Capacitors

C 53 Ceramic capac.	[illegible] μμF		C 67 Paper capac.	[illegible]	[illegible]
C 54 Electrol. capac.	5 μF	125 V	C 68 Ceramic capac.	[illegible]	
C 55 Electrol. capac.	50 μF	180 V	C 69 Ceramic capac.	[illegible]	
C 56 Electrol. capac.	5 μF	125 V	C 70 Ceramic capac.	[illegible]	
C 57 Paper capac.	0,47 μF	125 V	C 71 Paper capac.	1,200 μμF	[illegible] V
C 58 Paper capac.	27,000 μμF	125 V	C 72 Paper capac.	[illegible] μμF	[illegible] V
C 59 Paper capac.	0,15 μF	125 V	C 73 Paper capac.	0,1 μF	[illegible] V
C 60 Paper capac.	3,900 μμF	400 V	C 74 Electrol. capac.	5 μF	[illegible] V
C 61 Paper capac.	1,500 μμF	500 V	C 75 Ceramic capac.	125 μμF	[illegible] V
C 62 Paper capac.	1,000 μμF	400 V	C 76 H.T.	1,000 μμF	[illegible] V
C 63 Paper capac.	0,1 μF	100 V	C 77 H.T.	1,000 μμF	[illegible] V
C 64 Paper capac.	0,47 μF	400 V	C 78 H.T.	1,000 μμF	[illegible] V
C 65 Paper capac.	0,1 μF	800 V	C 79 Paper capac.	0,22 μF	[illegible] V
C 66 Paper capac.	17,800 μμF	125 V			

Resistors

R 1	56 Ω	10 W	R 30	0,82 MΩ	[illegible] W	R 60	47 kΩ	[illegible] W
R 2	30 Ω	8 W	R 31	1 MΩ	[illegible] W	R 61	33 kΩ	[illegible] W
R 3	68 Ω	6 W	R 32	10 kΩ	[illegible] W	R 62	0,15 MΩ	[illegible] W
R 4	68 Ω	6 W	R 33	33 Ω	[illegible] W	R 63	30 kΩ	Lin.
R 5	66 Ω	6 W	R 34	8,2 kΩ	[illegible] W	R 64	22 kΩ	[illegible] W
R 6	83 Ω	10 W	R 35	1,5 kΩ	[illegible] W	R 65	8,2 MΩ	[illegible] W
R 7	500 Ω	7 W	R 36	47 Ω	[illegible] W	R 66	8,2 MΩ	[illegible] W
R 8 cold 3 kΩ			R 37	1,5 kΩ	[illegible] W	R 67	0,15 MΩ	[illegible] W
hot 50 Ω			R 38	12 kΩ	[illegible] W	R 68	27 kΩ	[illegible] W
R 9	[illegible] kΩ	1 W	R 39	0,47 MΩ	[illegible] W	R 69	56 kΩ	[illegible] W
R 10	1 kΩ	3 W	R 40	8,2 kΩ	[illegible] W	R 70	0,1 MΩ	[illegible] W
R 11	1,5 kΩ	[illegible] W	R 41	4,7 kΩ	[illegible] W	R 71	0,18 MΩ	[illegible] W
R 12	1,8 kΩ	[illegible] W	R 42	22 kΩ	[illegible] W	R 72	1,8 MΩ	[illegible] W
R 13	0,22 MΩ	[illegible] W	R 43	1,5 kΩ	[illegible] W	R 73	0,47 MΩ	[illegible] W
R 14	0,1 MΩ	Lin.	R 44	10 kΩ	[illegible] W	R 74	0,5 MΩ	Lin.
R 15	27 kΩ	[illegible] W	R 45	8,2 kΩ	[illegible] W	R 75	47 kΩ	[illegible] W
R 16	12 kΩ	[illegible] W	R 46	47 Ω	[illegible] W	R 76	0,22 MΩ	[illegible] W
R 17	0,68 MΩ	[illegible] W	R 47	1,5 kΩ	[illegible] W	R 77	1 MΩ	Lin.
R 18	10 kΩ	Lin.	R 48	8,2 kΩ	[illegible] W	R 78	1,5 MΩ	[illegible] W
R 19	470 Ω	[illegible] W	R 49	1,5 kΩ	[illegible] W	R 79	27 Ω	[illegible] W
R 20	270 Ω	[illegible] W	R 50	120 Ω	[illegible] W	R 80	27 kΩ	[illegible] W
R 21	270 Ω	[illegible] W	R 51	1,5 kΩ	[illegible] W	R 81	100 Ω	[illegible] W
R 22	1,5 MΩ	[illegible] W	R 52	4,7 kΩ	[illegible] W	R 82	56 kΩ	[illegible] W
R 23	0,12 MΩ	[illegible] W	R 53	1,5 kΩ	[illegible] W	R 83	1,5 MΩ	[illegible] W
R 24	0,1 MΩ	Log.	R 54	680 Ω	[illegible] W	R 84	1,5 MΩ	[illegible] W
R 25	1,5 MΩ	[illegible] W	R 55	120 Ω	[illegible] W	R 85	27 kΩ	[illegible] W
R 26	8,2 MΩ	[illegible] W	R 56	39 kΩ	[illegible] W	R 86	33 kΩ	1 W
R 27	1,5 MΩ	[illegible] W	R 57	22 kΩ	[illegible] W	R 87	27 kΩ	[illegible] W
R 28	0,39 MΩ	[illegible] W	R 58	3,3 kΩ	[illegible] W	R 88	33 kΩ	1 W
R 29	0,1 MΩ	[illegible] W	R 59	4,7 kΩ	1 W	R 89	22 kΩ	[illegible] W

Resistors

R 90	20 kΩ	Lin.	R 94	27 Ω	[illegible] W	R 97	2,2 MΩ	1 W
R 91	15 kΩ	[illegible] W	R 95	1960 Ω	2 W	R 98	1,2 MΩ	[illegible] W
R 92	0,47 MΩ	[illegible] W		2 × 3,9 kΩ parallel		R 99	0,5 MΩ	Lin.
R 93	0,18 MΩ	[illegible] W	R 96	27 Ω	[illegible] W			

Valves and tubes

V1 UF 42	V 6 UB 41	V11 UF 42	V16 EY 51
V2 UF 42	V 7 MW 22-14	V12 UCH 42	V17 UCH 42
V3 UF 42	V 8 UF 42	V13 UL 44	V18 UL 46
V4 UF 42	V 9 UAF 42	V14 UY 41	V19 PZ 30
V5 UL 46	V10 UL 41	V15 EY 51	

13.3 A television receiver circuit for negative modulation

The receiver reviewed in this paragraph is a projection receiver with Schmidt projector; see 11.9. The picture size is 45 × 34 cm and the equipment is suitable for reception of the European system of 625 lines. A channel selector makes it possible to tune to each of the channels in Band I (41 — 68 Mc/s). If a different channel selector is employed, the channels in the 174 — 216 Mc/s band can also be received. The I.F. of this receiver is such that self-whistles cannot occur; see 8.28. The I.F. for the sound carrier is 18 Mc/s and that of the vision carrier 23.5 Mc/s. The oscillator frequency is higher than that of the incoming R.F. signal.

