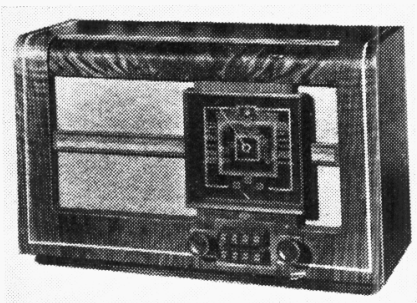
Supplement to The Wireless & Electrical Trader, April 15, 1939

"TRADER" SERVICE SHEET

397

MULLARD MAS24 AND MUS24



The Mullard MAS24, which incorporates mechanical press-button tuning.

AN RF amplifier is included in the Mullard MAS24 4-valve (plus rectifier) AC 3-band press-button superhet. The MUS24 is similar, but is fitted with a converter unit for use on DC mains. The AC model can be used on 100-260 V, 50-100 C/S AC mains; the DC model is for 200-250 or 100-150 V mains, according to the converter fitted.

Mullard "E" type valves are used, and the set has a mechanical press-button system for eight stations, using the direct action principle, and incorporating a special type of 3-gang condenser. A CR tuning indicator is fitted, and inverse feed-back is included in the circuit.

The Mullard MAS15 is similar, except that there is no press-button tuning, a normal gang condenser being fitted, and inverse feedback is omitted.

Release date of MAS24: August, 1938.

CIRCUIT DESCRIPTION

Aerial input is via coupling coils **L1** (SW), **L2** (MW) and **L3** (LW) to single-tuned circuits **L4, C40** (SW), **L5, C40** (MW) and **L6, C40** (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, C44** (SW), **L8, L11, C44** (MW) and **L9, L12, C44** (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 **C45**; parallel trimming by **C48** (SW), **C49** (MW) and **C13, C50** (LW); series tracking by **C14** (SW), **C15, C46** (MW) and **C47** (LW). Reaction by **L16** (SW), **L17** (MW) and **L18** (LW).

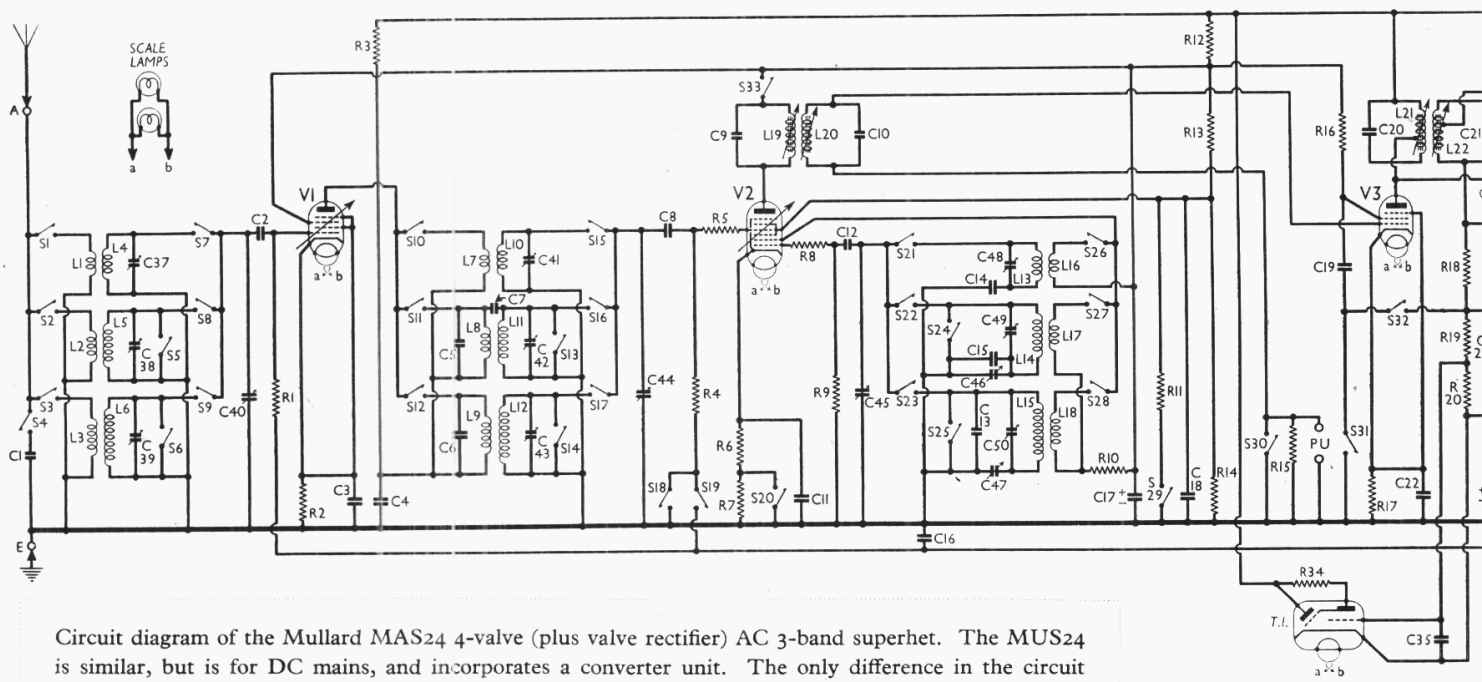
Third valve (**V3, Mullard EF9**) is an RF pentode operating on radio with fixed GB as intermediate frequency amplifier with tuned-primary tuned-secondary iron-cored transformer couplings **C9, L19, L20, C10** and **C20, L21, L22, C21**; tuning is effected by adjustment of iron cores.

