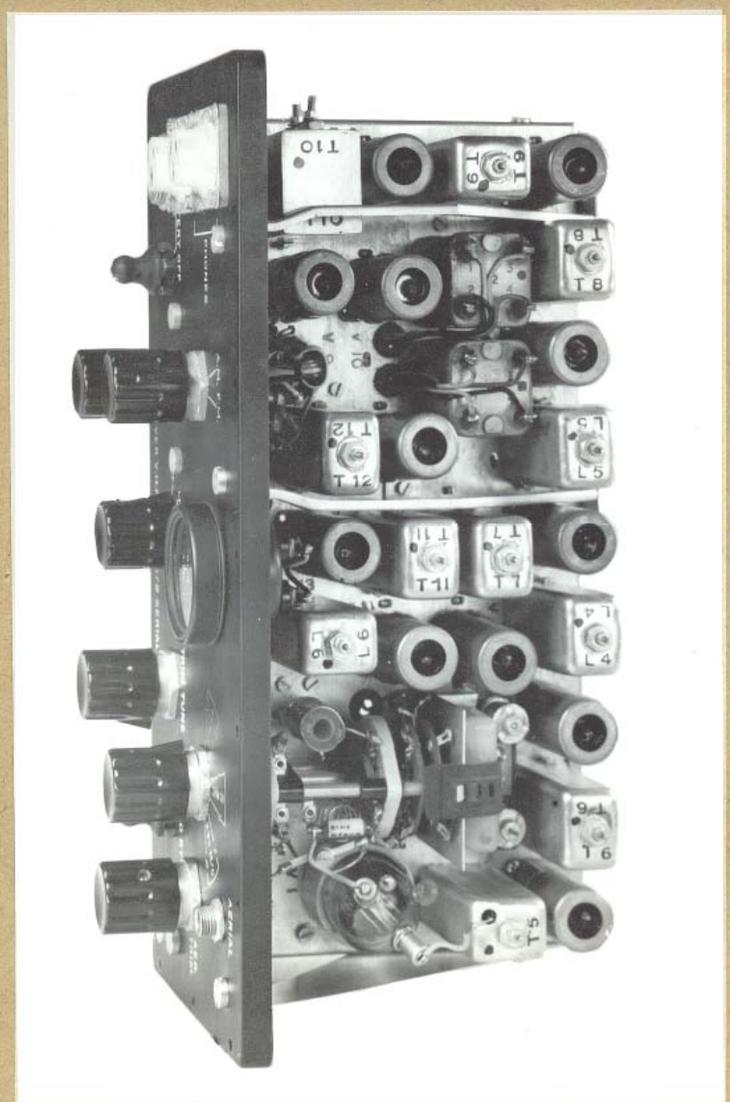
READY FOR OPERATION


RECEIVER ON BATTERY

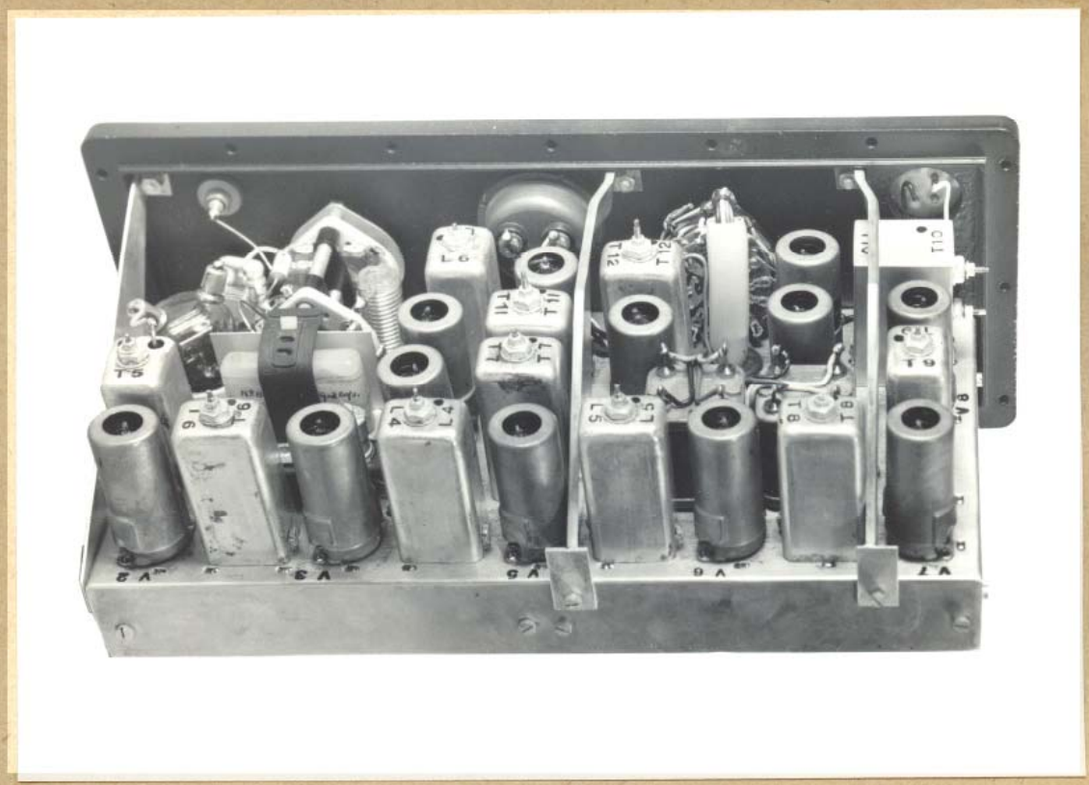

RECEIVER IN CASE


RECEIVER FRONT PANEL

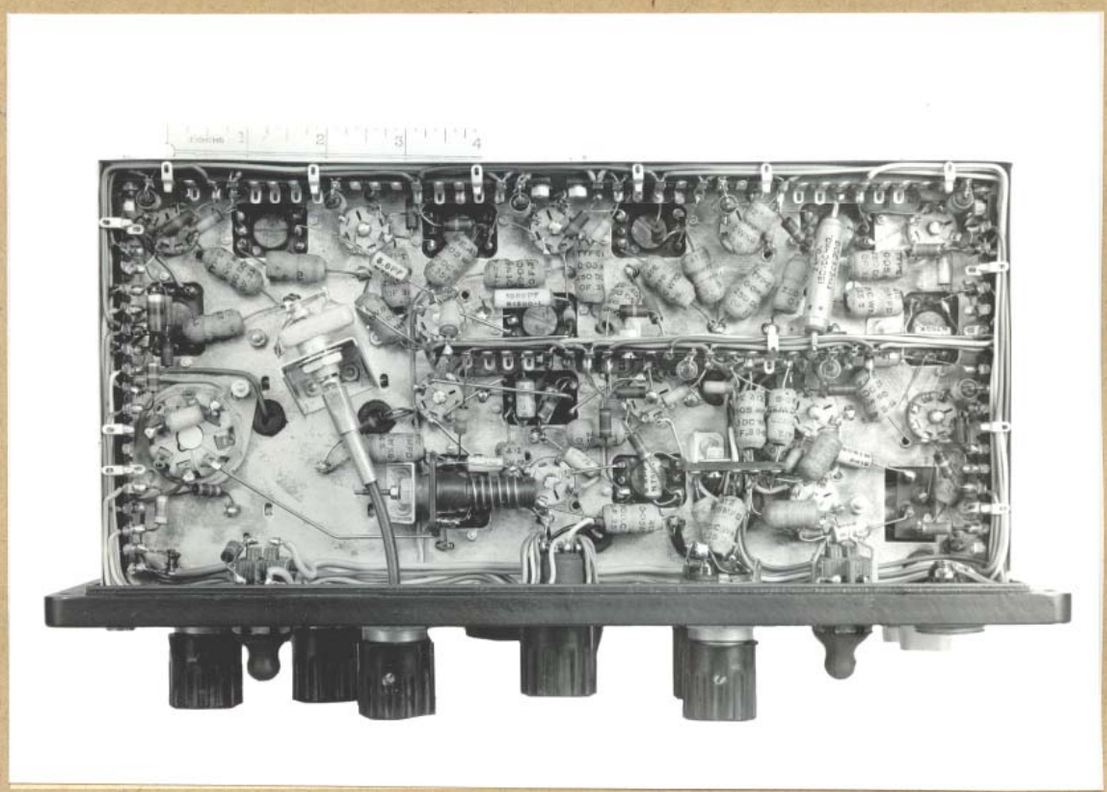


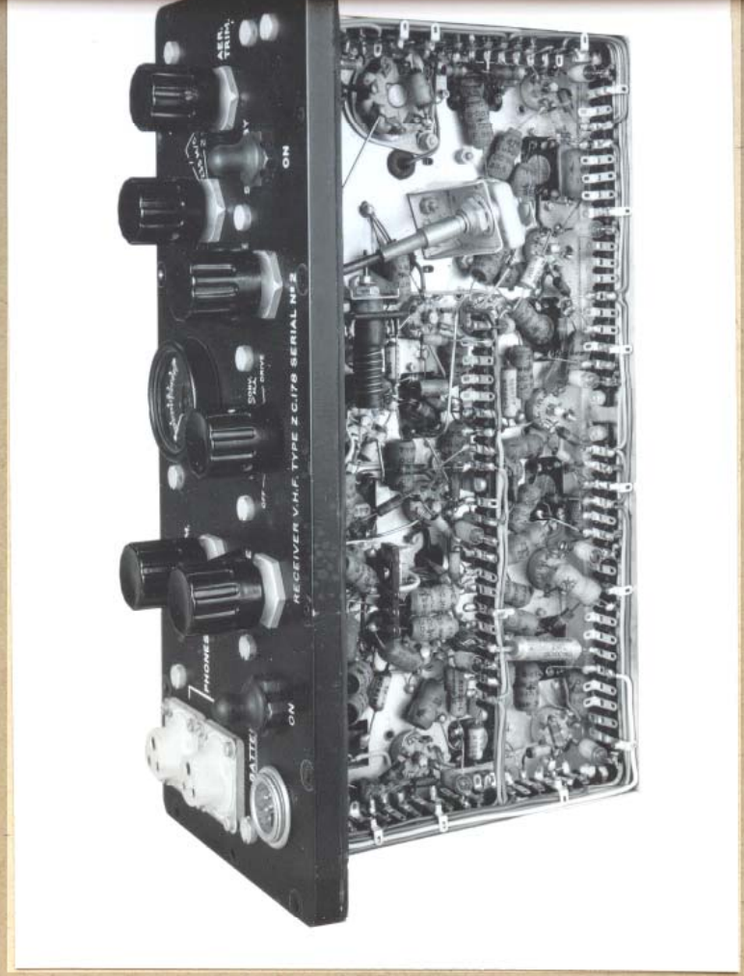

TOP VIEWS OF RECEIVER

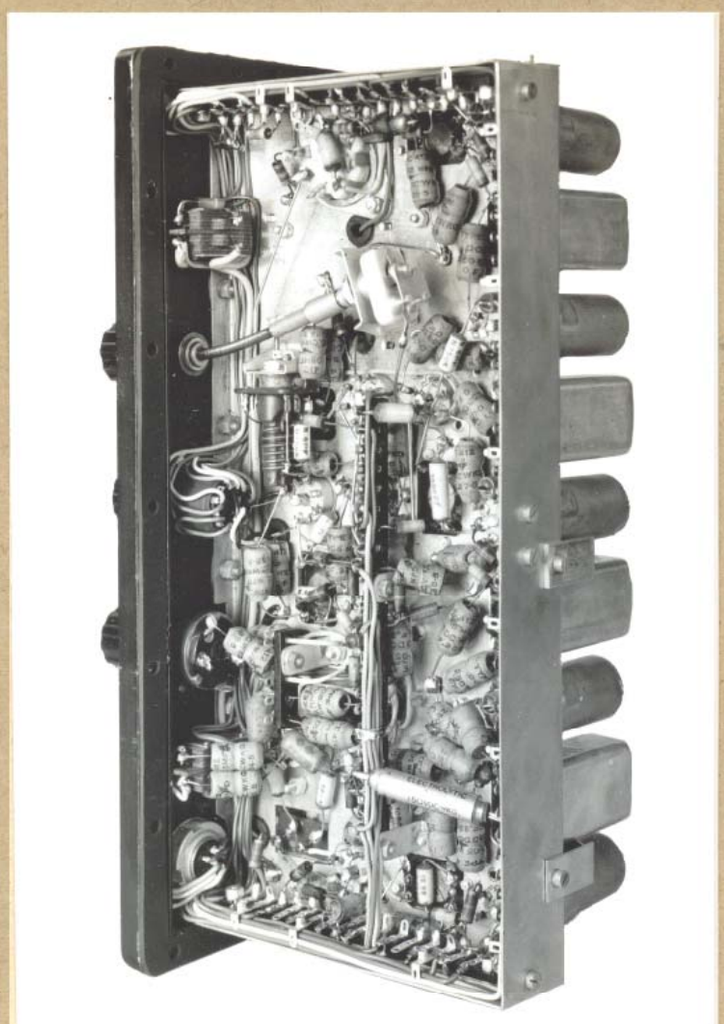


RECEIVER REAR VIEW.



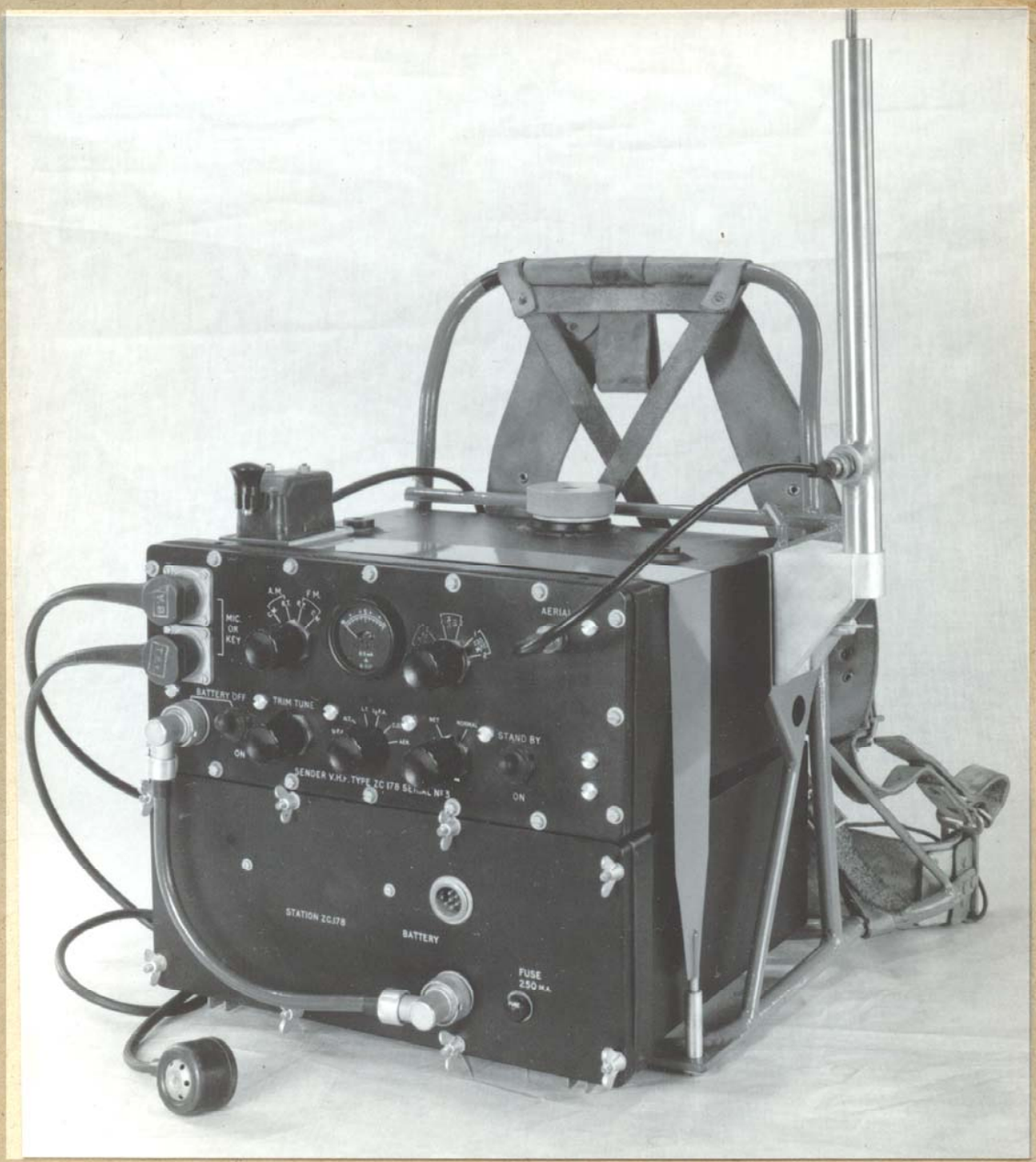
RECEIVER BOTTOM CHASSIS.



RECEIVER BOTTOM CHASSIS


CONTENTS OF RECEIVER SIGNAL SATCHEL.