This receiver is suitable for operating on A.C. mains 220 V (± 10 %) 45-65 c/s without the use of a mains transformer; the valve filaments are connected in series in two groups, one taking 300 mA and the other 100 mA. In both groups resistors with negative temperature coefficient are included (*R* 12 and *R* 285) in order to limit the current flowing in the cold filaments when the receiver is switched on. Considerable attention has been paid to the smoothing of the various D.C. supplies. (+ 1 to + 7) and the wiring in the filament circuits, and the combined precautions make it possible to operate the receiver on A.C. mains which are not synchronized with the field-frequency of the television transmitter. The hum level of this receiver is sufficiently low to prevent the appearance of ripple bars in the picture.

Fig. 13.3-1 shows a block diagram of the receiver; the complete theoretical circuit diagram will be found at the end of the book in Plate II.

The aerial is connected to the receiver by means of a screened balanced cable, the characteristic impedance of which is 70 ohms. In receivers without mains transformer the chassis is at mains potential. Therefore *C* 42, *C* 43 and *C* 44 are high-voltage capacitors (2,000 V test) so that the aerial- and earth terminals will at no time be under tension. Resistors R 31 and R 32 are provided to earth possible static charges from the aerial. The aerial cable is terminated by the receiver in such a way as to avoid reflections in all channels; see 10.7.2 and 10.8.

The R.F. stage and frequency-changer are combined to form a separate unit: the channel selector. This continuously tunable selector has already been described in 8.30. B 3, B 4, B 5 and B 6 are the amplifying valves for

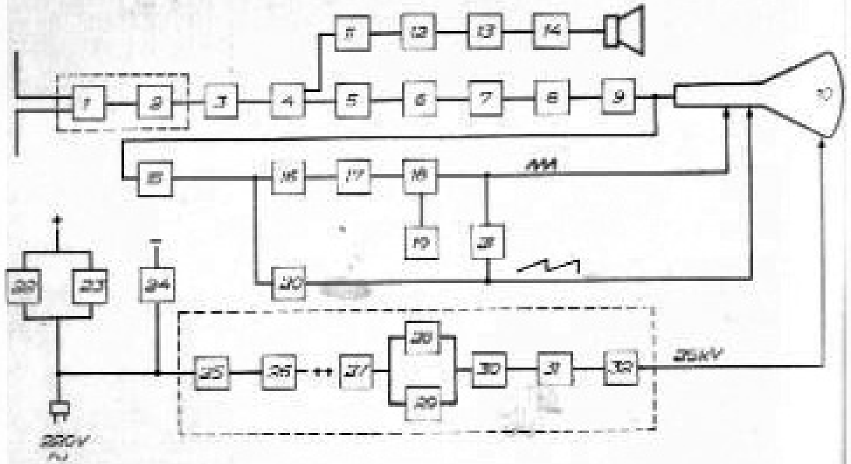


Fig. 13.3-1

Block diagram of a receiver for negative modulation

1 R.F. amplifying stage (pentode) } channel selector
2 Fequency-changer (pentode) } channel selector
3-4-5-6 Vision I.F. amplifier (4 pentodes)
7 Video detector and D.C. restoring diode (double diode)
8 Video amplifying stage and A.G.C. (pentode)
9 Video output stage (pentode)
10 Projection tube
11-12 Sound I.F. amplifier (2 pentodes)
13 Limiter and F.M. phase detector (7-grid valve)
14 Audio output stage (pentode)
15 Sync separator (triode-pentode)
16 Phase detector of horizontal deflection generator (double diode)
17 Oscillator for horizontal saw-tooth voltage (triode-pentode)
18 Output stage for horizontal deflection (pentode)
19 Booster (diode)
20 Generator for vertical deflection (triode-pentode)
21 Safety circuit for projection tube (pentode)
22-23 Mains rectifiers (2 diodes)
24 Negative voltage rectifier (diode)
25 26 Rectifiers with voltage doubling (2 diodes)
27 Blocking oscillator (1,000 c/s saw-tooth) (diode pentode)
28-29 Output amplifier of E.H.T. pulse generator (2 pentodes)
30 31 32 E.H.T. rectifiers (3 diodes)
25 to 32 E.H.T. generator (25 kV) for projection tube 10

the vision I.F. amplifier; S 31, S 44, S 47, S 48 and S 50 are the inductances of 5 simple circuits which together constitute a Butterworth system of staggered circuits; see 8.18. The tuning capacitances comprise only the valve- and wiring capacitances. Damping resistances R 61, R 70, R 75, R 81 and R 85, together with the detector damping, ensure the correct circuit quality factor. Each circuit is tuned to the desired resonant frequency by means of the coil core; owing to the use of rejection filters coupled to the circuits, these resonances differ from the theoretical values; see 8.22. S 32, C 18 is a filter for rejection of the vision carrier of the adjacent channel and is accordingly tuned to 16.5 Mc/s. S 51, C 116 comprise another filter tuned to this frequency. Filters S 43, C 94 and S 49, C 110 are tuned to 25 Mc/s and reject the sound carrier of the other adjacent channel. In this receiver the adjacent-channel rejection factor is 200. Filter S 46, C 101 is so proportioned as to ensure maximum rejection of sound in the vision I.F. amplifier, the actual rejection factor being about 30. The selectivity curve for the vision channel is reproduced in fig. 13.3-2. Resistances R 65 and R 77 connected to the cathode

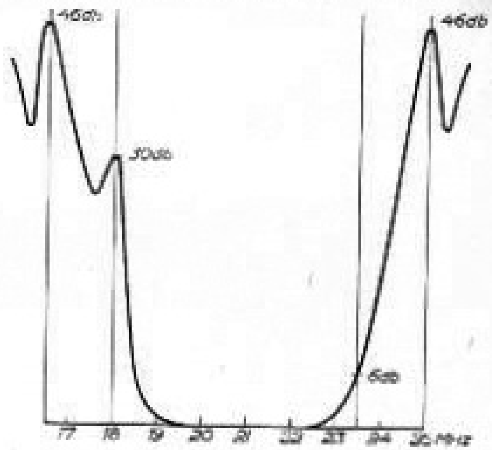


Fig. 13.3-2

Selectivity curve for the vision channel of the receiver shown in Plate II.

of valves B 3 and B 5 are un-bypassed, since the gain from these valves is controlled by varying the grid bias; see 8.2.1.

