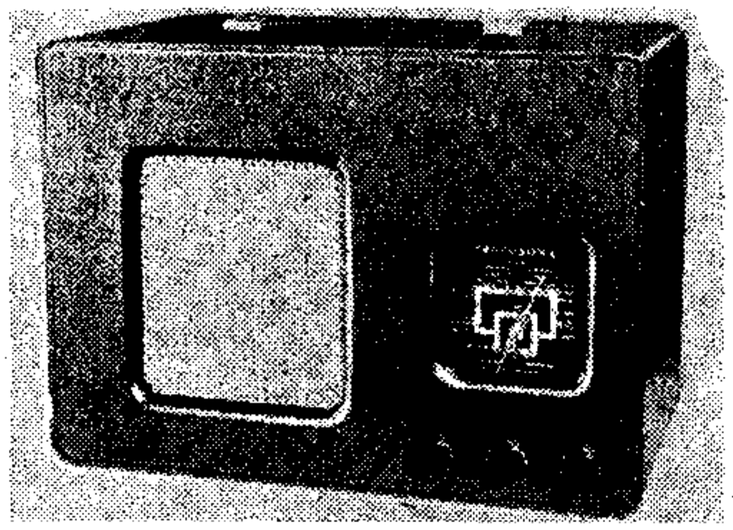
FERGUSONIC 907

AC/DC/BATTERY SUPERHET



THE Fergusonic 907 can be operated from AC or DC mains or from its self-contained all-dry batteries. When first switched on, if connected to the mains, it begins to operate immediately on its batteries, automatically changing over to mains operation when its rectifier heats up. If the mains supply ceases for any reason, the receiver automatically reverts to battery operation. An indicator lamp illuminates a red spot on the scale when operating from mains.

The receiver is a 4-valve (plus rectifier) 2-band portable superhet employing 1.4 V all-dry battery valves, whose filaments are connected in series for battery or mains operation. It is designed to operate from mains of 200-250 V 40-100 C/S in the case of AC.

Release date: *November*, 1939.

CIRCUIT DESCRIPTION

Tuned frame aerial input **L3** (MW), plus **L4** (LW), and **C19** precedes first valve **(V1, Mullard metallised DK1),** an octode operating as frequency changer with electronic coupling. Provision for the connection of an external aerial and an earth via coupling windings **L1** (MW) and **L2** (LW), which are isolated from the chassis.

V1 oscillator control grid coils **L5** (MW), plus **L6** (LW), are tuned by **C20.** Parallel trimming by **C21** (MW) and **C22** (LW); series tracking by **C23** (MW) and **C24** (LW). Reaction coupling by anode coil **L7,** via coupling condenser **C4,** on both wavebands, with additional coupling across the common impedance of the tracking condensers **C23** and **C24,** which are included in the return paths of grid and anode circuits, on their respective wavebands.

Second valve **(V2, Mullard metallised DF1)** is a variable-mu RF pentode operating as intermediate frequency amplifier with tuned-primary, tuned secondary transformer couplings **C25, L8, L9, C26** and **C27, L10, L11, C28.** The second IF transformer primary **L10, C27** is damped by the shunt resistance **R4.**

Intermediate frequency 470 KC/S.

Diode second detector is part of single diode triode valve **(V3, Mullard metallised DAC1).** Audio frequency component in rectified output is developed across load resistance **R5** and passed via resistance **R6,** AF coupling condenser **C9** and manual volume control **R11** to control grid of triode section, which operates as AF amplifier. IF filtering in diode circuit by **C7, R6** and **C8,** and in control grid circuit by condenser **C10.**

