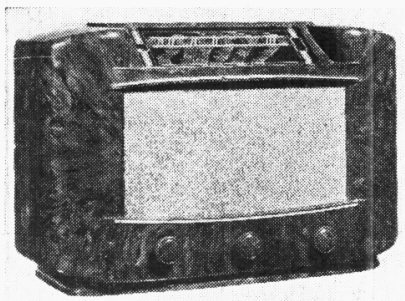
Supplement to The Wireless & Electrical Trader, January 14, 1939

TRADER " SERVICE SHEET

378

PHILIPS 650A

3-BAND AC SUPERHET



AN RF amplifier is included in the Philips 650 A 4-valve (plus rectifier) AC 3-band superhet, which has provision for both an extension speaker and a gramophone pick-up, a short-wave range of 16·7-51 m, a cathode-ray tuning indicator, and a switch for bringing the pick-up into circuit. The receiver is for mains of 100-260 V, 50-100 C/S.

Release date : August, 1938.

CIRCUIT DESCRIPTION

Aerial input is via coupling coils **L1** (SW), **L2** (MW) and **L3** (LW) to single-tuned circuits **L4, C37** (SW), **L5, C37** (MW) and **L6, C37** (LW), which precede first valve (**V1, Mullard EF8**), a variable-mu low-noise hexode operating as RF amplifier. **C1,** via **S4,** shunts aerial circuit on MW and LW bands.

Tuned-secondary RF transformer coupling by **L7, L10, C41** (SW), **L8, L11, C41** (MW) and **L9, L12, C41** (LW) between **V1** and octode valve (**V2, Mullard EK2**) which operates as frequency changer with electron coupling. Oscillator grid coils **L13** (SW), **L14** (MW) and **L15** (LW) are tuned by **C42** ; parallel trimming by **C45** (SW), **C46** (MW) and **C13, C47** (LW) ; series tracking by **C14** (SW), **C15, C43** (MW) and **C16, C44** (LW). Reaction by coils **L16** (SW), **L17** (MW) and **L18** (LW).

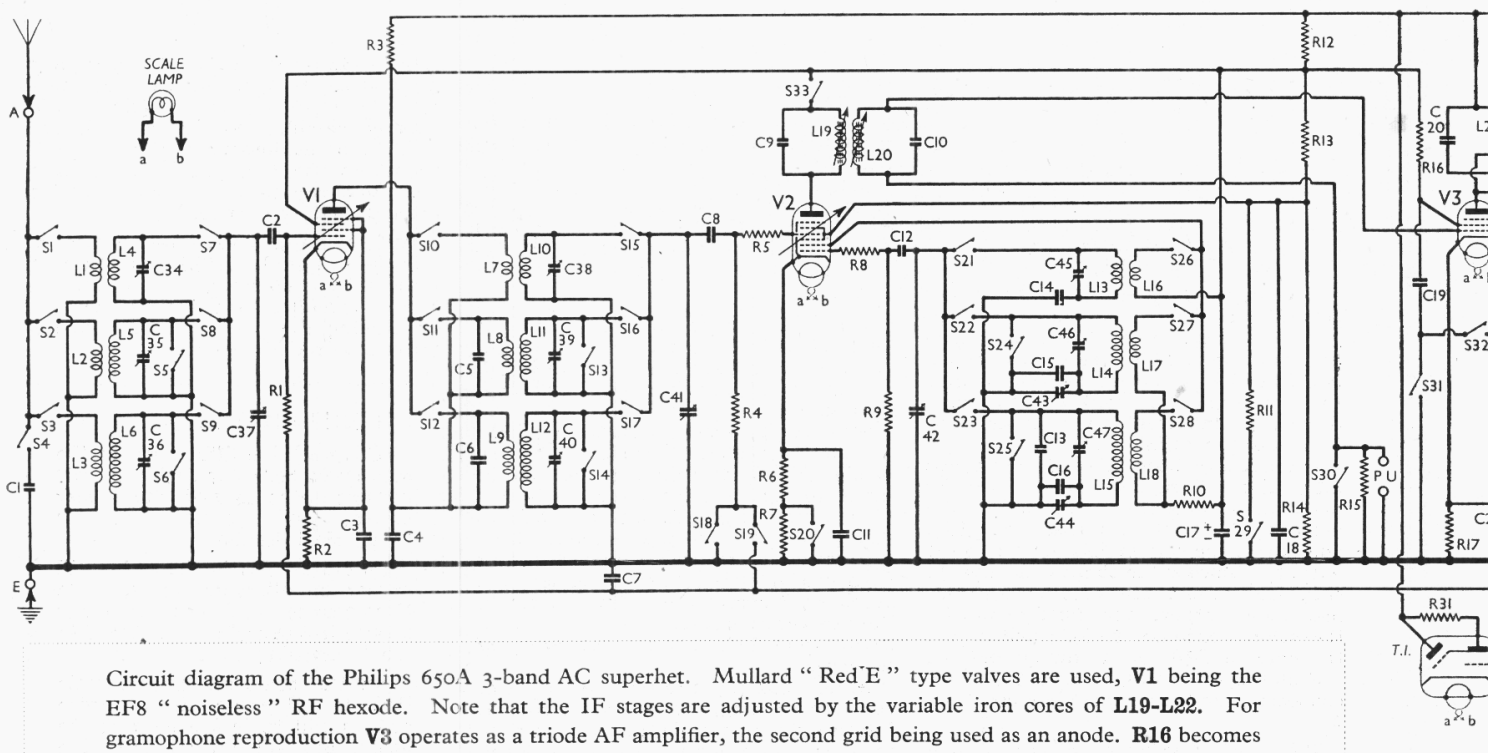
Third valve (**V3, Mullard EF9**) is an RF pentode operating on radio with fixed GB as intermediate frequency amplifier with tuned-primary tuned-secondary iron-cored transformer couplings **C9, L19, L20, C10** and **C20, L21, L22, C21 ;** tuning is effected by adjustment of iron cores.

