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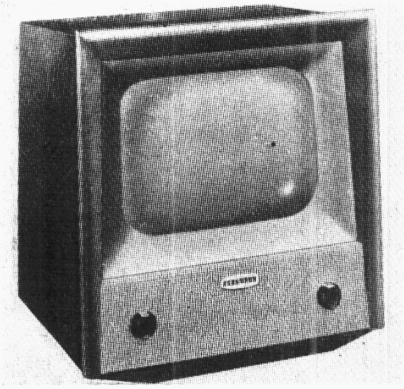
Supplement to W… Electrical Trader, J…

"TRADER" SERVICE SHEET

1095/T39

FERGUSON 991T

Covering 990T, 993T and 995T

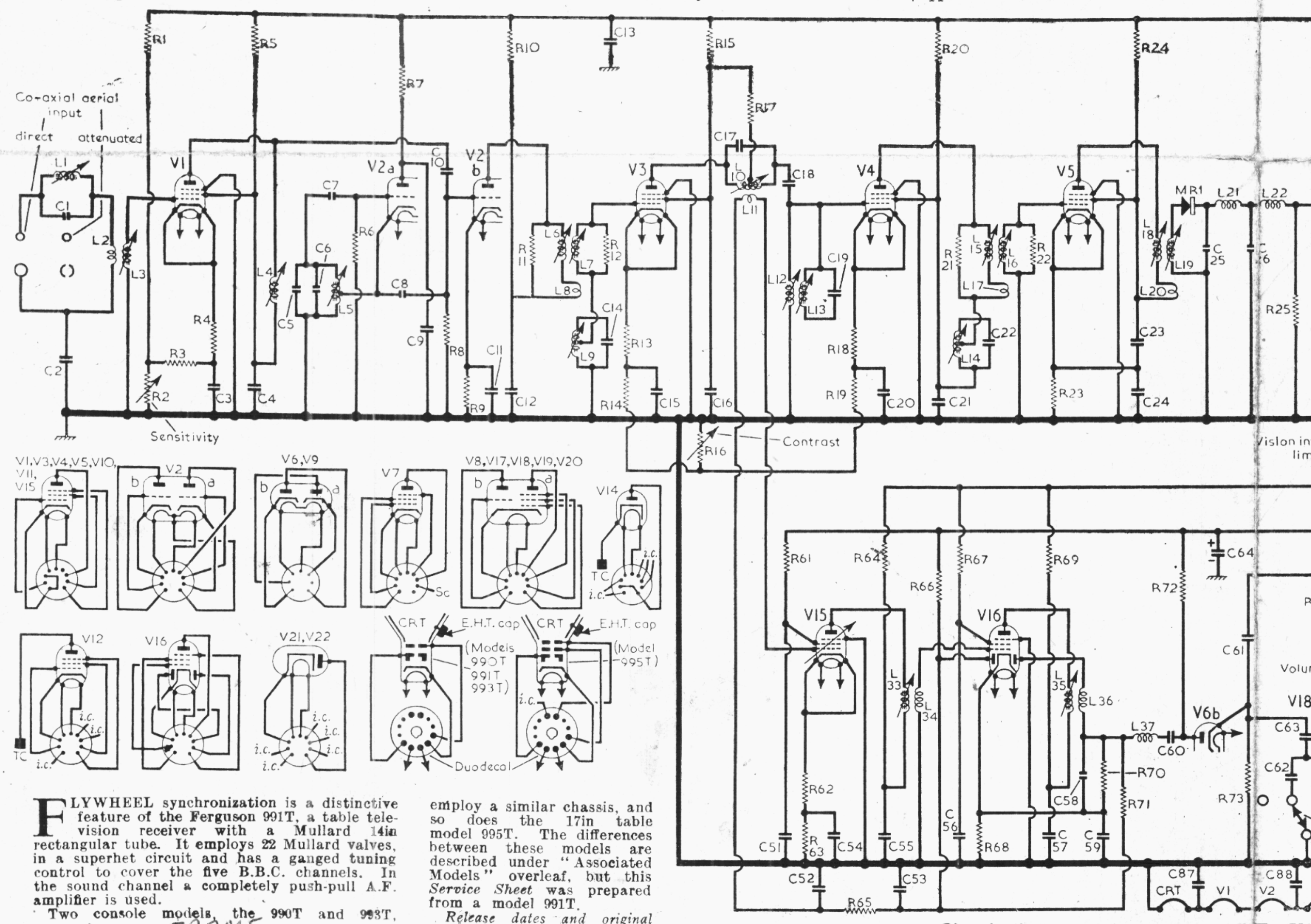


Appearance of Model 991T.

