NUMBER 154

'TRADER' SERVICE SHEETS

FERGUSON 378 (A.C.)

TABLE, CONSOLE AND RADIO-GRAM

FOUR wave bands are covered by the Ferguson 378 7-valve (plus rectifier) A.C. superhet. Provision is made for both a gramophone pick-up and an extension speaker.

The same chassis is fitted in the 378 (A.C.) console and the 378 (A.C.) automatic radio-gramophone.

An A.C./D.C. version of the 378 is also made.

This *Service Sheet* was prepared on a 378 (A.C.) table model receiver.

CIRCUIT DESCRIPTION

Aerial input via fixed condenser **C1** (S.W., M.W. and L.W.), coupling condenser **C2** (S.W. and M.W.), coupling condenser **C4** (S.W. only), coupling coil **L5** (M.W.) and condenser **C3** (L.W.) to independently switched single tuned circuits comprising **C36** and **L3** (S.W.1), **L4** (S.W.2), **L6** (M.W.), **L7** (L.W.).

First valve (**V1, National Union 6D6**) is a variable-mu pentode signal-frequency amplifier.

Choke-fed tuned-grid coupling by **L8, C9** and **L9** (S.W.1), **L10** (S.W.2), **L11, L12** (M.W.), **L13** (L.W.) which are tuned by **C41,** to heptode frequency changer valve (**V2, National Union 6A7**). Oscillator grid coils **L14** (S.W.1), **L16** (S.W.2), **L18** (M.W.), **L20** (L.W.) are tuned by **C42**; trimming by **C43** (S.W.1), **C44** (S.W.2), **C45** (M.W.), **C46, C55** (L.W.); tracking by **C47** (S.W.1), **C48** (S.W.2), **C49** (M.W.), **C13, C50** (L.W.); oscillator anode reaction coils **L15** (S.W.1), **L17** S.W.2), **L19** (M.W.).

Third valve, a variable-mu H.F. pentode (**V3, National Union 6D6**), operates as intermediate frequency amplifier with tuned-primary tuned-secondary transformer couplings **C51, L21, L22, C52** and **C53, L23, L24, C54.**

Intermediate frequency 456 KC/S.

Sensitivity control by variable resistance **R4** in **V1** and **V3** common cathodes circuit, which varies fixed G.B. applied.

Diode second detector is part of double diode triode valve (**V4, National Union 75**). Audio-frequency component in rectified output is developed across load resistance **R13** and passed via coupling condenser **C16** and manual volume control **R15** to C.G. of triode section which operates as L.F. amplifier. Variable tone control by R.C. filter **R16, C19.** Provision for connection of gramophone pick-up by change-over switches **S25, S26.** I.F. filtering by by-pass condensers **C17, C18** and **C22.**

D.C. potential developed across diode load **R13** is fed back through decoupling circuits as G.B. to H.F., F.C. and I.F. valves, giving automatic volume control.

Resistance-capacity coupling by **R19, C23** and **R22, R23** to one section (**V7**) of push-pull output stage comprising two pentodes (**V6, V7, National Union 42's**). Second section (**V6**) is fed by phase reversing triode valve (**V5, National Union 76**), which obtains its input voltage from junction of **R22, R23.** Fixed tone correction in output stage by condensers **C26, C27.** Provision for connection of high-impedance external speaker across primary of internal speaker input transformer **T1.**

H.T. current is supplied by full-wave rectifying valve (**V8, National Union 80**). Smoothing by speaker field coil **L27** and dry electrolytic condensers **C29, C30.** Mains H.F. by-passing by **C31.**

