Supplement to The Wireless & Electrical Trader, October 16, 1948

"TRADER" SERVICE SHEET 882

INVICTA 31

Four-Band A.C. Superhet

A PLATE aerial for S.W. operation and a frame aerial for the M.W. and L.W. bands are fitted in the Invicta 31, so that the receiver may be operated on the four wavebands provided if desired in the absence of an external aerial. A normal aerial may be fitted, however, in permanent installations.

The receiver is a 3-valve (plus rectifier) superhet for operation from A.C. mains of 200-250 V, 40-100 c/s. The four waveband ranges are: 14-40 m (S.W.1), 60-200 m (S.W.2), 200-550 m (M.W.) and 900-2,000 m (L.W.). Provision is made for the connection of a gramophone pick-up and an external speaker.

It should be carefully noted that the rectifier may be an AZ31 or an EZ35. This is explained overleaf.

Release date and original price: May 1948; £18 18s. plus purchase tax.

CIRCUIT DESCRIPTION

On the two S.W. bands, input from external or plate aerial is inductively coupled by **L1** to single-tuned circuit **L3, C30** on S.W.1, and directly coupled, via a tapping, to single-tuned circuit **L4, C30.**

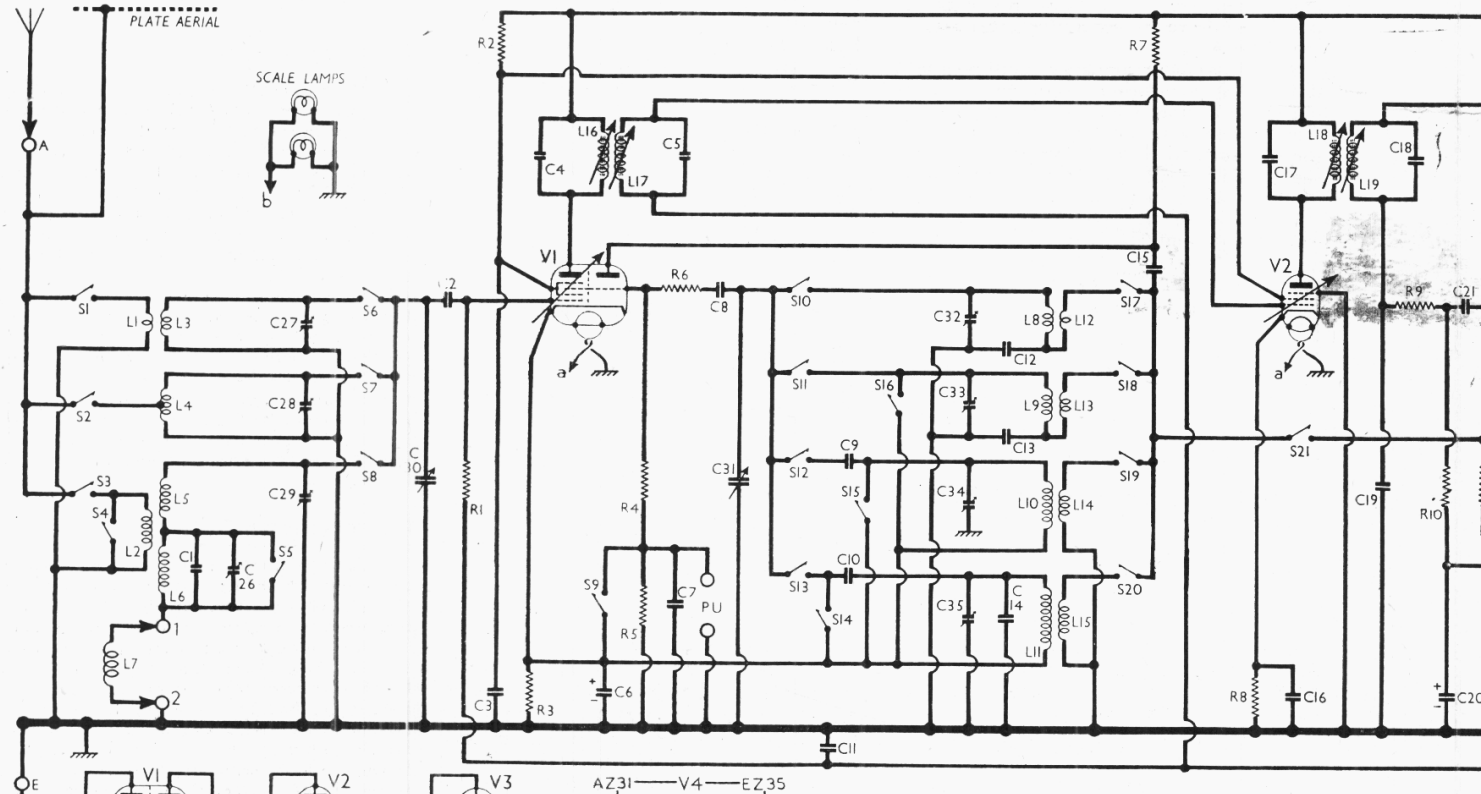
On M.W. and L.W., frame aerial input is provided by **L7,** in conjunction with loading coils **L5** (M.W.) and **L6** (L.W.), tuned by **C30.** Provision is made for the connection of an external aerial, which is operative on all bands, insertion of the aerial plug automatically opening **S4** to remove the short-circuit across the aerial coupling coil **L2.**

