A technical history of
Radio Communication Equipment
in the British Army

WIRELESS *for the* WARRIOR

by Louis Meulstee

VOLUME 1
WIRELESS SETS
NO. 1 – 88

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Equipment Type Nomenclature

Initial Type Nomenclature

Originally British Army radio sets were described by their nominal input, e.g. 30 watt, 120 watt, etc. After World War I this notation was changed into a system of lettering, using single letters. The letter 'A' represented a set used in the most forward localities and the further the set was from the forward troops, the later it came in the alphabet.

Armoured Fighting Vehicles (AFVs) and other mobile stations had a prefix 'M', e.g. MA, MB, etc.

However, when new sets came into service whilst the old ones were still in use, 'marks' and 'stars' had to be added to show the difference between them.

Revised Type Designation

In 1929, the future policy about Signals was formulated, and to meet this policy the design of a series of new Army radios was undertaken. Initially six sets were developed, described as follows:

1. Short range Brigade/Batt and RA Bde set (No. 1 set)
2. Short range Division/Brigade set (No. 2 set)
3. Medium range Corps/Division set (No. 3 set)
4. GHQ/Corps medium/long range set (No. 4 set)
5. Base/GHQ Long-range set (No. 5 set)
6. Army Chain world wide range (No. 6 set)

In the late 1930s, following the 1929 designation, a station or transmitter design was denoted by numbers, the last figure representing the level or purpose for which a set was used. New versions of the same type were noted by the addition of a preceding figure.

Receivers had similar notations, starting with R100, explained in a later Volume in this series.

Type of set	Designation	Later designs
Short range Brigade/ Artillery/GP	No. 1	11, 21, etc.
Short range Division/GP	No. 2	12, 22, 62, etc.
Medium range Corps mobile set	No. 3	23, 33, 43, etc.
Long range transportable GHQ/Base set	No. 5	15
Long range (transportable) Army Chain	No. 6	–
Interim AFV set	No. 7	–
Infantry Battalion manpack set	No. 8	18, 28, 38, etc.
AFV set	No. 9	19, 29, 49, etc.
Local control set for AFVs	No. 14	24, 34
Jamming set	No. 16	56

Early in World War II several notations were changed and amended as follows:

Special types	No. 26	36, 46, 76, etc.
Special types	No. 17	27, 37, 47, etc.
UHF sets with optical path	No. 10	20

Sets still in the experimental stage were allotted a number, prefixed by a letter 'X' and suffixed by a letter indicating the particular model; e.g. the experimental model coded as X53, the final design being issued as Wireless Sender No. 53.

Tropicalisation

As an interim measure, until sets designed for tropical conditions became available, it was decided to tropicalise a proportion of the current field sets in the construction stage. Complete tropicalisation was considered as not practicable, but by using selected components, pvc-insulated wiring, and by treating exposed parts with fungicide in manufacture a considerable improvement on existing standards was achieved.

The special treated sets were distinguished from standard production models by the addition of the suffix 'T' to the normal number, e.g. Wireless Set No. 22 (T).

The suffix 'T' did not really mean that the equipment concerned was fully tropic-proof. However, all possible steps were taken, in the time available, to render the equipment proof against tropical conditions. Whilst the sets were in production, improvements were often made which did not in themselves justify a new nomenclature or Mark number and when a set was produced by more than one manufacturer, it was not always possible to get manufacturers to introduce the same improvement. Therefore although two sets may be of the same type and bearing suffix 'T', it was possible that there were slight differences between them if they were produced at an appreciably different time or by different manufacturers.

New Series

During mid-1943 the requirements for a future series of sets for forward use were specified. The main features of this new development were compactness and full tropic-proofing in hermetically sealed cases.

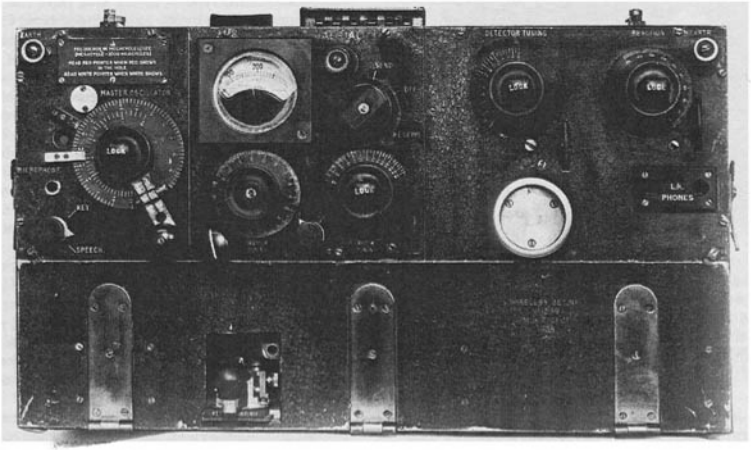
Original title	Nomenclature in use during development	Nomenclature used when design was finished
Series 1	X78	WS No. 78
Series 2	X88a	WS No. 88
Series 2/5	X42a	WS No. 42
Series 3	X39a	WS No. 49 (B40/C40)