DISMANTLING THE SET

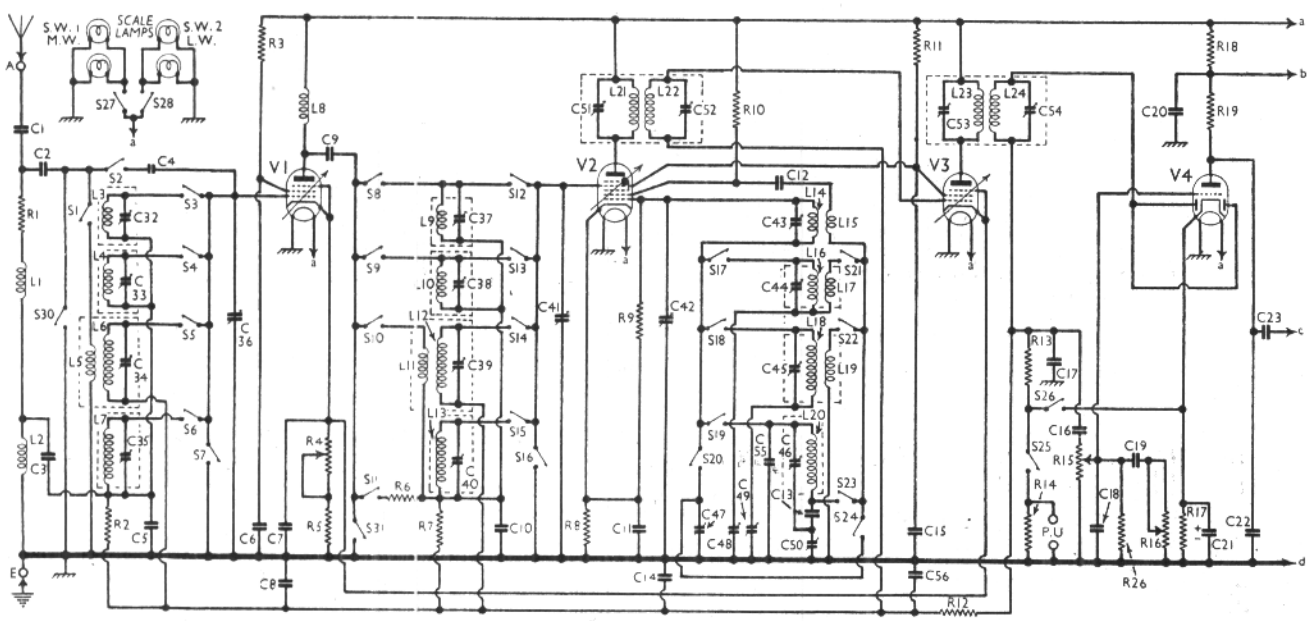
Removing Chassis.—If it is desired to remove the chassis from the cabinet, first remove the six control knobs (recessed grub screws) and then the four bolts (with spring washers and washers) holding the chassis to the bottom of the cabinet. The chassis can now be withdrawn to the extent of the speaker leads, which is sufficient for normal purposes.

When replacing, do not forget the felt washers between the knobs and the cabinet, and note that the knobs are marked so that they must be placed on the correct spindles. Also note that the wave-change switch knob is marked "G," "LW," "MW," "SW" and "USW"; and as there is no flat on the spindle, care must be taken to see that it is replaced correctly.

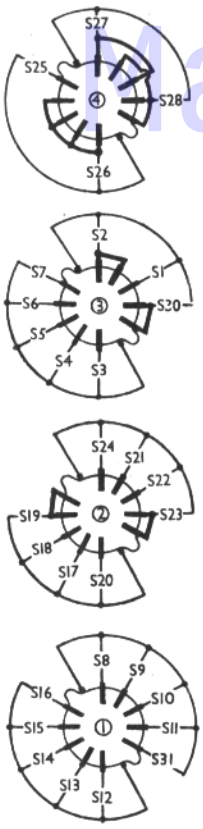
To free the chassis entirely, remove the speaker plug from the socket at the back of the chassis.

Removing Speaker.—To remove the speaker from the cabinet, remove the nuts from the four bolts holding it to the sub-baffle. *When replacing,* see that the transformer is on the right.