Intermediate frequency 470 KC/S.

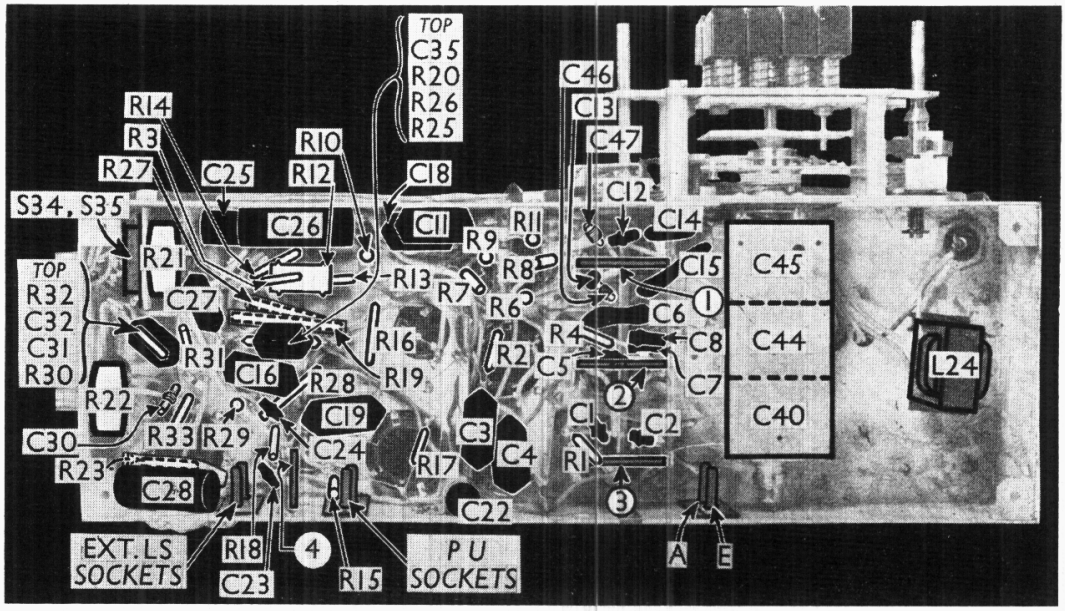
Diode second detector is part of double diode output pentode valve (**V4, Mullard EBL1**). Audio frequency component in rectified output is developed across load resistances **R18** and **R21,** the latter operating also as manual volume control, and passed via AF coupling condenser **C27** and grid stopper **R24** to CG of pentode section, which provides the only AF amplification on radio. Fixed tone correction by **C29** in anode circuit. Variable tone control by **R22, R23** and **C28,** also in anode circuit. Provision for connection of low impedance external speaker across secondary of output transformer **T1.** The tertiery winding on this transformer provides voltages which are fed back to **V4** grid circuit in like or reverse phase according to the position of the slider of **R21.** These voltages are fed via the filter **R30, C31, R31** to the "top" of **R21** for positive feed-back and via the filter **R32, C32, R33** for negative feed-back, and the position of **R21** slider determines the relative amount of feed-back from each arm. When the volume control is turned down for the reception of strong transmissions, the negative sense preponderates; when the control is up for weak transmissions, the feed-back increases the stage-gain.

