Supplement to The Wireless & Electrical Trader, January 25, 1947

"TRADER" SERVICE SHEET

800

FERGUSON 461

3-BAND A.C. SUPERHET

THE Ferguson 461 is a 4-valve (plus rectifier) 3-band superhet designed to operate from A.C. mains of 200-250 V, 50 c/s. The S.W. range is 13.5-50 m. Provision is made for the connection of a gramophone pick-up and a high impedance external speaker.

Release date and original price: September, 1946; £22 1s. plus £4 14s 10d purchase tax.

CIRCUIT DESCRIPTION

On L.W., aerial input is via the R.F. transformer **L1, L2, C2,** the primary of which is permanently connected across the aerial-earth circuit. The low impedance secondary winding **L2** is connected via switch **S1** to the low potential end of the L.W. aerial tuning circuit **L5, C34,** and thus injects signals into the circuit. **S2** is open, and **S1** closed.

On M.W., **S1** opens, while **S2** and **S4** close, so that the "top" of **L5** is connected to chassis, and the "bottom" of it is joined via **S2, C1** to the aerial, "inverting" the coil. Since **L4** and **L5** are wound on the same former, they are magnetically coupled, and thus **L5** transfers the signal to the M.W. aerial tuning circuit **L4, C34.**

On S.W., **S1, S2** and **S4** are open, and **S3** is closed, providing capacitative coupling via **C1, C4** to the S.W. aerial tuning circuit **L3, C34.** On M.W. and S.W., **L1** remains in circuit, but behaves as a high impedance choke shunt.

First valve **(V1, Mullard metallized ECH35)** is a triode hexode operating as frequency changer with internal coupling. Triode oscillator anode coils **L8** (S.W.), **L9** (M.W.) and **L10** (L.W.) are tuned by **C40.** Parallel trimming by **C37** (S.W.), **C38** (M.W.) and **C11, C39** (L.W.); series tracking by **C10** (S.W.), **C35** (M.W.) and **C36** (L.W.).

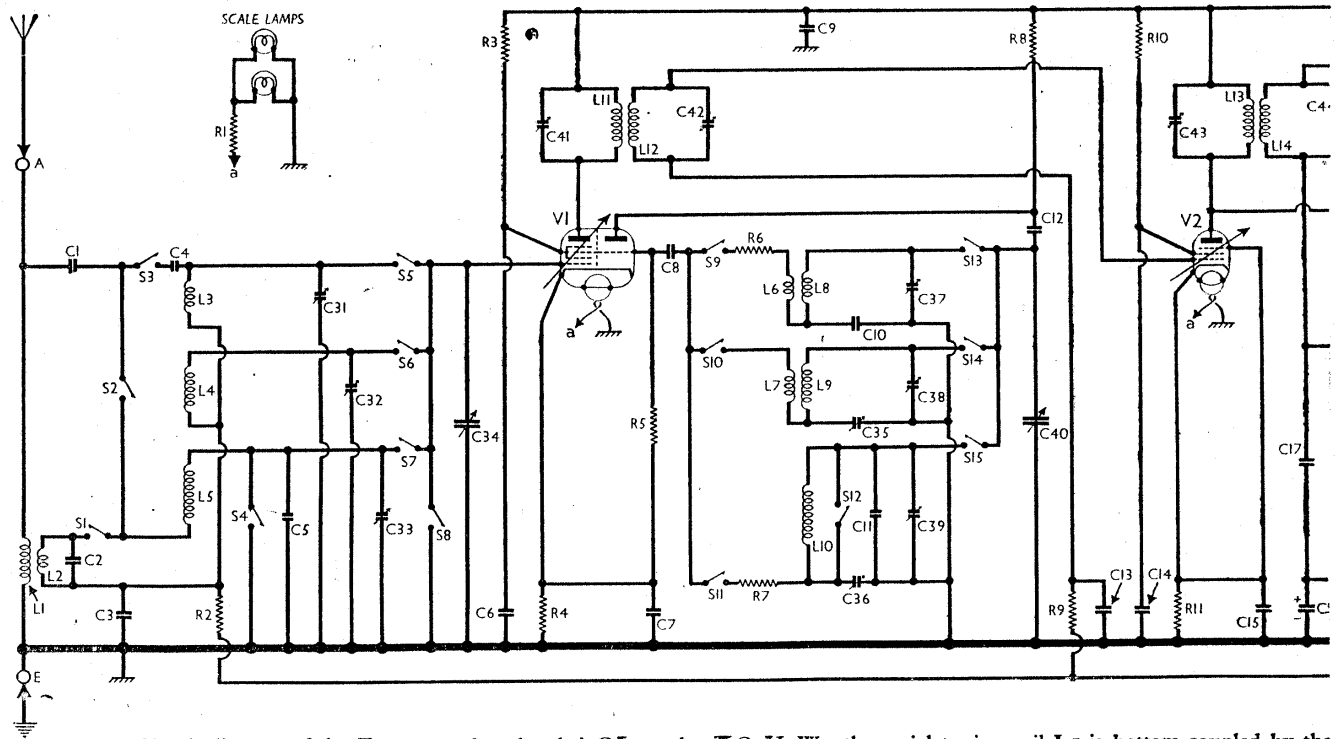
Reaction coupling to grid circuit is obtained from the common impedance of trackers on all bands, with additional inductive coupling by **L6** (S.W.) and **L7** (M.W.).