The new series of hermetically sealed equipment (which did not carry the 'T' suffix) rendered the sets fully tropic-proof. It was not until after the war that this new equipment was introduced.

Canadian and Australian Sets

Sets carrying the letter 'C' in front of the code number were of Canadian design and manufacture, normally not having any exact British equivalent.

Equipment designed and manufactured in Australia, linked with British models, started with 100; e.g. WS No. 1 becoming WS No. 101 (Aust). However, still inconsistent in notation, were Wireless Sets No. 11 (Aust), No. 19 (Aust) and No. 22 (Aust); sets with quite similar specifications and general layout to their British parent sets.



WIRELESS SET No. 1 (1933)

DATA SUMMARY

Purpose: Short range Infantry Brigade/Battalion, Royal Artillery Regiment and general purpose communications.

System: AM R/T and CW

Frequency Coverage: 4.200–6.660MHz

Range: (miles)	Aerial	CW	R/T
On the move	6ft rod	5	2
Stationary/ground	9ft rod	7-9	3½

Types of Aerial:
Vertical rod: 6–9ft vehicle station, 6–18ft ground station.
Aerials, Horizontal, End-fed; Aerials, Horizontal, 'A'

RF Power Output: 0.5 watt.

Power Supply: LT 6 volt, 16Ah, accumulator; HT 240 volt dry battery.

Consumption:	HT	LT
Receive	5mA	0.35A
Transmit CW	11mA	0.35A
Transmit R/T	8mA	0.35A

Size (inches) and Weight:

	height	length	width	weight
Set only	12	20	8½	45 lb
HT battery box	11¼	16	4	26 lb
LT accumulator	9½	8	6	17 lb
Aerial gear in bag				13 lb
Complete station				237 lb

Valves:

Transmitter		Receiver	
function	*type*	*function*	*type*
Master osc.	AR4	RF amp.	ARS6
RF power amp.	ARS6	Detector	AR4
		AF amps.	2x AR4

General Description

Wireless Set No. 1 was designed as a portable short-range ground station or mobile vehicle station used for Infantry Brigade/Battalion, Royal Artillery Brigade and general purpose communication. A station consists principally of Wireless Set No. 1, a 6-volt LT accumulator in wooden box, an HT battery box and a number of accessories. The combined transmitter-receiver is built into a copper-iron 'plymax' case, with the copper inside. Fitted on top of the case are two sockets for connecting the LT and HT batteries. A detachable lid, fitted with spring clips in which a microphone and a pair of headphones are carried, protects the set controls during transport.

The case is divided into three main compartments. The bottom part of the front plate is fitted with hinges and forms a door through which the valves are accessible. Two screen-grid valves, (receiver RF amplifier and transmitter RF power amplifier) are mounted in a horizontal position parallel to the main panels and lie partly in one compartment and partly in the next, passing through slots cut in the partitions. A Morse key is mounted on a slide in a separate compartment accessible from the front panel and can be drawn out to a suitable position for operating.

Remote control, up to 400 yards, is provided using two additional control units. Remote aerial coupling units allow the aerial to be erected up to 30 feet distant from the set.

It is interesting to note that the No. 1 Set was the first operational Army set in which screen grid valves were employed. It was also the first practical field set made in quantities to employ radio telephony and the first non-AFV set specially developed to work on the move.

