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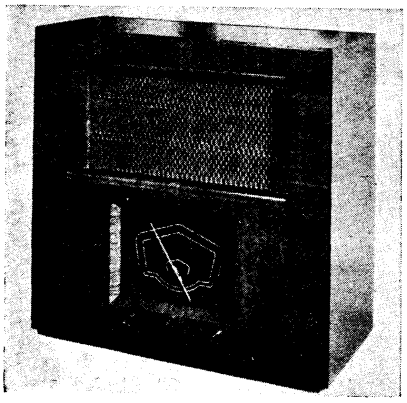
491

FERGUSON 104 (AC)

and Model 454 *(Released 1945)*



The appearance of the Ferguson 104 AC superhet receiver.

THE Ferguson model 104 is a 5-valve (plus rectifier) 3-band table superhet.

The circuit includes a signal frequency amplifying stage, and provision is made for connection of a gramophone pick-up and a high-impedance external speaker. The short waverange is 13.5 to 50 m, and the receiver is designed to operate with AC mains of 200 to 250 V, 50 to 100 C/S.

The five receiving valves, with the exception of **V4,** are of the Mullard "E" series with American octal bases, and further reference to this is made under "General Notes."

Release Date: September, 1940.

CIRCUIT DESCRIPTION

Aerial input on SW via **C1, S3, C3** to single tuned circuit **L3, C34.** On LW, the signal is picked up from **L1,** which is permanently connected across the aerial circuit, by the coupling coil **L2,** which is included in the low-potential end of the LW tuning circuit **L5, C34** via **S1.**

On MW, coupling is via **C1, S2** to **L5,** and **S4** closes so that **L5** becomes "inverted" and operates as a coupling coil to the MW tuning circuit **L4, C34.**

First valve **(V1, Mullard EF39)** is a variable-mu RF pentode operating as signal frequency amplifier, with a MW and LW RF transformer primary **L6** as a coupling choke in its anode circuit. On LW the choke is shunted by **C9.**

On SW, coupling is effected by **L6, C10** and the tuned circuit **L7, C38** between **V1** and a triode-heptode valve **(V2, Mullard ECH33)** operating as frequency changer with internal coupling.

On MW and LW, coupling is via tuned-secondary RF transformer **L6, L8, C38** (MW) and **L6, L9, C38** (LW). The small top coupling condenser **C12** is permanently connected between **V1** and **V2** heptode control grid on all bands.

V2 triode oscillator anode coils **L12** (SW), **L13** (MW) and **L14** (LW) are tuned by **C44.** Parallel trimming by **C41** (SW), **C42** (MW) and **C43** (LW); series tracking by **C16** (SW), **C39** (MW) and **C40** (LW).

