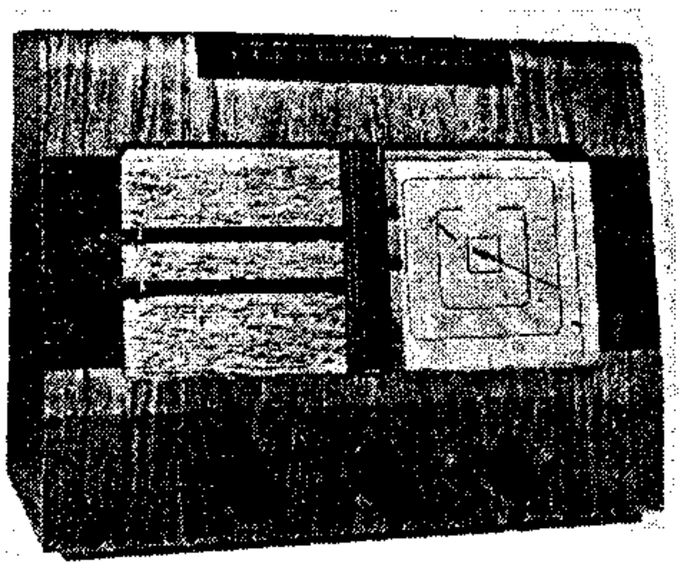
EKCO PB510 & C511

MOTOR TUNED PRESS-BUTTON SUPERHETS



The Ekco PB510.

MOTOR-DRIVEN "Radio Brain" automatic tuning for eight stations, with motor-driven automatic waveband selection, are the outstanding features of the Ekco PB510, a 4-valve (plus rectifier) 3-band superhet designed for use on AC mains of 200-250 V, 50-60 c/s. The SW range is 13-50 m.

The C511 is a console employing a chassis identical with that in the PB510. This *Service Sheet* covers both models, but it was prepared from a PB510.

Release date, both models: July, 1939. *Original prices: PB*510, £14 14s.; *C*511, £17 17s.

CIRCUIT DESCRIPTION

Except that the receiver is muted during automatic tuning operations, there is no difference in the circuit between automatic and manual tuning. In the following description, therefore, no reference is made to the automatic circuits until the end of the receiver circuit description, where it is fully described.

Aerial input on MW and LW is via **C1** (MW), or **L1** (LW), to tappings on the primary coils of a band-pass filter circuit. Primary coils **L2, L3** are tuned by **C39**; secondaries **L6, L7** by **C43**. Coupling by mutual inductance of primary and secondary windings. Image suppression by **C36** on MW.

On SW, input is via coupling coil **L4** to single-tuned circuit **L5, C43.**

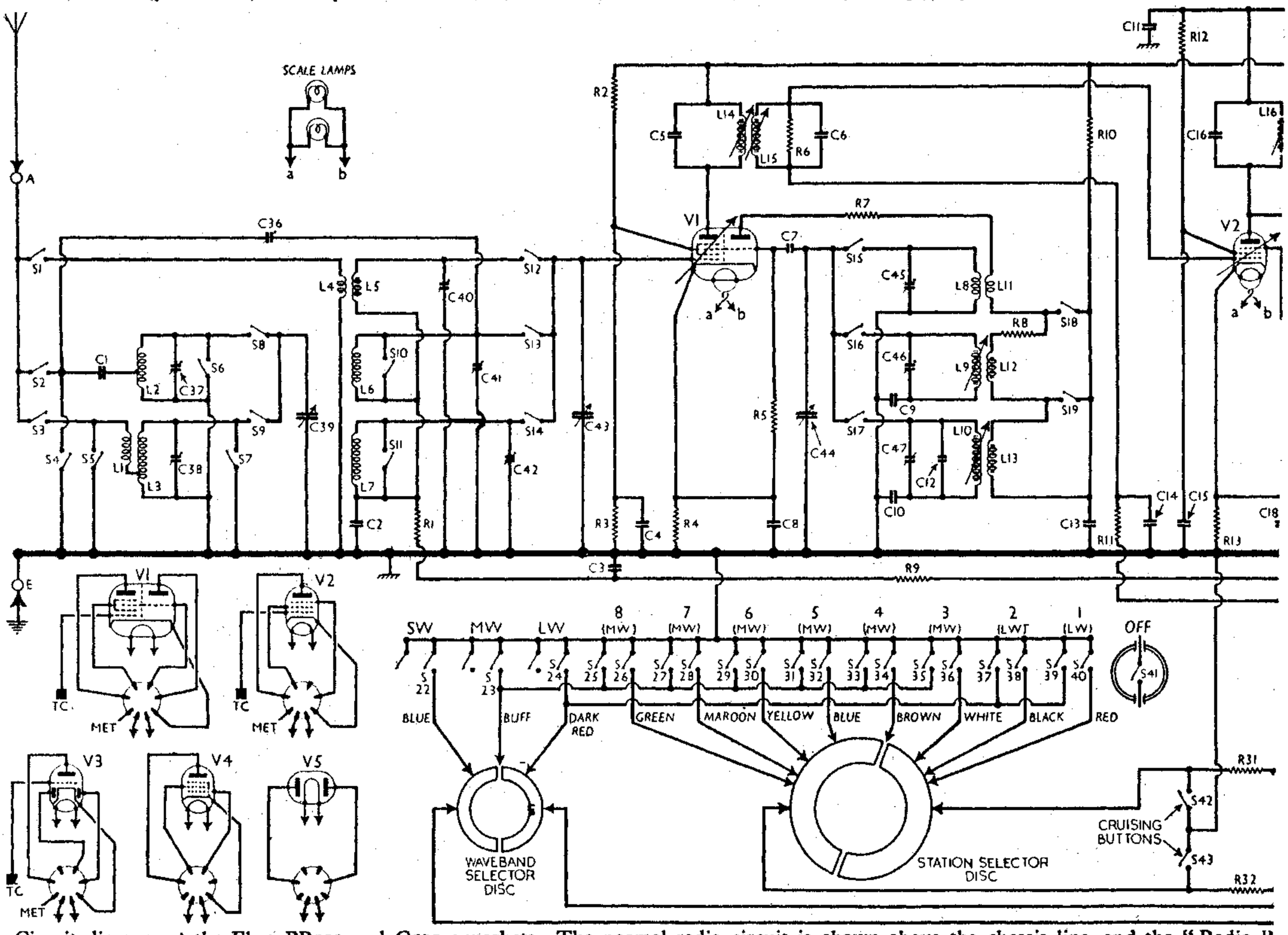
First valve **(V1, Mullard metallised ECH3)** is a triode-hexode operating as frequency changer with internal coupling. Triode oscillator grid coils **L8** (SW), **L9** (MW) and **L10** (LW) are tuned by **C44.** Parallel trimming by **C45** (SW), **C46** (MW) and **C12, C47** (LW); fixed series tracking by **C9** (MW) and **C10** (LW). No tracking adjustment is provided for the SW band, but on MW and LW the coils have adjustable dust-iron cores. Reaction coupling by coils **L11** (SW), **L12** (MW) and **L13** (LW) which are connected in series, MW and LW coils being short-circuited by **S18, S19** when not required.