One of the diodes of valve B 7 functions as video detector; the detector capacitor consists of the capacitance of the wiring together with that which occurs between the cathode and filament of the diode. The video signal across R 88 is of negative polarity; see 8.26. This video signal is amplified by B 8 and B 9 and is thus applied with negative polarity to the cathode of the picture tube B 10. No capacitance is provided between R 88 and the grid of the first video amplifier B 8; the D.C. component is thus retained in the anode current of B 8, this being essential for the proper working of the A.G.C. which is produced by this valve. The electron stream towards the anode of valve *B* 8 is greatest during the synchronizing pulses, since these are applied to the control grid with positive polarity, and this momentary current is a measure of the peak value of the television signal; see 4.1.3. Positive pulses are applied to the third grid of *B* 8 through *C* 144, *R* 163 and *C* 166, these pulses being produced across coil *S* 60 of the horizontal output transformer during the fly-back. At those moments, therefore, the third grid intercepts electrons on their way to the anode and assumes an average negative potential, the value of which is proportional to the peak value of the television signal. This voltage across *R* 161 is smoothed by an integrating network *R* 160–*C* 91, *R* 76–*C* 104 and *R* 41–*C* 58–*C* 59, and is then applied to the control grids of the first I.F. valve *B* 3, fourth I.F. valve *B* 5 and R.F. valve *B* 1. The lower end of *R* 161 is connected to a positive potential which is adjustable by means of the contrast control *R* 80. Owing to the positive impulses on the third grid of *B* 8 and the particular values of *C* 166 and *R* 161, the value of the A.G.C. voltage, is almost entirely independent of possible interfering pulses in the television signal; the value of *R* 161 is such that the control voltage varies considerably with only small changes in the peak value of the video signal on the grid of *B* 8, notwithstanding the fact that the mutual conductance of the third grid is low (so-called amplified A.G.C.). Resistance *R* 99 connected to the anode of the first video amplifying valve *B* 8 is relatively low, and compensation is therefore unnecessary. In this stage the gain is approximately 4.

The sync pulses on the control grid of *B* 9 are of negative polarity. The peaks of strong interference pulses fall beyond the cut-off point and are thus clipped (see fig. 13.3.3); this is important also for the efficient working of the separator *B* 15. Cathode compensation is applied in the case of *B* 9 (see 8.11 and 8.12): by means of a switch Sw 2 a high capacitance *C* 126 can be connected in parallel with *R* 101, *C* 125 in the cathode circuit, rendering the compensation inoperative; the gain from *B* 9 then increases at the lower frequencies. It is true that picture definition suffers in consequence, but the effect is nevertheless better on weak signals, since interference and thermal noise are then not so pronounced in the picture. Moreover, the sensitivity of the receiver is increased by a factor of $1 - SR_k \approx 2$. The anode of *B* 9 is connected, through a series-compensation coil *S* 63, to the cathode of the picture tube *B* 10. The D.C. component of the signal is lost in *C* 123 between *B* 8 and *B* 9, and has to be restored; this is done in the grid circuit by means of a D.C. restoring diode *B* 7, the video signal being applied to the anode of this diode with negative polarity. *R* 93 is a separating resistance which ensures that the anode-to-cathode

capacitance of the diode will not affect video signals of the higher frequencies applied to the picture tube. Peak rectification across the capacitor *C* 119 in the cathode lead produces a positive voltage of roughly the same value as the potential difference between the peaks of the sync pulses and the mean video signal. Across *R* 90 a positive voltage, derived from the brightness control *R* 94, is also applied to *C* 119, and the combined voltages are taken across *R* 91 to the grid of the picture tube *B* 10. In this way it is possible to adjust the potential of the grid by means of the brightness control, so that the black level of the applied video signal corresponds to the cut off point of the picture tube. The D.C. restoring diode ensures that the setting of R 94 is independent of the picture information in the video signal.

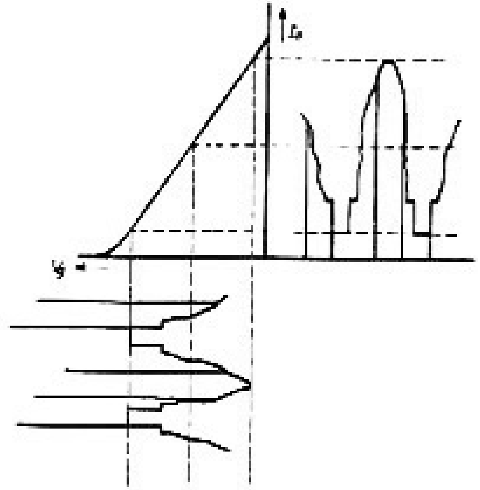


Fig. 13.3.3
Strong interfering pulses are clipped in the grid circuit of the video output valve B 9 (Plate II)

The I.F. sound signals are taken from the second I.F. valve to a filter *S* 45, *S* 46, *C* 101 and thence to the control grid of *B* 11. A band pass filter is included in the anode circuit of this pentode. *B* 12 amplifies the sound signal for passing to a second band-pass filter, *S* 9, *S* 10, the voltage across the primary circuit of which is applied to the fifth grid, and the secondary voltage to the third grid of *B* 13. This is the F.M. phase detector; the valve has 7 grids, the first and seventh (suppressor) of which are connected to the cathode. The second, fourth and sixth grids are connected internally and carry about 20 V with respect to cathode; they function as screen grids. The anode current is determined by the amplitude and phase displacement of the voltages on the third and fifth grids, when these amplitudes are large, a constant current will flow in the anode circuit during such time as the two grids are positive. When g_3 becomes negative, however, all electrons passing g_1 proceed to g_2; when g_5 is negative, the electrons go to g_4, so that in both cases the anode current is zero. If two alternating voltages of the same frequency be applied to g_3 and g_5, the anode current will consist of practically rectangular pulses, the width of which will depend on the phase difference φ between the two A.C. voltages;

