G.E.C. RADIO

MADE IN ENGLAND

SERVICE BULLETIN No. 93

5 Valve Superhet Receiver

Model **BC4650** for AC Mains	190/250 V.	40/100 Cycles
Model **BC4650L** for AC Mains	110/130 & 210/230 V.	40/100 Cycles

DESCRIPTION OF RECEIVER

The BC4650 5 valve Superhet is a 3 wave-band table model receiver designed for A.C. mains operation. Five valves, including rectifier, are used and a permanent magnet loudspeaker is incorporated. The 3 wave-bands covered are: S.W., 16·5/50 metres, M.W., 192/550 metres, and L.W., 1,000/2,000 metres. Band selection and off-on operation is by a four way push-button unit. Other controls are Tuning, Volume and Tone. Terminals are provided for connecting gramophone pick-up and low impedance extension loudspeaker.

CIRCUIT

The stages are: triode-hexode, frequency changer (X61M.), variable-mu R.F. tetrode, I.F. amplifier (KTW61), double-diode-triode, signal diode, A.V.C. diode and A.F. amplifier (DH63), tetrode power output valve (KT61), bi-phase half wave rectifier (U50).

The aerial is coupled inductively (L1) to the frequency changer input circuit on the short wave-band and by the common impedance of C2 on the medium and long wave-bands. Local oscillations are maintained on S.W. by inductive coupling (L6) and on M.W. and L.W. by the impedance of T8, C9 and C7 common to both anode and grid circuits of the triode section. Tuning is by a twin ganged condenser.

The frequency changer is followed by the KTW61 intermediate frequency amplifier operating at 456Kc/s., the I.F.T's having magnetic cored coils. Both valves are controlled on all ranges by A.V.C. derived from the secondary of the second I.F.T.

The third valve, a double-diode-triode, DH63, operates conventionally, passing on the amplified A.F. signal to the output power tetrode, KT61, and providing delayed A.V.C. The delay is obtained from the voltage drop across R19, in the DH63 cathode circuit and the potential developed across R26 in the H.T. negative feed. Standing bias for the X61M and KTW61 is also derived from R26. The volume control potentiometer constitutes part of the signal diode load.

Full tone compensation is effected in the coupling between the double-diode-triode and the power output valve. C22 and R21 give a rising frequency characteristic in the treble register, and C23 and R23 a rising characteristic in the bass.

A permanent magnet loudspeaker with a speech coil of 3 ohms impedance is fitted and terminals are provided for connecting a low impedance extension loudspeaker.

The H.T. supply is obtained from a U50 bi-phase half wave rectifier valve.

When used with a gramophone pick-up the receiver should be switched to S.W. where the treble compensator circuit is inoperative.

