



SERVICE DATA SHEET

TELEVISION

T21 SERIES

TELEVISION RECEIVERS

CIRCUIT DESCRIPTION

Vision IF amplifier comprises three stages of amplification using three overcoupled bandpass transformers and a single tuned transformer as the inter-stage coupling circuits. The coupling and bandwidth of these circuits is arranged to give an overall phase linear response about the vision carrier.

The detector transformer L5 is overcoupled and damped so its response is nearly flat over the passband (see Fig. 6). This ensures the impedance presented to the diode detector is substantially constant (and low in value) over the video band.

This is preceded by a similarly coupled and damped transformer L4 to give the composite curve as in Fig. 7. The damping was made heavy to make the coil easier to duplicate in production. The tilt shown in Fig. 7 is due to a small amount of mixed coupling in L4.

The first IF transformer is tuned to the centre frequency and gives response shown in Fig. 8 when added to other circuits.

Tuner coupling is by bottom capacitively-coupled circuit formed by mixer anode coil, the input coil L2 and the coupling capacitor C2. The connecting cable also forms an important part of this circuit, effectively adding more capacitance across C2. The two coils are overcoupled and aligned to give overall response curve in Fig. 9. The mixer anode is series damped by R1 and the input coil by R5 so they have about equal Q.

The sound IF is attenuated by L2A to provide the necessary difference in sound and vision carrier levels, and further traps are provided in L1 and L3A which attenuate the adjacent sound and vision carriers respectively.

The first IF amplifier V3 is a remote cut-off type and AGC-controlled. L2C forms a filter to prevent any line pulse appearing on the grid of this valve.

The network C13, R14 is included to prevent the last IF amplifier and detector diode from being overloaded when the set is first switched on and the AGC is inoperative.

Video Detector. A germanium diode D2 is used to demodulate the vision IF and mix sound and vision carriers to provide the 5.5 MC/s sound IF signal. The diode load R19 and charge capacitor C18 are made low in value to ensure wideband demodulation and to provide sufficient 5.5 MC/s output.

Video Amplifier. The video amplifier comprises one stage of amplification using V6P. The composite video waveform from the video detector is fed to the video amplifier grid via L5C, L5D and L6, which act as series peaking coils as well as IF chokes, and compensate the HF end of the video spectrum. The video amplifier has a low anode load to ensure wideband response and is further compensated by L7 and L17B. The low frequency compensation is provided by cathode circuit bypass C19 which gives an overall flat response to 5 MC/s.

The 5.5 MC/s sound signal is prevented from reaching the picture tube by the sound trap L17A.

Contrast control is made possible by R66, R20, R18 which give a variable positive voltage on grid of video amplifier and thus reduce or increase gain via the AGC valve, which is DC-coupled to the video amplifier and responds to the change in anode voltage. R18 prevents any DC current from flowing in diode D2, and C16 bypasses this for the video waveform. Such a small value is possible because of the high impedance of the video amplifier grid circuit and causes no loss in low frequency response so long as the video amplifier does not draw grid current. This is ensured by the cathode biasing resistor R23.

ALIGNMENT PROCEDURE

Equipment necessary: AM signal generator covering range 25-230 MC/s with output of 100 mV and termination resistance of 75 Ω ; wobulator with sweep width of 10 MC/s and centre frequency of 31 MC/s; an oscilloscope connected as in Fig. 2 with provision for external sweep; a variable negative bias voltage of 0-9V.

Procedure. 1. Disconnect red oscillator HT lead to tuner and switch tuner to Ch.10; this is important as low-band channels upset overall IF response.

• Turn AGC, contrast and noise suppressor fully anti-clockwise.

• Connect CRO as in Fig. 2 to junction of L6 and R21. The filter network shown eliminates any instability caused by connection of CRO.

• Connect bias voltage to junction of R79 and R80 positive lead to chassis.

2. Set wobulator with markers at 31.5, 34 and 36 MC/s to centre frequency of 34 MC/s and full output (0.5V peak) and connect it to grid of V5P. Align the detector coil L5A and L5B to give the bandpass shown in Fig. 6. Check alignment by moving each core slightly until curve responds symmetrically.

3. Connect wobulator to grid of V4P and reduce the output of wobulator to obtain 2V output from the detector. Align L4A and L4B to give the bandpass in Fig. 7. Check alignment as before until curve varies symmetrically.

4. Connect wobulator to grid of V3 via 0.001 μ F ceramic capacitor (so as not to short bias). Adjust bias voltage to -6V and set wobulator to give 2V output at detector. Tune L3 (bottom core) to give bandpass in Fig. 8.

5. Connect wobulator to tuner test point and set output as before. Adjust mixer anode coil and L2B (bottom slug) to obtain response in Fig. 9. The curve will not be obtained if traps are not on frequency.

6. Remove wobulator and connect signal generator to tuner test point. With frequency at 37.5 MC/s and 30% AM align L1 to give minimum output. With frequency at 30.5 MC/s and 30% align L2B (top core) for minimum output.

Note: Bias may have to be reduced to obtain sufficient output at these frequencies.

7. Repeat 2-6 as crossback to obtain overall IF curve in Fig. 9.

8. Remove bias and check that regenerative spikes do not appear on the bandpass and that shape does not change appreciably.

VISION IF PERFORMANCE FIGS

Measurements taken on TF 1066 signal generator giving 100 mV RMS at 0db when terminated 75 Ω .

Sensitivities taken on 34 MC/s for 2V DC output at junction of L6 and R21.

Rejection figures in respect to 34 MC/s: Sensitivity at first IF grid and zero bias, 40-46 db; sensitivity at tuner test point, 23 db.

This figure is a guide only, as there is a large loss from test point to mixer grid and figure is not a true indication of IF sensitivity.

Rejection figures: 37.5 MC/s (adjacent sound), 36 db; 30.5 MC/s (co-sound), 24-28 db.

OVERALL SENSITIVITY CHECK

1. Apply shorting links across R79 and C1 to ensure that IF and tuner bias voltage will be zero.

2. Connect high impedance voltmeter (20,000 Ω) between junction of L6 and R21 and chassis, positive to lead to chassis.

The sensitivity figures below are for 2V DC read on voltmeter. These figures will only apply when generator is correctly matched to tuner and a suitable matching network is shown in Fig. 1.

The db figures only apply when this matching device is used and when 0 db on generator equals 100 mV. The voltage figures given are actual voltages across tuner input.

Channel	Frequency	Input	
2	66.5 MC/s	76 db	8 μ V
7	184.5 MC/s	74 db	10 μ V
9	198.5 MC/s	74 db	10 μ V

SOUND IF AMPLIFIER

The sound IF amplifier and detector comprises one stage of amplification using V7P as neutralised pentode limiter followed by the 6DT6 locked quadrature grid oscillator as the FM discriminator.

The 5.5 MC/s sound signal is taken off after the video amplifier using series/parallel tuned circuit formed by C20, C21 and L8. This was the most efficient take-off system tried as the gain of the video amplifier is added to that of the sound; the sound take-off capacitor C20 is not very critical and was chosen as a compromise between gain and bandwidth. Too low a value reduces the gain unnecessarily, while too large a value damps the sound take-off coil and allows the higher video frequencies to pass into the limiter grid.