Second valve **(V2, Mullard metallised EF9)** is a variable-mu RF pentode operating as intermediate frequency amplifier with tuned-primary, tuned-secondary dust-iron cored transformer couplings **C5, L14, L15, C6** and **C16, L16, L17, C17.**

***Intermediate frequency* 126.5 kc/s.**

Diode second detector is part of double diode triode valve **(V3, Mullard metallised EBC3).** Audio frequency component in rectified output is developed across load resistor **R15** and passed via **R16, C23, C24** and the manual volume control **R20, R21** to CG of triode section, which operates as AF amplifier. IF filtering by **C19, R14, C20.** Provision for connection of gramophone pick-up across **R20, R21** via **C24, R18.**

Second diode of **V3,** fed from **V2** anode via **C22,** provides DC potentials which are developed across load resistors **R25, R26** and fed back through decoupling circuits as GB to FC and IF valves, giving automatic volume control. Delay voltage, together with GB for triode



Circuit diagram of the Ekco PB510 and C511 superhets. The normal radio circuit is shown above the chassis line, and the "Radio B

section, is derived from the drop along **R22** in cathode lead to chassis.

Resistance-capacity coupling by **R24, C18** and the potential divider **R27, R28,** between **V3** triode and pentode output valve **(V4, Mullard EL3).** Whistle suppression by low-pass filter **L18, C29** in anode circuit. Fixed tone correction by **C30.** Provision for connection of low impedance external speaker across speech coil secondary of output transformer **T1,** while the speech coil **L19** may be muted by opening **S21.**

A second secondary winding on **T1** provides voltages which are fed back through filter circuits **R19, C26, R17, C25** and **R18, C24** to **V3** triode CG circuit in inverse, or negative, sense, and **R17,** which is the variable tone control, can be adjusted to obtain the desired tonal balance. **S20,** which closes on SW, short-circuits the feedback output, but **R30** prevents the switch from short-circuiting the secondary winding.

HT current is supplied by full-wave rectifying valve **(V5, Mullard AZ1).** Smoothing by iron-cored choke **L20** and electrolytic condensers **C32, C33.**

Automatic Tuning Control.

The mains transformer **T2** has a fourth secondary winding to energise the tuning motor, and one end of it is normally connected via the station setting plug and socket **N** to chassis. The tuning motor windings are connected via tag **Z** to the free end of this secondary, so that the motor will run if either of the terminals **X, Y** at the opposite end is connected to chassis, clockwise or anti-clockwise according to which of the two alternative connections is used. It is in these leads to chassis that the press-button station and waveband selection mechanism are inserted.

Station Selection.—Considering first the station selection alone, it will be seen from the circuit diagram that the common bus-bar of the press-button switch unit is connected to chassis. When any of the buttons, which are numbered 1 to 8, is pressed, connection is thus made between one of the station selector disc plates and chassis. If No. 5 button is pressed, for instance, **S31** and **S32** close, and all the other switches on the bank remain open, and the blue lead contacts a disc plate via its clip, which also is numbered 5, like its button.

An unnumbered clip contacts the same plate (the left-hand one in our diagram) and thus permits current to flow from that plate via **R32** and **S45** (which is closed) to the **Y** connection of the motor winding, so that the motor will run, in a given direction.

The selector disc is mechanically coupled to the tuning motor through a chain of gears, and the condenser gang is directly coupled to the disc. When the motor runs, the direction of disc rotation is such that the insulated gap (the upper one in our diagram) travels towards the contact clip. In our case, the disc would now travel anti-clockwise.

When the gap reaches clip No. 5, therefore, in our example, the current is cut off. In practice, the gap over-runs the clip, owing to momentum, and the clip contacts the opposite plate. Current then flows via the second unnumbered clip, **R31** and **S44** to motor contact **X**; the motor reverses, and the gap comes back again to clip No. 5.