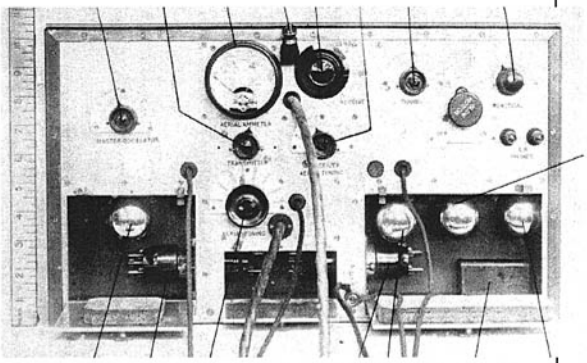
The LT, GB and HT battery connections, fitted on top of the set case, were designed primarily to facilitate the fast removal of the set from the vehicle to set up a ground station. When used in a vehicle, long screened leads are used; short battery leads are provided when the set is used on the ground. The HT battery box includes the grid bias battery and comprises twenty 12-volt units (Batteries, Dry, Refill, 8-cell, No. 1) including a spare unit. One and a half units (18 volts) are used for grid bias. The working life

Historical Development

In October 1929 a new series of Army radio sets were formulated and the design of six new types of sets initially laid down. The new pattern 'A' MkIII Set, already at hand in 1928 for Brigade and Artillery communication, was re-designated Wireless Set No. 1. The experience with the development of both the experimental 'A' MkIII Set and the 'R/T Set for Artillery' were incorporated in further design of the No. 1 Set. An important feature was the inclusion of R/T and operation of the set from a vehicle on the move. Additionally, the set appeared to be suitable for mounting in a special door-frame of an Austin-7 car.

In April 1930 six SEE-manufactured prototype No. 1 Sets were sent to Southern Command for trials, fitted in Austin-7 two-seater cars. Reports from these trials were generally favourable. After completing a number of minor modifications, second trials were carried out in September 1930. In February 1931 the design of the set with further modifications was approved by the War Office. The first production sets, manufactured by STC (Standard Telephones & Cables) were issued in 1933. Review of the contracts showed that the rate of completion was very slow.

This was due to the fact that the SEE design was not very suitable for mass-production. "...if an emergency arose it would be impossible to obtain fulfilment of even an approach to requirements..." (*Proceedings RE Board*). Redesign of the set for quantity production or 'ease of production' involved many alterations to the design. Ferranti Ltd submitted a proposal for redesign and an order for three sets were placed in 1935. When these models were tested in 1936 they proved to be a failure and no further order was placed in view of the progress which was being made with the design of the No. 11 Set. Taken on the whole, the primary disadvantages of the No. 1 Set were a limited working range and, due to receiver bandwidth, at least 20kHz separation had to be allowed between adjacent channels which limited the number of channels considerably. It is estimated that about 1800 No. 1 Sets were manufactured by the trade, the last sets believed delivered as late as 1938.



(Figure 1-3) Experimental W/T Set 'A' MkIII (design No. 1), developed in 1928, formed the base for the Wireless Set No. 1. Note the close resemblance to the prototype of the No. 1 Set

Operating on the Move

In the prototype and initial issues of the set, fitted in a 1930 model Austin 7 two-seater, the set was carried in a specially-made near-side door frame of the car allowing the set to be removed quite easily. The batteries were housed in a locker at the back of the car.

A later conversion of the 1931 model Austin-7 vehicle body provided a more convenient method of carrying the set when fitted against the dashboard facing the operator. The aerial was mounted on a special bracket bolted to the near-side of the body in front of the windscreen. In this new position the aerial was more out of the way then when mounted on the door.

Eventually, during 1932 it was considered that the weight of the No. 1 Set and its attachment was too great for the Austin-7 car and in later issues Morris Minor cars were provided. In 1936 Morris Eight cars were issued, modified with the front seat removed and carrying the set alongside the operator who occupied one rear seat.

Still the fitting was not fully satisfactory. No further action was taken as in 1936 it was decided to replace eventually all light cars carrying No. 1 Sets by Morris 8-cwt 'Pick-Up' trucks.

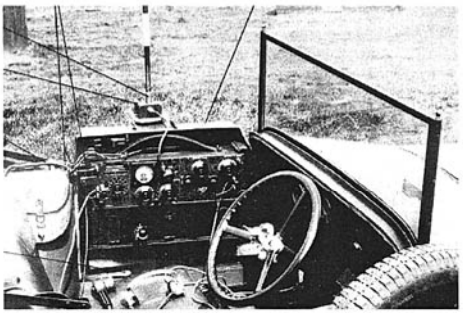
In May 1931 additional experimental work was started on other methods of transport of the set. Animal packs were designed (the final design was made in India) and the No. 1 Set was fitted in other vehicles than light cars.

Experiments mounting a No. 1 Set in the turret of a light tank showed that the fitting was acceptable and speech was practically unaffected by the movement of the tank. It was found that the R/T range of the No. 1 Set in a moving tank, using an 8ft vertical rod aerial, was limited to approximately 1 mile.

