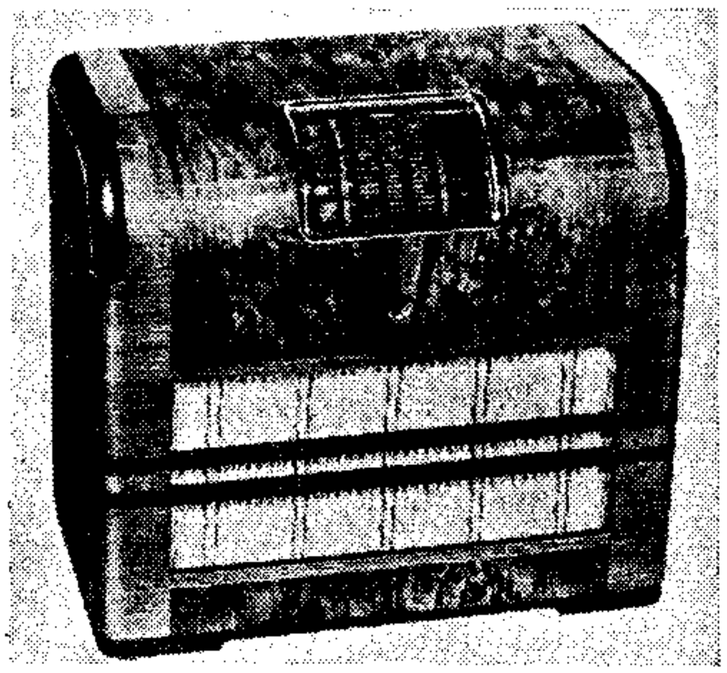
FERGUSON 904, 904U



THE Ferguson 904 is an AC 3-band 5-valve (plus rectifier and tuning indicator) table superhet, while the 904U is the corresponding AC/DC model.

The main chassis in each case is almost identical, except for the heater and scale lamp wiring. A separate power and output chassis is used, and this differs in the two series.

The speaker in the AC models is an energised type, while in the AC/DC models it is a permanent magnet type.

In this *Service Sheet* both series are included, with separate diagrams and chassis illustrations for the AC/DC versions. Both models are therefore covered, and their divergencies fully explained.

Release date : *Both models, Aug.*, 1939.

CIRCUIT DESCRIPTION

Except for the series heater wiring and the addition of **R25** and **C52,** the 904U (AC/DC) receiver chassis is similar to the AC model, and the circuit description covers both types. The descriptions of the power and output units, which differ considerably, follow that of the receiver chassis.

Receiver Chassis.—Aerial input on SW is via **C1, C2** and **C4** to single tuned circuit **L3, C34.** On LW, the signal is picked up from **L1**, which is permanently shunted across the aerial circuit by the coupling **L2, C3**, and is thus fed into the low potential end of the single tuned circuit **L5, C34.** On MW, when **S1** and **S3** close, the coupling is mixed; the signal is fed via **C1, C2** and **S3** to one end of **L5,** which now operates as a coupling coil, while **L2, C3** are connected via **S1** to the other end, and the signal is thus passed on to the MW circuit **L4, C34.**

First valve **(V1, Mullard EF8)** is a variable-mu hexode operating as signal frequency amplifier, with a choke-transformer coupling unit **L6, L7, C9** in its anode circuit.

Coupling is then via **C8, C10** (SW) and **L7, C9** and **S11** (LW) to the RF tuning circuits **L8, C38** (SW) and **L10, C38** (LW), while on MW **S12** closes and connects **C8** across **L6.** On MW, **S10** and **S13** close and the signal is passed via **L10** to the MW RF circuit **L9, C38.**

Second valve **(V2, Mullard ECH3)** is a triode heptode operating as frequency changer with internal coupling. Triode oscillator anode coils **L12** (SW), **L13** (MW) and **L14** (LW) are tuned by **C45.** Parallel trimming by **C42** (SW), **C43** (MW) and **C44** (LW); series tracking by **C18, C39** (SW), **C40** (MW) and **C41** (LW). Reaction coupling is effected on all bands by the common impedance of the trackers in grid and anode circuits, augmented on SW by the addition of the reaction coil **L11.**

Third valve **(V3, Mullard EF9)** is a variable-mu RF pentode operating as intermediate frequency amplifier with triple-tuned transformer couplings **C46, L15, L16, C47, L17, C48** and **C49, L18, L19, C50, L20, C51.**

Intermediate frequency 470 KC/S.

Diode second detector is part of double diode triode valve **(V4, Mullard EBC3)** in which the two diode anodes are strapped together to operate as a single diode. Audio frequency component in rectified output is developed across load resistance **R18** and passed via **R17, AF** coupling condenser **C26, S33** and manual volume control **R19** to CG of triode section, which operates as AF amplifier. Tone compensation by **C25.** IF filtering in diode circuit by **C24** and **R17;** in triode CG circuit by **C27;** and in triode anode circuit by **C29.**

Provision for connection of gramophone pick-up across **R19** via switch **S34,** which closes when the control is turned to the "gram" position while **S33** opens to mute radio. Variable tone control by **R21, C30** in triode anode circuit.