The size of the tuning capacitor C21 and grid stopper R26 was chosen to eliminate harmonic radiation from the limiter grid which appeared on Ch.2 as a beat pattern. The amplifier V7P is neutralised by C25

(Continued overleaf)



Tecdata Series No. 2

and C23 and acts as a grid and plate limiter at levels about 50 mV at the video amplifier grid. This was done to prevent overloading the 6DT6 syntector which acts as a more efficient limiter than the pentode at lower levels. The limiter is coupled to the syntector by means of the double-tuned transformer L9.

OPERATION OF SYNTECTOR

In this form of detector, a voltage is induced across the tuned circuit in the suppressor grid by means of electron coupling from the control grid. At resonance the tuned circuit is resistive and voltage across it is 90° out of phase with control grid voltage. This is caused by the electron coupling which acts as a small negative capacitor connected between grid and suppressor, causing an almost entirely capacitive current to flow in the tuned circuit at G3. These two voltages both act on the anode current and give rise to the relations shown in Fig. 5.

As the frequency of input changes, the tuned circuit in G3 is no longer resistive and the phase of voltage on G3 changes either side of 90° and so increases or decreases the anode current as in Fig. 5. Thus the anode current becomes a function of input frequency and the circuit acts as an FM discriminator.

High level operation: At high input levels, the circuit behaves as described above and the FM input to the syntector is injected via L9A and L9B. The signal at the grid is about 4V P-P and the grid acts as an AM detector with the unbypassed cathode resistor acting as a diode load, across which is developed an audio voltage.

This causes degeneration at audio frequencies and further reduces any AM component in the output.

Low level operation: At low input levels the circuit oscillates in a type of tuned plate-tuned grid manner, with the suppressor acting as the oscillator plate. This does not affect the operation of the detector, however, as the voltages on G1 and G3 remain much the same as before, and the oscillator frequency locks to the input frequency. The oscillator will follow the FM signal as it varies so long as the amplitude of the input is above a critical level known as the "minimum locking level", and this level is proportional to deviation.

Below this level the oscillator no longer locks to the input and becomes free running at a frequency determined by L9B.

As long as the oscillatory voltage on G1 is large compared with the input signal, the anode current is independent of the signal amplitude, and the AM rejection is high. Poor AM rejection at low levels is mainly caused by overcoupling in L9, which damps L9B and reduces the oscillator voltage on G1. This also causes large frequency drifts and results in reduced sensitivity.

General Notes:

In the anode circuit, R35 acts as filter for any 5.5 MC/s which might radiate from the audio amplifier connecting leads, and R33 is the audio load. The screen voltage does not materially affect the operation of the syntector and the screen bleed resistor R32 is included to stabilise the screen voltage sufficiently to obviate the need for an electrolytic bypass.

SOUND AMPLIFIER PROCEDURE

Equipment required: AM/FM signal generator; frequency, 5.5 MC/s with maximum error of 2 KC/s; output, variable up to 100 mV; deviation, ± 50 KC/s at 1 KC/s; AM, 30% at 1 KC/s. An audio oscilloscope.

Alignment procedure: 1. Turn AGC, contrast, noise suppressor and brightness controls fully anti-clockwise.

2. Connect signal generator to junction of L6, R20, R21.

3. Connect oscilloscope to junction of C29, C31.

4. Set signal generator to FM ± 50 KC/s and 100 mV output. Tune L10 for maximum output and linearity.

Note: (a) L10 must be adjusted at high levels so that the 6DT6 is not oscillating and the only circuit affecting the detection is L10. It may be necessary to adjust L9A and L9B roughly at this stage if a pure sinewave output cannot be obtained by adjusting L10.

(b) There are two tuning points for L10, the correct one being further into the coil. The incorrect tuning point gives slightly distorted output and poor AM rejection which will result in background buzz on the sound.

5. When L10 has been correctly adjusted, reduce output of generator until sinewave becomes distorted. Adjust L9B (top core) and L9A (bottom core) until sinewave is restored to its original shape. Again reduce the input and repeat these adjustments until no further improvement can be made.

6. Adjust L8 to clear distortion, decreasing generator output as before, until maximum sensitivity is obtained.

7. Readjust L9A and L9B if necessary.

Note: At minimum input level, the sinewave should distort symmetrically on both peaks. If distortion occurs asymmetrically then either L10 or L9A is out of adjustment. L10 must not be adjusted at low inputs.

PERFORMANCE FIGURES

1. With generator set to ± 50 KC/s deviation, the generator output should not be more than 600 μ V to obtain undistorted audio output.

2. With generator set to ± 50 KC/s deviation and maximum output, the peak-to-peak audio voltage at junction of C29 and C31 should be 50V.

3. With generator switched to AM $\pm 30\%$ the audio voltage should not rise above 1V peak-to-peak.

4. With generator connected to grid of V7P and set at ± 50 KC/s deviation, the generator output should not be more than 15 mV to obtain undistorted audio output.

SOUND TRAP ALIGNMENT

Equipment required: A switched generator to provide 5.5 MC/s and 1 MC/s at equal levels and 1V output. Demodulator probe and indicator as shown in Fig. 4.

Procedure: 1. (a) Turn contrast, AGC, brightness and noise suppressor controls fully anti-clockwise; (b) connect demodulator to pin 7 on picture tube and earth; (c) connect the generator to junction of L6 and R21.

2. Switch to 5.5 MC/s and full output and tune L17A for minimum output. Note the output obtained.

3. Reduce output of generator by 26 db and note that the indicated output is lower than when the generator is switched to 1 MC/s.

AUTOMATIC GAIN CONTROL

A composite video signal with noise interference removed by noise suppressor action, is fed via R33 to grid of the AGC valve V10T. Positive 600V flyback pulses from horizontal scan transformer are fed to V10T anode. Due to the finite anode-to-grid capacity (about 3 pF) undesirable positive pulses would appear on the grid and are therefore neutralised by negative pulses applied via C48 (3 pF) to grid of the same valve.

A negative voltage, dependent upon the coincidence of anode and grid signals and upon the amplitude of the video waveform is developed at the anode of V10T. This voltage is used to control the gain of RF and IF amplifiers, keeping the video amplifier output constant, irrespective of signal strength fluctuations at the aerial terminals of the receiver.

A two-stage integrating filter network is provided for the negative voltage prior to its application to the RF cascade valve and the grid of first IF valve. This filter removes the low frequency modulation which may be present at the anode of V10T when the horizontal oscillator is non-synchronous. If no provision is made to remove this modulation, its amplified form (via IF and video amplifiers) may seriously overload the synchronising separator, giving rise to a sync. "lock-out" condition.

The AGC controlled first IF stage is a frame grid variable mu valve, operating under "sliding screen" conditions. The screen voltage varies from 50V to 200V, depending on signal strength, thereby extending the effective grid base and providing an improved signal handling capacity. The cathode compensation maintains constant input impedance.