Second valve **(V2, Mullard metallized EF39)** is a variable-mu R.F. pentode operating as intermediate frequency amplifier with tuned-primary, tuned-secondary transformer couplings **C41, L11, L12, C42** and **C43, L13, L14, C44.**

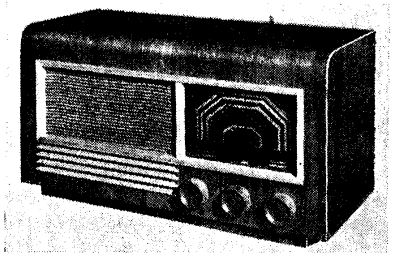
Intermediate frequency 470 kc/s.

Diode second detector is part of double diode triode valve **(V3, Mullard metallized EBC33).** Audio frequency component in rectified output is developed across load resistor **R12,** and passed via I.F. filter circuit **C17, R13** and **C18,** A.F. coupling capacitor **C20,** and manual volume control **R14** to C.G. of triode section, which operates as A.F. amplifier. Treble boost is provided by **C21,** and there is provision for the connection of a gramophone pick-up across **R14,** via **S16.** In the "gram" position of the waveband switch, **S4** and **S8** close to mute radio, while **S16** closes to connect the pick-up.

Second diode of **V3,** fed from **V2** anode via **C16,** provides D.C. potential which is developed across load resistor **R20** and fed back through decoupling circuits as G.B. to F.C. and I.F. valves, giving automatic volume control. Delay voltage, together with G.B. for triode section, is



Circuit diagram of the Ferguson 461 3-band A.C. superhet. On L.W., the aerial tuning coil **L5** is bottom-coupled by the forms the secondary winding of the aerial transformer **L1, L2,** switch **S1** then being closed. On M.W., **S1** opens and verting" **L5** and connecting it between aerial and earth. **L5** then operates as the M.W. aerial coupling coil. **R19, C24** provide negative feed-back voltages whose character is varied by adjusting the tone control **R19.** These are coupled back via **R17.** In early chassis **C22, R16** and **R17** were omitted, and **R19** was then returned to chassis.



obtained from the drop along resistor **R15** in **V3** cathode lead to chassis.

Resistance-capacitance coupling by **R17, R18, C25** and **R21,** via grid stopper **R22,** between **V3** triode and pentode output valve **(V4, Mullard EL33).** I.F. filtering in **V3** triode anode circuit by capacitor **C23.** Provision for the connection of a high impedance external speaker across **T1** primary.

The output developed in **V4** anode circuit is fed back via the coupling circuit **C24, R19** to a tapping on **V3** triode anode load. The amplitude and frequency characteristic of the feed-back are determined by the position of **R19** slider, and the whole circuit forms the variable tone control.