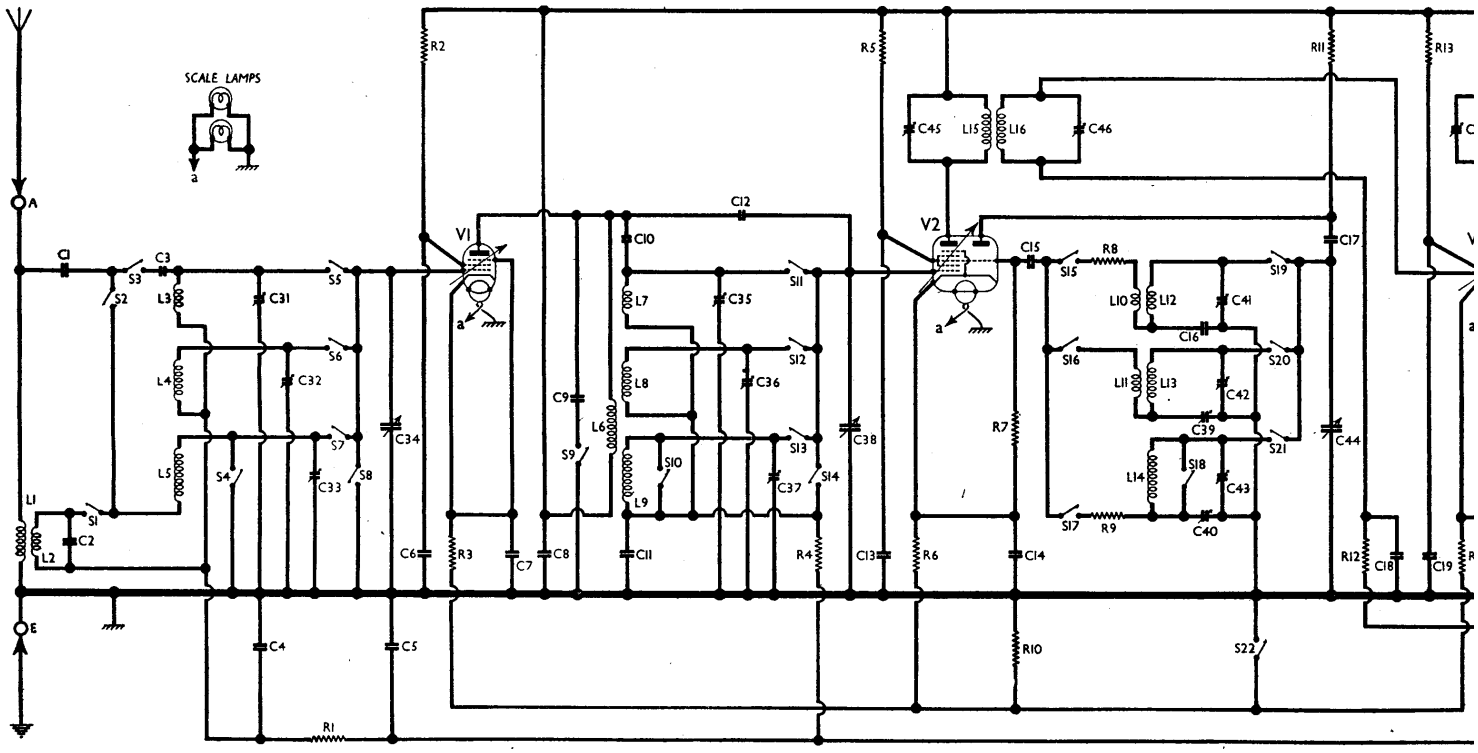
Reaction coupling is effected by common impedance of tracking condensers on all bands, augmented on SW by the reaction coil **L10** and on MW by a similar coil **L11.** The resistances **R8** (SW) and **R9** (LW) are included to ensure stability in the reaction circuit.

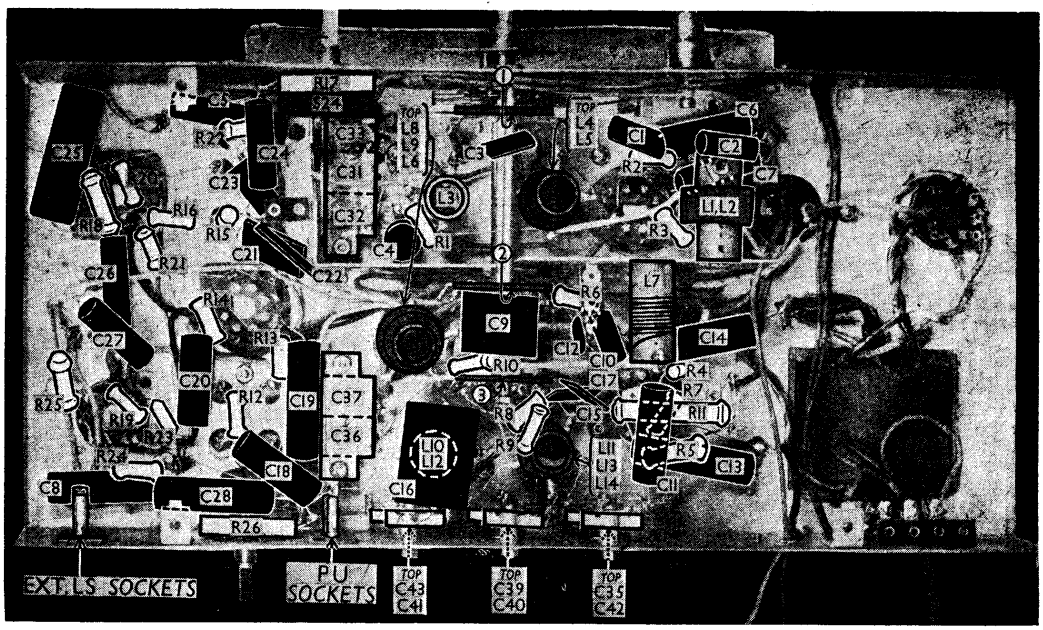
Third valve **(V3, Mullard EF39)** is a second variable-mu RF pentode, but operating this time as an intermediate frequency amplifier with tuned-primary, tuned-secondary transformer couplings **C45, L15, L16, C46** and **C47, L17, L18, C48.**