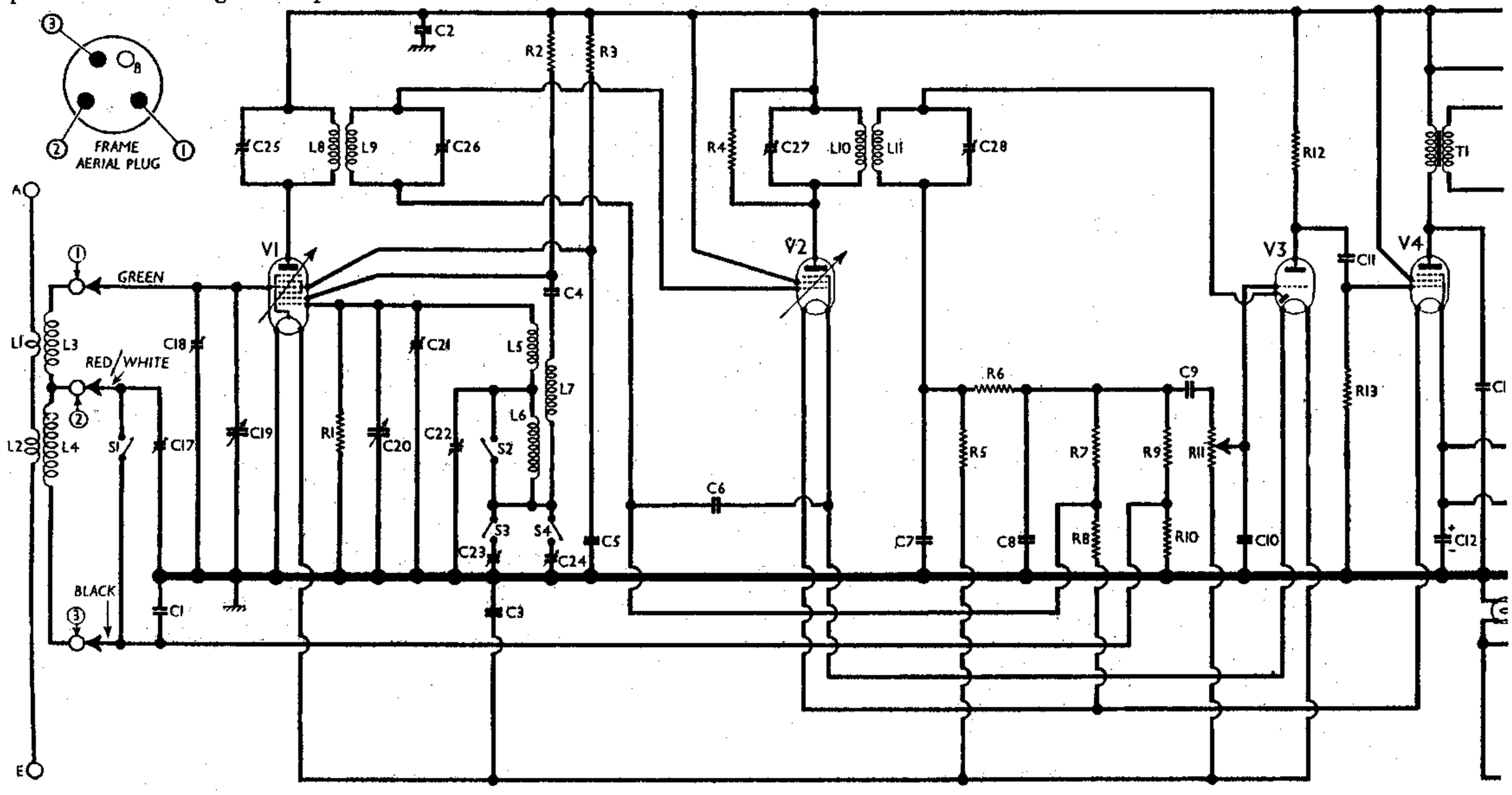
DC potential developed by the flow of diode current across **R5** appears also across **R7, R8** and **R9, R10,** both pairs of which are connected as potential dividers across **R5.** The potential at the junction of **R9** and **R10** is tapped off and fed back via **C1** to the frequency changer as GB, while that at the junction of **R7, R8** goes via **C6** as GB to the IF amplifier, giving automatic volume control.

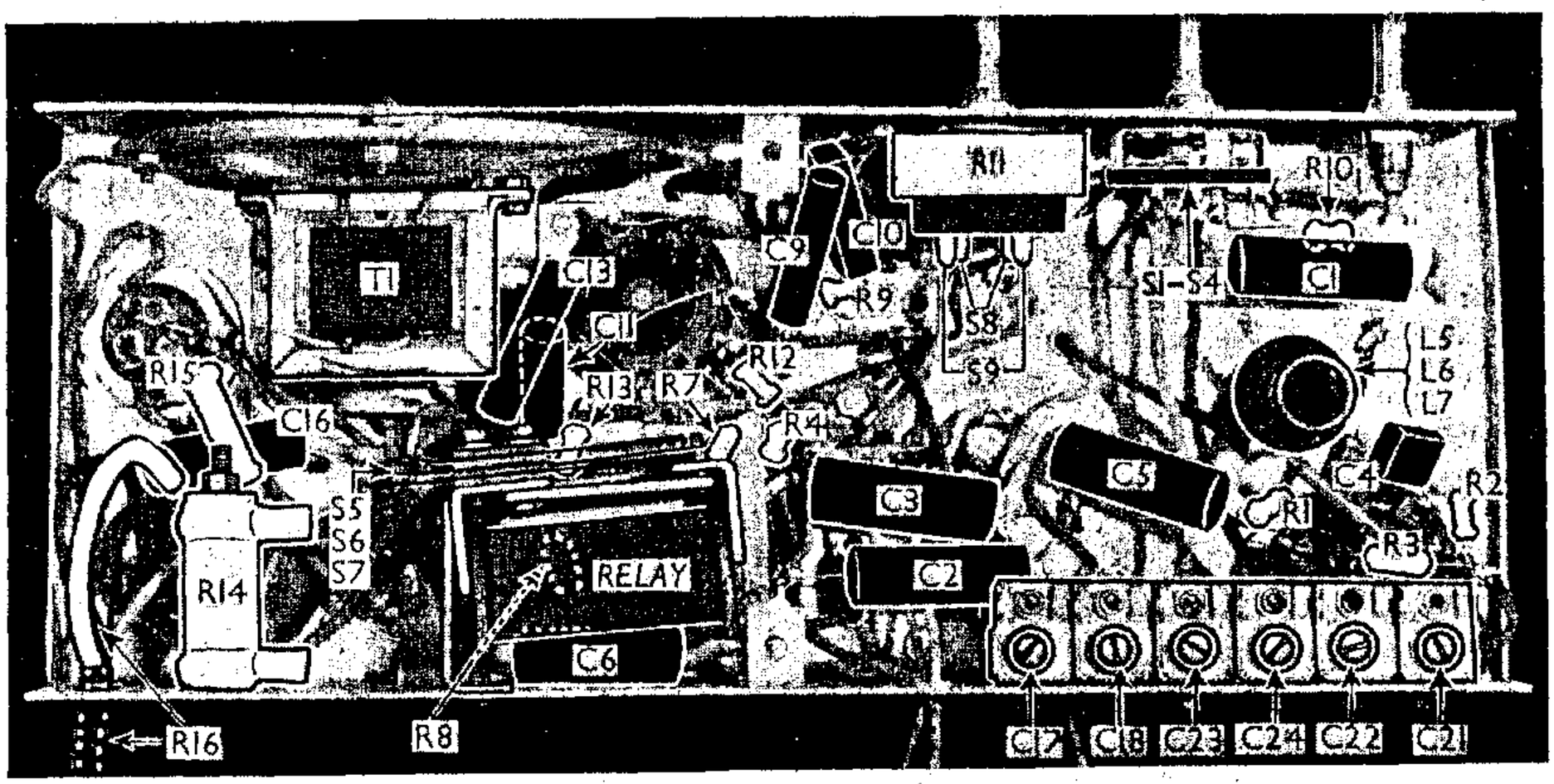
Resistance-capacity coupling by **R12, C11** and **R13** between **V3** triode and pentode output valve **(V4,. Mullard DL1).** Fixed tone correction by **C13.**