Capacitors		
C1	20pF	A4
C2	0·001μF	A4
C3	0·001μF	J9
C4	0·002μF	H9
C5	‡	J8
C6	10pF	A4
C7	30pF	H8
C8	2pF	H8
C9	0·001μF	H8
C10	150pF	H9
C11	0·001μF	H8
C12	0·0025μF	H9
C13	800pF	H8
C14	100pF	B4
C15	0·0025μF	H8
C16	0·0025μF	H8
C17	100pF	C4
C18	0·001μF	C4
C19	100pF	B3
C20	0·0025μF	G8
C21	0·0025μF	G8
C22	100pF	C3
C23	0·0025μF	F8
C24	0·0025μF	G8
C25	5pF	D3
C26	5pF	F8
C27*	50μF	F8
C28	0·1μF	F8
C29	0·1μF	F8
C30	150pF	G6
C31	50pF	H6
C32	0·1μF	G5
C33	0·02μF	H5
C34	1μF	G5
C35	0·01μF	B1
C36	0·01μF	B1
C37	75pF	H5
C38*	32μF	C1
C39	0·001μF	H6
C40	50pF	H6
C41	0·01μF	H6
C42*	32μF	C1
C43	0·01μF	G6
C44	0·01μF	B2
C45	0·002μF	B2
C46	0·25μF	H8
C47	0·01μF	G8
C48	500pF	H7
C49	0·01μF	H8
C50	0·001μF	B2
C51	0·0025μF	G9
C52	0·0025μF	G9
C53	0·1μF	G9
C54	0·0025μF	G9
C55	0·0025μF	G9
C56	0·0025μF	G9
C57	0·0025μF	G9
C58	30pF	G9
C59	0·0025μF	G9
C60	0·1μF	F9
C61	0·01μF	F9
C62	0·005μF	J8
C63	0·02μF	F9
C64*	8μF	C1
C65	0·002μF	F5
C66	0·002μF	F6
C67	0·002μF	G5
C68*	50μF	F5
C69	5pF	F5
C70	5pF	G5
C71	0·005μF	E6
C72	0·01μF	G6
C73	150pF	G6
C74	0·01μF	F6
C75*	4μF	G5
C76	500pF	F7
C77	500pF	F7
C78	0·02μF	F7
C79*	50μF	F7
C80	0·1μF	F7
C81	0·1μF	F7
C82	0·01μF	F6
C83	0·05μF	D1
C84*	200μF	D2
C85*	100μF	D2
C86	0·1μF	A1
C87	0·001μF	H9
C88	0·001μF	H9
C89	0·0025μF	F9
C90	0·0025μF	G8

Resistors		
R1	120kΩ	J9
R2	5kΩ	J9
R3	150Ω	J9
R4	47Ω	J9
R5	1kΩ	H9
R6	33kΩ	H8
R7	1kΩ	H8
R8	220kΩ	H8
R9	2·2kΩ	H8
R10	1kΩ	G9
R11	18kΩ	B4
R12	18kΩ	B4
R13	47Ω	H8
R14	150Ω	H8
R15	1kΩ	H8
R16	5kΩ	E5
R17	2kΩ	C4
R18	47Ω	G8
R19	150Ω	H8
R20	1kΩ	G8
R21	18kΩ	C4
R22	18kΩ	C4
R23	180Ω	G8
R24		
R25		
R26		
R27		
R28		
R29		
R30		
R31		
R32		
R33		
R34		
R35		
R36		
R37		
R38		
R39		
R40		
R41		
R42		
R43		
R44		
R45		
R46		
R47		
R48		
R49		
R50		
R51		
R52		
R53		
R54		
R55		
R56		
R57		
R58		
R59		
R60		
R61		

*Electrolytic. †Approximate resistance in ohms.



Circuit diagram of the Ferguson 991T. V1…

FLYWHEEL synchronization is a distinctive feature of the Ferguson 991T, a table television receiver with a Mullard 14in rectangular tube. It employs 22 Mullard valves, in a superhet circuit and has a ganged tuning control to the five B.B.C. channels. In the sound channel a completely push-pull A.F. amplifier is used.

Two console models, the 990T and 993T, employ a similar chassis, and so does the 17in table model 995T. The differences between these models are described under "Associated Models" overleaf, but this *Service Sheet* was prepared from a model 991T.