Owing to the "slow-motion" action of the condenser drive, however, reversal of direction of travel introduces a 5 to 1 reduction ratio in speed, so that the gap returns at one-fifth of its original speed, and the disc stops without over-running, and the station is tuned.

The motor bearings are permitted a certain amount of intentional end-play, and when at rest, a spring pushes the armature spindle towards one end bearing. When the motor runs, the armature is pulled magnetically against the spring, towards the opposite end-bearing, so that one end of the armature spindle projects further out of the motor casing and the other end recedes. The projecting end presses the blades of switch **S46,** so that it closes and short-circuits the pick-up sockets, muting the receiver as long as the motor is running; the receding end draws in the lugs of a dog-clutch attached to it, engaging the condenser drive mechanism. This clutch is introduced to permit the motor to expend its momentum freely after the current has been cut off, disengaging it from the drive.

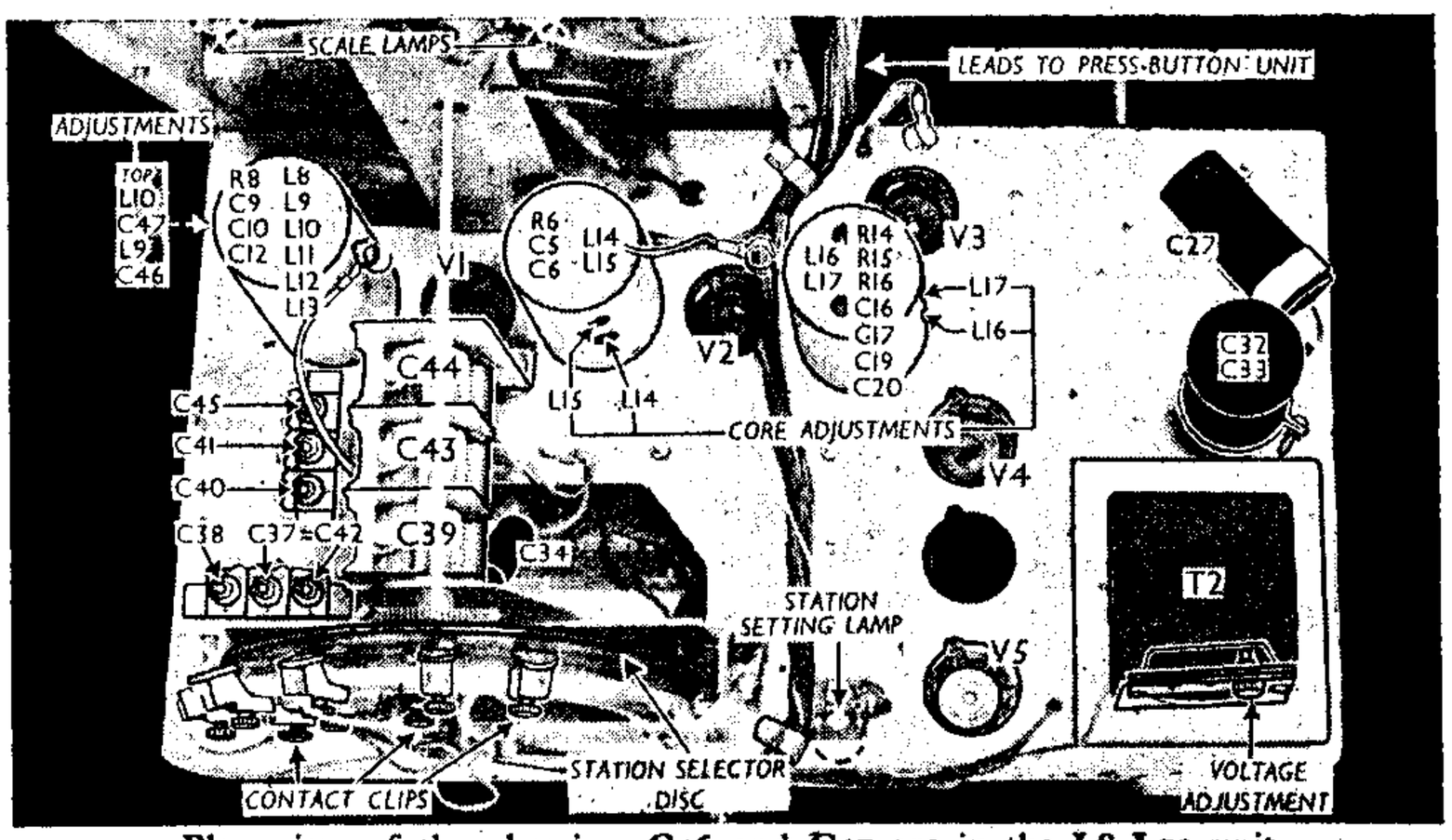
The two "cruising" buttons are provided to permit manual control of the electrical drive system when tuning manually.

Station Setting.—For setting up the system to receive the desired stations, a station setting lamp replaces the motor drive and acts as an indicator. The station setting plug is transferred from its normal socket **N** to the setting socket **S,** so that only a small portion of the motor secondary winding on **T2** is in circuit between the motor connection **Z** and chassis, and the lamp is in series with it.

