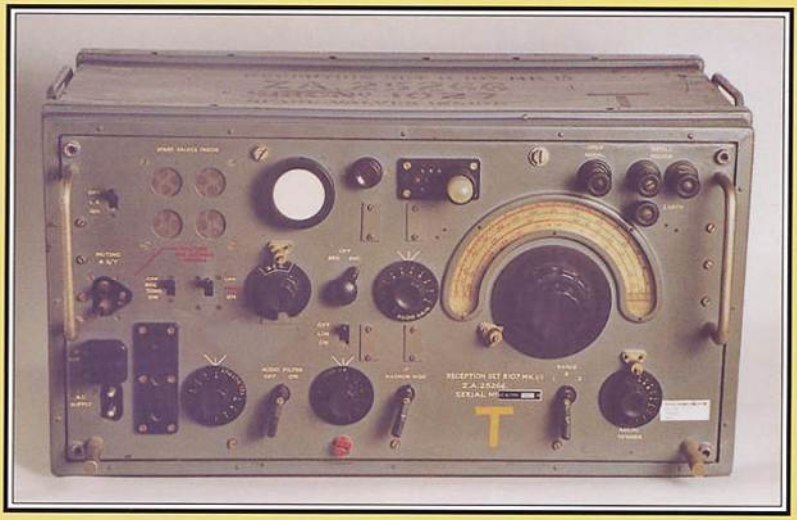
A technical history of
Radio Communication Equipment
in the British Army

WIRELESS *for the* WARRIOR

by Louis Meulstee

VOLUME 3

RECEPTION SETS



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Other Sets mentioned in this book include the following:

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Wireless Set No. 11 *see Reception Set R103A, R105*
Wireless Set No. 12, 12HP, and 33 *see Reception Set R107 and R209*
Wireless Set No. 16 *see Reception Set RG42C*
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Introduction

More pages than expected

It was initially not anticipated how many pages could be expected for this volume. When discussing this issue with Geoff Arnold during the 'Volume 3 kick-off' meeting in April 1998, I made a rough estimate of about 350 pages, a size similar to Volume 1. Very soon, however, it became evident that this estimate was considerably adrift, and much more space had to be allotted for new material.

Again, and not surprisingly as this had already been experienced in the previous volumes, on some equipment a large quantity of valuable and reliable information on development history could be traced, notably Reception Sets R107, R109, R206 and R209, which were well recorded. However, the development history and technical details of some of the other receivers described in this volume remained obscure.

During the process of gathering material and writing of this volume, it was realised that receivers from the trade (nowadays called 'Commercial Off The Shelf') appeared to be introduced at a very early stage. For example, well before World War II, small quantities of Eddystone receivers were purchased, in addition to Hammarlund, Hallicrafters and receivers from other commercial makers. The HRO receiver manufactured by the National Radio Co. was particularly successful and used throughout World War II.

There is an interesting repetition in development history if we compare the pre-war development of Reception Set R100 and that of post-war Reception Sets R218 and R219. In both cases the mechanical and electrical specifications were set very high, causing a long and costly development time, with the result that at the end the initial concept was obsolescent and a commercial set could be obtained which, although mechanically slightly inferior, still fulfilled the job at a fraction of the cost.

Personal experiences

Of particular interest to myself has always been the Reception Set R109, being the first commercially-made receiver that I owned. In the early and mid-1950s one of these receivers, powered by a small 6-volt ex-Army accumulator, accompanied me during many holiday vacations spent at the family allotment garden. Later in the very early 1960s the R109 was used again as main receiver (sometimes with a 2-metre band convertor) and various home-made transmitters during many amateur radio summer Field Days. I still own this receiver and though definitely not up to today's standards (according to reports apparently also not to the standards of late World War II...) it is still a pleasure to be able to listen to it from time to time.

This explains possibly the nicer thing about any receiver, no licence is required to operate it, making it working again is usually not such a big effort as the HT seldom exceeds 200 volts, and a simple wire as antenna will bring in loads of stations. Great fun!

Time era

The success formula of Volumes 1 and 2, a layout comprising a mix of highly technical details, circuit diagrams, technical specifications and alignment data in addition to technical development history, complete station lists and fitting instructions, was repeated in this volume.