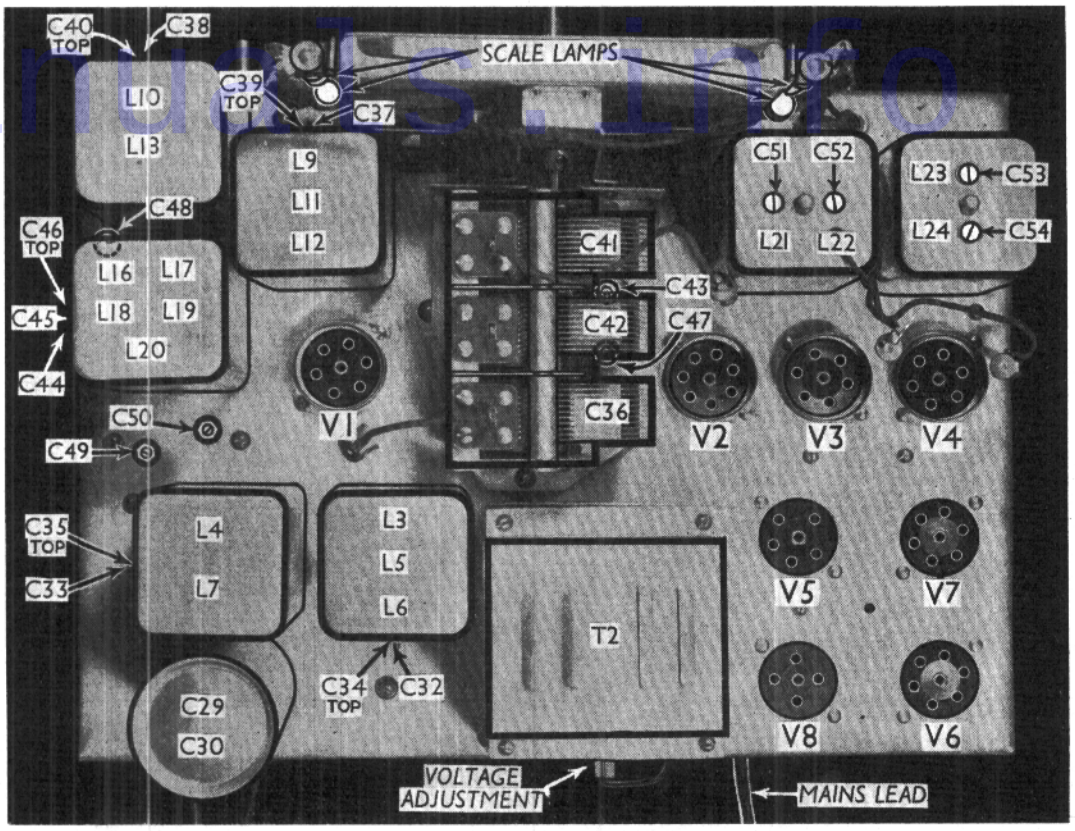
Alternatively, the speaker and the sub-



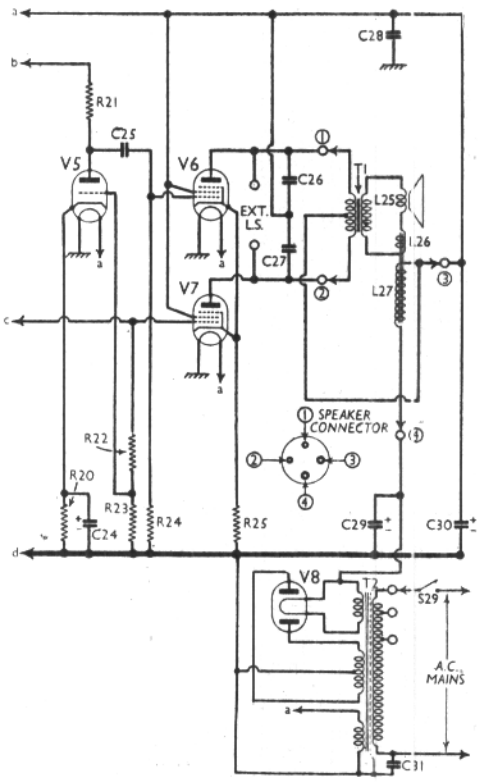
Circuit diagram of the Ferguson 378 A.C. all-wave superhet. A diagram of the speaker plug, viewed from the ends of the pins, is inset, the numbers corresponding with those in the circuit.