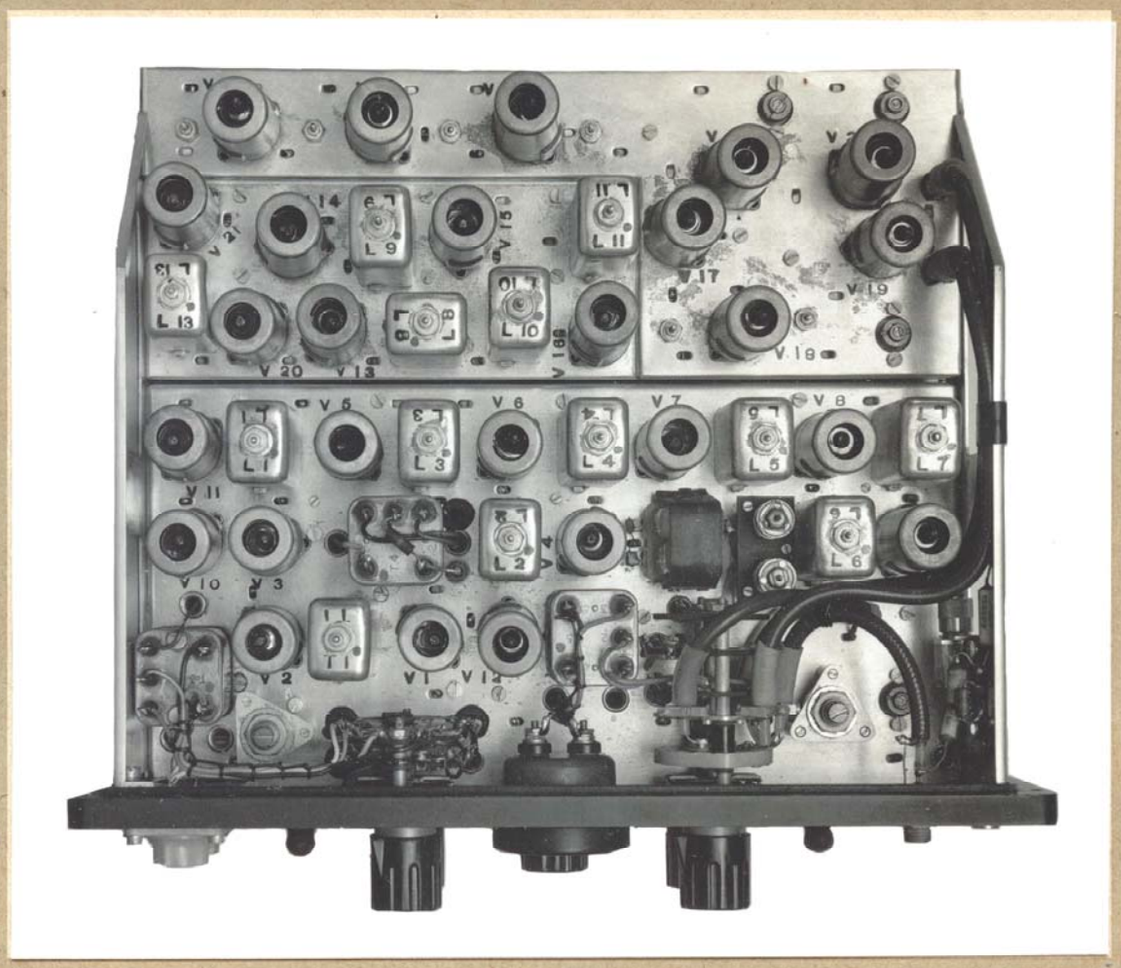



SENDER READY FOR OPERATION.

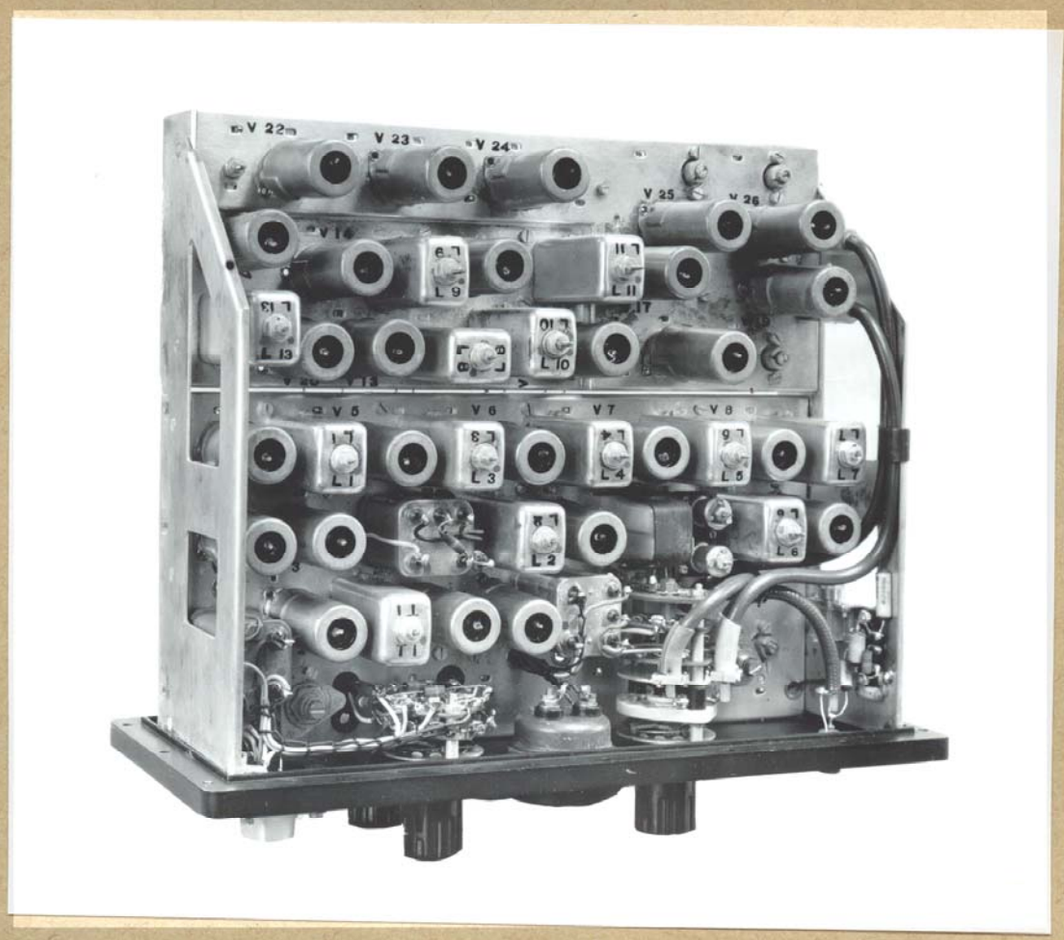

SENDER ON BATTERY.

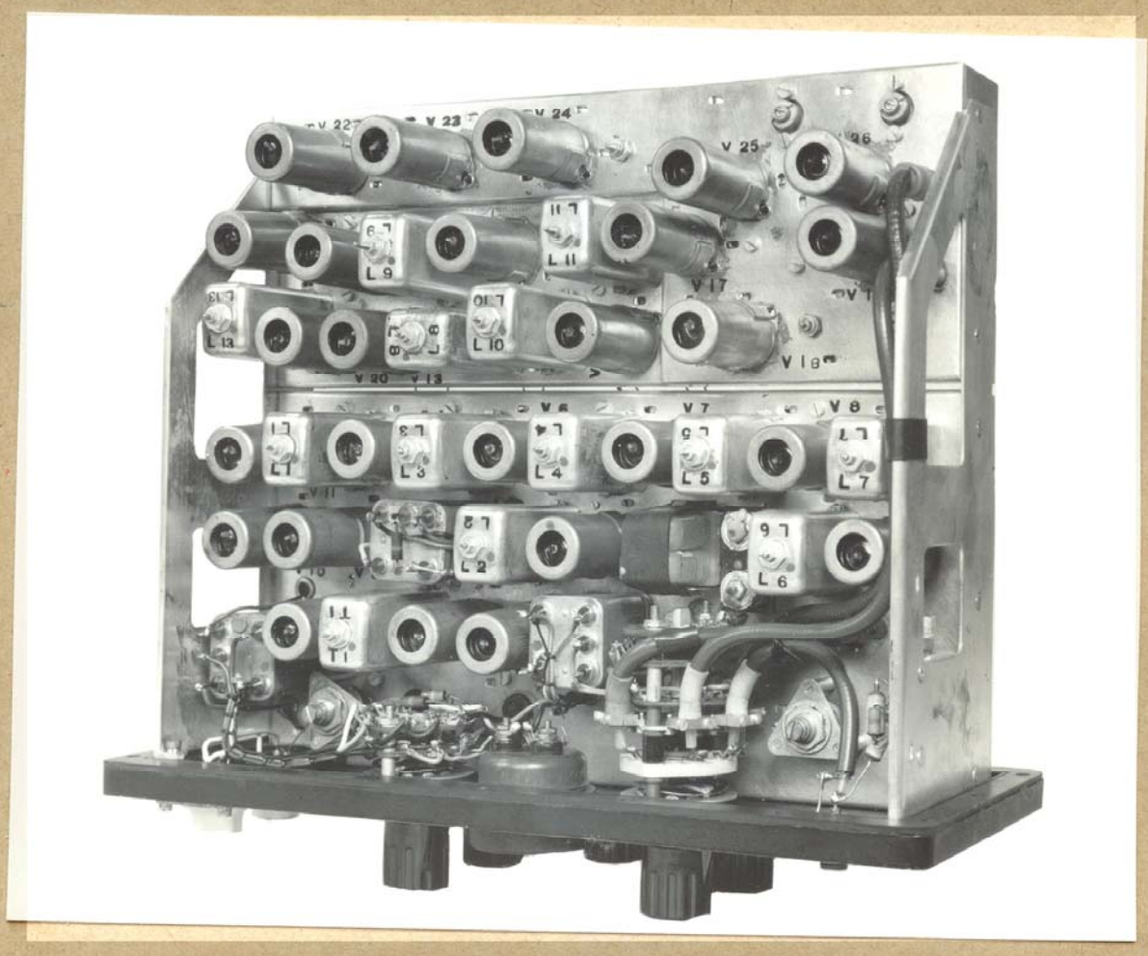

SENDER IN CASE.


SENDER FRONT PANEL.

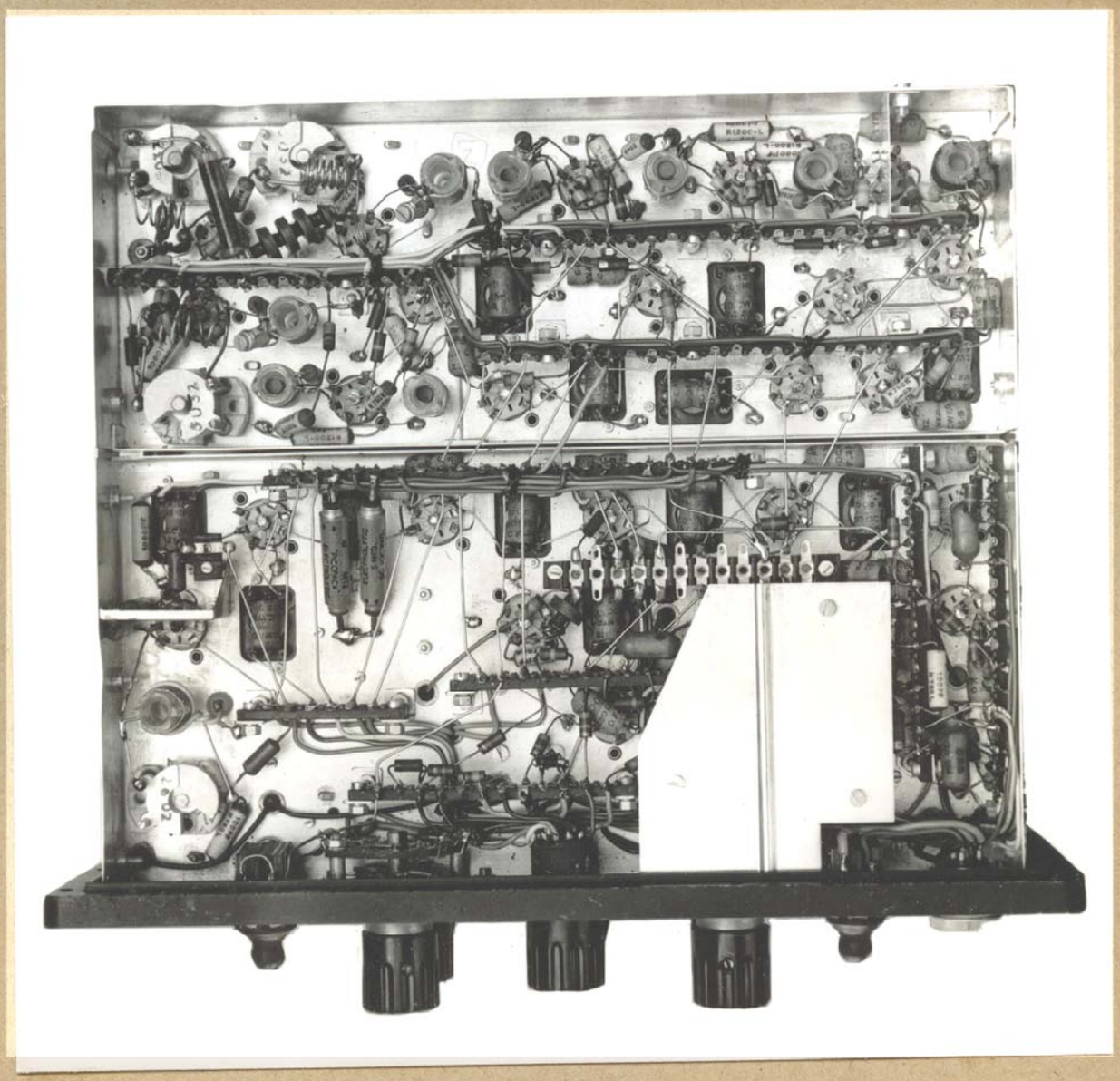



SENDER TOP CHASSIS.