DC potential developed across **R18** is

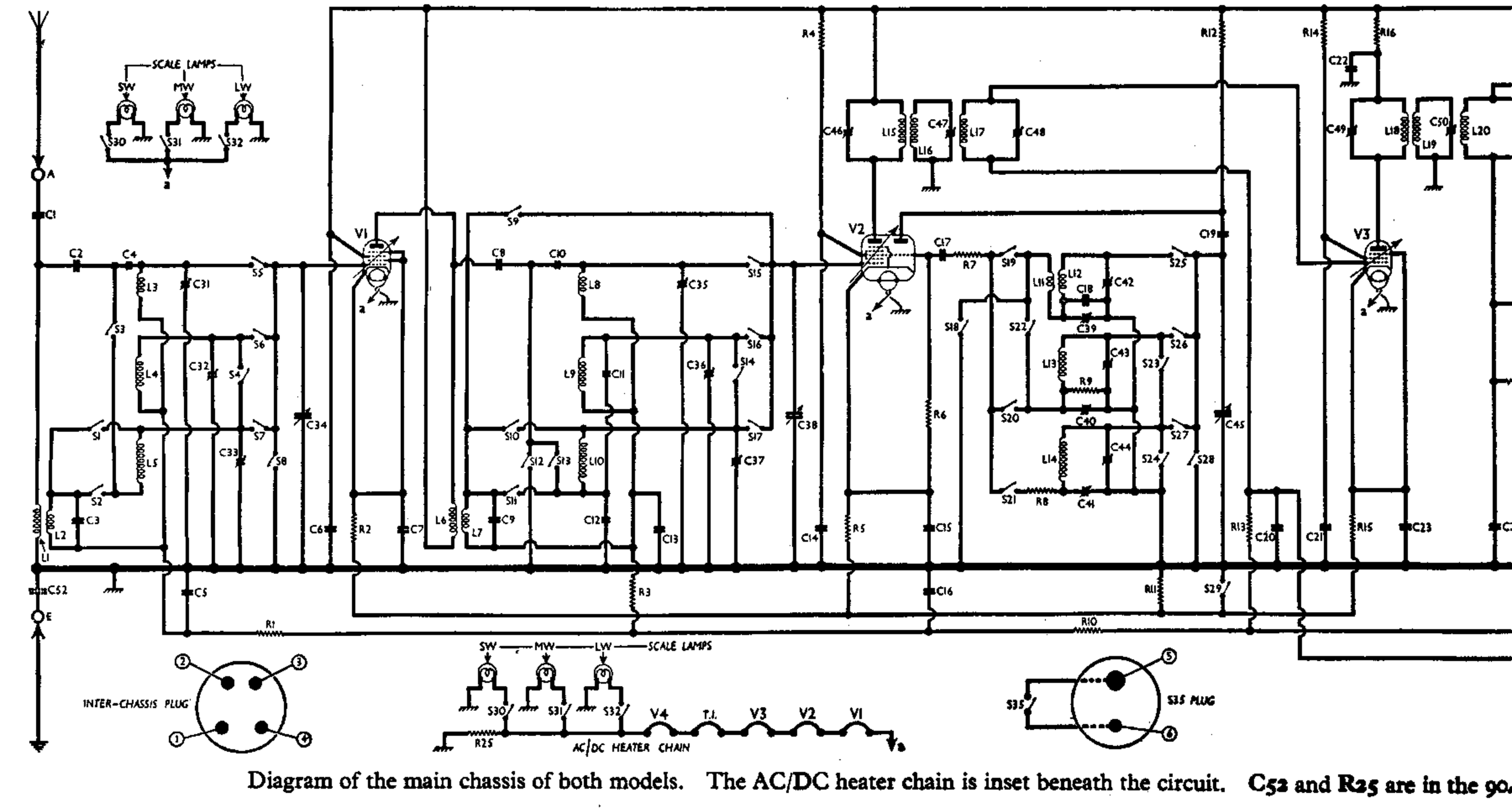
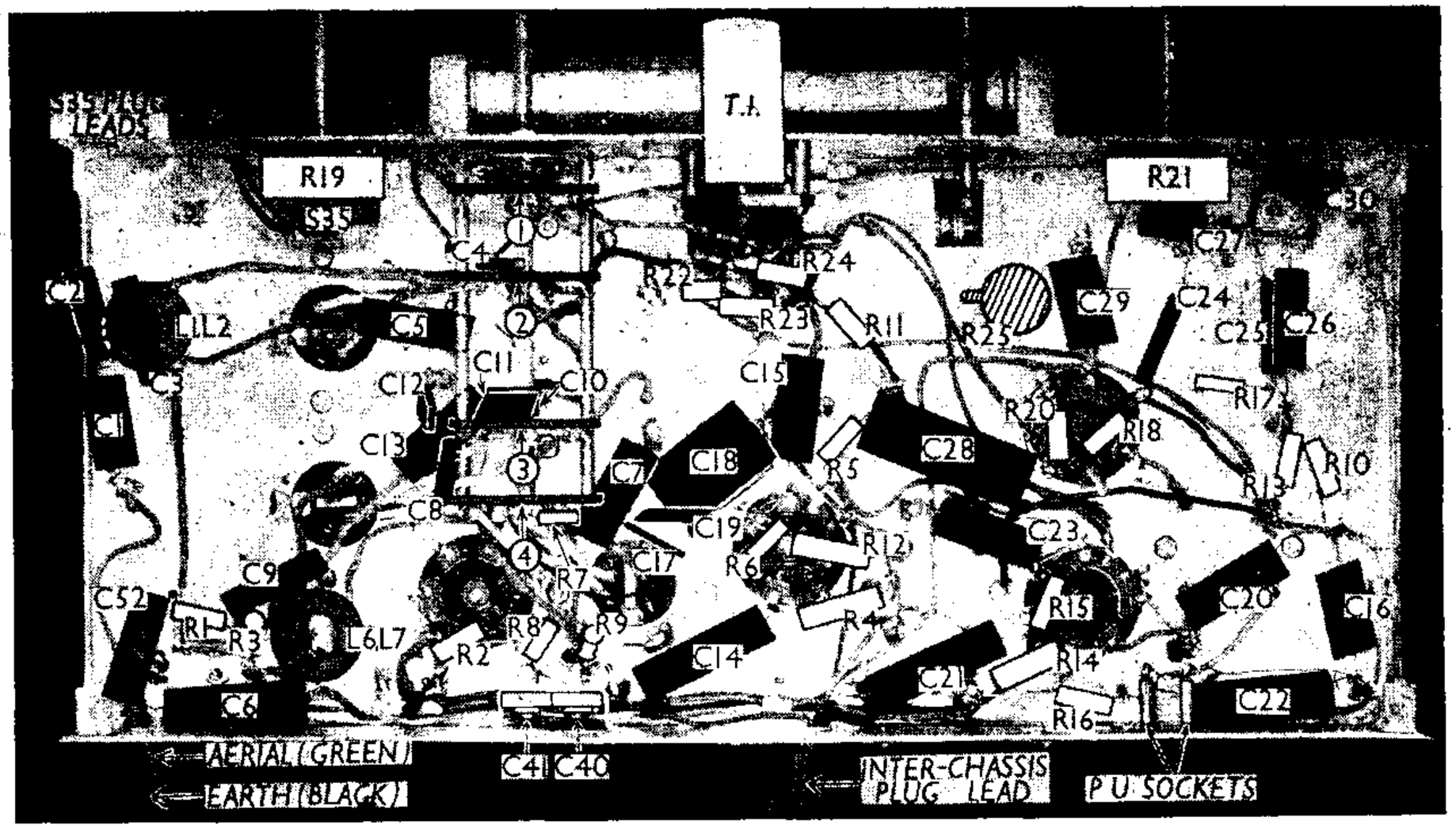


Diagram of the main chassis of both models. The AC/DC heater chain is inset beneath the circuit. **C52** and **R25** are in the 90.