Diagrams of the switch units, seen from the underside of the chassis.



Plan view of the chassis. The trimmers in the coil units are at the sides of the units, and the top one is indicated in each case. There are also five trimmers operated through holes in the chassis.



baffle may be removed together by removing the four countersunk-head wood screws holding the sub-baffle to the cabinet front.

If the leads should be unsoldered from the speaker transformer, reconnect as follows, number the tags from bottom to top :—1 and 3 joined together, yellow ; 2, blue ; 4, blue ; 5, red.

VALVE ANALYSIS

Valve voltages and currents given in the table (col. 3) are those measured in our receiver when it was operating on mains of 215 V, using the 220 V tapping on the mains transformer. Both the volume and sensitivity controls were at maximum (fully clockwise) and the set was tuned to the lowest wavelength on the medium band, but there was no signal input.

Voltages were measured on the 1,200 V scale of an Avometer, chassis being negative.

Valve	Anode Voltage (V)	Anode Current (mA)	Screen Voltage (V)	Screen Current (mA)
V1 6D6* ..	265	5·6	70	1·6
V2 6A7 ..	265	1·5	75	2·6
V3 6D6 ..	265	5·7	75	1·4
V4 75 ..	65	0·2	—	—
V5 76 ..	50	0·4	—	—
V6 42 ..	250	27·0	265	5·3
V7 42 ..	250	26·0	265	4·7
V8 80 ..	300†	—	—	—

* Osc. anode (G2) 150 V, 4·0 mA.
† Each anode, A.C.

COMPONENTS AND VALUES

	RESISTANCES	Values (ohms)
R1	Aerial series resistance ..	2,500
R2	V1 C.G. decoupling	500,000
R3	V1 S.G. H.T. feed	100,000
R4	Sensitivity control	3,000
R5	Sensitivity control fixed min.	200
R6	V2 F.C. G.B. series resistance (L.W.)	50,000
R7	V2 F.C. C.G. decoupling ..	500,000
R8	V2 fixed G.B. resistance ..	500
R9	V2 osc. C.G. resistance ..	50,000
R10	V2 osc. anode resistance ..	25,000
R11	V2, V3 S.G.'s H.T. feed ..	50,000
R12	A.V.C. line decoupling ..	250,000
R13	V4 signal diode load	250,000
R14	Gram. P.U. shunt	25,000
R15	Manual volume control ..	500,000
R16	Variable tone control	500,000
R17	V4 G.B. resistance	10,000
R18	V4, V5 anodes decoupling ..	100,000
R19	V4 triode anode load	250,000
R20	V5 G.B. resistance	10,000
R21	V5 anode load	250,000
R22	V7 C.G. resistances ..	500,000
R23		50,000
R24	V6 C.G. resistance	500,000
R25	V6, V7 G.B. resistance ..	300
R26	Manual vol. control shunt ..	250,000

(*Continued overleaf*)