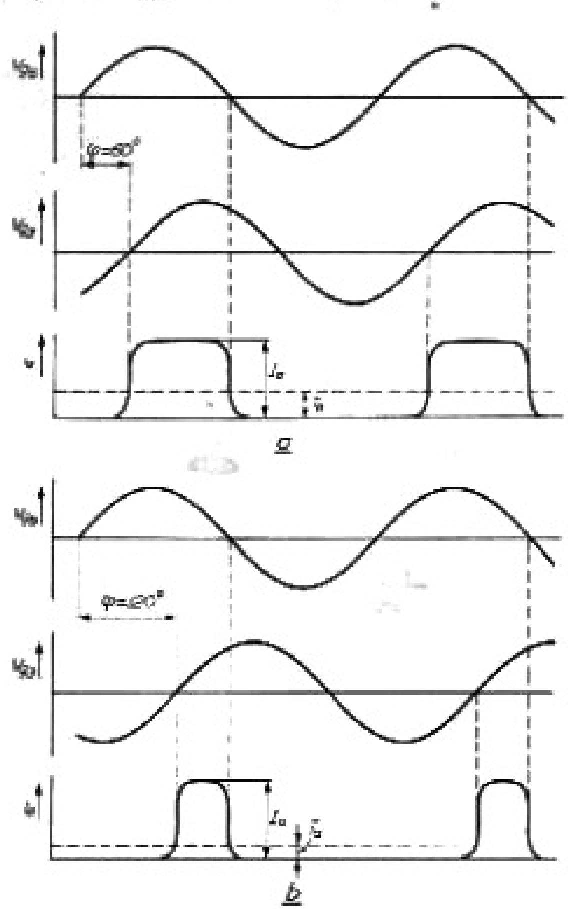


Fig. 13.3–4
a. Phase difference φ = 60° between the sinusoidal grid voltages V_{g3} and V_{g5}.
b. – do – φ = 120°.

see fig. 13.3–4. In a band-pass filter the phase difference between the voltages on primary and secondary varies with frequency; for the resonant frequency the phase difference is 90°, so that, in the case of F.M. signals,

the phase difference varies around this 90°. The anode circuit of *B* 13 includes a resistor the value of which is so high that the parasitic shunt capacitance is sufficient to suppress the fundamental and harmonics of the impulses. Only the slowly varying average anode current $\bar{i}_a$, the amplitude of which is proportional to the width of the pulses, produces audio voltages across *R* 22. The frequency of such audio signals depends on the variation in the periodicity of the pulses. That the valve also acts as limiter follows from the fact that above a certain amplitude (about 8 V_{rms}) of the I.F. voltages on g_3 and g_5, the anode current is constant, so that unwanted amplitude modulation of the grid voltages is not detected.

The audio signals are amplified by the output pentode *B* 14 and are passed by way of a transformer to the loudspeaker *S* 14. *R* 26 + *R* 27 is the volume control.

The video signal with negative polarity in the anode circuit of *B* 9 is taken, through *C* 127 and *R* 104, to the control grid of the pentode section of *B* 15; this separator works on the principle outlined in 4.4.2. Owing to the low screen-grid voltage, the grid base is only small. The screen-grid voltage is derived from resistors *R* 130 and *R* 162 in the cathode circuit of the horizontal output valve *B* 18. The cathode of *B* 15 carries a small positive potential which is obtained from *R* 162, so that, in the absence of an input signal, the valve *B* 15 is cut off and possible noise voltages cannot reach the deflection generators. When a video signal arrives, the sync signals are so strong that they cause grid current to flow, with the result that only the sync pulses occur across the anode resistor *R* 108. Since strong interfering signals in the grid circuit of the video output valve are clipped, these pulses, provided they are not too pronounced, will have little effect on the working of the separator. *R* 104 and the low resistance of the grid-to-cathode part of *B* 15 comprise a potentiometer for such interference peaks. The time constant of *R* 107, *C* 127 is not made too high in order that the clipping level shall not be affected too much by the interfering pulses. For the rest, the combination of phase detector *B* 16 and stabilized generator *B* 17 ensures that the saw-tooth voltage remains unaffected even should strong interference pulses mask the sync pulses for a time (flywheel effect). *C* 128 in the anode circuit serves to smooth out sharp interference pulses. The other side of each of the sync pulses is clipped and amplified in the triode section of *B* 15. In this way sync signals are produced across the anode resistor *R* 109, in which the horizontal sync pulses are of positive polarity. These sync signals are applied to the horizontal and vertical deflection generators.

In the receiver under review a horizontal deflection generator with automatic phase control is used, of the kind described in 6.2.1.3. The double diode *B* 16 is the phase detector, and the triode-pentode *B* 17 is the multivibrator for generating the saw-tooth voltage for horizontal deflection, stabilized by the flywheel circuit *S* 56, *C* 136. The viewer can adjust the oscillator to the centre of the synchronization zone by means of a potentiometer *R* 124.

The output stage for the horizontal deflection comprises a pentode *B* 18 and a booster diode *B* 19 in a circuit such as that described in 6.2.1.2. *S* 57, *R* 129 and *R* 131 prevent parasitic oscillations. *S* 64 is an adjustable iron-cored coil by means of which the amplitude of the saw-tooth current passing through the horizontal deflector coils *S* 4, and thus the width of the picture, is adjusted. *R* 149, *C* 160 and *R* 151, *C* 161 suppress oscillations in the saw-tooth current; such oscillations are manifested as a number of alternate light and dark vertical bands on the left-hand side of the picture. Fly-back pulses with positive polarity are taken from a tap on the primary windings *S* 59, *S* 60 of the horizontal output transformer through *C* 144, and are used for various purposes. We have already seen that they are taken from *C* 166 as pulses for the A.G.C. on the third grid of *B* 8; they are also integrated by *R* 115, *C* 133, to form a saw-tooth voltage for the phase detector *B* 16. Besides this they are applied to the control grid of the protecting valve *B* 21, but reference will be made to this later. The negative pulses produced across the secondary *S* 63 of the output transformer during the fly-back are passed, through *C* 121, *R* 96 and *R* 92, to the grid of the picture tube *B* 10, to blank out the beam during the fly-back. This is desirable since, in the case of deflection generators with automatic phase control, the start of the fly-back need not coincide with the front of the horizontal sync pulse. This depends amongst other things on the setting of the horizontal hold control *R* 124 within the synchronization range of the multivibrator *B* 17. If the fly-back does not occur within the horizontal blanking period of the video signal, picture signals are also applied to the picture tube during a part of the fly-back, and the picture is fogged. In the receiver under review the beam is also suppressed during the vertical fly-back, for which purpose the saw-tooth voltage from the vertical oscillator *B* 20 is differentiated in the network *C* 117, *R* 87, *R* 91, to produce negative pulses for applying to the grid of the picture tube. Should the vertical synchronization waver as a result of interference, causing the picture to move or jump vertically, the fly-back lines are not visible in the scene. Moreover, the setting of the brightness control *R* 94 is then less critical, since, even if the potential of the grid of the picture tube is set somewhat too high, the fly-back lines remain