Release dates and original

VALVE 19 IS FRAME SYNC CLIPPER

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F7	R24	1kΩ	F8	R62	47Ω	G9
F7	R25	3·9kΩ	F8	R63	270Ω	G9
F7	R26	82kΩ	J5	R64	1kΩ	G9
F7	R27	5kΩ	J5	R65	100kΩ	G8
F6	R28§	3kΩ	F8	R66	10MΩ	G9
D1	R29	150kΩ	F8	R67	68kΩ	G9
D2	R30	12kΩ	F8	R68	270Ω	G9
D2	R31	100kΩ	F8	R69	1kΩ	F9
A1	R32	220kΩ	F8	R70	47kΩ	G9
H9	R33	680kΩ	F8	R71	330kΩ	F9
H9	R34	150kΩ	F8	R72	3·3MΩ	F9
F9	R35	15kΩ	F8	R73	1MΩ	F9
G8	R36	100kΩ	G6	R74	500kΩ	F5
	R37	150kΩ	H6	R75	470kΩ	F5
	R38	100kΩ	G6	R76	220kΩ	F6
J9	R39	100kΩ	G6	R77	220kΩ	F6
J9	R40	1MΩ	H6	R78	750kΩ	F5
J9	R41	470kΩ	G5	R79	1MΩ	F6
J9	R42	12kΩ	H5	R80	2·2kΩ	F9
H9	R43	620Ω	G6	R81	680kΩ	F5
H8	R44	4·7kΩ	J7	R82	680kΩ	F5
H8	R45	470kΩ	H6	R83	100kΩ	F5
H8	R46	12kΩ	H6	R84	100kΩ	G5
H8	R47	27kΩ	G6	R85	100Ω	F5
G9	R48	5·6kΩ	G6	R86	100Ω	F5
B4	R49	12kΩ	G5	R87	15kΩ	E6
B4	R50	2·2MΩ	G6	R88	180kΩ	F6
H8	R51	100kΩ	E5	R89	470kΩ	F6
H8	R52	68kΩ	E5	R90	1MΩ	F6
H8	R53	100kΩ	F9	R91	150kΩ	G6
E5	R54	500kΩ	F9	R92	18kΩ	G6
C4	R55	100kΩ	B2	R93	22kΩ	G6
G8	R56	220kΩ	G8	R94	1MΩ	J6
H8	R57	22kΩ	B2	R95	470kΩ	J6
G8	R58	910Ω	B2	R96	220kΩ	F7
C4	R59	1kΩ	B2	R97	220kΩ	F7
C4	R60	1kΩ	B2	R98	500kΩ	E5
G8	R61	1kΩ	G9	R99	470kΩ	F7

R100	22kΩ	F6
R101	2·2MΩ	F6
R102	12kΩ	F7
R103	150kΩ	D1
R104	15kΩ	D1
R105	620Ω	F6
R106	100kΩ	D1
R107	250kΩ	J6
R108	350Ω	B1
R109	60Ω	B1
R110	60Ω	B1
R111	20Ω	B1
R112	20Ω	B1
R113	40Ω	A1
R114	40Ω	A1

Coils†

L1	—	A4
L2	—	A4
L3	—	A4
L4	—	B4
L5	—	A4
L6	—	B4
L7	—	B4
L8	—	B4
L9	—	B4
L10	—	C4
L11	—	C4
L12	—	B3
L13	—	B3
L14	—	C3
L15	—	C4
L16	—	C4
L17	—	C4
L18	—	D3
L19	—	D3
L20	—	D3
L21	1·0	F8
L22	2·5	F8
L23	7·5	F8
L24	7·5	F8
L25	127·0	B1
L26	112·0	B1
L27	23·0	B1
L28	1·25	B2
L29	2·0 (total)	B2
L30		B2
L31	10·0 (total)	B2
L32		B2
L33	—	C4
L34	—	C4
L35	—	D4
L36	—	D4
L37	—	F9
L38	2.5	E7
L39	37·0	E8

Transformers†

T1	a-b	7·5	G7
	c-d	5.25	
	d-e	8·5	
	e-f	12·5	
	f-g	15,000·0	
	h-j	—	
T2	a	335·0	E6
	b	335·0	
	c	—	
T3	a	1,150·0	D1
	b	—	

Miscellaneous

MR1	OA61	D3
MR2	FS1187A	F8
S1, S2	—	F5
Thermistor	CZ1	A1

‡Length of twin feeder.

§Two 6kΩ resistors in parallel.

...prices: 991T, November 1952, £51 16s 9d; 990T, March 1953, £85 12s 2d; 993T, March 1953, £62 16s 8d; 995T, February 1953, £64 8s 1d.

CIRCUIT DESCRIPTION

Co-axial 75 Ω input to single-valve T.R.F. sound and vision amplifier **(V1, EF80)**. Rejection of interfering images by **L1, C1.** Double triode valve **(V2, ECC81)** operates as frequency changer, the oscillator being formed by section **a** whose output is combined in section **b** with the amplified signal from **V1** to produce separate sound and vision intermediate frequencies of 19.5 Mc/s and 17.75 Mc/s (mean) respectively.