In the case of the tuner, a delay voltage is provided by a 12 M Ω resistor (R7) connected to HT3 and the suppressor grid of V3 with an M3 diode connected in parallel. Since the AGC valve V10T can develop very large negative voltage, only about a quarter of it (R79, R80) is used for the IF amplifier, thereby permitting a higher than usual delay voltage on the tuner. It is about 50V and once overcome, tuner gain decreases very rapidly with the IF gain remaining about constant. This enables the receiver to handle signals from 10 μ V to 200 mV without any cross modulation effects.



SYNCHRONISING PULSE SEPARATOR NOISE SUPPRESSOR, PHASE SPLITTER

The video signal from V6P is fed to grid of the synchronising pulse separator V6T via R76, C43 and C42. The video signal is also fed to grid of noise suppressor V7T, which is normally held just below cut-off by adjustment of the noise suppressor control R74. When noise pulses appear on video waveform, V7T will conduct and develop across R76 a voltage in opposition to that fed direct from the video amplifier V6P. The negative synchronising pulses from V6T anode are fed via C40 into grid of synchronising phase splitter V5T. Positive and negative line pulses for the horizontal AFC circuit are derived from the anode and cathode respectively of the phase splitter via C57 and C62.

The negative pulse for the vertical oscillator is derived from the cathode of the phase splitter, via an integrating network and an interlace diode D3.

NOISE SUPPRESSOR CONTROL SETTING

With a strong signal and no disturbing interference present, the noise suppressor is best turned off (i.e. hard anti-clockwise, viewing receiver from the back).

If there is impulsive interference present, upsetting the vertical and horizontal holds, then the noise suppressor should be brought into operation by adjusting R74 clockwise slowly, until the picture is displaced to the left and thrown out of synchronism. The control should then be backed off slightly (about $\frac{1}{4}$ turn) and picture will lock in firmly. This procedure should be carried out with the contrast control R66 in about middle of its range.

In fringe areas, this adjustment should be carried out with the strongest signal available, so that the AGC is still exercising the control over the receiver. If it is made under extremely weak signal conditions, sync inversion may take place when the signal strength rises to the level at which the AGC assumes full control.

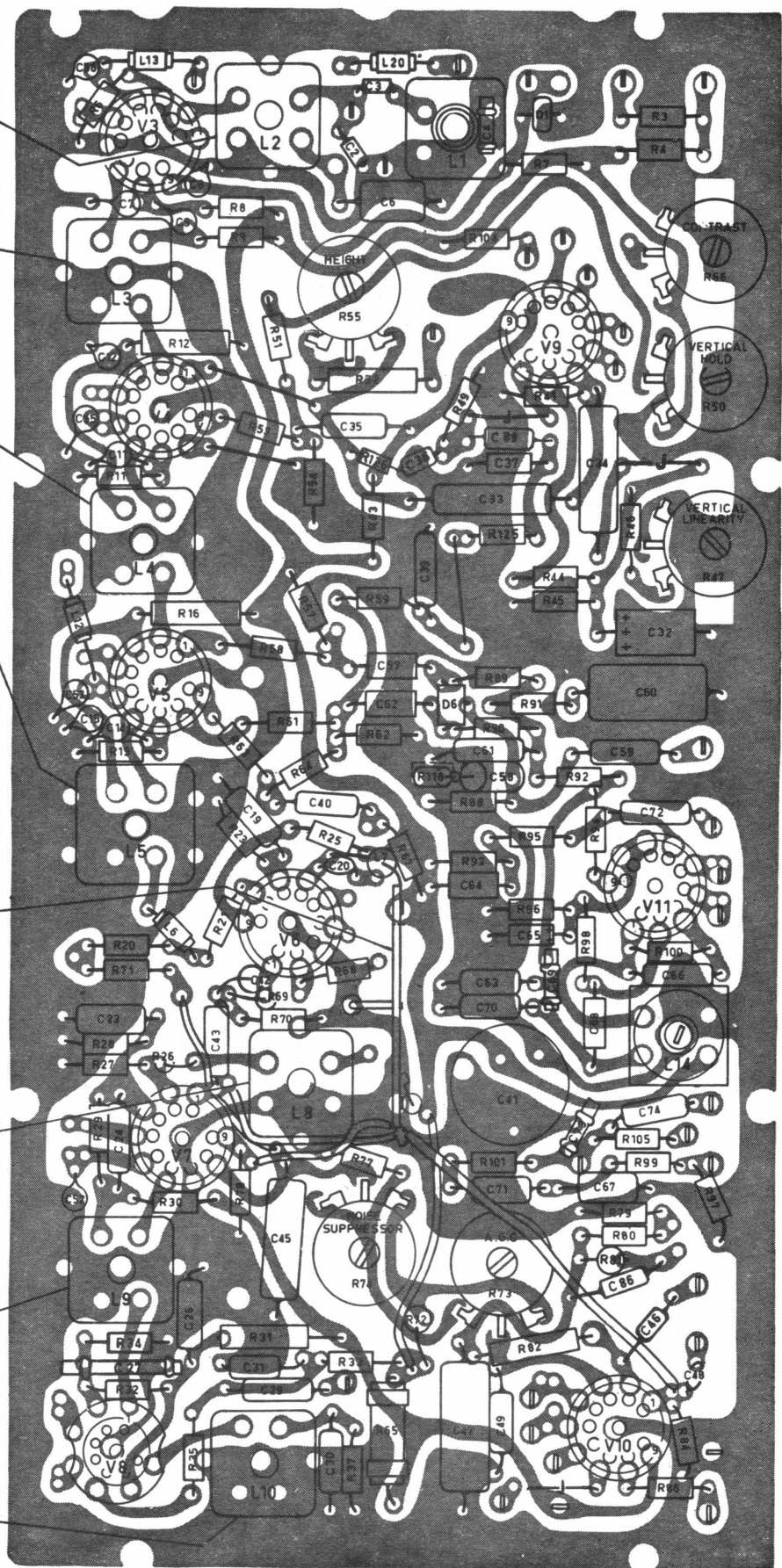
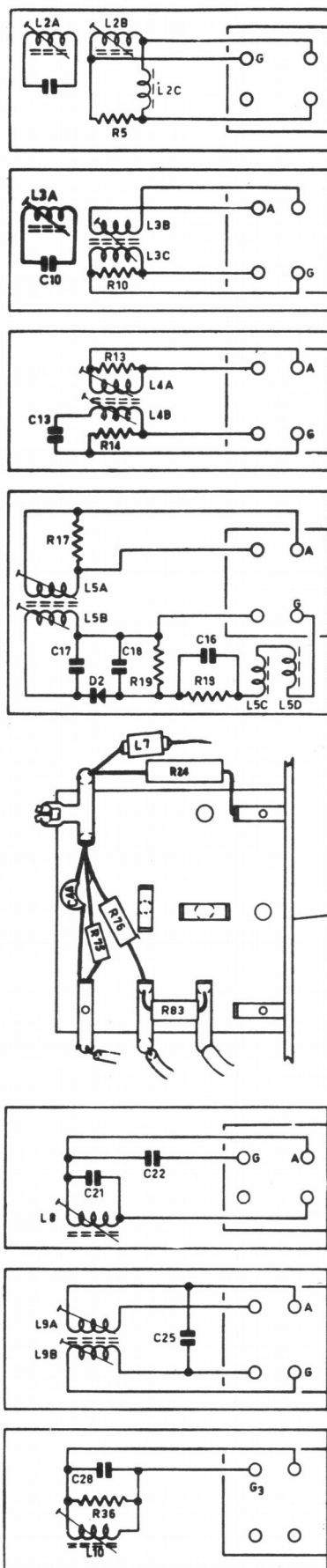
VERTICAL SCAN TIMEBASE

The vertical scan circuit consists of V9T oscillator, V4T discharge valve, and V9P output stage, working into T1 the vertical output transformer.