When fitted in a vehicle, the set was usually mounted in a metal frame, packed with felt at the corners, to avoid direct contact with the vibration of the vehicle. A loose board, covered with felt was fitted at the bottom of the frame for the set to stand on. This board rested on two long curved springs, supported on adjustable screws.

As a result of the successful tests with the sets in light tanks, a number of No. 1 Sets were modified to cover an extended frequency range to work MB Sets. The new tuning range covered 3.1 to 5.1MHz.

It is recorded that the No. 1 Set has been installed in the following operational vehicles: Austin-7, Hillman 'Minx', Ford V8 Truck, Morris Minor two-seater, Morris Eight, Morris 8-cwt truck, Rolls-Royce Armoured Car 1920 pattern, Light Tank MkII/IIa/III/VI and various other vehicles at trials only.



(Figure 1-4) 1930 Prototype Wireless Set No. 1 fitted in an Austin 7. The aerial support is an ebonite insulator mounted on a hinged plate. Aerial Base MkII was used with later issues of the station

Vehicle Stations

The Morris 30-cwt 18 HP six-wheelers housing a complete No. 2 High Power Set in a special body were reported as being very much overloaded resulting in wheel wobble and unstable driving. Although measures were taken to reduce its weight, including fitting sets in similar 25 HP vehicles, the problem was never solved since the high-power set was abandoned in 1935.

In 1937 a No. 2 Set low-power station was developed, fitted in a 15-cwt truck with a specially designed body having a discrete compartment for the charging set. Trials showed that the performance of the vehicle was satisfactory. The vehicle as finally fitted was suitable for carriage of both No. 2 and No. 9 Set stations.

(Figure 2-7) No. 2 Set installed in a Morris 25-HP 6-wheeler with Aerial, Roof, No. 3. The generating set and accumulators are mounted in the forward compartment, accessible through the door of the fitter's compartment in the centre. The rear compartments of the vehicle body housed the operators and the No. 2 Set which was fitted to the partition wall

(Figure 2-8) Operating position of Wireless Set No. 2 removed from the vehicle to form a ground station

Ground Station

The tray carrying the transmitter, receiver and power units as well as the operator's table could be detached from the vehicle and used on the ground to form a ground station.

A 20 to 24ft vertical aerial, made up from 6 and 4ft aerial rods was normally used in a ground station supported by an aerial base Insulator, W/T, 'B' (Illustration in the No. 1 Set section). A counterpoise earth (WS No. 1, Leads, Counterpoise), assembled of insulated wires, was laid out crosswise on the ground.

1934 four high-power and a number of low-power sets (of which two were for use in India) were issued for further trials. In 1935 it was decided that the HP Set was underpowered and not to be introduced. By then, drawings for contract purposes of the low-power set were completed and all modifications included in the trade pattern design.

A contract for 50 sets (first deliveries scheduled to begin late 1935) was given to the lowest tender, a manufacturer without adequate financial reserves. Because the construction of the set proved more difficult and expensive than initially anticipated, the firm went bankrupt, resulting in the set being stillborn. Later another firm took over the production and eventually 50 low-power sets were issued; however, it was too late as another more successful set (Wireless Set No. 9) had been developed.

All available SEE-built No. 2 Sets were sent abroad during the 1936 emergency in the Near East where they were reported as having performed satisfactorily.

Selective Jamming Set

During 1936 one of the Type A high-power No. 2 Sets was modified to work as a selective jamming set, installed in a Morris 30-cwt six-wheeler. A selection of wobbled CW or MCW, speech or a combination could be produced. A wavemeter was provided to enable the transmitter to be accurately set to the same frequency as the signal to be jammed. The experience with this set (designated Wireless Set No. 15) was later used for the design of Wireless Set No. 16 which was especially developed for jamming purposes only.

To simplify tuning for the operator, Wireless Set No. 11 Tablets, Calibration No. 1-4 are issued. Fitted into a slide on the left of the front panel, these give predetermined positions for the anode and aerial tap controls, positions which vary according to the type of aerials used and the frequency of which the set is operating. Remote control operation on R/T or CW up to 1200ft is possible when using Remote Control Unit A. An additional feature is working from cover with an aerial erected at a distance up to 30ft from the set, using Coupling Equipment C.

Historical Development

Due to a number of operational disadvantages and the failure to convert the No. 1 Set to mass production, in 1935 it was decided to supersede it by a new set, designated Wireless Set No. 11.