FERGUSON 378 (A.C.)—*Continued*

	CONDENSERS	Values (μF)
C1	Aerial series condenser	0·01
C2	Aerial coupling (S.W. & M.W.)	0·00025
C3	Aerial coupling (L.W.)	0·01
C4	Aerial coupling (S.W.)	0·00005
C5	V1 C.G. decoupling	0·002
C6	V1 S.G. by-pass	0·1
C7	V1, V3 cathodes by-pass	0·1
C8	V1 A.V.C. line decoupling	0·1
C9	V1 to V2 H.F. coupling	0·00025
C10	V2 F.C. C.G. decoupling	0·002
C11	V2 cathode by-pass	0·1
C12	V2 osc. anode condenser	0·00025
C13	Oscillator L.W. fixed tracker	0·00025
C14	V2 A.V.C. line decoupling	0·1
C15	V2, V3 S.G.'s by-pass	0·1
C16	L.F. coupling to V4 triode	0·01
C17	I.F. by-passes	0·00025
C18	I.F. by-passes	0·00025
C19	Tone control condenser	0·01
C20	V4, V5 anodes decoupling	0·1
C21*	V4 cathode by-pass	30·0
C22	V4 anode I.F. by-pass	0·001
C23	V4 to V7 L.F. coupling	0·01
C24*	V5 cathode by-pass	5·0
C25	V5 to V6 L.F. coupling	0·01
C26	Tone correctors	0·002
C27	Tone correctors	0·002
C28	H.T. supply H.F. by-pass	0·1
C29*	H.T. smoothing	8·0
C30*	H.T. smoothing	8·0
C31	Mains H.F. by-pass	0·01
C32‡	Aerial circuit trimmer (S.W.1)	—
C33‡	Aerial circuit trimmer (S.W.2)	—
C34‡	Aerial circuit trimmer (M.W.)	—
C35‡	Aerial circuit trimmer (L.W.)	—
C36†	Aerial circuit tuning	—
C37‡	F.C.C.G.circuit trimmer(S.W.1)	—
C38‡	F.C.C.G.circuit trimmer(S.W.2)	—
C39‡	F.C.C.G. circuit trimmer(M.W.)	—
C40‡	F.C.C.G.circuit trimmer (L.W.)	—
C41†	F.C.C.G. circuit tuning	—
C42†	Oscillator circuit tuning	—
C43‡	Osc. circuit trimmer (S.W.1)	—
C44‡	Osc. circuit trimmer (S.W.2)	—
C45‡	Osc. circuit trimmer (M.W.)	—
C46‡	Osc. circuit trimmer (L.W.)	—
C47‡	Osc. circuit tracker (S.W.1)	—
C48‡	Osc. circuit tracker (S.W.2)	—

	CONDENSERS (*Continued*)	Values (μF)
C49‡	Osc. circuit tracker (M.W.)	—
C50‡	Osc. circuit tracker (L.W.)	—
C51‡	1st I.F. trans. pri. tuning	—
C52‡	1st. I.F. trans. sec. tuning	—
C53‡	2nd I.F. trans. pri. tuning	—
C54‡	2nd I.F. trans. sec. tuning	—
C55	Osc. circuit trimmer (L.W.)	0·000025
C56	V3 A.V.C. line decoupling	0·01

* Electrolytic † Variable ‡ Pre-set

	OTHER COMPONENTS		Approx. Values (ohms)
L1	Aerial choke coils		21·0
L2	Aerial choke coils		17·0
L3	Aerial tuning coil (S.W.1)		Very low
L4	Aerial tuning coil (S.W.2)		0·05
L5	Aerial coupling coil (M.W.)		0·5
L6	Aerial tuning coil (M.W.)		5·5
L7	Aerial tuning coil (L.W.)		25·0
L8	V1 anode H.F. choke		21·0
L9	F.C. C.G. tuning coil (S.W.1)		Very low
L10	F.C. C.G. tuning coil (S.W.2)		0·05
L11	F.C. C.G. coupling coil (M.W.)		0·5
L12	F.C. C.G. tuning coil (M.W.)		5·5
L13	F.C. C.G. tuning coil (L.W.)		25·0
L14	Osc. tuning coil (S.W.1)		Very low
L15	Osc. reaction coil (S.W.1)		0·6
L16	Osc. tuning coil (S.W.2)		0·05
L17	Osc. reaction coil (S.W.2)		0·6
L18	Osc. tuning coil (M.W.)		3·2
L19	Osc. reaction coil (M.W.)		2·5
L20	Osc. tuning coil (L.W.)		6·0
L21	1st I.F. trans.	Pri.	9·5
L22	1st I.F. trans.	Sec.	13·0
L23	2nd I.F. trans.	Pri.	13·0
L24	2nd I.F. trans.	Sec.	8·5
L25	Speaker speech coil		1·6
L26	Hum neutralising coil		0·1
L27	Speaker field coil		1,000·0
T1	Speaker input trans.	Pri. total	750·0
		Sec.	0·2
T2	Mains trans.	Pri. total	23·0
		Heater sec.	0·05
		Rect. fil sec.	0·1
		H.T. sec. total	310·0
S1-24	Waveband and muting switches		—
S30-31	Waveband and muting switches		—
S25-26	Gram. P.U. switches		—
S27-28	Scale lamp switches		—
S29	Mains switch, ganged R16		—