H.T. current is supplied by a full-wave rectifying valve **(V4, Mullard AZ31).** Smoothing by speaker field **L17** and electrolytic capacitors **C28, C29.** Mains R.F. filtering by **C30.**

COMPONENTS AND VALUES

	CAPACITORS	Values (μF)
C1	Aerial M.W. coupling ...	0·0005
C2	Part L.W. aerial coupling	0·002
C3	V1 hex. C.G. decoupling...	0·1
C4	Aerial S.W. coupling ...	0·00001
C5	Aerial L.W. fixed trimmer	0·00005
C6	V1 S.G. decoupling ...	0·1
C7	V1 cathode by-pass ...	0·1
C8	V1 osc. C.G. capacitor ...	0·0001
C9	H.T.circuit R.F. by-pass...	0·1
C10	Osc. circ. S.W. tracker ...	0·005
C11	Osc. L.W. fixed trimmer...	0·00005
C12	V1 osc. anode coupling ...	0·0001
C13	V2 C.G. decoupling ...	0·1
C14	V2 S.G. decoupling ...	0·1
C15	V2 cathode by-pass ...	0·1
C16	V3 A.V.C. diode coupling	0·0001
C17	I.F. by-pass capacitors ...	0·0001
C18		0·0001
C19*	V3 cathode by-pass ...	25·0
C20	A.F. coupling to V3 C.G....	0·02
C21	Treble boost capacitor ...	0·00003
C22	V3 triode H.T. decoupling	0·5
C23	I.F. by-pass capacitor ...	0·0001
C24	Part variable tone control	0·005
C25	A.F. coupling to V4 C.G....	0·02
C26	Fixed tone corrector ...	0·005
C27*	V4 cathode by-pass ...	25·0
C28*	H.T. smoothing capacitors	16·0
C29*		8·0

(*Continued next column*)

* Electrolytic.

	CAPACITORS (*continued*)	Values (μF)
C30	Mains R.F. by-pass ...	0·01
C31‡	Aerial circ. S.W. trimmer	0·00003
C32‡	Aerial circ. M.W. trimmer	0·00003
C33‡	Aerial circ. L.W. trimmer	0·00011
C34†	Aerial circuit tuning ...	—
C35‡	Osc. circ. M.W. tracker ...	0·00065
C36‡	Osc. circ. L.W. tracker ...	0·00025
C37‡	Osc. circ. S.W. trimmer ...	0·00003
C38‡	Osc. circ. M.W. trimmer...	0·00003
C39‡	Osc. circ. L.W. trimmer...	0·0002
C40†	Oscillator circuit tuning...	—
C41‡	1st I.F. trans. pri. tuning	0·00018
C42‡	1st I.F. trans. sec. tuning	0·00018
C43‡	2nd I.F. trans. pri. tuning	0·00018
C44‡	2nd I.F. trans. sec. tuning	0·00018

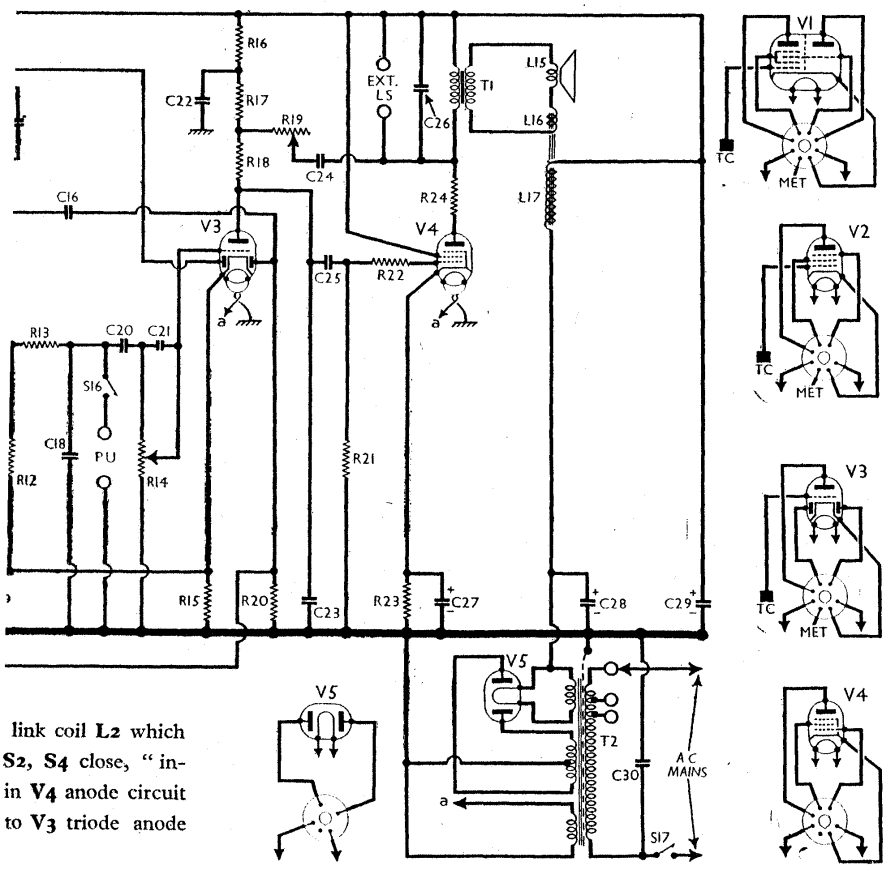
† Variable. ‡ Pre-set.