The imposed time era (1932 to 1945) based on the year of issue or development of equipment described was maintained rather strictly in Volumes 1 and 2. Although the main bulk of receivers described in this volume were developed prior to and during World War II, it was eventually decided to lift the '1945 barrier' and to add a selection of receivers which were in use or being developed for use in the British Army in the period 1945 up to the 1960s.

For the reason of space, on a number of receivers no extensive descriptions and circuit diagrams will be provided, for example the complex diversity receivers for the Army Wireless Chain and COMCAN.

Again, do not expect glossy colour photographs as most of the pictures available were either procured from archives, contemporary handbooks or operating instruction manuals. Only a limited number of photographs were taken from surviving equipment. It must also be noted that in the alignment procedures it is assumed that 'old' contemporary test instruments such as valve voltmeters are used. However, when available, modern test equipment, for example frequency counters, radio test sets, may be used which makes alignment definitely much easier than in the early days. I personally take advantage of the use of a modern Marconi type 2945 radio test set.

The Data Summary in each section was aimed to be as consistent as possibly. This could not always be achieved, especially in those cases where the Performance Specifications from the maker's data were used. Here it was found that different measuring methods were employed.

Still maintained, and definitely against the Euro policy, are sizes in inches/feet and weights in lb.! See later in this Introduction for conversion tables.

Some confusion may be caused in this series by the fact that Mark numbers are provided in both Roman (e.g. Wireless Set No. 38 Mk.II) and in Arabic (Wireless Set No. 38 Mk.3) for the same type of set. In the interests of standardisation, we have generally converted all Mark numbers to the Arabic form.

It must be noted that the change from Roman lettering commenced after 1945. In the same time period tropicalised sets marked with a large (sometimes bright yellow coloured) T and the addition 'T' were designated /1, for example Wireless Set No. 18 Mk.IIIT became Wireless Set No. 18 Mk.3/1

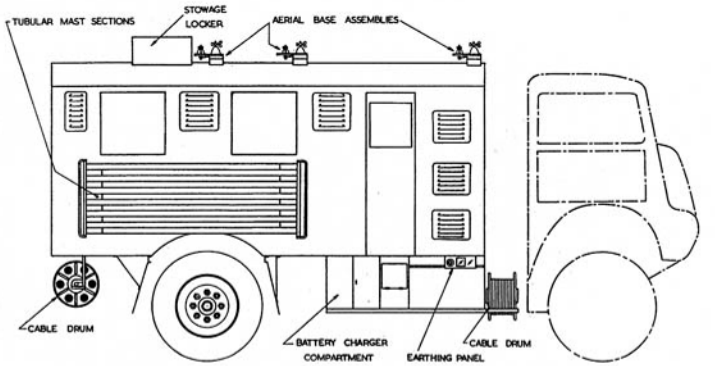
Operational histories

As in the previous volumes, generally no operational histories are given. These have been published in many other books and are in some cases rather subjective. An exception will be made for the following interesting stories the first of which is highly relevant to the Intercept type of receivers described in this Volume:

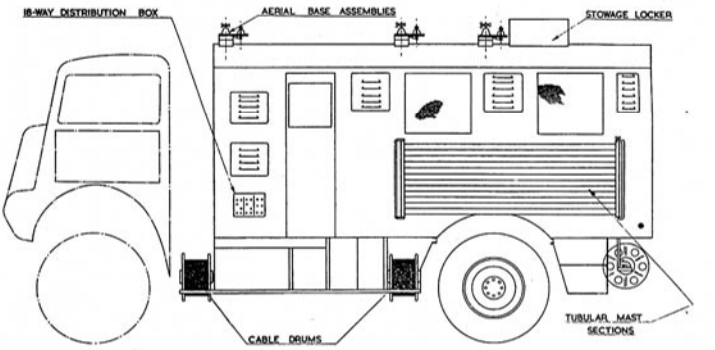
> A special receiving set was designed at the Signals Experimental Establishment for interception work *(meant was the R206 Mk.II, L.M.)* and was brought by the young designer to the station for comments. Asked was why he'd put the tuning control at the far right of the front panel. He said, 'Because most people are right-handed'. He was then taken to an operations room where he saw the vast majority of operators WRITING with their right hands and keeping their left hand on the tuning dials for the fine adjustments usually needed. Apparently it was too late to make a change – or maybe he'd lose face doing so, so either extra space would be needed per operator or they'd have to continue working almost 'cross-handed'.
>
> *Excerpt from a report from HQ War Office Y Group Beaumanor Park (December 1943)*