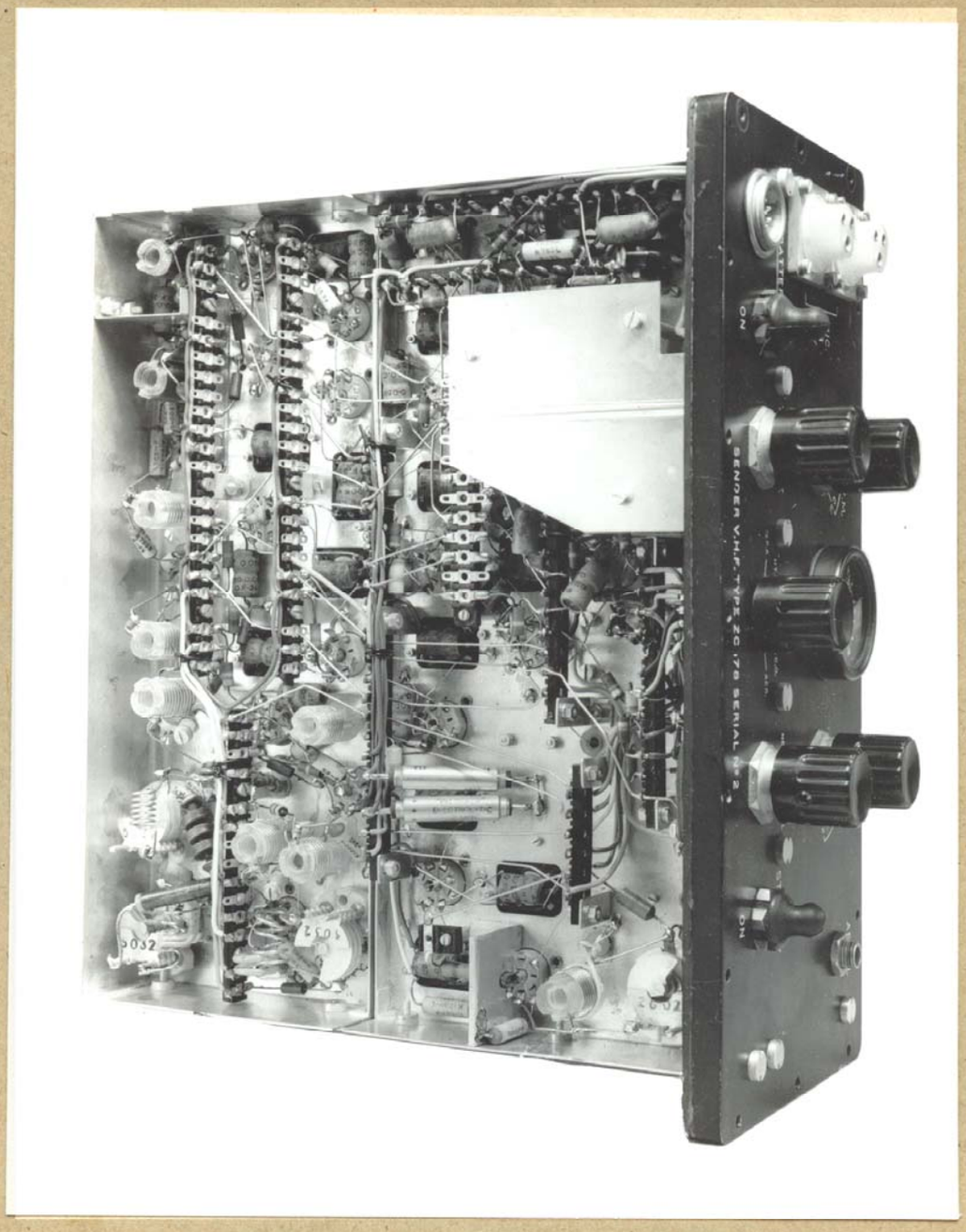


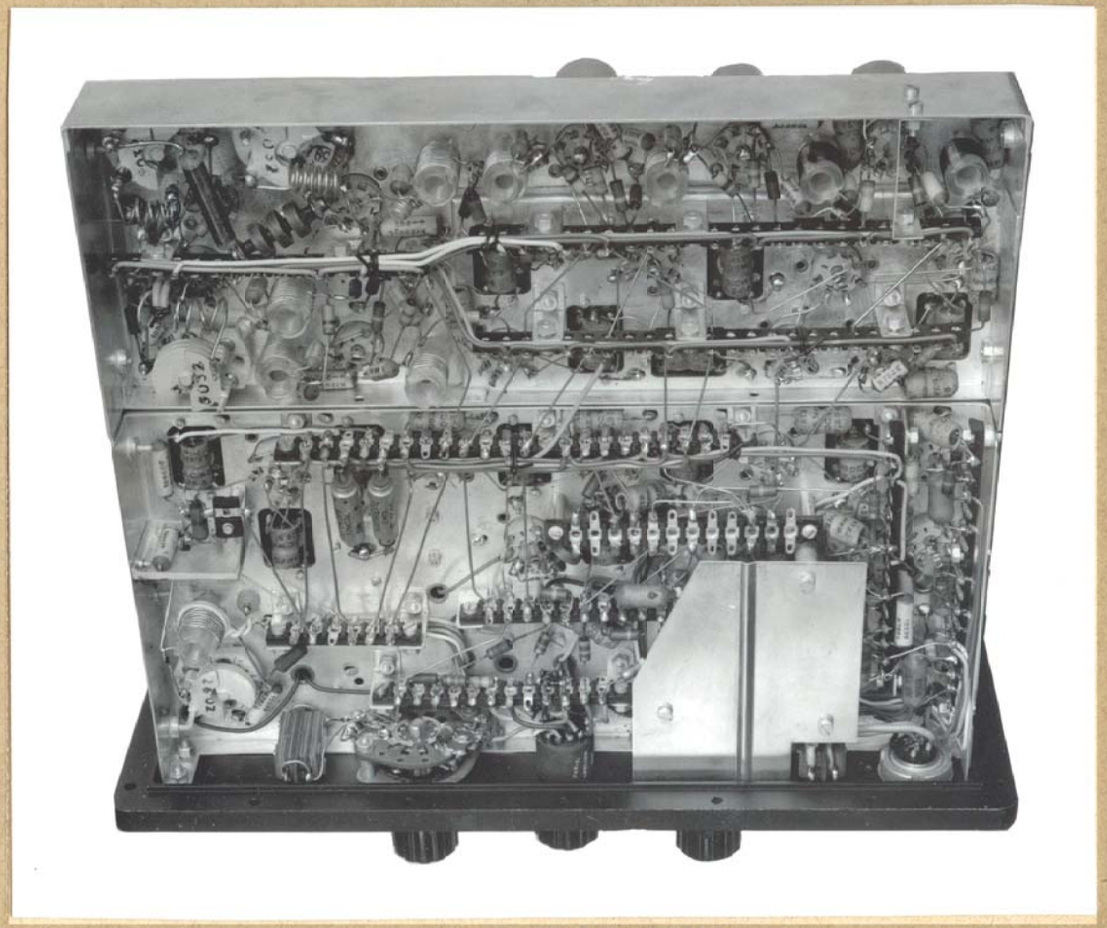

SENDER TOP CHASSIS VIEWS



SENDER BOTTOM CHASSIS



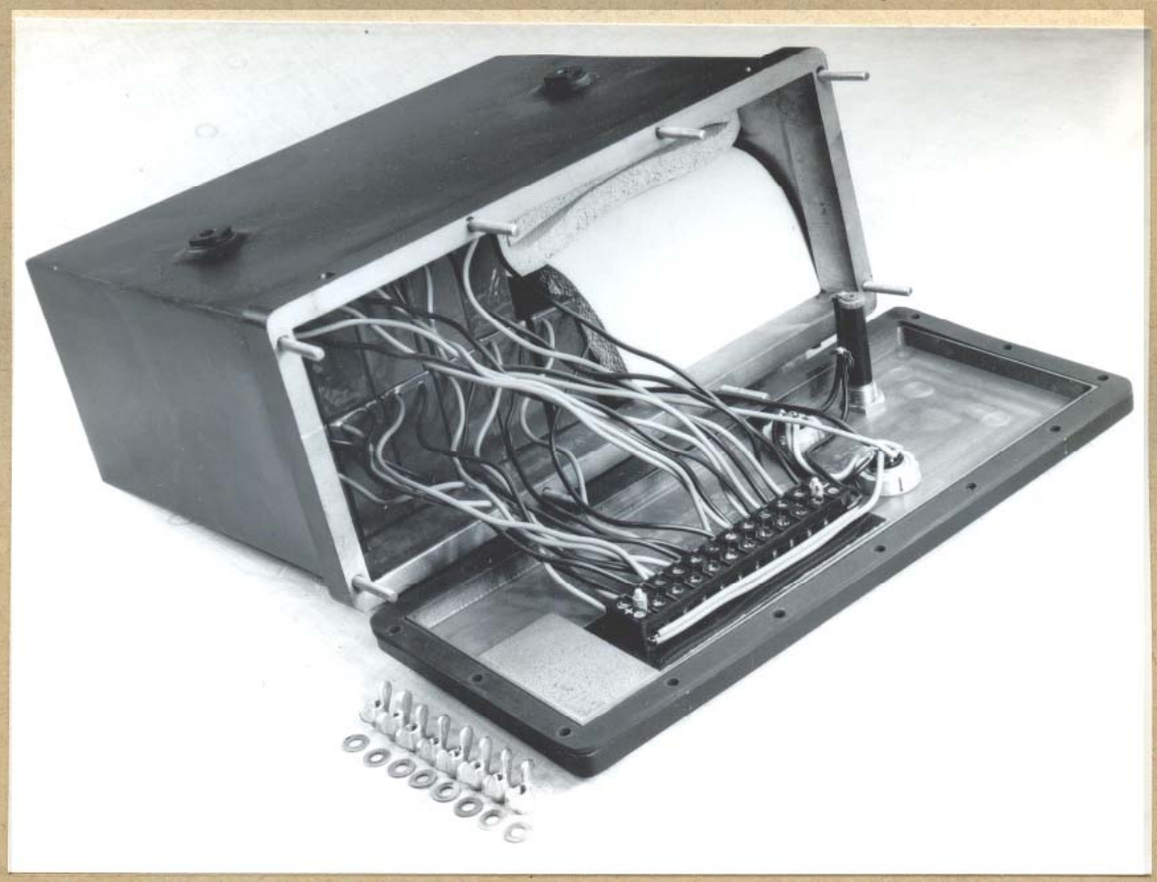

SENDER BOTTOM CHASSIS.



SENDER BOTTOM CHASSIS.


CONTENTS OF SENDER SIGNAL SATCHEL.


BATTERY IN CASE.

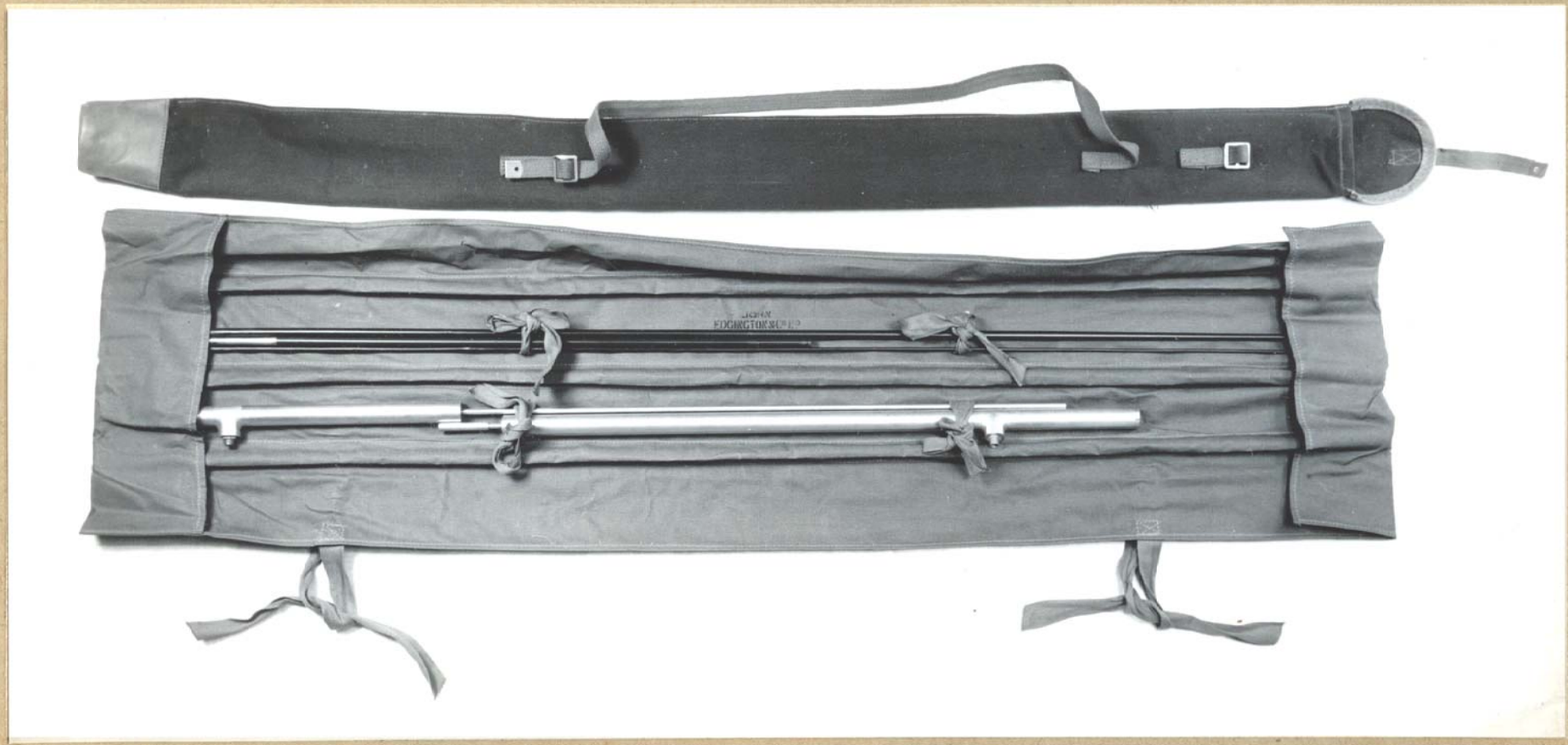


BATTERY CASE OPEN (PACKING IN).

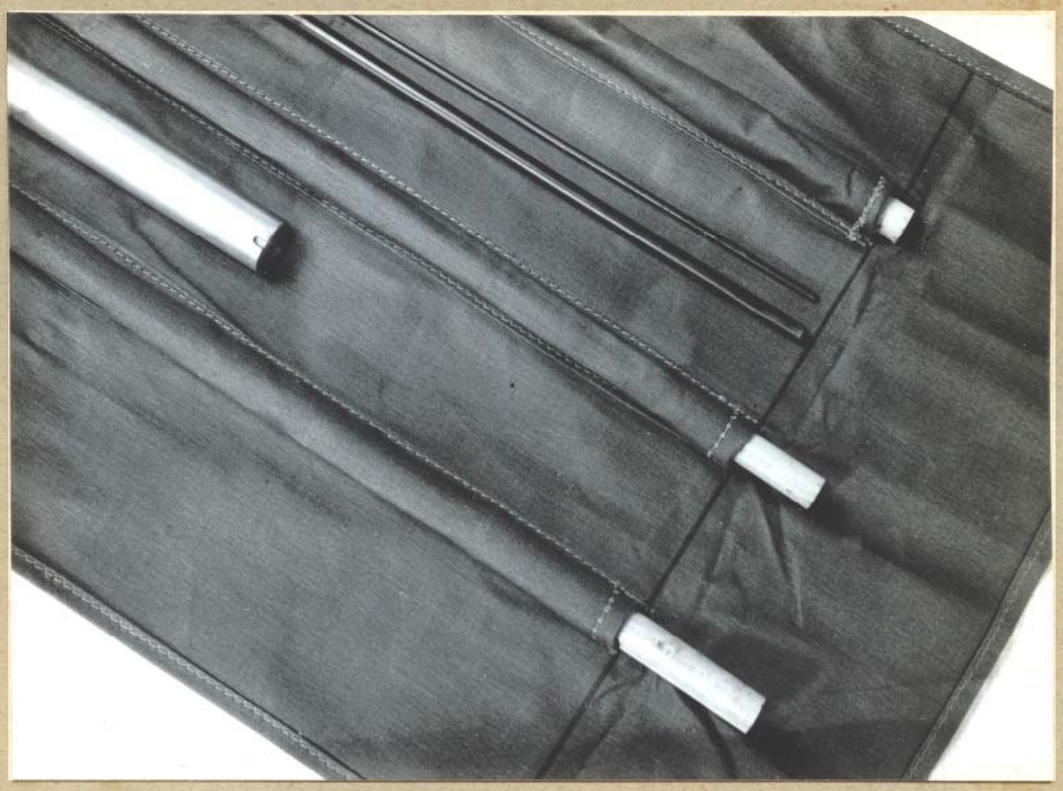
BATTERY CASE OPEN (PACKING OUT).


12-VOLT HT BLOCK AND L.T. BATTERY

12-VOLT BLOCK, EXPLODED

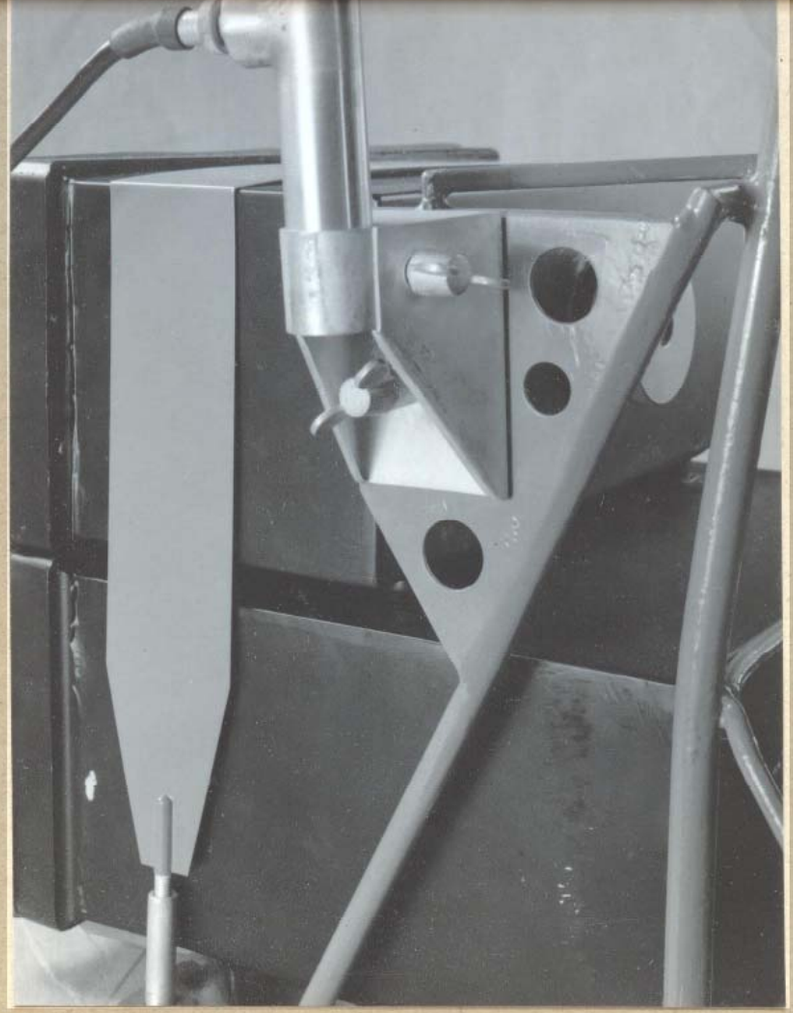


AERIALS IN HOLDER, WITH CARRYING BAG.