	RESISTORS	Values (ohms)
R1	Scale lamp ballast ...	2
R2	V1 hex. C.G. decoupling...	500,000
R3	V1 S.G. H.T. feed ...	100,000
R4	V1 fixed G.B. resistor ...	500
R5	V1 osc. C.G. resistor ...	50,000
R6	Osc. S.W. stabiliser ...	50
R7	Osc. L.W. stabiliser ...	10,000
R8	V1 osc. anode H.T.feed...	25,000
R9	V2 C.G. decoupling ...	500,000
R10	V2 S.G. H.T. feed ...	100,000
R11	V2 fixed G.B. resistor ...	500
R12	V3 signal diode load ...	500,000
R13	I.F. stopper	100,000
R14	Manual volume control ...	2,000,000
R15	V3 fixed G.B.: A.V.C. delay	1,000
R16	V3 triode H.T. decoupling	56,000
R17	Feed-back coupling ...	1,000
R18	V3 triode anode load ...	50,000
R19	Variable tone control ...	100,000
R20	V3 A.V.C. diode load ...	1,360,000*
R21	V4 C.G. resistor	500,000
R22	V4 C.G. stopper	5,000
R23	V4 G.B. resistor ...	150
R24	V4 anode stopper ...	100

* Made up of two 680,000 resistors in series.

	OTHER COMPONENTS		Approx. Values (ohms)
L1	Aerial L.W. coupling transformer		205·0
L2			11·5
L3	Aerial S.W. tuning coil ...		Very low
L4	Aerial M.W. tuning coil...		3·2
L5	Aerial L.W. tuning coil ...		28·5
L6	Osc. S.W. reaction coil ...		0·15
L7	Osc. M.W. reaction coil ...		0·9
L8	Osc. S.W. tuning coil ...		Very low
L9	Osc. M.W. tuning coil ...		1·9
L10	Osc. L.W. tuning coil ...		5·5
L11	1st I.F. trans.	Pri. ...	8·6
L12		Sec. ...	8·6
L13	2nd I.F. trans.	Pri. ...	7·6
L14		Sec. ...	7·6
L15	Speaker speech coil ...		1·5
L16	Hum neutralising coil ...		0·25
L17	Speaker field coil		1,500·0

(*Continued overleaf*)



link coil **L2** which **S2, S4** close, " in- in **V4** anode circuit to **V3** triode anode

OTHER COMPONENTS (*continued*)			Approx. Values (ohms)
T1	Speaker input trans.	Pri.	470·0
		Sec.	0·3
T2	Mains trans.	Pri., total ...	28·5
		Heater sec. ...	0·1
		Rect. heat. sec.	0·05
		H.T. sec., total...	500·0
S1-S16	Waveband switches ...		—
S17	Mains switch, ganged R14		—

VALVE ANALYSIS

Valve voltages and currents given in the table below are those quoted by the manufacturers, who give the unsmoothed H.T. voltage as 366 V, and total H.T. current as 61 mA.

Readings were taken with the receiver tuned to the longest wavelength on the M.W. band, but with no signal input. Voltages were measured on a Model 40 Avometer, chassis being the negative connection.