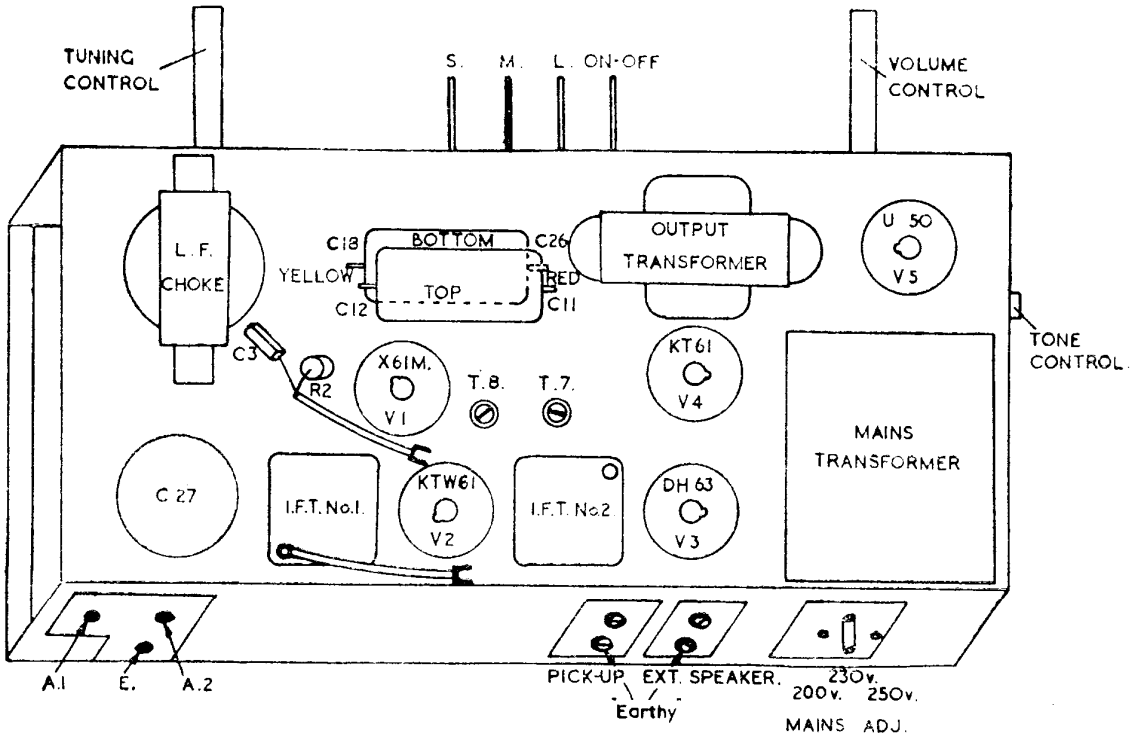

FIG. 1. PLAN VIEW OF CHASSIS

DISMANTLING RECEIVER

A detachable base cover is provided to permit rapid inspection of the underside of the chassis. To dismantle receiver, remove the base and back covers. Pull off the Volume and Tuning knobs and remove the Tone knob and its spindle by freeing the coupling under the chassis. There is no necessity to remove the push button knobs. Unscrew the four chassis securing bolts underneath the cabinet, and the two loudspeaker baffle assembly bolts located, one on each side of the loudspeaker. The complete chassis assembly may then be withdrawn.

DIAL LAMPS

2 OSRAM or G.E.C. 6·5 volt, 0·3 amp., Type " S." M.E.S. round lamps, Cat. No., O.S. 75, are fitted. *Other types should not be substituted as they may give an unduly short life or fail to provide sufficient illumination.*

VOLTAGE AND CURRENT VALUES

Measurements are approximate only, being average values taken with no signal input, the receiver tuned to 1 Mc/s. (300 metres) and the mains transformer correctly adjusted to the supply. Measurements which are not taken on the decoupled side of a circuit may give rise to false readings caused by oscillation of the circuit to which the meter is connected. D.C. voltage measurements are taken from chassis, with an 0-1200 voltmeter having a total resistance of 200,000 ohms. Readings taken with other meters may vary considerably from the accompanying figures.

Total H.T. voltage (unsmoothed)	308 volts
Total H.T. voltage (smoothed)	256 volts
Total H.T. current	72 mA.
A.C. H.T. secondary voltage...	320-0-320

Valve.		Electrode.	Voltage.	Current.
V1	X61M	Anode	180	1·7 mA.
		Screen	70	2·6 mA.
		Osc. Anode	90	3·3 mA.
V2	KTW61	Anode	256	8·2 mA.
		Screen	60	2·3 mA.
V3	DH63	Anode	70	0·7 mA.
V4	KT61	Anode	239	42 mA.
		Screen	256	6·9 mA.
V5	U50	Each Anode	320 AC	

NOTE.—The set is designed for the valves mentioned above and other types must not be substituted.

OSRAM VALVES are supplied for British Empire Markets and GEC-VALVES for other territories. Both are identical, except for the trade mark stamping, and are produced for The General Electric Co., Ltd., at the M.O Valve Works, London. Replacements should always be made with the appropriate type.

WIRING COLOUR CODE

The inter-connecting wiring of the receiver conforms to a standard colour code, details of which are as follows :—

WHITE : high potential connections to aerial circuit, first section of band-pass circuits and the non-earthy side of speech coil connections.

GREEN : grid connections and high potential ends of signal circuits.

GREEN/WHITE : grid circuit de-coupling and A.V.C. wiring.

BLUE : screen grid connections.

BLUE/WHITE : screen grid de-coupling.

PINK : cathode connections.

PINK/WHITE : cathode de-coupling.

BLACK : earth or chassis connections.

SLATE : H.T. negative, when not directly connected to earth or chassis.
RED : H.T. positive (smoothed).
RED/WHITE : H.T. positive (unsmoothed).
BLACK/RED, **BLACK/WHITE** } heater or filament wiring.

STANDARD RESISTOR COLOUR CODE

For convenience the Standard Resistor Colour Code is given, as the majority of resistors used in the receiver are colour coded for value and tolerance. The resistance value is indicated by distinctive colour markings and the tolerance by means of gold or silver end markings.