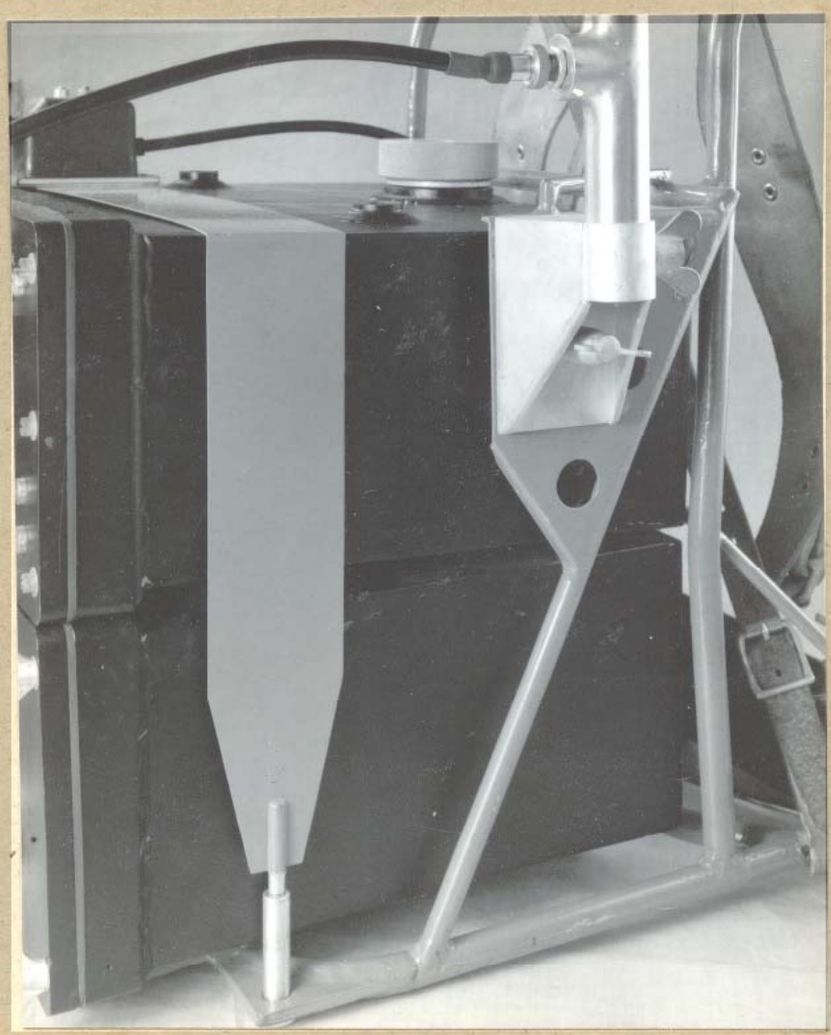


CANE STIFFENERS IN AERIAL HOLDER

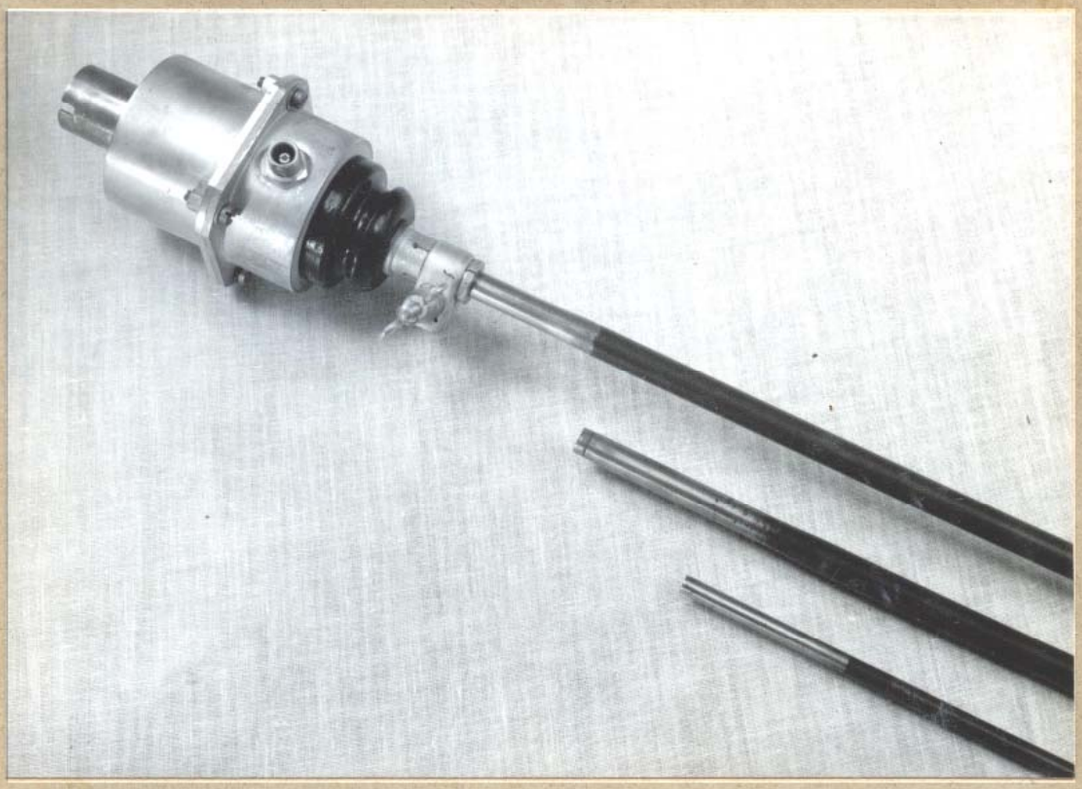
OPEN END OF AERIAL CARRYING BAG



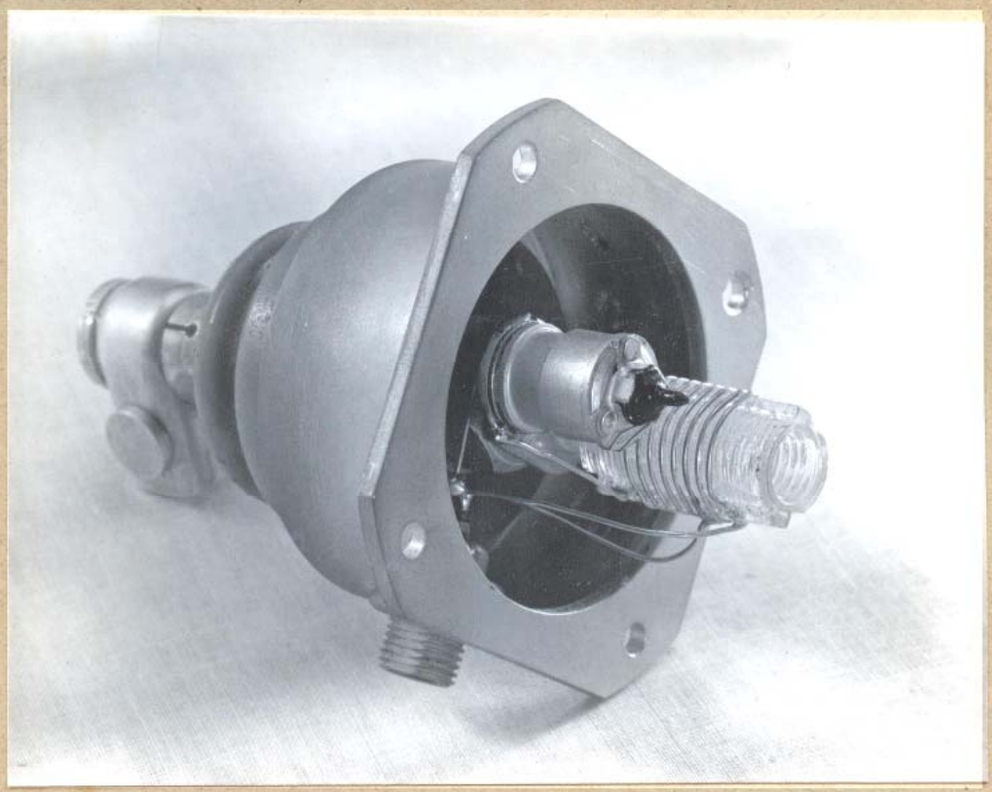
FITTING OF AERIAL BRACKET ON RECEIVER.



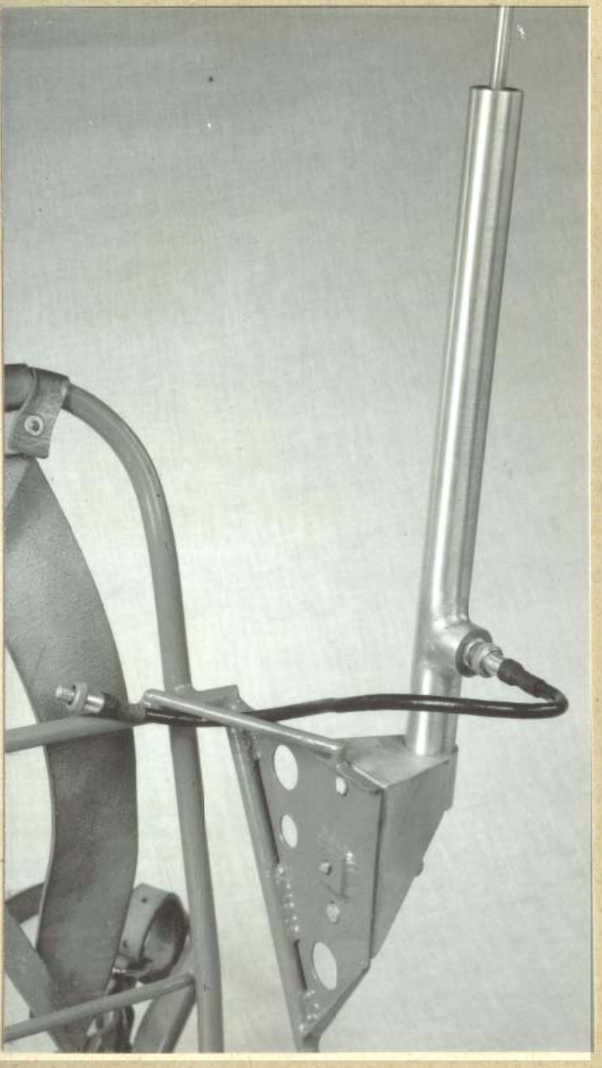
FITTING OF AERIAL BRACKET ON SENDER.



45 MC/S AERIAL MATCHING UNIT & AERIALS 10 FT.

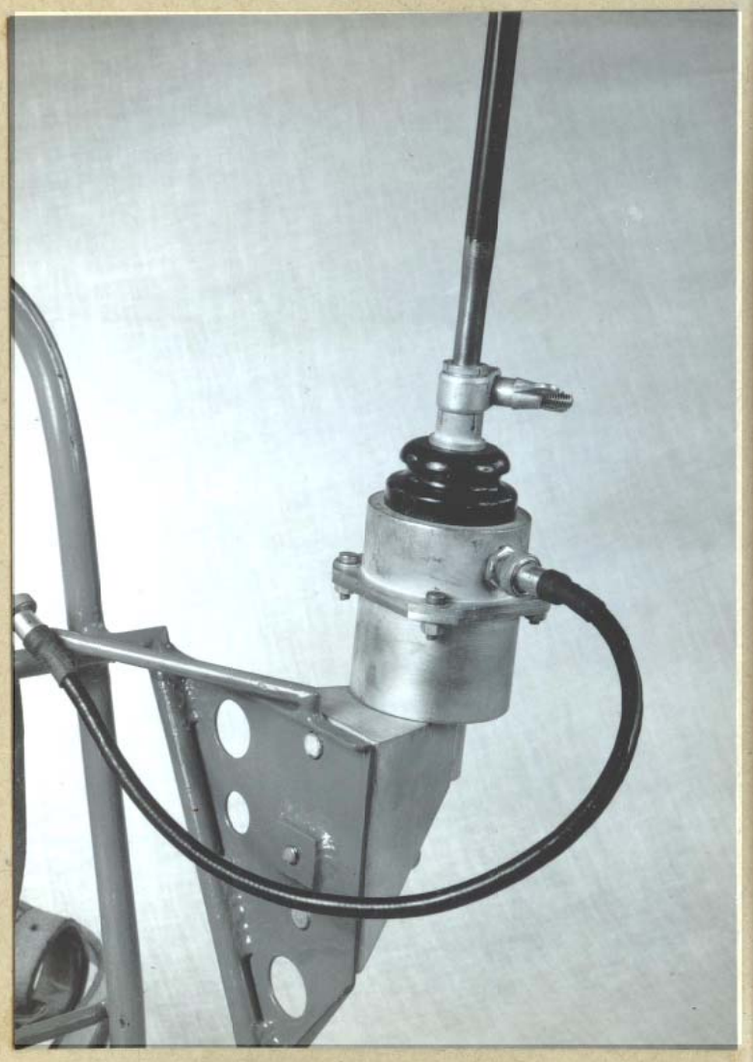


45 MC/S AERIAL MATCHING UNIT WITH BOTTOM OFF



235 MC/S

115 MC/S



45 MC/S

AERIALS MOUNTED ON CARRIER

MODIFIED EVEREST CARRIER

# WIRELESS SETS ZC.178

## PART II

Contents:-

# PARTS LIST No.1.

## RECEIVER ZC 178.

| Item No. | Part Description | No. Per Receiver | Remarks |
|---|---|---|---|
| 1 | Panel, front receiver. | 1 | |
| 2 | Chassis. | 1 | Brass S.P. |
| 3 | Bracket, panel L.H. | 1 | " " |
| 4 | " " Centre. | 1 | " " |
| 5 | " " R.H. | 1 | " " |
| 6 | " trimmer. | 1 | " " |
| 7 | " coil, T.13. | 1 | " " |
| 8 | " terminal, strip, mounting. | 3 | " " |
| 9 | Drive, flexible. | 1 | |
| 10 | Bushing 32 T.P.I. | 1 | For Item 9. |
| 11 | Socket, miniature valve. | 12 | ceramic. |
| 12 | " , aerial co-axial. | 1 | Pye miniature sealed. |
| 13 | " , phones. | 2 | |
| 14 | " , 8 pin octal, ceramic. | 1 | |
| 15 | Plug, 6 pin battery. | 1 | Plessey, sealed 10H/19014. |
| 16 | Meter .5mA sealed. | 1 | Nalder Bros. & Thompson ZA 24968. |
| 17 | Shields, miniature valve. | 12 | On item 11. |
| 18 | Switch, band selector, assembly. | 1 | Frequency. |
| 19 | " system. | 1 | AM - FM selector. |
| 20 | " toggle, stand-by. | 1 | Arrow DPST. |
| 21 | " " , battery ON-OFF | 1 | " " |
| 22 | " meter, range. | 1 | Minibank 2 pole, 6 posn. |
| 23 | Seals, toggle switch. | 2 | For items 20, 21. |
| 24 | " , spindle 26 T.P.I. | 1 | Mitcham Works. |
| 25 | " , " 32 T.P.I. | 4 | Mitcham Works, Ltd., MS 013.03. |
| 26 | Rings sealing 1⅛" x 1" x 1/16" rubber. | 2 | On Item 13. |
| 27 | " " .630" x .433" x .080" rubber. | 5 | On Items 24, 25. |
| 28 | " " .250" x .140" x .080" rubber. | 10 | On item 43. |
| 29 | Gasket, panel sealing. | 1 | Panel to case seal. |
| 30 | Grommet rubber 7/16" x 7/32" x 5/32". | 6 | |
| 31 | " rubber ⅞" x 7/16" x 3/16" | 1 | |
| 32 | Case, receiver. | 1 | |
| 33 | Desiccator, case. | 1 | |
| 34 | Knobs, control. | 6 | ZN. 0333 |
| 35 | Strip terminal 19 lug, 2 hole | 2 | |
| 36 | " " 18 " , 2 " | 1 | |
| 37 | " " 16 " , 2 " | 1 | |
| 38 | " " 21 " , 2 " | 1 | |
| 39 | " " 4 " , 1 " | 1 | |
| 40 | Spacer Brass 6 B.A. x ¼" x 3/32" | 8 | |
| 41 | Spacer brass. | 1 | Aerial trimmer mtg. |
| 42 | Bolt, hammerhead 10 B.A. | 20 | |
| 43 | " special 4 B.A. | 10 | |
| 44 | Inductance 45 m/c. L1. | 1 | |
| 45 | " 115 m/c. L2. | 1 | |
| 46 | " 235 m/c. L3. | 1 | |
| 47 | " I.F. 4.9 m/c. L4. | 1 | |
| 48 | " I.F. 4.9 m/c. L5 | 1 | |
| 49 | " crystal 5.829 M/C. L6 | 1 | |

Item No. 50.

| Item No. | Part Description | No. per Receiver | Remarks |
|---|---|---|---|
| 50 | Chokes filament. RFC. | 10 | |
| 51 | Transformers, discriminator audio. T1. | 1 | |
| 52 | " audio output. T2. | 1 | |
| 53 | " I.F. 25 m/c. T5. | 1 | |
| 54 | " I.F. 25 m/c. T6. | 1 | |
| 55 | " oscillator 20.1 m/c. T7. | 1 | |
| 56 | " I.F. 4.9 m/c. T8. | 1 | |
| 57 | " I.F. 4.9 m/c. T9. | 1 | |
| 58 | " Discriminator 4.9 m/c. T10. | 1 | |
| 59 | " 17.5 m/c. T11. | 1 | |
| 60 | " 35 m/c. T12. | 1 | |
| 61 | " 70 m/c. T13. | 1 | |
| 62 | Crystal, polythene mounted. LF. | 1 | 5829.2 k/c ± 100 cps. |
| 63 | " " " HF. | 1 | 5837.5 k/c ± 100 cps. |
| 64 | Potentiometer 1 megohm. | 1 | Morgan B.J. |
| 65 | Resistors 15,000 ohms 1/16 W. | 1 | Erie or Globar. |
| 66 | " 4.7 meg" " " | 1 | " " " |
| 67 | " 1.9 ohms 1/4 " | 1 | Erie or Morgan insulated 10% tol. |
| 68 | " 15 " 1/10 " | 1 | " " " " " " |
| 69 | " 1,000 " " " | 1 | " " " " " " |
| 70 | " 2,200 " " " | 1 | " " " " " " |
| 71 | " 3,900 " " " | 1 | " " " " " " |
| 72 | " 4,700 " " " | 1 | " " " " " " |
| 73 | " 6,800 " " " | 1 | " " " " " " |
| 74 | " 10,000 " " " | 3 | " " " " " " |
| 75 | " 15,000 " " " | 6 | " " " " " " |
| 76 | " 22,000 " " " | 1 | " " " " " " |
| 77 | " 27,000 " " " | 4 | " " " " " " |
| 78 | " 47,000 " " " | 10 | " " " " " " |
| 79 | " 68,000 " " " | 3 | " " " " " " |
| 80 | " 100,000 " " " | 8 | " " " " " " |
| 81 | " 180,000 " " " | 2 | " " " " " " |
| 82 | " 220,000 " " " | 1 | " " " " " " |
| 83 | " 270,000 " " " | 1 | " " " " " " |
| 84 | " 470,000 " " " | 4 | " " " " " " |
| 85 | " 1 megohm " " | 3 | " " " " " " |
| 86 | " 1.5 " " " | 1 | " " " " " " |
| 87 | " 2.2 " " " | 1 | Erie or Morgan insulated 10% tol. |
| 88 | " 10 " " " | 1 | " " " " " " |
| 89 | Condensers variable 18.5pf. max., ceramic. | 1 | Ingersoll 130B, 32 T.P.I. Bushing. |
| 90 | " " C.2pf.Max. " | 1 | " " " " |
| 91 | " " 1-7pf ceramic tubular. | 1 | " 153 Miniature |
| 92 | " tubular, .1 mfd. 150V. W. | 12 | Dubilier Type 412. |
| 93 | " " .05 mfd. 250V.W. | 27 | " " " |
| 94 | " " .002 " 350V. W. | 2 | Hunts. |
| 95 | " electrolytic, 2 mfd. 150V.W. | 1 | T.C.C.Picopack, CE309. |
| 96 | " concentric var. 3-30pf. | 2 | Mullard. |