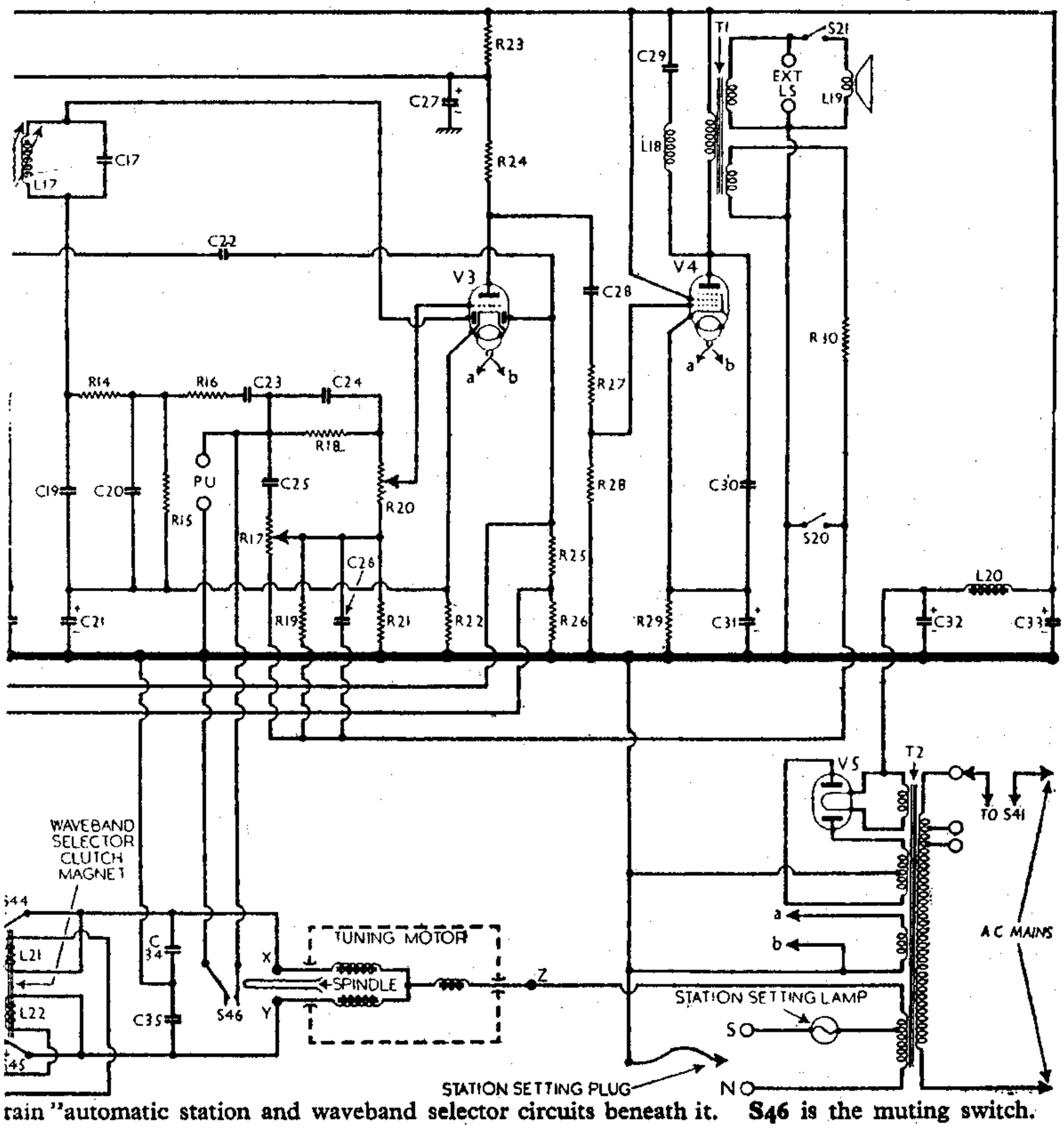
If a press-button that would normally cause the motor to run were now pressed, the lamp would light; the motor, although still in circuit, would not run at the low voltage now available.

When the appropriate clip has been moved along its carrier rail to a position where its contact lies on the insulated gap between the two plates, the light will go out, and the gang will in future return to the same position when that button is pressed and the setting plug is at **N.** Prior to this operation the operator, of course, has tuned the set manually to the desired station.

Waveband Selection.—No purely manual or mechanical control is provided for wave-



Plan view of the chassis. **C46** and **C47** are in the **L8-L13** unit.



rain "automatic station and waveband selector circuits beneath it. **S46** is the muting switch.

band switching. Instead, three press-buttons are used, one for each band, and they are associated with switches **S22, S23** and **S24** on the press-button unit.

The principle of waveband selection is the same as that just described for station selection, but it involves the use of another selector disc and a relay. If, for instance, matters were arranged as shown in our diagram, with the set switched to MW, and the LW button were pressed, connection would be made between chassis and the **Y** motor contact, but now the current would flow via the LW clip (dark red lead), the right-hand plate on the waveband selector disc and the magnet winding **L22.**

The magnet forms part of a relay, and has two windings **L21, L22.** When either winding energises the magnet, the armature, or latch-bar, is attracted; but the latch-bar engages with a geared dog-clutch, and when the relay is energised the clutch closes and engages with the tuning drive to the condenser gang, so that it becomes motor-driven with the gang, and as its gear teeth are engaged with those of the waveband selector disc, this rotates until the gap between the plates reaches the LW contact clip, when the motor current is cut off. The set is then switched to the LW band.

The latch-bar, however, also performs a second function. When the relay closes, two insulated prods on the latch-bar press against the blades of switches **S44** and **S45,** so that they open and disconnect the station selector disc and its associated circuit from the motor altogether until the wave-changing operation is completed, when the relay relaxes, disengaging the dog-clutch and permitting **S44, S45** to close again.