POWER SUPPLIES

This receiver is designed to operate from AC or DC mains, or its own self-contained batteries. The foregoing description relates only to the receiving circuits, and is the same irrespective of whether the power source is battery or mains. Following is a description of the power supply circuits, since their operation may not be immediately apparent from a study of the circuit diagram.

The change-over from battery to mains and *vice versa* is accomplished by means of a magnetic relay, with which are asso-





Under-chassis view. The relay, with its associated switches **S5-S7**, is seen near the rear member. **R8, C6, R13** and **R7** are beneath the relay, and in the actual chassis they would be obscured by a sheet of insulating material. Diagrams of the **S1-S4** and relay switch units appear in cols. 5 and 6 overleaf.

ciated the change-over switches **S5, S6** and **S7.** These three switches are each labelled (Relay) in the circuit diagram to distinguish them from the manually operated switches. In the "relaxed" or unenergised condition of the relay, **S5** and **S7** are closed, and **S6** is open.

At the commencement of operations, whether it is intended to operate the receiver from batteries or mains, **S8** and **S9** close as the combined volume and switch control is turned from its minimum position, and the receiver begins to operate from its batteries.

HT Circuit.—The HT battery circuit is very simple. HT negative is connected directly to chassis, and HT positive goes via **S5** to the HT positive line.

Unless the mains are connected, the receiver will continue to receive its HT supply from the battery; if the mains are connected, however, when **S9** closes, the heater of the indirectly heated rectifying valve **(V5, Brimar 1D5)** is connected in series with the line cord resistance **R16** across the mains input.

V5 anode is tapped off at a suitable point along **R16,** and as the heater warms up and the valve becomes conductive, current begins to flow from the cathode through the relay magnet winding, ballast resistance **R14,** through the series heater circuits to chassis, and via the indicator lamp back to the chassis side of the mains. When this current reaches the operating value of the relay, the armature is attracted and the relay switches change over to the mains operation positions: **S5** and **S7** open, disconnecting the batteries, while **S6** closes, connecting the rectifier output to the HT positive line. Smoothing is effected by resistance **R15** and dry electrolytic condensers **C14, C15.** The indicator lamp is illuminated only by the passage of **V1-V4** filament and HT currents, and its purpose is to indicate that the receiver is operating from the mains.

If the mains are subsequently switched off or they fail, or if the mains plug is withdrawn from its socket, **V5** heater cools, and as the emission falls, the relay relaxes, and the receiver automatically reverts to battery operation.