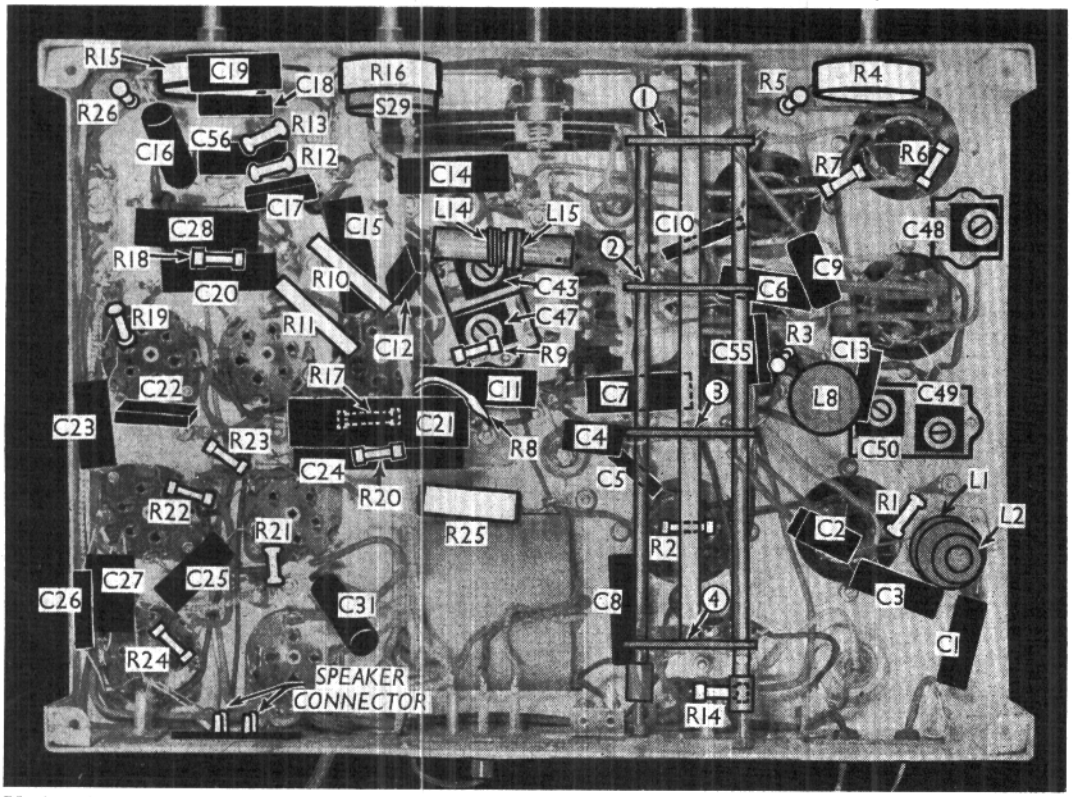
GENERAL NOTES

Switches.—In all there are twenty-eight wavechange, muting and scale lamp switches, and two pick-up switches, arranged in four 5-position rotary units, ganged together beneath the chassis. The numbers in circles in our under-chassis view refer to the units as shown in the separate switch diagrams, the arrows indicating the directions in which they are viewed.

Note that each unit consists of two separate sets of five switches.

The table below gives the switch positions for the various control settings, O indicating open, and C, closed.