First valve **(V1, Mullard metallized ECH35)** is a triode-hexode operating as frequency changer with internal coupling. Triode oscillator grid coils **L8** (S.W.1), **L9** (S.W.2), **L10** (M.W.) and **L11** (L.W.) are tuned by **C31,** with parallel trimming by **C32** (S.W.1), **C33** (S.W.2), **C34** (M.W.) and **C14, C35** (L.W.); and series tracking by **C12** (S.W.1), **C13** (S.W.2), **C9** (M.W.) and **C10** (L.W.). Reaction coupling from anode, via **C15,** by coils **L12** (S.W.1), **L13** (S.W.2), **L14** (M.W.) and **L15** (L.W.), additional coupling on the two S.W. bands being obtained by the inclusion of the tracking capacitors, which form a common impedance in the grid and anode circuits.

Second valve **(V2, Mullard metallized EF39)** is a variable-mu R.F. pentode operating as intermediate frequency amplifier with tuned transformer couplings **C4, L16, L17, C5** and **C17, L18, L19, C18,** in which the tuning capacitors are fixed and alignment adjustments are made by varying the positions of the iron-dust cores.

Intermediate frequency 465 kc/s.

Diode second detector is part of double diode pentode output valve **(V3, Mullard metallized EBL31).** Audio frequency component in rectified output is developed across diode load resistor **R10,** and passed



Circuit diagram of the Invicta 31 4-band superhet. A plat S.W. bands) and a frame winding **L7** (for M.W. and L.W provided to permit the receiver to operate without an external gramophone operation, the pick-up input is fed to the grid section of **V1,** which then becomes an A.F. amplifier, and t passed via **S21** to **V3** pentode. Where **V4** is an EZ35, **R21**

via A.F. coupling capacitor **C21,** manual control **R11,** and C.G. stopper **R16,** to control grid of pentode section. I.F. filtering by **C19, R9** in diode circuit, and **R16** in **V3 C.G.** circuit.

Second diode of **V3,** fed from **L19** via **C23,** provides D.C. potential which is developed across load resistor **R20** and fed back, through a decoupling circuit **R19, C11,** as **G.B.** to F.C. and I.F. valves, giving automatic gain control. Delay voltage, together with G.B. for pentode section, is obtained from the drop across **R17, R18** in **V3** cathode lead to chassis.

Three-position tone control is provided via the potential divider network **R12, R13, C22, R14, R15** and **S22, S23,** which is connected across the output of **V3** pentode section. The fraction of the output which is developed across **R15** is applied to the control grid circuit of the valve, via **R11,** giving negative feed-back, and the frequency response is modified from the "Brilliant" condition (both switches open) to "Normal" (**S22** closed), or "Mellow" (**S23** closed).