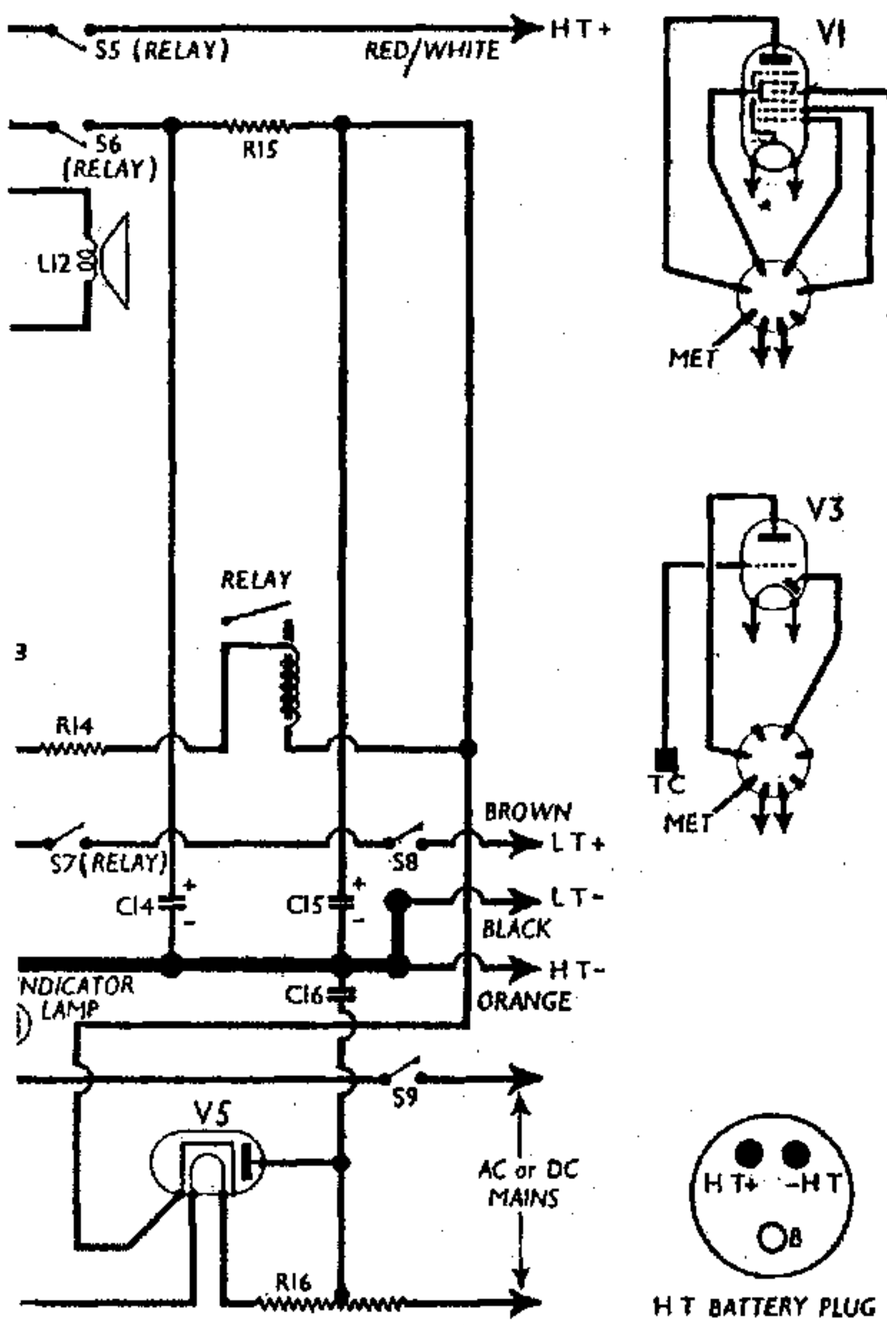
LT Circuit.—Since the heaters of **V1-V4** are connected permanently in series, little change occurs here between battery and mains operation. For battery operation, the negative lead of the 6 V dry LT battery is connected directly to chassis, and the positive lead is connected via **S8** and the relay switch **S7** to the positive end of the heater series. When operating from the mains, current from **V5** operates the relay and energises the valve filaments. It is a direct current, and is separately smoothed by the relay, **R14** and the dry electrolytic condenser **C12,** which remains in circuit on battery or mains operation.

What is rather intricate in the LT circuit is the sequence of the filaments in the series, and the method of obtaining grid bias potentials, which are derived entirely from the LT circuit. It is very important when rewiring any part of it to adhere strictly to the original circuit.

