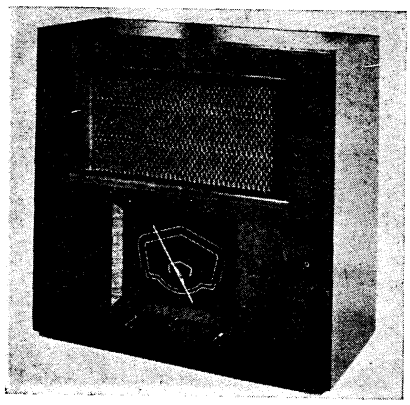
Supplement to The Wireless & Electrical Trader, January 4, 1941

"TRADER" SERVICE SHEET

500

FERGUSON 104U

AC/DC SUPERHET



Three-quarter front view of the Ferguson 104 U AC/DC superhet.

THE Ferguson model 104U is a 5-valve (plus rectifier) 3-band AC/DC 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 mains of 200 to 250 V, 50 to 100 C/S in the case of AC.

The aerial, earth and pick-up sockets are isolated by condensers from the chassis, but the external speaker sockets are connected directly to the HT circuit, and are therefore "live" to the mains. The heater circuit current is automatically regulated by a barretter-type resistance, so that no voltage adjustment tappings are provided for different mains voltages.

Release date: September, 1940.

CIRCUIT DESCRIPTION

Aerial input on SW via **C3, S3, C5** to single tuned circuit **L3, C38.** 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, C38** via **S1.**

On MW, coupling is via **C3, S2** to **L5,** and **S4** closes so that **L5** becomes "inverted" and operates as a coupling coil to the MW tuning circuit **L4, C38.**

On all bands the **A** and **E** sockets are isolated by the condensers **C1** and **C2.**

First valve **(V1, Mullard EF39)** is a variable-mu RF pentode operating as signal frequency amplifier, with the MW and LW RF transformer primary **L6** as a coupling choke in its anode circuit. On LW the choke is shunted by **C10.**

On SW, coupling is effected by **L6, C11** and the tuned circuit **L7, C42** between **V1** and a triode-heptode valve **(V2, Mullard CCH35)** which operates as frequency changer with internal coupling.

On MW and LW, coupling is via tuned-secondary RF transformer **L6, L8, C42** (MW) **and L6, L9, C42** (LW). The small top coupling condenser **C13** 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 **C48.** Parallel trimming by **C45** (SW), **C46** (MW) and **C47** (LW); series tracking by **C17** (SW), **C43** (MW) and **C44** (LW).