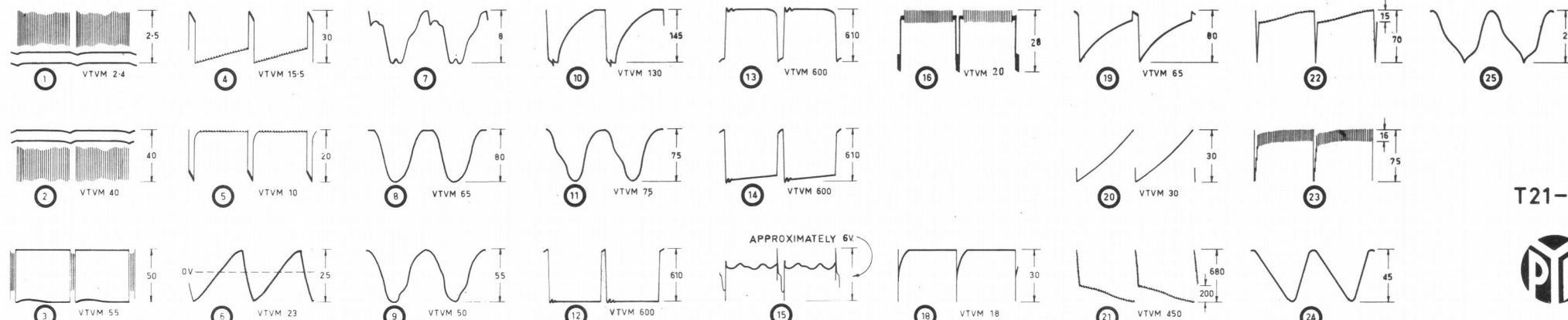
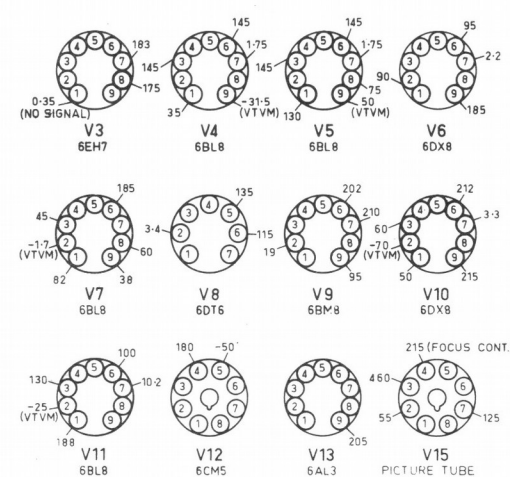
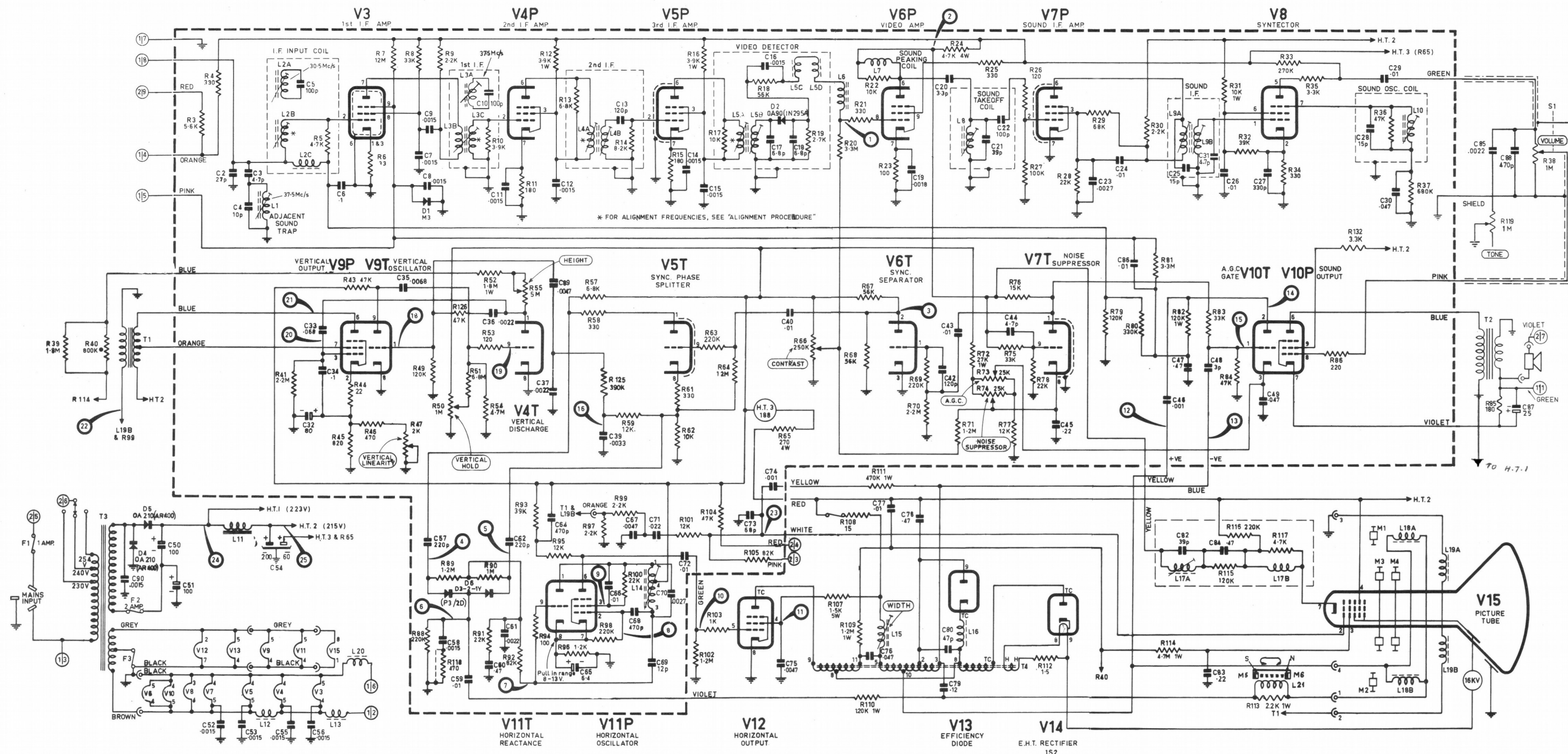
The oscillator valve is triggered off by the leading edge of negative frame synchronising pulse derived from cathode of the synchronising phase splitter. A sawtooth waveform is built up at the anode of discharge valve V4T in conjunction with R49 and C36 shaping network. This sawtooth is applied to the grid of the output stage V9P via C33. Vertical linearity is controlled by varying the cathode bias in the output stage V9P by adjusting R47. Vertical scan size is controlled by varying the drive waveform amplitude to the grid of the output stage by adjusting R55. Vertical hold is also a DC control, arranged in the grid of the discharge valve by means of R50. The screen tap on T1 is chosen for the output stage to operate in the most favorable vertical linearity range. The damping effect of the screen feedback reduces the pulse voltage developed at the anode of V9P by adjusting flyback time to the correct value with regard to the transmitted waveform.