Intermediate frequency 470 KC/S.

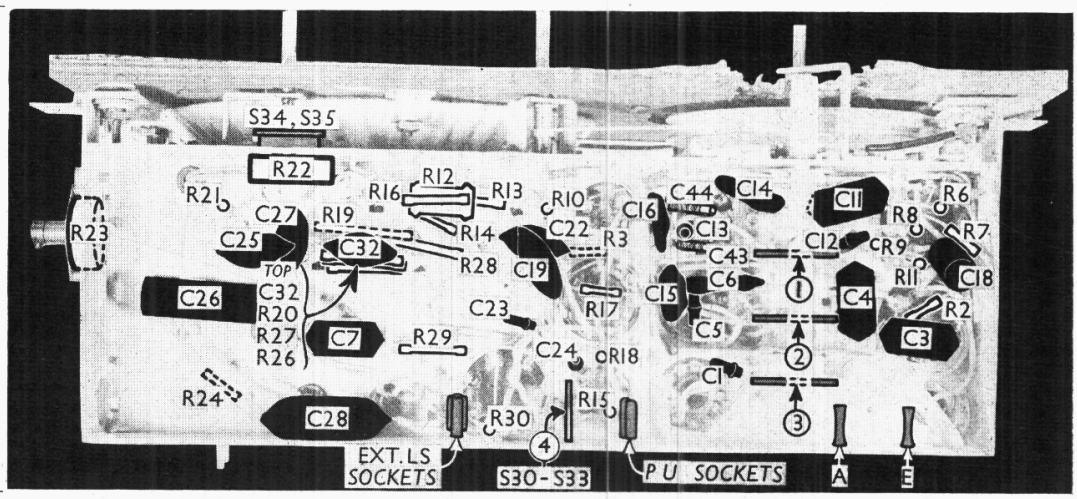
Diode second detector is part of double diode output pentode valve (**V4, Mullard EBL1**). Audio frequency component in rectified output is developed across load resistances **R18** and **R22,** the latter operating also as manual volume control, and passed via AF coupling condenser **C27** and grid stopper **R25** to CG of pentode section, which provides the only AF amplification on radio. Tone compensation by **R21, C25** across part of **R22.** Fixed tone correction by **C29** in anode circuit. Variable tone control by **R23, R24** and **C28,** also in anode circuit. Provision for connection of low impedance external speaker across secondary of output transformer **T1.**

Operating potential for the cathode ray tuning indicator (**T.I., Mullard EM1**) is applied to its control grid from the junction of the resistances **R19** and **R20,** which form a potential divider across **R22.**

Special arrangements are made for using a gramophone pick-up. Sockets are provided across **S30,** which is closed on radio, between **L20** and chassis, so that when its plugs are inserted the pick-up is included in the grid circuit of **V3,** which operates on gram as a triode AF amplifier with its second grid as the anode. **R16,** which on radio is the screen feed resistance, becomes the anode load, and **C19,** which on radio is the screen by-pass, becomes the AF coupling



Circuit diagram of the Philips 650A 3-band AC superhet. Mullard " Red E " type valves are used, **V1** being the EF8 " noiseless " RF hexode. Note that the IF stages are adjusted by the variable iron cores of **L19-L22.** For gramophone reproduction **V3** operates as a triode AF amplifier, the second grid being used as an anode. **R16** becomes the anode load, and **C19** the AF coupling condenser.