The vision I.F. amplifier **(V3-V5, EF80's)** is coupled via band-pass transformers to crystal vision detector **(MR1, Mullard OA61).** Sound rejection by **L10, C17; L13, C19;** and **L14, C22.** Adjacent sound channel rejection by **L9, C14.**

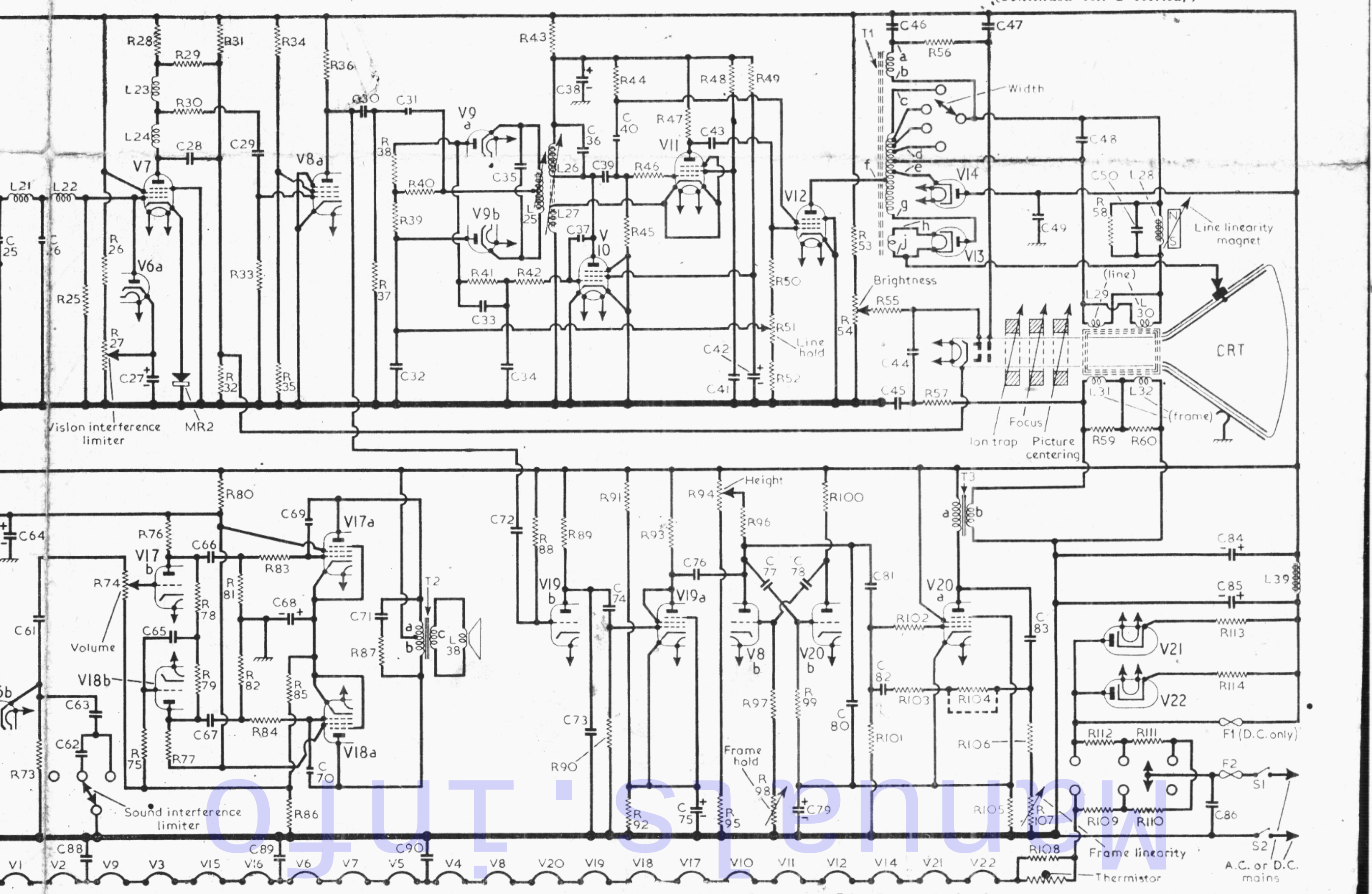
Positive-going picture signal is developed across load resistor **R25** and directly coupled to the control grid of the video amplifying valve **(V7, PL83).** I.F. filtering by **C25, L21, C26** and **L22.** Metal rectifier **MR2 (S.T.C., FS1187A)** in **V7** cathode circuit acts as a constant voltage device, holding the cathode voltage constant at all frequencies. It can be compared in operation to a 30Ω resistor decoupled by an infinitely large capacitor to prevent attenuation at low frequency and low D.C. levels.

Negative-going output from **V7** is coupled via D.C. step-down network **C28, R29, R31** and **R32** to cathode of cathode ray tube.

Negative-going output from **V7** is also passed via **R30** and **C29** to control grid of sync separator valve section **a** of **V8 (ECL80).**

The output from **V8a** (part of **V8, ECL80**) as it appears across **R36** is coupled via differentiator **C30, R37** and **C31** to the flywheel synchroniz-

(Continued col. 1 overleaf)



...n 991T. **V19b is a frame sync** pulse separator, **and V19a is a** "clipper". R57, C45, C44, suppress the frame fly-back trace.