A special feature of the vertical scan circuit is the inclusion of a temperature-dependent resistor, R40, intended to maintain a constant picture height over a wide temperature range. As the vertical deflection coils warm up their resistance increases, thereby causing loss of scan. At the same time, R40, being in close contact with the T1 windings, decreases in resistance thereby increasing drive to the output pentode and hence the height. R40 is shunted by R39 for a better match of the compensating characteristics.

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NOTE:- THE NUMBERS PRINTED ON THE ACTUAL PRINTED WIRING BOARD ARE FOR PRODUCTION PURPOSES ONLY, AND DO NOT REFER TO THE NUMBERS SHOWN ON THIS DRAWING OR ON THE CIRCUIT DIAGRAM.



TEST CONDITIONS:
1. ALL CONTROLS SET TO GIVE NORMAL PICTURE.
2. TO ACHIEVE GIVEN SYNC AND VIDEO VOLTAGES, THE CONTRAST CONTROL SHOULD BE SET TO GIVE 40 VOLTS P-P AT THE OUTPUT OF THE VIDEO AMPLIFIER.
3. SIGNAL STRENGTH ADJUSTED SO THAT A.G.C. VOLTAGE ON THE TUNER IS ZERO.

NOTE:- THIS WAVEFORM IS TAKEN WITH 6EH7 REMOVED.

WAVEFORM MEASUREMENTS MADE ON HIGH IMPEDANCE C.R.O. (TEKTRONIX, 10 MA/14pF) VTVM P-P VOLTAGE MEASUREMENTS MADE ON VOLTOHMIST 1A56074.

T21-L SERIES



RESISTORS

No.	Value in Ohms	+ % Tol.	Watts	Part No.	R119 R120	1M 1M	Tone (See Table) Volume
R1	22	10	1/2	EBJ072	R121	100K	Brightness
R2	12K	10	1/2	EBJ078	R122	4.7	10
R3	5.6	10	1/2	EBJ075	R123	220K	10
R4	330	10	1/2	EBJ046	R124	2.2	10
R5	4.7K	10	1/2	EBJ106	R125	390K	10
R6	33	10	1/2	EBJ192	R126	47K	10
R7	12M	10	1/2	EBJ190	R127	3.3	10
R8	33K	10	1/2	EBJ049	R128	250K	Brightness
R9	2.2K	10	1/2	EBJ109	R130	47K	10
R10	3.9K	10	1/2	EBJ097	R131	82K	10
R11	180	10	1/2	EBJ100	R132	3.3K	20
R12	3.9K	10	1	EBH253	Reference:	60LR Handset only.	
R13	6.8K	10	1/2	EBJ103		60C, 60W only.	
R14	8.2K	10	1/2	EBJ054		60LR only.	
R15	180	10	1/2	EBJ100		60C, 60LR, 60W Handsets.	
R16	3.9K	10	1	EBH253		+ Steanes Tuner only.	
R17	10K	10	1/2	EBJ034		60C, 60W Handsets.	
R18	56K	10	1/2	EBJ083			
R19	2.7K	10	1/2	EBJ048			
R20	3.3M	10	1/2	EBJ183			
R21	330	10	1/2	EBJ066			
R22	10K	10	1/2	EBJ063			
R23	100	5	1/2	EBJ067	Code	Value in	
R24	4.7K	10	1/2	EBK082	No.	mfd's	
R25	330	20	1/2	EBJ046	C1	.1	10
R26	120	20	1/2	EBJ008	C2	27p	10
R27	100K	10	1/2	EBJ042	C3	4.7p	.5p
R28	22K	10	1/2	EBJ017	C4	10p	10
R29	68K	10	1/2	EBJ003	C5	100p	10
R30	2.2K	20	1/2	EBJ109	C6	.1	10
R31	10K	10	1	EBH257	C7	.0015	+50-20
R32	39K	10	1/2	EBJ013	C8	.0015	+50-20
R33	270K	20	1/2	EBJ132	C9	.0015	+50-20
R34	330	20	1/2	EBJ066	C10	100p	10
R35	3.3K	20	1/2	EBJ127	C11	.0015	+50-20
R36	47K	20	1/2	EBJ027	C12	.0015	+50-20
R37	680K	20	1/2	EBJ071	C13	120p	20
R38	1M	Volume (See Table)	1/2	EBJ107	C14	.0015	+50-20
R39	1.8M	10	1/2	EBJ134	C15	.0015	+50-20
R40	800K	25 at 25°C	1/2	EBK078	C16	.0015	+50-20
R41	2.2K	20	1/2	EBJ004	C17	6.8p	.5p
R42	1.2K	10	1/2	EBJ094	C18	6.8p	.5p
R43	47K	10	1/2	EBJ030	C19	.0018	10
R44	22	10	1/2	EBJ072	C20	3.3p	.25p
R45	820	10	1/2	EBJ188	C21	39p	10
R46	470	10	1/2	EBJ021	C22	100p	10
R47	2K	Vert. Linearity	1/2	EBJ118	C23	.0027	10
R49	120K	10	1/2	EBJ029	C24	.01	10
R50	1M	Vert. Hold	1/2	EBJ109	C25	15p	10
R51	6.8M	10	1/2	EBJ175	C26	.01	10
R52	1.8M	10	1	EBH285	C27	330p	10
R53	120	20	1/2	EBJ008	C28	15p	10
R54	4.7M	10	1/2	EBJ018	C29	.01	10
R55	5M	Height	1/2	EBJ138	C30	.047	10
R57	6.8K	5	1/2	EBJ177	C31	4.7p	10
R58	330	20	1/2	EBJ046	C32	80	+50-10
R59	12K	10	1/2	EBJ047	C33	.068	10
R61	330	20	1/2	EBJ046	C34	.1	10
R62	10K	5	1/2	EBJ086	C35	.0068	10
R63	220K	20	1/2	EBJ096	C36	.0022	10
R64	1.2M	20	1/2	EBJ130	C37	.0022	10
R65	270	10	1/2	EBK083	C39	.0033	10
R66	250K	Contrast	1/2	EBJ107	C40	.01	10
R67	56K	10	1/2	EBJ083	C42	120p	20
R68	56K	10	1/2	EBJ083	C43	.01	10
R69	220K	20	1/2	EBJ036	C44	4.7p	.5p
R70	2.2M	20	1/2	EBJ004	C45	.22	10
R71	1.2M	10	1/2	EBJ026	C46	.001	10
R72	27K	1	1/2	EBH209	C47	.47	10
R73	25K	A.G.C.	1/2	EBJ105	C48	3p	.25p
R74	25K	Noise Suppressor	1/2	EBJ105	C49	.047	10
R75	33K	10	1/2	EBJ049	C50	100	+50-10
R76	15K	10	1/2	EBJ016	C51	100	+50-10
R77	12K	10	1/2	EBJ047	C52	.0015	+50-20
R78	10K	10	1/2	EBJ017	C53	.0015	+50-20
R79	120K	10	1/2	EBJ029	C54	60+200	+50-10
R80	330K	10	1/2	EBJ098	C55	.0015	+50-20
R81	3.3M	10	1/2	EBJ183	C56	.0015	+50-20
R82	120K	20	1	EBH260	C57	220p	5
R83	33K	10	1/2	EBJ049	C58	.0015	10
R84	47K	10	1/2	EBJ030	C59	.01	10
R85	180	5	1/2	EBJ184	C60	.47	10
R86	220	20	1/2	EBJ101	C61	.0022	10
R88	220K	20	1/2	EBJ036	C62	220p	5
R89	1.2M	5	1/2	EBJ181	C64	470p	10
R90	1M	5	1/2	EBJ189	C65	6.4	+50-10
R91	22K	10	1/2	EBJ017	C66	.01	10
R92	82K	10	1/2	EBJ019	C67	.0047	10
R93	39K	10	1/2	EBJ013	C68	470p	10
R94	100	20	1/2	EBJ043	C69	12p	10
R95	12K	10	1/2	EBJ047	C70	.0027	10
R96	1.2K	10	1/2	EBJ094	C71	.022	10
R97	2.2K	20	1/2	EBJ109	C72	.01	10
R98	220K	20	1/2	EBJ036	C73	68p	10
R99	2.2K	10	1/2	EBJ037	C74	.001	10
R100	22K	20	1/2	EBJ044	C75	.0047	10
R101	12K	10	1/2	EBJ047	C76	.047	20
R102	1.2M	10	1/2	EBJ026	C77	.01	10
R103	1K	20	1/2	EBJ002	C78	.47	10
R104	47K	20	1/2	EBJ027	C79	.12	10
R104	120K	20	1/2	EBJ029	C80	47p	10
R105	82K	20	1/2	EBJ031	C80	68p (19" only)	10
R106	100K	Brightness (See Table)	1/2	EBJ119	C82	39p	10
R107	1.5K	10	5	EBK071	C83	.22	20
R108	15	10	1/2	EBJ200	C84	.47	10
R109	1.2M	10	1	EBH261	C85	.0022	10
R110	120K	10	1	EBH265	C86	.01	10
R111	470K	10	1	EBH215	C87	25	+50-10
R112	1.5	10	1	EBK058	C88	.001	10
R113	2.2K	10	1	EBH259	C89	.0047	10
R114	4.7M	20	1	EBH272	C90	.0015	+50-20
R115	120K	10	1/2	EBJ029	C91	.1	10
R116	220K	10	1/2	EBJ062	C92	470p	10
R117	4.7K	20	1/2	EBJ001	C93	560p	10
R118	470	20	1/2	EBJ006			600