Owing to the presence of **L21, L22,** the voltage of the motor secondary on **T2** is higher than is required by the motor in order to compensate for the drop along these windings when they are in use. For station selection only, the voltage would consequently be too high, so **R31** and **R32** are inserted in the station selector leads to drop the same voltage.

Combined Action.—If the receiver is switched to one band, say MW, and a button of the other band (say No. 2 button, LW) is pressed, the "Radio Brain" system automatically selects first the correct waveband and then the desired wavelength.

All the MW buttons control a duplicate of switch **S23** for waveband control, and the two LW buttons control a duplicate of **S24,** in addition to their station selector switches. When No. 2 button is pressed, therefore, **S37** and **S38** close, bringing in circuit station selector clip No. 2 (black lead) and the LW clip on the waveband selector. Obviously, both systems will try to work, but the waveband selector magnet will open **S44, S45** and the station selector will be cut out of circuit until the waveband has been selected as described under "Waveband Selection."

Immediately this is completed **S44, S45** close, and the procedure described under "Station Selection" is performed.

COMPONENTS AND VALUES

	RESISTORS	Values (ohms)
R1	V1 hex. CG decoupling ...	1,000,000
R2, R3	V1 SG HT feed potential divider	47,000 / 68,000
R4	V1 fixed GB resistor ...	200
R5	V1 osc. CG resistor ...	100,000
R6	1st IF trans. sec. shunt ...	470,000
R7, R8	Oscillator reaction circuit damping resistors	220 / 1,000
R9	AVC line decoupling ...	150,000
R10	V1 osc. anode HT feed ...	47,000
R11	V2 CG decoupling ...	680,000
R12	V2 SG HT feed	91,000
R13	V2 fixed GB resistor ...	510
R14	IF stopper	270,000
R15	V3 signal diode load ...	100,000
R16	AF feed resistor	56,000
R17	Variable tone control ...	500,000
R18, R19	Parts of tone corrector circuit	220,000 / 47,000
R20	Manual volume control	1,000,000
R21	Part feed-back coupling	820
R22	V3 GB resistor	1,000
R23	V3 triode anode decoupling	3,300
R24	V3 triode anode load ...	56,000
R25, R26	V3 AVC diode load resistors	470,000 / 470,000
R27, R28	V4 CG potential divider	100,000 / 270,000
R29	V4 GB resistor	120
R30	Feed-back coupling ...	15,000
R31, R32	Tuning motor ballast resistors	5 / 5

	CONDENSERS	Values (μF)
C1	Aerial MW coupling ...	0·001
C2	V1 hex. CG decoupling ...	0·1
C3	AVC line decoupling ...	0·02
C4	V1 SG decoupling ...	0·1
C5, C6	1st IF transformer tuning condensers	0·00014 / 0·00014
C7	V1 osc. CG condenser ...	0·000025
C8	V1 cathode by-pass ...	0·1
C9	Osc. circ. MW tracker ...	0·001505
C10	Osc. circ. LW tracker ...	0·000425
C11	HT circuit RF by-pass ...	0·1
C12	Osc. LW fixed trimmer ...	0·00002
C13	V1 osc. anode decoupling	0·1
C14	V2 CG decoupling ...	0·01
C15	V2 SG decoupling ...	0·1
C16, C17	2nd IF transformer tuning condensers ...	0·00014 / 0·00014
C18	V2 cathode by-pass ...	0·1
C19, C20	IF by-pass condensers ...	0·0002 / 0·0002
C21*	V3 cathode by-pass ...	25·0
C22	AVC diode coupling ...	0·000015
C23	Coupling to V3 triode ...	0·01
C24, C25, C26	Parts of tone corrector circuit	0·0003 / 0·0025 / 0·08
C27*	V1 and V3 triode anode decoupling	4·0
C28	AF coupling to V4 ...	0·1
C29	Whistle filter tuning ...	0·005
C30	Fixed tone corrector ...	0·0025
C31*	V4 cathode by-pass ...	50·0
C32, C33	HT smoothing condensers	8·0 / 14·0
C34, C35	Tuning motor shunt condensers	0·02 / 0·02
C36‡	Image suppressor ...	—
C37‡	B-P pri. MW trimmer ...	—
C38‡	B-P pri. LW trimmer ...	—
C39†	Band-pass pri. tuning ...	—
C40‡	Aerial circ. SW trimmer	—
C41‡	B-P sec. MW trimmer ...	—
C42‡	B-P sec. LW trimmer ...	—
C43†	B-P sec. and SW tuning	—
C44†	Oscillator circuit tuning	—
C45‡	Osc. circ. SW trimmer ...	—
C46‡	Osc. circ. MW trimmer ...	—
C47†	Osc. circ. LW trimmer ...	—