Underneath view of the main chassis of both models.

fed back via **R17** and decoupling circuits as GB to RF, FC and IF valves, giving automatic volume control. Fixed GB voltages for these valves is obtained automatically in the usual manner by passing their cathode currents to chassis via the resistances **R2, R5** and **R15** respectively, but on MW and LW the voltages are increased by returning the resistances to chassis via a further resistance **R11.** On SW **R11** is short-circuited by **S29.**

AVC potential as applied to **V3** is tapped off and used as control voltage for the cathode ray tuning indicator **(T.I., Mullard EM4),** which is of the double-action type.

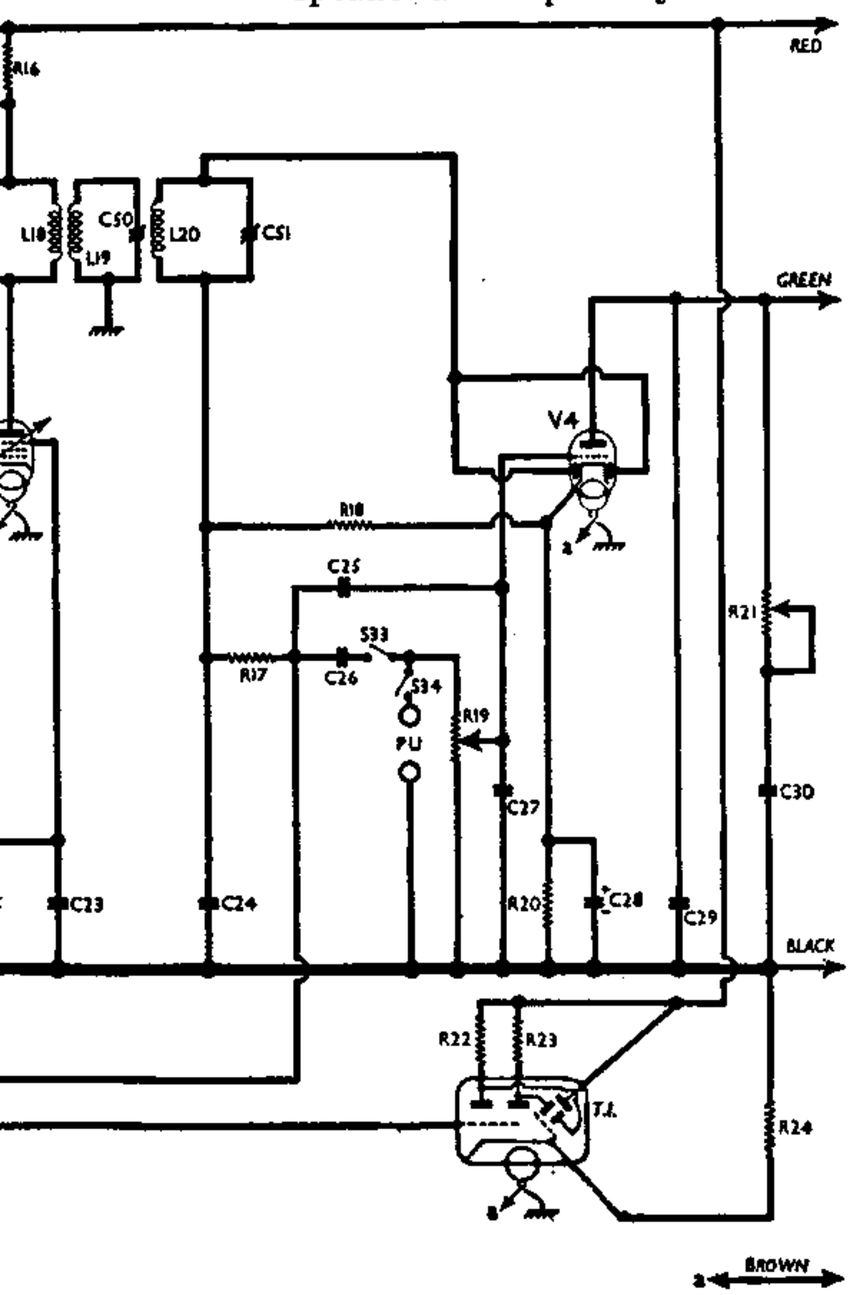
Power and Output Unit (AC).— Resistance-capacity coupling by **R101, C101** and **R102** between **V4** triode and tetrode output valve **(V101, Mullard EL3).** Fixed tone correction by **C102, R105** in anode circuit. Provision for connection of high impedance external speaker across primary of internal speaker input transformer **T101.**

HT current is supplied by full-wave rectifying valve **(V102, Mullard 5Y3G).** Smoothing by speaker field **L103** and electrolytic condensers **C104** and **C105.**

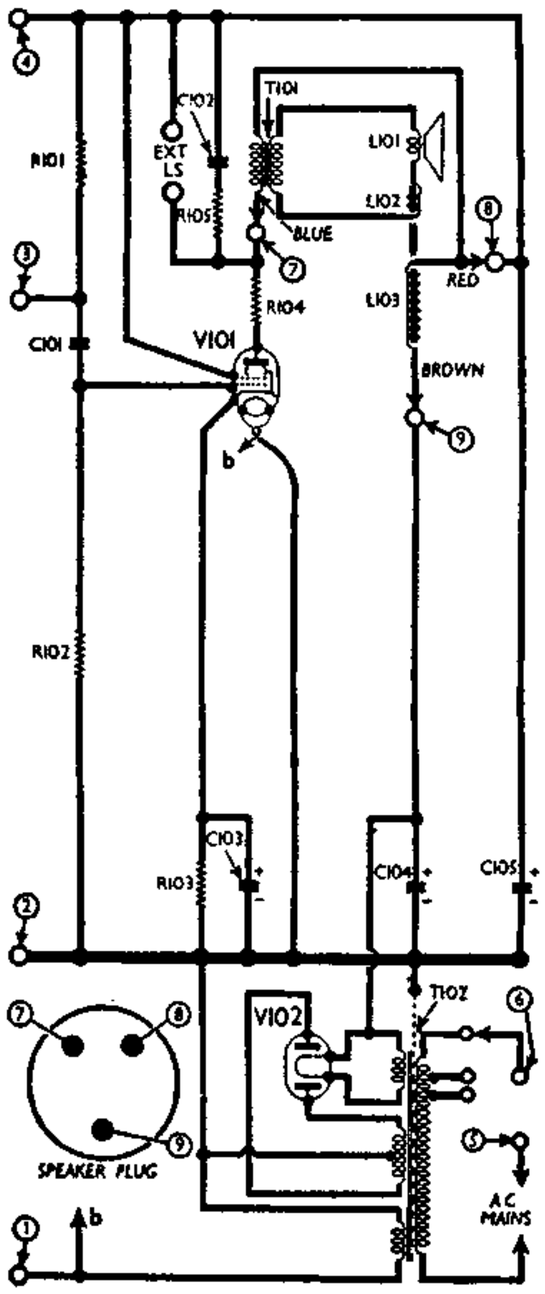
Power and Output Unit (AC/DC).— Resistance-capacity coupling by **R201, C201** and potential divider **R202, R203** between **V4** triode and pentode output valve **(V201, Mullard CL4).** Fixed tone correction by **C202, R206** in anode circuit. Provision for connection of high impedance external speaker across primary of internal speaker input transformer **T201.**