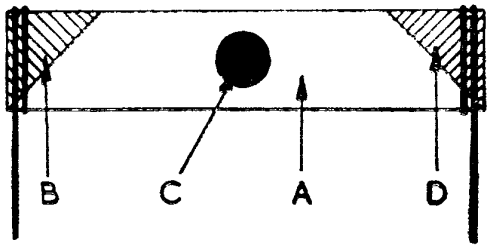

FIG. 2

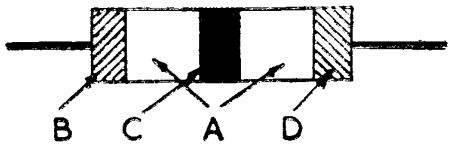

FIG. 3

The resistance is determined by the respective colours of " Body " (A) " End " (B) and " Dot " (C), see Fig. 2. The colour of the " body " determines the first figure of the resistance value, the colour of the " end " the second figure, and that of the " dot " the number of ciphers following the second figure. In addition to the above, the resistors having a closer tolerance than ± 20% have a second " end " indication (D).

The key to the complete code is given below.

First Figure, " Body " (A)	Second Figure, " End " (B)	Ciphers, " Dot " (C)	Tolerance, (D)
0=Black	0=Black	None =Black	± 5% =Gold
1=Brown	1=Brown	0 =Brown	±10% =Silver
2=Red	2=Red	00 =Red	
3=Orange	3=Orange	000 =Orange	
4=Yellow	4=Yellow	0000 =Yellow	
5=Green	5=Green	00000 =Green	
6=Blue	6=Blue	000000=Blue	
7=Violet	7=Violet		
8=Grey	8=Grey		
9=White	9=White		

N.B.—When the colour of the " dot " is the same as the colour of the " body," the " dot " of course, does not show, and the number of ciphers after the second figure is the same as the first figure of the resistance value.

It will be noted in Fig. 3 that the " dot " is replaced with a narrow band of colour. Resistors of both types are incorporated in the receiver.

ALIGNMENT INSTRUCTIONS

APPARATUS REQUIRED

Output Meter. This should be an A.C. voltmeter with a full scale deflection of approximately 100 v. and resistance of not less than 20,000 ohms. A universal multiple range service meter operating on a suitable A.C. volts range is usually the most convenient form of output meter.

Service Oscillator. The oscillator should cover the wave range of the receiver and the intermediate frequency. The attenuator should provide a suitable minimum output, and two dummy aerials, one for the short wave band and one for the higher wave bands should be available. It must be capable of modulation to a depth of 30% at audio frequency (400—1,000 cycles).

Alignment should not be attempted or the trimmers disturbed unless the above mentioned apparatus is available.

PREPARATION

The receiver must be switched on for at least five minutes before alignment is commenced. The concentricity of pointer and tuning scale should be checked. At maximum capacity of the tuning condenser the pointer should be exactly horizontal.

Connect output meter across C24 (primary winding of the output transformer). A reading of approximately 13·5 volts indicates a 50 mW. output. In order to avoid the effects of A.V.C., an output of 13·5 volts must not be exceeded during adjustment. Great care must be taken to keep the output meter leads well clear of the volume control, frequency changer and R.F. circuit wiring, and to avoid a short circuit of the H.T. supply by accidental contact with the chassis.

Set volume control to maximum and tone control to " brilliant."

Section (1) below gives a tabular summary of the alignment operations, and Section (2) gives full detailed instructions.

The under chassis view, Fig. 9, Page 12 should be referred to for the trimmer positions.

(1) Tabular Summary.

Adjustments must be made in the sequence shown.

Range.	Alignment Frequency	Adjust trimmers for maximum output	Notes.
Intermediate frequency	456 Kc/s.	T12, T11, T10, T9	Tuning condenser at maximum and L.W. button depressed
M.W.	1·4 Mc/s. (214 metres)	T5, T2	
192/550 metres	600 Kc/s. (500 metres)	T8	
	1·4 Mc/s. (214 metres)	T5, T2	Check
L.W.	300 Mc/s. (1,000 metres)	T6, T3	
1,000/2,000 metres	165 Kc/s. (1,818 metres)	T7	
	300 Kc/s. (1,000 metres)	T6, T3	Check Repeat at 165 Kc/s., if appreciable adjustment necessary Recheck at 300 Kc/s.
S.W. 16·5/50 metres.	18 Mc/s. (16·7 metres)	T4, T1	T4 minimum capacity setting. Final adjustments to T1 to be accompanied by adjustment of tuning condenser to minimise effects of pulling between circuits

(2) Detailed Procedure.

(*a*) Intermediate frequency, 456 Kc/s.

(i) Set tuning condenser to maximum capacity and depress L.W. button.

(ii) Tune service oscillator to 456 Kc/s. and connect output to grid (top cap) of X61M. valve through an isolating condenser of not less than 0·001 mF. The receiver grid connection should not be removed.

(iii) Adjust trimmers T12, T11, T10, T9, in sequence for maximum output. It is important that the output meter reading should not exceed 13·5 volts and this should be maintained during alignment by progressively reducing the output from the service oscillator.

MEDIUM WAVE-BAND. Range 192/550 metres.