Switch	S.W.1 (U.S.W.)	S.W.2 (S.W.)	M.W.	L.W.	Gram.
S1	O	O	C	O	O
S2	C	C	O	O	O
S3	C	O	O	O	O
S4	O	C	O	O	O
S5	O	O	C	O	O
S6	O	O	O	C	O
S7	O	O	O	O	C
S8	C	O	O	O	O
S9	O	C	O	O	O
S10	O	O	C	O	O
S11	O	O	O	C	O
S12	C	O	O	O	O
S13	O	C	O	O	O
S14	O	O	C	O	O
S15	O	O	O	C	O
S16	O	O	O	O	C
S17	O	C	O	O	O
S18	O	O	C	O	O
S19	O	O	O	C	C
S20	C	O	O	O	O
S21	O	C	O	O	O
S22	O	O	C	O	O
S23	O	O	O	C	C
S24	C	O	O	O	O
S25	O	O	O	O	C
S26	C	C	C	C	O
S27	C	O	C	O	O
S28	O	C	O	C	C
S30	O	O	O	C	C
S31	O	O	O	O	C



Under-chassis view. R8 is a flexible resistor. Note the S.W.1 oscillator coils L14, L15. The numbers in circles refer to the switch diagram on p. VII.

S29 is the Q.M.B. mains switch, ganged with control **R16.**

Coils.—**L1** and **L2, L8** and **L14, L15** are beneath the chassis, the remaining coils being in seven screened units on the chassis deck. Six of the units incorporate two trimmers each, the seventh containing three.

Scale Lamps.—These are two National Union M.E.S. types, marked "6-8 V."

External Speaker.—Provision is made for an external high resistance speaker.

Condensers C29, C30.—These are two 8 μF dry electrolytics in a single metal can on the chassis deck, with a common negative (black) lead. The red lead is the positive of **C29** and the yellow the positive of **C30.**

Condenser C21.—In our chassis this consists of a 25 μF tubular, with an extra 5 μF, inside the **C24** unit in parallel.

Circuit Alignment.—See p. IV this week.

MAINTENANCE HINTS & PROBLEMS

Routine Tests : Helpful Gadgets : Unusual Faults

Two Component Faults

Recently a Marconiphone receiver, a model 262 D.C., was found to be silent upon test. The D.H. valve heater had burned out and a new one was fitted. All that could then be obtained from the loud-speaker was loud crackling and plopping noises. Upon investigation it was discovered that the 3,000 O hum control potentiometer had become overheated and the former upon which the wire was wound was badly distorted, thus preventing the variable arm making clean and proper contact. A new potentiometer was fitted and the set functioned quite all right. The cause of the potentiometer becoming overheated was due to the D.H. valve, across the heater of which the former was connected, burning-out and leaving the fine wire potentiometer in series with the other valve heaters and voltage dropping resistances which were connected to the 230 V mains.

* * *

A Ferranti Parva all-wave A.C. receiver gave badly distorted reproduction on all wavebands ; a new output pentode was tried, but results were the same. The original valve was replaced and an anode emission test made by interposing the meter between the red lead from the speaker and its appropriate socket on the panel attached to the mains transformer. The meter indicated 40 mA passing, this being rather higher than the figures given in the service manual, 32 to 36 mA. It was thought that the bias resistance had decreased in value or that the cathode condenser had become partially short-circuited, but these were quite in order ; so, also, was the control grid to chassis circuit. The next test was carried out with a neon tester connected between top cap (anode) of the detector and top cap (control grid) of the output valve. A tiny glow in the neon was observed, which indicated a leakage. The chassis was removed from the cabinet, and the 0·01 μF coupling condenser disconnected and tested with a megger. The resistance was found to be between five and six megohms, resulting in a positive bias on the pentode grid in opposition to the automatic negative bias. When a new condenser had been fitted, an emission test was again made, and the current passing was exactly 32 mA, while the quality of reproduction was again up to standard.—M. F.

Bad Metallising Connection

Recently a customer brought in a Mullard MU35 with the complaint that the set was intermittently unstable.

Whilst trying out the set on signals I noticed that on touching the I.F. valve, which is a Mullard side contact metallised VP13A, the instability was in evidence, and could be brought on or off by wobbling the valve in its holder.

The valve was suspected, and a new Mullard VP13A was substituted, but with no improvement. I naturally concluded that the fault lay either in the valveholder or in its associated wiring. Accordingly the chassis was thoroughly inspected for dry joints and the valveholder was changed.