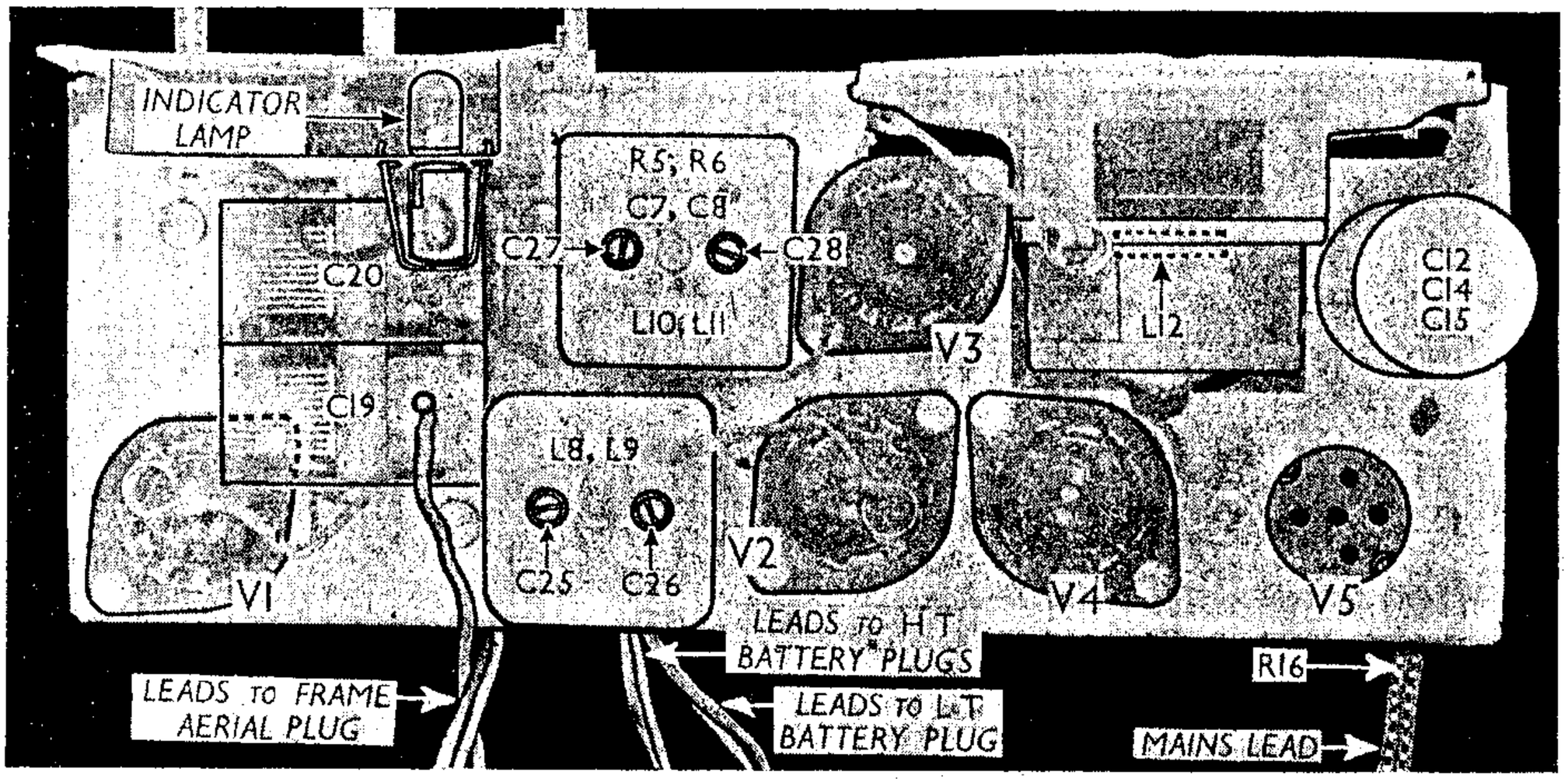
V1 is the most negative filament in the chain; **V3** is next, followed by **V2; V4** is at the most positive end. In case the potential gradient on the filament should affect the operation, the "sense" or direction in which the filament pins of each valve holder in our chassis were wired is explained in "General Notes."

In the case of **V4,** the CG resistance **R13** is returned directly to chassis; but as the filament is at a positive potential of 4.5-6 V with respect to chassis, this potential is applied as negative GB.

V3 triode obtains a small bias voltage from the potential gradient along its filament. The control grid is returned via **R11** to the negative end of the filament,



Circuit diagram of the Fergusonic 907 AC/DC/Battery portable superhet receiver. The change-over from battery to mains is effected automatically by the relay (seen on the right), which controls switches **S5 - S7.** The filaments of **V1-V4** are connected in series for battery or mains operation, and bias potentials are obtained from various points along the 6 V drop across the series. A diagram of the frame aerial plug appears in the top left-hand corner, while that of one of the two HT battery plugs is shown in the bottom right-hand corner. Both plugs are viewed from the free ends of their pins.



Plan view of the chassis. **R5, R6** and **C7, C8** are located in the second IF transformer unit; **C7, C8** actually form part of the **C28** assembly, as described under "Pre-set Condensers" in col. 5. **R16** is the line cord resistance, located in the mains lead. The indicator lamp is illuminated only when the receiver operates from the mains.

so that the average potential difference between the control grid and filament is 0.7 V. The diode load resistance **R5** is returned to the same point, but the diode anode is probably located about that end of the filament, which is by-passed to chassis by **C3.**

V2 receives its fixed GB potential from the junction of **R7, R8,** from which point it also receives its AVC potential. **R5, R6, R7** and **R8** form a potential divider between the positive end of **V1** filament and the negative end of **V4** filament; and since the value of **R5** and **R6** is small compared with that of **R7** and **R8,** the fixed GB to **V2** will be in the neighbourhood of 1 V negative with respect to its filament, which is about 4 V positive with respect to chassis.

V1 hexode control grid is returned to the junction of **R9** and **R10;** these have a much higher value than **R5, R6,** and with them form a potential divider across **V1** filament, applying a slightly positive potential to the control grid when no diode current is flowing.