(*b*) 1·4 Mc/s. (214 metres).

(i) Depress M.W. button and set tuning pointer to 214 metres.

(ii) Tune service oscillator to 1·4 Mc/s. and connect to Aerial 2 and Earth terminals of receiver through M.W. dummy aerial.

(iii) Adjust trimmers T5, T2, in sequence, for maximum output.

(*c*) 600 Kc/s. (500 metres).

(i) Set tuning pointer to 500 metres.

(ii) Tune service oscillator to 600 Kc/s.

(iii) Adjust padding condenser T8 for maximum output. Move tuning condenser slightly and re-adjust T8 for maximum response. If output is less than before, move condenser in opposite direction, again adjusting T8 for maximum, noting output meter reading.
Continue "rocking" the tuning condenser until a maximum reading has been obtained. This should be very close to 500 metres on the tuning scale.

(*d*) 1·4 Mc/s. (214 metres).

Repeat procedure given in section (*b*) to ensure correct alignment.

LONG WAVE-BAND. Range 1,000/2,000 metres.

(*e*) 300 Kc/s. (1,000 metres).

(i) Depress L.W. button and set tuning pointer to 1,000 metres.

(ii) Tune service oscillator to 300 Kc/s.

(iii) Adjust trimmers T6, T3, in sequence, for maximum output.

(*f*) 165 Kc/s. (1,818 metres).

(i) Set tuning pointer to 1,818 metres.

(ii) Tune service oscillator to 165 Kc/s.

(iii) Adjust padding condenser T7 for maximum output.
"Rock" tuning condenser for maximum response as described in Section (*c*) (iii).

(*g*) 300 Kc/s. (1,000 metres).
Repeat procedure given in Section (*e*). If appreciable re-adjustment is necessary, repeat both Section (*f*) and Section (*e*).

SHORT WAVE-BAND. Range 16·5/50 metres.

(*h*) 18 Mc/s. (16·7 metres)

(i) Depress S.W. button and set tuning pointer to 16·7 metres.

(ii) Tune service oscillator to 18 Mc/s. and connect to Aerial 2 and Earth terminals through S.W. dummy aerial.

(iii) Adjust trimmers T4, T1, in sequence, for maximum output. Two settings for T4 will be found; the lower capacity position must be used. The final adjustment to T1 should be accompanied by slight retuning of the tuning condenser to obtain maximum output. If excessive retuning is required the pointer should be reset at 16·7 metres and T4 re-adjusted. The final procedure for adjusting T1 should be repeated.

Seal the trimmers with a cellulose adhesive, taking care to keep the adjusting screw slots clear and to confine the adhesive to the top trimmer plate.

DRIVE WIRE REPLACEMENT INSTRUCTIONS

Before the drive wire can be replaced it is necessary to remove the pointer, loudspeaker and baffle. Release the pointer by holding its spindle by means of a screwdriver placed in the end slot and removing the locking nut with a spanner. The pointer can now be removed by unscrewing in an anti-clockwise direction. If difficulty is experienced in releasing the nut, warm the sealing adhesive by application of a hot soldering iron for a short period.

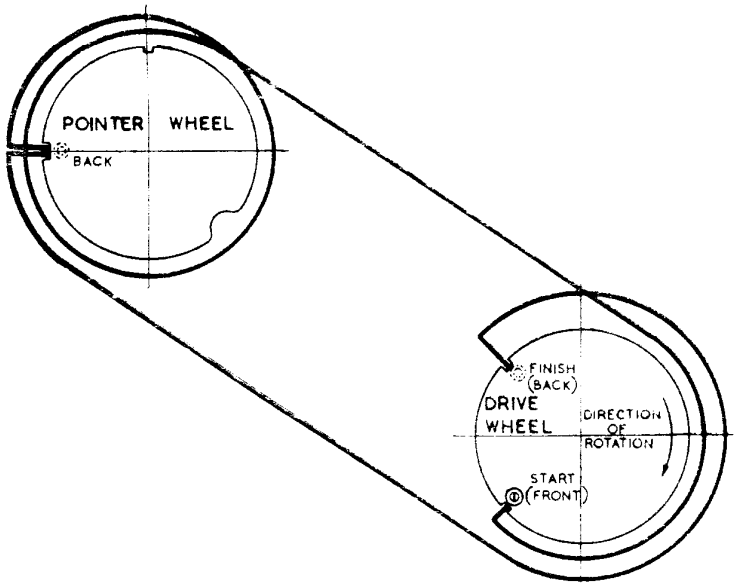

FIG. 4. DRIVE WIRE DETAIL

Having completed the removal of the baffle, which is secured by four fixing bolts located two on each side, immediately below the dial lamps, place the chassis with controls facing the operator, rotate the tuning condenser until the plates are completely disengaged and move the pointer drive wheel so that the fixing screw on the rear is at 9 o'clock, see fig. 4.