Intermediate frequency 470 KC/S.

On MW and LW, the fixed grid bias voltages for **V1, V2** and **V3** as developed across the resistances **R3, R6** and **R14** respectively are increased by the inclusion of the resistance **R10** in their common return path to chassis. On SW, however, this resistance is short-circuited by **S22.**

Diode second detector is part of double diode triode valve **(V4, Brimar 6Q7G).**





Under-chassis view. Excepting those of the IF transformers, all the coils and trimmer condensers are indicated, although some of the trimmer adjusting screws are not indicated here. These are shown in the plan view. Diagrams of the switch units are shown over leaf.

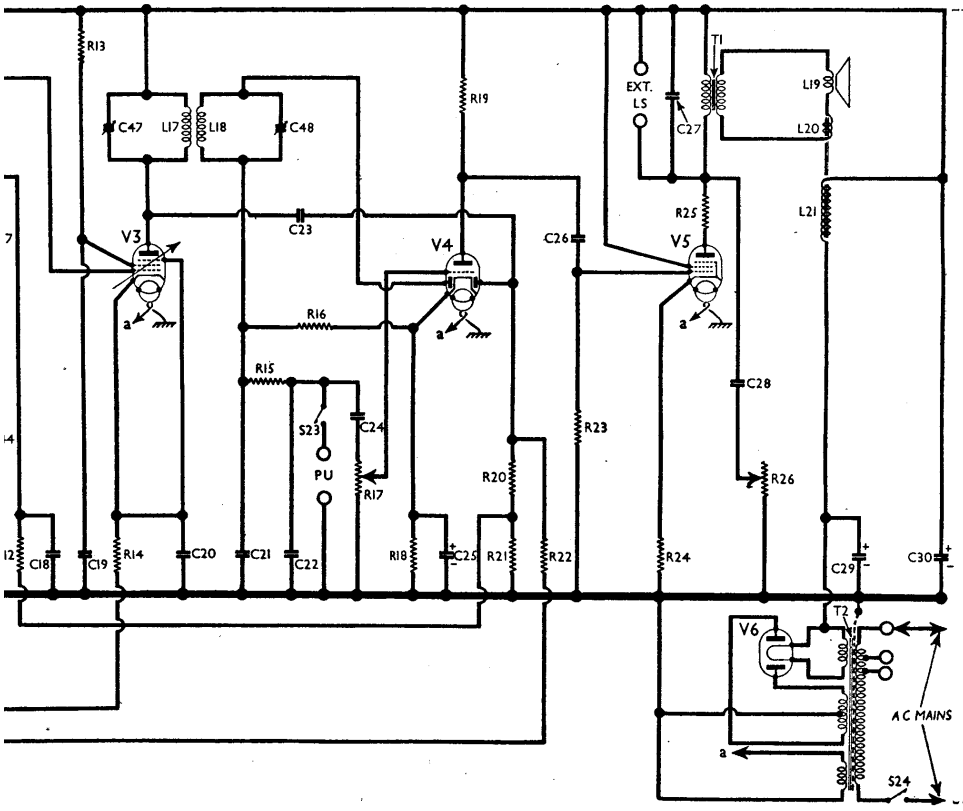
Audio frequency component in rectified output is developed across load resistance **R16** and passed via IF filter circuit **C21, R15, C22,** audio frequency coupling condenser **C24** and manual volume control **R17** to CG of triode section, which operates as AF amplifier. Provision for connection of gramophone pick-up via switch **S23** across the manual volume control and **C24.**

Second diode of **V4,** fed from **V3** anode via **C23,** provides DC potentials which are developed across load resistances **R20** and **R21** and fed back through decoupling circuits as GB to RF amplifier, frequency changer and IF amplifier valves, giving automatic volume control on all bands.