* Electrolytic. † Variable. ‡ Pre-set

	OTHER COMPONENTS	Approx. Values (ohms)
L1	Aerial LW coupling coil ...	28·0†
L2, L3	Band-pass primary coils	3·0 / 28·0
L4	Aerial SW coupling coil ...	0·2
L5	Aerial SW tuning coil ...	Very low
L6, L7	Band-pass secondary coils	3·0 / 29·0
L8	Osc. SW tuning coil ...	Very low
L9	Osc. MW tuning coil ...	3·0
L10	Osc. LW tuning coil ...	10·0
L11	Osc. SW reaction coil ...	0·5
L12	Osc. MW reaction coil ...	0·5
L13	Osc. LW reaction coil ...	0·7
L14, L15	1st IF trans. Pri. ... / Sec. ...	43·0 / 46·0
L16, L17	2nd IF trans. Pri. ... / Sec. ...	43·0 / 46·0
L18	Whistle filter coil ...	85·0
L19	Speaker speech coil ...	2·4
L20	HT smoothing choke ...	650·0
L21, L22	Clutch magnet windings ...	5·5 / 5·5
T1	Output trans. Pri. ... ... / Speech Sec. ... / FB sec. ...	360·0 / 0·4 / 45·0
T2	Mains mains Pri., total ... / Heater sec. ... / Rect. heat sec. / Motor sec., total / HT sec., total ...	33·0 / 0·2 / 0·2 / 2·0 / 540·0
TM	Tuning motor windings ...	5·0*
S1-S20	Waveband switches ...	—
S21	Int. speaker switch ...	—
S22-S40	Press-button switches ...	—
S41	Mains switch	—
S42, S43	PB cruising switches ...	—
S44, S45	Wavechange clutch switches	—

† Including the lower end of L3.
* Either winding. Measured between X and Z or Y and Z.

DISMANTLING THE SET

The base of the cabinet is fitted with a detachable cover, upon removal of which (eight countersunk head wood screws) access can be gained to most of the components beneath the chassis.

Removing Chassis.—Remove the three rotary control knobs (recessed grub screws); remove the four bolts (with washers) holding the chassis to the bottom of the cabinet; free the press-button leads from the cleat holding them to the top of the cabinet, when the chassis may be withdrawn.

Chassis may be freed entirely if the two cheese-head screws (with lock-washers) holding the press-button unit to the front of the cabinet (one at each end) are removed, freeing the unit; and the two speaker leads are unsoldered.

When replacing, the press-button unit should be fitted with the mains switch on the right, when viewed from the rear.

Before inserting chassis replace cruising buttons.

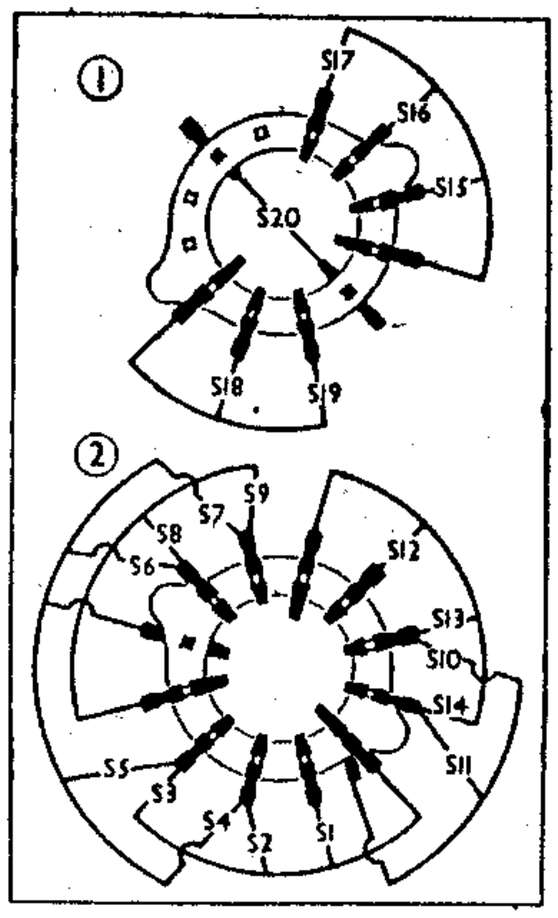
Removing Speaker.—Slacken the nuts holding the four clamps to the rim of the speaker, and swivel the clamps.

When replacing, the connecting panel should be on the right.

GENERAL NOTES

Switches—S1-S20 are the waveband and feed-back muting switches, in two ganged rotary units beneath the chassis. These are indicated in our under-chassis view, and shown in detail in the diagrams below, where they are drawn, as seen when viewed in the directions of the arrows in the under-chassis view.