Fasten one end of the wire under the front securing screw (now at 8 o'clock) on tuning drive wheel, pass around groove in an anti-clockwise direction for a half turn and then direct to and over the pointer drive wheel. After making slightly more than a complete turn anti-clockwise, the wire is looped around the locating screw on the back of the pointer wheel and secured. Continuing in the groove in the same direction the wire is passed under the tuning drive wheel and along the groove in an anti-clockwise direction, terminating under the head of the screw fitted at 10 o'clock on the rear of the wheel.

SPARE PARTS PRICE LIST

Material.	Part No.	List Price. U.K. and N.I. only.
Cabinet (less fittings)	R.800642	42/- each
Loudspeaker P.M.	RK.201687	33/6 each
Mains Transformer (Standard)	R.802339	38/- each
Mains Transformer (Low Voltage) ...	R.802343	46/3 each
Aerial Coil Assembly	CRP.101890	7/- each
Oscillator Coil Assembly	CRP.101886	5/9 each
I.F. Transformer (I.F.T. 1)	RK.201299/Ass 3	13/3 each
I.F. Transformer (I.F.T. 2)	RK.201308/Ass 1	13/3 each
Tuning Drive Unit	RK.200436	8/- each
Switch Unit (Type F)	RK.200437	13/- each
Volume Control (Type C)	RK.200439	2/6 each
Tone Control (Type C)	RK.200438	2/6 each
Tuning Condenser, 2 ganged	RK.200013	18/9 each
Output Transformer	RK.200504	12/- each
Smoothing Choke	CRP.100879	12/- each
Register	R.802274	2/3 each
Mains Lead	RK.200805	7/- each
Valve Holders, Octal	R.800632	9d. each
Tuning Pointer	R.800291	1/- each
Window Glass	RP.101845	6d. each
Control Knobs (Tuning/Tone/Volume)	CRP.101975	9d. each
Control Knobs (Push Button, 4 per set)	RK.200515	5d. each
Back Cover (BC4650)	R.801880	3/- each
Back Cover (BC4650L)	R.801888	3/- each
Base Cover...	R.800628	1/9 each
Pointer Drive Wire (approx. 33") ...	for BC. 4650/L	3d. each
Electrolytic Condensers.		
16 mF. 450 v. wkg. (C 27)	RK.201574	7/- each
8 + 4 mF. packs 450 v. wkg. (C11, C12 and C18, 26)	RK.201575	5/9 each
25 mF. 25 v. wkg.	RK.200598	2/6 each
Close Tolerance Condensers.		
0·003 mF. Silvered Mica (C2) ...	RK.201615	3/6 each
0·00395 mF. Silvered Mica (C7) ...	RK.201611	4/- each
Condensers-Tubular : Up to 0·02 mF., 1/- each ; 0·05 mF. (500 and 750v), 1/3 each ; up to 0·01 mF., 1,000 v., 2/- each.		

Note.—The prices shown above are those ruling at the time of going to press and are subject to alteration without notice.