When the receiver is used with AC mains, HT current is supplied by IHC half-wave rectifying valve **(V202, Mullard CY1),** which with DC mains behaves as a low resistance. Smoothing is effected by iron-cored choke **L202** and dry electrolytic condensers **C204** and **C205.**

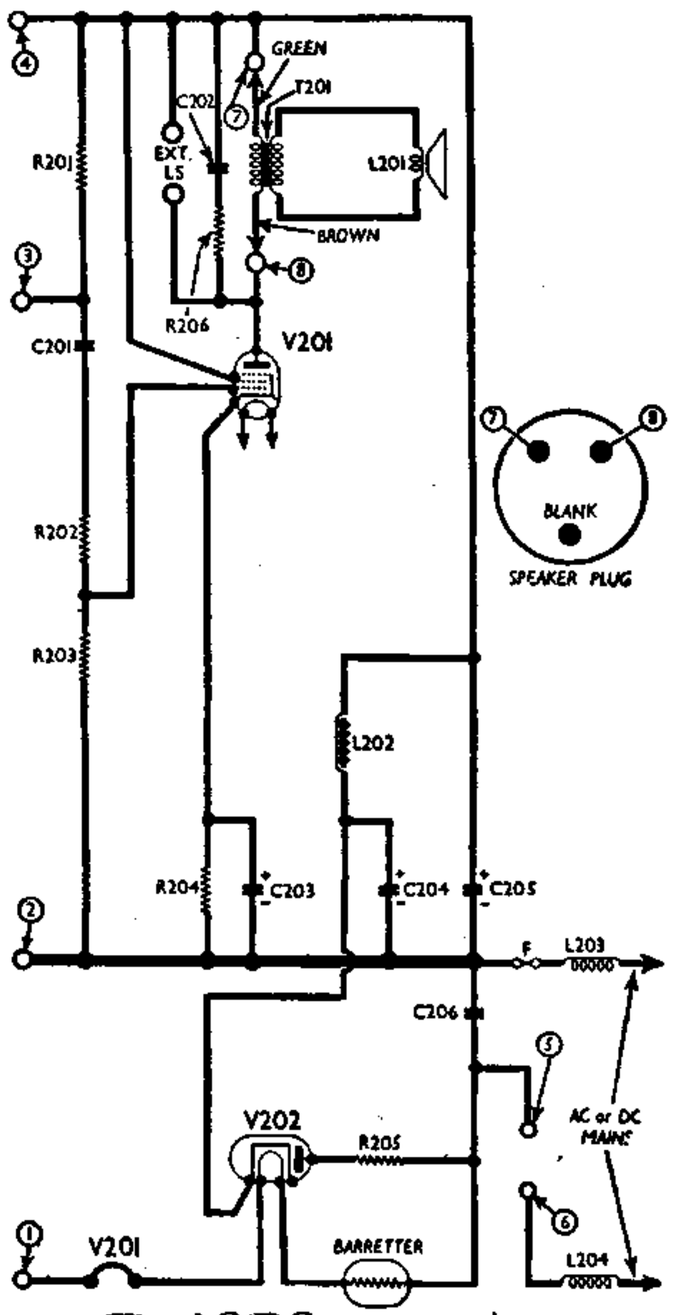
Valve heaters of both the power and output unit and the receiver chassis, together with the scale lamps and special barretter lamp, are connected in series across mains input. Filter circuit comprising air-cored chokes **L203** and **L204** and condenser **C206** suppresses mains borne interference, while fuse **F** affords protection against accidental short-circuit.



5 are in the 904U model only.



The AC output unit.



The AC/DC output unit.

DISMANTLING THE SET

The receiver consists of two units: the receiver chassis, and the power and output unit. The two units and the speaker are interconnected by plugs and sockets which are not interchangeable.

Removing Receiver Chassis. — Remove the four control knobs (pull-off).

Withdraw from the power and output unit the two plugs connecting it to the receiver chassis.

Remove the four screws (with lock-washers and claw washers) holding the chassis to the shelf in the cabinet. (If a long screwdriver is used, the screws can be reached through holes in the bottom of the cabinet.)

Loosen the four nuts on the bolts holding the shelf to the fillets on the side of the cabinet.

Remove the two slotted wooden packing pieces from beneath the shelf, lowering the shelf on to the fillets.

The chassis can now be withdrawn.

When replacing, fit a felt washer to each control spindle, between the knob and the cabinet.

Removing Power and Output Unit.—Withdraw the two plugs referred to above, and a third connecting the speaker to the unit.

Remove the two screws (with washers and lock-washers) holding the unit to the bottom of the cabinet.

When replacing, note that the square claw washer goes on to the front fixing screw, and the round one on the rear screw, where a recess is made in the cabinet to accommodate it.

Removing Speaker.—Withdraw the speaker plug from the power and output unit.

Remove the four nuts holding the speaker to the sub-baffle.

When replacing, see that the transformer is at the bottom.