CAPACITORS

No.	Value in	+ % Tol.	Watts	Part No.
R10	Ohms	Tone (See Table)		EBL085
R119	1M	Volume		EBL135
R120	1M	Brightness		EBL136
R121	100K			EBK043
R122	4.7		1/2	EBJ062
R123	220K		1/2	EBK056
R124	2.2		1/2	EBJ129
R125	390K		1/2	EBJ030
R126	47K		1/2	EBK096
R127	3.3		1/2	EBL107
R128	250K	Brightness	1/2	EBJ030
R130	47K		1/2	EBJ019
R131	82K		1/2	EBJ127
R132	3.3K		1/2	
Reference:	■ 60LR Handset only.			
	■ 60LC, 60W only.			
	■ 60LR only.			
	+ 60LC, 60LR, 60W Handsets.			
	+ Steanes Tuner only.			
	Ø 60LC, 60W Handsets.			

CAPACITORS

Code	Value in	+ % Tol.	DC WV	Part No.
No.	mfd's			
C1	.1	10	125	EBA526
C2	.27p	10	500	EBA527
C3	4.7p	.5p	500	EBA528
C4	10p	10	500	EBA529
C5	100p	10	600	EBA530
C6	.1	10	125	EBA531
C7	.0015	+50-20	500	EBA532
C8	.0015	+50-20	500	EBA533
C9	.0015	+50-20	500	EBA534
C10	100p	10	600	EBA535
C11	.0015	+50-20	500	EBA536
C12	.0015	+50-20	500	EBA537
C13	120p	20	500	EBA538
C14	.0015	+50-20	500	EBA539
C15	.0015	+50-20	500	EBA540
C16	.0015	+50-20	500	EBA541
C17	6.8p	.5p	500	EBA542
C18	6.8p	.5	500	EBA543
C19	.0018	10	400	EBA544
C20	3.3p	.25p	500	EBA545
C21	39p	10	500	EBA546
C22	100p	10	500	EBA547
C23	.0027	10	400	EBA548
C24	.01	10	400	EBA549
C25	15p	10	500	EBA550
C26	.01	10	400	EBA551
C27	330p	10	500	EBA552
C28	15p	10	500	EBA553
C29	.01	10	400	EBA554
C30	.047	10	125	EBA555
C31	4.7p	10	500	EBA556
C32	80	+50-10	25	EBA128
C33	.068	10	400	EBA528
C34	.1	10	400	EBA525
C35	.0068	10	400	EBA568
C36	.0022	10	400	EBA527
C37	.0022	10	400	EBA527
C39	.0033	10	400	EBA546
C40	.01	10	400	EBA523
C42	120p	20	600	EBA509
C43	.01	10	400	EBA523
C44	4.7p	.5p	500	EBA508
C45	.22	10	125	EBA537
C46	.001	10	400	EBA529
C47	.47	10	125	EBA531
C48	3p	.25p	500	EBA533
C49	.047	10	125	EBA533
C50	100	+50-10	200	EBA576
C51	100	+50-10	200	EBA576
C52	.0015	+50-20	500	EBA568
C53	.0015	+50-20	500	EBA568
C54	60+200	+50-10	300	EBA130
C55	.0015	+50-20	500	EBA568
C56	.0015	+50-20	500	EBA568
C57	220p	5	600	EBA508
C58	.0015	10	400	EBA530
C59	.01	10	400	EBA523
C60	.47	10	125	EBA531
C61	.0022	10	400	EBA527
C62	220p	5	600	EBA508
C64	470p	10	600	EBA510
C65	6.4	+50-10	25	EBA084
C66	.01	10	125	EBA539
C67	.0047	10	400	EBA532
C68	470p	10	600	EBA510
C69	12p	10	500	EBA566
C70	.0027	10	200	EBA587
C71	.022	10	4000	EBA545
C72	.01	10	400	EBA523
C73	68p	10	500	EBA569
C74	.001	10	400	EBA529
C75	.0047	10	400	EBA532
C76	.047	20	1000	EBA461
C77	.01	10	400	EBA523
C78	.47	10	125	EBA531
C79	.12	10	400	EBA549
C80	47p	10	5000	EBA217
C80	68p (19" only)	10	5000	EBA213
C82	39p	10	500	EBA046
C83	.22	20	600	EBA501
C84	.47	10	125	EBA531
C85	.0022	10	400	EBA527
C86	.01	10	400	EBA523
C87	25	+50-10	6.4	EBA132
C88	.001	10	400	EBA529
C89	.0047	10	400	EBA532
C90	.0015	+50-20	500	EBA568
C91	.1	10	400	EBA525
C92	470p	10	600	EBA510
C93	560p	10	600	EBA563

The scanning beam is suppressed during the vertical and horizontal flyback periods by applying to picture tube grid, negative pulses derived from the vertical output and horizontal output transformers, via suitable RC networks.