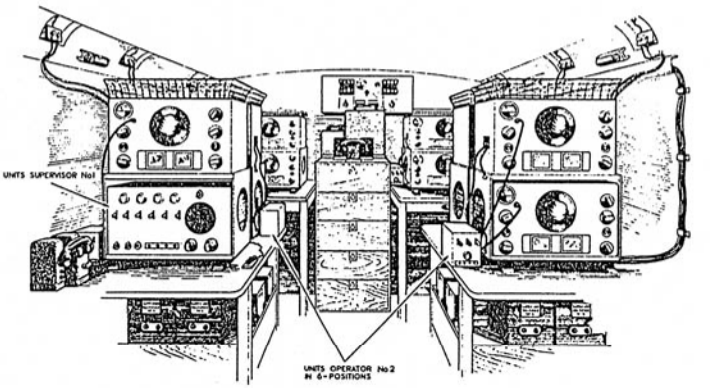
Also from the Y service:

> '... in the early days the receiving equipment was culled from a variety of sources with the result that operators and instrument mechanics were presented with an array of



(Figure 106-35/36) Left-hand and right-hand side of Truck 3-ton GS Wireless 'R' type B. Four cable drums are slung below the body, one on the right-hand side, and two on the left-hand side. On one of them is wound 200 yards of twin connector mains input lead. On each of the other cable drums is wound approximately ¼ mile D8 cable





(Figure 106-37) Inside view Truck 3-ton GS Wireless 'R' type B showing operator position 6 (right) and supervisor position 3 (left). Note 'Units Supervisors No. 1' below Reception Set R106 at position 3

Mobile Station with T1154

As an interim measure, at a time when supplies of Army low/medium power transmitters were exhausted, RAF type T1154 aircraft transmitters were fitted in standard 15-cwt wireless trucks along with Reception Sets R106 providing a low/medium-power mobile radio station.

The vehicle aerial base is mounted on a bracket on the forward wall of the vehicle, access being provided by the "feeder cable entry" in this wall. *(see Fig. 106-38 below)*

The R106 receiver and Supply Unit Vibratory No. 2, RAF transmitter T1154 and its associated Power Unit Type 32A, the Control Unit No. 14 and Morse Key and Plug Assembly No. 2B are mounted on the operator's desk. The Switchboard Charging No. 9 is fixed beneath the table.

Lockers and shelves are provided in the vehicle for stowage of Remote Control Unit D No. 2, Remote Control Unit C and Cases Spare Valves No. 4A and 4H. The aerial mast sections and some of the aerial gear are stowed on the nearside floor

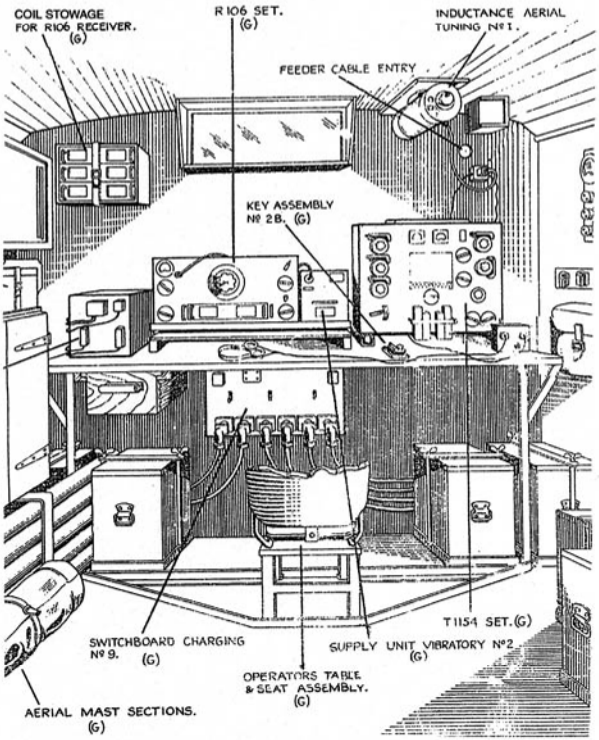
The installation (including the operator's table) can be readily removed from the vehicle and assembled either on the ground or in a building.