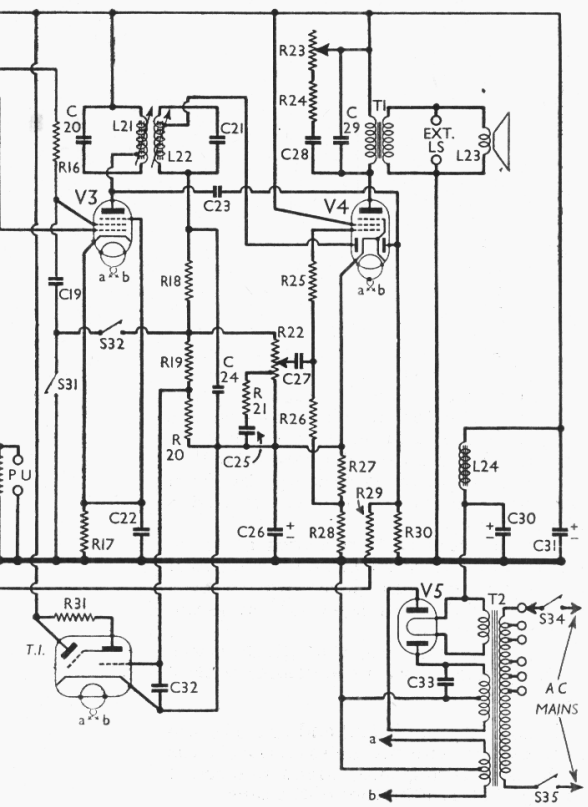


Under-chassis view. The three wavechange switch units (1 to 3) and the radio/gram switch unit (4) are shown in detail overleaf, as seen looking in the directions of the arrows in this view. **C43** and **C44** are wire-wound pre-set condensers.

condenser. **S31** opens, and **S32** closes to connect **C19** to **R22**; **S33**, in **V2** pentode anode circuit, opens to mute radio.

Second diode of **V4**, fed from **V3** anode via **C23**, provides **DC** potential which is developed across load resistance **R30** and fed back through decoupling circuit as GB to RF (on all bands) and FC (except on SW) valves, giving automatic volume control. To render AVC to **V2** inoperative on SW, **S18** closes, while **S19** opens. Delay voltage is obtained from drop along resistances **R27, R28** in **V4** cathode lead to chassis.

HT current is supplied by full-wave rectifying valve (**V5, Mullard AZ1**). Smoothing by iron-cored choke **L24** and electrolytic condensers **C30** and **C31.**



COMPONENTS AND VALUES

NOTE.—*To avoid confusion when ordering a replacement component from the manufacturers, dealers should quote the full description and value, not merely the component number.*

	RESISTANCES	Values (ohms)
R1	V1 CG resistance	800,000
R2	V1 fixed GB resistance	400
R3	V1 anode HT feed	2,000
R4	V2 pentode CG resistance	800,000
R5	V2 pentode CG stabiliser	32
R6	V2 fixed GB resistances	500
R7		160
R8	V2 osc. CG stabiliser	50
R9	V2 osc. CG resistance	50,000
R10	V2 osc. anode MW and LW HT feed	2,000
R11	V1 SG, V2 pentode anode,	20,000
R12	SG and osc. anode, and V3	8,000
R13	SG (anode on gram), HT	32,000
R14	feed pot. divider	50,000
R15	Gram pick-up shunt	500,000
R16	V3 SG HT feed; anode load on gram.	50,000
R17	V3 GB resistance	320
R18	Part V3 signal diode load	50,000
R19	T.I. CG feed pot. divider	5,000,000
R20		64,000
R21	Part of tone compensator	50,000
R22	Part V3 signal diode load; manual volume control	350,000
R23	Parts of variable tone control	50,000
R24		100
R25	V4 pentode CG stopper	1,000
R26	V4 pentode CG resistance	1,000,000
R27	V4 pentode GB and AVC	160
R28	delay resistances	200
R29	AVC line decoupling	1,250,000
R30	V4 AVC diode load	640,000
R31	T.I. anode HT feed	2,000,000