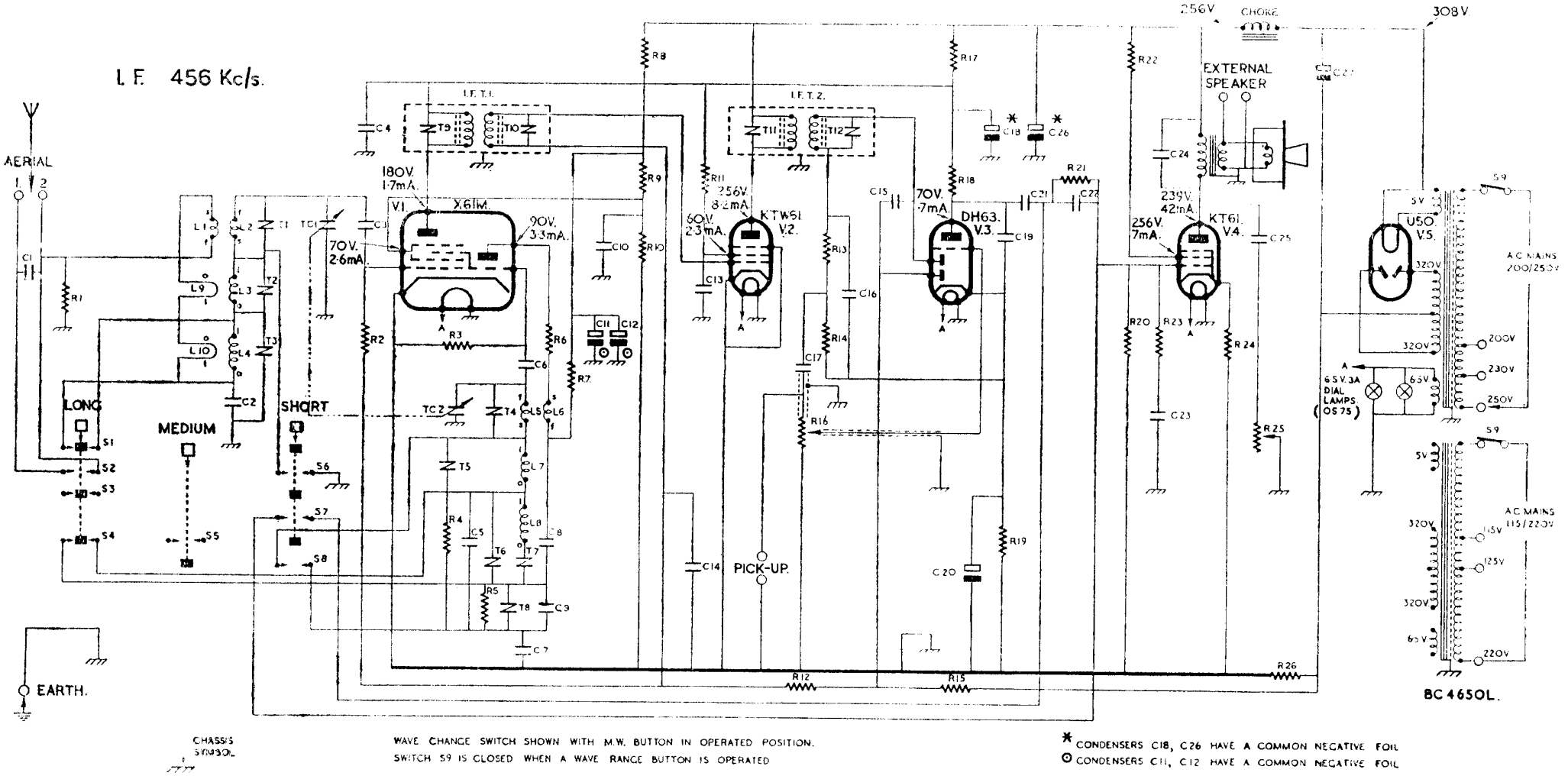

FIG. 5. CIRCUIT DIAGRAM OF BC4650 & BC4650L RADIO RECEIVERS

CONDENSER VALUES

C1	22 pF.	Protected Silvered Mica	C15	22 pF.	Protected Silvered Mica
C2	*0·003 mF.	Silvered Mica	C16	300 pF.	Moulded Mica foil
C3	100 pF.	Moulded Mica foil	C17	0·02 mF.	Tubular (750v.)
C4	0·05 mF.	Tubular (500v.)	C18	4 mF.	Electrolytic Pack (450v.)
C5	39 pF.	Protected Silvered Mica	C19	500 pF.	Moulded Mica Foil
C6	100 pF.	Moulded Mica Foil	C20	25 mF.	Electrolytic (25v.)
C7	*0·00395 mF.	Silvered Mica	C21	0·02 mF.	Tubular (750v.)
C8	0·005 mF.	Tubular (1,000v.)	C22	200 pF.	Moulded Mica Foil
C9	100 pF.	Protected Silvered Mica	C23	0·0015 mF.	Moulded Mica Foil
C10	0·05 mF.	Tubular (500v.)	C24	0·005 mF.	Tubular (1,000v.)
C11	8 mF.	Electrolytic Pack (450v.)	C25	0·05 mF.	Tubular (500v.)
C12	4 mF.		C26	8 mF.	Electrolytic Pack (450v.)
C13	0·05 mF.	Tubular (500v.)	C27	16 mF.	Electrolytic (450v.)
C14	0·05 mF.	Tubular (500v.)			*Close Tolerance