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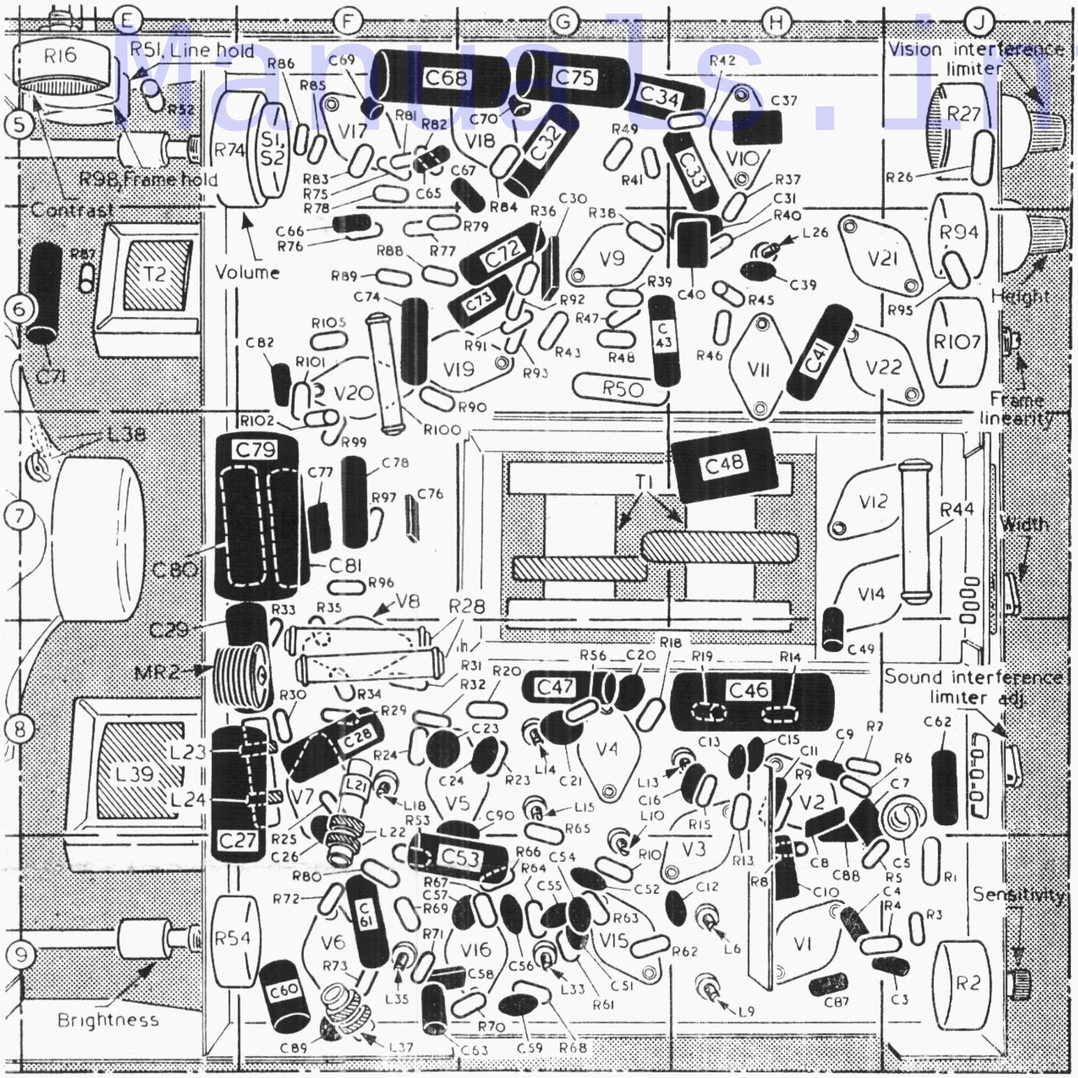
Supplement to Wireless & Electrical Trader, June 6, 1953



Underside view of the chassis.

Circuit description—*continued*

ing circuit of the line time-base, whose sawtooth output is derived from a sinusoidal cathode-coupled oscillator comprising **V11, L26, L27** and various capacitances, including a reactance valve **(V10, EF80)** which operates as a variable tuning capacitor across **L26. V11** is another **EF80.**

The sine wave output at **V11** anode is "chopped" or "sliced" by the components in its anode circuit, so that a square-wave signal is applied to the control grid of the line output valve **(V12, PL81),** whose sawtooth output is developed in the anode circuit and coupled via an auto-transformer **T1** to the parallel-connected line deflector coils **L29, L30.**

The principle of fly-wheel synchronizing is to control the frequency of the time-base oscillator by some device that will not respond to sudden changes in the signal, which might include interference pulses, but will respond slowly only to regular features such as sync pulses, increasing the frequency or reducing it to keep the repetition frequency in step with that of the sync pulses.

This function is performed by a discriminator circuit, whose output is applied to the control grid of the reactance valve **V10.** A change of **V10** bias changes the capacitative effect on the grid winding **L26** of **V11** and thus determines the frequency of oscillation.