The set was then tried again, but the instability was still present. One end of a short length of wire was clipped to the chassis, and the other touched on the metallising of the I.F. valve. This cured the fault, so the valve was taken out, and the resistance between the metallising and the corresponding side contact proved to be nearly 250 O.

Our spare valves (Mullard) were then checked, some giving 5-10 O, others between 100 and 500 O.—T. W. G.

[NOTE.—We have had several complaints lately of the same nature, and it would seem that in some sets a low resistance contact to the metallising of certain valves is essential to avoid instability. In the case of less critical sets, the trouble does not arise. We should like to know whether valves returned on account of the instability they cause due to bad metallising contact are regarded as faulty and replaced by the makers.—TECH. ED.]

Corroded Winding

I recently had to service an Ekco AC86, the trouble being bad crackling after the set had been switched on a few minutes.

This noise ceased when the set was switched to gram, which led me to suppose that the frequency changer stage was at fault. The valve was replaced by a "known to be good" one but with the same results.

The main H.T. feed line voltage was found to vary in sympathy with the crackles. Examination of the circuit diagram showed that the primary of the first I.F. transformer was shorted out for gram.

This winding was tested for continuity, and seemed O.K., but when compared with the resistance of the secondary it was much too high. (Actually 5,000 O compared with the secondary, 100 O.)

The coil was removed, and when tested with a neon lamp in series with the A.C. mains, proved to be the culprit. There was apparently a "green spot" of corrosion in the winding which formed a high resistance joint. The current could be seen arcing at this spot when tested with the neon and 230 V A.C.—F. R. E.

CIRCUIT ALIGNMENT FOR FERGUSON 378

(See pages VI, VII and VIII for circuit diagram and chassis illustrations.)

I.F. Stages.—First inject a signal of 456 KC/S between the grid of **V3** and chassis, and adjust **C53** and **C54** for maximum output. Next, switch the set to M.W., and turn the gang condenser to maximum. Inject the 456 KC/S signal between the grid (top cap) of **V2** and chassis, and adjust **C51** and **C52** for maximum output, keeping the input as low as possible to avoid A.V.C. action. Re-adjust **C53** and **C54** if necessary. Owing to the high I.F. sensitivity, instability may occur as the circuits come into line, due to the long leads from the signal generator. This may be counteracted by reducing the I.F. sensitivity slightly with the aid of the sensitivity control.

H.F. Stages.—On completion of the I.F. alignment, the tracking condensers **C47, C48, C49, C50** should be adjusted for maximum output at the top of each band (gang condenser fully meshed). The simplest method of doing this is to connect a high frequency buzzer via a 50 $\mu\mu$F condenser to the aerial lead of the set, and adjust the trackers for maximum sound output. It will be found that the padders peak quite sharply on resonance.

Commencing with the L.W. band, set the scale pointer to 1,200 m. and feed in a 1,200 m. signal to the A and E leads. Adjust the oscillator trimmer **C46** for maximum output. Next adjust **C40** and **C35** (inter-stage and aerial trimmers). Fully mesh the gang condenser, and re-track **C50** with the buzzer input. Return to 1,200 m., and re-adjust **C46, C40** and **C35.** Re-track once more.

The same procedure should be followed for the M.W., S.W.2 and S.W.1 bands, the calibration points being 250 m. (1,200 KC/S), 34 m. (8,820 KC/S) and 15.5 m. (19,350 KC/S) respectively. The correct trackers and trimmers to use can be seen from the circuit diagram and condenser table. On the S.W.1 band two peaks will be found on the oscillator trimmer **C43.** The correct one is that produced with the lower trimmer capacity (higher frequency).

If a new coil unit has to be fitted, only the corresponding waveband need be re-aligned.

Scale Pointer.—This should be in the vertical position when the gang is fully meshed and the drive disc occupies the left-hand side of the assembly when viewed from the front of the scale. See that the disc is at the end of its travel before bolting the drive collar to the gang spindle.