RESISTOR VALUES

No.	Resistance.	Rating.	Type.	Tol.	No.	Resistance.	Rating.	Type.	Tol.
R1	10,000 ohms.	½ watt	E8	±10%	R14	470,000 ohms.	½ watt	E8	±10%
R2	1 megohm.	½ ,,	E8	±20%	R15	470,000 ,,	½ ,,	E8	±10%
R3	100,000 ohms.	½ ,,	E8	±10%	R16	1 megohm.	Volume Control Type C		
R4	68 ,,	½ ,,	E8	±10%	R17	15,000 ohms.	½ watt	E8	±10%
R5	10,000 ,,	½ ,,	E8	±10%	R18	100,000 ,,	½ ,,	E8	±10%
R6	470 ,,	½ ,,	E8	±10%	R19	2,200 ,,	½ ,,	E8	±10%
R7	22,000 ,,	½ ,,	E8	±10%	R20	330,000 ,,	½ ,,	E8	±10%
R8	10,000 ,,	1 ,,	E2	±10%	R21	680,000 ,,	½ ,,	E8	±10%
R9	15,000 ,,	1 ,,	E2	±10%	R22	100 ,,	½ ,,	E8	±10%
R10	22,000 ,,	½ ,,	E8	±10%	R23	150,000 ,,	½ ,,	E8	±10%
R11	56,000 ,,	½ ,,	E8	±10%	R24	91 ,,	½ ,,	E8	±10%
R12	1 megohm.	½ ,,	E8	±20%	R25	55,000 ,,	Tone Control Type C		
R13	56,000 ohms.	½ ,,	E8	±10%	R26	39 ,,	½ watt	E8	±10%

RESISTANCE OF MISCELLANEOUS COMPONENTS

I.F. Transformers

I.F.T.1 Prim. or Sec.	7·0 ohms.
I.F.T.2 Prim. or Sec.	4·0 ,,

Output Transformer

Primary	430 ,,
Secondary	0·49 ,,

Loudspeaker

Speech Coil	2·3 ,,

Smoothing Choke ... ... 650 ,,

Mains Transformers

Primary (Standard)

0—200 V.	27 ,,
0—230 V.	31 ,,
0—250 V.	34 ,,
H.T. Secondary (Total) ...	340 ,,
Rectifier Fil. Secondary ...	0·13 ,,
Heater Secondary	0·16 ,,

Primary (Low Voltage)

0—110/120 V.	10·5 ,,
0—120/130 V.	11·5 ,,
0—210/230 V.	26·0 ,,

COIL ASSEMBLY DETAILS

OSCILLATOR.

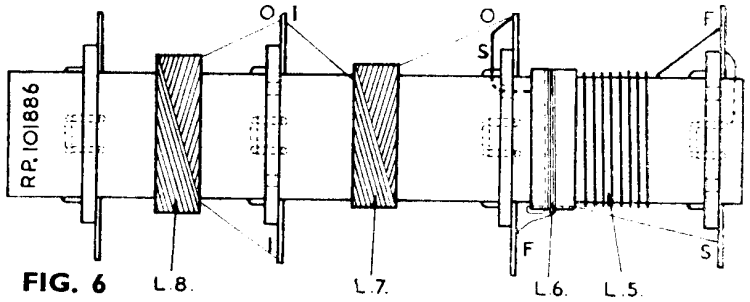

FIG. 6

AERIAL.

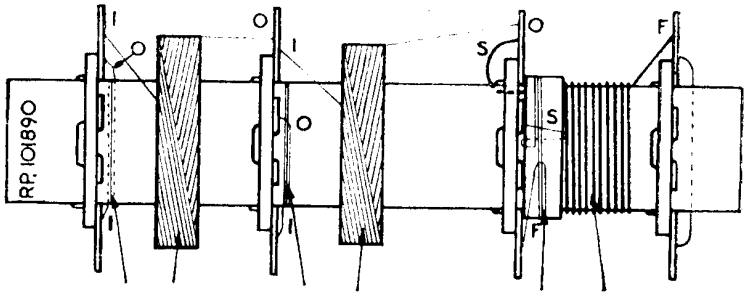

FIG. 7

COIL MEASUREMENTS

L1, L9, L10	Total Series Resistance	0·36 ohms.
L2	Aerial S.W. Sec.	0·06 ,,
L3	Aerial M.W. Coil	2·80 ,,
L4	Aerial L.W. Coil	19·50 ,,
L5	Oscillator S.W. Grid	0·06 ,,
L6	Oscillator S.W. Anode	0·32 ,,
L7	Oscillator M.W. Coil	3·40 ,,
L8	Oscillator L.W. Coil	7·70 ,,

SWITCH OPERATION

	Metres	S1	S2	S3	S4	S5	S6	S7	S8	S9
Long	1000–2000	O	C	O	O	C	O	O	O	C
Med.	192–550	C	O	C	C	O	O	O	O	C
Short	16·5–50	C	O	C	C	C	C	C	C	C
Off		C	O	C	C	C	O	O	O	O