invisible. The generator for the vertical deflection comprises a triode-pentode *B* 20, the triode section of which is employed for the blocking oscillator and the pentode part as an output stage. The sync signals coming from *B* 15 are twice integrated in the network *R* 140, *C* 148, *C* 151, *R* 137, *C* 150 to produce the vertical sync pulses; see 4.5.1. Double integration ensures that interfering pulses will have little effect on the vertical synchronization. The anodes of *B* 20 are fed from capacitor *C* 145, which is charged by the booster diode *B* 19 in the horizontal deflection generator to about 480 V with respect to chassis. *R* 134 is the amplitude control for the vertical saw-tooth voltage, and serves for adjustment of the height of the picture. By means of *R* 139 the frequency of the blocking oscillator can be adjusted to a value just below the field-frequency of the television signal; see 5.4.1.3 and 5.4.1.5.

C 159 is the charging capacitor in the anode circuit of the blocking oscillator and hence provides the saw-tooth voltage; this is taken through a correcting network to the control grid of the output pentode. The output transformer is relatively small and its self-inductance cannot therefore be regarded as infinitely high; as pointed out in 6.2.2.2, the current flowing in the primary winding of *S* 67 must comprise a combination of saw-tooth and parabolic currents. To counteract microphony in the output valve (see 6.2.2.3), negative-voltage feedback from the anode circuit to the grid is employed, and this feedback also provides the parabolic voltage in the grid circuit of *B* 20. The current on the secondary side *S* 68 of the output transformer being saw-toothed, a similar voltage will occur on the primary side *S* 67. Since the scan of the control voltage is of positive polarity, the saw-tooth voltage on the anode will be negative. During the fly-back, however, the peaks of this voltage are positive, owing to the self-inductance of the deflector coils, which cannot be disregarded on account of the short duration of the fly-back. Differentiation in the network comprising *C* 154, *R* 145, *R* 146 results in a parabolic voltage with positive peaks across *R* 146; see fig. 13.2–36. These peaks would tend to increase the fly-back time too much, but in the circuit in question they are counterbalanced by the negative peaks set up across *R* 146 by the differentiating effect of *C* 157, *C* 158 and *R* 146 upon the positive saw-tooth voltage across *C* 159. *C* 156 isolates the control grid of the pentode from the D.C. anode voltage of the blocking oscillator; by comparison with *C* 157 in series with *C* 158, this capacitance is so high that it may be regarded as a short-circuit. Across *C* 158, *R* 146, therefore, there is a combined saw-tooth and parabolic voltage, this being the control voltage for *B* 20. Now, if we consider the network *C* 159, *R* 147, *R* 143, *C* 157 and *C* 158 (i.e. excluding *R* 146), we see that this is the same as in fig. 6.2–31. This network is so proportioned that the form of the parabolic voltage can be modified to a certain extent by means of the variable resistor *R* 147, without affecting the amplitude of the control voltage for *B* 20. The amplitude control (*R* 134) and the linearity control (*R* 147) are thus practically independent of each other. *R* 142 and *C* 153 are connected across the primary *S* 67 of the output transformer to prevent parasitic oscillation. *C* 155 is provided across the secondary *S* 68 to neutralize possible induced line fly-back pulses.

The vertical output transformer has a third winding *S* 69 which is used for heating the filament of the protecting valve *B* 21. This is a battery valve of low filament wattage, so the emission drops rapidly when the filament voltage is cut off. If a projection tube is operated without one of its deflecting fields, the beam will describe only a vertical or horizontal line, and the luminescent screen then quickly burns as a result of local overheating. The safety circuit ensures that if one or both of the deflection generators should fail, the beam is quickly suppressed by a high negative voltage applied to the grid of the picture tube. The fly-back pulses from the horizontal output transformer are applied to the grid of *B* 20 through *C* 171. Current pulses in the cathode circuit are integrated by *C* 170 to produce a positive D.C. voltage, and this capacitor is able to discharge across the brightness control *R* 94. The lower end of *R* 94 is connected to a high negative voltage, but the negative voltage (–) received by the grid of *B* 21 through *R* 150 is still higher. Immediately, in the absence of fly-back pulses on this grid, *B* 21 is cut off and *C* 170 discharges rapidly across *R* 94, thus giving the grid of the picture tube a high negative potential and suppressing the beam. Should the vertical saw-tooth voltage disappear, the filament of *B* 21 would cool sufficiently quickly, on account of its low thermal capacity to cut off emission before the luminescent screen of the picture tube would have time to burn.

The extra high tension (25 kV) for the projection tube is supplied by a pulse generator such as that described in 7.3. The triode of *B* 27 is the blocking oscillator for generating a saw-tooth voltage of 1,000 c/s. *B* 28 and *B* 29 are pentodes connected in parallel to supply current of the required value and wave-form for the primary side *S* 183, *S* 184 of the E.H.T. transformer. *B* 30, *B* 31 and *B* 32 are E.H.T. rectifiers. The supply voltage for the anodes and screen grids of *B* 27, *B* 28 and *B* 29 is 400 V, this being obtained by rectification and doubling of the mains voltage by means of rectifiers *B* 25 and *B* 26. This voltage is also employed to energize the focusing coil, the current flowing in the coil being controlled by means of *R* 13 for correct focusing.

Diode *B* 24 supplies the negative voltage (–) for the safety circuit.

The following controls are provided on the front panel of the receiver:

channel selector with fine tuning (*C* 64–*C* 70–*C* 71–*C* 72);
volume control and mains switch (*R* 26–*R* 27 and Sw. 1);
contrast control (*R* 80);
brightness control (*R* 94);
focusing control (*R* 13);
horizontal-hold control (*R* 124);
vertical-hold control (*R* 139).

At the rear of the receiver there are controls for:

vertical amplitude (picture height) (*R* 134);
horizontal amplitude (picture width) (*S* 64);
vertical linearity (*R* 147);
band-width and video amplification (Sw 2).