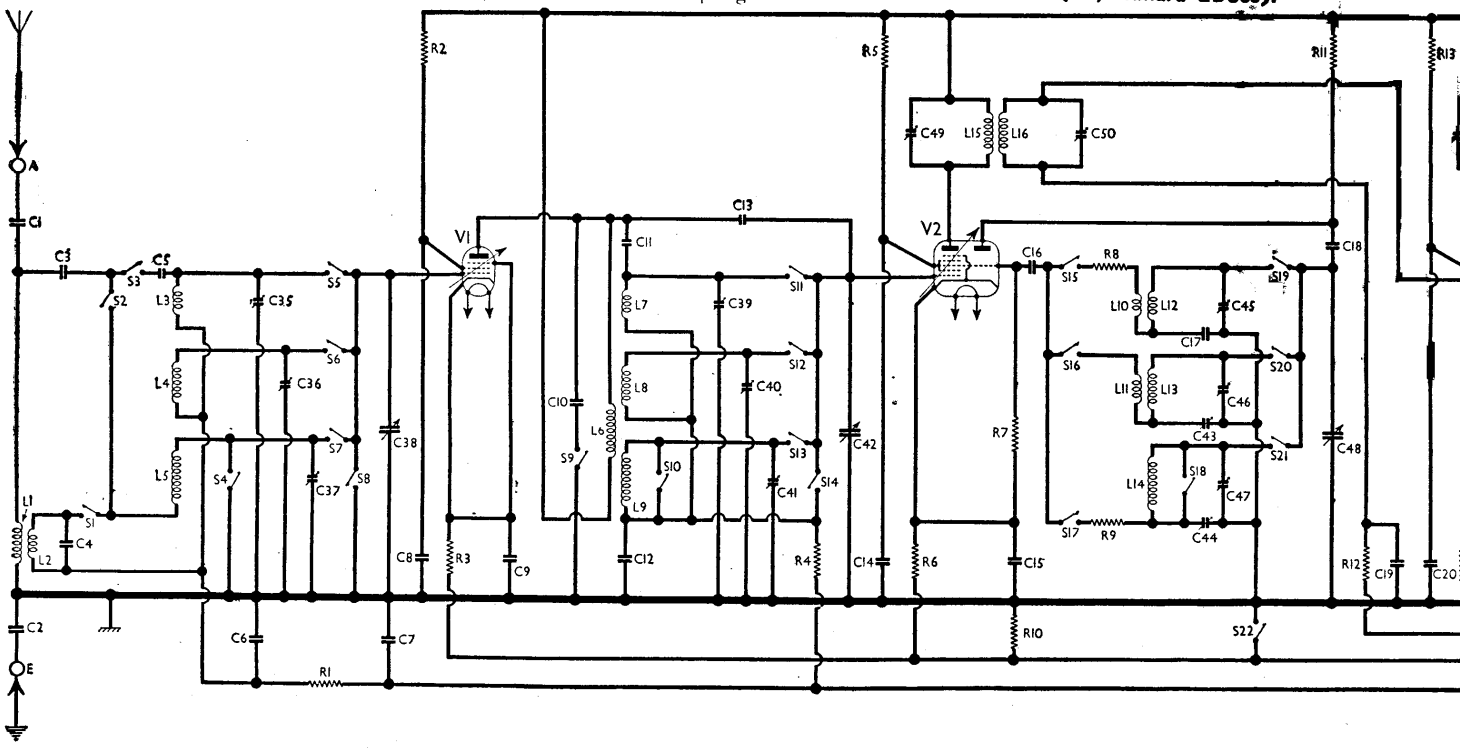
Reaction coupling is effected by common impedance of tracking condensers on all bands, augmented on SW by the reaction coil **L10** and on MW by a similar coil **L11.** The resistances **R8** (SW) and **R9** (LW) are included to ensure stability in the reaction circuit.

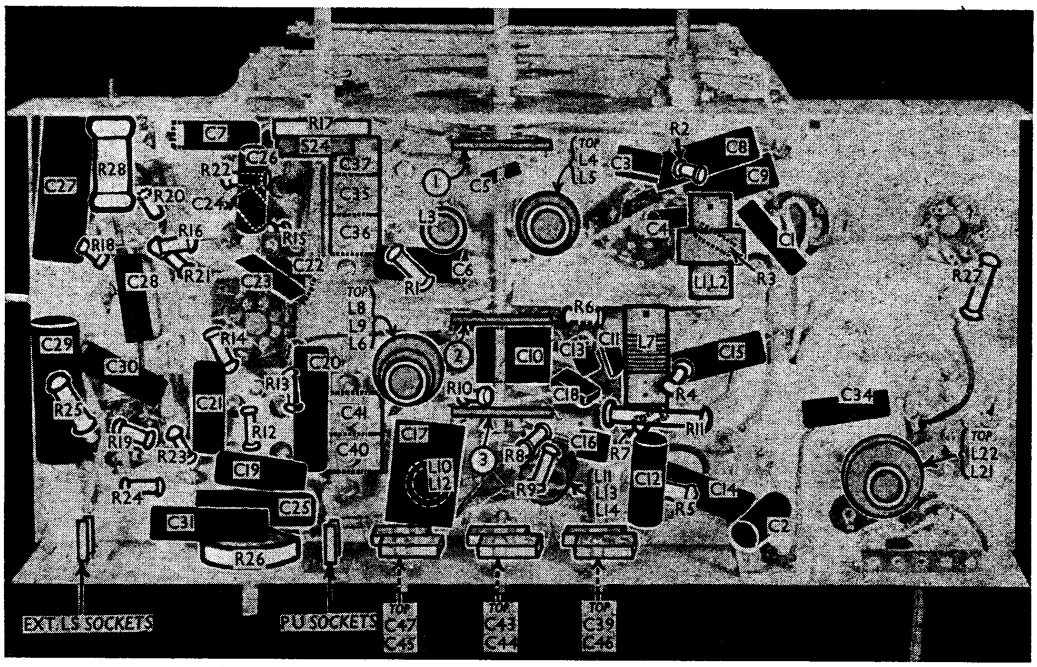
Third valve **(V3, Mullard EF39)** is a second variable-mu RF pentode, but operating this time as an intermediate frequency amplifier with tuned-primary, tuned-secondary transformer couplings **C49, L15, L16, C50** and **C51, L17, L18, C52.**