The discriminator bias is derived from the voltage-drops along resistors **R38, R39,** which form the loads of the two diodes **V9a, V9b (EB91)** and are added together algebraically: that is to say, plus and minus sums cancel out. As the two diodes are connected in opposition, therefore, if they both produce the same output voltage the resultant voltage across them will be zero.

The diode cathodes are fed with a sinusoidal waveform from the oscillator via coupling winding **L25,** whose ends are in opposite phase. Thus each diode will conduct on alternate half-cycles, when its cathode is negative, and the net output across **R38** and **R39** in series is zero.

Sync pulses are fed in via **C31** and **C32** to the centre of **L25** and the anodes of the diodes. If neither diode is conducting when the sync pulse arrives, equal current flows because it drives both cathodes equally negative, and this is the condition for synchronization, when oscillator and sync pulses are in phase. The A.C. input to both diodes should be zero at the moment when the sync pulse arrives.

If one of the diodes is conducting when the sync pulse arrives, that is to say its cathode is at some point on the negative half-cycle, the pulse will increase the potential to some extent. This will upset the balance between the two, because when the other diode conducts on its next half-cycle, the amplitude will be normal, and unaffected by the sync pulse.

A smaller voltage will be developed on the load resistor of one diode than on the other when this happens, and a difference voltage will appear across **C34.** This is applied to **V10** control grid, changing the reactance of the valve and altering the oscillator frequency in such a direction as to correct the discrepancy.

This action will continue until zero A.C. voltage at **L25** coincides with the sync pulses. The combined effect of **C33, C34** and **R41** produces a time-constant which has an effect like inertia and prevents the control voltage from changing suddenly, so that irregular impulses, such as interference pulses, cannot affect the oscillator frequency, which goes on fly-wheel fashion undisturbed by them. The mean bias voltage for **V10** is derived from grid current flowing through **R50, R51, R52** from **V12,** and **R51** acts as line hold control to adjust the oscillator frequency manually.

MODIFICATIONS

MR1 is quoted as a Mullard OA61, but it might equally be a Brimar GD3 or a B.T.H. CG5G or CG5M. Prior to serial No. 1360, **R62** was omitted, and **R63** was 330 Ω; subsequently the cathode circuit of **V15** is as shown in our diagram. This prevents sound on vision arising as a result of detuning **L11** with varying signal levels. Prior to serial No. 1200 the suppressor grid of **V11** was connected to chassis, and **C49** was not fitted.

R104 was not fitted in early versions, but it may be 27 kΩ in others. Where it is fitted it is usually short-circuited, but the short-circuit should be cut open if the picture is cramped at the top. In areas of severe interference, greater limiting effect may be obtained from **V6a** if its anode is transferred to the junction of **C25** and **L21**: i.e., directly across the detector output, but some I.F. harmonic beat patterns might become visible on the screen, particularly in the Wenvoe area.

The addition of **C49** and **V11** suppressor change was made to avoid an effect on the raster which somewhat resembles the Barkhausen effect when the set is operated in an area of very low signal strength, where the contrast control has to be turned to maximum. The makers describe the fault as giving a "veneered" appearance to a strip of the picture about 1in wide. Where this is experienced under these conditions in an early receiver, **C49** should be added.

GENERAL NOTES

Fly-wheel Sync Phasing.—Although this circuit is self-correcting, it is important that it is properly adjusted before the signal is applied. The adjustments are the cores of **L25** and **L26.**

To adjust these, first short-circuit **R37** to suppress the sync input, and adjust **R51** (line hold) to mid-position. Then while receiving a picture, adjust **L26** until the picture is properly resolved, as though it were synchronized. In this condition, a very small movement either way will move the picture over the raster area to the right or left, and it should be centred.

Remove short-circuit, restoring sync, when picture should lock, but it may be displaced right or left. This indicates that, although the sync pulse repetition and oscillator frequencies are equal, they are not in phase. Care must be exercised that an off-centre raster is not confusing the centering of the picture within the raster. Then adjust **L25** to centre the picture so that its sides are at equal distances from the edges of the raster, which can be seen if the brightness control is turned up.

Mains Voltage Adjustment.—This is a simple matter of turning a 3-position disc until the appropriate voltage range is uppermost, and is the same for A.C. or D.C. mains. On low-voltage D.C. mains, however, of 200 V or less, a 2.5 A fuse should be fitted in the right-hand fuse-holder (viewed from rear) to short-circuit the rectifying valves **V21, V22.** At the same time, the 1.5 A fuse normally used for A.C. mains in the left-hand holder should be replaced with a 2.5 A fuse. Two fuses of each rating are supplied with each receiver. Such receivers should be connected to the mains by a non-reversible plug.