For "Gram" operation, when **S9** opens, **V1** triode section is converted to an A.F. amplifier by connection of the pick-up, shunted by **R5, C7,** in its grid circuit. The amplified A.F. voltages developed

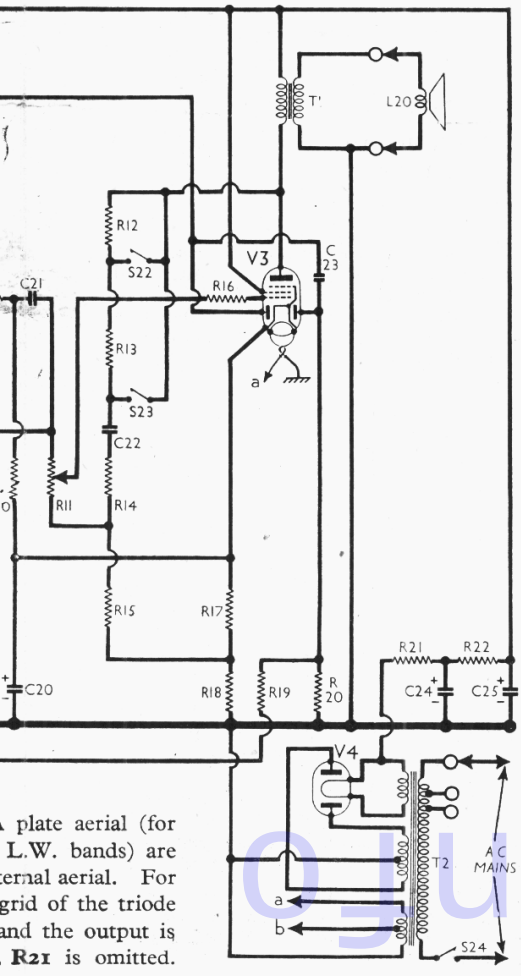
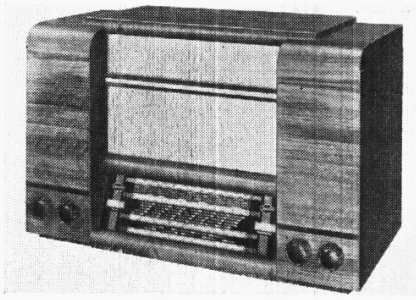


plate aerial (for L.W. bands) are ternal aerial. For grid of the triode and the output is **R21** is omitted.



across the triode anode load resistor **R7** are fed, via **C15** and **S21,** to **V3** C.G. circuit.

H.T. current is supplied by full-wave rectifying valve **(V4, Mullard AZ31** or **EZ35).** Smoothing by resistor **R22** and electrolytic capacitors **C24, C25.**

COMPONENTS AND VALUES

	RESISTORS	Values (ohms)	Locations
R1	V1 hex. C.G. ...	1,000,000	B2
R2	S.G.'s H.T. feed ...	47,000	L4
R3	V1 fixed G.B. ...	220	L3
R4	V1 triode C.G. resistors ...	47,000	M4
R5	V1 triode C.G. resistors ...	200,000	M4
R6	Osc. stabilizer ...	56	M4
R7	Osc. H.T. feed ...	47,000	M4
R8	V2 fixed G.B. ...	220	L5
R9	I.F. Stopper ...	47,000	K5
R10	Sig. diode load ...	470,000	K5
R11	Volume control ...	1,000,000	G3
R12	Negative feed-back potential divider resistors ...	100,000	H3
R13	Negative feed-back potential divider resistors ...	33,000	H3
R14	Negative feed-back potential divider resistors ...	15,000	G3
R15	Negative feed-back potential divider resistors ...	4,700	J4
R16	V3 C.G. stopper ...	100,000	D2
R17	V3 G.B., A.G.C. delay resistors ...	150	J4
R18	V3 G.B., A.G.C. delay resistors ...	330	J4
R19	A.G.C. decoupling	1,000,000	K5
R20	A.G.C. diode load ...	1,000,000	K5
R21	V4 surge limiter ...	100	J5
R22	H.T. smoothing ...	1,500	J4