The station is capable of operation from either 6V and 12V batteries or from 250V AC mains. Six batteries 6V 170Ah are carried, connected to Switchboard Charging No. 9. The batteries are charged by the power takeoff dynamo when the vehicle is in motion and an external charging engine when stationary.

Considering the weight of the equipment carried, only one operator was allowed to travel on the inside of the vehicle when on the move. Two (including the driver) may travel in the front of the vehicle.

For operation on the move normally a 16ft twin-rod is used. To provide correct matching of this aerial to the T1154 transmitter at lower frequencies, Inductance Tuning No. 1 (originally developed for Wireless Set No. 19 High Power) is employed as series loading. A typical calibration card with approximate settings was normally supplied and final adjustments had to be made in conjunction with the PA Tuning and loading control to give maximum brilliance to the resonance indicator lamp

For short halts a 32ft vertical aerial was erected and at static working a dipole or end-fed aerial was used, sections for two 36ft masts being carried in the vehicle.



(Figure 106-38) R106 and T1154 in Truck 15-cwt. Note Control Unit No. 14 mounted on the right-hand side of the operator's desk

Alignment data

Alignment preliminary notes

A dummy aerial of 80Ω should be made of non-inductive resistors which together with the impedance of the signal generator will give a resistance of 80Ω.

To align the IF circuits correctly it is essential to detune the primary circuits before the adjustment is made. The coils must then be adjusted in the given order, and on no account must further adjustment be made to the secondary coils after the primaries have been adjusted.

The adjustment is made by using a modulated signal from a signal generator, and the RF output should be reduced to a convenient level as each circuit is tuned.

IF Alignment

• Connect the power supply and switch the receiver to the low band. Turn the VOLUME control to maximum.

• Unscrew all the cores of the IF primary coils (L7A, L7B and L7C).

• Connect the AF output meter to the headphones jack. Switch to TELEPHONES. Switch the CRASH LIMITER off.

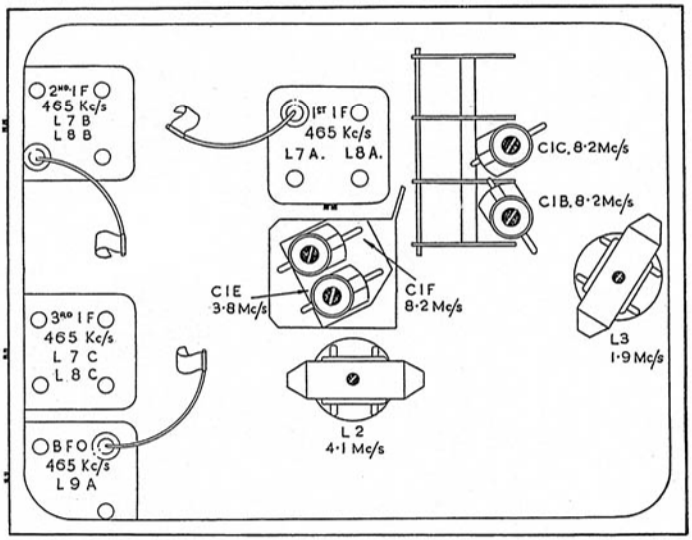
• Connect the signal generator between the control grid of V1F and chassis via a 0.1μF feed condenser with a 500kΩ resistor between grid and chassis.

• Adjust the signal generator to give 400Hz, 30% modulated signal at 465kHz.

• Adjust the third IF secondary (L8C) to give maximum reading in the output meter, then adjust the primary (L7C) for maximum reading.