Delay voltage, together with grid bias for triode section of **V4,** is obtained from drop along resistance **R18** in cathode lead to chassis.

Resistance-capacity coupling by **R19, C26** and **R23** between **V4** triode and pentode output valve **(V5, Mullard EL33).** Fixed tone correction in anode circuit by **C27,** connected between the outer end of the anode stopper **R25** and HT positive line. Variable tone control by **C28** and **R26** also in anode circuit, but this time returned to chassis. Provision for connection of high impedance external speaker in anode circuit across **C27.**

HT current is supplied by full-wave rectifying valve **(V6, Mullard Amerty 5Y3G).** Smoothing by speaker field **L21** in conjunction with electrolytic condensers **C29** and **C30.** HT circuit RF filtering by **C8.**



Circuit diagram of the Ferguson 104 AC superhet. **V1** is an RF amplifier with tuned-secondary transformer coupling on MW and LW. On SW, tuned-grid coupling is used, the transformer primary operating as an anode choke. Note the common additional GB resistance **R10** for **V1, V2** and **V3.** On SW it is short-circuited by **S22.**

DISMANTLING THE SET

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

remove the four round-head screws (with lock-washers and square claw-washers) holding the chassis to the cabinet.

The chassis may now be withdrawn to the extent of the speaker leads, which is sufficient for normal purposes.

To free chassis entirely, unsolder from the speaker transformer the three leads connecting it to chassis.

When replacing, the speaker leads should be connected as follows, numbering the tags on the speaker transformer from top to bottom :

1 and 2, joined together, red;

3, no external connection;
4, blue;
5, white lead with pink tracer.

Removing Speaker.—Unsolder the connecting leads as described above; remove the four brass nuts holding the speaker to the sub-baffle.

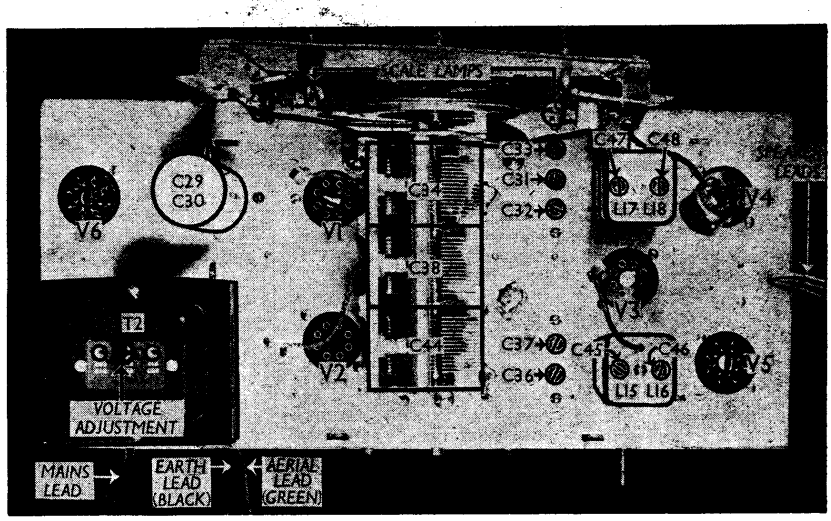
When replacing, the transformer should be on the right and the leads should be connected as indicated above.