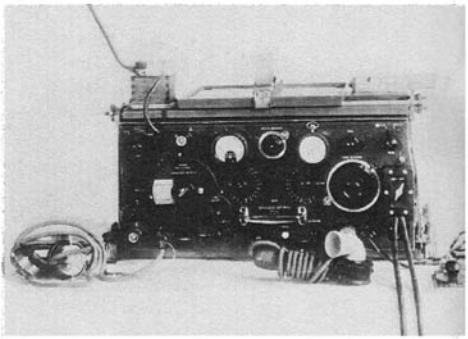
Signals Experimental Establishment started development of this set in 1936, in close collaboration with E. K. Cole, the firm that was selected to make the first batch of contract models. Twenty sets were built by SEE in 1937 and issued to Cavalry and RA Brigade Signals for field trials. The reports on the field trials were very favourable on the whole and after full consideration a number of modifications were made after which production started. Delivery of production models started in November 1938. Production ceased in 1942; at that time approximately 19 000 sets had been manufactured. The No. 11 Set was the first set developed with a circuit where the transmitter and receiver are automatically tuned to the same frequency, thus simplifying the operation of the set considerably.

Together with the No. 9 Set, it was the backbone of Army radio communication in the early phases of the war. It is interesting to note that the Germans, who captured a fairly large number of No. 11 Sets in 1940 during the retreat of the BEF in France, used the set to some extent.

One of the drawbacks of the set appeared to be the frequency coverage which is not low enough. Thus the communication range is limited when working sky-wave at night.

Though the set had been fitted in tanks, it really was not very suitable for this purpose. In this role the set was eventually superseded by Wireless Set No. 19 in 1942.

Early in World War II, Wireless Set No. 21 was introduced as a replacement for the No. 11 Set in ground and non-AFV roles. Though it was more suitable for mass production it was not a really a success.



(Figure 11-1) Prototype Wireless Set No. 11, developed by Signals Experimental Establishment in 1937. From this troop trial model modifications are carried out and production of contract models by E. K. Cole started

Technical Description

The receiver is a superheterodyne with one RF stage (V1a), frequency changer (V2a) and three IF stages (V1b,c,d,), followed by a detector and AF output stage (V2b). The intermediate frequency is 475kHz. The second local oscillator (BFO) (V2b) is tuned to 475kHz.

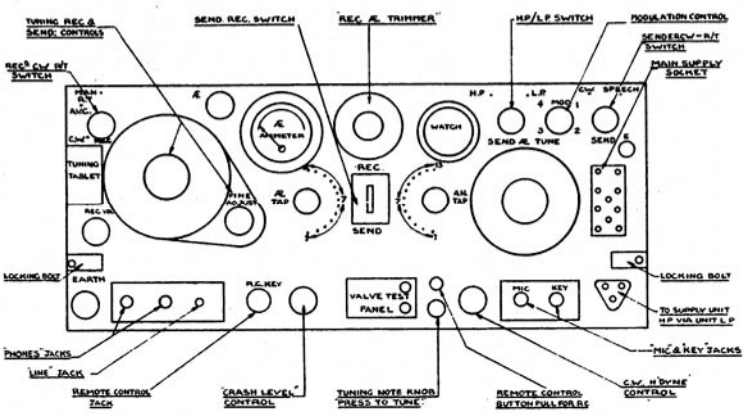
For reception of CW signals the heterodyne note is varied by means of the CW heterodyne control. The second detector and AVC voltage rectifier are Westector metal rectifiers.

When switched to transmit, the output of the receiver local oscillator valve (V2a) (signal frequency plus 475kHz) and the 475kHz output of the BFO valve (V2b) are applied to the transmitter frequency change valve V1e. The difference (signal frequency) is selected by a tuned circuit, amplified in a buffer stage (V1a) and applied to the RF power amplifier valve (V3a). In transmit position the BFO frequency is not variable and fixed at 475kHz.

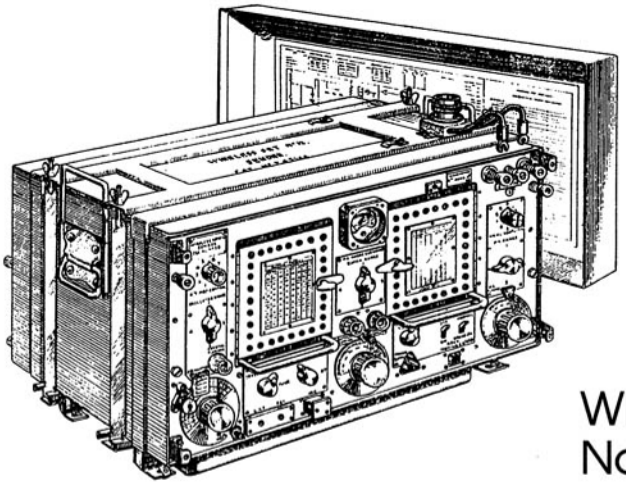
On High Power the anode voltage of the power amplifier is doubled by the HP Supply Unit, providing that the HP/LP switch on the front panel is set to HP.