• Transfer the signal generator to the control grid of V1E and adjust first the second IF secondary (L8B) and then the primary (L7B) for maximum output.

• Transfer the signal generator to the control grid of V1D and adjust the first IF secondary (L8A) and then the primary (L7A) for maximum output.



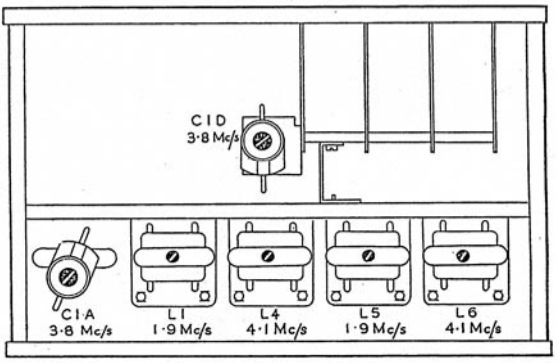
(Figure 109-15) Positions of trimmers and coil units for Reception Set R109 and R109C

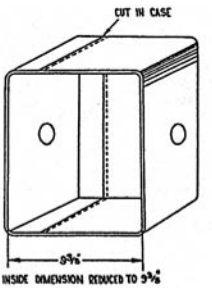
NOTE

The trimming frequencies of the R.F. circuits indicated in these diagrams apply only to the R109 and R109C receivers.

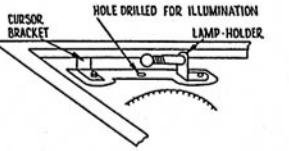
For R109A and R109B receivers the following trimming frequencies should be used:—

R109A	R109B
2.1 Mc/s	2.6 Mc/s
4.7 Mc/s	5.4 Mc/s
5.0 Mc/s	5.6 Mc/s
11.8 Mc/s	11.8 Mc/s