C = Closed O = Open

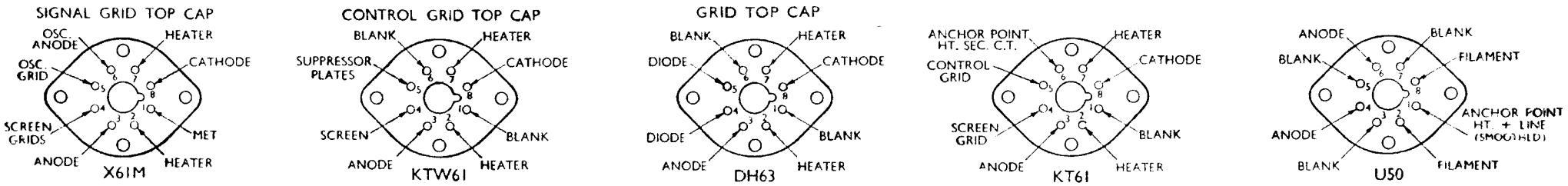

FIG. 8. UNDER CHASSIS VIEW OF VALVE SOCKETS

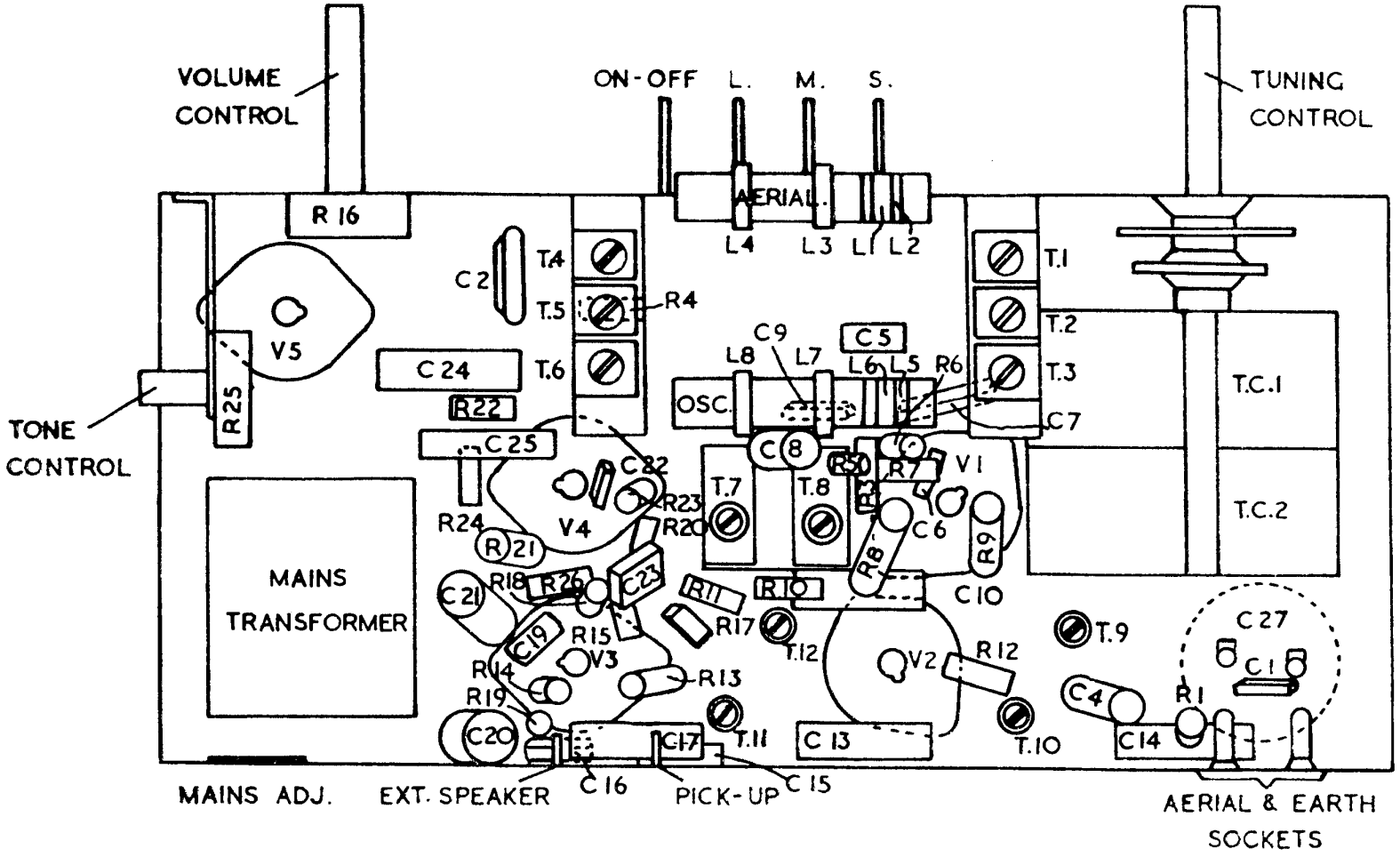

FIG. 9. UNDER CHASSIS VIEW