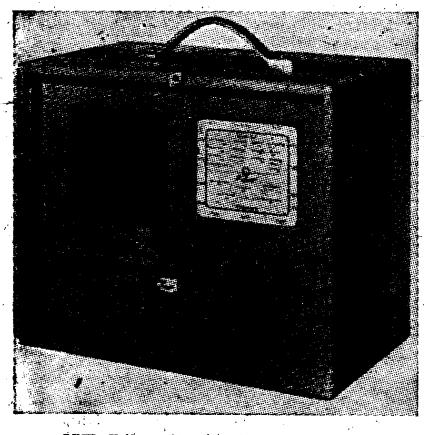
Supplement to The Wireless & Electrical Trader, Oct. 28, 1939

"TRADER" SERVICE SHEET

433

PILOT TWIN MIRACLE

AC, DC, BATTERY TRANSPORTABLE



THE Pilot Twin Miracle receiver is designed for AC, DC or battery operation, and is interesting in that it automatically changes over to battery operation should the mains fail or be switched off, and from battery to mains operation when the mains are switched on. The battery supply is an all-dry combined LT and HT unit.

The receiver is a 4-valve plus rectifier superhet, and is fitted with frame aerials in a leatherette-finished carrying case. It covers the MW and LW bands, and when operating on AC or DC mains it is suitable for voltages of 200-240 V.

Release date: August, 1939.

CIRCUIT DESCRIPTION

Tuned frame aerial input **L3,C19** (MW), plus **L4,C19** (LW) to first valve **(V1, Brimar 1A7EG)**, a heptode operating as frequency changer with electron coupling. Provision for connection of external aerial via **A** socket, isolating condenser **C1** and frame aerial coupling coils **L1, L2** to **L3** and **L4**. An external earth must not be connected, because the chassis is "live" to the mains.

V1 oscillator grid coils **L5** (MW), plus **L6** (LW) are tuned by **C20**; parallel trimming by **C21** (MW) and **C22** (LW); series tracking by **C24** (MW) and **C23** (LW). Reaction from anode via **C5** by coil **L7** and common impedance of tracking condensers which are included in both grid and anode circuits.

Second valve **(V2, Brimar 1N5G)** is a variable-mu RF pentode operating as intermediate frequency amplifier with tuned-primary tuned-secondary iron-cored transformer couplings **C25, L8, L9, C26** and **C27, L11, L12, C28.**

Intermediate frequency 451KC/S.

Diode second detector is part of single diode triode valve **(V3, Brimar 1H5G).** Audio frequency component in rectified output is developed across load resistance **R6** and passed via AF coupling condenser **C8** and manual volume control **R7** to CG of triode section, which operates as AF amplifier. IF filtering in diode circuit by **C7, R3,** and in triode anode circuit by **C9.**

DC potential appearing across **R6** is also developed across **R4, R5,** and that at their junction is tapped off and fed back through decoupling circuit as GB to FC and IF valves, giving automatic volume control.