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 **R21.**

Special arrangements are made for



Circuit diagram of the Mullard MAS24 4-valve (plus valve rectifier) AC 3-band superhet. The MUS24 is similar, but is for DC mains, and incorporates a converter unit. The only difference in the circuit is in the primary of **T2,** which is slightly modified.

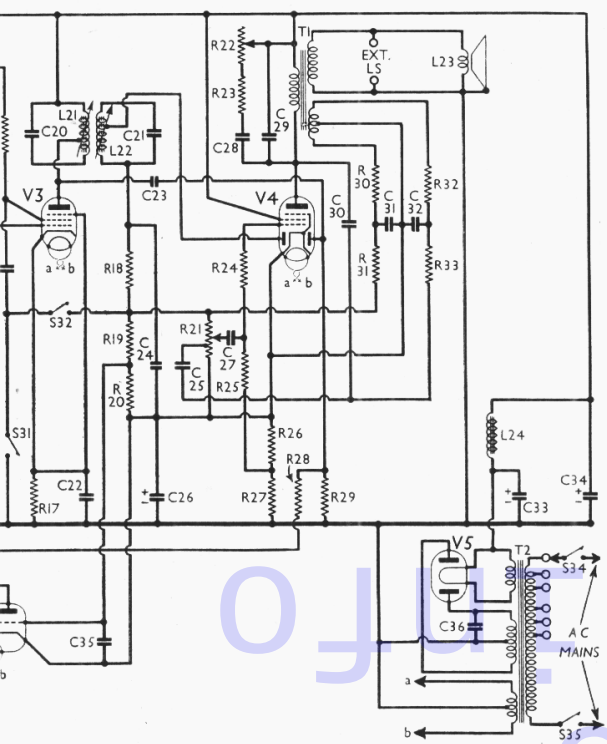


Under - chassis view. The three wavechange switch units (1 to 3) and the radio/gram switch unit (4) are shown in detail overleaf, as seen looking in the directions of the arrows in this view. **C46** and **C47** are wire-wound preset condensers.

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 condenser, **S31** opens, and **S32** closes to connect **C19** to **R21 ; 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 **R29** 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 **R26, R27** 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 **C33** and **C34.**



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 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		640,000
R21	Manual volume control total	700,000*
R22	Variable tone control	50,000
R23	Part of variable tone control	100
R24	V4 pentode CG stopper	1,000
R25	V4 pentode CG resistance	1,000,000
R26	V4 pentode GB and AVC	160
R27	delay resistances	200
R28	AVC line decoupling	1,250,000
R29	V4 AVC diode load	640,000
R30		10,000
R31	Part of feed-back circuit	800,000
R32	coupling	1,250
R33		8,000
R34	T.I. anode HT feed	2,000,000

* Tapped at 40,000 Ω from V4 cathode.