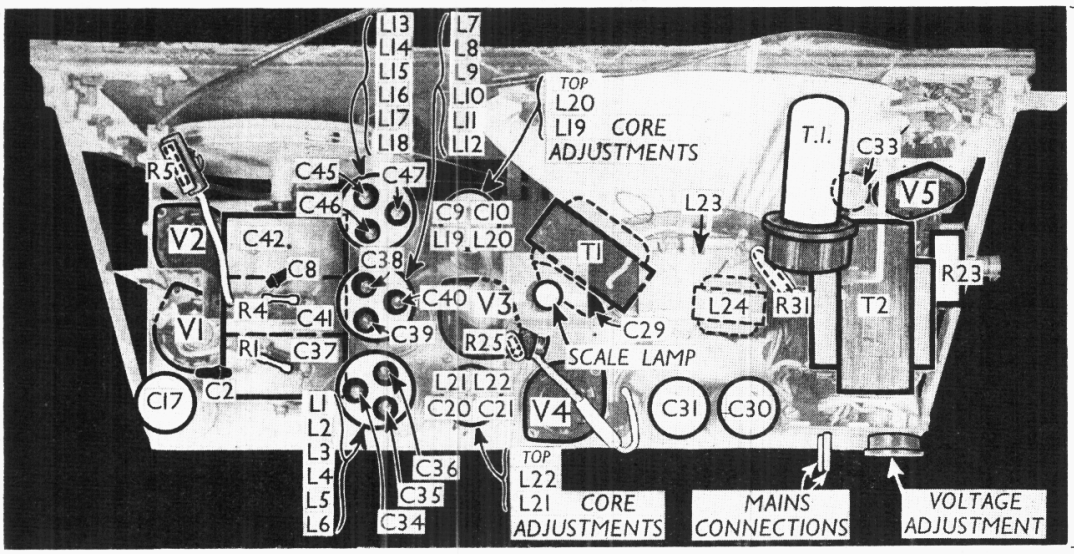
	CONDENSERS	Values (μF)
C1	MW and LW aerial shunt	0·00008
C2	V1 CG condenser	0·0001
C3	V1 cathode by-pass	0·1
C4	V1 anode decoupling	0·05
C5	RF transformer MW pri. shunt	0·00005
C6	RF transformer LW pri. shunt	0·00025
C7	AVC line decoupling	0·1
C8	V2 pentode CG condenser	0·0001
C9	1st IF transformer fixed tuning condensers	0·000091
C10		0·000097
C11	V2 cathode by-pass	0·1
C12	V2 osc. CG condenser	0·00005
C13	Osc. circuit LW fixed trimmer	0·00004
C14	Osc. circuit SW tracker	0·0047
C15	Osc. circuit MW fixed tracker	0·0004
C16	Osc. circuit LW fixed tracker	0·000136
C17*	V1 SG and V2 anodes decoupling	25·0
C18	V2 SG decoupling	0·1
C19	V3 SG decoupling (radio); V3 AF anode to V4 pent. coupling (gram.)	0·05

Continued in next column

	CONDENSERS (*Continued*)	Values (μF)
C20	2nd IF transformer fixed tuning condensers	0·0001
C21		0·0001
C22	V3 cathode by-pass	0·05
C23	Coupling to V4 AVC diode	0·000008
C24	IF by-pass	0·00005
C25	Part of tone compensator	0·05
C26*	V4 cathode by-pass	25·0
C27	AF coupling to V4 pentode	0·02
C28	Part of variable tone control	0·05
C29	Fixed tone corrector	0·002
C30*	HT smoothing condensers	28·0
C31*		32·0
C32	T.I. CG decoupling	0·05
C33	V5 anode RF by-pass	0·02
C34‡	Aerial circuit SW trimmer	0·00003
C35‡	Aerial circuit MW trimmer	0·00003
C36‡	Aerial circuit LW trimmer	0·00003
C37†	Aerial circuit tuning	0·00049
C38‡	RF trans. sec. SW trimmer	0·00003
C39‡	RF trans. sec. MW trimmer	0·00003
C40‡	RF trans. sec. LW trimmer	0·00003
C41†	RF trans. secondary tuning	0·00049
C42†	Oscillator circuit tuning	0·00049
C43‡	Osc. circuit MW tracker	—
C44‡	Osc. circuit LW tracker	—
C45‡	Osc. circuit SW trimmer	0·00003
C46‡	Osc. circuit MW trimmer	0·00003
C47‡	Osc. circuit LW trimmer	0·00003

* Electrolytic. † Variable. ‡ Pre-set.