| Item No. | Part Description | No. Per Receiver | Remarks |
|---|---|---|---|
| 97 | Condensers ceramic 5.6pf | 4 | Erie N750K. 10% tol. |
| 98 | " " 10 " | 1 | " " 10% " |
| 99 | " " 20 " | 6 | " " 2% " |
| 100 | " " 51 " | 14 | " " 2% " |
| 101 | " " 100 " | 5 | " N750L. 5% " |
| 102 | " " 1,000 " | 2 | " K1200L. 5" " |
| 103 | Valve, type IT4. | 9 | |
| 104 | " " IS5. | 2 | |
| 105 | " " IR5. | 1 | |
| 106 | " " HY144B. | 1 | |
| 107 | Desiccator, case, insert & lock ring. | 1 | |
| 108 | " " " " "seal | 1 | |
| 109 | Nuts 32 T.P.I. x 3/8". | 1 | On items 22,90. |
| 110 | Screws 6 B.A. x 3/8" CH. | 13 | Brass S.P. |
| 111 | " 6 B.A. x 5/16" CH. | 14 | " " |
| 112 | " 6 B.A. x 3/16" CH. | 8 | on T1 and T2. |
| 113 | " 6 B.A. x 5/16" CH. | 8 | M.S.Cad.Plated on Items 13. |
| 114 | " 4 B.A. x 3/4" CH. | 16 | " " Panel-case mtg |
| 115 | Nuts 4 B.A. small Hex. | 10 | Brass S.P. |
| 116 | " 6 B.A. Hex. | 24 | |
| 117 | " 6 B.A. " lock. | 2 | On item 14. |
| 118 | " 10 B.A. " | 22 | Coil can mtg. |
| 119 | Washer spring, single coil 4 B.A. | 10 | Phos.bronze S.P. |
| 120 | " " single " 6 B.A. | 22 | " " " |
| 121 | " " " "10 " | 22 | " " " |
| 122 | " 6 B.A. x 5/16" x 24 S.W.G. | 2 | Brass S.P. |
| 123 | " 6 B.A. x 3/16" x 24 S.W.G. | 8 | For Item 113. |
| 124 | " 4 B.A. x 5/16" x 24 S.W.G. | 16 | MS. Cad.Plating for Items 114. |
| 125 | " shakeproof, 3/8". | 4 | On Items 20,21,22,90. |
| 126 | Wire T.Copper 23 S.W.G. PVC Covered. | | |
| 127 | " " " 7/36 S.W.G. PVC Covered. | | |
| 128 | " " " 9/31 S.W.G. PVC Covered. | | |
| 129 | " T.C. 22 S.W.G. | | |

R.P.U.
WOOLWICH COMMON,
S.E.18.
15th April, 1946.
PBA/VE.

SENDER ZC 178.

| Item No. | Part Description | No. per Sender | Remarks |
|---|---|---|---|
| 1 | Panel front. | 1 | |
| 2 | Chassis, main. | 1 | Brass S.P. |
| 3 | " , sub. | 1 | " " |
| 4 | Bracket, panel L.H. | 1 | " " |
| 5 | " " R.H. | 1 | " " |
| 6 | " , shield, 45 m/c PA. | 1 | V9 inter-section shield. |
| 7 | " , sheild. | 1 | V22 grid-plate shield. |
| 8 | " , terminal, strip mounting. | 18 | Brass S.P. |
| 9 | " and strap, polythene crystal mount. | 1 | |
| 10 | Plate potentiometer mtg. | 2 | |
| 11 | " bottom shield. | 1 | |
| 12 | Pillars, 3/16" x ¾" | 12 | On items 10, 22, 47. |
| 13 | " , bottom shield. | 3 | On item 11. |
| 14 | Socket, miniature valve. | 26 | ceramic. |
| 15 | " , polythene crystal. | 1 | |
| 16 | " , aerial co-axial | 1 | Pye miniature, sealed |
| 17 | " , microphone & key. | 2 | |
| 18 | Plug, co-axial. | 2 | Pye, unsealed. |
| 19 | " , 6 pin battery. | 1 | Plessey, sealed 10H/19014 |
| 20 | Holder, crystal valve. | 1 | |
| 21 | Meter .5mA sealed. | 1 | Nalder Bros. & Thompson ZA 24968. |
| 22 | Panel, crystal trimmer mtg. | 1 | For trimmers C50, C51. |
| 23 | Shields miniature valve. | 26 | For item 14. |
| 24 | Feed-through, polythene. | 1 | |
| 25 | Switch, band selector. | 1 | S1. |
| 26 | " , system AM/FM. | 1 | S2. |
| 27 | " , netting. | 1 | S3. |
| 28 | " , toggle stand-by. | 1 | S4. |
| 29 | " , toggle, battery ON/OFF | 1 | S5. |
| 30 | " , meter range. | 1 | Minebank, AB Metals, Ltd. |
| 31 | Seals, toggle switch. | 2 | For items 28, 29. |
| 32 | " , spindle 32 T.P.I. | 4 | Philips, Ltd. MS.013.03 |
| 33 | Rings, sealing, 1⅛" x 1" x 1/16" rubber. | 2 | For item 17. |
| 34 | Rings, sealing, .630" x .433" x .080" rubber. | 4 | " " 32. |
| 35 | Rings, sealing, .250" x .140" x .180" rubber. | 8 | " " 151. |
| 36 | Gasket, panel sealing. | 1 | Panel to case seal. |
| 37 | Case, sender. | 1 | |
| 38 | Knob, control. | 5 | ZN. 0333. |
| 39 | Strip terminal, 21 lug, 3 hole | 2 | On item 3. |
| 40 | " " 14 " 2 " | 1 | " " 3. |
| 41 | " " 15 " 3 " | 1 | " " 2. |
| 42 | " " 14 " 2 " | 1 | " " 2. |
| 43 | " " 12 " 2 " | 2 | " " 2. |
| 44 | " " 13 " 2 " | 1 | " " 2. |
| 45 | " " 21 " 3 " | 1 | " " 2. |
| 46 | " " 6 " 2 " | 1 | " " 2. |
| 47 | " " 1 " 1 " | 1 | " " 2. |
| 48 | " " 3 " 2 " | 1 | " " 5. |
| 49 | Spacer brass, 6 B.A. x ¼" x 3/32" | 5 | On items 41, 48. |



/Item No. 50

| Item No. | Part Description | No. per Sender | Remarks |
|---|---|---|---|
| 50 | Desiccator, case. | 1 | On item 37. |
| 51 | Grommet rubber 7/16" x 7/32" x 5/32" | 4 | |
| 52 | Transformers, FM Oscillator 2.083 m/c T1. | 1 | |
| 53 | Transformer, 45 m/c P.A. Tank. T2. | 1 | |
| 54 | Transformer, Microphone & MCW Osc. T3. | 1 | |
| 55 | Transformer, AM driver. T4. | 1 | |
| 56 | " , modulation (AM) T5. | 1 | |
| 57 | " , R.F., 57.5 m/c. T6. | 1 | |
| 58 | " , 115m/c TA Tank. T7. | 1 | |
| 59 | " , RF, 58.75m/c. T8. | 1 | |
| 60 | " , 235m/c. P.A. Tank. T9. | 1 | |
| 61 | Coil, FM, buffer tank 2.083 m/c. L1. | 1 | |
| 62 | " , crystal osc. tank 5.83 m/c. L2. | 1 | |
| 63 | " , 3.75 m/c. mixer Tank. L3. | 1 | |
| 64 | " , tripler tank, 11.25 m/c. L4. | 1 | |
| 65 | " , Amplifier Plate Tank 11.25 m/c. L5. | 1 | |
| 66 | " , doubler plate Tank 22.5 m/c. L6. | 1 | |
| 67 | " , doubler plate Tank 45 m/c. L7. | 1 | |
| 68 | " , 11.6 m/c crystal multiplier Tank. L8. | 1 | |
| 69 | " , 9.583 m/c mixer Tank. L9. | 1 | |
| 70 | " , tank, 28.75 m/c. L10. | 1 | |
| 71 | " , " , 28.75 m/c. L11. | 1 | |
| 72 | " , " , 57.5 m/c. L12. | 1 | |
| 73 | " , " , 17.5 m/c. L13. | 1 | |
| 74 | " , " , 19.583 m/c. L14. | 1 | |
| 75 | " , " , 19.583 m/c. L15. | 1 | |
| 76 | " , " , 58.75 m/c. L16. | 1 | |
| 77 | " , doubler tank, 117.5 m/c. L17. | 1 | |
| 78 | Choke, RF, 3 pie RFC1 A-C. | 3 | |
| 79 | " , RF, 235 m/c. Plate. RFC2. | 1 | |
| 80 | " , RF, aerial. RFC3. | 1 | |
| 81 | Crystal, polythene mounted. L.F. | 1 | 5829.2 k/c ± 100 cps. |
| 82 | " " " H.F. | 1 | 5837.5 k/c ± 100 cps. |
| 83 | Potentiometer 25,000 ohms. | 1 | Morgan B.J. |
| 84 | " 10,000 " | 1 | " " |
| 85 | Resistor 5.1 ohms 1/10 W. | 4 | Erie insulated ± 10% tol. |
| 86 | " 220 " 1/10 W. | 4 | " " " " " |
| 87 | " 220 " 1/4 W. | 2 | " " " " " |
| 88 | " 470 " 1/4 W. | 4 | " " " " " |
| 89 | " 680 " 1/10 W. | 1 | " " " " " |

/Item No.90

| Item No. | Part Description | No. per Sender | Remarks |
|---|---|---|---|
| 90 | Resistor 1,500 ohms 1/10 W. | 1 | Erie insulated ± 10% tol. |
| 91 | " 2,200 " " " | 7 | " " " " " |
| 92 | " 2,200 " 1/16 " | 11 | " " " " " |
| 93 | " 3,300 " 1/10 " | 1 | " " " " " |
| 94 | " 3,300 " 1/4 " | 1 | " " " " " |
| 95 | " 3,900 " 1/10 " | 1 | " " " " " |
| 96 | " 3,900 " 1/4 " | 1 | " " " " " |
| 97 | " 4,700 " 1/10 " | 3 | " " " " " |
| 98 | " 6,800 " 1/4 " | 1 | " " " " " |
| 99 | " 10,000 " 1/4 " | 1 | " " " " " |
| 100 | " 12,000 " 1/10 " | 2 | " " " " " |
| 101 | " 15,000 " 1/10 " | 9 | " " " " " |
| 102 | " 22,000 " 1/10 " | 6 | " " " " " |
| 103 | " 22,000 " 1/4 " | 3 | " " " " " |
| 104 | " 27,000 " 1/10 " | 4 | " " " " " |
| 105 | " 27,000 " 1/4 " | 1 | " " " " " |
| 106 | " 47,000 " 1/16 " | 1 | " " " " " |
| 107 | " 47,000 " 1/10 " | 8 | " " " " " |
| 108 | " 47,000 " 1/4 " | 3 | " " " " " |
| 109 | " 68,000 " 1/10 " | 1 | " " " " " |
| 110 | " 100,000 " 1/16 " | 5 | " " " " " |
| 111 | " 100,000 " 1/10 " | 6 | " " " " " |
| 112 | " 150,000 " 1/16 " | 1 | " " " " " |
| 113 | " 180,000 " 1/4 " | 2 | " " " " " |
| 114 | " 220,000 " 1/16 " | 5 | " " " " " |
| 115 | " 220,000 " 1/10 " | 7 | " " " " " |
| 116 | " 270,000 " 1/10 " | 1 | " " " " " |
| 117 | " 330,000 " 1/10 " | 1 | " " " " " |
| 118 | " 1 megohm 1/16 " | 1 | " " " " " |
| 119 | " 1 " 1/10 " | 1 | " " " " " |
| 120 | " 2.2 " 1/10 " | 1 | " " " " " |
| 121 | Condenser, 7 plate var. 27pf. | 1 | Polar, Cat. No. 2602. |
| 122 | " ," " "3-12pf. | 3 | " " " 5032. |
| 123 | " ,2 " " 2pf. | 1 | Ingersoll, Type 130B 32 T.P.I. bushing. |
| 124 | " ,Mullard, Air Trimmer 3-30pf. | 2 | Philips, Ltd. |
| 125 | " ,Miniature, Ceramic Var. 1-7pf. | 2 | Ingersoll Type 153. |
| 126 | " ,electrolytic 2 mfd. | 2 | Picopack TCC. 150V.W. CE 30G. |
| 127 | " , " 5 mfd. | 1 | " TCC 50V. W. |
| 128 | " , tubular .05 mfd. | 34 | Dubilier, Type 412. 250V. W. |
| 129 | " " .002 " | 3 | Hunts. 350V. W. |
| 130 | " , " .003-.005" | 1 | Hunts. 350V. W. |
| 131 | " ,silver mica. 80pf. | 1 | Lemco ± 2% tol. |
| 132 | " ,1 pf. ceramicon. | 3 | Erie N750K ± 25% |
| 133 | " ,2.2pf. " | 4 | " " " 10% |
| 134 | " ,5.6pf. " | 4 | " " " 10% |
| 135 | " , 10pf. " | 7 | " " " 2% |
| 136 | " , 10pf. " | 2 | " " " 10% |
| 137 | " , 20pf. " | 2 | " " " 10% |
| 138 | " , 20 pf. " | 7 | " " " 2% |
| 139 | " , 51pf. " | 8 | " " " 10% |
| 140 | " , 51pf. " | 3 | " " " 2% |
| 141 | " ,100pf. " | 8 | " " " 10% |
| 142 | " ,100pf. " | 1 | " " " 5% |
| 143 | " 1,000pf. " | 13 | Erie K1200L ± 20% |

/Item No. 144

| Item No. | Part Description | No. per Sender | Remarks |
|---|---|---|---|
| 144 | Valve, type IT4. | 11 | |
| 145 | " , " IR5. | 4 | |
| 146 | " , " IS5. | 1 | |
| 147 | " , " 3A4 | 6 | |
| 148 | " , " 3A5 | 4 | |
| 149 | Crystal Valve, type CV 103 | 1 | |
| 150 | Bolt, 10 B.A. Hammerhead. | 26 | Coil can mounting. |
| 151 | Bolt Special 4 B.A. | 8 | Chassis-panel mounting. |
| 152 | Nut 3/8" x 32 T.P.I. Cad. Plate, Hex. | 3 | Mounting items 30,83,84. |
| 153 | Screw 4 B.A. x $\frac{1}{4}$" CH. | 1 | M.S. Cad.Plated. on Item 4. |
| 154 | " 6 B.A. x 3/8" C/sk. | 4 | Brass S.P. |
| 155 | " 6 B.A. x 3/8" CH. | 3 | " " |
| 156 | " 6 B.A. x 5/16" CH. | 8 | M.S. Cad.Plated. On Item 17. |
| 157 | " 6 B.A. x 5/16" C/sk. | 10 | Brass S.P. On items 4 & 5. |
| 158 | " 6 B.A. x 5/16" CH. | 48 | " " |
| 159 | " 6 B.A. x 3/16" CH. | 12 | " " " " 54,55,56. |
| 160 | " 8 B.A. x 1/4" CH. | 2 | " " " " 20. |
| 161 | " 10 B.A. x 1/4" C/sk. | 10 | " " |
| 162 | " 10 B.A. x 1/4" CH. | 17 | " " |
| 163 | Nut, 4 B.A. Hex. (small) | 14 | " " |
| 164 | " 6 B.A. " | 45 | " " |
| 165 | " 8 B.A. " | 8 | " " |
| 166 | " 10 B.A. " | 32 | " " |
| 167 | Washer, spring 4 B.A. | 9 | Phos.Bronze S.P. |
| 168 | " " 6 B.A. | 67 | " " " |
| 169 | " " 8 B.A. | 4 | " " " |
| 170 | " " 10 B.A. | 44 | " " " |
| 171 | " ,shakeproof, 3/8". | 7 | Cad. Plated. |
| 172 | " 4 B.A. x 5/16" x 22 S.W.G. | 7 | Brass S.P. |
| 173 | " 6 B.A. x 3/16" x 24 S.W.G. | 8 | M.S. Cad. Plated. |
| 174 | " 8 B.A. x 7/32" x 26 S.W.G. | 6 | Brass S.P. |
| 175 | " 10 B.A. x 5/32" x 28 S.W.G. | 5 | |
| 176 | Eyelet N.P. Valve Socket mtg. | 52 | |
| 177 | " " wiring feed through. | 14 | |
| 178 | Desiccaotr insert & ring, & ring sealing. | 1 | |
| 179 | Screws 4 B.A. CH. x 3/4" | 16 | M.S. Cad.Plate (Panel-case) |
| 180 | Washer 4 B.A. | 16 | -ditto- |
| 181 | Wire 23 SWG. TC. PVC. covered. | | |
| 182 | Wire 7/36 SWG. TC. PVC. covered. | | |
| 183 | Wire 9/31 SWG TC. PVC. covered. | | |
| 184 | Wire 20 SWG TC. | | |
| 185 | Wire 22 SWG. TC. | | |

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PARTS LIST NO.3.