	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	0·0002
C7	RF trans. MW coupling	0·000002
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	0·00475
C15	Osc. circuit MW fixed tracker	0·0004
C16	AVC line decoupling	0·1
C17*	V1 SG and V2 anodes decoupling	32·0
C18	V2 SG decoupling	0·1
C19	V3 SG decoupling (radio); V3 AF anode to V4 pent. coupling (gram.)	0·05
C20	2nd IF transformer fixed tuning condensers	0·000103
C21		0·000103
C22	V3 cathode by-pass	0·05
C23	Coupling to V4 AVC diode	0·000008
C24	IF by-pass	0·00005
C25	Part of feed-back feed	0·05
C26*	V4 cathode by-pass	25·0
C27	AF coupling to V4 pentode	0·0032
C28	Part of variable tone control	0·05
C29	Fixed tone corrector	0·002
C30	Parts of feed-back coupling	0·000125
C31		0·002
C32		0·064
C33*	HT smoothing condensers	32·0
C34*		28·0
C35	T.I. CG decoupling	0·05
C36	V5 anode RF by-pass	0·02
C37‡	Aerial circuit SW trimmer	0·00003
C38‡	Aerial circuit MW trimmer	0·00003
C39‡	Aerial circuit LW trimmer	0·00003
C40†	Aerial circuit tuning	0·00049
C41‡	RF trans. sec. SW trimmer	0·00003
C42‡	RF trans. sec. MW trimmer	0·00003
C43‡	RF trans. sec. LW trimmer	0·00003
C44†	RF trans. secondary tuning	0·00049
C45†	Oscillator circuit tuning	0·00049
C46‡	Osc. circuit MW tracker	0·0002
C47‡	Osc. circuit LW tracker	0·0002
C48‡	Osc. circuit SW trimmer	0·00003
C49‡	Osc. circuit MW trimmer	0·00003
C50‡	Osc. circuit LW trimmer	0·00003

* Electrolytic. † Variable. ‡ Pre-set.

	OTHER COMPONENTS	Approx. Values (ohms)
L1	Aerial SW coupling coil	2·1
L2	Aerial MW coupling coil	26·0
L3	Aerial LW coupling coil	105·0

Continued overleaf

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OTHER COMPONENTS (*Continued*)			Approx. Values (ohms)
L4	Aerial SW tuning coil	..	Very low
L5	Aerial MW tuning coil	..	4·2
L6	Aerial LW tuning coil	..	40·0
L7	RF trans. SW pri. coil	..	2·1
L8	RF trans. MW pri. coil	..	290·0
L9	RF trans. LW pri. coil	..	500·0
L10	RF trans. SW sec. coil	..	Very low
L11	RF trans. MW sec. coil	..	4·2
L12	RF trans. LW sec. coil	..	40·0
L13	Osc. circuit SW tuning coil		Very low
L14	Osc. circuit MW tuning coil		7·0
L15	Osc. circuit LW tuning coil		22·0
L16	Oscillator SW reaction	..	0·5
L17	Oscillator MW reaction	..	4·0
L18	Oscillator LW reaction	..	3·5
L19	1st IF trans. Pri.	..	7·0
L20	1st IF trans. Sec.	..	7·0
L21	2nd IF trans. Pri., total		7·0
L22	2nd IF trans. Sec., total		7·0
L23	Speaker speech coil	..	3·75
L24	HT smoothing choke	..	350·0
T1	Output trans. Pri.	..	800·0
	Output trans. Sec.	..	0·2
	Output trans. Tert., total		500·0
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 R21		—

DISMANTLING THE SET

Removing Chassis. — A detachable bottom is fitted to the cabinet, and upon removal, access can be gained to the underside of the chassis. To remove the chassis from the cabinet, remove the two control knobs and the flat escutcheon plate from the front of the cabinet, and two knobs from the side of the cabinet (set screws inside cabinet). *When replacing*, one flat spring washer should be fitted between each of the front knobs and the escutcheon plate. Remove the tuning indicator and holder (knurled screw) and scale lamps from their brackets; loosen screw in spring-loaded pointer drum boss, hold the drum and slip the wire cord from the hook on the drum and allow the spring to turn the drum slowly until the tension is released; unsolder the two speaker leads; remove the four bolts holding the chassis to the bottom of the cabinet, and the screw holding the earthing tag to the screening in the base of the cabinet, then slip the chassis partly out of the cabinet, when the waveband indicator cable can be freed from the scale assembly by unscrewing its adjusting nipple. The chassis can now be completely withdrawn. *When replacing*, the pointer drum must be wound (about four turns) in a clockwise direction, and the fixing screw tightened.