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ASSOCIATED MODELS

This *Service Sheet* was prepared from a sample 991T receiver, a table model with an MW36-24 14in diagonal C.R. tube. The **990T** is a console model with doors, and it employs an MW41-1 16in circular metal tube. As this has no external coating, like the glass tube, a 0.0005 μF reservoir capacitor, rated at 15 kV, is fitted. This receiver has an 8in speaker, and contrast, line and frame hold controls are at the front of the cabinet.

The **993T** is another console. It has no doors, and the tube is the same as in the 991T. Controls and speaker as in 990T. The **995T** is a 17in table model using an MW43-64 diagonal pentode C.R. tube, with the middle anode (anode 2) connected externally to cathode. With the tube a slightly weaker focus magnet is fitted. In some 995T models the tube might be an Emitron 17ASP4 tetrode tube, which has the same base connections as the MW36-24.

VALVE ANALYSIS

Valve voltages and currents given in the table below are those derived from the manufacturers' information and are the average of readings taken on a number of receivers which were operated from 208 V A.C., the voltage adjustment being set to the 200-210 V tapping. The contrast and sensitivity controls were turned to maximum and the remaining controls set for normal operation, but there was no signal input.

Voltages were measured on a 1,000 ohms-per-volt meter, except where otherwise indicated, and chassis was the negative connection in every case. Total H.T. current was 250 mA. When operating the receiver from 200 V A.C. mains, on the 200-210 V tapping, the E.H.T. voltage falls to 13.4 kV, H.T. voltage **(V20a** screen grid) to 187 V and H.T. current to 237 mA.

Valve		Anode V	Anode mA	Screen V	Screen mA	Cath. V
V1 EF80		183	9·4	183	2·3	2·3
V2 ECC81	a	188	5·7	—	—	—
	b	190	2·3	—	—	5·0
V3 EF80		183	9·4	183	2·3	2·3
V4 EF80		183	9·4	183	2·3	2·3
V5 EF80		180	9·8	180	2·4	2·2
V6 EB91		—	—	—	—	—
V7 PL83		154	12·5	194	2·0	5·0
V8 ECL80	a	120	0·5	15	‡	—
	b	25	0·25	—	—	—
V9 EB91		—	—	—	—	—
V10 EF80		175	9·0§	175	2·2§	—
V11 EF80		126	2·0	159	4·5	—
V12 PL81		*	90·0	128	13·0	—
V13 EY51		*	—	—	—	14·0kV‖
V14 PY81		194	90·0	—	—	500·0¶
V15 EF80		185	8·4	171	2·3	3·5
V16 EBF80		188	4·4	71	1·6	1·8
V17 ECL80	a	187	14·0	173	2·5	6·8
	b	50	0·5	—	—	6·8
V18 ECL80	a	187	14·0	173	2·5	6·8
	b	50	0·5	—	—	6·8
V19 ECL80	a	185	‡	185	‡	38·0
	b	35	0·3	—	—	38·0
V20 ECL80	a	180	9·5	194	2·0	10·5
	b	85	4·5	—	—	10·5
V21 PY82		208†	—	—	—	209·0
V22 PY82		208†	—	—	—	209·0

CRT MW36-24** CRT MW41-1†† CRT MW43-64‡‡	1st anode 340 V; 2nd anode 14·0kV.‖

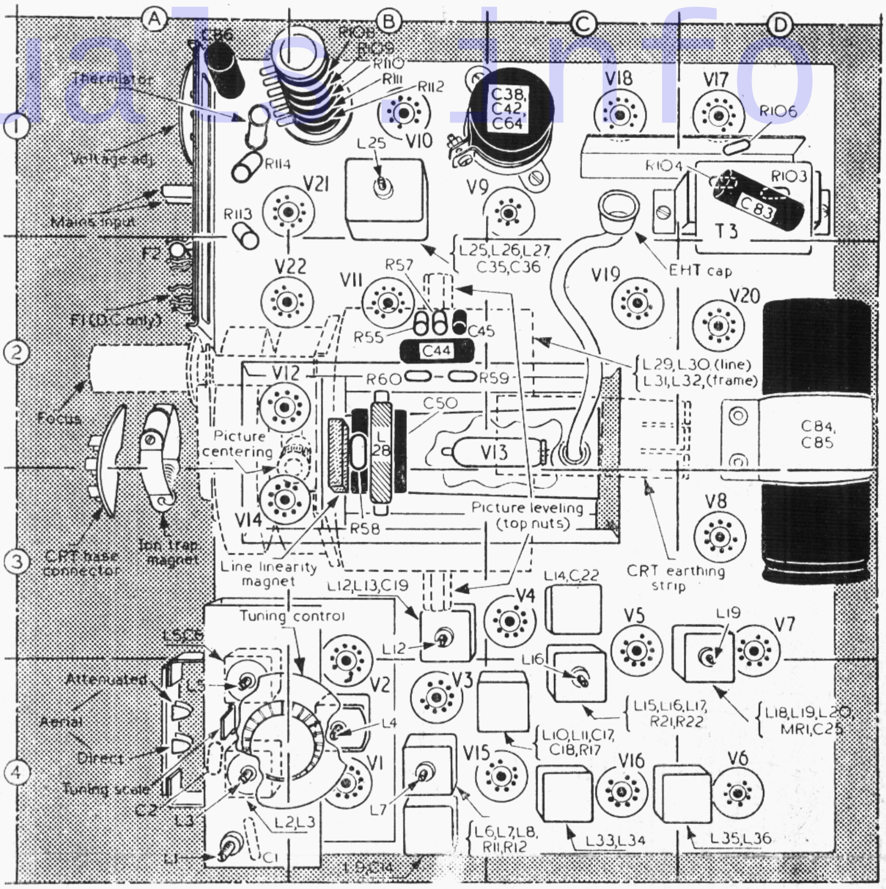
* No reading taken. † A.C. reading. ‡ Very low. § Subject to large variations with setting of line hold control ¶ Measured at junction of C46, R56. ‖ Measured with electrostatic meter ** Models 991T and 993T †† Model 990T. ‡‡ Model 995T.