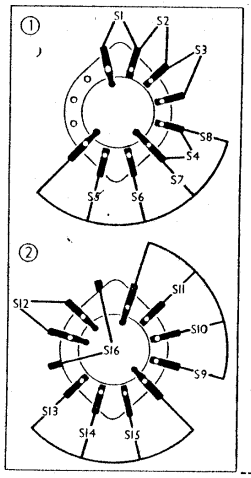
Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 ECH35	262	0·87	70	1·8
	Oscillator			
	125	5·1		
V2 EF39	262	5·5	67	1·6
V3 EBC33	112	2·7	—	—
V4 EL33	242	38.0	262	5·2
V5 AZ31	345†	—	—	—

† Each anode, A.C.

GENERAL NOTES

Switches.—S1-S16 are the waveband 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. 2, where they are drawn as seen when viewed from the rear of an inverted chassis.

Switch Diagrams and Table



Diagrams of the waveband switch units (left) as seen from the rear of an inverted chassis. On the right is the associated table.

Switch	S.W.	M.W.	L.W.	Gram.
S1	—	—	C	—
S2	—	C	—	—
S3	C	—	—	—
S4	—	C	—	—
S5	C	—	—	—
S6	—	C	—	—
S7	—	—	C	—
S8	—	—	—	C
S9	C	—	—	—
S10	—	C	—	—
S11	—	—	C	—
S12	—	C	—	—
S13	C	—	—	—
S14	—	C	—	—
S15	—	—	C	—
S16	—	—	—	C

The table (Col. 3) gives the switch positions for the four control settings, starting from the fully anti-clockwise position of the control knob. A dash indicates open, and **C**, closed.

S17 is the Q.M.B. mains switch, ganged with the manual volume control **R14.**

Coils.—L1, L2 form the L.W. aerial coupling transformer, permanently connected across the aerial circuit. This is a tubular unscreened unit beneath the chassis. The aerial tuning coils **L3** and **L4, L5,** and the oscillator coils **L6, L8** and **L7, L9, L10** are in four further unscreened tubular units beneath the deck. The I.F. transformers **L11, L12** and **L13, L14** are in two screened units on the chassis deck, with their associated trimmers.

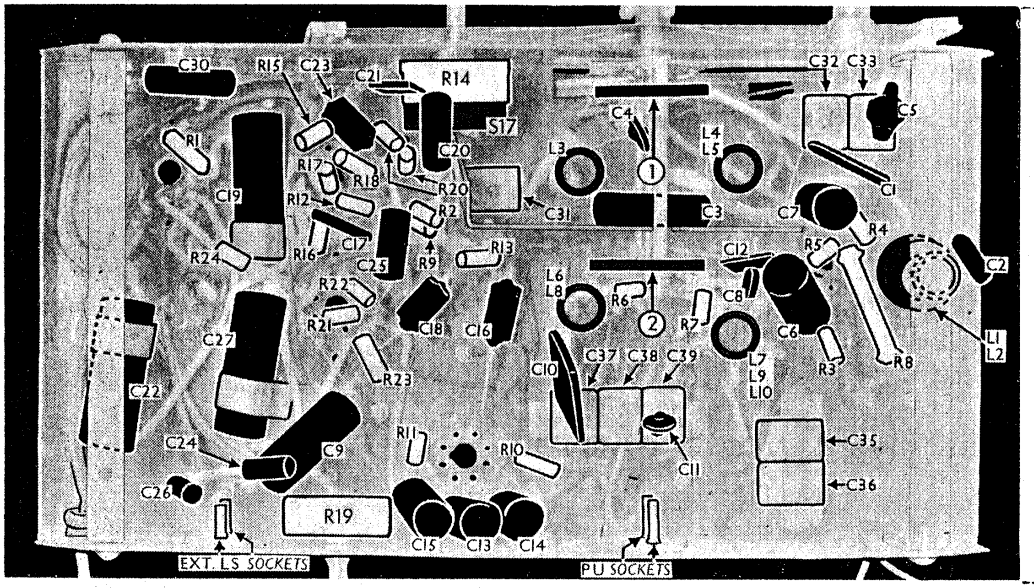
Scale Lamps.—These are two Osram lamps, with M.E.S. bases and small clear sperical bulbs, rated at 6.5 V, 0.3 A. As they are connected across the 6.3 V heater winding, they are provided with a series ballast resistor of 2 Ω.

External Speaker.—Two sockets are provided at the rear of the chassis for the connection of a high-impedance (about 7,000 Ω) external speaker.