CW transmission is accomnplished by means of a relay, keying the screen grid of the RF power amplifier. On R/T, grid modulation of the RF power amplifier is employed. Sidetone is provided by detection of a small proportion of the RF output, applied to the AF amplifier V2b.

The parts common to transmitter and receiver are the local oscillator, the BFO and RF amplifier; the receiver AF amplifier is also used in the transmitter to apply side-tone to the headphones.



(Figure 11-2) Position of controls on front panel Wireless Set No. 11



WIRELESS SET No. 12 (1941)

DATA SUMMARY

Purpose: General purpose low-power transmitter for use as a ground station, Line of Communication and vehicle station in 15-cwt truck.

System: AM R/T, MCW and CW

Frequency Coverage:

1.2–17.5MHz in four ranges:

Range 1	10–17.5MHz
Range 2	5.2–10.5MHz
Range 3	2.5–5.3MHz
Range 4	1.2–2.55MHz

Range: (miles)

	Stationary	On the move
R/T	15	10
CW	60	25

Type of Aerial: Dipole, End fed, Wyndom or vertical rod

RF Power Output: 25 watts CW, 7 watts R/T

Power Supply: 100–225V, 40–60Hz, single-phase AC. Usually supplied by 250W generating set

Consumption: 260 watts maximum

Weight: 134 lb, complete station 18 cwt.

Size (inches): height 12½, length 24, width 17½, with covers in position

Valves:

function	*type*
Master osc.	ATS25
Buffer/doubler	ATS25
Power amp.	ATP35
Modulator	ATS25
Mic. amp./MCW osc.	ARP34
Sidetone	EA50
GB rectifier	AU1
Stabiliser	2x AW3

General Description

The No. 12 Set was a general purpose low-power transmitter for CW, R/T and MCW, primarily designed as a ground station. It was normally used in association with the Reception Set R107. The set was also installed in class B vehicles (Trucks, 15-cwt., 4-wheeled, Wireless No. 1), replacing Wireless Set No. 9, suitable for operation whilst on the move. Keying is by hand or high-speed Morse apparatus (Wheatstone Morse transmitter). It can be operated with either local or remote control. In conjunction with a Wireless Remote Control Unit 'C', the transmitter can be switched on and off, and keyed on CW or MCW including teleprinter working from a remote point up to 1 mile away from the set. Provision is made for 'break- in' working on CW and MCW. When the transmitter is operating the receiver is muted. Sidetone is also fed back to the receiver. The aerial can be at some distance from the transmitter if it is connected by means of a feeder cable and Aerial Coupling Equipment F.

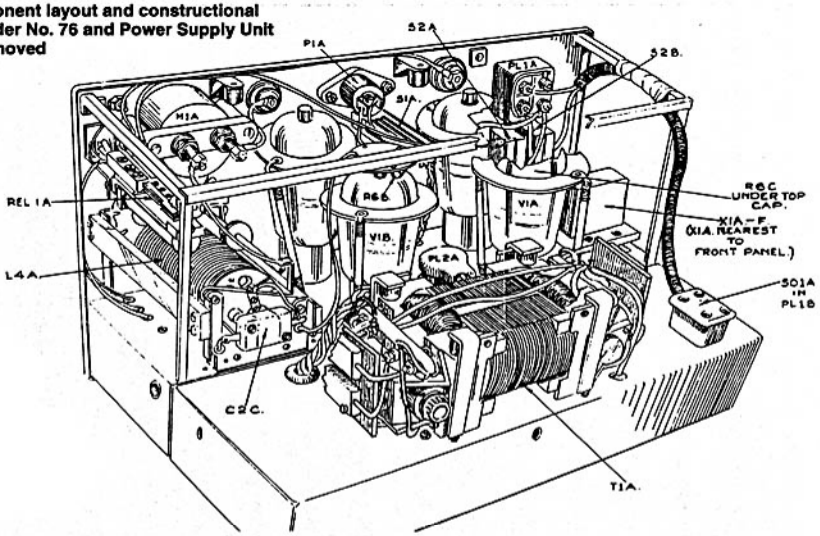
The set is self-contained and mounted on a steel chassis which, with the front panel holding the controls, may be completely withdrawn from its case after unscrewing two draw bolts. Two inspection doors in the front panel, with safety switches, allow the valves to be changed without taking the chassis out of its case. The case has removable top, back and front covers. The back and front covers, when in position fixed to the chassis by coin-slot screws, keep the top cover in position. Double carrying handles are provided on each side of the case.