	CAPACITORS	Values (μF)	Locations
C1	Aerial L.W. trim. ...	0·000022	B2
C2	V1 hex. C.G. ...	0·0003	A1
C3	S.G.'s decoupling ...	0·02	L5
C4	1st I.F. transformer tuning ...	0·00007	C2
C5	1st I.F. transformer tuning ...	0·00007	C2
C6*	V1 cath. by-pass ...	50·0	L4
C7	P.U. tone corrector	0·005	M4
C8	V1 osc. C.G. ...	0·0001	O3
C9	Osc. M.W. tracker	0·00057	N3
C10	Osc. L.W. tracker	0·00034	O3
C11	A.G.C. decoupling	0·1	L5
C12	Osc. S.W.1 track ...	0·005	M3
C13	Osc. S.W.2 track ...	0·002	N4
C14	Osc. L.W. trimmer	0·00014	M4
C15	Osc. anode coupling	0·02	M3
C16	V2 cath. by-pass ...	0·1	L5
C17	2nd I.F. transformer tuning ...	0·00014	D2
C18	2nd I.F. transformer tuning ...	0·00014	D2
C19	I.F. by-pass ...	0·0001	K5
C20*	V3 cath. by-pass ...	50·0	H5
C21	A.F. coupling ...	0·01	K5
C22	F.-B. coupling ...	0·01	H3
C23	A.G.C. coupling ...	0·000022	K5
C24*	H.T. smoothing capacitors ...	32·0	E1
C25*	H.T. smoothing capacitors ...	32·0	E1
C26‡	Aerial L.W. trim.	0·00003	B2
C27‡	Aerial S.W.1. trim.	0·00003	B2
C28‡	Aerial S.W.2. trim.	0·00003	A2
C29‡	Aerial M.W. trim.	0·00003	B2
C30†	Aerial tuning ...	0·000537	B1
C31†	Oscillator tuning ...	0·000537	B1
C32‡	Osc. S.W.1. trim. ...	0·00004	N4
C33‡	Osc. S.W.2. trim. ...	0·00004	N4
C34‡	Osc. M.W. trim. ...	0·00004	O4
C35‡	Osc. L.W. trim. ...	0·00004	O4

* Electrolytic. † Variable. ‡ Pre-set.

	OTHER COMPONENTS	Approx. Values (ohms)	Locations
L1	Aerial coupling coils ...	0·1	B2
L2	Aerial coupling coils ...	68·0	B2
L3	Aerial tuning coils	Very low	B2
L4	Aerial tuning coils	0·3	A2
L5	Aerial tuning coils	2·3	B2
L6	Aerial tuning coils	12·7	B2
L7	Frame aerial ...	0·6	A2
L8	Oscillator tuning coils ...	Very low	N3
L9	Oscillator tuning coils ...	0·3	N4
L10	Oscillator tuning coils ...	2·2	M3
L11	Oscillator tuning coils ...	3·3	M4
L12	Oscillator reaction coils ...	18·0	N3
L13	Oscillator reaction coils ...	23·0	N4
L14	Oscillator reaction coils ...	68·0	M3
L15	Oscillator reaction coils ...	83·0	M4
L16	1st I.F. trans. Pri.	8·0	C2
L17	1st I.F. trans. Sec.	8·0	C2
L18	2nd I.F. trans. Pri.	6·0	D2
L19	2nd I.F. trans. Sec.	6·0	D2
L20	Speech coil ...	2·5	—
T1	Output trans. Pri. ...	340·0	K4
T1	Output trans. Sec. ...	0·1	K4
T2	Mains trans. Pri., total	26·0	F2
T2	Mains trans. Heat. sec. Rect. heat. sec.,	Very low	F2
T2	Mains trans. H.T. sec., total	510·0	F2
S1-S21	W/band and Gram. switches ...	—	—
S22	Tone control switches ...	—	H3
S23	Tone control switches ...	—	H3
S24	Mains sw., g'd R11	—	G3