COMPONENTS AND VALUES

	CONDENSERS	Values (μF)
C1	V1 hexode CG decoupling	0·1
C2	HT circuit RF by-pass ...	0·1
C3	V1, V3 filaments RF by-pass	0·1
C4	V1 osc. anode coupling ...	0·00025
C5	V1 SG decoupling ...	0·1
C6	V2 CG decoupling ...	0·02
C7	IF by-pass condensers ...	0·0001
C8		0·0001
C9	AF coupling to V3 triode	0·001
C10	IF by-pass	0·0001
C11	V3 triode to V4 AF coupling	0·001
C12*	Heater circuit by-pass ...	40·0
C13	Fixed tone corrector ...	0·001
C14*	HT smoothing condensers	16·0
C15*		32·0
C16	Mains RF by-pass ...	0·01
C17‡	Frame aerial LW trimmer	0·000016
C18‡	Frame aerial MW trimmer	0·000046
C19†	Frame aerial tuning ...	—
C20†	Oscillator circuit tuning...	—
C21‡	Osc. circuit MW trimmer	0·00014
C22‡	Osc. circuit LW trimmer...	0·000046
C23‡	Osc. circuit MW tracker...	0·00029
C24‡	Osc. circuit LW tracker ...	0·000132
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.

	RESISTANCES	Values (ohms)
R1	V1 osc. CG resistance ...	250,000
R2	V1 osc. anode HT feed ...	25,000
R3	V1 SG HT feed	50,000
R4	2nd IF trans. pri. shunt...	500,000
R5	V3 diode load resistance ...	500,000
R6	IF stopper	250,000
R7	V2 AVC feed potential divider resistances	4,000,000
R8		4,000,000
R9	V1 AVC feed potential divider resistances	4,000,000
R10		4,000,000
R11	Manual volume control ...	2,000,000
R12	V3 triode anode load ...	1,000,000
R13	V4 CG resistance... ...	1,000,000
R14	V1-V4 heater circuit ballast	2,200
R15	HT smoothing resistance	5,000
R16	Line cord; V5 heater circuit ballast	870†

† Tapped at 580 ohms from V5 heater end.

	OTHER COMPONENTS	Approx. Values (ohms)
L1	External aerial coupling windings	0·1
L2		0·7
L3	Frame aerial windings ...	1·0
L4		16·0
L5	Osc. circuit MW tuning coil	2·0
L6	Osc. circuit LW tuning coil	5·0
L7	Oscillator reaction coil ...	0·8
L8	1st IF trans. Pri. ...	17·0
L9	Sec. ...	17·0
L10	2nd IF trans. Pri. ...	17·0
L11	Sec. ...	17·0
L12	Speaker speech coil ...	2·5
T1	Speaker input trans. Pri.	500·0
	Sec.	0·3
Relay	Magnet winding	1,000·0
S1-S4	Waveband switches ...	—
S5-S7	Mains/battery change-over switches (Relay operated)	—
S8	Battery on/off switch ganged R11	—
S9	Mains on/off switch	—

DISMANTLING THE SET

Removing Chassis.—Remove the three control knobs (pull-off) from the front of the case;

remove the back cover, which is held in position at the top by two hinged clips;

withdraw from the frame aerial connecting socket inside the back cover the plug connecting it to the chassis;

disconnect and remove the batteries;

remove the two round-head set screws (with metal washers and lock washers) holding the chassis to the bottom of the case.

The complete chassis assembly, with the speaker, can now be withdrawn as a single unit.

VALVE ANALYSIS

Valve voltages and currents given in the tables below are those measured in our receiver when it was operating with (a) a new HT battery reading 90 V on load (see battery table); and (b) AC mains of 232 V (see mains table). The receiver was tuned to the lowest wavelength on the MW band, and the volume control was at maximum, but there was no signal input, as the frame aerial plug was withdrawn and short-circuited.

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

Battery Table

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 DK1	90 Oscillator	0.3	81	0.3
	65	0·5		
V2 DF1	90	1·2	90	0·3
V3 DAC1	15	0·03	—	—
V4 DL1	88	2.1	90	0.5

Mains Table

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 DK1	105 Oscillator	0.75	93	0.4
	77	0.7		
V2 DF1	105	1.9	105	0.5
V3 DAC1	17	0·04	—	—
V4 DL1	103	3·7	105	0·7
V5 1D5	145*	—	—	—
	154†			

* Cathode to chassis, DC. † Anode to chassis, AC

GENERAL NOTES

Switches.—S1-S4 are the waveband switches, in a single rotary unit beneath the chassis. The unit is indicated in our under-chassis view, and shown in detail in the diagram in col. 5, where it is drawn as seen when viewed from the rear of the underside of the chassis. In the MW (clockwise) position of the control, **S1, S2** and **S3** are closed, while **S4** is

open. In the LW (anti-clockwise) position **S4** is closed, and **S1**, **S2** and **S3** are open.