VALVE ANALYSIS

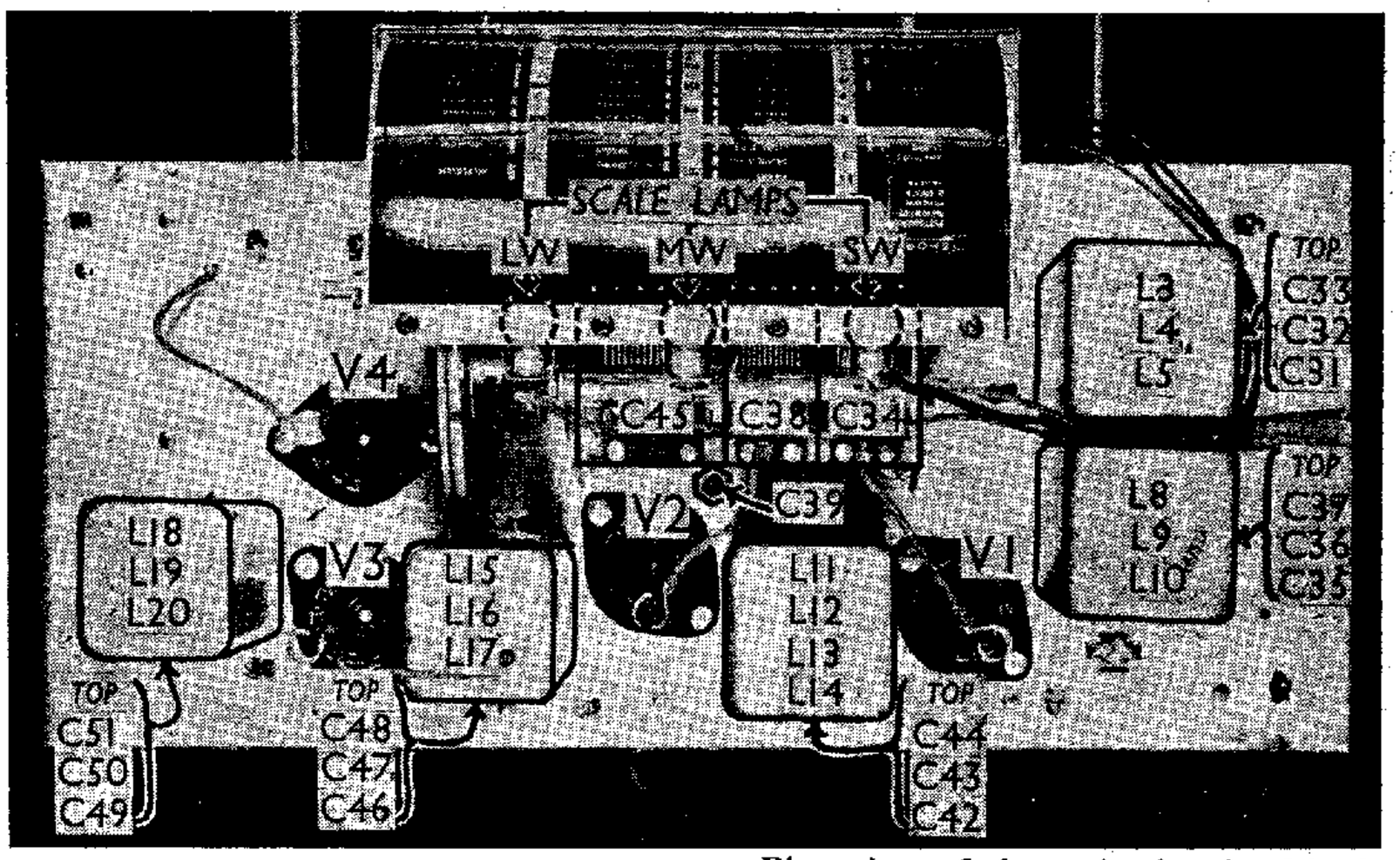
Valve voltages and currents given in the table below are those measured in our receivers when they were operating on AC mains of 235V, using the 220-230V tapping on the mains transformer in the case of the AC model. The receivers were tuned to the lowest wavelength on the MW band.

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
	AC MODEL			
V1 EF8	265	4.7	265	0.2
V2 ECH3	265 Oscillator 135	4.0 4.3	160	0.6
V3 EF9	258	3.8	133	1.3
V4 EBC3	60	0.8	—	—
V101 EL3	230	29.8	265	5.3
V102 5Y3G	293†	—	—	—
T.I. EM4	35* Target 265	0.2* 0.8	—	—
	AC/DC MODEL			
V1 EF8	250	4.7	250	0.2
V2 ECH3	250 Oscillator 130	3.5 3.8	165	0.5
V3 EF9	245	3.3	128	1.2
V4 EBC3	60	0.8	—	—
V201 CL4	220	32.5	250	5.7
V202 CY1	270§	—	—	—
T.I. EM4	35* Target 250	0.2* 0.7	—	—

† Each anode, AC. * Approx. each anode, DC.
§ Cathode to chassis, DC.

COMPONENTS AND VALUES

	RESISTANCES	Values (ohms)
R1	V1 CG decoupling ...	250,000
R2	V1 fixed GB resistance ...	400
R3	V2 heptode CG decoupling	250,000
R4	V2 SG HT feed	100,000
R5	V2 fixed GB resistance ...	500
R6	V2 osc. CG resistance ...	50,000
R7	Osc. reaction stabiliser ...	20
R8	Osc. LW reaction damping	25,000
R9	Osc. circuit MW damping	5,000
R10	AVC line decoupling ...	100,000
R11	V1, V2, V3 MW and LW GB	200
R12	V2 osc. anode HT feed ...	25,000
R13	V3 CG decoupling ...	500,000
R14	V3 SG HT feed	100,000
R15	V3 fixed GB resistance ...	500
R16	V3 anode HT feed ...	1,000
R17	IF stopper	25,000
R18	V4 diode load resistance ...	500,000
R19	Manual volume control ...	500,000
R20	V4 triode GB resistance ...	25,000
R21	Variable tone control ...	100,000
R22	T.I. anodes HT feed ...	1,000,000
R23		1,000,000
R24	T.I. GB resistance ...	1,000
R25	Scale lamps shunt (AC/DC model only.) ...	100
	AC MODEL	
R101	V4 triode anode load ...	240,000
R102	V101 CG resistance ...	500,000
R103	V101 GB resistance ...	150
R104	V101 anode stabiliser ...	100
R105	Part fixed tone corrector	10,000
	AC/DC MODEL	
R201	V4 triode anode load ...	240,000
R202	V201 CG input potential divider	100,000
R203		250,000
R204	V201 GB resistance ...	300
R205	V202 anode surge limiter	100
R206	Part fixed tone corrector	10,000



Plan view of the main chassis of both models.