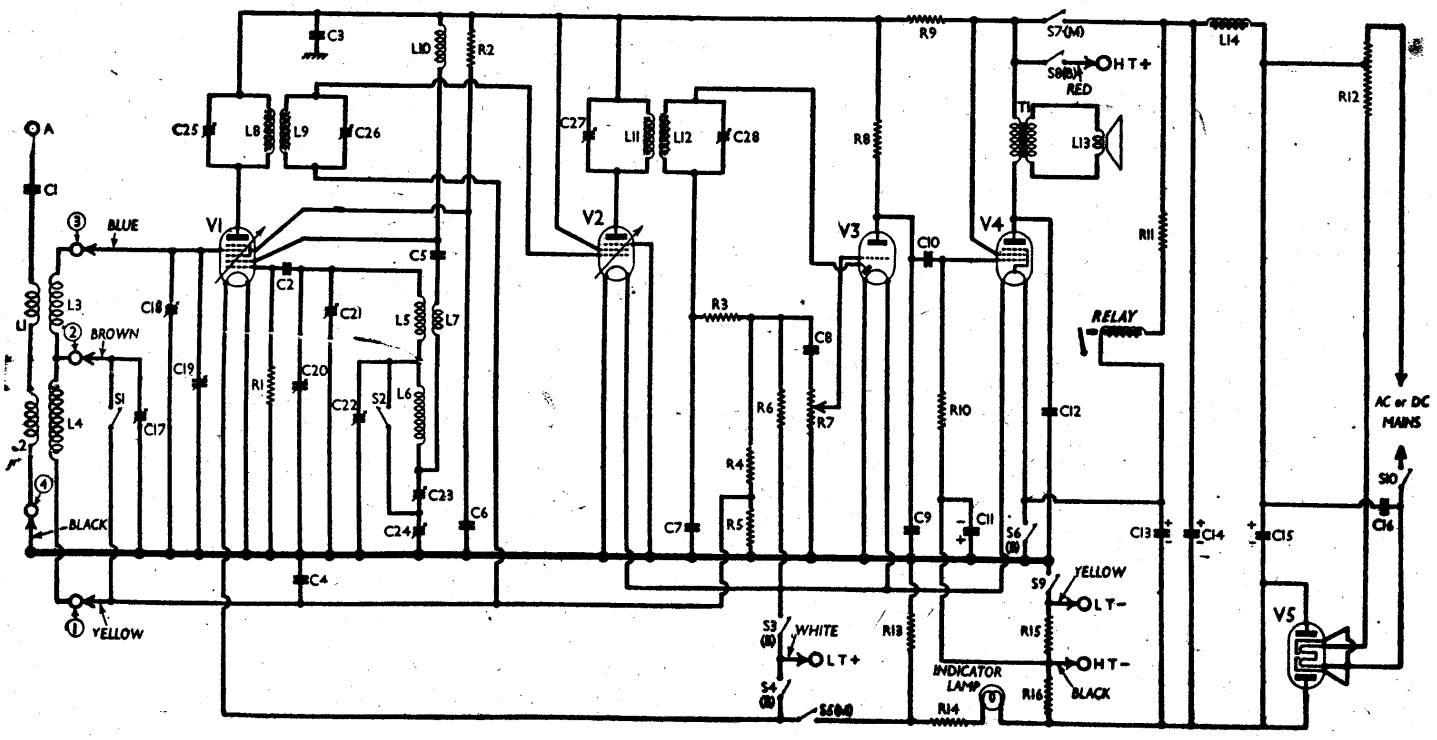
Resistance-capacity coupling by **R8, C10** and **R10** between **V3** triode and pentode output valve **(V4, Brimar 1C5EG).** Fixed tone correction by **C12** in anode circuit.

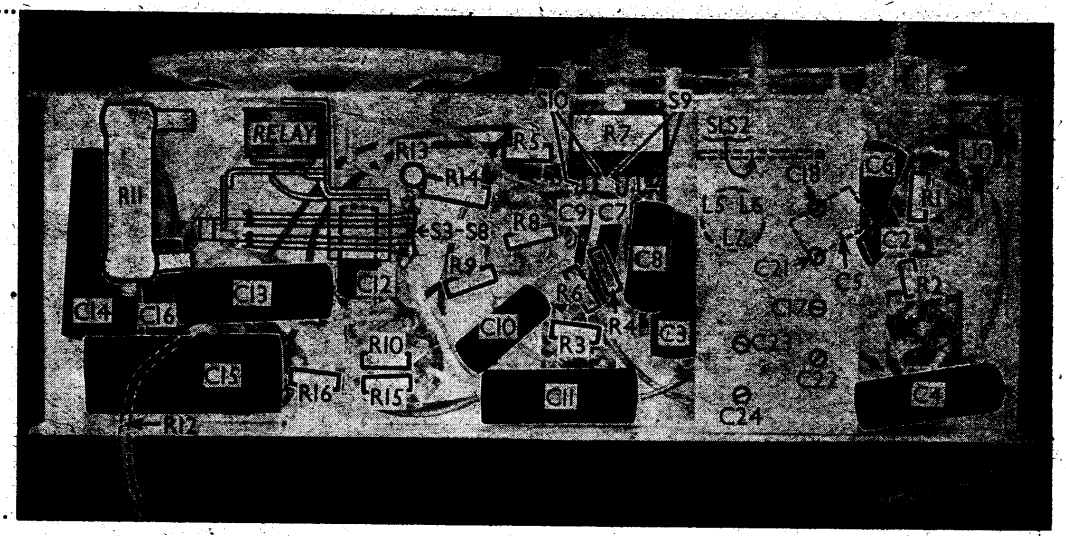
Power Supply

This receiver is designed to operate from dry batteries or AC or DC mains, and automatically to adjust itself to which of these forms of supply is presented.