Horizontal sync. pulses in anti-phase are derived from the synchronising phase splitter V8T and applied to the discriminator diodes D6. The reference waveform is obtained by shaping the voltage waveform, tapped from the horizontal output transformer with an RC network consisting of R110, C59, C58 and R88. The reference is then applied to junction of D6 selenium diodes. Because of the slight asymmetry in the reference waveform, the control voltage is taken from the point somewhat displaced from the centre of the D6 load, consisting of R89 and R90.

The amplitude and sense of the control voltage depend upon the relative phase of the sync pulses and reference waveform. The control voltage is filtered and applied to the grid of VIIT, which is a reactance valve. This valve controls the free running frequency of the horizontal oscillator VI1P, which is a sinewave oscillator, and the centre frequency is adjusted by varying the core position of LI4.

When synchronising occurs, the discriminator and reactance valve keep the oscillator at the correct frequency.

A suitable waveform developed in the anode circuit of V11P is used to drive the horizontal scan output stage V12. This stage employs T4, a high efficiency output transformer with low-loss ferrite cores. Direct current flows in opposite directions through the two windings of T4 connected by C76. The DC fluxes created by each winding cancel out, thus desaturating the core and allowing a higher performance of the smaller cross-section of core utilised.

A high pulse voltage which is present at V12 anode during the flyback period is stepped up by an auto winding on T4 and is rectified by V14 to provide EHT for the picture tube. V14 heater voltage is derived from an additional winding on T4. The EHT voltage is smoothed by the capacity between internal and external coatings on the picture tube, the external coating being connected to ground.

The efficiency diode V13 "damps out" shock oscillation in the horizontal scan output transformer and the bias voltage developed is used as additional HT for the vertical discharge valve V9T, the horizontal scan output valve V12 and picture tube V15.

Width adjustment is achieved by varying the point at which the tuning capacitor C80 is tapped across the horizontal scan transformer winding.

R108 is a fusible resistor, introduced to protect the horizontal output stage if the oscillator fails with a subsequent loss of drive.

Equipment required: An Avometer or VTVM with a DC voltage scale; pair of shorting leads and plastic screw driver.

Procedure. 1. With receiver switched on and allowed to warm up for at least 20 mins, the Avometer positive terminal is connected to cathode (pin 7 and 8) of the horizontal oscillator and the negative terminal is returned to ground. 0-25V DC range is most suitable for this procedure.

2. The junction of R63 and R64 is shorted to ground. The reference voltage is removed by shorting the junction of R88, C58 and C59 to chassis.

3. The oscillator should now be free running and the core of L14 is adjusted until frequency is correct and the picture is almost stable.

4. Removing either of the shorts described under 2 should make very little difference to the picture stability horizontally. An 8th turn of L14 should bring the oscillator back to same frequency in either case.

5. Both shorts are now removed and the picture should lock firmly with the cathode voltage reading about 10.5V on the Avometer.

To check the pull-in range, the core of L14 is rotated clockwise until the picture falls out of synchronism. This condition can be accelerated by switching channels. The core is then returned slowly until the picture locks in. The voltage reading is noted (about 8V), and pull-in frequency is esti-

mated by counting the number of frames (3 or 4) visible on the screen just before the lock-in occurs.

The core is then rotated anti-clockwise and the procedure repeated. The voltage on the cathode should be about 13V when the lock-in occurs and the number of frames should again be 3 or 4, constituting a fairly symmetrical pull-in range of about 200 C/s on either side of the correct setting of L14.

Electron beam focusing is achieved by varying the voltage on pin 4 of the picture tube. Adjustments are made by varying the connection of the focusing lead to either HT2 (pin 5, picture tube) boosted rail voltage or the chassis. Connections can be made at the picture tube base and are optimised in the factory. Readjustments may be needed when the tube is replaced.

Centering of the picture on the screen is effected by means of two magnets M3 and M4 which are rotatable about the neck of the tube independently of each other, the position of the picture depending upon the combined magnetic fields of both magnets.

Three mains voltage selection positions are the feature of the primary winding. In the secondary, the HT is obtained by means of two silicon diode rectifiers, D4 and D5, in a voltage doubler circuit and it is smoothed by L11 and C54. The valve heaters are in two sections with the valves in each



INPUT SERIES	MODEL	VOL.	BRIGHTNESS	tone	SL	CONC.
		R38	R106	R119	ON POT	PORTS
T21-1A	501P	EB1110	EB1110		EB1110	R38, R106
T21-1B etc.	501P	EB1119	EB1119		EB1119	R38, R106
T21-2B etc.	501P	EB1120	EB1045	EB1085	EB1120	
	501P/1					
T21-4C etc.	601X	EB1123	EB1124	EB1123	EB1123	R38, R119
	601D					
T21-50 etc.	501A/1	EB1075	EB1045	EB1075	EB1075	R38, R119
T21-12G etc.	501A/2	EB1120	EB1045	EB1085	EB1120	
T21-4H etc.	601B	EB1123	EB1124	EB1123	EB1123	R38, R119
	601S					
T21-10G	601R	EB1133	EB1134	EB1133		R38, R119
T21-14H etc.	601C	EB1128) EB1107)	EB1129) EB1144)			
T21-15H etc.	601G	EB1141	EB1142		EB1141	
T21-16H	601H	EB1150	EB1151		EB1150	
T21-19J	601K	EB1141	EB1142		EB1141	
T21-4H	601A	EB1167	EB1168		EB1167	
T21-4K	611G	EB1167	EB1168		EB1167	
T21-20V etc.	601L	EB1141	EB1142		EB1141	
T21-20V etc.	601M	EB1141	EB1142		EB1141	
T21-20V etc.	601T	EB1141	EB1142		EB1141	
T21-36V etc.	601L	EB1141	EB1142		EB1141	
T21-36V etc.	601M	EB1141	EB1142		EB1141	
T21-36V etc.	601T	EB1141	EB1142		EB1141	
T21-39V etc.	601Q	EB1141	EB1142		EB1141	
T21-40K etc.	601W	EB1158	EB1159			
T21-42K etc.	601V (19")	EB1163	EB1163		EB1163	R38, R106
T21-43K etc.	501P	EB1119	EB1119		EB1119	R38, R106
T21-45K etc.	611C	EB1167	EB1168		EB1167	
T21-45K etc.	611D	EB1167	EB1168		EB1167	
T21-45K etc.	611P	EB1167	EB1168		EB1167	
T21-45K etc.	611Q (25")	EB1167	EB1168		EB1167	
T21-46K etc.	611R (25")	EB1167	EB1168		EB1167	
T21-48K etc.	611R (25")	EB1167	EB1168		EB1167	
T21-49K etc.	611S (25")	EB1167	EB1168		EB1167	
T21-52L	611X (25")	EB1163	EB1164		EB1163	