VALVE ANALYSIS

Valve voltages and currents given in the table below are those measured in our receiver when it was operating on mains of 223 V, using the 220-230 V tapping on the mains transformer. The receiver

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 ECH35	243	1·5	66	2·1
	Oscillator			
	86	3·4		
V2 EF39	243	5.5	66	1·6
V3 EBL31	233	35·0	243	4·3
V4 AZ31*	330†	—	—	—

* May be EZ35. See "Alternative Rectifiers."
† Each anode, A.C.

was tuned to the lowest wavelength on the M.W. 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 Avometer, chassis being the negative connection.

DISMANTLING THE SET

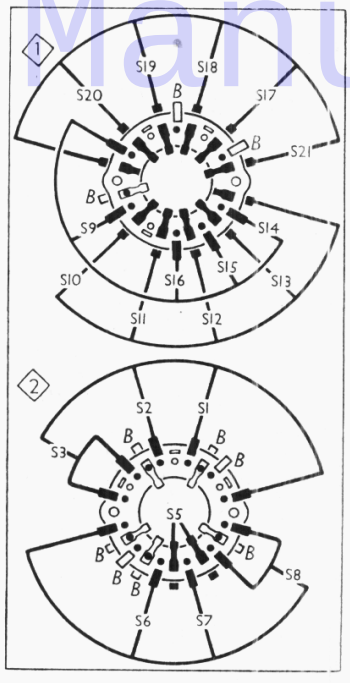
The cabinet is provided with a detachable bottom cover, upon removal of which (four round-head wood screws) access may be gained to the majority of the underchassis components, including several which are involved in circuit alignment.

Removing Chassis.—Remove the four control knobs (recessed grub screws) from the front of the cabinet;

unplug the internal speaker leads from sockets on the rear edge of the chassis, and unsolder the white plastic-covered lead which is connected to the plate aerial inside the top of the cabinet;

remove the four 2BA cheese-head screws (with steel washers, rubber grommets and brass sleeves) securing the chassis

Switch Diagrams and Table



Switch	Gram.	S.W.1	S.W.2	M.W.	L.W.
S1	—	C	—	—	—
S2	—	—	C	—	—
S3	—	—	—	C	C
S4	—	—	—	C†	C†
S5	C	C	C	C	—
S6	—	C	—	—	—
S7	—	—	C	—	—
S8	—	—	—	C	C
S9	—	C	C	C	C
S10	—	C	—	—	—
S11	—	—	C	—	—
S12	—	—	—	C	—
S13	—	—	—	—	C
S14	C	C	C	C	—
S15	C	C	C	—	C
S16	C	C	—	C	C
S17	—	C	—	—	—
S18	—	—	C	—	—
S19	—	—	—	C	—
S20	—	—	—	—	C
S21	C	—	—	—	—

† Opens upon insertion of external aerial plug

Diagrams of the waveband switch units, drawn as seen when viewed from the rear of an inverted chassis. *B* indicates blank tags. The associated table is on the right of these diagrams, in col. 2. **S4** is shown in location M5 in our chassis illustration opposite.

to the base of the cabinet, and slide out the chassis.

When replacing, two of the specially shaped rubber grommets should be fitted to each chassis retaining screw, one going on each side of the cabinet base, with a brass sleeve between them; a flat steel washer fits beneath the head of each screw. This operation is simplified if the two front grommets are placed in position in their recesses before inserting the chassis. A felt washer should be fitted between each control knob and the front of the cabinet.

Removing Speaker.—Unplug the two leads from sockets on the rear edge of the chassis and remove the four 4BA nuts securing the speaker to the sub-baffle. *When replacing*, the connecting panel should be at the top.