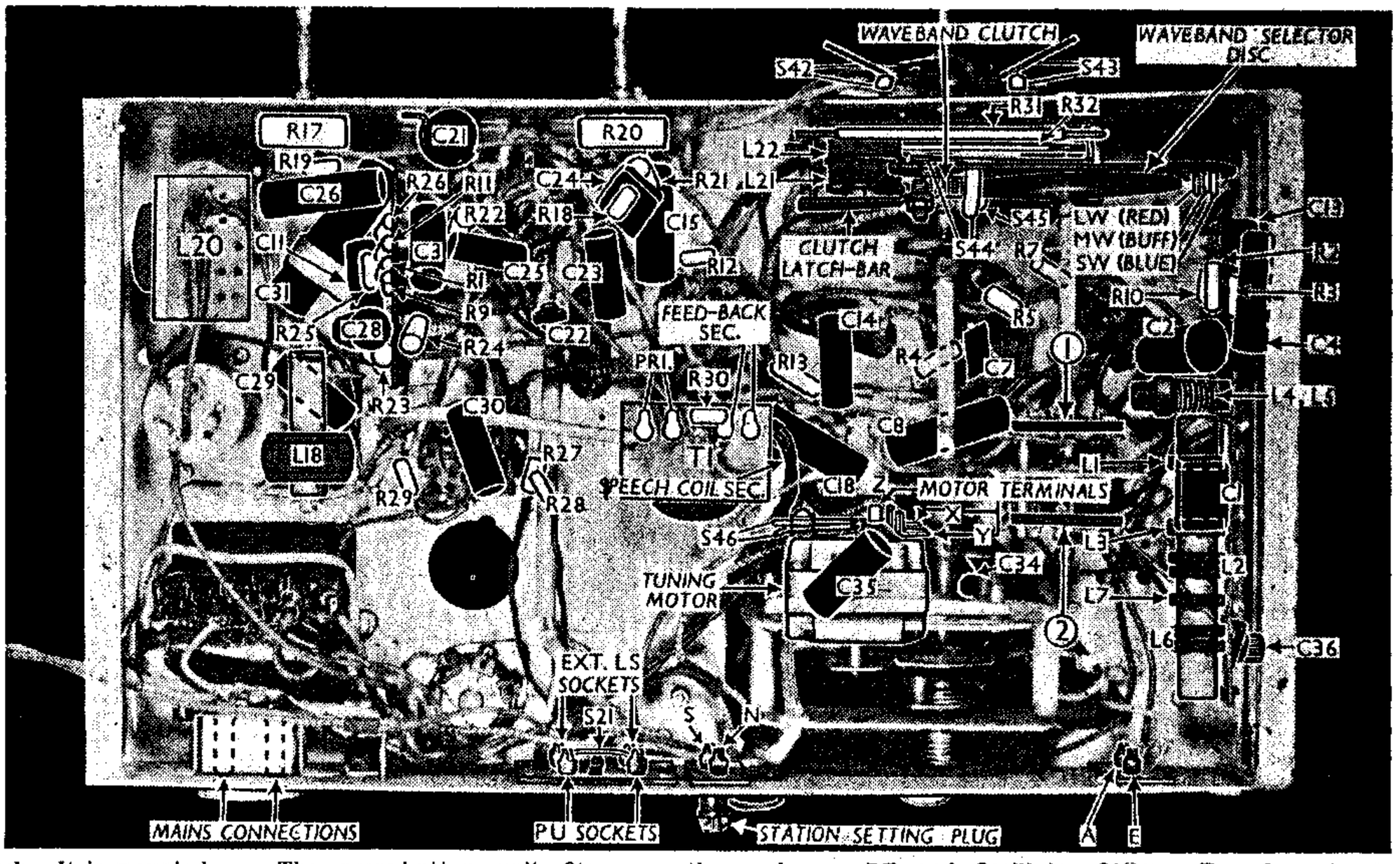
The usual waveband control knob for manual operation is omitted in this receiver, and waveband changing is performed electrically. It is controlled automatically by the press-buttons, which are associated with switches **S22-S40.** The action of these switches is fully explained under "Circuit Description," and the unit is shown



Above : Diagrams of the waveband switch units.

Below : The associated switch table.

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



Under-chassis view. The tuning motor is seen near bottom centre. The mechanism associated with waveband switching is mounted in an assembly at the top right corner.

in detail in the drawing in cols. 5 and 6, where the unit is viewed from above and to the rear of the chassis deck. The action of the waveband switches **S1-S20** is shown for the three waveband positions in the table in col. 3.

S21 is the screw type internal speaker muting switch.

S41 is the mains circuit switch. It is mounted on the press-button unit and controlled by any button, although it has a button of its own marked "OFF."

S42, S43 are the cruising button switches, controlled by two separate press-buttons mounted on the front of the cabinet, one being either side of the manual tuning control knob. Their purpose is to permit rapid traversal of the scale when tuning manually.

S44, S45 are included to isolate the automatic tuning circuits while waveband changing is being performed. Their function is fully explained under "Circuit Description."

S46 is an automatic muting switch, which silences the receiver during automatic waveband and station selection. It is operated by the tuning motor armature spindle, and is entirely automatic.

S42-S46 are all indicated in our under-chassis illustration.

Scale and Setting Lamps.—These are all MES types, rated at 6.5 V, 0.35 A. The makers' number for them is A5767. Replacements should not be of a lower voltage, as the heater circuit voltage is 6.3 V.

External Speaker.—Two sockets are provided on a panel at the rear of the chassis for the connection of a low impedance (3-4 Ω) external speaker.

Condensers C27, C32, C33.—In our chassis these consist of two units: **C27** in a cardboard tubular container mounted at a corner on the chassis deck, and rated at 4 μF, 500 V DC working, 600 V surge; and **C32, C33** in a wet electrolytic unit of three sections mounted partly above and partly below the chassis deck.

In the makers' manual, **C27, C32** and **C33** are all contained in the wet unit, but they explain that sometimes the arrangement found in our chassis may be used. The three sections of the wet unit are rated at 10 μF, 350 V working (brought out to the red terminal), 8 μF, 440 V working (yellow terminal) and 4 μF, 440 V working (green terminal). The terminals are all positive, and the case forms the common negative connection.

In the original arrangement **C27** was the 4 μF section, **C33** was 10μ F, and **C32** was 8 μF. In our chassis, where **C27** was a separate unit, the spare 4 μF section was connected in parallel with the 10μ F section (red and green terminals joined together), making **C33** 14 μF, although the makers say that the 4μF will then be connected in parallel with the 8 μF section.

Automatic Tuning Mechanism.—The tuning motor is indicated in our under-chassis view, beneath the tuning condenser gang. On it are shown the conectnions of **S46**, and its own connecting tags are marked **X, Y** and **Z** to agree with the circuit diagram. It drives, through reduction gears, the manual tuning spindle which runs from front to rear across the chassis via two flexible couplings.

The press-button unit fits over the scale assembly, but it is actually fitted to the cabinet.

Chassis Divergencies.—Apart from the different electrolytic condenser arrangements, explained under "Condensers **C27, C32, C33,**" there are also several other differences in early models.