The frequency band is covered in four overlapping ranges selected by switches which rotate coil turrets or select coil tappings, thus avoiding the change of coils. The set can only be operated from AC between 100–250 volts. When stationary it was usually powered from the AC supply mains, with the provided 250W generator (usually Power Unit, AC/DC, 250W, No. 1A) as stand-by. A teleprinter can be connected using Apparatus, telegraph, 2-tone. This unit provides two audio tones for the space and mark of the teleprinter.

Historical Development

As early as 1937, specifications were drawn up for a future replacement of the ill-conceived No. 2 Set, to be designated Wireless Set No. 12. It was abandoned in 1938 but under the pressure of war, specifications were redrawn in 1940. Its principal features were taken from 'Special Set No. 1', a Combined

(Figure 76-13) Component layout and constructional details Wireless Sender No. 76 and Power Supply Unit No. 18 with cover removed



Technical Description

The transmitter circuit consists of an ATS25 valve (V1A), operating in a modified Pierce crystal oscillator circuit. In this circuit the crystal is connected between grid and anode and no tuning is required. On frequencies above 6.5MHz the oscillator operates on half the signal frequency, the second harmonic being selected in the power amplifier circuit. Six crystals are included in the set. The crystals must be specially selected to withstand the high crystal current which was the cause of frequent crystal breakdown if the power amplifier was not properly tuned or the aerial wire got disconnected. During operations, crystals were issued in pairs so in case of a crystal breakdown a spare could be instantly selected. The power amplifier valve is an ATS25 (V1B), tuned in the anode circuit.

At frequencies higher than 6.5MHz this stage operates as a combined frequency doubler and power amplifier. As the output frequency is governed only by the tuning of the anode circuit of the power amplifier is thus possible to obtain at least two transmission frequencies from any crystal with a fundamental frequency between 2 and 6MHz. The PA tuning is divided into three bands: 6–12MHz range 1, 3.5–6MHz range 2 and 2–3.5MHz range 3.

The power amplifier is matched to the aerial by a variable inductor. Tuning of the PA circuit is facilitated by a tuning-indicator lamp which is coupled to both coils of the PA circuit. When pressing the Press-to-tune button it allows tuning of the PA circuit for maximum brightness. Final adjustment of PA tuning and aerial tuning should be carried out by means of the aerial current meter with the Morse key down. The PA tuning ranges do not overlap the other tuning ranges. As a result, at frequencies near the ends of the bands it may be impossible to tune the PA to the maximum, although some output will still be obtained. Furthermore, at frequencies near 3.5 and 6MHz it may be possible to obtain more RF output on the adjacent band to the one specified and both tuning positions should be tried and the one giving the highest reading used.

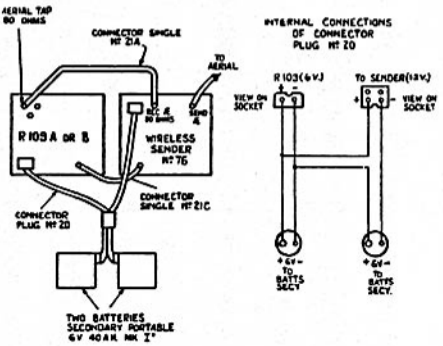
A calibration plate attached to the front panel of the set gives an approximate guide to the settings of the controls. The receiver is connected on a low-impedance tap of the PA circuit so the AE tuning is common to both transmitter and receiver. Keying is carried out in the cathode of both valves by means of a relay. During transmit the relay earths the AE terminal of the receiver. The maximum keying speed is up to 30 words per minute.