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, Mullard EBC33).**





Under - chassis view. The three switch units are indicated, and are shown in detail in the diagram in col. 3. overleaf. All the tuning coils and trimmers, except those of the IF transformers, are indicated here, although some of the trimmer adjusting screws are shown in the plan view. These are reached through holes in the chassis deck.

Audio frequency component in rectified output is developed across load resistance **R16** and passed via IF filter circuit **C22, R15, C23,** audio frequency coupling condenser **C26** 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** and isolating condenser **C25** across the manual volume control and **C26.**

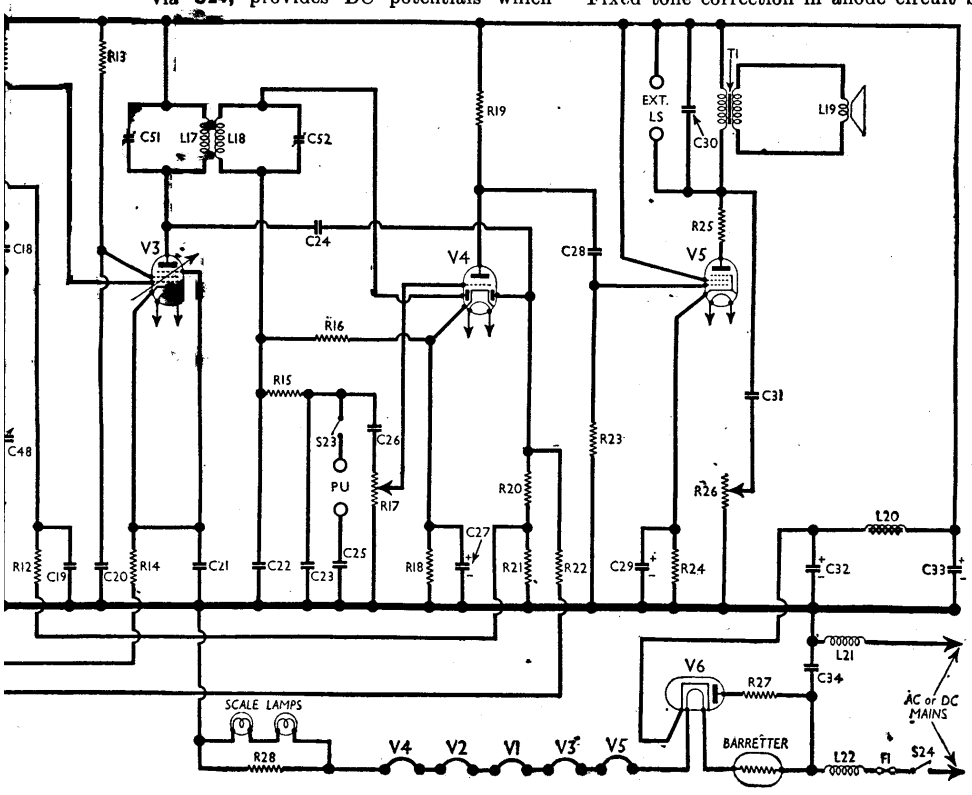
Second diode of **V4,** fed from **V3** anode via **C24,** provides DC potentials which are developed across load resistances **R20** and **R21** and fed back through decoupling circuits as GB to RF amplifier, frequency changer and IF amplifier valves, giving automatic volume control on all bands.