COMPONENTS AND VALUES

	RESISTANCES	Values (ohms)
R1	V1 CG decoupling ...	250,000
R2	V1 SG HT feed	100,000
R3	V1 fixed GB resistance ...	400
R4	V2 heptode CG decoupling	250,000
R5	V2 SG HT feed	100,000
R6	V2 fixed GB resistance ...	200
R7	V2 osc. CG resistance ...	50,000
R8	Osc. SW reaction damping	25
R9	Osc. LW reaction damping	10,000
R10	V1, V2, V3 MW and LW GB resistance	200
R11	V2 osc. anode HT feed ...	25,000
R12	V3 CG decoupling ...	500,000
R13	V3 SG HT feed	100,000
R14	V3 fixed GB resistance ...	300
R15	IF stopper	100,000
R16	V4 signal diode load ...	500,000
R17	Manual volume control ...	2,000,000
R18	V4 triode GB ; AVC delay	2,500
R19	V4 triode anode load ...	250,000
R20	V4 AVC diode load resistances	500,000
R21		500,000
R22	AVC line decoupling ...	100,000
R23	V5 CG resistance ...	500,000
R24	V5 GB resistance... ...	150
R25	V5 anode stopper ...	100
R26	Variable tone control ...	100,000

	CONDENSERS	Values (μF)
C1	Aerial MW coupling ...	0·0005
C2	Part LW coupling ...	0·002
C3	Aerial SW coupling ...	0·00001
C4	V1 CG decoupling ...	0·1
C5	AVC line decoupling ...	0·02
C6	V1 SG decoupling ...	0·1
C7	V1 cathode by-pass ...	0·1
C8	HT circuit RF by-pass ...	0·1
C9	RF trans. pri. shunt ...	0·0004
C10	RF SW coupling ...	0·000005
C11	V2 heptode CG decoupling	0·1
C12	RF "Top" coupling condenser	0·000005
C13	V2 SG decoupling ...	0·1
C14	V2 cathode by-pass ...	0·1
C15	V2 osc. CG condenser ...	0·0001
C16	Osc. circuit SW tracker ...	0·005
C17	V1 osc. anode coupling ...	0·0001
C18	V3 CG decoupling ...	0·1
C19	V3 SG decoupling ...	0·1
C20	V3 cathode by-pass ...	0·1
C21	IF by-pass condensers ...	0·00025
C22		0·00025
C23	Coupling to V4 AVC diode	0·0001
C24	AF coupling to V4 triode	0·02
C25*	V4 cathode by-pass ...	25·0
C26	V4 triode to V5 AF coupling	0·02
C27	Fixed tone corrector ...	0·005
C28	Part of variable tone control	0·05
C29*	HT smoothing condensers	16·0
C30*		16·0
C31‡	Aerial circ. SW trimmer...	0·00003
C32‡	Aerial circ. MW trimmer...	0·00003
C33‡	Aerial circ. LW trimmer...	0·00011
C34†	Aerial circuit tuning ...	—
C35‡	RF coupling SW trimmer	0·00003
C36‡	RF trans. MW trimmer ...	0·00003
C37‡	RF trans. LW trimmer ...	0·00011
C38†	RF circuit tuning... ...	—
C39‡	Osc. circuit MW tracker...	0·0006
C40‡	Osc. circuit LW tracker ...	0·00025
C41‡	Osc. circuit SW trimmer...	0·00003
C42‡	Osc. circuit MW trimmer	0·00003
C43‡	Osc. circuit LW trimmer	0·0002
C44†	Oscillator circuit tuning...	—
C45‡	1st IF trans. pri. tuning ...	—
C46‡	1st IF trans. sec. tuning...	—
C47‡	2nd IF trans. pri. tuning...	—
C48‡	2nd IF trans. sec. tuning...	—

* Electrolytic. † Variable. ‡ Pre-set.



Plan view of the chassis. Most of the trimmer adjusting screws are indicated, the remaining six being shown in the under-chassis view.