	CONDENSERS	Values (μF)
C1	Aerial series condenser ...	0.00025
C2	Aerial MW coupling ...	0.00025
C3	Part LW aerial coupling	0.002
C4	Aerial SW coupling ...	0.00002
C5	V1 CG decoupling ...	0.1
C6	V1 SG decoupling ...	0.1
C7	V1 cathode by-pass ...	0.1
C8	Part RF coupling ...	0.0001
C9	Part LW RF coupling ...	0.002
C10	V1 to V2 hept. SW coupling	0.00002
C11	RF MW fixed trimmer ...	0.000005
C12	Part RF coupling ...	0.00001
C13	V2 heptode CG decoupling	0.1
C14	V2 SG decoupling ...	0.1
C15	V2 cathode by-pass ...	0.1
C16	AVC line IF by-pass ...	0.00025
C17	V2 osc. CG condenser ...	0.0001
C18	Osc. circ. SW fixed tracker	0.002
C19	V2 osc. anode coupling ...	0.0001
C20	V3 and T.I. CG's decoupling	0.1
C21	V3 SG decoupling ...	0.1
C22	V3 anode decoupling ...	0.1
C23	V3 cathode by-pass ...	0.1
C24	IF by-pass condenser ...	0.00025
C25	Tone compensator ...	0.00025
C26	AF coupling to V4 triode	0.01
C27	IF by-pass	0.0001
C28*	V4 cathode by-pass ...	25.0
C29	IF by-pass	0.00025
C30	Part of variable tone control	0.01
C31‡	Aerial circuit SW trimmer	—
C32‡	Aerial circuit MW trimmer	—
C33‡	Aerial circuit LW trimmer	—
C34†	Aerial circuit tuning ...	—
C35‡	RF coupling SW trimmer	—
C36‡	RF coupling MW trimmer	—
C37‡	RF coupling LW trimmer	—
C38†	RF coupling tuning ...	—
C39‡	Osc. circuit SW tracker	—
C40‡	Osc. circuit MW tracker	—
C41‡	Osc. circuit LW tracker	—
C42‡	Osc. circuit SW trimmer	—
C43‡	Osc. circuit MW trimmer	—
C44‡	Osc. circuit LW trimmer	—
C45†	Oscillator circuit tuning	—
C46‡ C47‡ C48‡	1st IF transformer tuning condensers ...	—
C49‡ C50‡ C51‡	2nd IF transformer tuning condensers ...	—
C52	Earth isolating condenser (AC/DC model only)	0.1
	AC MODEL	
C101	V4 triode to V101 AF coupling	0.01
C102	Part fixed tone corrector	0.01
C103*	V101 cathode by-pass ...	25.0
C104* C105*	HT smoothing condensers	8.0 16.0
	AC/DC MODEL	
C201	V4 triode to V201 AF coupling	0.01
C202	Part fixed tone corrector	0.01
C203*	V201 cathode by-pass ...	25.0
C204* C205*	HT smoothing condensers	16.0 16.0
C206	Mains RF by-pass ...	0.1

* Electrolytic. † Variable. ‡ Pre-set.

	OTHER COMPONENTS	Approx. Values (ohms)
L1	Aerial circuit choke ...	200.0
L2	Aerial LW coupling ...	15.0
L3	Aerial SW tuning coil ...	Very low
L4	Aerial MW tuning coil ...	4.0
L5	Aerial LW tuning coil ...	25.0
L6	V1 anode circuit choke ...	200.0
L7	LW RF coupling coil ...	13.0
L8	RF SW tuning coil ...	Very low
L9	RF MW tuning coil ...	4.0
L10	RF LW tuning coil ...	25.0
L11	Osc. SW reaction coil ...	0.5
L12	Osc. circuit SW tuning ...	Very low
L13	Osc. circuit MW tuning ...	4.5
L14	Osc. circuit LW tuning ...	19.0
L15 L16 L17	1st IF trans. Pri. ... Sec. ... Tert. ...	17.0 17.0 17.0
L18 L19 L20	2nd IF trans. Pri. ... Sec. ... Tert. ...	17.0 17.0 17.0
S1–S32	Waveband switches ...	—
S33, S34	Radio/gram change switches	—
S35	Mains switch, ganged R19	—
	AC MODEL	
L101	Speaker speech coil ...	2.2
L102	Hum neutralising coil ...	0.15
L103	Speaker field coil ...	1,500.0
T101	Speaker input trans. Pri. ... Sec. ...	650.0 0.3
T102	Mains trans. Pri., total ... Heater sec. ... Rect. heat. sec. HT sec., total ...	32.0 0.15 0.1 410.0
	AC/DC MODEL	
L201	Speaker speech coil ...	2.2
L202	HT smoothing choke ...	300.0
L203 L204	Mains filter chokes ...	3.5 3.5
T201	Speaker input trans. Pri. ... Sec. ...	650.0 0.3
F	Mains circuit fuse (1A) ...	—

GENERAL NOTES

Note that components in the main chassis are numbered normally; those in the AC unit are numbered from 101 upwards; and those in the AC/DC unit are numbered from 201 upwards.

Switches.—S1—S32 are the waveband switches, and **S33, S34** the radio/gram change switches, in four rotary units beneath the chassis. They are shown in detail in the diagrams in col. 5, where they are drawn as seen looking from the rear of the underside of the chassis. The table (col. 4) gives the switch positions for the four control settings, starting from fully anti-clockwise. A dash indicates open, and **C**, closed.

S35 is the QMB mains switch, ganged

with the volume control **R19.** Its leads terminate in a 2-pin plug, fitting into a socket in the power and output chassis.

Coils.—L1, L2 and **L6, L7** are in two unscreened units beneath the chassis. **L3-L5, L8-L10, L11-L14** and the IF transformers **L15-L17** and **L18-L20** are in five screened units on the chassis deck. Each unit contains three trimmers, the positions of which are indicated in the plan chassis view.

Scale Lamps.—These are three National Union type N51 bulbs, with miniature bayonet cap bases. They are switched by **S30-S32,** and the one in use is shunted by **R25** in the AC/DC model.

External Speaker.—Two sockets are provided on the deck of the power and ouptut unit for a high impedance (5,000 O) external speaker.

Smoothing Condensers.—In the case of of the AC model, **C104** and **C105** are two dry electrolytics in a single metal can mounted on the deck of the power and output unit. The can is the common negative; the red spotted tag is the positive of **C105** (16μF) and the plain tag is the positive of **C104** (8μF).

In the AC/DC model, the condensers **C204** and **C205** are in a single unit, mounted horizontally beneath the deck of the power and output unit. Both condensers are rated at 16μF in this case. The can is negative; the red tag is the positive of **C204** and the plain tag the positive of **C205.**

Chassis and Speaker Connections.—The inter-connections between the two chassis, and the speaker, are carried out by various plugs and sockets.

The main chassis is connected to the power and output unit by a 4-pin plug and socket. A diagram of the plug, viewed from the free ends of the pins, is beneath the circuit diagram. The pins are numbered 1 to 4, and the connection points indicated in the circuit.

