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SERVICE NOTES

for the

cathode-ray oscilloscope

GM 5654 X

1954

A. GENERAL

A1 Purpose

This oscilloscope is suitable for the reproduction of sinusoidal voltages with a frequency up to 7 Mc/s (-3 dB) and pulses with a frequency up to 500 kc/s.
Further details about use and application can be found in the directions for use.

A2 List of illustrations

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Fig. 8. Probe.
Fig. 9. Transformer

see also the manual GM5654 in Dutch

A3 Technical data

A3a Cathode-ray tube

Screen diameter - 100 mm
Deflection - symmetrical
Anode voltage - 1200 V (anode grounded)

	Vert. plates (Bu9-Bu10)	Hor. plates (Bu12-Bu13)
Deflection sensitivity	approx. 8 Vrms/cm (23 V peak-peak/cm)	approx. 9 Vrms/cm (25 V peak-peak/cm)
Input resistance	> 100 MΩ	> 100 MΩ
Input capacitance with respect to earth	20 pF	18 pF

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A3b Vertical amplifier

Voltage gain	- approx. 80 X
Maximum sensitivity	- approx. 100 mVrms/cm (280 mV peak-peak/cm)
Input resistance	- 1 MΩ
Input capacitance	- 15 pF
Maximum input voltage	- 8 Vrms
Frequency range for square wave signals	- 50 c/s - 500 kc/s
Frequency range for sinusoidal signals	- 1 c/s - 7 Mc/s (see C3e)
Amplitude of the image	- 5 cm at 1 Mc/s, marked on the graticule; at least 3 cm at 8 Mc/s

A3c Probe

Probe input	Admissible voltage	Input resistance	Input capacitance
1:1	8 Vrms	0,6 MΩ	70 pF
15:1	120 Vrms *	10 MΩ	8 pF

* In the position 15:1 the top value of the alternating voltage and a direct voltage component may be 2000 V together.

A3d Time-base generator

Frequency ranges - SK3 pos.		
	1	5 - 25 c/s
	2	15 - 75 c/s
	3	50 - 250 c/s
	4	150 - 750 c/s
	5	500 - 2500 c/s
	6	1.5 - 7.5 kc/s
	7	5 - 25 kc/s
	8	10 - 50 kc/s
	9	25 - 125 kc/s
	10	100 - 500 kc/s

Time base voltage (Bu12-Bu13) : 80-90 Vrms (220-250 V peak-peak).

A3e Horizontal amplifier

Voltage gain	- approx. 45 x
Maximum sensitivity	- approx. 200 mVrms/cm (570 mV peak-peak/cm)
Input resistance	- 50,000 Ω
Input capacitance	- 20-55 pF (dependent on position R6.)
Maximum input voltage	- 100 Vrms
Frequency range for square wave signals	- 40 c/s-30 kc/s (R6 turned clockwise)
Frequency range for sinusoidal signals	- 3 c/s-1 Mc/s (see under C5g)

A3f Supply

110-125-145-200-220 and 245 V (40-100 c/s); approx. 150 W.

A3g Dimensions

31,5 x 25 x 46,5 cm

A3h Weight

approx. 26 kg.

A3j Valves

See electrical list of parts; supplied by Comm. Dept. "Electronica".

B. CIRCUIT DESCRIPTION

Successively the following parts will be described:

1. Amplifier for vertical deflection.
2. Probe.
3. Time-base generator (which can be switched over for use as horizontal amplifier).
4. Cathode-ray tube circuit.
5. Supply parts.

B1 Amplifier for vertical deflection

This amplifier contains the valves B1, B2, B3, B4 and B5. Valve B1 is connected as a cathode follower thus causing impedance transformation. This circuit allows the use of a low impedance attenuator SK5 (1, 1/10) and continuous attenuator R7, thus obviating the use of frequency correction. The lower end of the cathode circuit of B1 is connected to -1200 V as a result of which the cathode is at earth potential. Adjustment is carried out by means of R14. The cathode circuit of B1 also includes the stabilising tube La3. By using this circuit no coupling capacitor between kB1 and g1B2 is necessary.

The signal is amplified by the valves B2 and B3 and the push-pull output stage B4/B5. The response for the highest frequencies is improved by means of the correction coils L1, L2, L3 and L4. The losses for the lowest frequencies can be compensated by means of R36 in the grid circuit of B3, which makes it possible to vary the RC product (R34+R36)x C6. The output valve B4 also operates as a phase inverter for B5; the anode alternating voltage is fed to the control grid of B5 through R41, C15 and R47. C14 in the cathode circuit of B4 makes it possible to correct the response curve for the highest frequencies.
When internal synchronisation of the time-base generator is employed the synchronising signal is taken from the screen grid of B5.