	OTHER COMPONENTS	Approx. Values (ohms)
L1	Aerial circuit choke ...	330·0
L2	Aerial LW coupling ...	20·0
L3	Aerial SW tuning coil ...	Very low
L4	Aerial MW tuning coil ...	3·0
L5	Aerial LW tuning coil ...	26·0
L6	RF trans. primary ...	40·0
L7	SW RF tuning coil ...	Very low
L8	RF trans. MW sec. ...	3·0
L9	RF trans. LW sec. ...	12·0
L10	Oscillator SW reaction ...	0·1
L11	Oscillator MW reaction ...	1·0
L12	Osc. circ. SW tuning coil	Very low
L13	Osc. circ. MW tuning coil	2·0
L14	Osc. circ. LW tuning coil	5·25
L15	1st IF trans. Pri. ...	8·5
L16	1st IF trans. Sec. ...	8·5
L17	2nd IF trans. Pri. ...	8·5
L18	2nd IF trans. Sec. ...	8·5
L19	Speaker speech coil ...	1·5
L20	Hum neutralising coil ...	0·2
L21	Speaker field coil... ...	1,500·0
T1	Speaker input trans. Pri. ...	400·0
	Speaker input trans. Sec. ...	0·15
T2	Mains trans. Pri., total ...	32·0
	Mains trans. Heater sec. ...	0·1
	Mains trans. Rect. heat. sec. .	0·15
	Mains trans. HT sec., total ...	480·0
S1-S22	Waveband switches ...	—
S23	Gram pick-up switch ...	—
S24	Mains switch, ganged R17	—

VALVE ANALYSIS

Valve voltages and currents given in the table below are those measured in our receiver when it was operating on mains of 230 V, using the 220-230 V tapping on the mains transformer. The receiver was tuned to the lowest wavelength on the medium wave band, and the volume control was at maximum, but there was no signal input

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

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 EF39	293	3·7	116	1·2
V2 ECH33	293	1·6	121	1·8
	Oscillator			
	144	5·0		
V3 EF39	293	4·6	128	1·4
V4 6Q7G	93	0·7	—	—
V5 EL33	270	39·0	293	4·9
V6 5Y3G	350†	—	—	—

† Each anode. AC.

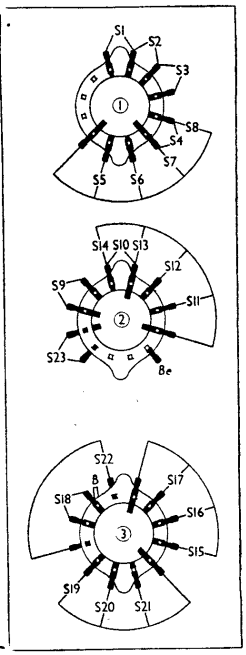
GENERAL NOTES

Switches.—S1-S22 are the waveband switches, and **S23** the pick-up switch, ganged in three rotary units beneath the chassis. They are indicated in our under-chassis view, and shown in detail in the diagrams below, where they are viewed in the direction of the arrows in the under-chassis view.

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.

S24 is the QMB mains switch, ganged with the volume control **R17.**

Diagrams of the switch units, as seen when viewed from the rear of the underside of the chassis, as indicated by the numbered arrows in the under-chassis view.



Coils.—L1, L2, L3, and **L4, L5** are in three unscreened tubular units in front of a metal screening shield, while the RF coils **L7** and **L6, L8, L9,** and the oscillator coils **L10, L12** and **L11, L13, L14** are in four unscreened tubular units behind the screen. They are shown in our under

chassis view. In the case of the **L10, L12** unit, **L12** is the thick wire winding.

The IF transformer coils **L15, L16** and **L17, L18** are mounted in cans with their associated trimmers on the chassis deck.

External Speaker.—Two sockets are provided at the rear of the chassis for a high impedance (about 5,000 O) external speaker. It should be noted that the sockets are in the HT positive circuit, and are "live."

Gramophone Pick-up.—Two further sockets on the rear of the chassis are provided for connection of a gramophone pick-up, which should have an impedance of about 2,000 O. Since a gramophone position is provided on the waveband switch, the leads from the pick-up may be left connected permanently.

Scale Lamps.—These are two Ever Ready MES types, rated at 6.2 V, 0.3 A, and are connected directly across the heater circuit.