Since the change-over switching action may not be immediately apparent from a study of the circuit diagram, the two circuits, one for battery operation and the other as it arranges itself for operation from AC or DC mains, are separately described in detail below, and the switches concerned in the change-over **S3** to **S8** are coded with the letters **B** and **M** to indicate when they open and close: when working from the battery unit all the **B** switches are closed, and the **M** switches are open; when working from AC or DC mains, the **M** switches are closed, and the **B** switches are open. The on/off switches **S9, S10** are ganged.

Battery Operation.—The combined dry HT and LT battery unit is permanently housed in the casing of the receiver, and permanently connected by a plug and socket connector to the chassis. When the receiver on/off switches are open,





Under-chassis view. Diagrams of the **S1, S2** and the **S3-S8** switch units are given overleaf. The tags of **S9** and **S10** are indicated. **R11** may be a tapped resistor in later models. **R12** is incorporated in the mains lead.

S3(B), S4(B), S6(B) and **S8(B)** are all closed; so that when the receiver is switched "on," by turning the volume control knob, **S9** closes and the receiver immediately begins to operate.

Under these circumstances, the HT circuit is from the junction of **R15** and **R16** (HT negative), via **V4** automatic grid bias resistance **R15, S9,** chassis, valve circuits, HT positive line and **S8 (B)** to HT positive.

The filament circuit is via **S9 (LT** negative) to chassis; then via **V1** filament and **S4(B)** to LT positive; and via **V2, V3** filaments and **S3(B),** to LT positive; and via **S6(B), V4** filament and **S3(B)** to LT positive; so that all the filaments are connected in parallel across the 1.5V section of the battery unit.

AC or DC Mains Operation.—When the receiver is switched "on" for mains operation, **S9** and the mains switch **S10,** since they are ganged, close together, and the receiver again begins immediately to operate from the battery supply.

Now, however, the mains supply is connected across the line cord **R12** and the heater of the rectifier valve **(V5, Brimar 25Z6G** or **1D5)** via **S10,** and the rectifier begins to warm up. When emission begins in **V5,** an electron flow will occur from the mains through **V5, R16, R15** and, via **S9** and **S6(B),** which is still closed, through the **relay** winding, **R11, L14** and part of **R12** back to the mains.

Until the current thus produced reaches a certain critical value, the **relay,** which controls all the change-over switches, remains open, but at that point it closes and effects the change-over, closing the two **M** switches and opening the four **B** switches.

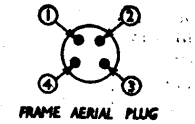
The HT circuit is now: **V5** anode, **R16, R15** (which continues to operate as **V4** GB resistance) **S9,** chassis, valve circuits, HT positive line, **S7(M), L14** and **R12** to the mains.

The filament circuit is now in series with the HT supply; it runs from **V5** anode via the mains indicator lamp, which glows when the receiver is operating from the mains, **R14, V1** filament and **R13** (connected in parallel via **S5(M)** and chassis), **V2** and **V3** filaments (connected in parallel), **V4** filament, **relay** and **R11** to HT positive line.

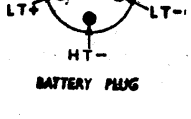
R13 and **V1** filament, **R14** and the indicator lamp are in parallel with **R15** and **R16.**

From the foregoing, it will be seen that, if the receiver is operating from its battery, it will automatically change over to mains operation if the mains are subsequently connected; and conversely, if it is operating from the mains, and the supply fails or is switched "off," the receiver will change over to battery operation and continue to function. The indicator lamp then provides an indication of the source of power.

If the receiver is connected to DC mains and the lamp fails to glow after the normal warming-up period, the indication is that the mains plug requires reversing.



FRAME AERIAL PLUG



BATTERY PLUG

Circuit diagram of the Pilot Twin Miracle receiver. The switches S3-S8 are relay operated, and control the mains to battery changeover, and vice-versa. Switches with the suffix M close for mains operation, while those with the suffix B close for battery operation. The frame aerial and battery plug and socket connections are indicated and colour-coded.

DISMANTLING THE SET

Removing Chassis.—Remove the three control knobs (pull off) and the back of the receiver, with frame aerials attached, (four set screws); withdraw the frame aerial plug and pull the mains cord through the hole in the back of its pressed-card container, when the back will be freed from the receiver. Unscrew the battery unit retaining clamp (two round-head woodscrews), withdraw its connecting plug, and remove the two wood retaining blocks (two countersunk head wood screws) screwed to the sides of the cabinet at the rear of the chassis. The chassis can now be withdrawn from the cabinet.