Removing Speaker.—To remove the speaker, unsolder the two leads from its connection panel and slacken the nuts holding the three clamps to the speaker, when the speaker may be withdrawn from the cabinet. *When replacing*, connect the two leads as follows, numbering from bottom to top: 1, orange; 2 and 3 joined together, yellow.

VALVE ANALYSIS

Valve voltages and currents in the table below are those measured in our receiver when it was operating on mains of 230 V, using the 220 V tapping on the mains transformer. The receiver was tuned to the lowest wavelength on the MW band and the volume control was at maximum. 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 ..	256	5·4	186	0·1
V2 EK2 ..	186	2·1	92	1·35
	Oscillator			
	177	2·7		
V3 EF9 ..	272	6·6	95	1·8
V4 EBL1 ..	245	38·0	272	7·0
V5 AZ1 ..	295†	—	—	—
T.I. EMI ..	24	0·25	—	—
	Target			
	272	1·85		

† Each anode, AC.

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 the three right-hand 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 on the left (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 **R21.**

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 by arrows in the plan chassis view.

L24, the smoothing choke, is mounted beneath the chassis.

External Speaker.—Two sockets are provided at the rear of the chassis for a low impedance (5-10 O) external speaker.

Scale Lamps.—These are two Philips MES types, part no. 8045D-00.

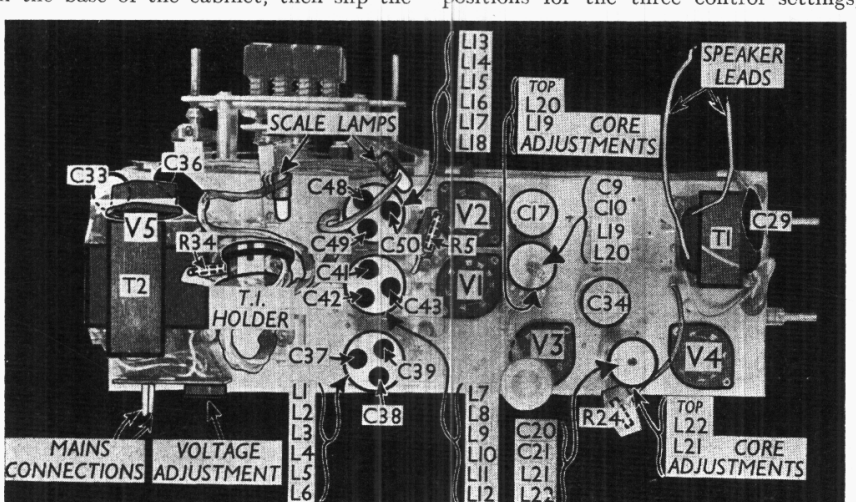
"E" Type Valve Bases.—The base connections for the Mullard "E" type valves used in this set were given in *Radio Maintenance* for November 5, 1938 (*Service Sheet* 362).

Resistance R34.—This is mounted inside insulating sleeving across two tags on the T.I. holder.

Volume Control R21.—This is tapped at about 40,000 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 **R21**; the single tag near the periphery is the tapping, and the tag near the centre of the control is the slider connection.

In some cases the tapping will be found to be 50,000 O from the cathode end of **R21.**

Condensers C46, C47.—These trackers are of the wire-wound type, and are adjustable by altering the length of the spiral wire winding. **C46** is in parallel with a fixed condenser **(C15).**



Plan view of the chassis. The cores of **L19-L22** are adjustable through holes in the sides of the cans.

PRESS-BUTTON UNIT

The mechanical press-button system used in this receiver was fully described and illustrated in the *A B C of Automatic Tuning*, on pages 4 and 5.

To select a station, first pull off the cap of the button which is to be used. This can be done easily after depressing the buttons on each side of it. Now tune the receiver manually (press-buttons out) to the station required.

Depress the button from which the cap has been removed. If the tuning appears to be correct, de-tune slightly by altering the adjusting screw of the button with the tool supplied. If, however, on depressing the button the tuning alters, unscrew the adjustment until the required station is again audible.