Condensers C29, C30.—These are two dry electrolytics in a single tubular metal can on the chassis deck, the can being the common negative connection. They are both 16 μF condensers, and are rated at 450 V working.

Pre-set Condensers.—All the aerial, RF and oscillator trimmers are made up in double or triple units and are mounted beneath the chassis; their adjusting screws are reached through holes in the chassis pressing. The aerial and RF trimmers **C31, C32, C33** and **C36, C37** are mounted on the underside of the chassis deck near their associated coil units, while the remaining RF SW trimmer **C35** is mounted on the rear chassis member. All the oscillator trimmers **C41, C42, C43** and the two pre-set trackers **C39** and **C40** are mounted on the rear chassis member.

They are all indicated in our under-chassis view, but the adjusting screws of **C31, C32, C33** and **C36, C37** are shown in our plan view.

Valves.—**V1, V2, V3** and **V5** are Mullard "E" type valves fitted with American type octal bases instead of the usual side-contact base. Thus EF39 is equivalent to EF9, the figure 3 indicating that the octal base is fitted. **V4** is a Brimar 6Q7G with the normal American octal base, while **V6** is one of the Mullard "Amerty" series with American octal base.

Switch Table

Switch	SW	MW	LW	Gram
S1	—	—	C	—
S2	—	C	—	—
S3	C	—	—	—
S4	—	C	—	C
S5	C	—	—	—
S6	—	C	—	—
S7	—	—	C	—
S8	—	—	—	C
S9	—	—	C	—
S10	—	C	—	C
S11	C	—	—	—
S12	—	C	—	—
S13	—	—	C	—
S14	—	—	—	C
S15	C	—	—	—
S16	—	C	—	—
S17	—	—	C	—
S18	—	C	—	—
S19	C	—	—	—
S20	—	C	—	—
S21	—	—	C	—
S22	C	—	—	—
S23	—	—	—	C

Chassis Divergencies.—In our chassis, **C9** and **S9** are connected in series between **V1** anode and chassis, whereas in the makers' diagram they are shown connected directly across **L6.** It will make no difference to the operation of the receiver which method of connection is used, but it should be borne in mind that the full HT voltage exists across **C9** on LW when the method shown in our diagram is used.

Also in the makers' diagram **S22** is shown as a three-position switch, possibly with a fourth open-circuit position on gram., connected in series between the common junction of **R3, R6, R14,** and **R10** on MW and LW, or to chassis on SW, whereas in our chassis **R10** is connected between the common junction of the three resistances mentioned and chassis, with **S22** across **R10.**

Again, in either case the operation will be the same, except that possibly on gram. the arrangement shown in the makers' diagram might open **V1, V2** and **V3** cathode circuits.

CIRCUIT ALIGNMENT

IF Stages.—Switch set the SW, and turn gang and volume control to maximum. Remove the top cap connector of **V2** and connect a 500,000 O resistance between the connector and the top cap of the valve. Connect the signal generator, via a 0.0002 μF condenser, between the grid (top cap) of **V2** and the earth lead.

Feed in a 470 KC/S signal and adjust **C48, C47, C46** and **C45** in turn for maximum output. Repeat these adjustments.

RF and Oscillator Stages.—With the gang at maximum, pointer should be horizontal. Connect signal generator, via a suitable dummy aerial, to aerial and earth leads.

SW.—Switch set to SW, tune to 15 m. on scale, feed in a 15 m (20 MC/S) signal, and adjust **C41,** using the peak involving the lesser capacity, then adjust **C35** and **C31** in that order for maximum output. There is no adjustable tracking on this band, but performance should be checked at 50 m (6 MC/S).

MW.—Switch set to MW, tune to 214 m on scale, feed in a 214 m (1,400 KC/S) signal, and adjust **C42,** then **C36** and **C32** for maximum output. Feed in a 500 m (600 KC/S) signal, tune it in, and adjust **C39** 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 **C43,** then **C37** and **C33** for maximum output. Feed in a 2,000 m (150 KC/S) signal, tune it in, and adjust **C40** for maximum output while rocking the gang for optimum results. Repeat the 1,250 m adjustments.

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