Accessories

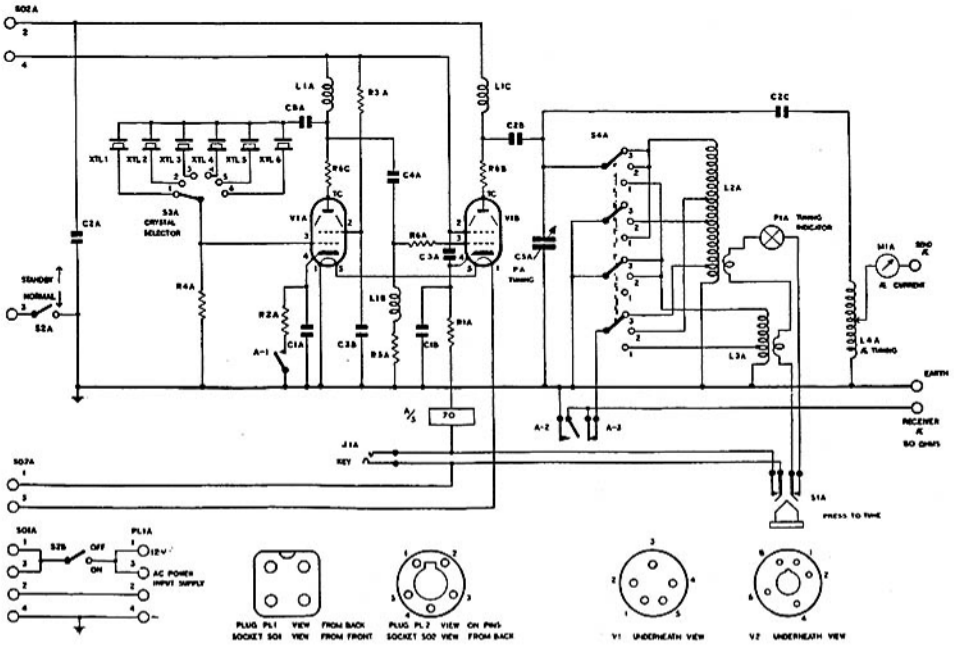
Connector assembly, 'Connector Plug No. 20', is used to give 12V to the transmitter and 6V for the R109 receiver from two 6V batteries. The receiver aerial terminal of the set is connected to the receiver by a single cable 'Connector Single No. 21a'; the earth by 'Connector Single No. 21c'.

There are two power packs: the standard 12V model 'Power Supply Unit No. 18' (ZA 21775) and a 100/230V, 50Hz mains power pack 'Supply Unit, Rectifier, No. 14' (ZA 21774). *(See page WS76 - 4 for circuits and layouts)*

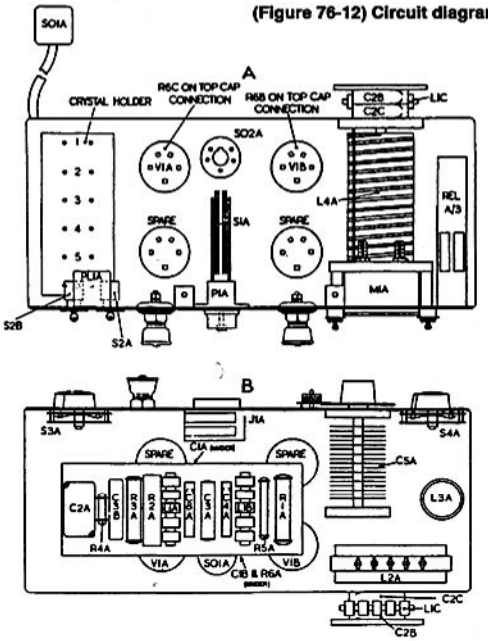
The supply units are connected to the transmitter by means of a lead terminating in a 5-point plug. A further lead terminating in a 4-point plug carries the battery or mains current to the supply unit. In the field the set is carried in a canvas satchel 'Case, Carrying No. 16' (ZA 21997).



(Figure 76-14) Connections of Wireless Sender No. 76 and Reception Set R109A or B. Note the 6V tap for powering the R109 receiver



(Figure 76-12) Circuit diagram of Wireless Sender No. 76



C1A-B	0.05µF	600V
C2A-D	0.01µF	2.2kV
C3A-B	0.002µF	600V
C4A	200pF	2.2kV
C5A	160pF	
C6A-B	0.01µF	600V
C7A	4µF	1kV
C8A	0.002µF	2.2kV
C9A-B	4µF	500V
R1A	220Ω	2W
R2A	370Ω	2W
R3A	47kΩ	2W
R4A	47kΩ	0.5W
R5A	22kΩ	1W
R6A-C	47Ω	0.5W
R7A	3kΩ	20W
R8A-B	5kΩ	6W
R9A	15kΩ	6W
V1A-B	ATS25	
V2A	5U4G	
M1A	500mA	
F1A	5A	
L1A-C	1.5mH	
L5A	10H	
L6A	10H	