B2 Probe

A probe, which makes it possible to increase the voltage range by 15 x and to obtain a high input resistance and a small input capacitance, can be connected to the input terminals Bu5 and Bu6 of the vertical amplifier. The attenuator consists of the resistors R10 and R11 and has been made independent of frequency by means of the trimmers C1 and C2. A correction ring has been placed around R11 allowing the stray capacitances of R11 to be adjusted.

B3 Time-base generator

B3a. Three-pentode-circuit

The valves B12, B13 and the pentode part of B14 form a so-called three-pentode-circuit. The valve B12 operates as the charging pentode which charges the capacitors C21 up to C29, C57 with a constant current. This charging current IaB12 and consequently the frequency of the saw-tooth voltage can be adjusted by means of R6. The ratio between the minimum and the maximum frequency (1:5) is preset with R66.
In the first 10 positions of SK3 the lower end of R6 is grounded by means of wafer SK3I. In the three highest frequency ranges (SK3 in position 10,25 and 100 kc/s) the charging current is increased by decreasing the cathode resistor of B12 in steps.

Successively R61, R65 and R60 are then connected in parallel with R62 by means of SK3II.
The periodic discharge of the charging capacitors takes place through valve B13, the cathode of which is connected to aB12 in the positions 1 up to 10 incl. by means of SK3IV. During the charging time B13 is cut off. As the capacitors are charged the cathode voltage of B13 decreases until B13 starts conducting, causing a negative pulse across R68, which is fed through C32 (in parallel with one of the capacitors C33 up to C41 incl.) and SK2I to the control grid of the pentode part of B14. This valve is then cut off and its anode voltage rises, causing g1B13 to become strongly positive.
As a result of this the discharge takes place rapidly. At the end of the discharge IaB13 decreases and VaB13 increases. This voltage rise reaches g1 of the pentode part of B14 in the form of a positive pulse which causes this valve to conduct again.
Consequently the anode voltage drops, causing B13 to be cut off thus initiating the following charging cycle.

The amplitude of the saw-tooth voltage is determined by the direct voltage on g1B13. This voltage can be varied by altering the screen grid voltage of B14 by means of R5. VaPB14 is then varied and consequently Vg1B13.
The maximum obtainable time-base amplitude is preset by means of R82.
The negative pulse which is present on aB13 during the discharge is fed to the control grid of the cathode-ray tube B15 through SK11, C20 and C19 for fly-back suppression.

B3b. Phase inverter

The symmetrical saw-tooth voltage required for the horizontal deflection is obtained by making use of the phase inverter B11.
The saw-tooth voltage on aB12 is applied to the horizontal deflection plate D2 through C42 while the deflection plate D2' receives its deflection voltage from B11.
The left hand triode of B11 is connected as a cathode follower.
The signal reaches the control grid of the right hand triode through R101 and R98. For the anode supply of B11 a voltage of +360 V is used. Because this voltage is not stabilised, part of this unstabilised voltage is applied to g1 by means of the voltage divider R99, R142, R103, R124 and R93, causing the variations of the anode voltage to be counteracted. Adjustment is carried out by means of R99.

B3c. Synchronisation amplifier

The triode part of B14 operates as a synchronisation amplifier and buffer. The amplified sync. voltage is applied to g2 of the pentode part of B14 through C47. In order to prevent the sync. signal to be superimposed on the saw-tooth voltage at the highest time-base frequencies through Cg1k of B13 the same voltage is applied to the cathode of B13, in opposite phase, i.e. from aTB14 through R75 and C55. Adjustment is carried out by means of C55.
R8 allows the direct voltage level of the sync. signal to be varied with respect to earth and makes it possible to adjust for the most favourable synchronisation-setting.

B3d. System switch SK2

This switch has the following positions:

Position 1 (Int. deflection - int.sync.)

R53 is connected to gTB14 through SK2II and C58.
aB13 is connected to g1 of the pentode part of B14 through C32,in parallel with one of the capacitors C33 up to C41 incl. and SK2I causing the time-base generator to operate as described under B3a.

Position 2 (Int.deflection - ext.sync.)

The internal sync. signal is short-circuited by connecting the lower end of R53 with the +250 V side of R51 by means of SK2II. gTB14 is connected with Bu4 through C58, SK2II, C49 and a filter R84, C44, R83.

Position 3 (Ext. deflection - int. sync.)

The time-base generator is made inoperative by short-circuiting the anode resistor R77 of the pentode part of B14 by means of SK2I. gTB14 is connected to R53 through C58 and SK2II. The sync. voltage on aTB14 is fed to Bu4 through C47, SK2II and C43 and can be used for synchronisation of the external time-base generator, the output of which is applied to the horizontal deflection plates (Bu12-Bu13); SK10 in position "ext.".