V1 hexode anode, its screen feed **R2** and oscillator anode feed **R10** were all taken to the HT positive line at the same point as **R12** and **V4** screen. **R10** was then 56,000 Ω instead of 47,000 Ω, **R13** was 1,000 Ω instead of 510 Ω, and **R23** was 10,000 Ω instead of 3,300 Ω. **R25** was omitted, and the bottom of **R11** went to the junction of **R26** and **V3** AVC diode anode, in common with **V1** AVC line. **R26** was then 1,000,000 Ω.

VALVE ANALYSIS

In the table below are the valve voltages and currents as quoted in the makers' manual.

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 ECH3	218	1.65	65	2·2
	Oscillator			
	82	2·7		
V2 EF9	250	4·8	110	1·4
V3 EBC3	100	2·2	—	—
V4 EL3	235	43·0	250	4·8
V5 AZ1	275†	—	—	—

† Each anode, AC.

CIRCUIT ALIGNMENT

IF Stages.—Switch set to LW, and turn the gang to maximum. Connect signal generator via a 0.01 μF condenser to CG (top cap) of **V1** and chassis, turn the gain control to maximum, feed in a 126.5 kc/s (2,372 m) signal and, using a fully insulated tool with a flat blade, adjust the cores of **L17** (upper coil), **L16** (lower coil) and **L15** (upper coil), **L14** (lower coil) for maximum output, keeping input low. These adjustments will not peak sharply.

RF and Oscillator Stages.—Transfer signal generator leads to **A** and **E** sockets, via a suitable dummy aerial. With the gang at maximum, the pointer should cover the 50 m calibration mark on the scale.

SW.—Press the SW button, and tune to 14 m on scale. Feed in a 14 m (21.4 Mc/s) signal, and adjust **C45** for maximum output, using the peak involving the lesser trimmer capacity if two are found. Tune to 15 m on scale, feed in a 15 m (20 Mc/s) signal, and adjust **C40** for maximum output. The calibration should now be correct at both ends of the scale. If it is not, check that the **C45** has been set to the correct peak.

MW.—Press the MW button, tune to 500 m on scale, feed in a 500 m (600 kc/s) signal, and adjust the core of **L9** for maximum output. Tune to 190 m on scale, feed in a 190 m (1,579 kc/s) signal, and adjust **C46** for maximum output, using the peak involving the lesser trimmer capacity. Tune to 250 m on scale, feed in a 250 m (1,200 kc/s) signal, and adjust **C37** and **C41** for maximum output. Readjust **L9** at 500 m, and if any adjustment is necessary to secure correct calibration, return afterwards to the 190 m and 250 m adjustments and repeat the MW procedure.

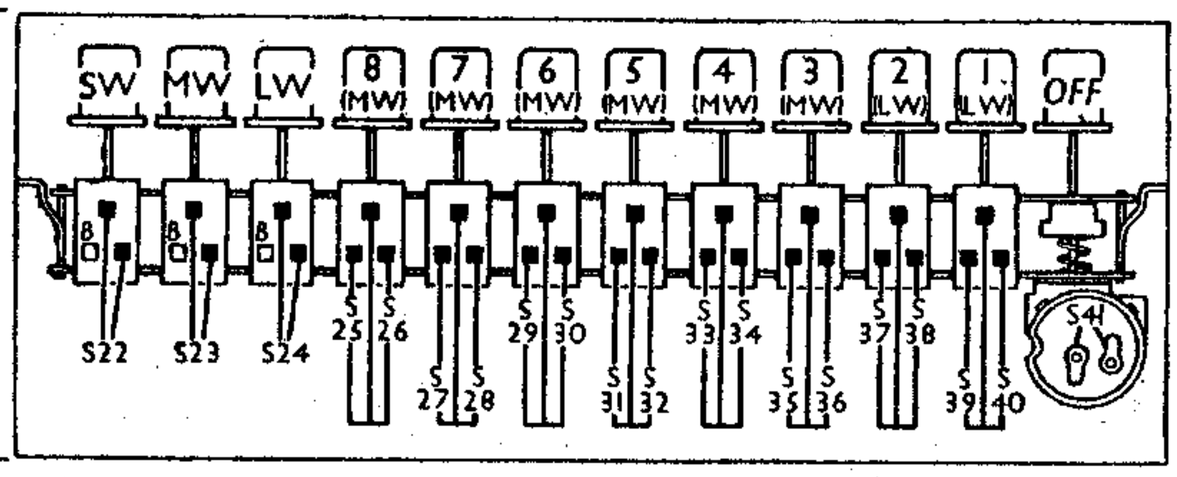
LW.—Press the LW button, tune to 1,700 m on scale, feed in a 1,700 m (176.6 kc/s) signal, and adjust **L10** for maximum output. Tune to 1,000 m on scale, feed in a 1,000 m (300 kc/s) signal, and adjust **C47** for maximum output, using the peak involving the lesser trimmer capacity if two are found.

Tune to 1,300 m on scale, feed in a 1,300 m (231 kc/s) signal, and adjust **C38** and **C42** for maximum output. Readjust **L10** at 1,700 m, and if any adjustment is required to secure correct calibration, return to 1,000 m and 1,300 m and repeat the LW procedure.

Image Suppressor.—Press the MW button, feed in a strong 300 m (1,000 kc/s) signal, and locate the image signal at about 406.5 m on scale. Then adjust **C36** for minimum output.

Station Setting.—This is explained under "Circuit Description" overleaf.

Diagram of the press-button switch unit, as seen from above and the rear.



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