Removing Speaker.—The speaker may be removed from the chassis by unsoldering its leads at **V4** holder, on the underside of the chassis, and withdrawing its fixing bolts. When replacing, connect the blue speaker lead to pin 3 on **V4** and the red lead to pin 4 on the same valveholder.

COMPONENTS AND VALUES

	CONDENSERS	Values (μF)
C1	Aerial isolating condenser...	0·0003
C2	V1 osc. CG condenser ...	0·00006
C3	HT circuit RF by-pass ...	0·25
C4	AVC line decoupling ...	0·1
C5	V1 osc. anode coupling condenser	0·0003
C6	V1 SG decoupling	0·01
C7	IF by-pass	0·0003
C8	AF coupling to V3 triode ...	0·01
C9	IF by-pass	0·0001
C10	V3 triode to V4 AF coupling	0·01
C11*	V4 CG decoupling	25·0
C12	Fixed tone corrector ...	0·005
C13*	Heater circuit smoothing (on mains)	25·0
C14*	HT smoothing condensers	40·0
C15*		40·0
C16	Mains RF by-pass	0·05
C17‡	Aerial LW trimmer... ...	—
C18‡	Aerial MW trimmer ...	—
C19†	Frame aerial tuning ...	—
C20†	Oscillator circuit tuning ...	—
C21‡	Osc. circuit MW trimmer ...	—
C22‡	Osc. circuit LW trimmer ...	—
C23‡	Osc. circuit LW tracker ...	—
C24‡	Osc. circuit MW tracker ...	—
C25‡	1st IF trans. pri. tuning ...	—
C26‡	1st IF trans. sec. tuning ...	—
C27‡	2nd IF trans. pri. tuning ...	—
C28‡	2nd IF trans. sec. tuning ...	—

* Electrolytic. † Variable. ‡ Pre-set.

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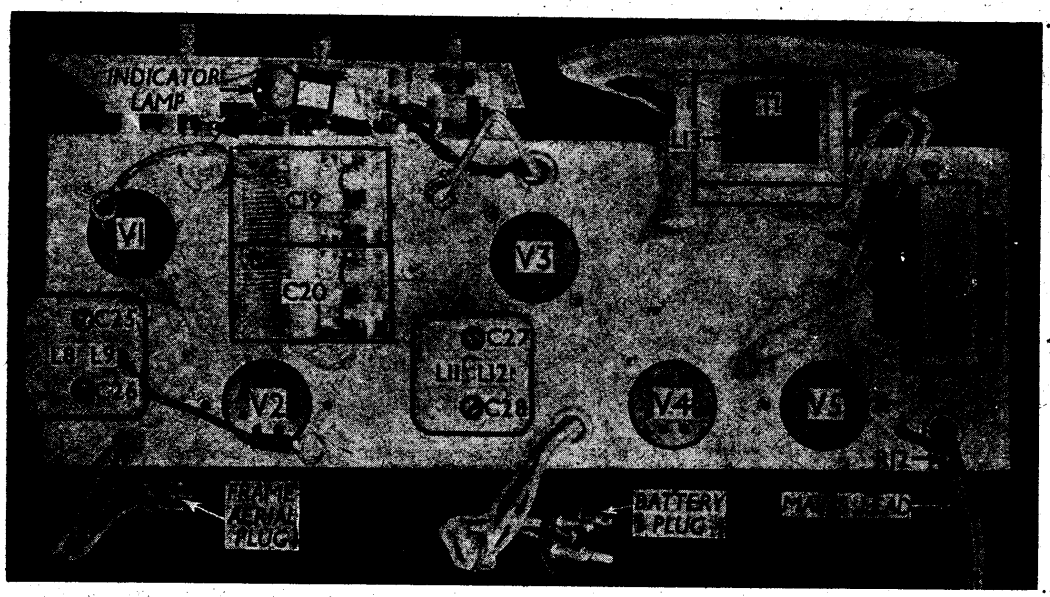

Plan view of the chassis. **R12** is incorporated in the mains lead. Battery and frame aerial plug connections and diagrams are given in the circuit diagram.