The picture is centred on the screen by tilting the focusing coil *S* 6. Three screws are provided, by means of which the position of the luminescent screen can be brought into adjustment in the Schmidt projector to give a sharply focused image on the projection screen. The throw should of course be in accordance with the particular correcting lens; see 11.9.

The following is a list of electrical components and their values:

Capacitors

C 1	Electrol. cap.	50 µF	350 V
C 2	Electrol. cap.	50 µF	350 V
C 3	Electrol. cap.	50 µF	350 V
C 4	Electrol. cap.	50 µF	350 V
C 5	Electrol. cap.	50 µF	300 V
C 6	Electrol. cap.	50 µF	300 V
C 7	Electrol. cap.	50 µF	300 V
C 8	Electrol. cap.	50 µF	300 V
C 9	Electrol. cap.	50 µF	300 V
C 10	Electrol. cap.	50 µF	300 V
C 11	Ceramic cap.	1,500 µµF	
C 12	Ceramic cap.	1,500 µµF	
C 13	Ceramic cap.	1,500 µµF	
C 14	Ceramic cap.	1,500 µµF	
C 15	Ceramic cap.	1,500 µµF	
C 16	Ceramic cap.	1,500 µµF	
C 17	Ceramic cap.	1,500 µµF	
C 18	Ceramic cap.	1,500 µµF	
C 19	Ceramic cap.	1,500 µµF	
C 20	Ceramic cap.	1,500 µµF	
C 21	Ceramic cap.	1,500 µµF	
C 22	Ceramic cap.	1,500 µµF	
C 23	Ceramic cap.	1,500 µµF	
C 24	Ceramic cap.	1,500 µµF	
C 25	Ceramic cap.	1,500 µµF	
C 26	Ceramic cap.	1,500 µµF	
C 27	Ceramic cap.	1,500 µµF	
C 28	Ceramic cap.	1,700 µµF	
C 29	Ceramic cap.	1,500 µµF	
C 30	Ceramic cap.	1,500 µµF	
C 31	Ceramic cap.	100 µµF	
C 32	Ceramic cap.	56 µµF	
C 33	Ceramic cap.	56 µµF	
C 34	Ceramic cap.	1,500 µµF	
C 35	Paper capac.	5,600 µµF	400 V
C 36	Paper capac.	47,000 µµF	125 V
C 37	Ceramic cap.	1,500 µµF	
C 38	Paper capac.	10,000 µµF	125 V
C 39	Electrol. cap.	50 µF	12.5 V
C 40	Paper capac.	4,700 µµF	10,00 V

Capacitors

C 41	Paper capac.	0,1 μF	600 V
C 42	Ceramic cap.	390 μμF	700 V
C 43	Ceramic cap.	390 μμF	700 V
C 44	Ceramic cap.	390 μμF	700 V
C 55	Ceramic cap.	68 μμF	
C 56	Ceramic cap.	68 μμF	
C 57	Ceramic cap.	27 μμF	
C 58	Ceramic cap.	820 μμF	
C 59	Ceramic cap.	820 μμF	
C 60	Ceramic cap.	820 μμF	
C 61	Ceramic cap.	820 μμF	
C 62	Ceramic cap.	820 μμF	
C 63	Ceramic cap.	82 μμF	
C 64	Tuning cap.	4–29 μμF	
C 65	Ceramic cap.	4.7 μμF	
C 66	Trimmer	1–5 μμF	
C 67	Trimmer	1–6.4 μμF	
C 68	Trimmer	4–6 μμF	
C 69	Trimmer	4–6 μμF	
C 70	Tuning cap.	4–29 μμF	
C 71	Tuning cap.	4–29 μμF	
C 72	Trimmer	1–5 μμF	
C 73	Ceramic cap.	82 μμF	
C 74	Ceramic cap.	47 μμF	
C 75	Ceramic cap.	820 μμF	
C 76	Ceramic cap.	820 μμF	
C 77	Ceramic cap.	100 μμF	
C 78	Ceramic cap.	12 μμF	
C 79	Ceramic cap.	820 μμF	
C 90	Ceramic cap.	1,500 μμF	
C 91	Paper capac.	0,47 μF	125 V
C 93	Ceramic cap.	1,500 μμF	
C 94	Ceramic cap.	12 μμF	
C 95	Ceramic cap.	1.5 μμF	
C 96	Ceramic cap.	1,800 μμF	
C 97	Ceramic cap.	1,500 μμF	
C 98	Ceramic cap.	100 μμF	
C 99	Ceramic cap.	1,500 μμF	
C 100	Ceramic cap.	1,500 μμF	
C 101	Ceramic cap.	12 μμF	
C 101a	Ceramic cap.	2.2 μμF	
C 102	Ceramic cap.	1,500 μμF	
C 103	Ceramic cap.	100 μμF	
C 104	Ceramic cap.	1,500 μμF	
C 105	Trimmer	3–30 μμF	
C 106	Ceramic cap.	100 μμF	

C 107	Ceramic cap.	1,500 μμF	
C 108	Ceramic cap.	1,500 μμF	
C 109	Ceramic cap.	3.3 μμF	
C 110	Ceramic cap.	12 μμF	
C 111	Ceramic cap.	1,500 μμF	
C 112	Ceramic cap.	100 μμF	
C 113	Ceramic cap.	1,500 μμF	
C 114	Ceramic cap.	1,500 μμF	
C 115	Ceramic cap.	4.7 μμF	
C 116	Ceramic cap.	12 μμF	
C 117	Paper capac.	3,300 μμF	400 V
C 118	Ceramic cap.	180 μμF	
C 119	Paper capac.	1,000 μμF	400 V
C 120	Ceramic cap.	47 μμF	
C 121	Ceramic cap.	220 μμF	
C 122	Ceramic cap.	100 μμF	
C 123	Paper capac.	39,000 μμF	400 V
C 124	Paper capac.	10,000 μμF	400 V
C 125	Ceramic cap.	820 μμF	
C 126	Electrol. cap.	100 μF	12.5 V
C 127	Paper capac.	56,000 μμF	400 V
C 128	Ceramic cap.	120 μμF	
C 129	Ceramic cap.	470 μμF	
C 130	Paper capac.	4,700 μμF	400 V
C 131	Paper capac.	1,000 μμF	400 V
C 132	Paper capac.	1,000 μμF	400 V
C 133	Paper capac.	5,600 μμF	400 V
C 134	Paper capac.	47,000 μμF	125 V
C 135	Paper capac.	0,47 μμF	125 V
C 136	Mica	10,000 μμF	
C 136a	Ceramic cap.	1,000 μμF	
C 137	Paper capac.	68,000 μμF	400 V
C 138	Ceramic cap.	180 μμF	
C 139	Paper capac.	1,800 μμF	400 V
C 140	Ceramic cap.	150 μμF	
C 141	Paper capac.	2,700 μμF	400 V
C 142	Electrol. cap.	25 μF	25 V
C 143	Ceramic cap.	1,500 μμF	
C 144	Paper capac.	1,800 μμF	400 V
C 145	Paper capac.	0,47 μF	400 V
C 146	Electrol. cap.	25 μF	500 V
C 147	Electrol. cap.	25 μF	500 V
C 148	Paper capac.	10,000 μμF	400 V
C 149	Ceramic cap.	270 μμF	
C 150	Paper capac.	10,000 μμF	400 V
C 151	Paper capac.	4,700 μμF	400 V