Position 4 (1 x trigger)

aB13 is connected to +245 V through SK2I and C32 (in parallel with one of the capacitors C33 up to C41 incl.) causing the time-base generator to stop.
Also aTB14 is connected to g1PB14 through C12 and R137 by means of SK2I.

a) R8 in position "1x"

Switch SK4 which is ganged with R8 is closed and makes the following connections:
The internal sync. signal is short-circuited, the lower end of R51 being connected to +250V by means of SK2II and SK4.
g1PB14 is connected with Bu4 by means of SK2I and also with -85 V by means of SK4.

As a result of the large negative voltage on g1PB14 this pentode part is cut off causing the anode voltage to be high. Consequently B13 is conducting while its cathode potential is nearly 245 V (load capacitors not charged). If Bu3 and Bu4 are connected together, the negative voltage on g1PB14 is removed causing VaPB14 to drop sharply and consequently Vg1B13. B13 is then cut off and the time-base stroke takes place; rate depends on the position of SK3 and R6. As soon as VkB13 has dropped sufficiently to make B13 conduct, this cathode voltage remains constant. On account of the RC coupling elements to the horizontal deflection plates, the light spot will then slowly move back from the right to the left.

b) R8 turned clockwise

Switch SK4 is open and Bu4 and g1PB14 are at earth potential. The internal sync. signal from R53 then reaches gTB14 through SK2II. When no signal is present the charging capacitors are charged and the cathode of B13 has a low potential. When a signal is present it will reach the control grid of the pentode part of B14 through C12/R137.

If this grid becomes sufficiently negative as a result of the signal, the penthode part will be cut off causing Vg1B13 to rise. B13 then starts conducting and the fly-back takes place. When the sync. signal on g1PB14 becomes positive, VaPB14 will drop and consequently Vg1B13. B13 is then cut off and the time-base stroke takes place. The phenomenon is reproduced with a speed which is dependent on the time-base frequency setting.

Position 5 (Int. deflection - 50 c/s sync.)

In this position the time-base generator operates normally as in position 1 but an alternating voltage from winding S7 of transformer T1 is used for synchronisation. This voltage is applied to gTB14 through R135, SK2II and C58. No synchronising signal from the vertical amplifier is applied by connecting R53 to +250V via SK2II.

Position 6 (Deflection 50 c/s AC)

SK3 must be placed in position 11 (Hor. 0.2 - 100 Vrms). An alternating voltage from transformer winding S2' is now applied to Bu2 through the filter R76-C13 and SK2II. The time-base generator is inoperative (R53 connected to +250 V) and B12 acts as a horizontal deflection amplifier (see under B3e).

B3e. Amplifier for horizontal deflection (B11-B12)

When SK3 is placed in position 11 the circuit is altered as follows:

1. By means of SK3IV a resistor R59 is placed in the anode circuit of B12 instead of C57, C21 up to C29 incl. so that this valve can operate as a normal amplifier.
2. By means of SK3III the resistor R88 with the parallel capacitors C45 and C48 is connected in parallel with the cathode resistor R62 of B12. The purpose of these capacitors is to correct the response for the highest frequencies. C45 is adjustable.
3. The coupling capacitor C30 is placed between the wiper of R6 and R64 (g1B12). In the preceeding positions of SK3III this capacitor was bridged by R136.
4. The junction R67-R86 is grounded by means of SK3II.
5. Bu2 which was connected with the lower end of R6 is disconnected from earth by means of SK3I.
6. The connection between aB12 and kB12 is broken by means of SK3IV.

B4. Cathode ray tube circuit

The anode of B15 is grounded.

Post-acceleration

An external post-acceleration voltage (max. 2000 V) can be connected to Bu8. The internal post-acceleration voltage of +360 V with respect to chassis is then disconnected. The picture becomes brighter, the amplitude smaller.

Focusing : This is carried out by means of R4.

Intensity: Adjustable by means of R3.

Deflection: The horizontal and vertical deflector plates are connected direct to Bu12-Bu13 and Bu9-Bu10 respectively. The output of the built-in time-base generator can be taken from the sockets Bu12-Bu13 (SK10 in "INT" position). With SK10 in the "EXT" position, the time-base generator or amplifier is switched off and an external time-base voltage or external signal can be applied. The sockets Bu9 and Bu10 are provided with switching contacts so that when plugs are inserted the vertical amplifier is automatically disconnected from the vertical deflector plates.