Capacitors C28, C29.—These are two electrolytics in a single tubular metal container, mounted on the chassis deck, the case forming the common negative connection. Of the two tags at the lower end, the red one is the positive of **C29** (8 μF) and the plain one that of **C28** (16 μF). The unit is rated at 450 V D.C. working.

Chassis Divergencies.—The negative feed-back circuit was not fitted in early models, but the end of **R19** was connected to chassis, so that it still operated as the tone control. In these chassis, **R16, R17** and **C22** are omitted. Also in early models the H.T. secondary of the mains transformer provided a lower voltage output to the rectifier than in later models, but this was offset by the use of a 1,000 Ω field winding for the speaker magnet.

C22, which was a 0.5 μF paper capacitor in our sample, may be a 2 μF or 4 μF electrolytic, when it would be rated at 350 V working. **C5** and **C11** may be



Under - chassis view. The waveband switch units (1 and 2 in circles) are indicated by arrows which show the direction in which they are viewed in the diagrams in col. 2 above. The mains circuit switch **S17** is seen in this chassis ganged with **R14,** but in some chassis it may be a separate unit mounted on the side of the cabinet.

omitted in some chassis. **R16** may be 25,000 Ω instead of 56,000 Ω, **R6** may be 25 Ω instead of 50 Ω, and **R20** may be a single 1,000,000 Ω resistor instead of two 680,000 Ω resistors in series.

DISMANTLING THE SET

Removing Chassis.—Remove the three control knobs (recessed grub screws); remove the four hexagonal head screws (with square metal washers) holding the chassis to the bottom of the cabinet.

The chassis may now be withdrawn to the extent of the speaker leads.

To free the chassis entirely, unsolder from the connecting panel on the speaker transformer the three leads connecting it to the chassis.

When replacing, connect the three speaker leads as follows, numbering the tags on the speaker transformer from left to right : 1 and 2, red; 3, no exernal connection; 4, blue; 5, yellow.

Removing Speaker.—Unsolder the three leads as described above; remove the four nuts (with lock washers) securing the speaker to the sub-baffle.

When replacing, the transformer should be at the bottom, and the leads should be reconnected as previously described.

CIRCUIT ALIGNMENT

I.F. Stages.—Switch the set to M.W., turn the gang to maximum capacitance, and turn the volume control to maximum. Connect signal generator leads to control grid (top cap) of **V1** and chassis, feed in a 470 kc/s (638.3 m) signal, and adjust **C41, C42, C43** and **C44** in turn for maximum output.

R.F. 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 be horizontal, and it should lie level with the scale base line. Check that the scale is horizontal, then turn the gang until the pointer is vertical, when it should coincide with the centre-line of the scale.

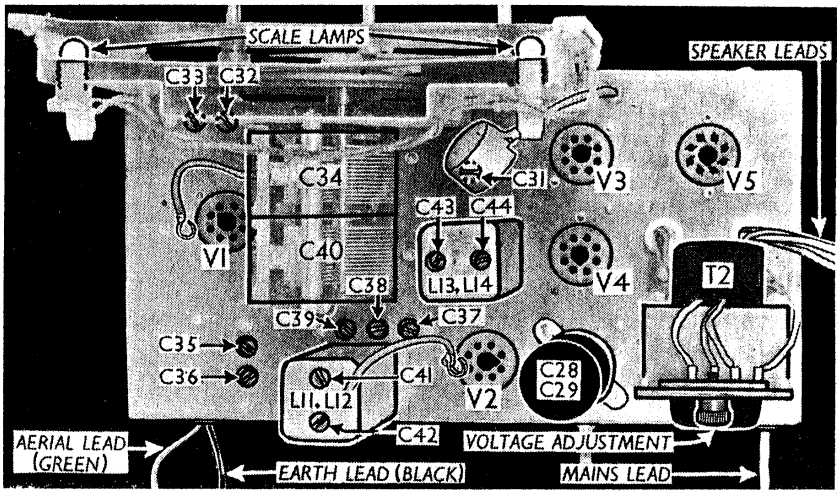
M.W.—Switch set to M.W., tune to 215 m on scale, feed in a 215 m (1,400 kc/s) signal, and adjust **C38,** then **C32,** for maximum output. Tune to 500 m on scale, feed in a 500 m (600 kc/s) signal, and adjust **C35** for maximum output, while rocking the gang for optimum results. Then repeat these operations until no improvement can be obtained.