Capacitors

C 152	Electrol. cap.	100 μF	12.5 V
C 153	Paper capac.	3,300 μμF	600 V
C 154	Paper capac.	0.1 μF	400 V
C 155	Paper capac.	0.1 μF	400 V
C 156	Paper capac.	56,000 μμF	400 V
C 157	Paper capac.	8,200 μμF	400 V
C 158	Paper capac.	18,000 μμF	125 V
C 159	Paper capac.	56,000 μμF	400 V
C 160	Paper capac.	2,200 μμF	400 V
C 161	Ceramic cap.	470 μμF	
C 165	Ceramic cap.	470 μμF	
C 166	Ceramic cap.	270 μμF	
C 170	Paper capac.	1,000 μμF	400 V

C 171	Ceramic cap.	3.3 μμF	
C 275	Mica	3,300 μμF	
C 276	Paper capac.	0,1 μF	400 V
C 277	Paper capac.	3,300 μμF	400 V
C 278	Electrol. cap.	25 μF	25 V
C 279	Paper capac.	27,000 μμF	400 V
C 280	Electrol. cap.	50 μF	350 V
C 281	Electrol. cap.	2×25 μF	500 V
C 282	Electrol. cap.	2×25 μF	500 V
C 283	Electrol. cap.	50 μF	350 V
C 284	H.T.	5,000 μμF	10 kV
C 285	H.T.	2,500 μμF	20 kV
C 286	H.T.	2,500 μμF	20 kV

Resistors

R 1	40 Ω	10 W
R 2	40 Ω	10 W
R 3	1 k Ω	6 W
R 4	1.8 k Ω	6 W
R 5	22 k Ω	1 W
R 6	3.3 k Ω	6 W
R 7	3.3 k Ω	6 W
R 8	2.2 k Ω	¼ W
R 9	220 Ω	6 W
R 10	120 Ω	6 W
R 11	300 Ω	6 W
R 12 cold	3 k Ω	
hot	44 Ω	
R 13	5 k Ω	Lin.
R 14	1 k Ω	6 W
R 15	150 Ω	½ W
R 16	12 k Ω	¼ W
R 17	1 k Ω	½ W
R 18	150 Ω	¼ W
R 19	12 k Ω	¼ W
R 20	1 k Ω	½ W
R 21	680 Ω	¼ W
R 22	1 M Ω	¼ W
R 23	3.9 k Ω	1 W
R 24	28 k Ω	2 W
	2×56 k Ω	parallel
R 25	18 k Ω	½ W
R 26	2 M Ω	Log.
R 27	0,65 M Ω	Log.
R 28	1.8 M Ω	½ W
R 29	330 Ω	¼ W

R 31	0.47 M Ω	¼ W
R 32	0.47 M Ω	¼ W
R 40	560 Ω	¼ W
R 41	10 k Ω	¼ W
R 42	1 k Ω	¼ W
R 43	1.5 k Ω	¼ W
R 44	22 k Ω	¼ W
R 45	47 k Ω	¼ W
R 46	47 k Ω	¼ W
R 47	10 k Ω	¼ W
R 48	1 k Ω	¼ W
R 59	100 Ω	¼ W
R 60	1 k Ω	¼ W
R 61	1.8 k Ω	¼ W
R 65	47 Ω	¼ W
R 68	1 k Ω	¼ W
R 69	1 k Ω	¼ W
R 70	4.7 k Ω	½ W
R 71	150 Ω	¼ W
R 72	150 Ω	½ W
R 73	1 k Ω	¼ W
R 74	150 Ω	¼ W
R 75	6.8 k Ω	¼ W
R 76	470 Ω	¼ W
R 77	47 Ω	¼ W
R 79	0,33 M Ω	1 W
R 80	50 k Ω	Lin.
R 81	1.8 k Ω	¼ W
R 82	1 k Ω	½ W
R 84	150 Ω	¼ W
R 85	3.9 k Ω	1 W