GENERAL NOTES

Switches.—**S1-S3** and **S5-S21** are the waveband and radio/gram change-over switches, ganged in two rotary units beneath the chassis. These units are indicated in our under-chassis view, and shown in detail in the diagrams in col. 1, where they are drawn as seen when viewed from the rear of an inverted chassis.

The table above gives the switch positions for the five control settings, starting from the fully anti-clockwise (gram) position of the control spindle. A dash indicates open, and **C**, closed.

S4 is associated with the aerial socket, and opens automatically upon insertion of a suitable aerial plug.

S22, S23 are the tone control switches, in a 3-position rotary unit beneath the chassis. This again is indicated in our under-chassis view. It is very simple, but it is shown in detail in the diagram below, where it is drawn as seen from the rear of an inverted chassis.

S24 is the Q.M.B. mains switch, ganged with the manual volume control **R11.**

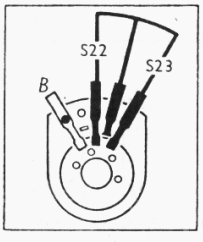
Scale Lamps.—There are two of these, rated at 6.5 V, 0.3 A. They have M.E.S. bases, and large, clear spherical bulbs.

Coils.—All the aerial circuit coils **(L1-L3; L5-L6)** excepting the S.W.2 unit **(L4)** and frame winding **(L7)** are in a single unit on the chassis deck. **L4** is beside it, and **L7** is mounted on the end of the chassis. The oscillator circuit coils are in two units beneath the chassis, the S.W. coils **L8, L9, L12, L13** being in one unit and the M.W. and L.W. coils **L10, L11, L14, L15** being in the other.

External Speaker.—Two sockets are provided at the rear of the chassis for the connection of the internal speaker or a low impedance (about 2Ω) external speaker. If both are required together, the external speaker plugs may be inserted in the sockets in the plugs of the internal speaker.

Capacitors C24, C25.—These are two dry electrolytics in a single tubular metal container, mounted on the chassis deck. Our sample was a Dubilier type CT unit, rated at 32+32 μF, 350 V D.C. working, 140 mA A.C. maximum. The two positive connections are brought out to two plain tags on the base, and the case forms the common negative connection.

Diagram of the tone control switch unit, as seen from the rear of an inverted chassis.

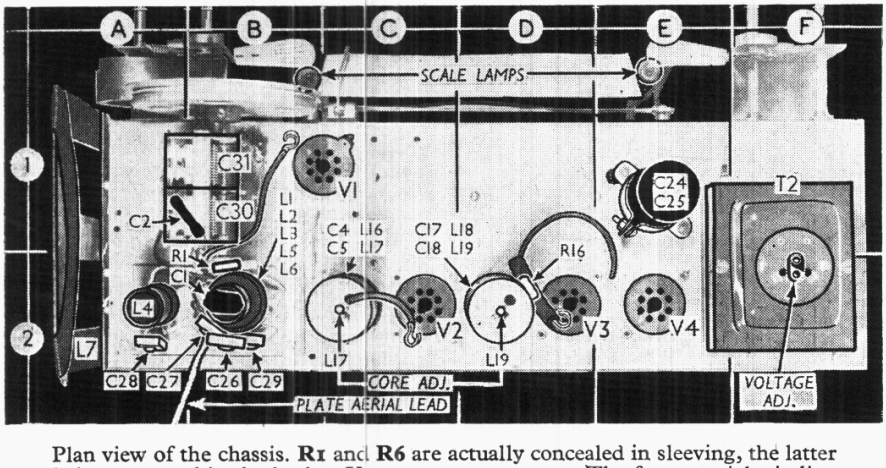


Alternative Rectifiers.—**V4** may be an AZ31 (with a 4 V filament) as in our sample, or an EZ35 (with a 6.3 V heater and an isolated cathode). The surge-limiting resistor **R21** is omitted when the slower-heating EZ35 is used, but the only other difference is in the heater winding on **T2** and the valve holder wiring.