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, C28** and **R23** between **V4** triode and pentode output valve **(V5, Mullard CL33).** Fixed tone correction in anode circuit by **C30,** connected between the outer end of the anode stopper **R25** and HT positive line. Variable tone control by **C31** and **R26** also in anode circuit, but this time returnable to chassis. Provision for connection of high impedance external speaker in anode circuit across **C30.**

When the receiver is used with AC mains, HT current is supplied by IHC half-wave rectifying valve **(V6, Mullard CY31)** which, with DC mains, behaves as a low resistance. Smoothing is effected by iron-cored choke **L20** and dry electrolytic condensers **C32, C33.**

Valve heaters, together with scale lamps and 0.2 amp. current regulating barretter **(Barretter, type 150A)** are connected in series across the mains input. Filter circuit comprising aircored chokes **L21, L22** and by-pass condenser **C34** suppresses mains-borne interference.



Circuit diagram of the Ferguson model 104 U AC/DC superhet. The circuit includes an RF stage, and provision is made for the connection of a gramophone pick-up and an external speaker. The aerial and RF amplifier couplings are unconventional, and are described in the "Circuit Description" above. AVC is applied to three valve circuits, while the fixed GB to the controlled valves is reduced on the SW band by closing **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 clawwashers) holding the chassis to the cabinet.

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	1,000
R19	V4 triode anode load ...	50,000
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
R27	V6 anode surge limiter ...	100
R28	Scale lamps shunt ...	200

	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 ...	2·4
L20	HT smoothing choke ...	300·0
L21	Mains filter chokes ...	3·5
L22		3·5
T1	Speaker input trans. Pri. ...	400·0
	Speaker input trans. Sec. ...	0·4
S1-S22	Waveband switches ...	—
S23	Gram pick-up switch ...	—
S24	Mains switch, ganged R17	—
F1	Mains circuit fuse, 5A ...	—

	CONDENSERS	Values (μF)
C1	Aerial isolating condenser	0·002
C2	Earth isolating condenser	0·1
C3	Aerial MW coupling ...	0·0005
C4	Part LW coupling ...	0·002
C5	Aerial SW coupling ...	0·00001
C6	V1 CG decoupling ...	0·1
C7	AVC line decoupling ...	0·02
C8	V1 SG decoupling ...	0·1
C9	V1 cathode by-pass ...	0·1
C10	RF trans. pri. shunt ...	0·0004
C11	RF SW coupling ...	0·000005
C12	V2 heptode CG decoupling	0·1
C13	RF "Top" coupling condenser	0·000005
C14	V2 SG decoupling ...	0·1
C15	V2 cathode by-pass ...	0·1
C16	V2 osc. CG condenser ...	0·0001
C17	Osc. circuit SW tracker ...	0·005
C18	V1 osc. anode coupling ...	0·0001
C19	V3 CG decoupling ...	0·1
C20	V3 SG decoupling ...	0·1
C21	V3 cathode by-pass ...	0·1
C22	IF by-pass condensers ...	0·00025
C23		0·00025
C24	Coupling to V4 AVC diode	0·0001
C25	Pick-up isolating condenser	0·1
C26	AF coupling to V4 triode	0·02
C27*	V4 cathode by-pass ...	25·0
C28	V4 triode to V5 coupling	0·02
C29*	V5 cathode by-pass ...	25·0
C30	Fixed tone corrector ...	0·005
C31	Part variable tone control	0·05
C32*	HT smoothing condensers	16·0
C33*		16·0
C34	Mains RF by-pass ...	—
C35‡	Aerial circ. SW trimmer...	0·00003
C36‡	Aerial circ. MW trimmer...	0·00003
C37‡	Aerial circ. LW trimmer...	0·00011
C38†	Aerial circuit tuning ...	—
C39‡	RF coupling SW trimmer	0·00003
C40‡	RF trans. MW trimmer...	0·00003
C41‡	RF trans. LW trimmer ...	0·00011
C42†	RF circuit tuning ...	—
C43‡	Osc. circuit MW tracker...	0·0006
C44‡	Osc. circuit LW tracker...	0·00025
C45‡	Osc. circuit SW trimmer...	0·00003
C46‡	Osc. circuit MW trimmer	0·00003
C47‡	Osc. circuit LW trimmer	0·0002
C48†	Oscillator circuit tuning...	—
C49‡	1st IF trans. pri. tuning...	—
C50‡	1st IF trans. sec. tuning...	—
C51‡	2nd IF trans. pri. tuning...	—
C52‡	2nd IF trans. sec. tuning...	—