L.W.—Switch set to L.W., tune to 2,000 m on scale, feed in a 2,000 m (150 kc/s) signal, and adjust **C36** for maximum output. Tune to 1,250 m on scale, feed in a 1,250 m (240 kc/s) signal, and adjust **C39,** then **C33,** for maximum output. Repeat these operations until no improvement can be obtained.

S.W.—Switch set to S.W., tune to the 20 Mc/s mark on scale, feed in a 20 Mc/s (15 m) signal, and adjust **C37,** then **C31,** for maximum output. If two peaks can be found for **C37,** select that involving the lesser trimmer capacitance. Tune to 6 Mc/s on scale, feed in a 6 Mc/s (50 m) signal, and check calibration.

DRIVE CORD REPLACEMENT

Although the cord drive system in this receiver is in itself very simple, the process of replacing the cord is somewhat complicated, and the instructions given should be followed carefully.

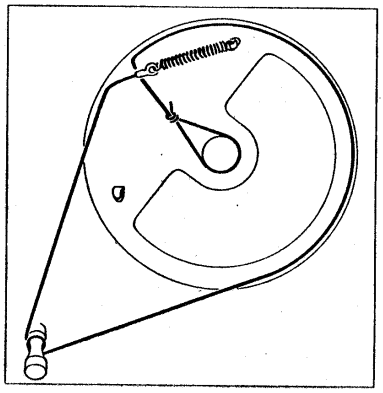


Plan view of the chassis. The positions of the tuning drive drum and the pointer, with the scale backing plate between them can be seen here.

It is essential that the replacement cord is made up to the correct length before it is fitted. A tag is fitted to one end to hook on to the tension spring, and a large non-slip loop is tied at the other to go over the drum boss. When made up, the overall length should be such that if two pins are knocked into the bench 19½in apart, the cord is taut, but the spring still closed, when the loop is slipped round one pin and the spring is hooked to the other.

A made-up replacement, complete with tag and loop, specially treated and stretched, can be obtained from the makers. When fitted, it takes up the position shown in the sketch below which is, however, drawn as it would appear if seen from the rear; actually, it cannot be seen thus as it is obscured by the scale-supporting structure.

To obtain access to the drum, remove the two vertical clamps holding the glass scale plate (four 6BA screws, nuts and lock-washers) and lift off the scale. Then remove the pointer (two recessed grub screws); the waveband indicator quadrant (two set-screws in boss) and the scale backing-plate (four 6BA nuts, screws and lock-washers).



The course taken by the drive cord, as it would be seen from the rear.

Now remove the drive drum from the gang spindle (two recessed grub screws) and lay it flat-side down on the bench, exposing the hollow side. Take the new cord, hook the spring to the anchor tag provided, as indicated in the sketch, and close the anchor tag down over it to prevent it from slipping off; slip the loop at the other end of the cord over the drum boss; then pass the rest of the cord in a loop through the slot in the periphery of the drum, taking it from the inside to out. The doubled length of cord outside the drum, taut but not stretched, should now measure exactly 7½in.

Having checked this, replace the drum on the gang spindle, hollow side first, with the drum groove in line with the waisted groove on the tuning control spindle, turn the gang to maximum, then turn the drum until the slot in the periphery is at about 2 o'clock (when viewed from the *front*), and tighten up the two grub screws in the boss.

Take the loop of cord now outside the drum, and twist it half a turn, so that the two strands cross inside the drum, as they do in our sketch, and pass it through the opening provided for it in the chassis deck to the underside of the chassis; then loop the cord twice over the end of the tuning control spindle beneath the chassis, making a little over one complete turn as shown in the sketch; and finally work the slack cord on to the groove in the periphery of the drum.

During the operation care should be taken that the tag which is tied to one end of the cord to provide a hook for the spring does not foul the other strand of the cord as they cross.

When replacing the scale, do not omit to replace the large felt washer between the face of the drum and the scale backing plate, and the small felt washer between the backing-plate and the scale pointer boss, which goes on next. See also that the flat rubber bands are in position round the vertical ends of the scale to take the pressure of the scale clamps.

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