S5, S6 and **S7** are operated by the mains/battery change-over relay. They are mounted on the frame of the relay, whose position is indicated in our under-chassis view. The connections to these switches are shown in the diagram in cols. 5 and 6; the tags are drawn as seen when the unit is viewed from a point a little below, and slightly to the left, of the point from which it is seen in our under-chassis view.

The operation of the switches is fully explained at the end of the "Circuit Description," under "Power Supplies."

S8, S9 are HT and LT master switches, ganged with the manual volume control **R11.**

Coils.—**L1, L2** and **L3, L4** are the frame aerial windings, wound in slots on two frames mounted inside the back cover of the carrying case, and they do not appear in our chassis illustrations.

The connections between **L3, L4** and the receiver chassis are acccomplished via a small four-pin plug and socket, and a diagram of the plug, viewing the free ends of the pins, is inset in the top left-hand corner of the circuit diagram.

The oscillator coils **L5-L7** are in a single unscreened tubular unit mounted vertically beneath the chassis.

The IF transformers **L8, L9** and **L10, L11** are in two screened units mounted vertically on the chassis deck. **R4,** which shunts **L10,** is fitted beneath the chassis, but several small components, **R5, R6** and **C7, C8** are mounted inside the **L10, L11** unit. **C7** and **C8** form part of the trimmer **C28** assembly, as described under "Pre-set Condensers."

Indicator Lamp.—This is a lamp rated at 6.2 V, 0.2 A. It has a tubular bulb, and is fitted with a small bayonet cap. The lamp is illuminated only when the receiver is operating on mains, by **V1-V4** filament and HT currents, and serves as an indication of the source of power.

Ballast Resistance R14.—This resistance is of the vitreous enamelled type, and is bolted to the rear member beneath the chassis. It forms **V1-V4** filaments ballast when operating from the mains, and serves also as a smoothing resistance. Its value is 2,200 O, and in operation it dissipates 5.5 watts, so that a replacement should be rated at 6 watts.

Line Cord Resistance.—**R16** is the ballast resistance for **V5** heater, and is connected in series with it directly across the mains. Its total resistance is 870 O, but a lead is tapped off at a point 580 O from the receiver end of it to feed **V5** anode.

Condensers C12, C14, C15.—These are three dry electrolytics in a single metal container mounted vertically on the chassis deck, and the can forms the common negative connection. The three connecting tags project through the chassis deck in the under-chassis compartment. The green spotted tag is the positive connection of **C12,** the yellow spotted tag that of **C14,** and the red spotted tag the positive of **C15. C12** is rated at 40 μF, 35 V working, 45 V surge; **C14** (16 μF) and **C15** (32 μF) are both rated at 150 V working, 250 V surge.

Pre-set Condensers.—All the RF and oscillator trimmers and trackers are mounted in a single row on the rear member beneath the chassis, where they are indicated in our under-chassis view.

The IF transformer trimmers **C25-C28** are fitted in pairs in their respective units, and their adjustments are reached through holes in the tops of the cans.

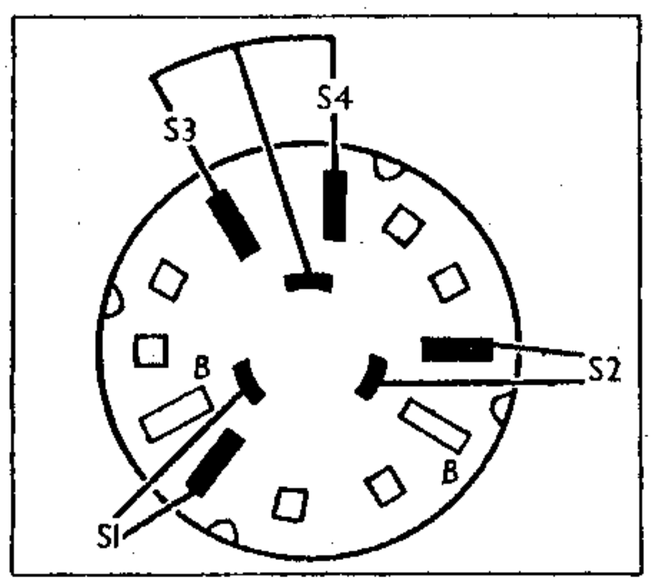


Diagram of the waveband switch unit as seen from the rear of the underside of the chassis.

C25-C27 are of quite normal type, but **C28** is a multiple assembly comprising **C7** and **C8** as well as the trimmer. **C28** forms the upper portion of the assembly, upon which the adjusting screw bears; **C7** consists of an earthed plate and the bottom plate of **C28** (which is connected to **R5, R6**), while **C8** is formed by fitting a final plate beneath the earthed plate of **C7.**

Valve Filaments.—The valves used in this receiver are taken from the Mullard range, and, excepting **V4,** follow normal dry battery valve practice. **V4,** however, is a Mullard DL1, and instead of the usual rating of 2.8 V, 0.05 A for the filament, it is rated at 1.4 V, 0.05 A. A 2.8 V valve could be used to replace it if an extra cell were wired in series with the LT battery, but the grid bias would then be raised, which may not suit the replacement valve. This could be adjusted, however, by returning the CG resistance **R13** to a suitable point on the filament circuit chain.