Centering: A circuit with 2 pairs of mechanically-coupled potentiometers (R1+R1' and R2+R2') has been applied in order to enable the light spot to be shifted horizontally or vertically. With this circuit equal voltages of opposite polarity are fed to the deflector plates so that the average potential between the plates remains equal to anode potential and the focusing is unaffected.

External beam modulation:

For this, an alternating voltage (> 2 Vrms) can be applied to Bu14. By means of SK11 the lead between g1B15 and aB13 carrying the blanking pulses is interrupted and also the time-base generator is prevented from being synchronized by the external signal.

Beam suppression:

The beam is suppressed by opening SK7. If a switch or polarizing voltage is connected between Bu15 and Bu16 the trace can be rendered visible at any desired moment. Due care should be exercised as these sockets are at a high potential.

B5. Supply part

The direct voltage for the vertical amplifier and the time-base generator (horizontal amplifier) is obtained by means of B10. This voltage is stabilised by B7. The voltage fluctuations are amplified by B7 and applied to the control grid of the regulating valve B6. The reference voltage for B7 is obtained from the neon valve La2. The magnitude of the stabilised voltage is set to the desired value by means of R111. Part of the current flows through R114 and R115. R115 serves to obtain proper stabilisation for mains voltage variations of ± 10%. L6 and C69 form a tuned circuit for 100 c/s. The high tension (-1200 V) for the cathode ray tube is supplied by the pentode B9 which is connected as a diode. This high tension is stabilised by means of B8. The stabilised voltage of +250 V is used as reference voltage for B8. The magnitude of the high tension is set to -1200 V by means of R119.

C. CHECKING AND ADJUSTMENTS

C1. Adjustment of the direct voltages

C1a. Set R1 and R2 to zero, R5, R6, R7 and R8 fully clockwise. SK2 in position 1, SK3 in position 3, SK7 in position "norm.", SK5 in position X1.

C1b. Adjust R111 to obtain a voltage of 250 V across C61/C62.

C1c. Adjust R114 until the voltage across C61/C62 remains practically equal to 250 V when the mains voltage is varied by ± 10% of the nominal value.

C1d. Adjust R119 to obtain a voltage of -1200 V between aB9 and chassis.

C1e. The line on the screen should be made as thin as possible by means of R132 at the rear panel of the apparatus (minimum hum).

C2. Adjustment of R1-R1' and R2-R2' resp.

Connect a valve voltmeter (GM 6004 or GM 7635) between the wiper R1(R2) and chassis. Turn the knob until the meter reading is zero; then turn the knob with respect to its spindle until it corresponds with 0 on the front panel. Now connect the meter between the wiper of R1' (R2') and chassis. Slightly loosen the screw in the bush of this potentiometer and, while holding the knob, turn this bush until the meter reading is again zero. Tighten the screw.

C3. Vertical amplifier

C3a. SK5 fully clockwise. When turning R7 the line on the screen may not move up and down. Adjust with R14.

C3b. Connect an AF generator to Bu5-Bu6. Frequency approx. 1000 c/s. SK3 in position 3, R5, R6 and R8 fully clockwise. Make a few cycles with a total height of 5 cm visible on the screen. The input sensitivity must be better than 120 mVrms per cm picture height. When B5 is removed the amplitude must drop to half its value (tolerance 20%). Reinsert B5. It must be possible to extend the picture to a height of 5 cm on the screen without any distortion being visible.

C3c. Connect a square wave generator to Bu5-Bu6. At a square wave frequency of 50 c/s the top of the picture must form a thin straight line. The picture must be properly square and no distortion must be visible. Adjust with R36. At 27 c/s the top of the picture may be slightly bent.

C3d. Square wave frequency 50 kc/s.
Unsolder C10 from anode B3. Connect the square wave voltage between the loose side of C10 and earth. Boost the square wave voltage so much that an amplitude of 5 cm is obtained on the screen.
Reproduce some squares on the screen and reduce the capacity of C14 so much that the most favourable form of rectangle is produced. Remove the square wave generator and resolder C10.
Connect the generator once more to Bu5-Bu6 and again display some squares with an amplitude of 5 cm on the screen. Then reduce the capacity of C5 until the most favourable form of rectangle is produced.
Check the whole frequency range up to 200 kc/s (if possible to 500 kc/s) during which SK3 and R6 are adjusted continuously. No distortion of the original signal should occur in any part of the frequency range. The horizontal top of the square wave pulses must remain straight over the entire range.

C3e. For checking the frequency response an AF generator and a standard signal generator must be used. (Sockets Bu5-Bu6).
The frequency response should comply with the limit given below.
Reference frequency = 1000 c/s; amplitude adjusted to 5 cm.