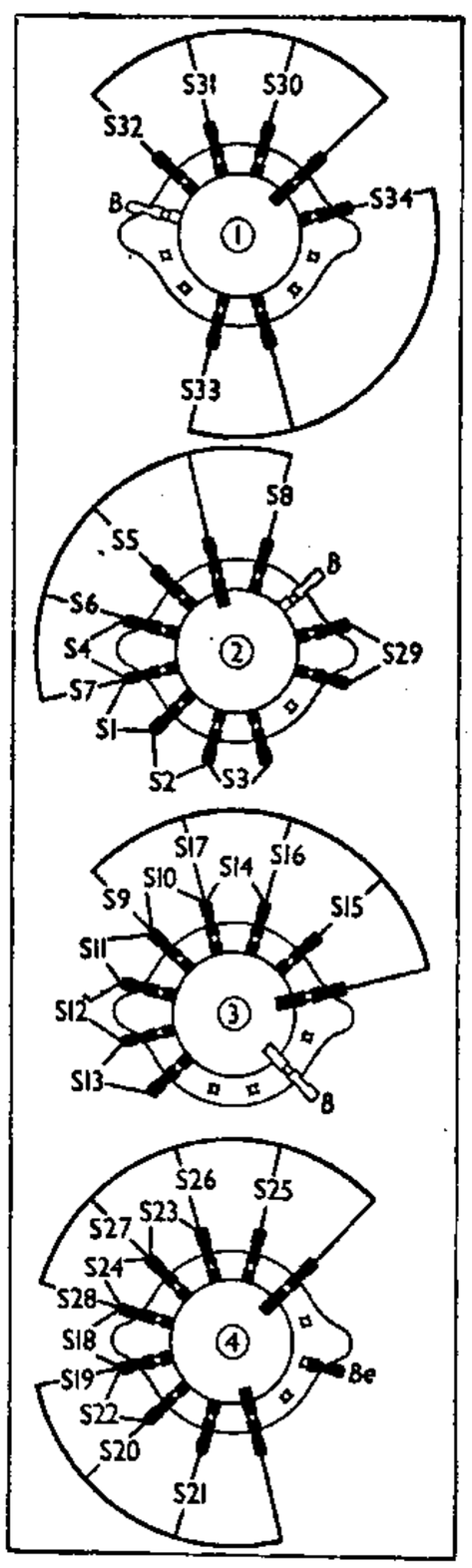
The mains switch **S35** is in the main chassis, but is connected to the other chassis by a 2-pin plug and socket. This plug is also shown beneath the main circuit diagram; the pins being numbered 5 and 6.

The speaker is connected to the power and output unit by a 3-pin plug and socket. This is shown associated with the separate circuit diagrams of the power and output units. In the AC model, all three pins are used (7-9), while in the AC/DC model only two pins are used (7 and 8), the third being blank.

Heater Wiring.—This differs in the two models. The main circuit diagram indicates the AC (parallel) wiring. Inset beneath it is a diagram of the series heater chain for the first four valves and the T.I. of the AC/DC model (the remaining two heaters being shown in the separate diagram of the AC/DC power and output unit).

Switch Table

Switch	SW	MW	LW	Gram
S1	—	C	—	—
S2	C	—	C	—
S3	—	C	—	C
S4	C	—	—	—
S5	C	—	—	—
S6	—	C	—	—
S7	—	—	C	—
S8	—	—	—	C
S9	—	—	—	C
S10	—	C	—	—
S11	C	—	C	C
S12	—	C	—	C
S13	—	C	—	—
S14	C	—	—	—
S15	C	—	—	—
S16	—	C	—	—
S17	—	—	C	—
S18	—	—	—	—
S19	C	—	—	—
S20	—	C	—	—
S21	—	—	C	—
S22	—	—	—	C
S23	C	—	—	—
S24	—	C	—	—
S25	C	—	—	—
S26	—	C	—	—
S27	—	—	C	—
S28	—	—	—	C
S29	C	—	—	—
S30	C	—	—	—
S31	—	C	—	—
S32	—	—	C	—
S33	C	C	C	—
S34	—	—	—	C



The four switch units, seen from the rear of the underside of the chassis.

Barretter.—This is used in the 904U model only. It fits into a 4-pin holder on the AC/DC power and output unit. The type fitted is numbered 150A, and is rated for a current of 0.2A. The make is not specified. In early models, in place of the barretter, a tapped ballast resistance may be fitted. At the upper end of this will be three mains voltage tappings. At the lower end will be two tappings, of which the upper one is used in the 904U.

Resistance R25.—This is the scale lamp shunt, which is only used in the AC/DC model. It is shown dotted in the underneath view of the main chassis.

Condenser C52.—The earth isolating condenser is only used in the AC/DC model. It is shown dotted in the circuit.

Chassis Divergencies.—R105 (AC) and **R206** (AC/DC) are not in the makers' diagram, neither are **C11** and a number of shorting switches. The makers show the control grid of the T.I. fed from the AVC line, and **C25** returned to chassis, instead of being connected to **V4** CG, as in our models. **C103** (AC) was missing in our chassis. Several of the components have values somewhat different from those in our models.

CIRCUIT ALIGNMENT

IF Stages.—Switch set to MW and turn gang to maximum. Remove top cap connector of **V2** and connect a 500,000 O resistance between the connector and the top cap of the valve. Connect signal generator, via a 0.00025μF condenser, between top cap of **V2** and earth lead. Feed in a 470 KC/S signal, and adjust **C51, C50, C49, C48, C47** and **C46** in turn for maximum output Repeat these adjustments.