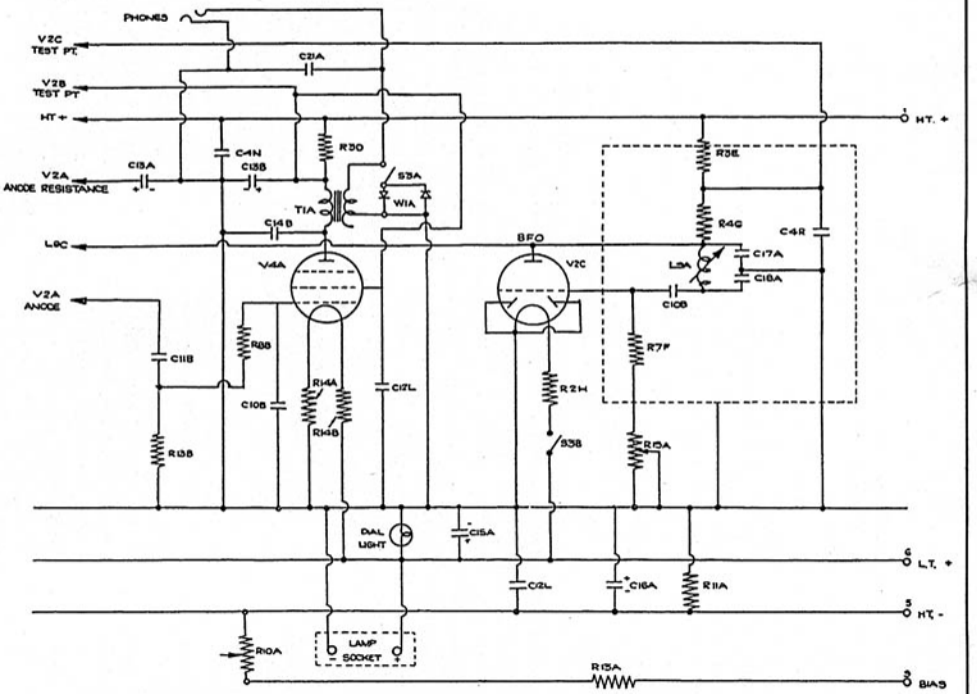




(Figure 109-22) The case inside dimension reduced to 9⅜ inches

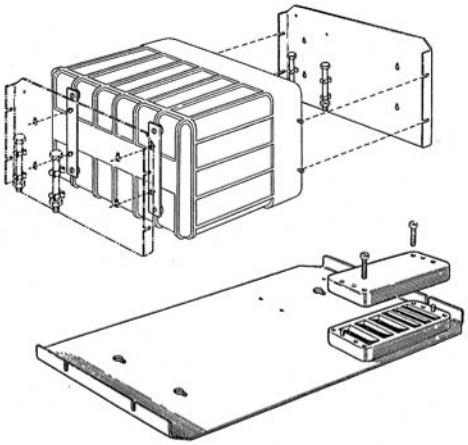


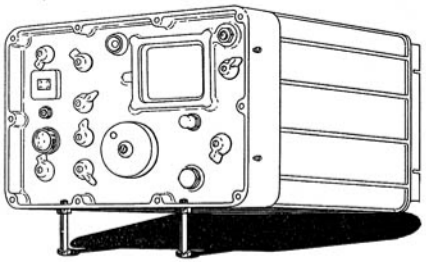
(Figure 109-23) Illumination of the tuning dial



V4A	CV65 (AF output valve)
R7F	10kΩ
R10A	500kΩ variable
R11A	160Ω
R13A,B	500kΩ
R14A,B	13.5Ω
R15A	100kΩ variable
C10B	220pF
C12L	0.1µF
C21A	0.3µF

(Figure 109-24) Modified part of circuit diagram R109A lightweight version





(Figure 216-3) (top left) Two positions of the panel cover, showing spring clips holding the screws used to elevate the receiver front panel (see Fig. 216-5)

(Figure 216-4) (left) Fitting of spares case to panel cover of supply unit

(Figure 216-5) (above) Elevation of the receiver front panel by the two 2½-inch screws

A protective metal panel cover is issued with each receiver and supply unit which may be fitted over the control panel during transit or when a unit is not in use. The covers provided are identical and suitably drilled to enable a spares case to be fitted to each cover issued with a supply unit, or four spring clips fitted when the cover is issued with a receiver, the latter securing the two screws which are used to elevate the front of the receiver. The panel covers should be temporarily secured to the back of the units when in operation. The spares cases are shaped to accommodate three fuses and three lamps for attaching to each supply unit panel cover.

Historical Development

Early in 1945 development commenced for Reception Set R508, projected as a high-grade lightweight VHF receiver for intercept and direction finding purposes replacing the Reception Set R308 and American Hallicrafters S27. At this stage it was decided to fit the receiver and both separate AC mains and 6-volt vibrator DC supply units in standard R209/No. 42 Set type die-cast cases. Development was continued at reduced priority after the end of the war. A prototype model, covering the frequency range of 18–151MHz in only two bands, was assembled around 1947. An interesting detail is that in this early approach a grounded-grid triode was used in the aerial circuit and variable inductance tuning for all RF circuits, extra capacity being switched in on the lower frequency range. In the same time development had started on the VHF DF aerial systems, eventually resulting in two types of aerials for horizontal and vertical polarisation.

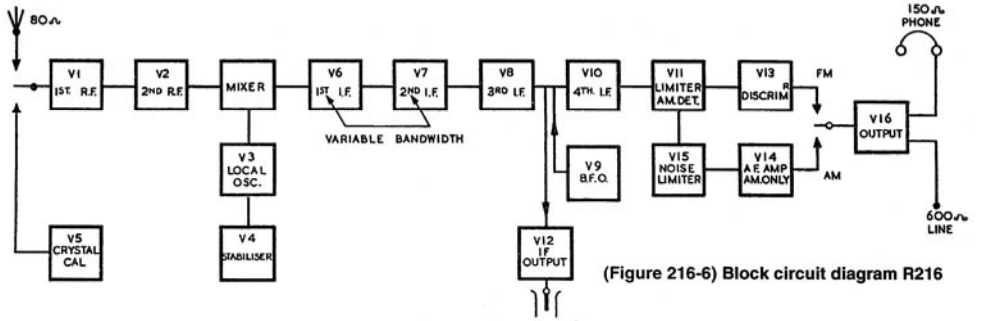
During late 1948 the R508 was renamed Reception Set R216. In the same year a development contract for both receiver and associated DF aerial equipment was placed with Messrs E. K. Cole Ltd at Southend where the further design was taken in hand. Initially many difficulties were experienced with the crystal diode mixer and the carbon-pile voltage regulator in the DC power supply unit. These were eventually overcome and the first B models were completed in 1950. It is noted that first production deliveries started in 1953.