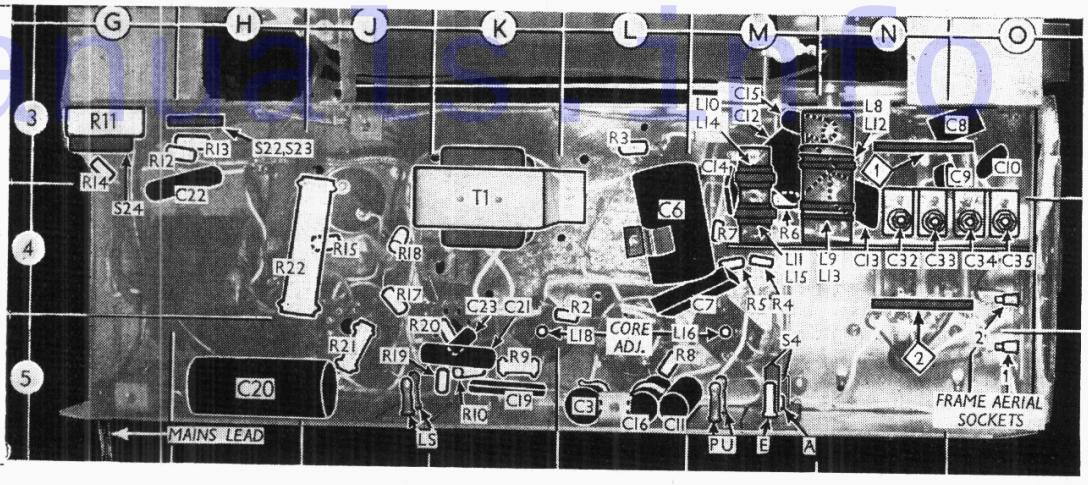
It will be seen from our base connection diagrams beneath the circuit diagram (where both types are shown) that the basings are different, but in the chassis, the cathode and heater (pins 7 and 8) are joined together. Care should be exercised, therefore, when replacing with an AZ31 that the chassis in question has a 4 V secondary winding, as otherwise the valve will be damaged.

Chassis fitted with the AZ31 bore serial numbers between 575800 and 580100. Our sample, for instance, bore the serial number 577488, and was fitted with an AZ31.

Other Divergencies.—In a very small number of models **C1** was omitted. In some chassis **R2** may be 22,000Ω instead of 47,000Ω.



Plan view of the chassis. **R1** and **R6** are actually concealed in sleeving, the latter being mounted in the lead to **V3** top cap connector. The frame aerial winding **L7** is seen on the extreme left of the chassis. The four aerial circuit trimmers are seen grouped round the aerial coils on the left.



Under-chassis view. The two waveband switch units are indicated here by diamonds numbered **1** and **2** to agree with the diagrams in col. 1, where they are shown in detail. Switch **S4**, which is operated by the aerial plug, is indicated in location M5.

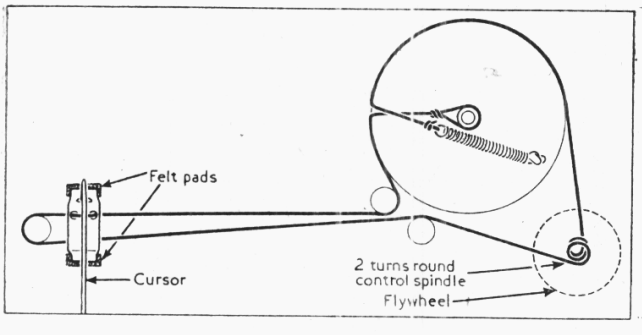
DRIVE CORD REPLACEMENT

Forty inches of Nylon braided glass yarn is required for the drive cord, which should be run as shown in the sketch below.

First thread the cord through the cursor carriage as shown in the sketch, with the free ends of the cord emerging from the rear of the carrier. Thread the right-hand end of the cord through the entry hole in the rim of the drum, then tie a loop about ½in in diameter and slip it into the groove round the centre boss of the drum.