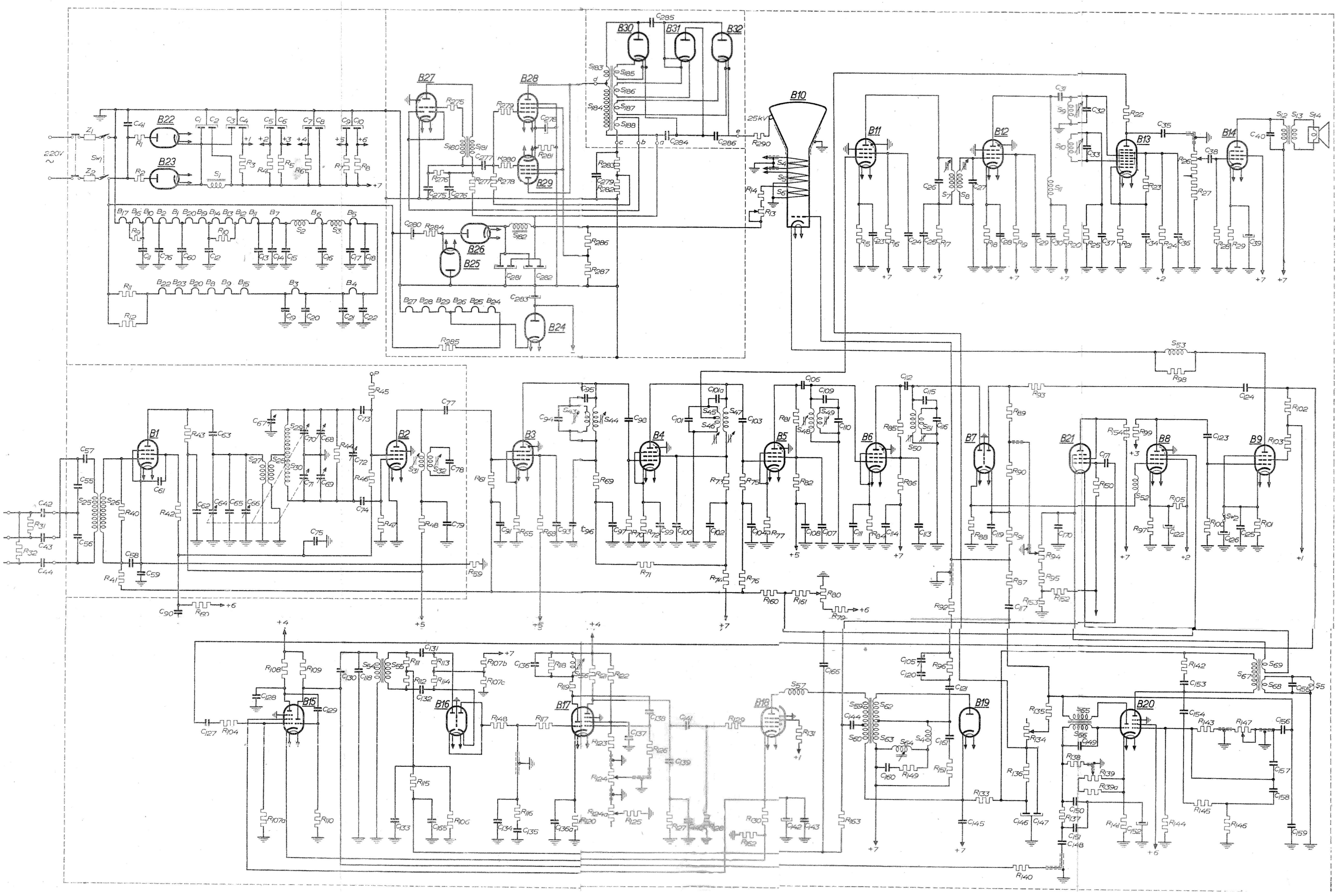
R 86	1 k Ω	¼ W
R 87	0.1 M Ω	½ W
R 88	2.7 k Ω	¼ W
R 89	47 k Ω	½ W
R 90	0.22 M Ω	¼ W
R 91	0.1 M Ω	½ W
R 92	0.18 M Ω	¼ W
R 93	10 k Ω	¼ W
R 94	1 M Ω	Lin.
R 95	0.39 M Ω	½ W
R 96	0.47 M Ω	¼ W
R 97	330 Ω	½ W
R 98	6.8 k Ω	½ W
R 99	1.2 k Ω	1 W
R 100	0.47 M Ω	¼ W
R 101	150 Ω	¼ W
R 102	3.9 k Ω	6 W
R 103	33 Ω	½ W
R 104	10 k Ω	¼ W
R 105	18 k Ω	3 W
R 106	1 M Ω	¼ W
R 107	0.68 M Ω	½ W
R 107b	0.18 M Ω	½ W
R 107c	1 k Ω	¼ W
R 108	22 k Ω	¼ W
R 109	18 k Ω	1 W
R 110	1 M Ω	¼ W
R 111	5.6 k Ω	¼ W
R 112	5.6 k Ω	½ W
R 113	0.15 M Ω	¼ W
R 114	0.15 M Ω	¼ W

Resistors

R 115	3,9 kΩ	½ W	R 135	0,68 MΩ	½ W	R 154	12 kΩ	¼ W
R 116	56 kΩ	¼ W	R 136	4,7 kΩ	½ W	R 160	0,47 MΩ	¼ W
R 117	100 Ω	¼ W	R 137	8,2 kΩ	¼ W	R 161	0,82 MΩ	¼ W
R 118	15 kΩ	½ W	R 138	0,33 MΩ	¼ W	R 162	27 Ω	½ W
R 119	8,2 kΩ	½ W	R 139	0,5 MΩ	Lin.	R 163	82 kΩ	1 W
R 120	1,2 kΩ	¼ W	R 139a	1 MΩ	¼ W	R 275	39 Ω	¼ W
R 121	1,2 kΩ	½ W	R 140	68 kΩ	¼ W	R 276	0,3 MΩ	½ W
R 122	68 kΩ	¼ W	R 141	820 Ω	½ W	R 277	39 kΩ	1 W
R 123	10 kΩ	½ W	R 142	39 kΩ	½ W	R 278	0,15 MΩ	¼ W
R 124	20 kΩ	Lin.	R 143	1 MΩ	½ W	R 279	39 Ω	½ W
R 124a	20 kΩ	Lin.	R 144	1 MΩ	¼ W	R 280	39 Ω	½ W
R 125	10 kΩ	½ W	R 145	0,47 MΩ	1 W	R 281	150 Ω	½ W
R 126	0,68 MΩ	¼ W	R 146	18 kΩ	½ W	R 282	0,22 MΩ	¼ W
R 127	27 kΩ	¼ W	R 147	1 MΩ	Lin.	R 283	0,27 MΩ	¼ W
R 128	0,56 MΩ	½ W	R 148	47 kΩ	¼ W	R 284	150 Ω	25 W
R 129	10 kΩ	½ W	R 149	2,2 kΩ	¼ W	R 285	hot 220 Ω	
R 130	120 Ω	1,5 W	R 150	8,2 MΩ	¼ W	R 286	2,8 kΩ	25 W
R 131	1,8 kΩ	1,5 W	R 151	680 Ω	1 W	R 287	10 kΩ	25 W
R 133	5,6 kΩ	1 W	R 152	0,12 MΩ	¼ W	R 290	1,5 MΩ	1 W
R 134	2,2 MΩ	Lin.	R 153	0,47 MΩ	¼ W			

Valves and tubes

B 1	EF 80	B 9	PL 83	B 17	ECL 80	B 25	UY 41
B 2	EF 80	B 10	MW 6-2	B 18	PL 81	B 26	UY 41
B 3	EF 80	B 11	EF 80	B 19	PY 80	B 27	UBC 41
B 4	EF 80	B 12	EF 80	B 20	ECL 80	B 28	UL 44
B 5	EF 80	B 13	EQ 80	B 21	DF 96	B 29	UL 44
B 6	EF 80	B 14	EL 42	B 22	PY 82	B 30	EY 51
B 7	EB 91	B 15	ECL 80	B 23	PY 82	B 31	EY 51
B 8	EF 80	B 16	EB 91	B 24	UY 41	B 32	EY 51


220V ~
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B21
B22
B23
B24
B25
B26
B27
B28
B29
B30
B31
B32
25kV