	OTHER COMPONENTS	Approx. Values (ohms)
L1	Aerial SW coupling coil	3·5
L2	Aerial MW coupling coil	28·0
L3	Aerial LW coupling coil	100·0
L4	Aerial SW tuning coil	0·05
L5	Aerial MW tuning coil	5·0
L6	Aerial LW tuning coil	45·0
L7	RF trans. SW pri. coil	2·5
L8	RF trans. MW pri. coil	280·0
L9	RF trans. LW pri. coil	470·0
L10	RF trans. SW sec. coil	0·05
L11	RF trans. MW sec. coil	5·0
L12	RF trans. LW sec. coil	45·0
L13	Osc. circuit SW tuning coil	Very low
L14	Osc. circuit MW tuning coil	8·5
L15	Osc. circuit LW tuning coil	19·0
L16	Oscillator SW reaction	1·0
L17	Oscillator MW reaction	3·5
L18	Oscillator LW reaction	3·5
L19	1st IF trans. Pri.	7·5
L20	1st IF trans. Sec.	7·5
L21	2nd IF trans. Pri., total	7·5
L22	2nd IF trans. Sec., total	7·5
L23	Speaker speech coil	4·0
L24	HT smoothing choke	280·0
T1	Output trans. Pri.	640·0
	Output trans. Sec.	0·6
T2	Mains trans. Pri., total	48·0
	Mains trans. Heater sec.	0·1
	Mains trans. Rect. heat. sec.	0·15
	Mains trans. HT sec., total	400·0
S1-S29	Waveband switches	—
S30-S33	Radio-gram change switches	—
S34, S35	Mains switches, ganged R22	—



Plan view of the chassis. **R5** and **R25** are on assemblies attached to the top cap connectors of **V2** and **V4**. The cores of **L19-L22** are adjustable through holes in the sides of the coil cans, indicated roughly by arrows. **L24** is the smoothing choke.

DISMANTLING THE SET

Most sets are so constructed that accesss can be gained to the chassis by swinging it out of the cabinet, without removing it entirely from the cabinet. Sets that can be dealt with in this way have two hexagonal-headed screws at each side of the chassis, holding it to the brackets on the sub-baffle. Sets with cheese-head screws cannot be dealt with in this way (see " Removing Assembly ").

Swinging Chassis Out of Cabinet.—To swing out of the cabinet those chassis which are suitable, remove the three control knobs at the front of the cabinet (recessed grub screws) and the knob at the side of the cabinet with its extension (grub screw accessible from the inside of the cabinet). Unsolder the speaker leads and the lead from the chassis to the screen on the bottom of the cabinet.

With a flat spanner remove the hexagonal-headed screws at the sides of the chassis, holding it to the brackets on the sub-baffle, and slacken the four screws holding the struts to the chassis and the sub-baffle. Place the set face downwards on a piece of felt, when the chassis can be lifted up. Care should be taken not to put too much strain on the control cables.

When replacing, the spindles of the tuning and volume controls may foul the sub-baffle and in this case the holes in the sub-baffle should be cut away slightly at the bottom. Connect the speaker leads as follows, numbering the tags from left to right :—1 and 2 joined, orange (and yellow earthing lead to the scale assembly) ; 3, yellow to output transformer.

Removing Assembly.—In sets with cheese-head screws the chassis and the speaker should be removed from the cabinet as a complete assembly. To do this remove the three control knobs at the front of the cabinet (recessed grub screws) and the knob at the side of the cabinet with its extension (grub screw accessible from the inside of the cabinet).

Next unsolder the lead from the chassis to the screen on the bottom of the cabinet and the lead from the speaker to the scale assembly, and remove the screw (with washer and lock washer) holding the drive wire to the pointer. Then loosen the nuts at each end of the drive wire, unscrew the bushes and free the drive wire from the brackets, and free the bowden cable from the wave-change indicator, loosen the nut holding the bush and unscrew the bush.