	RESISTANCES	Values (ohms)
R1	V1 osc. CG resistance ...	220,000
R2	V1 SG HT feed	56,000
R3	IF stopper	47,000
R4	AVC line feed resistances...	3,300,000
R5		3,300,000
R6	V3 signal diode load resistance	2,200,000
R7	Manual volume control ...	2,000,000
R8	V3 triode anode load ...	1,000,000
R9	V1, V2, V3 HT feed... ...	2,000
R10	V4 CG resistance	3,300,000
R11	V1-V4 heater circuit ballast	700
R12	V5 heater ballast (line cord)	620*
R13	V1 heater shunt (on mains)	25
R14	Indicator lamp series ...	50
R15	V4 automatic GB resistances	1,200
R16		2,000

*Tapped at 200 Ω from mains plug end.

	OTHER COMPONENTS	Approx. Values (ohms)
L1	Frame aerial coupling coils	0·1
L2		0·2
L3	Frame aerial tuning coils ...	1·5
L4		21·0
L5	Osc. circuit MW tuning coil	3·5
L6	Osc. circuit LW tuning coil	6·5
L7	Oscillator reaction coil ...	85·0
L8	1st IF trans. Pri.	6·5
L9	1st IF trans. Sec.	6·5
L10	V1 osc. anode HT feed choke	130·0
L11	2nd IF trans. Pri.	7·5
L12	2nd IF trans. Sec.	4·5
L13	Speaker speech coil... ...	3·0
L14	HT smoothing choke ...	200·0
T1	Speaker input trans. Pri.	430·0
	Speaker input trans. Sec.	0·3
Relay	Magnet winding	100·0
S1, S2	Waveband switches ...	—
S3-S8	Battery/mains change-over switches	—
S9	Battery switch ganged R7	—
S10	Mains switch ganged R7	—

VALVE ANALYSIS

Valve voltages and currents given in the tables (col. 2) are those measured in our receiver when it was operating on (a) a new HT battery reading 87V on load (battery table); (b) AC mains of 230V (mains table). The receiver was tuned to the lowest wavelength on the medium band and the volume control was at maximum, but there was no signal input.

Voltages were measured on the 400V scale of a model 7 Universal Avometer, chassis being negative.

Battery Operation

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 1A7EG	75	0·3	37	0·6
	Oscillator			
	78	1·3		
V2 1N5G	75	0·8	75	0·1
V3 1H5G	15	0·02	—	—
V4 1C5EG	78	4·7	80	2·0

Mains Operation

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 1A7EG	78	0·8	40	0·6
	Oscillator			
	80	1·1		
V2 1N5G	76	0·9	76	0·1
V3 1H5G	15	0·02	—	—
V4 1C5EG	85	8·2	90	2·8
V5 25Z6G	100†	—	—	—

†Measured between pin 5 on V5 and HT+ line at pin 4 on V4.

GENERAL NOTES

Switches.—S1, S2 are the waveband switches in a rotary unit beneath the chassis, under the metal plate carrying the group of trimmers. The diagram below shows the positions of the switches in the unit as seen from the rear of the underside of the chassis. Both switches are *closed* on MW and *open* on LW.

S3-S8 are in the relay-operated leaf switch unit beneath the chassis. This is also indicated in our under-chassis view, and a diagram of the end of the unit, showing the tags of the various switches, viewed from the right hand end of the chassis, is given below.

The action of these switches is fully explained under "Power Supply," and it should be noted that switches with the suffix **B** are *closed* for battery operation and *open* for mains operation, while those with the suffix **M** are *closed* for mains operation and *open* for battery operation.

S9 and **S10** are the battery and mains switches respectively, both ganged with **R7**, and closed when the set is switched on. The tags of these switches are indicated in our under-chassis view.

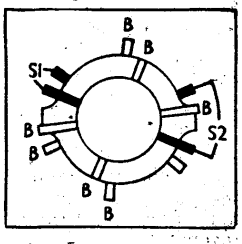

Diagram of the **S1, S2** switch unit, as seen from the rear of the underside of the chassis.

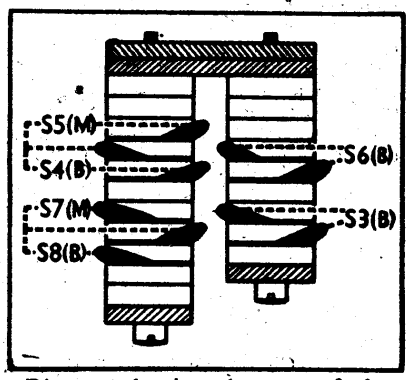

Diagram showing the tags of the S3-S8 switch unit, viewed from the right hand end of the chassis.