1 c/s	85%	118 mVrms/cm	100 kc/s	100%	100 mVrms/cm
3 c/s	130%	77 mV "	1 Mc/s	100%	100 mV "
10 c/s	110%	91 mV "	3 Mc/s	95%	105 mV "
1000 c/s	100%	100 mV "	5 Mc/s	90%	111 mV "
10 kc/s	100%	100 mV "	7 Mc/s	70%	143 mV "

C3f. If the switch SK5 is set to position 10 x the attenuation must amount to approx. 10. When the square wave voltage is increased by a factor 10 the height of the picture must remain about the same.

C4. Probe

C4a. Connect the probe to Bu5-Bu6. Apply a square wave signal of 5 kc/s to Bu18-Bu19 (1:1) and adjust the oscilloscope to obtain a stationary picture.
Then apply the square wave signal to Bu17-Bu19 (15:1). The wave form should remain the same. If necessary readjust C2.

The rubber sleeve can be removed by rolling it off.
Before the sleeve is put back around the probe apply talcum powder to the inside.

C4b. In case the original probe is replaced by a new one proceed as follows:

1. Remove the rubber sleeve and the metal casing.
2. Set C2 approximately at half its capacity.
3. Connect the probe to Bu5-Bu6.
4. Apply a square wave signal of 5 kc/s to Bu17-Bu19 (15:1) and adjust C1 until the picture is approximately square. C1 consists of a length of polythene cable, one core of which is cut off to obtain the correct capacity.
5. Then adjust C2 until the square wave form is equal to that without attenuation.
6. Mount the metal casing and fix it with the appropriate screws. In case this causes the square wave form to alter, shift the metal band around R11 slightly without touching R1 with the hands. If necessary slightly readjust C2.
7. Mount the metal casing again and repeat point 6.

N.B. If the trimmer C1 is defective it can be replaced by a piece of twin lead the code number of which is given in the Electrical Parts List. The screening braid has to be removed and replaced by the insulating sleeve from the old trimmer.

C5. Time-base generator and horizontal amplifier

C5a SK2 in position 1, SK3 in position 6, R6 fully clockwise. Set R5 to obtain a picture width of 6-7 cm. Connect a square wave generator or an AF generator to Bu5-Bu6 and make one complete cycle visible on the screen. Then turn R6 fully anti-clockwise. 5 to 6 complete cycles should now be visible. If necessary readjust R66. Remove the input signal to Bu5-Bu6.

MECHANICAL PARTS

Qty	Fig.	Item	Description	Code number
11	3	1	Valve holder EF80-ECC81-ECL80-PL81-KL84	B1 506 59.0
1	2	2	Valve holder GZ32	B1 505 26.1
1	2	3	Valve holder DG10-6	B1 505 67.0
1	2	4	Anode contact DG10-6	B1 885 06.0
4	3	5	Valve holder La2-La3-EF91	B1 506 55.0
1	4	6	Spindle	E3 870 19.0
1	4	7	Spring	A1 986 06.1
1	4	8	Bushing	A1 612 06.0
1	4	9	Graticule	M7 748 11.0
7	4	10	Knob ∅ 22mm	B1 545 07.0
7	4	11	Cap for knob	23 653 40.0
1	4	12	Instruction plate	M7 188 46.0
1	4	13	Emblem holder	S8 060 76.0
1	4	14	Philips emblem	S8 159 52.0
4	4	15	Knob ∅ 30 mm	E2 440 67.0
4	4	16	Cap for knob	23 653 38.0
12	4	17	Screw for knob	A9 999 98/2x12
4	4	18	Arrow for knob	23 680 53.0
1	4	19	Lens (green)	A9 861 05.0
6	4	20	Plug socket	B1 615 00.0
1	4	21	Insulating plate	M7 111 58.1
1	5	22	Voltage adaptor	M7 701 12.0
1	5	23	Mains socket	M7 603 27.0
2	5	24	Fuse holder VL2-VL3	B1 506 53.0
3	5	25	Plug socket with switch	A3 186 07.0
5	5	26	Plug socket	B1 615 00.0
1	5	27	Slide switch	V3 577 28.0
1	5	28	Male socket	M7 751 52.0
1m	8	29	Screened cable	R 209KA/01BBC
1	8	30	Rubber sleeve	M7 047 10.0
4	8	31	Screw ∅ 1 mm	07 333 01.0
1	8	32	Cap	M7 053 22.0
1	8	33	Measuring prod.	M7 731 19.1
1	8	34	Probe casing	M7 696 68.0
1	8	35	Spring	M7 762 09.0
1	8	36	Disc	A9 864 12.1
2	8	37	Single pole plug	E2 556 38.0
1	8	38	Plug	E2 796 43.2
2	8	39	Cable tag	08 189 22.0
2	8	40	Milled nut	A9 999 92/M3
1	8	41	Brass sleeve	E2 098 49.0
1	8	42	Outer sheath	E2 098 50.0
1	8	43	Plug (complete)	A9 865 45.0