BATTERY, STATION ZC.178.

| | Description. | No. | Remarks. |
|---|---|---|---|
| 1. | Case Battery | 1 | |
| 2. | Panel, Case Battery. | 1 | |
| 3. | Plug 6 pin, Battery. | 2 | |
| 4. | Holder Fuse, (Bulgin) | 1 | |
| 5. | Fuse, 250 ma. | 1 | |
| 6. | Strip, connector. | 1 | |
| 7. | Sheet, insulating, connector strip. | 1 | |
| 8. | Gasket, panel sealing. | 1 | |
| 9. | Battery No.6. 1½ volts. | 2 | "A" Battery, 2 in parallel. |
| 10. | Battery, special 12 volts. | 11 | "B" Battery 132 volts. |
| 11. | Wing nuts, special 2 B.A. | 8 | |
| 12. | Screws 6 B.A. CH. x 7/8" M.S. Cadmium Plated. | 2 | For securing item 6. |
| 13. | Washers, 6 B.A. M.S. Cadmium Plated. | 2 | |
| 14. | " 2 B.A. M.S. Cadmium Plated. | 8 | Under Wing Nuts. |
| 15. | Nuts 6 B.A. Hex. M.S. Cadmium Plated. | 4 | |
| 16. | Sponge rubber 1/2". | sq.ft.1 | |
| 17. | P.V.C.Wire,9 Strand (Black | 12" | |
| | (Orange | 12" | |
| 18. | Wire T.C. 20 S.W.G. | 3' | |
| 19. | Wire T.C. 10 S.W.G. | 12" | |
| 20. | P.V.C. Sleeving 2 mm.Red. | 12" | |
| | Black | 12" | |
| | Orange. | 12" | |
| 21. | P.V.C.Sleeving 3.5mm. Red. | 4" | |
| | Black. | 4" | |

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STATION ZC.178 PARTS LIST No.4.

| Item No. | Part Description | No. Recr. | No. Send. | Spares | Total | Remarks |
|---|---|---|---|---|---|---|
| 1 | Carrier, Everest, modified | 1 | 1 | - | 2 | |
| 2 | Receiver ZC.178 | 1 | - | - | 1 | List No. 1 |
| 3 | Sender ZC.178 | - | 1 | - | 1 | List No. 2 |
| 4 | Battery ZC.178 | 1 | 1 | - | 2 | List No. 3 |
| 5 | Strap, hold-down, receiver | 1 | - | - | 1 | |
| 6 | " " " sender | - | 1 | - | 1 | |
| 7 | Nut, strap hold-down | 2 | 2 | - | 4 | |
| 8 | Connector, battery, short | 1 ≠ | 1 ≠ | 1 ≠ | 3 | |
| 9 | " " long | - | - | 1 ≠ | 1 | |
| 10 | Co-axial connector, short | 1 ≠ | 1 ≠ | 1 ≠ | 3 | |
| 11 | " " long | - | - | 1 ≠ 1 ≠ | 2 | |
| 12 | Headsets I.T.E. No.1, Mk.II | 2 ≠ | - | - | 2 | |
| 13 | Key, morse | - | 1 ≠ | 1 ≠ | 2 | |
| 14 | Microphone | - | 1 ≠ | 1 ≠ | 2 | |
| 15 | Aerial, mounting bracket | 1 | 1 | - | 2 | |
| | ·ial matching unit, 45 m/c | 1 ≠ | 1 ≠ | - | 2 | List No. 4A. |
| 17 | " 115 m/c | 1 ø | 1 ø | - | 2 | One in each aer.bag List 4B. |
| 18 | " " erial 35 m/c | 1 ø | 1 ø | - | 2 | One in each aer.bag List 4C. |
| 19 | 'F' Section No.1 (modified) | 1 ø | 1 ø | 2 ø | 4 | 2 in each aerial bag. |
| 20 | 'F' Section No. 2 | 1 ø | 1 ø | 2 ø | 4 | 2 in each aerial bag. |
| 21 | 'F' Section No. 3 | 1 ø | 1 ø | 2 ø | 4 | 2 in each aerial bag. |
| 22 | Bag Aerial | 1 | 1 | - | 2 | |
| 23 | Box, spare valves, filled. | - | - | 1 ≠ | 1 | List No.8 |
| 24 | Satchel, Signals, receiver and sender. | 1 | 1 | - | 2 | |

/Item No.25

| Item No. | Part Description | No. Recr. | No. Sender | Spares | Total | Remarks |
|---|---|---|---|---|---|---|
| 25 | Instruction Card, receiver | 1 ≠ | - | - | 1 | |
| 26 | " " sender | - | 1 ≠ | - | 1 | |
| 27 | Fuses 250 mA. | 6 ≠ | 6 ≠ | - | 12 | |
| 28 | Screwdriver | 1 ≠ | 1 ≠ | - | 2 | For panel screws. |
| 29 | Desiccator, spare | - | - | 1≠ 1≠ | 2 | |

≠ In Satchel, Signals, Receiver (List No. 6).

≠ " " " , Sender (List No. 5).

ø " Bags Aerial (List No. 7).

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11th April, 1946.

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# AERIAL MATCHING UNIT 45 m/c.

## (Item 16 in List 4)

| Item No. | Part Description | No. | Remarks |
|---|---|---|---|
| 1 | Bottom | 1 | |
| 2 | Top | 1 | |
| 3 | Aerial rod socket | 1 | |
| 4 | " " " , clamp | 1 | |
| 5 | " " " " bolt | 1 | |
| 6 | " " " " " bush | 1 | |
| 7 | " " " " " ring | 1 | |
| 8 | " " " " " wing nut | 1 | |
| 9 | " " " , nut 5/16" Whit. | 1 | |
| 10 | " " " , washer 5/16" | 1 | |
| 11 | Coil and condenser bracket | 1 | |
| 12 | " " " " , nut 6 B.A. | 1 | |
| 13 | " " " " , washer 6 B.A. | 1 | |
| 14 | Insulating washer | 1 | |
| 15 | Insulator | 1 | |
| 16 | Polystarine former and winding, 45 m/c. | 1 | See coil specifica--tion sheet. |
| 17 | " " , mounting screw 6 B.A. CH. x $\frac{3}{8}$" | 1 | |
| 18 | Condenser, Mullard, trimmer, 3-30 pF. | 1 | - tuning. |
| 19 | Socket co-axial (Pye) and nut | 1 | |
| 20 | Ring sealing 2.030" x 1.906" x .070" | 1 | Body seal. |
| 21 | " " 1.248" x 1.125" x .090" | 1 | Insulator - body seal. |
| 22 | " " .5625" x .375" x .0625" | 1 | Aerial rod socket--insulator seal. |
| 23 | Screws M.S., 4 BA.CH. x $\frac{1}{2}$", Cadmium plate | 4 | |
| 24 | Washers, M.S., 4 BA, small | 8 | |
| 25 | Polystarine former, mounting screw washer, 6 BA, spring. | 1 | On item 17. |

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STATION ZC.178 PARTS LIST No. 4B.

## AERIAL MATCHING UNIT, 115 M/C.

Item 17 in List 4.

| Item No. | Part Description | No. | Remarks |
|---|---|---|---|
| 1 | Tube, matching, 115 m/c | 1 | |
| 2 | Tube, mounting, co-axial socket | 1 | |
| 3 | Plug ¼" bottom | 1 | |
| 4 | Rod ¼" x 26" long | 1 | |
| 5 | Spacers, polythene | 3 | |
| 6 | Washers 'C', 'oak' type | 6 | |
| 7 | Plug, polythene | 1 | |
| 8 | Socket, brass | 1 | To take 'F' section No.3. |
| 9 | " " , retaining pin | 1 | |
| 10 | Socket, co-aaxial (Pye) and nut | 1 | |
| 11 | Contact, co-axial socket | 1 | |

STATION ZC.178 PARTS LIST No. 4C.

## AERIAL MATCHING UNIT AND AERIAL, 235 M/C.

Item 18 in List 4.

| Item No. | Part Description | No. | Remarks |
|---|---|---|---|
| 1 | Tube matching, 235 m/c | 1 | |
| 2 | Tube mounting, co-axial socket | 1 | |
| 3 | Plug ¼" bottom | 1 | |
| 4 | Rod matching and aerial ¼ x 36-3/16"long | 1 | |
| 5 | Spacer, polythene | 1 | |
| 6 | Washers 'C', 'oak' type | 2 | |
| 7 | Plug, polythene | 1 | |
| 8 | Socket, co-axial (Pye) and nut | 1 | |
| 9 | Contact, co-axial socket | 1 | |

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CONTENTS OF SATCHELS SIGNAL - SENDER ZC.178 LIST 5.

| Item No. | Part Description | No. | |
|---|---|---|---|
| 1 | Connector battery, short | 1 | |
| 2 | " " long | 1 | |
| 3 | Key, morse | 2 | |
| 4 | Microphone | 2 | |
| 5 | Aerial matching unit, 45 m/c | 1 | |
| 6 | Box spare valves, filled | 1 | |
| 7 | Instruction card, sender | 1 | |
| 8 | Desiccator | 1 | |
| 9 | Fuses 250 mA. | 6 | |
| 10 | Screwdriver | 1 | |
| 11 | Co-axial connector short | 1 | |
| 12 | " " long | 1 | |
| 13 | Brackets, Aerial | 1 | |

CONTENTS OF SATCHELS SIGNAL - RECEIVER ZC.178. LIST 6.

| Item No. | Part Description | No. | |
|---|---|---|---|
| 1 | Connector, battery, short | 2 | |
| 2 | Co-axial connector, short | 2 | |
| 3 | " " , long | 1 | |
| 4 | Headsets I.T.E. No.1 Mk.II | 2 | |
| 5 | Aerial matching unit, 45 M/C. | 1 | |
| 6 | Instruction card, receiver | 1 | |
| 7 | Desiccator | 1 | |
| 8 | Fuses, 250 mA. | 6 | |
| 9 | Screwdriver | 1 | |
| 10 | Brackets, Aerial | 1 | |

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Contents of one Bags, aerial. Z.C.178. List 7.

| Item. | Part Description. | No. | |
|---|---|---|---|
| 1 | Aerial matching unit 115 m/c. | 1 | |
| 2 | " " " and aerial 235 m/c. | 1 | |
| 3 | "F" Section No.1 (modified) | 2 | |
| 4 | "F" " No.2 | 2 | |
| 5 | "F" " No.3 | 2 | |

Contents of Boxes spare valves. Z.C.178. List 8.

| Item. | Part Description. | No. | |
|---|---|---|---|
| 1 | HY114B | 1 | |
| 2 | IT4 | 4 | |
| 3 | 3A5 | 2 | |
| 4 | 3A4 | 2 | |
| 5 | IR5 | 2 | |
| 6 | IS5 | 1 | |
| 7 | CV.103 (crystal) | 4 | |

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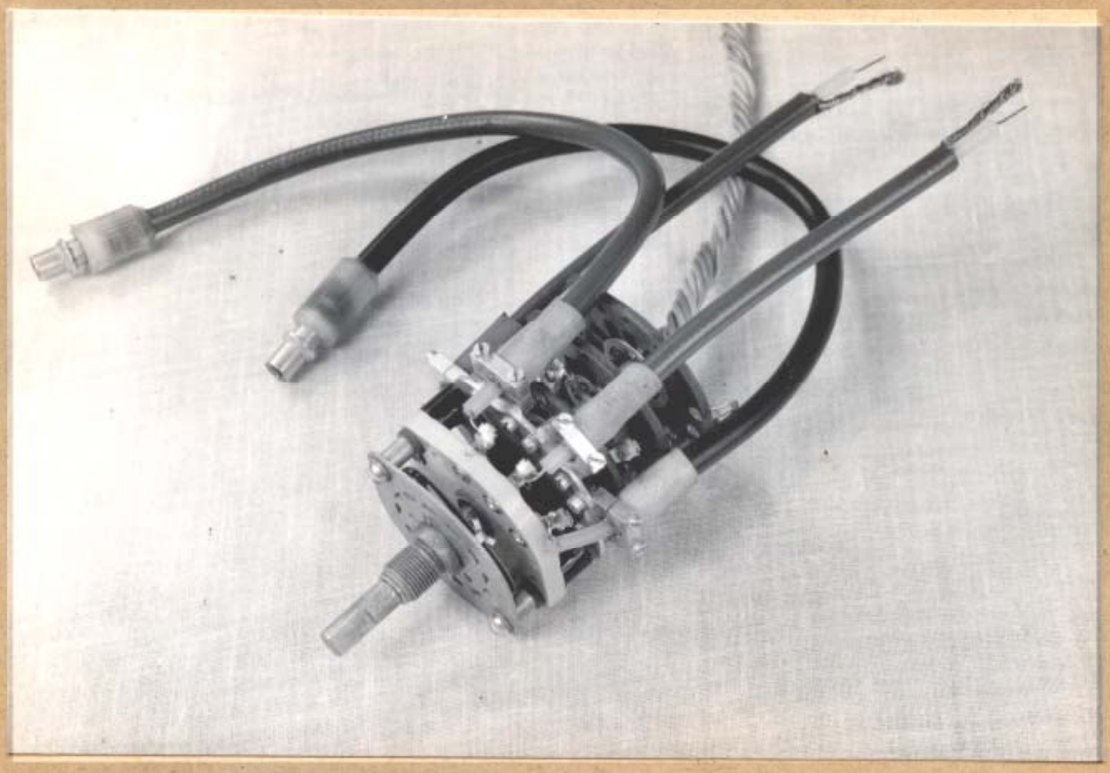
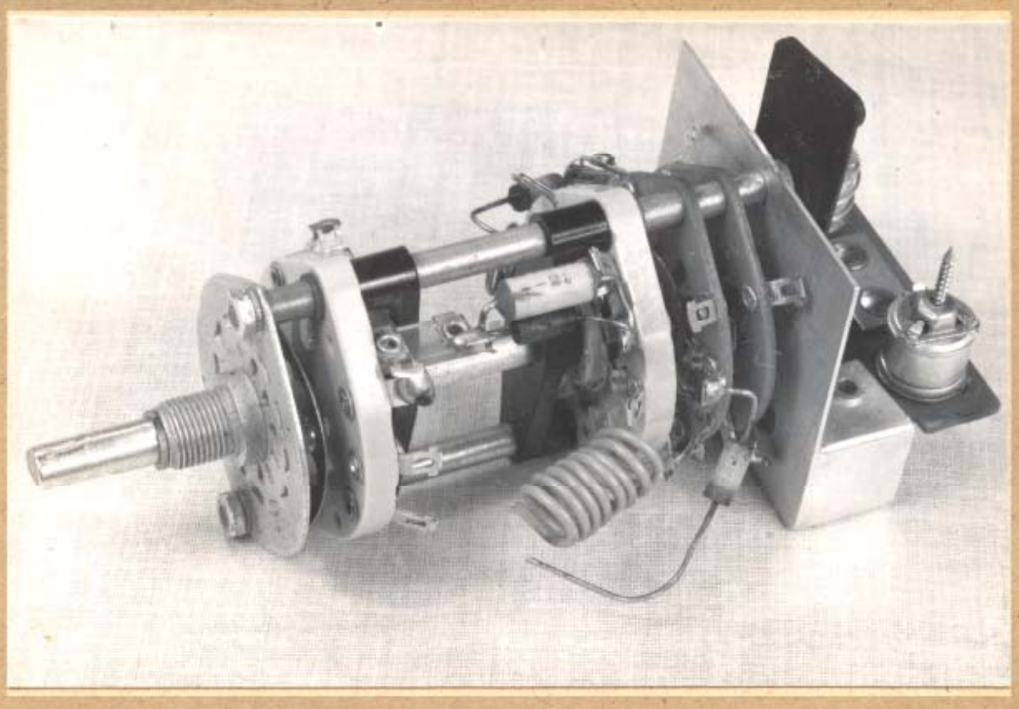
KEY, HEADSETS I.T.E. AND MICROPHONE