Coils.—L1-L4 are the frame aerial coupling and tuning coils, mounted on the back of the receiver. They are connected to the receiver by a small 4-pin plug and socket device. A diagram of the plug, viewed from the free ends of the pins, is given on the right of the circuit diagram. The pins are numbered to agree with the numbers in the circuit diagram itself, where the leads are also colour-coded.

L5-L7 are in an unscreened unit beneath the chassis, close to the **S1, S2** switch unit. The IF transformers **L8, L9** and **L11, L12** are in two screened units on the chassis deck, with their associated trimmers. **L10** is beneath the

chassis. **L14** is the smoothing choke, mounted on the chassis deck.

Indicator Lamp.—This is an Ever Ready type, rated at 6.3V, 0.15A, and fitted with a miniature bayonet cap. The bulb is sprayed red.

External Speaker.—No provision is made for this, but a low resistance (about 30) type could be connected across the speech coil of the internal speaker.

Battery.—The battery used in an Ever Ready All-Dry No. 3, giving 1.5V LT and 90V HT. It is fitted with a 4-pin socket, and is connected to the receiver by a 4-pin plug at the end of a lead. A diagram of the plug, looking from the free ends of the pins, is given at the right of the circuit diagram. It is coded to agree with the connections in the circuit diagram.

Rectifier Valve.—Receiver with serial numbers from 12,001 to 13,501 use a 25Z6G rectifier for **V5** (as in our case); with serial numbers of 13,502 upwards **V5** is a 1D5. This has a 5-pin base, instead of the octal used on the 25Z6G.

When the 1D5 is used, slight circuit modifications are made. In the first place, the line cord resistor **R12** becomes 910 O, and is not tapped. **L14** and the top of **C15** then go direct to the mains.

In addition, there is an extra resistance of 800 O between **L14** and the top of **C14**. This is not achieved by a separate resistor, but the vitreous enamelled resistor **R11** becomes 1,500O, tapped at 700O from the relay end, the remaining 800O forming the additional resistance mentioned. **S7(M)** and the top of **C14** then go to the tapping on the modified **R11**. Also, **C15** becomes a 20μF 250V working type, instead of 40μF, 150V.

Resistor R12.—Where the line cord **R12** is tapped (25Z6G valve), the tapping is the red lead emerging from the chassis end of the cord.

Chassis Divergencies.—Apart from those mentioned above, the following divergencies were found: **C4** was 0.1μF, not 0.05μF as given by the makers; **R9, R16** were 2,000O, not 2,200O; and **C16** is shown by the makers as being on the opposite side of **S10.**

Valve Connections.—The valves use American octal bases, and their connections are standard ones for their types. Pin 1 is blank in all cases, and pins 2 and 7 are the filament connections.

The only unusual valve is **V3**, a single diode triode. Its connections are: 1, blank; 2, filament; 3, anode; 4, blank; 5, diode; 6, blank; 7, filament; 8, blank; top cap, grid.

CIRCUIT ALIGNMENT

IF Stages.—Connect signal generator via a 0.1μF condenser to grid (top cap) of **V1**, and via a similar condenser to chassis. Feed in a 451 KC/S signal, and adjust **C25, C26, C27** and **C28** in turn for maximum output. Repeat these adjustments.

RF and Oscillator Stages.—With gang at maximum, pointer should be horizontal. Connect signal generator via a suitable dummy aerial to the **A** socket, and via a 0.1μF condenser, to chassis. Alternatively, couple the output of the generator to the frame aerials by a turn or two of wire wound round the outside of the cabinet. The trimmers can be reached through a removable panel at the base of the cabinet, but only after the battery has been removed. The receiver is then aligned when operating from the mains.

MW.—Switch set to MW, tune to 200m on scale, feed in a 200m (1,500 KC/S) signal, and adjust **C21**, then **C18**, for maximum output. Feed in a 500m (600KC/S) signal, tune it in, and adjust **C24** for maximum output, while rocking the gang for optimum results.

LW.—Switch set to LW, tune to 1,200m on scale, feed in a 1,200m (250 KC/S) signal, and adjust **C22**, then **C17**, for maximum output. Feed in a 1,900m (158 KC/S) signal, tune it in, and adjust **C23** for maximum output, while rocking the gang for optimum results.

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