JM/RSw

T1		M7 614 34.1
V11	125° C	08 100 99.1
V12	5 A	08 141 07.0
V13	2,5 A	08 141 90.0
L1	0,65 µH	M7 573 29.0
L2	0,65 µH	M7 573 29.0
L3	0,65 µH	M7 573 29.0
L4	10 µH	M7 573 30.0
L5	1 mH	M7 573 93.0
L6	3 H	M7 450 01.0
L7	27 µH	M7 513 06.0
L8	27 µH	M7 513 06.0
C1	3 pF	80 mm {R206 KN/01BB0 see chapter C4b
C2	3-30 pF	28 212 36.4
C3	0,1 µF	A9 999 06/V100K
C4	0,12 µF	A9 999 06/120K
C5	45-275 pF	A9 999 07/45E-275E
C6	0,22 µF	A9 999 06/220K
C7	10 µF	48 313 09/10
C8	25 µF	{AC 5309/25+25
C9	25 µF	
C10	0,22 µF	A9 999 06/220K
C11	100 pF	A9 999 04/100E
C12	0,22 µF	A9 999 06/220K
C13	0,22 µF	A9 999 06/220K
C14	45-275 pF	A9 999 07/45E-275E
C15	0,22 µF	A9 999 06/220K
C16	0,1 µF	A9 999 06/100K
C17	220 pF	A9 999 04/220E
C18	0,1 µF	A9 999 06/100K
C19	47000 pF	A9 999 06/V47K
C20	47000 pF	A9 999 06/V47K
C21	27 pF	A9 999 05/27E
C22	150 pF	A9 999 05/150E
C23	270 pF	A9 999 05/270E
C24	1000 pF	A9 999 06/V1K
C25	0,39 µF	A9 999 06/V390K
C26	3300 pF	A9 999 06/V3K3
C27	10000 pF	A9 999 06/V10K
C28	33000 pF	A9 999 06/V33K
C29	0,15 µF	A9 999 06/V150K
C30	0,22 µF	A9 999 06/220K
C31	0,1 µF	A9 999 06/100K
C32	150 pF	A9 999 05/150E
C33	68 pF	A9 999 05/68E
C34	150 pF	A9 999 05/150E
C35	270 pF	A9 999 05/270E
C36	1000 pF	A9 999 06/V1K
C37	3300 pF	A9 999 06/V3K3
C38	10000 pF	A9 999 06/V10K
C39	33000 pF	A9 999 06/V33K
C40	0,15 µF	A9 999 06/150K
C41	0,39 µF	A9 999 06/390K
C42	0,47 µF	A9 999 06/470K
C43	22000 pF	A9 999 06/22K
C44	18 pF	A9 999 04/18E
C45	45-275 pF	A9 999 07/45E-275E
C46	0,47 µF	A9 999 06/470K
C47	0,47 µF	A9 999 06/470K
C48	2200 pF	A9 999 06/2K2
C49	22000 pF	A9 999 06/22K
C50	150 pF	A9 999 04/150E
C51	12,5 pF	XU 052 16.0
C52	0,1 µF	A9 999 06/100K
C53	50 µF	{48 317 59/50+50
C54	50 µF	
C55	12,5 pF	XU 052 16.0
C56	33000 pF	A9 999 06/33K
C57	15 pF	A9 999 05/15E
C58	22000 pF	A9 999 06/22K
C59	0,22 µF	A9 999 06/V220K
C60	10000 pF	A9 999 06/10K
C61	50 µF	{48 317 59/50+50
C62	50 µF	
C63	0,22 µF	A9 999 06/220K
C64	1 µF	48 347 10/S1M
C65	0,1 µF	48 113 10/R100K
C66	0,47 µF	A9 999 06/470K
C67	25 µF	{48 317 61/25+25
C68	25 µF	
C69	0,47 µF	A9 999 06/470K
C70	25 µF	{48 317 61/25+25
C71	25 µF	
C72	10000 pF	A9 999 06/V10K
C73	10000 pF	A9 999 06/V10K
C74	22000 pF	A9 999 06/22K
C75	1500 pF	A9 999 04/1K5