* Electrolytic. † Variable. ‡ Pre-set.

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 two 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, red;
2 and 3, no external connection;
4, blue.

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.

VALVE ANALYSIS

Valve voltages and currents given in the table in col. 2 are those measured in our receiver when it was operating on AC mains of 236 V.

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 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	215	3·2	93	0·9
V2 CCH35	215	0·9	88	1·3
	Oscillator			
	105	3·2		
V3 EF39	215	2·8	77	1·0
V4 EBC33	100	1·9	—	—
V5 CL33	187	49·0	215	8·8
V6 CY31	237†	—	—	—

† Cathode to chassis, DC.

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 (col. 3), 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.**

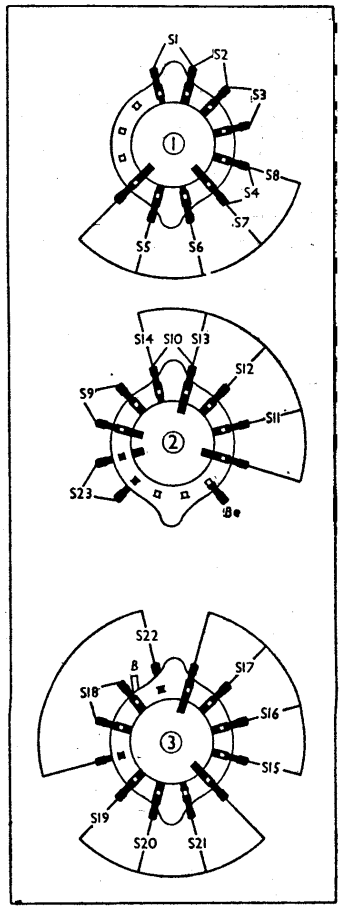
Coils.—L1, L2, L3, and **L4, L5** are in three unscreened tubular units in front of a metal screening shield, while the RF coils **L7** and **L6, L8, L9,** and the oscillator coils **L10, L12** and **L11, L13, L14** are in four unscreened tubular units behind the screen. They are shown in our under-chassis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