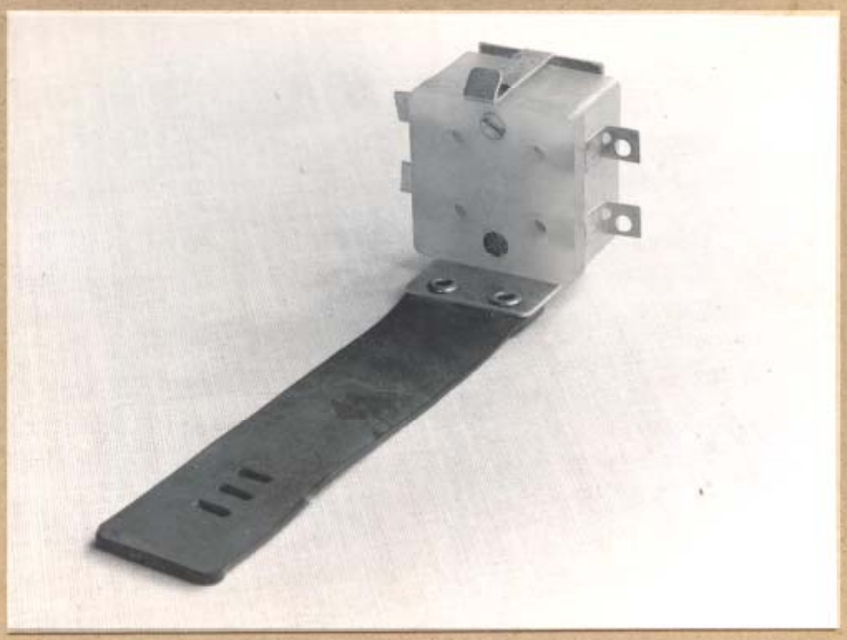
DESICCATOR & STORAGE SEALING CAP



BAND SWITCH SENDER



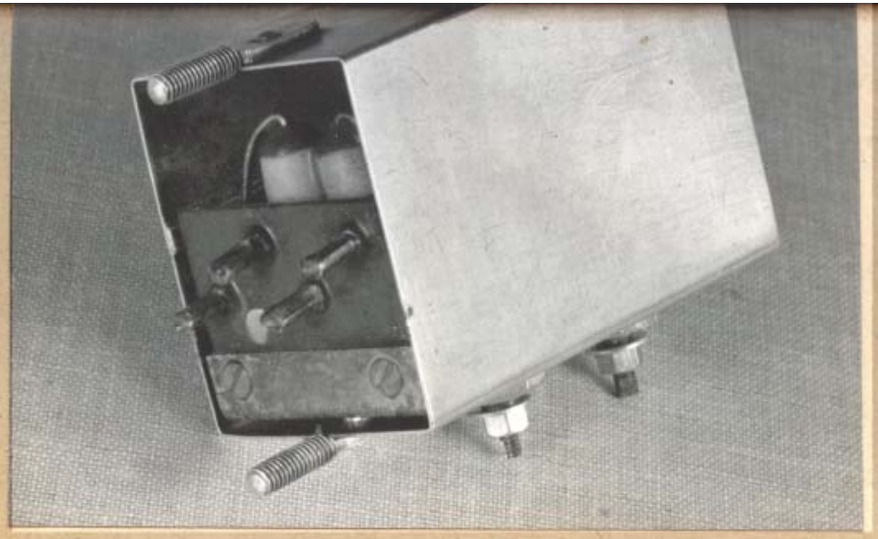
BAND SWITCH RECEIVER
AND
CRYSTAL HOLDER

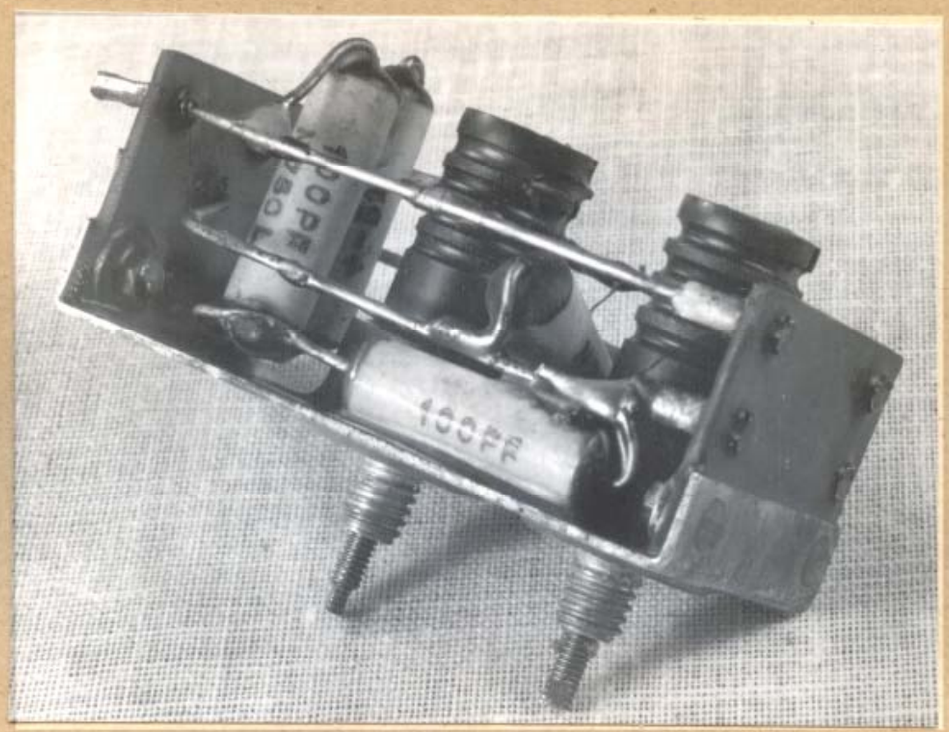


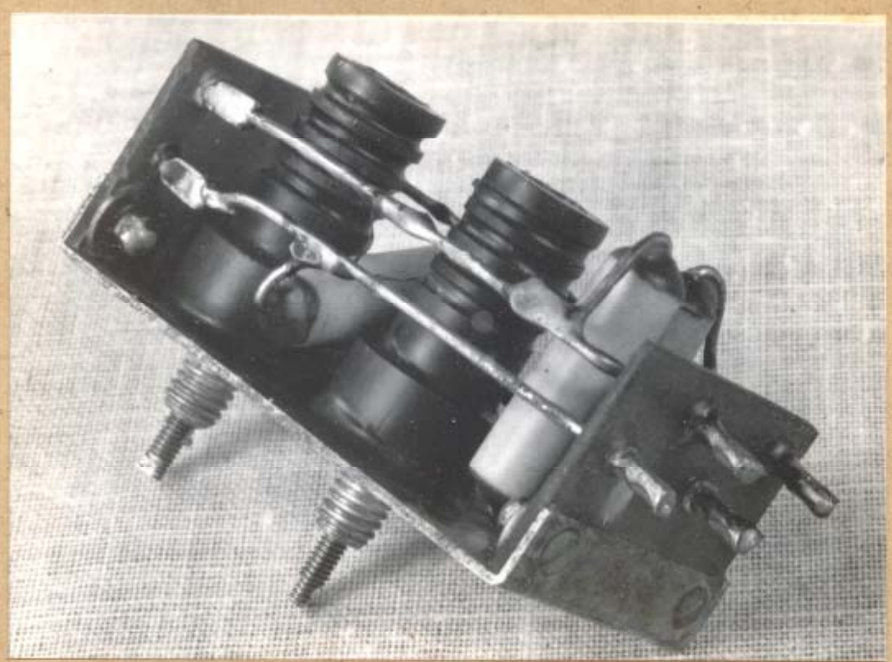
QUARTZ CRYSTAL HOLDER


QUARTZ CRYSTAL, POLYTHENE MOUNTED.

SILICON CRYSTAL HOLDER

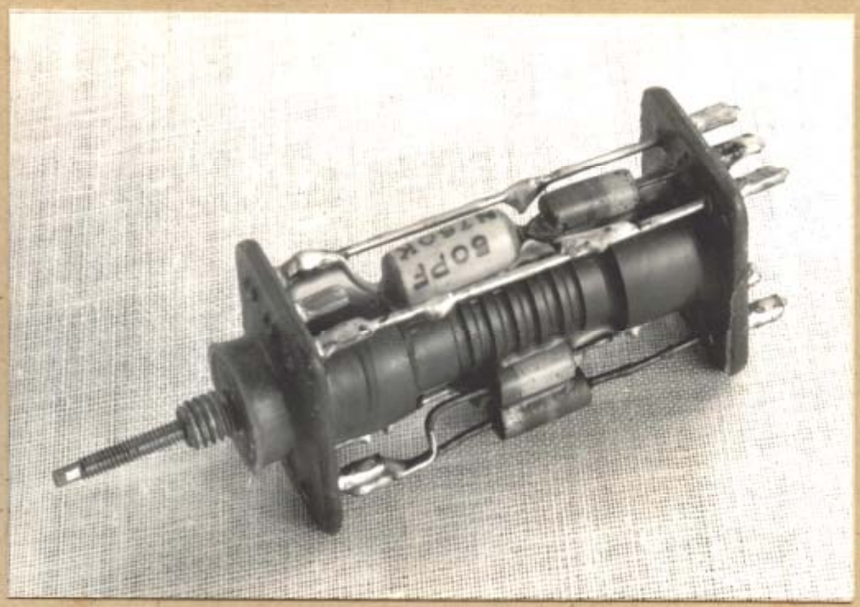




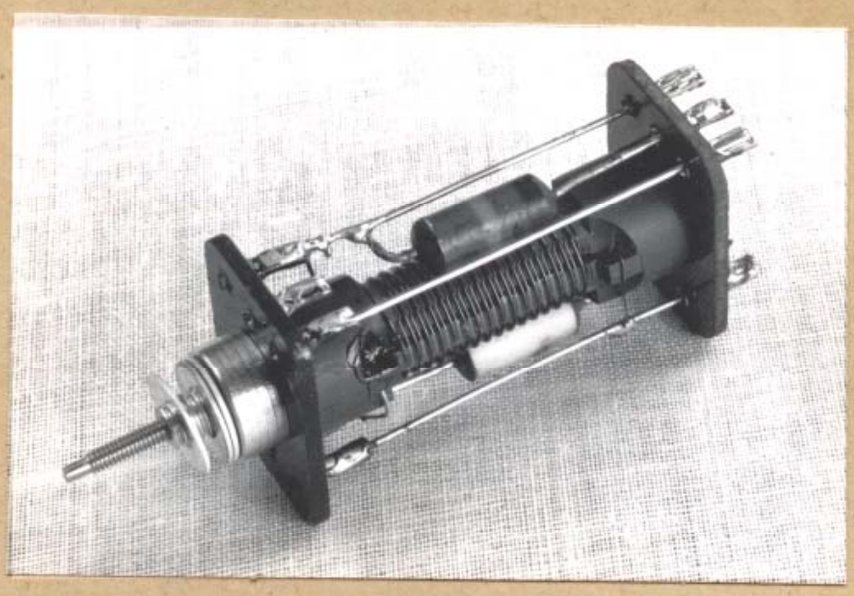



VIEWS OF TRANSFORMER, DISCRIMINATOR AUDIO (T10)

TYPICAL SHIELDED COIL.

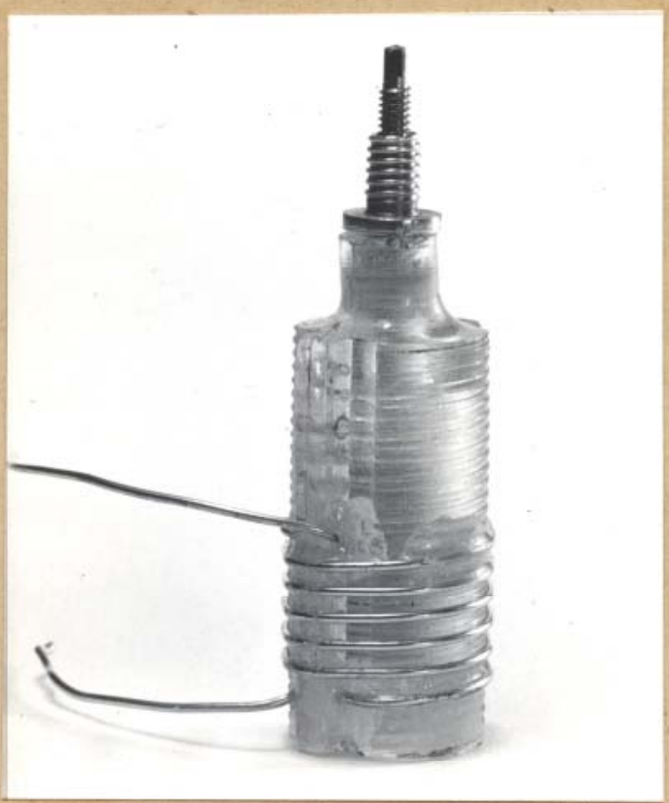



TYPICAL I.F. COIL.

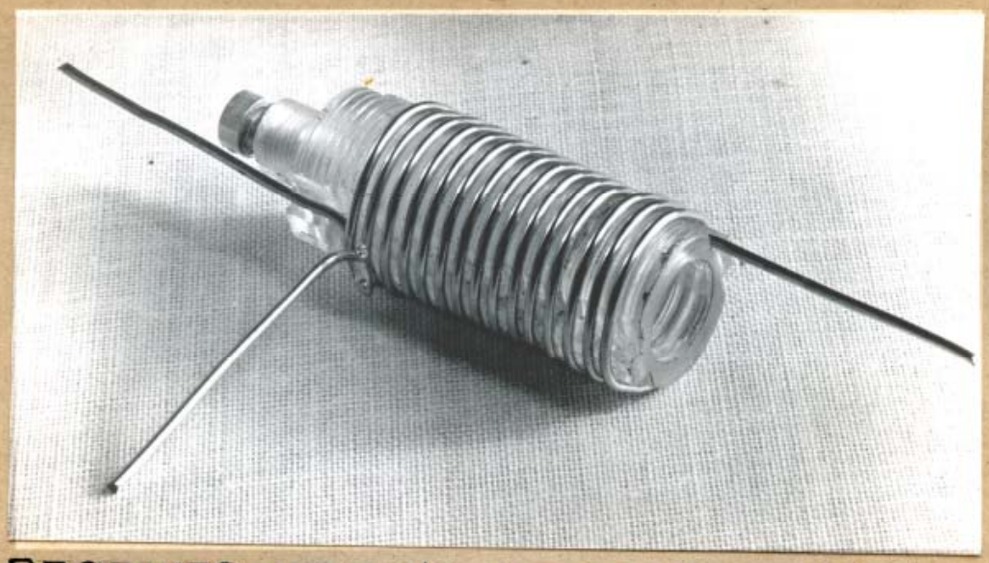


TYPICAL R.F. COIL

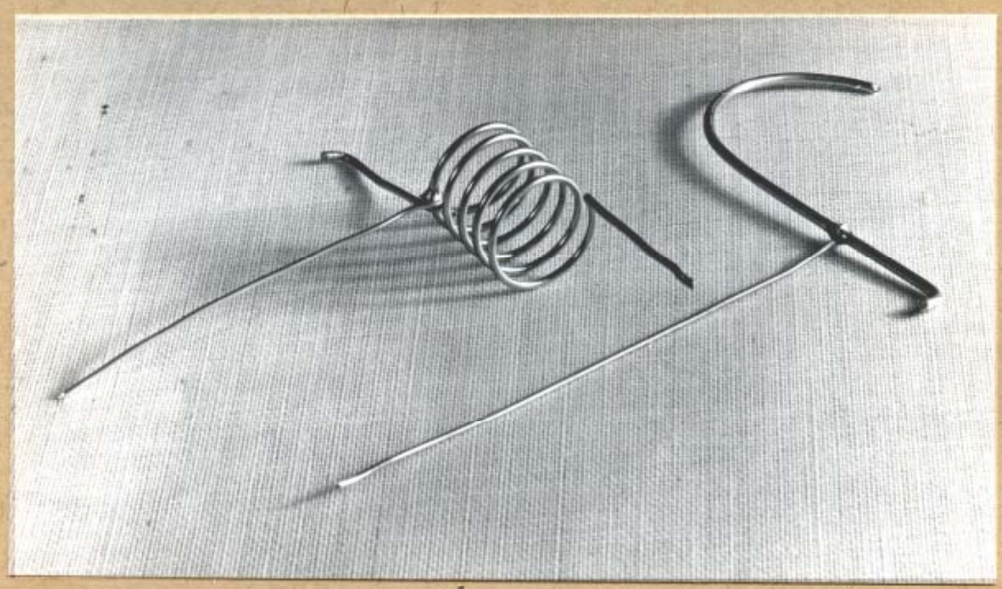

70 MC/S COIL



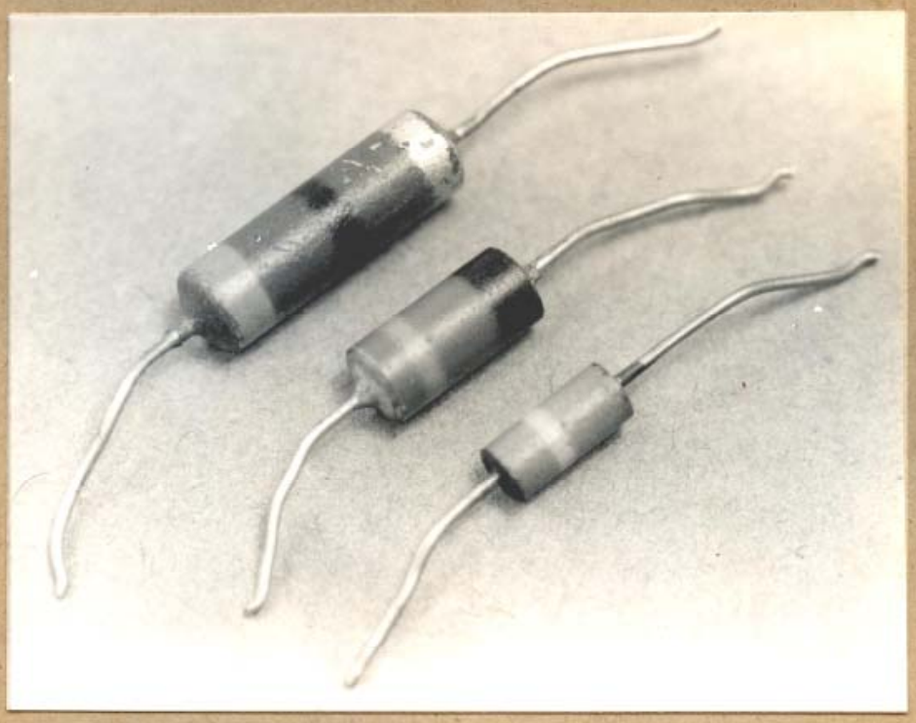
VHF COIL WITH DUST-CORE



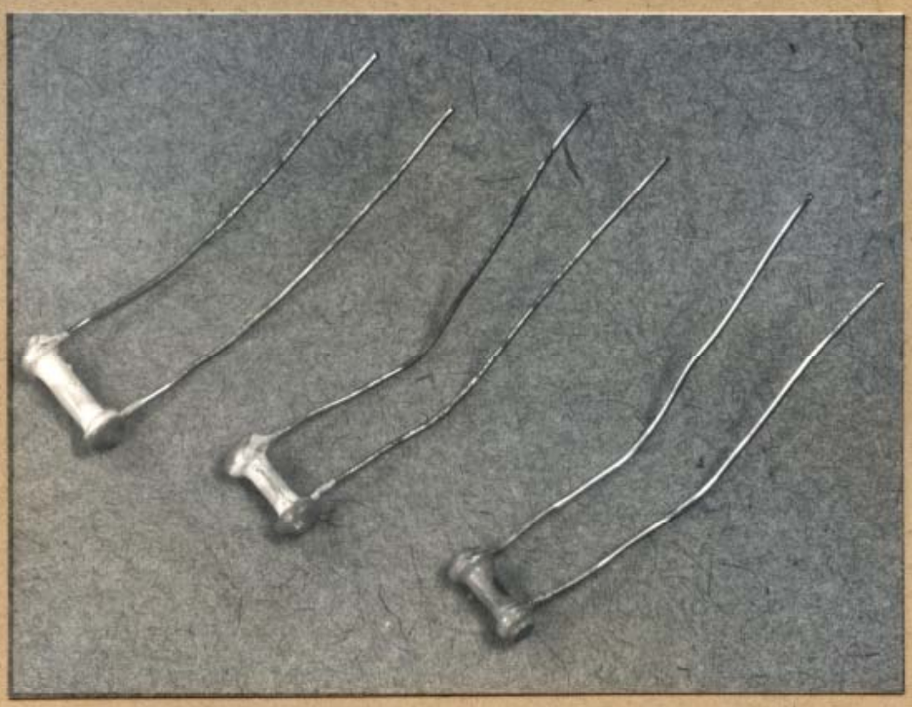
RECEIVER 45 MC/S AERIAL COIL (L1).