Finally remove the tuning indicator holder bracket (knurled screw) and the eight screws (with washers and spring washers) holding the brackets on the sub-baffle to the cabinet. By lifting the back upwards, the assembly can now be withdrawn from the cabinet.

Removing Speaker.—Before the speaker can be removed from the cabinet the chassis must be swung out of the cabinet or the assembly withdrawn as described above, according to the type of the receiver. This is necessary in order to gain access to the bottom clamp. After this has been done, unsolder the leads and slacken the three clamps (nuts and lock nuts) holding the speaker to the sub-baffle.

When replacing, see that the terminal panel is at the top and connect the leads as follows, numbering the tags from left to right: 1 and 2 joined, orange and yellow earthing lead to the scale assembly ; 3, yellow to the output transformer.

VALVE ANALYSIS

Valve voltages and currents given in the table (col. 3) are those measured in our receiver when it was operating on mains of 232 V, using the 245 V tapping on the mains transformer. 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 EF8 ..	245	5·1	180	0·1
V2 EK2 ..	180 Oscillator 172	1·6 2·8	82	1·4
V3 EF9 ..	258	6·2	82	1·9
V4 EBL1 ..	240	27·0	258	4·1
V5 AZ1 ..	270†	—	—	—
T.I. EM1 ..	22 Target 258	0·1 0·3	—	—

† Each anode, A.C.

GENERAL NOTES

Switches.—**S1-S29** are the waveband switches, in three rotary units beneath the chassis. These are indicated in our under-chassis view, and shown in detail in the top three units of the diagram in col. 6, where they are drawn as seen looking from the rear of the underside of the chassis.

The table (col. 5) gives the switch positions for the three control settings, starting from fully anti-clockwise. A dash indicates *open* and **C** *closed*.

S30-S33 are the radio-gram change switches, ganged in a single lever-operated unit at the rear of the chassis. This is indicated in our under-chassis view, and shown in detail in the bottom unit (4) of the switch diagram in col. 6, where it is drawn as seen looking from the tone control end of the underside of the chassis.

S30, S31 and **S33** are closed on radio (lever down towards bottom of chassis) and open on gram (lever up towards chassis deck.) **S32** is closed on gram, and open on radio.

S34 and **S35** are the QMB mains switches, ganged with the volume control **R22.**

Coils.—**L1-L6, L7-L12** and **L13-L18** are in three large screened units on the chassis deck, each having three trimmers reached through holes in the tops of the cans.

The IF transformers **L19, L20** and **L21, L22** are in two smaller screened units on the chassis deck. They contain the fixed trimmers **C9, C10** and **C20, C21** respectively, and the core adjustments are at the sides of the cans, as indicated roughly by arrows in the plan chassis view.

L24, the smoothing choke, is mounted on the chassis deck.

External Speaker.—Two sockets are provided at the rear of the chassis for a low impedance (7O) external speaker.

Scale Lamp.—This is a Philips MES type, part no. 8091D/oo.

" E " Type Valve Bases.—The base connections for the Mullard " E " type valves used in this set were given in *Radio Maintenance* for November 5, 1938, (*Service Sheet* 362).

Resistances R5, R25.—These are mounted on small assemblies attached to the top cap connectors of **V2** and **V4** respectively.

Resistance R31.—This is mounted inside insulating sleeving across two tags on the T.I. holder.

Volume Control R22.—This is tapped at about 75,000 O from the bottom end (as drawn in our circuit diagram). The two tags close together near the periphery of the control are the two ends of **R22 ;** the single tag near the periphery is the tapping, and the tag near the centre of the control is the slider connection.

Condensers C43, C44.—These trackers are of the wire-wound type, and are adjustable by altering the length of the spiral wire winding. Each is in parallel with a fixed condenser (**C15, C16**).

Chassis Divergencies.—**C8** and **C16** are not shown on the makers' diagram. **C17** is given as 32 μF, but is 25 μF in our chassis. **C14** may be 0·0045 μF, not 0·0047 μF.

CIRCUIT ALIGNMENT

NOTE.—The core adjustments of **L19, L20** are inaccessible unless the chassis is swung away from the baffie. (See " Dismantling the Set.")

IF Stages.—Switch set to MW and connect an earth to the chassis. Turn gang to minimum, and volume control to maximum. Cut out the AVC by short-circuiting **C7.** Connect signal generator to control grid (top cap) of **V2,** via a 0·032 μF condenser, and chassis, and feed in a 470 KC/S signal.