It is important that the filaments should be wired throughout in the same order as shown in the circuit diagram, but they should also have the same polarity as they had originally. Therefore, the order in which the actual filament pins of the valve holders were wired is given, as follows:

From **R14,** at the positive end, a lead is connected to pin 2 of **V4** holder; from pin 3 of **V4** holder, the next lead goes to pin 3 of **V2** holder; next, from pin 2 of **V2** holder to pin 3 of **V3** holder; from pin 2 of **V3** holder a lead goes to pin 2 of **V1** holder; and pin 3 of **V1** holder is taken to chassis.

Batteries.—The HT battery consists of two 45 V units, each fitted with a special 3-pin socket. There are only two HT battery leads, and each terminates in a 3-pin plug, a diagram of which, viewed from the free ends of the pins, appears on the right of the circuit diagram overleaf. In each plug the top left-hand pin is positive, and the right-hand one negative. The bottom pin is blank. The two HT plugs are joined by a lead, which connects the two batteries in series. A suitable replacement battery is the Ever Ready All-dry No. 2.

The LT battery is a 6 V unit fitted with a 2-pin socket to fit the plug attached to the receiver. This plug is fitted with two pins, the thicker of which is the positive. A suitable replacement battery is the Ever Ready All-dry No. 15.

CIRCUIT ALIGNMENT

IF Stages.—Connect the signal generator leads via a 0.1 μF condenser to control grid (top cap) of **V1** and chassis, and short-circuit the **C20** section of the gang. Feed in a 470 KC/S (638.3 m) signal, and adjust **C28, C27, C26** and **C25** in that order for maximum output. Repeat these adjustments, and remove short-circuit from **C20.**

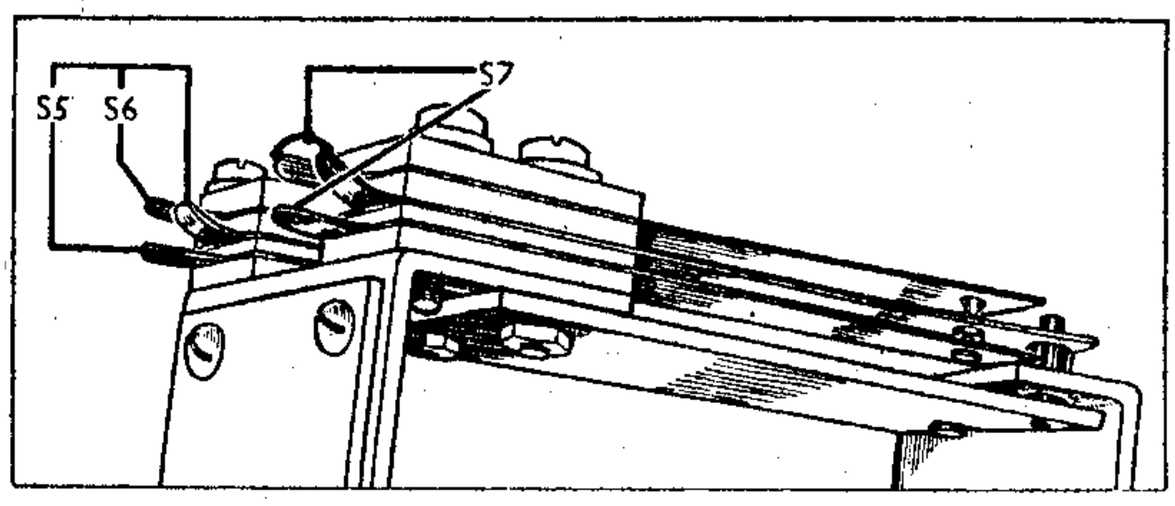
RF and Oscillator Stages.—With the gang at maximum, the pointer should be horizontal. For the rest of the alignment, the chassis should be in the cabinet, the back cover should be in position, and the batteries should be in their compartment connected ready for use. By inverting the receiver, the trimmers and trackers can now be reached through a slot in the floor of the carrying case.

Connect the signal generator to a length of wire, and couple this to the receiver by winding it once or twice round the carrying case.

MW.—Switch set to MW, tune to 214 m on scale, feed in a 214 m (1,400 KC/S) signal, and adjust **C21,** then **C18,** for maximum output. Feed in a 500 m (600 KC/S) signal, tune it in, and adjust **C23** for maximum output, while rocking the gang for optimum results. Repeat the 214 m adjustments.

LW.—Switch set to LW, tune to 1,250 m. on scale, feed in a 1,250 m (240 KC/S) signal, and adjust **C22,** then **C17,** for maximum output. Feed in a 2,000 m (150 KC/S) signal, tune it in, and adjust **C24** for maximum output, while rocking the gang for optimum results. Repeat the 1,250 m adjustments.

Diagram showing the positions of the connecting tags of the switches **S5-S7** associated with the relay.



Printed in Great Britain by The Cornwall Press Ltd., Paris Garden, London, S.E.1

★