Slide the cursor along the cord so that it takes up a position somewhere on the upper horizontal run, and complete the circuit as shown, making two turns round the control spindle and tying off so that the tension spring is extended to about 1½ times its closed length.

With the spring unhooked, the cursor can be slid comfortably along the cord to approximately the correct position, final adjustment being made on the taut cord with the scale in position after replacing the chassis in the cabinet.



Sketch showing the tuning drive system as it appears when viewed from the front, with the gang at minimum capacitance, which is the correct position for fitting a new cord.

CIRCUIT ALIGNMENT

For these operations the chassis must be in position in the cabinet.

I.F. Stages.—Connect signal generator, via an 0.1 μF capacitor in the "live" lead, to control grid (top cap) of **V1** and the **E** socket, after removing the original top cap connector and joining a 100,000 Ω resistor between the top cap of the valve and chassis.

Switch set to M.W., turn gang and volume control to maximum, feed in a 465 kc/s (645.16 m) signal, and adjust the cores of **L16, L17, L18** and **L19** (location references M5, C2, K5, D2) for maximum output. Finally, remove the 100,000 Ω resistor and replace **V1** top cap connector.

R.F. and Oscillator Stages.—With the gang at maximum capacitance the cursor should be vertical and coincident with the high wavelength ends of the four scales. It may be adjusted in position by sliding the cursor carriage along the drive cord. Transfer "live" signal generator lead to "**A**" socket, via a suitable dummy aerial.

M.W.—Switch set to M.W., tune to 200 m on scale, feed in a 200 m (1,500 kc/s) signal, and adjust **C34** (O4) and **C29** (B2) for maximum output. Tune to 500 m on scale, feed in a 500 m (600 kc/s) signal, and check calibration.

L.W.—Switch set to L.W., tune to 1,000 m on scale, feed in a 1,000 m (300 kc/s) signal, and adjust **C35** (O4) and **C26** (B2) for maximum output. Tune to 2,000 m on scale, feed in a 2,000 m (150 kc/s) signal, and check calibration.

S.W.1.—Switch set to S.W.1, tune to 15 m on scale, feed in a 15 m (20 Mc/s) signal, and adjust **C32** (N4) and **C27** (B2) for maximum output, while rocking the gang. Tune to 40 m on scale, feed in a 40 m (7.5 Mc/s) signal, and check calibration.

S.W.2.—Switch set to S.W.2, tune to 60 m on scale, feed in a 60 m (5.0 Mc/s) signal, and adjust **C33** (N4) and **C28** (A2) for maximum output. Tune to 200 m on scale, feed in a 200 m (1,500 kc/s) signal, and check calibration.

Service Short Cuts

Vibrating Barretter

I have recently experienced a familiar trouble on an A.C./D.C. receiver using a barretter in the heater circuit. The barretter is mounted sufficiently close to the speaker to feel the influence of its magnetic field, and when it is operated on A.C. mains, the alternating flow of current in the resistance element causes the wire to be attracted and repelled at mains frequency, so that it vibrates visibly.

In this particular model, a G.E.C. BC4835, the vibration was so violent that adjacent wires touched, causing crackles in the speaker. I cured it in this case by fitting an iron screen between the barretter and the speaker, but I think some kind of screen should be fitted in all cases, as much milder vibration than this can shorten the life of the barretter considerably.—**H. B.**, Crewe.

Marconiphone 262

A Marconiphone 262 I had in recently gave very distorted results on high notes, almost as though the speech coil was faulty, but another speaker sounded just as bad.

It was noticed that what appeared to be a 2 μF bias decoupling capacitor in the block had been replaced by a 2 μF electrolytic type, but as this capacitor is part of an audio feed-back circuit to the detector anode (actually it was C10 in "Trader" *Service Sheet* 518), to increase low note response, the electrolytic type was not suitable.

Replacing it with a 2 μF paper capacitor completely restored the quality of tone, although the electrolytic capacitor appeared to be perfectly O.K. on test.—**L. T.**, Scarborough.

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