Connect a 0·00008 μF condenser across **L21,** then adjust the core of **L22** for maximum output. Transfer the 0·00008 μF shunt condenser to **L22,** and adjust the core of **L21** for maximum output. Transfer the shunt condenser to **L19,** and adjust the core of **L20** for maximum output, and finally transfer the shunt condenser to **L20** and adjust the core of **L19** for maximum output.

Seal the coil cores, remove the shunt condenser, and the short circuit from **C7.**

RF and Oscillator Stages.—Signal generator must be connected to **A** and **E** sockets via suitable dummy aerials for the various wavebands. Volume control should be at maximum.

MW.—Switch set to MW. Fit the usual Philips 15 degree jig to the front of the gang condenser, and set the gang to it. Feed in a 1,442 KC/S (208 m) signal, and adjust **C46, C39** and **C35** for maximum output.

Remove 15 deg. jig, then connect an aperiodic amplifier (GM2404) via a 25 $\mu\mu$F condenser to anode of **V2,** and transfer the output meter to the amplifier output. Short-circuit **C42,** and feed a 550 KC/S (545 m) signal into the receiver. Tune the receiver to give maximum output from the amplifier, then disconnect amplifier, transfer output meter to receiver output, and remove short-circuit from **C42.** *Do not alter setting of gang condenser.*

Adjust **C43** (by altering length of wire winding) for maximum output. Replace 15 deg. jig and adjust gang to it, feed in a 1,442 KC/S (208 m) signal, and re-trim **C46.** Remove jig, and seal MW trimmers.

LW.—Switch set to LW. Fit the 15 deg. jig and set the gang condenser to it. Feed in a 405 KC/S (740 m) signal, and adjust **C47, C40** and **C36** for maximum output.

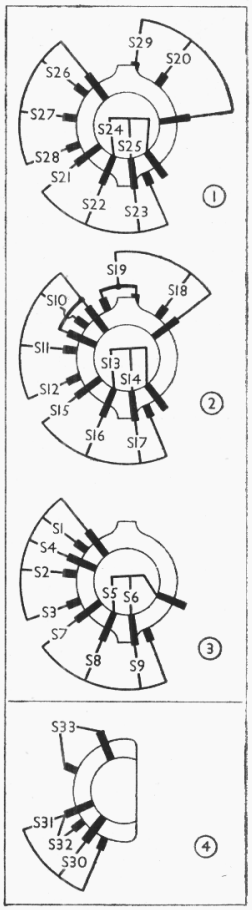
Remove jig, then connect the aperiodic amplifier via 25 $\mu\mu$F condenser to the anode of **V2,** transferring the output meter to the amplifier output as before. Short-circuit **C42,** and feed a 160 KC/S (1,875 m) signal into the receiver. Tune the receiver to give the maximum output from the amplifier, then disconnect the amplifier, transfer the output meter to the receiver output and remove the short-circuit from **C42.** *Do not alter setting of the gang.*

Adjust **C44** (by altering the length of the wire winding) for maximum output. Replace the 15 deg. jig, and adjust gang to it, feed in a 405 KC/S (740 m) signal, and re-trim **C47.** Remove jig, and seal LW trimmers.

TABLE AND DIAGRAMS OF THE SWITCH UNITS

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

Diagrams of the wave-change switch units (1-3) and the radio-gram switch unit (4). The first three are as viewed from the rear of the underside of the chassis, and the fourth as viewed from the tone control end of the underside of the chassis.



SW.—Switch set to SW. Fit the 15 deg. jig, and set the gang to it. Feed in a 17 MC/S (17·65 m) signal (via a SW dummy aerial), and adjust **C45, C38** and **C34** for maximum output. **C45** should be set to the first peak reached from *minimum* capacity. Remove 15 deg. jig, and seal SW trimmers.

Pointer Adjustment.—Switch set to MW, feed in an 811 KC/S (370 m) signal, tune it in accurately, and adjust the pointer carefully to 370 m on the scale by altering the position of the pointer carriage on the drive wire.

TECHNICAL SECTION

This week the fifth article in the series " Cathode Ray Oscilloscopes " appears in the body of *The Trader* under the general heading " Technical Section."

Future articles in the series will appear on alternate weeks, while Maintenance Problems or other service features will be published in the intervening weeks' issues.

Service engineers should note that in all cases these service articles will be in the body of the paper, and will not appear in the Service Sheets.