CODE NO.	DESCRIPTION
L1	Coil - Adjacent Sound Trap
L2 A & B	Coil - IF Input
L2C	Choke - IF
L2A	
B & C	Coil - 1st IF
L4 A & B	Coil - 2nd IF
L5 A & B	Coil - Video Detector
L5C	Coil - Ch. 9
L5D	Choke - IF
L6	Choke - IF
L7	Coil - Sound Peaking
L8	Coil - Sound Tape Off
L9 A & B	Coil - Sound IF
L10	Coil - Sound Quad. Osc.
L11	Choke - Smoothing
L12	Choke - Heater
L13	Choke - Heater
L14	Coil - Horiz. Osc.
L15	Control - Width
L16	Choke - IF
L17A	Coil - Sound Trap
L17B	Coil - Anode Series
L18 A & B	Coils - Horiz. Yoke
L19 A & B	Coils - Vert. Yoke
L20	Choke - Heater
L21	Control - Horiz. Lin.

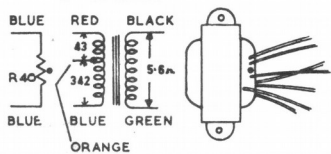
CODE NO.	DESCRIPTION	PART NO.
S1	Switch-ganged to R38	EB1L19
F1	Fuse - 1A	EBQ1L1
F2	Fuse - 2A	EBQ1L0
F3	Fuse - 3/4 SWG Tinned Copper Wire	
M1	Magnet - Horiz. Correction.	ECG721
M2	Magnet - Horiz. Correction.	ECG721
M3	Magnet - Shift	ECG71A
M4	Magnet - Shift	ECG71A
M5	Magnet - Horizontal Lin.	ECG721
M6	Magnet - Horizontal Lin.	ECG721

NOTES.

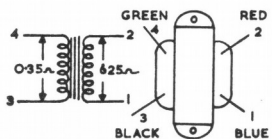
CODE NO.	DESCRIPTION	PART NO.
T1	Vertical Output	EAB163
T2	Sound Output	EAB164
T3	Mains	EAB147
T4	Horizontal Output	EAF300 or EAF311

T 21 SERIES

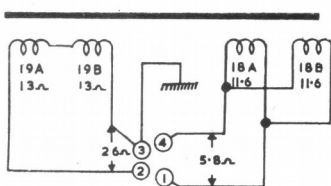
TI VERTICAL OUTPUT TRANSFORMER.



T2 SOUND OUTPUT TRANSFORMER.



DEFLECTION COIL AND PLUG.



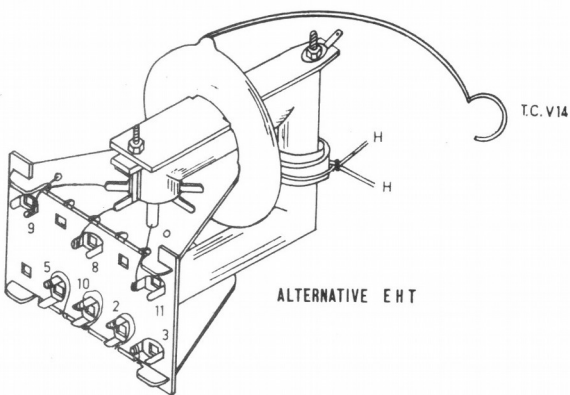
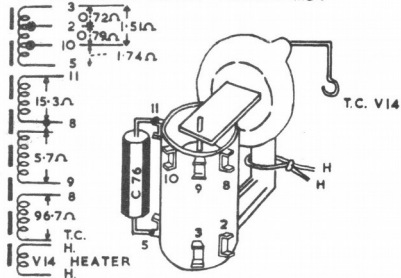
LII H.T. SMOOTHING CHOKE.

L14 HORIZONTAL OSCILLATOR COIL. 34-IN 1-3, 8.9-IN 1-4, 25.2-IN 4-3.

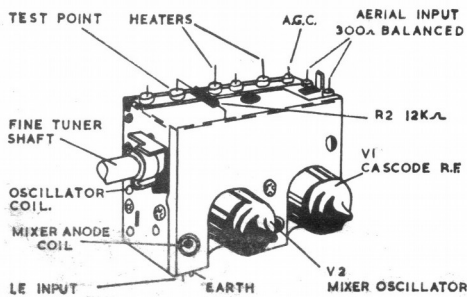
L 15 INJECTION CHOKE. 35A



T4 HORIZONTAL OUTPUT TRANSFORMER

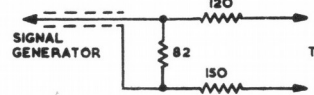


ALTERNATIVE E H T



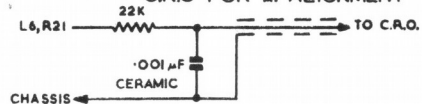
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TUNER MATCHING NETWORK



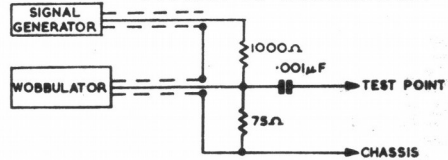
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METHOD OF CONNECTING C.R.O FOR IF ALIGNMENT



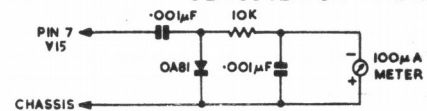
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METHOD OF CONNECTING MARKER TO WOBBULATOR



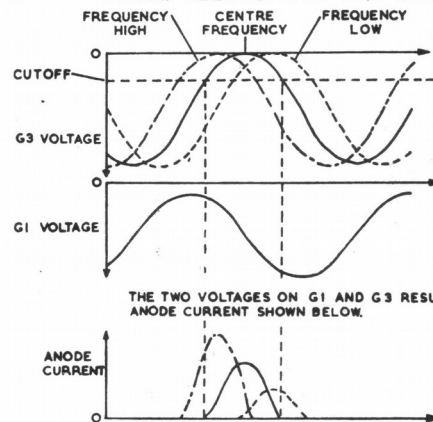
4

DEMODULATOR PROBE



5

PHASE RELATIONS IN THE SYNTECTOR



THE TWO VOLTAGES ON G1 AND G3 RESULT IN THE ANODE CURRENT SHOWN BELOW.

AS THE INPUT FREQUENCY VARIES, THE PHASE OF THE VOLTAGE ON G3 CHANGES AND THE ANODE CURRENT VARIES IN ACCORDANCE WITH THE NEW EFFECTIVE G1 VOLTAGE.

VISION IF AMPLIFIER RESPONSE CURVES