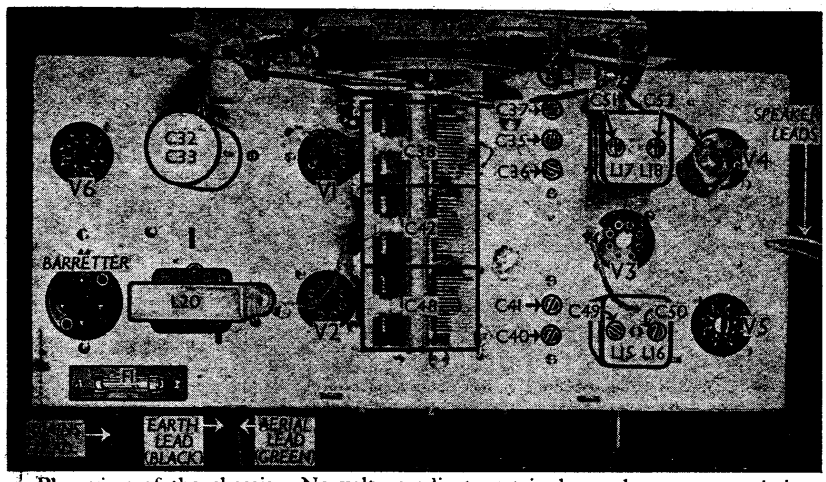
L20 is the iron-cored HT smoothing choke mounted on the chassis deck between **V2** and the barretter socket.

L21, L22 are the mains RF filter coils, wound on a single unscreened tubular former mounted close to the barretter holder beneath the chassis.

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



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



Plan view of the chassis. No voltage adjustment is shown, heater current being regulated automatically by the barretter resistance tube. The adjusting screws of several trimmers seen in the under-chassis view are indicated.

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. The "Earthy" socket is isolated from chassis by the condenser **C25.**

Scale Lamps.—These are two Ever Ready MES types, rated at 6.2 V, 0.3 A. They are connected in series at the chassis end of the valve-heater chain, and are shunted by the resistance **R28.**

Condensers C32, C33.—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 **C35, C36, C37** and **C40, C41** are mounted on the underside of the chassis deck near their associated coil units, while the remaining RF SW trimmer **C39** is mounted on the rear chassis member. All the oscillator trimmers **C45, C46, C47** and the two pre-set trackers **C43** and **C44** are mounted on the rear chassis member.

They are all indicated in our under-chassis view, but the adjusting screws of **C35, C36, C37** and **C40, C41** are shown in our plan view.

Valves.—All the receiving valves **V1-V5** are normal Mullard "E" types or their AC/DC equivalents, fitted with American type octal bases instead of the usual side-contact base. Thus EF39 is equivalent to EF9, the figure 3 indicating that an octal base is fitted. The rectifying valve CY31 is the octal based version of the CY1.

Chassis Divergencies.—In our chassis, **C10** 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 **C10** 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.

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

CIRCUIT ALIGNMENT

IF Stages.—Switch set to 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 (638.3 m) signal and adjust **C52, C51, C50** and **C49** in turn for maximum output. Repeat these adjustments until no further improvement results.

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 **C45,** using the peak involving the lesser capacity, then adjust **C39** and **C35** 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 **C46,** then **C40** and **C36** for maximum output. Feed in a 500 m (600 KC/S) signal, tune it in, and adjust **C43** 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 **C47,** then **C41** and **C37** for maximum output. Feed in a 2,000 m (150 KC/S) signal, tune it in, and adjust **C44** for maximum output while rocking the gang for optimum results. Repeat the 1,250 m adjustments.

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OWING in some cases to damage to premises, and in others to the fact that dealers who have not previously executed repairs in their own workshops are now beginning to do so, we are receiving constantly increasing demands for reprints of *The Trader* Service Sheets, sometimes as many as several hundred being demanded in a single order.

While we are grateful for the compliment that this implies, we would respectfully request our readers to note that, whereas in most of the orders the Service Sheets required are grouped according to the make of receiver they cover, our stocks are arranged in numerical order according to the number of the Service Sheet.

Normally, it would not inconvenience the storekeeper's staff unduly to rearrange the orders into numerical sequence, but since we have been reduced to a war footing, the depleted staff find the extra work difficult to handle.

Therefore, it would be appreciated as a favour if dealers, when ordering large numbers of Service Sheet reprints, would arrange them in numerical order.

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