Technical Description

Reception Set R216 is a conventional superheterodyne. Signals from the aerial input are amplified by two RF stages V1 and V2 and the output fed to a silicon crystal diode mixer MR1 (CV291). The local oscillator valve V3 is connected as a grounded grid Colpitts type. HT voltage for the local oscillator is stabilised by a neon valve V4. The 4.86MHz output from the mixer is taken through a coaxial cable and plug to the IF/AF unit where it is amplified by IF amplifiers V6 to V10.

The IF bandwidth has alternative wide (120kHz) or narrow (30kHz) pass-band controlled by a switch. These two bandwidths are obtained by varying the capacitance coupling between the circuits of V6–V7 and V7–V8. The IF output from V10 is fed to the limiter stage V11 and FM discriminator V13. The limiter grid-cathode circuit is used as a diode detector for reception of AM signals. An automatic noise limiter V15 is permanently in circuit.

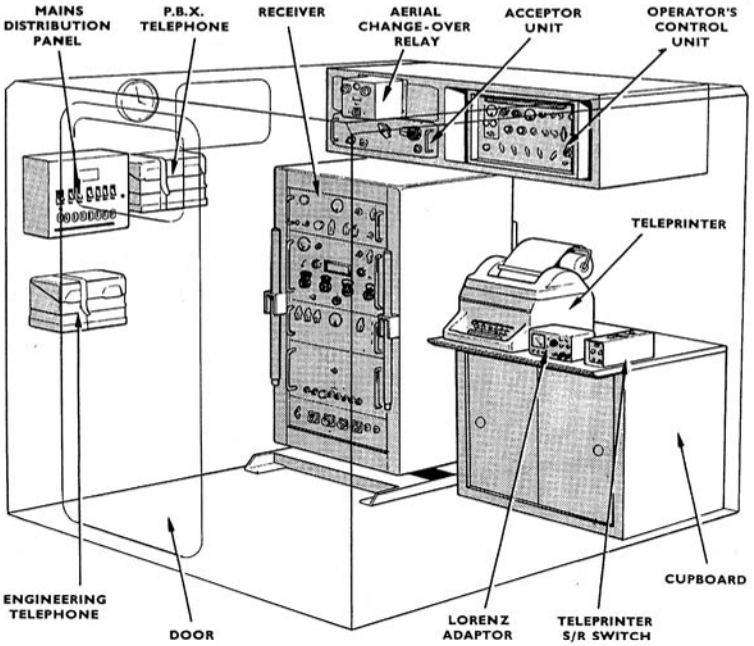
Bias for the two RF valves and the first three IF valves is



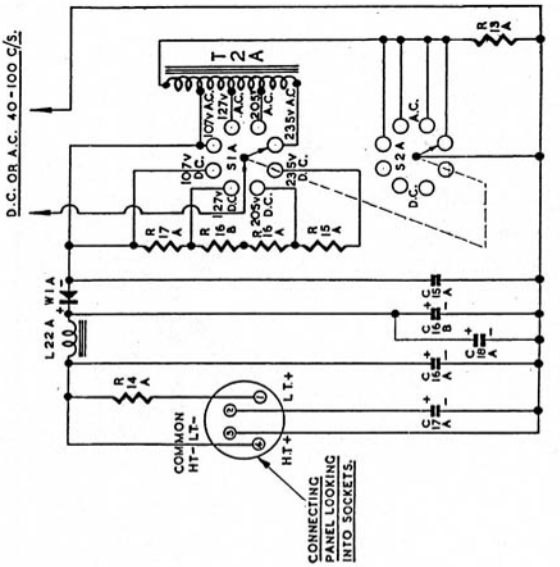
(Figure 216-6) Block circuit diagram R216