R1	1 MΩ		48 473 52.0
R1'	1 MΩ		49 473 58.0
R2	1 MΩ		49 473 58.0
R2'	1 MΩ		49 473 58.0
R3+SK1	0,1 MΩ		49 501 15.0
R4	0,5 MΩ		49 472 26.0
R5	50 kΩ		49 472 21.0
R6	50 kΩ		49 472 21.0
R7	2 kΩ		49 472 25.0
R8+SK4	1 MΩ		B1 638 05.0
R9	1,2 MΩ		A9 999 00/1M2
R10	1,5 MΩ		A9 999 00/1M5
R11	10 MΩ		M7 632 15.0
R12	470 Ω		A9 999 00/470E
R13	4,7 MΩ		A9 999 00/4M7
R14	10 kΩ		49 472 28.0
R15	0,15 MΩ		A9 999 00/150K
R16	13,5 kΩ	2x	A9 999 00/27K par.
R17	50 kΩ		48 768 05/50K
R18	10 MΩ		A9 999 00/10M
R19	50 kΩ		48 768 05/50K
R20	220 Ω		A9 999 00/220E
R22	2,2 kΩ		A9 999 00/2K2
R23	120 Ω		A9 999 00/120E
R24	0,1 MΩ		A9 999 00/100K
R25	470 Ω		A9 999 00/470E
R26	1,5 MΩ		A9 999 00/1M5
R27	150 Ω		A9 999 00/150E
R28	1,2 kΩ		A9 999 00/1K2
R29	2,2 kΩ		A9 999 00/2K2
R30	6,8 kΩ		A9 999 00/6K8
R31	47 Ω		A9 999 00/47E
R33	47 Ω		A9 999 00/47E
R34	0,33 MΩ		A9 999 00/330K
R35	470 Ω		A9 999 00/470E
R36	1 MΩ		49 472 34.0
R37	1,8 kΩ		A9 999 00/1K8
R38	180 Ω		A9 999 00/180E
R39	1 MΩ		A9 999 00/1M
R40	470 Ω		A9 999 00/470E
R41	330 Ω		A9 999 00/330E
R42	600 Ω	2x	A9 999 00/1K2 par.
R43	120 Ω		A9 999 00/120E
R44	900 Ω		48 496 05/900E
R45	47 Ω		A9 999 00/47E
R46	1 MΩ		A9 999 00/1M
R47	470 Ω		A9 999 00/470E
R48	900 Ω	3x	A9 999 00/2K7 par.
R49	2,2 kΩ		A9 999 00/2K2
R50	150 Ω		A9 999 00/150E
R51	1,2 kΩ		A9 999 00/1K2
R52	47 Ω		A9 999 00/47E
R53	3,9 kΩ		A9 999 00/3K9
R54	0,47 kΩ		A9 999 00/470K
R55	5,6 MΩ		A9 999 00/5M6
R56	5,6 MΩ		A9 999 00/5M6
R57	10 MΩ		A9 999 00/10M
R58	10 MΩ		A9 999 00/10M
R59	16,5 kΩ	2x	A9 999 00/33K par.
R60	390 Ω		A9 999 00/390E
R61	6,8 kΩ		A9 999 00/6K8
R62	3,9 kΩ		A9 999 00/3K9
R63	47 Ω		A9 999 00/47E
R64	470 Ω		A9 999 00/470E
R65	2,7 kΩ		A9 999 00/2K7
R66	1 MΩ		49 472 34.0
R67	0,22 MΩ		A9 999 00/220K
R68	560 Ω		A9 999 00/560E
R69	47 Ω		A9 999 00/47E
R70	47 Ω		A9 999 00/47E
R71	12 kΩ		A9 999 00/12K
R72	47 Ω		A9 999 00/47E
R73	56 kΩ		A9 999 00/56K
R74	23,5 kΩ	4x	A9 999 00/100K par.
R75	12 kΩ		A9 999 00/12K
R76	1 MΩ		A9 999 00/1M
R77	23,5 kΩ	4x	A9 999 00/100K par.
R78	3,3 kΩ		A9 999 00/3K3
R79	47 Ω		A9 999 00/47E
R80	47 Ω		A9 999 00/47E
R81	10 kΩ		A9 999 00/10K
R82	0,1 MΩ		49 472 36.0
R83	56 kΩ		A9 999 00/56K
R84	82 kΩ		A9 999 00/82K
R85	220 kΩ		A9 999 00/220K
R86	100 Ω		A9 999 00/100E
R87	2,2 MΩ		A9 999 00/2M2
R88	390 Ω		A9 999 00/390E
R89	0,82 MΩ		A9 999 00/820K