CHANNEL CHANGING

Provided that the receiver is correctly aligned, this is accomplished by first adjusting the tuning control so that the appropriate channel number on the metal cursor coincides with the edge of the mounting bracket, and then adjusting the control carefully for maximum sound output while receiving the required transmission.

CIRCUIT ALIGNMENT

Equipment Required.—An accurately calibrated signal generator with an output impedance of 75 Ω; a 100 V D.C. meter for use as vision output meter (the manufacturers use the 100 V range of a Model 7 Avometer); a sound ouput meter, and a 1 kΩ damping resistor.



Plan view of chassis, showing deflector coil and focusing assembly in broken outline.

Connect the vision output meter across **R28**, and the sound output meter across **T2** secondary winding. Turn contrast, sensitivity and volume controls to maximum, and adjust the remaining controls for normal operation. Feed in an unmodulated signal for vision alignment and a 30% modulated signal for sound alignment.

Make the adjustments in the order shown in the alignment tables. "V" under "Meter deflection" means vision and "S" means sound. "Max. V" means maximum increase in the vision output meter reading.

I.F. Stages.—The 1 kΩ damping resistor should be connected across the coil indicated under "Shunt" in the following table. Disconnect **R7** from the anode pin of the oscillator, taking care not to disturb **C5**. Connect output of signal generator, via an 0.1 μF capacitor in each lead, to anode (pin 7) of **V1** and chassis. If two peaks are found for any of the following adjustments, the one nearer to the adjusting end should be chosen. Carry out the alignment detailed in the following table.

I.F. Table

Sig. Gen. Output (Mc/s)	Shunt	Adjust	Location	Meter deflection
14·5	—	L9	H9	Min. V
19·5	—	L14	G8	Min. V
19·5	—	L13	H8	Min. V
19·5	—	L10	G9	Min. V
19·5	—	L33	G9	Max. S
19·5	—	L35	F9	Max. S
17·75	L18, L20	L19	D3	Max. V
17·75	L19	L18	F8	Max. V
17·75	L15, L17	L16	C4	Max. V
17·75	L16	L15	G8	Max. V
17·75	—	L12	B3	Max. V
17·75	L6, L8	L7	B4	Max. V
17·75	L7	L6	H9	Max. V

R.F. and Oscillator Stages.—Transfer signal generator leads to aerial sockets, removing 0.1 μF isolating capacitors. It should be noted that the resonance curve of **L5** is extremely sharp, and in the table below, it is adjusted in two steps, the first being to find the approximate setting, and the second to reset the core accurately. It is advisable to check the accuracy of the signal generator for this adjustment by beating it against the transmitted sound signal.

Reconnect **R7** to the oscillator anode and set the tuning control (location reference **A4**) so that the appropriate channel number on the metal cursor coincides with the edge of the mounting bracket.

C1, L1 form an image-frequency rejector circuit and the core of **L1** is adjusted in the table to minimize any interfering signal which falls within the range 70-100 Mc/s. The rejector is aligned at 95 Mc/s at the factory. Make the adjustments in the following table.

R.F. & Oscillator Table

Sig. Gen. Output	Adjust	Location	Meter deflection
*	L5	A4	Max. S
*	L5	A4	Min. V
—	L1‡	A4	Min. V
†	L4	B4	Max. V
†	L3	A4	Max. V

* Sound carrier frequency. † Vision carrier frequency less 1·5 Mc/s. ‡ Adjust for minimum interference pattern on screen when receiving transmission.

Sound Rejection.—Connect signal generator to aerial sockets, feed in a signal at vision carrier frequency and note the reading on the vision output meter for a given input. Feed in a signal at the sound channel frequency and check that to maintain the same reading on the vision output meter, the output of the signal generator has to be increased at least 180 times (45 db) that required at the vision channel frequency.

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