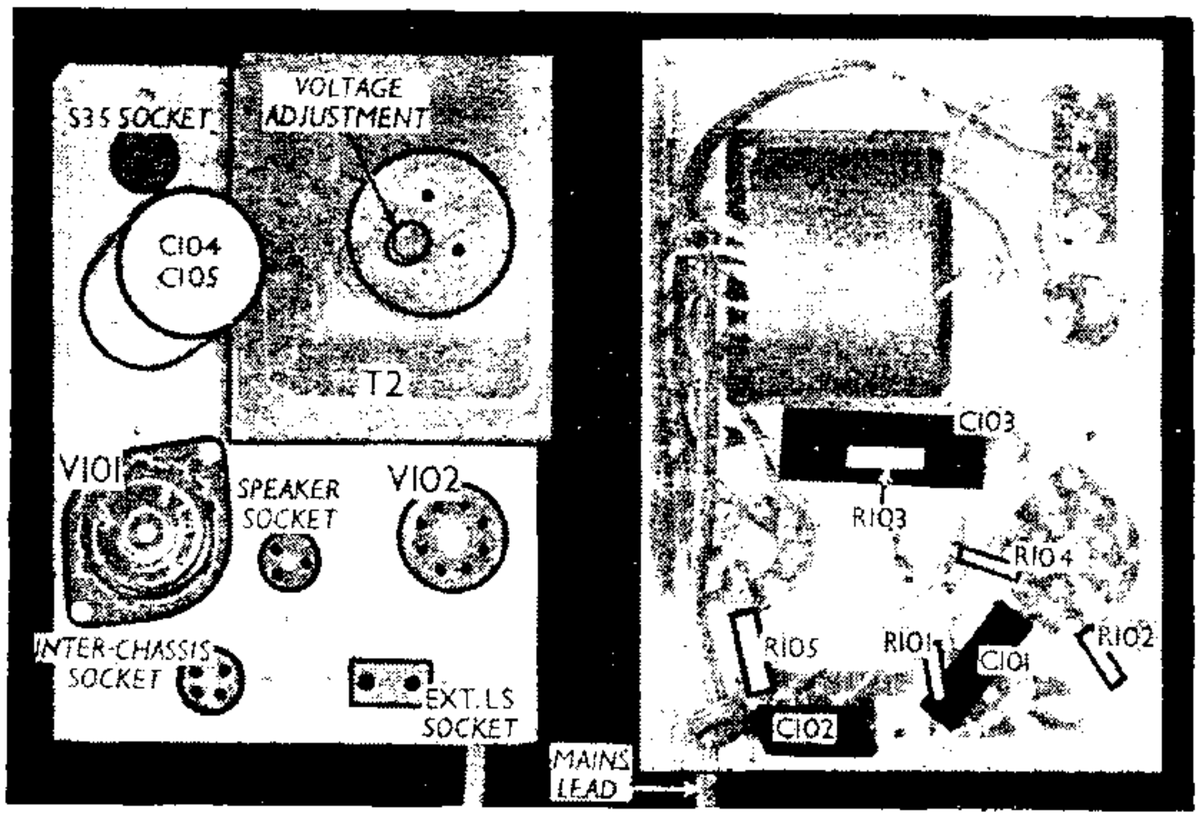
RF and Oscillator Stages.—With gang at maximum, pointer should be over the two short horizontal lines at the top left-hand edge of the scale. Connect signal generator, via a dummy aerial, to **A** and **E** leads.

SW.—Switch set to SW, tune to 16 MC/S on scale, feed in a 16 MC/S (18.75 m) signal, and adjust **C42** for maximum output, using the peak involving the lesser trimmer capacity. Then adjust **C35** and **C31** for maximum output. Feed in a 6 MC/S (50 m) signal, tune it in, and adjust **C39** for maximum output, while rocking the gang for optimum results. Repeat the 16 MC/S adjustments.

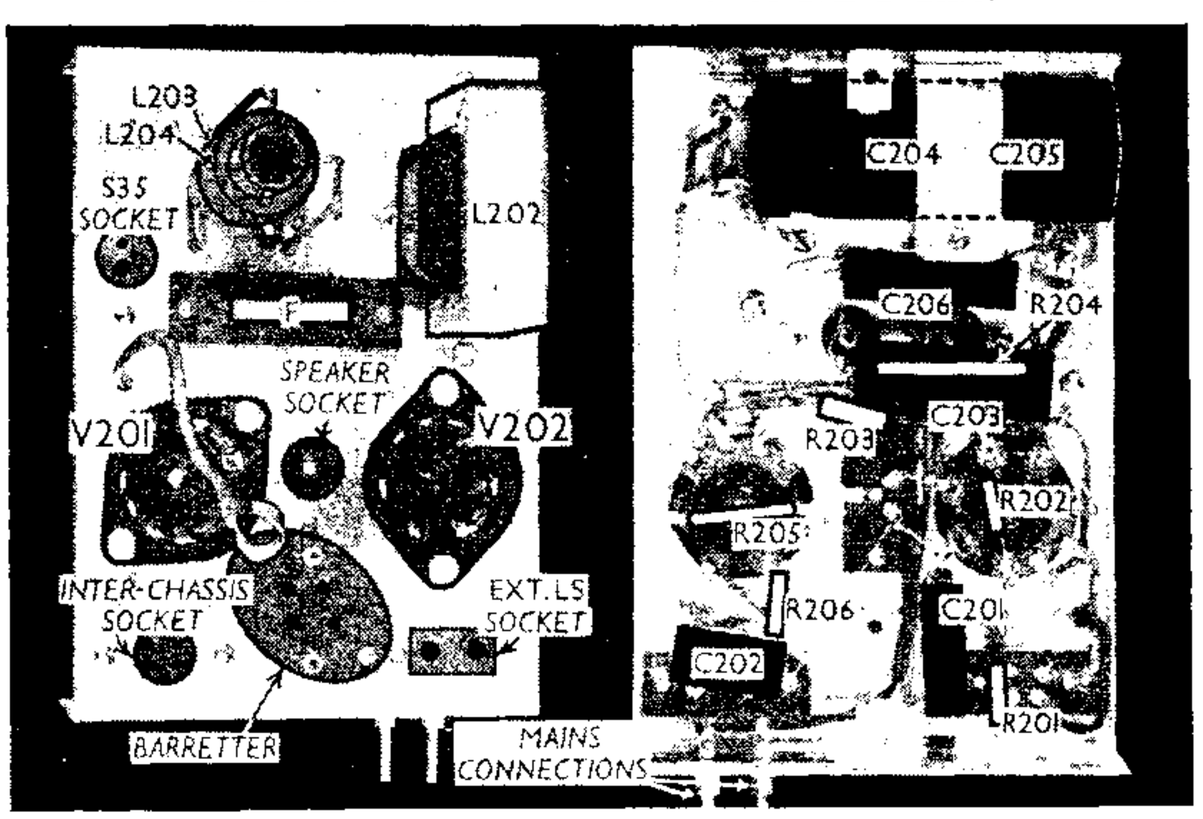
MW.—Switch set to MW, tune to 214 m on scale, feed in a 214 m (1,400 KC/S) signal, and adjust **C43,** then **C36** and **C32,** for maximum output. Feed in a 500 m (600 KC/S) signal, tune it in, and adjust **C40** for maximum output, while rocking the gang for optimum results. Repeat the 214 m adjustments.

LW.—Switch set to LW, tune to 1,250 m on scale, feed in a 1,250 m (240 KC/S) signal, and adjust **C44,** then **C37** and **C33,** for maximum output. Feed in a 2,000 m (150 KC/S) signal, tune it in, and adjust **C41** for maximum output, while rocking the gang for optimum results. Repeat the 1,250 m adjustments.

Plan and underneath views of the AC unit.



Plan and underneath views of AC/DC unit.



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