Move the scale pointer by means of the manual tuning knob to the extreme anti-clockwise position ("keyboard tuning"), and then adjust the screw of the button accurately to the desired station.

CIRCUIT ALIGNMENT

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 **C16.** 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 **C16.**

RF and Oscillator Stages.—Before alignment is commenced it is necessary to set the gang condenser to a certain capacity by depressing one of the buttons, and proceeding as follows.

Unsolder the leads to **C45** in the gang and connect a Mullard GM4140 capacity-resistance tester to **C45** by means of the shortest possible leads (about 3 in. long). Set the gang to minimum and depress the second button from the right in the top row. By means of the adjusting tool adjust **C45** accurately to 28·3 $\mu\mu$F, using the GM4140 set to this value. Disconnect the instrument, and re-solder the connections to **C45.** *Do not disturb the setting of the press-button until the whole of the alignment has been carried out.*

The signal generator must be connected to the **A** and **E** sockets via suitable dummy aerials for the various wave-bands. Volume control should be at maximum.

MW.—Switch set to MW. Turn gang to minimum, and depress the button just adjusted. Feed in a 1,420 KC/S (211 m) signal, and adjust **C49, C42** and **C38** for maximum output.

Set receiver for manual tuning by pulling out knob, 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 **C45,** and feed a 546 KC/S (550 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 **C45.** *Do not alter setting of the gang condenser.*

Adjust **C46** (by altering length of wire winding) for maximum output. Turn gang to minimum, and depress the adjusted button, feed in a 1,420 KC/S (211 m) signal, and re-trim **C49.** Set receiver for manual tuning, and seal MW trimmers.

LW.—Switch set to LW. Turn gang to minimum, and, and press the adjusted button. Feed in a 390 KC/S (780 m) signal, and adjust **C50, C43** and **C39** for maximum output.

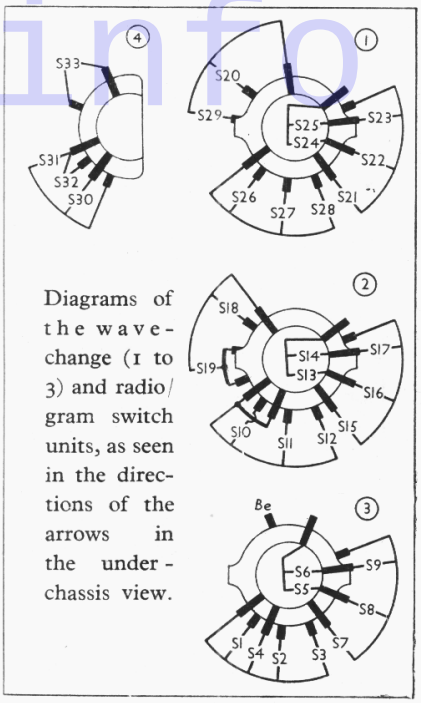
Set receiver for manual tuning, then connect the aperiodic amplifier via 25 $\mu\mu$F condenser to the anode of **V2,** transferring the output meter to the amplifier output as before. Short-circuit **C45,** and feed a 160 KC/S (1,875 m) signal into the receiver. Tune the receiver to give the maximum output from the amplifier, then disconnect the amplifier, transfer the output meter to the receiver output and remove the short-circuit from **C45.** *Do not alter setting of the gang.*

Adjust **C47** (by altering the length of the wire winding) for maximum output. Turn gang to minimum, and press the adjusted button, feed in a 390 KC/S (780 m) signal and re-trim **C50.** Set receiver for manual tuning, and seal LW trimmers.

SW.—Switch set to SW. Turn gang to minimum and press the adjusted button. Feed in a 15·8 MC/S (19 m) signal (via a SW dummy aerial), and adjust **C48, C41** and **C37** for maximum output. **C48** should be set to the first peak reached from minimum capacity. Set receiver for manual tuning, and seal SW 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 (1 to 3) and radio/gram switch units, as seen in the directions of the arrows in the under-chassis view.

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