(Figure 230-14) (left) Fitting of R230 in receiver cabin with tent cover in position

(Figure 230-15) (right) Cabins Radio, Air Transportable Type B ready for road transport with demountable two-wheeled running gear in running position



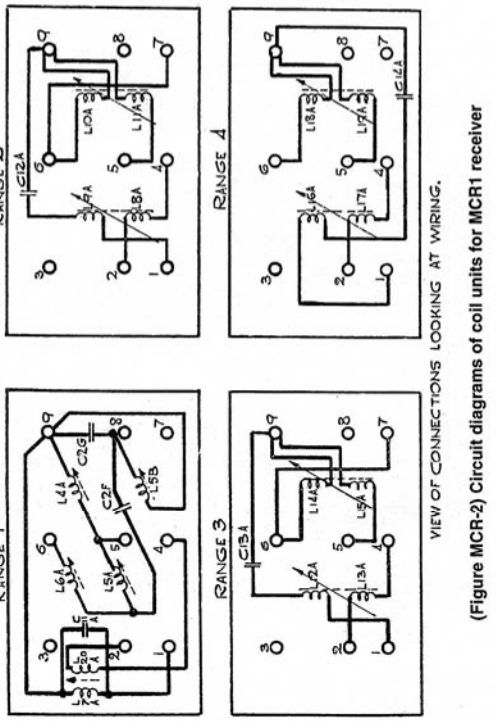
(Figure 230-16) Detailed layout of equipment in receiver cabin. Ancillaries, for example aerial gear, are stowed in the cabin during transport



(Figure MCR-3) Circuit diagram of AC/DC power pack Type 38/1 for MCR1

R1a-b	470kΩ	R13a	2.2kΩ	C10a	500pF
R2a-b	100kΩ	R14a	1.5kΩ	C11a	9pF
R3a-b	18kΩ	R16a	390Ω	C12a	300pF
R4a-b	3.3MΩ	R17a	200Ω	C13a	400pF
R5a-b	1.2MΩ	C1a	100pF	C14a	600pF
R6a	220kΩ	C2a-g	50pF	C15a	0.01µF
R7a	2.2MΩ	C3a	300pF	C16a	16µF
R8a	270kΩ	C4a	60pF	C17a	250µF
R9a	470Ω	C5a-e	0.05µF	C18a	5µF
R10a	330Ω	C6a-d	0.1µF	VC1a	15pF
R11a	220Ω	C7a	0.001µF	VC2a	121pF
R12a	68kΩ	C8a-b	0.01µF	VC3a	121pF
VR1a-b	250kΩ	C9a	300pF	VC4a	15pF

(List MCR-1) List of components Receiver MCR1



(Figure MCR-2) Circuit diagrams of coil units for MCR1 receiver

Historical Development

Receiver MCR1 was developed in 1943 and manufactured by Philco GB from late 1943 onwards. Its principal requirement was for SOE and a great proportion of the sets were distributed (dropped) to Resistance organisations in Europe for reception of broadcast transmissions. It is interesting the note that the designer (Captain J. Brown) also developed the SOE/Special Forces suitcase set Type 3 Mk.2, better known as 'B2'.

Technical Description

The MCR1 receiver is a superheterodyne with some special features. It comprises a mixer V2a (1R5), separate local oscillator V1a (1T4) followed by an IF amplifier V1b (1T4) operating on 1730kHz.

The local oscillator operates 1730kHz above the signal frequency. When used on range 1, covering 150kHz to 1.6MHz, the aerial tuning cannot be maintained and a low-pass aerial filter is used instead.

There is no AGC and the volume is varied by the sensitivity control VR1a, controlling the negative bias of the IF amplifier and mixer valves. The grid leak detector V1c (1T4) may be used as a BFO when put into oscillation by moving the reaction control VR1b nearly fully clockwise. The audio output valve V1d (1T4) has an output transformer to match 800Ω impedance headphones.

The mains power pack Type 38/1 is powered from AC or DC mains and operates on a wide range of voltages. There is no isolation transformer and the MCR1 chassis (which is electrically 'floating') may be connected to the mains should one of the circuit to chassis decoupling capacitors fail.