RECEIVER 115 MC/S AND 235 MC/S AERIAL COILS (L2 AND L3).

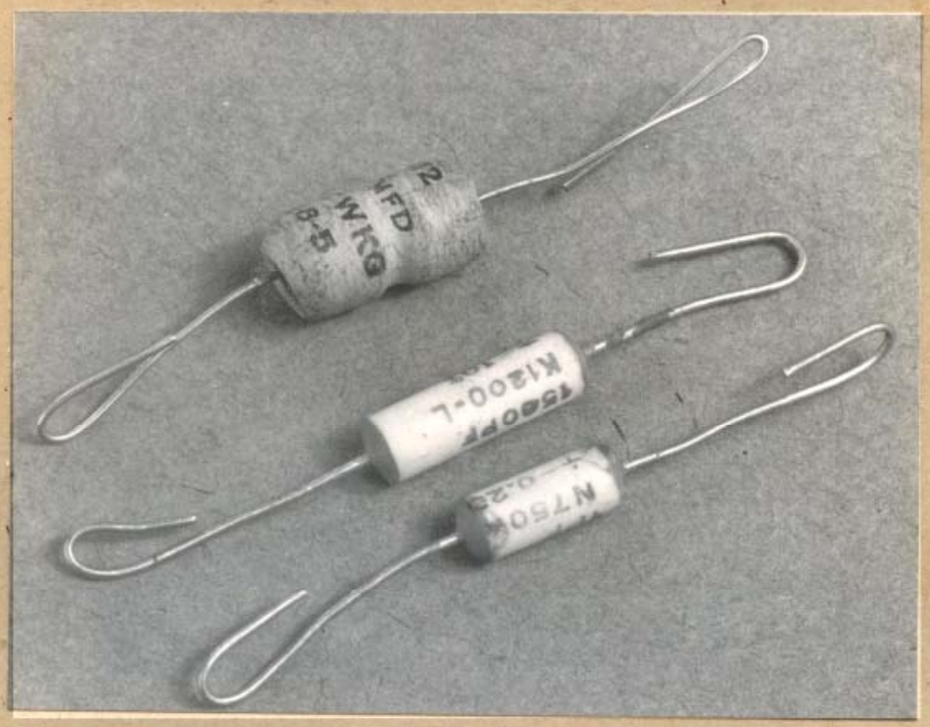


RESISTORS, CARBON, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{10}$, WATT.



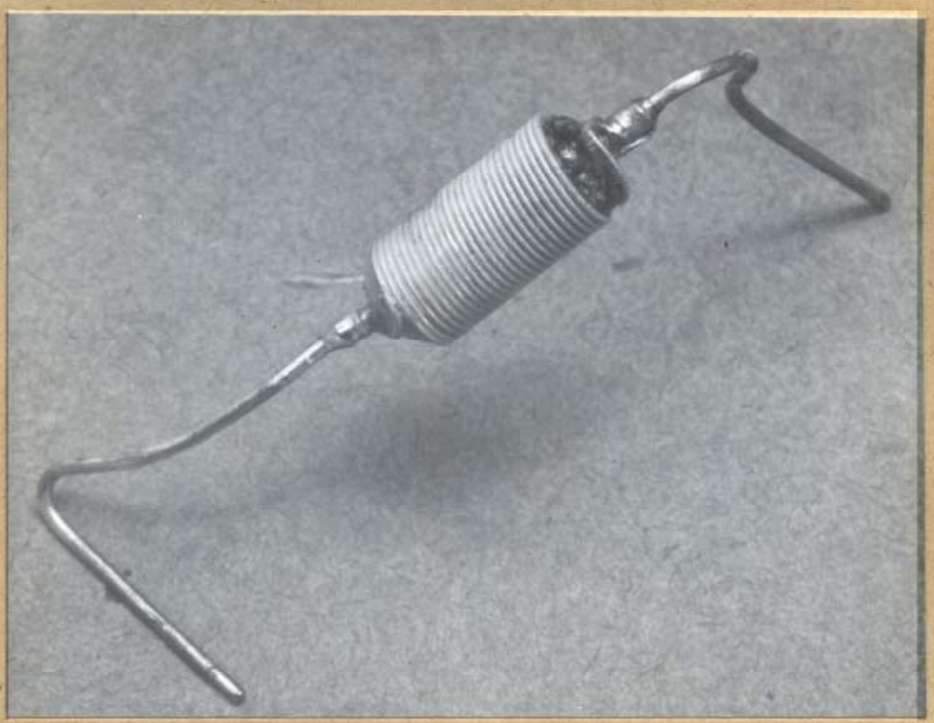
RESISTORS, CARBON, $\frac{1}{16}$, WATT.

MULLARD AIR TRIMMERS 3/30 P.F.




TYPICAL MINIATURE TUBULAR CONDENSERS

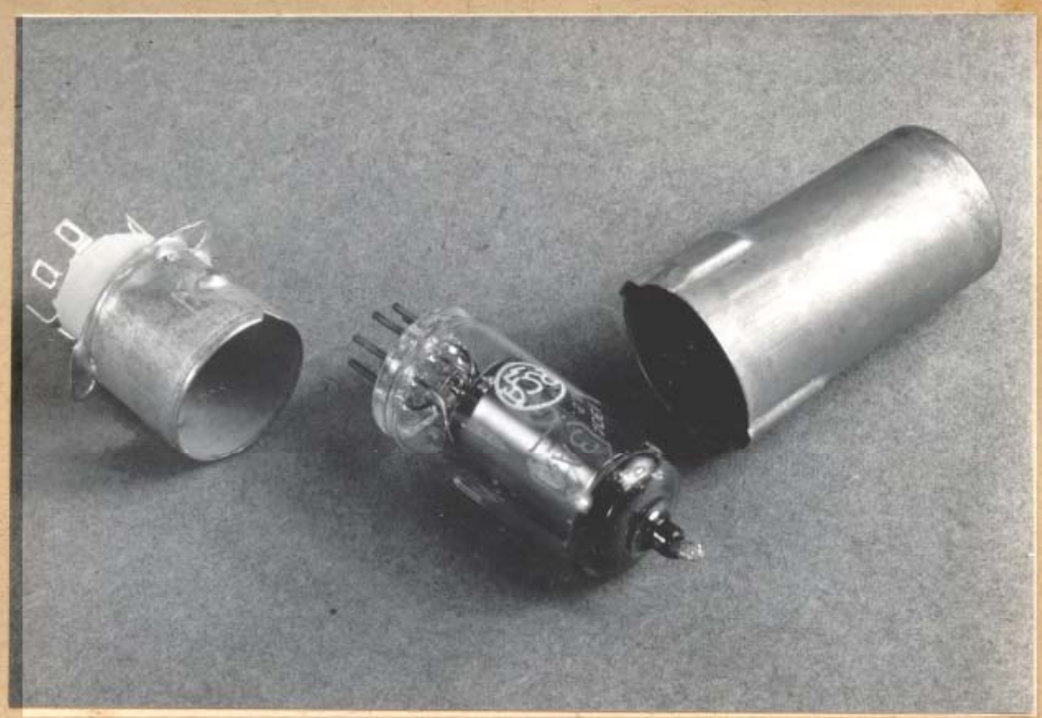

T.C.C. PICOPACK & SILVER-MICA. CONDENSERS



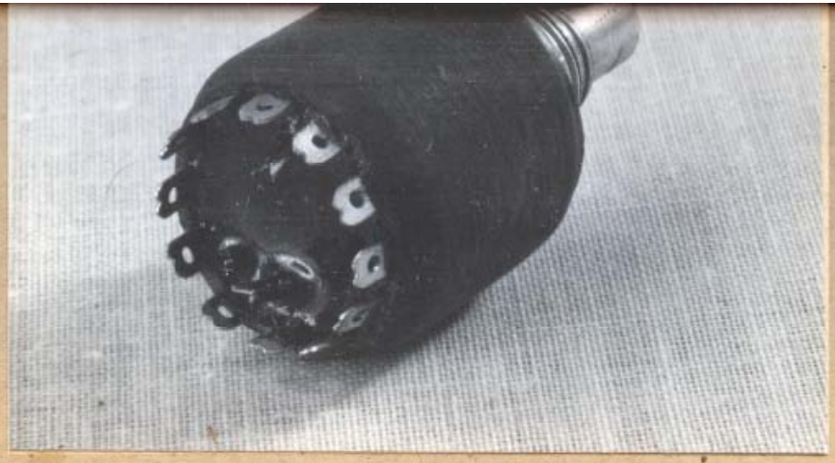
FILAMENT CHOKE.

MORSE KEY & COVER.


MINIATURE SEALED METER



MINIATURE TUBE, SOCKET, AND SHIELD



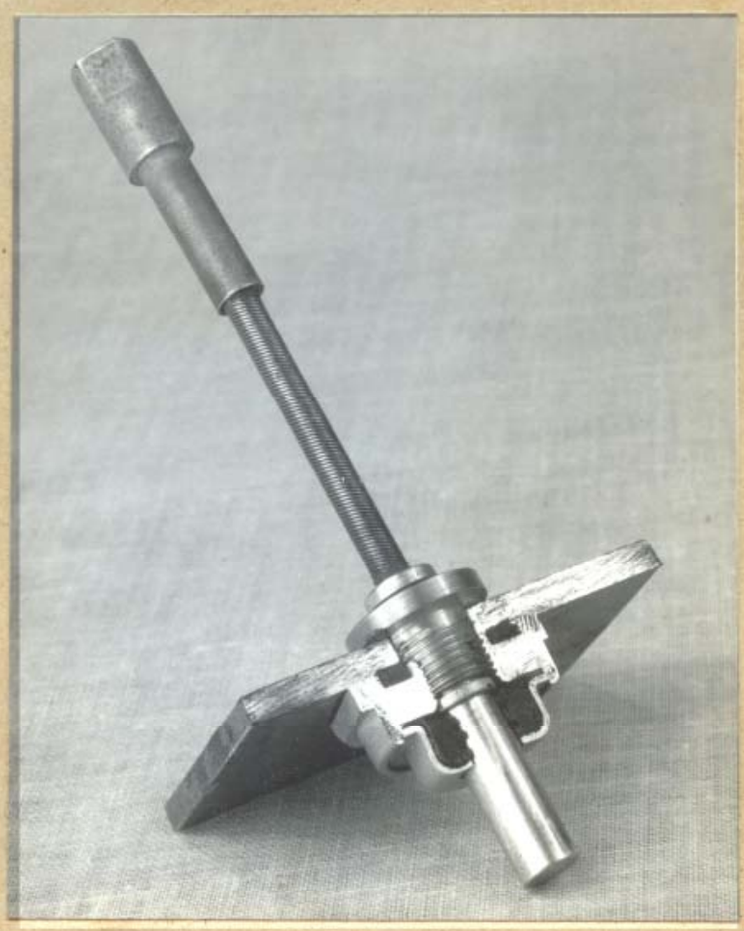
MINIATURE METER SWITCH

POLYTHENE PHONES SOCKET

MINIATURE SEALED AUDIO TRANSFORMER

INGERSOLL TRIMMER CONDENSER

PYE MIN. CO-AXIAL SEALED PLUG & SOCKET



SECTION OF PANEL - SPINDLE SEAL

# ZC178. WHERE DOES IT FIT IN?

## By D.K.Collett ZL4BN

The answer to this question is that the ZC178 has no connection with any other equipment bearing the prefix ZC, but it was designed and built by N.Z. radio engineers working in the U.K. during the war period of 1944 to 1946.

In June 1944 twelve technical specialists were sent by the N.Z. Government to the U.K. in response to a request by the British Government to help fill a shortage of technical people in the U.K. These twelve were drawn from the N.Z. radio manufacturing industry, the N.Z. Post and Telegraph Department, the N.Z. Department of Scientific and Industrial Research and Army technical personnel. The leader of the group was Ralph Slade, from Philips Electrical.

However, by the time the group arrived in the U.K. their need for technical people had largely disappeared, and as a result all but five of the group returned to N.Z. The remaining five members were already committed to projects in the U.K., and remained there to complete their work. Of these five members one was Ian Walker from DSIR, who became involved with radar development at Malvern. Another was John Gifford, from Radio Corp. Wellington, who filled a job with the British Ministry of Supply in London.

The remaining three members were Noel Curtis from Dominion Radio and two Army officers, Captain D.K.Collett, seconded from 2NZEF Italy to 2NZEF U.K. and Lieutenant D.P.Joseph, seconded from N.Z. Army signals Wellington to 2NZEF U.K.. Towards the end of 1944 these three were joined by another technical man from 2NZEF Italy and seconded to 2NZEF U.K., Lieutenant P.Armitage.

These last group of three remained to fill an urgent request from N.Z. D.S.I.R. This was for some portable equipment, operating in the V.H.F. bands for propagation testing in the jungle conditions of the Pacific war zone. Communications generally were poor, but little ground work had been done to provide any reliable information about the best frequencies to use, or ranges to be expected in this difficult terrain. The urgent need arose for suitable gear to evaluate the problems, and to provide some answers for future planning.

The small team accepted the challenge, and carried out the development and construction of suitable V.H.F. equipment, working at the Radio Pre Production unit at Woolwich South London, where excellent facilities were available.

The project was named Z.C.178, the ZC, the ZC because of its New Zealand origin, and the number 178 came out of the hat, being chosen as one which could not have already been taken up by anybody else!

So the work started. the design work was done by Dave Joseph and Kem Collett, and approved by Dr. Coop, who was the N.Z. Government scientist in the U.K. Noel Curtis acted as liaison and procurement officer, and later, Phil. Armitage compiled the parts lists, operating manuals



and arranged the packing cases. All the odd jobs that technical people hate to have to have t do!

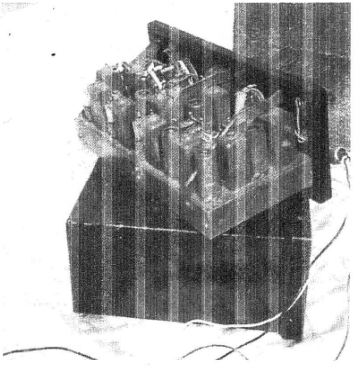
The design was for equipment which for would operate on three crystal controlled frequencie Low 45mHz, Med 115mHz and High 235mHz with two spot frequencies on each. Operatir modes were C.W., A.M. and narrow band F.M. Transmitter radiated power w approximately one watt. Each complete station consisted of three units, a receiver, transmitter and a battery box each in similar tropic proofed cases and each mounted on bac pack carriers called Everest carriers. Each station was complete with half wave aerials ar coax. fed aerial matching units, headphones, Morse keys and spares.

All this was a lot of work for three to four people. New techniques were being developed that time, involving moisture proofing, high temperature protection, corrosion prevention etc and much of our design work had to make allowance for all these new tropical generate effects. All the units had to meet the total immersion tests , floatation tests and the battery be had to have enough buoyancy to still float when loaded with batteries.

After six complete stations had been completed, field trials were held at the British Nation Physical Laboratories, at Teddington, near London. These trails gave true figures f transmitter radiated power and receiver performance, which included the efficiency of tl aerial systems. The equipment performed well and won a special commendation for conce and performance.

The six stations were then packed in special cases and dispatched to D.S.I.R. Wellington a that was the last the ZC 178 team ever heard of their offspring, which was two years in t making! Unless this gear has been destroyed, somewhere there should exist, six transmitte six receivers , six battery boxes and all the aerial gear plus the carrying cradles and oth accessories. I wonder where it has all got to?

This ZC178 history has been compiled by D.K.Collett. Most of the story will be reasonab correct, but he passage of 50 years could have clouded some of the details.



The ZC178 receiver chassis sitting on its case, see last Bulletin for the frontal view.