R90	1 MΩ		A9 999 00/1M
R91	0,15 MΩ		A9 999 00/150K
R92	28 kΩ	2x	A9 999 00/56K par.
R93	0,56 MΩ		A9 999 00/560K
R94	47 Ω		A9 999 00/47E
R95	10 MΩ		A9 999 00/10M
R96	39 kΩ		A9 999 00/39K
R97	270 Ω		A9 999 00/270E
R98	47 Ω		A9 999 00/47E
R99	0,1 MΩ		A9 472 28.0
R100	18 kΩ		A9 999 00/18K
R101	0,12 MΩ		A9 999 00/120K
R102	6,2 kΩ		A9 999 00/1K5) ser. A9 999 00/4K7)
R103	0,33 MΩ		A9 999 00/330K
R104	47 Ω		A9 999 00/47E
R105	47 Ω		A9 999 00/47E
R106	6,8 kΩ		A9 999 00/6K8
R107	0,12 MΩ		A9 999 00/120K
R108	1 MΩ		A9 999 00/1M
R109	47 Ω		A9 999 00/47E
R110	23,5 kΩ	2x	A9 999 00/47K par.
R111	0,1 MΩ		A9 472 28.0
R112	0,22 MΩ		A9 999 00/220K
R113	47 Ω		A9 999 00/47E
R114	900 Ω		48 516 10/900E
R115	1,8 kΩ		48 496 10/1K8
R116	10 MΩ		A9 999 00/10M
R117	1 kΩ		A9 999 00/1K
R118	0,1 MΩ		A9 999 00/100K
R119	1 MΩ		A9 472 34.0
R120	1,5 MΩ		A9 999 00/1M5
R121	1,2 MΩ		A9 999 00/1M2
R122	1 kΩ		A9 999 00/1K
R123	680 Ω		A9 999 00/680E
R124	680 kΩ		A9 999 00/680K
R125	0,47 MΩ		A9 999 00/470K
R126	0,27 MΩ		A9 999 00/270K

R127	0,47 MΩ		A9 999 00/470K
R128	47 kΩ		A9 999 00/47K
R129	0,47 MΩ		A9 999 00/470K
R130 *	50 Ω	2x	A9 999 00/100E par.
R131 *	50 Ω	2x	A9 999 00/100E par.
R132	50 Ω		E3 133 29.1
R133	47 Ω		A9 999 00/47E
R134	47 Ω		A9 999 00/47E
R135	47 kΩ		A9 999 00/47K
R136	0,47 MΩ		A9 999 00/470K
R137	5,6 kΩ		A9 999 00/5K6
R138	3 Ω	4x	A9 999 00/12E par.
R139	0,27 MΩ		A9 999 00/270K
R140	0,22 MΩ		A9 999 00/220K
R142	22kΩ-0,1 MΩ		A9 999 00/22K-00/100K
R143	47 Ω		A9 999 00/47E
R144	4,3 kΩ		A9 999 00/3X3) ser. A9 999 00/1K)

B1	EF80
B2	EF91
B3	EF91
B4	EL84
B5	EL84
B6	PL81
B7	EF80
B8	PL83
B9	PL81
B10	GZ32
B11	ECC81
B12	EF80
B13	EF80
B14	ECL80
B15	DG10-6
La1	8034D/00
La2	85A2
La3	85A2

*Deze weerstanden zijn ter beveiliging van het apparaat vastgesoldeerd met tin, dat een laag smeltpunt heeft (180° C). Bij een kortsluiting in het voedingsgedeelte raken deze weerstanden los, waardoor de hoogspanning wordt uitgeschakeld. Bij reparatie zo mogelijk de nog aanwezige tin gebruiken.

*In order to protect the apparatus, these resistors have been soldered into place with solder having a low melting-point (180° C).
If a short-circuit occure in the power supply, these resistors fall off thereby switching off the H.T. supply.
When replacing these resistors, use as much of the original solder as possible.

*Pour protéger l'appareil, ces résistances ont été soudées avec de l'étain à souder d'un point de fusion bas (180° C). Avec un courtcircuit dans la partie d'alimentation ces résistances se détachent, en suite de quoi la haute tension est déconnectée.
En cas de réparations utiliser la soudure disponible encore, si possible.

*Als Schutzmassregel sind diese Widerstände des Apparats mit Lötzinn, das einen niedrigen Schmelzpunkt hat (180° C) festgelötet. Bei einem Kurzschluss im Speisungsteil werden diese Widerstände loslassen, wodurch die Hochspannung ausgeschaltet wird. Bei Reparaturen wenn möglich das noch vorhandene Zinn verwenden.

* Para proteger el aparato, se han soldado estas resistencias con estaño para soldadura de un punto de fusión bajo (180° C). En caso de un cortocircuito en la fuente de alimentación estas resistencias se sueltan, por lo que la alta tensión se desconecta. Para reparaciones úsese el estaño disponible todavía si posible.

JM/MZ

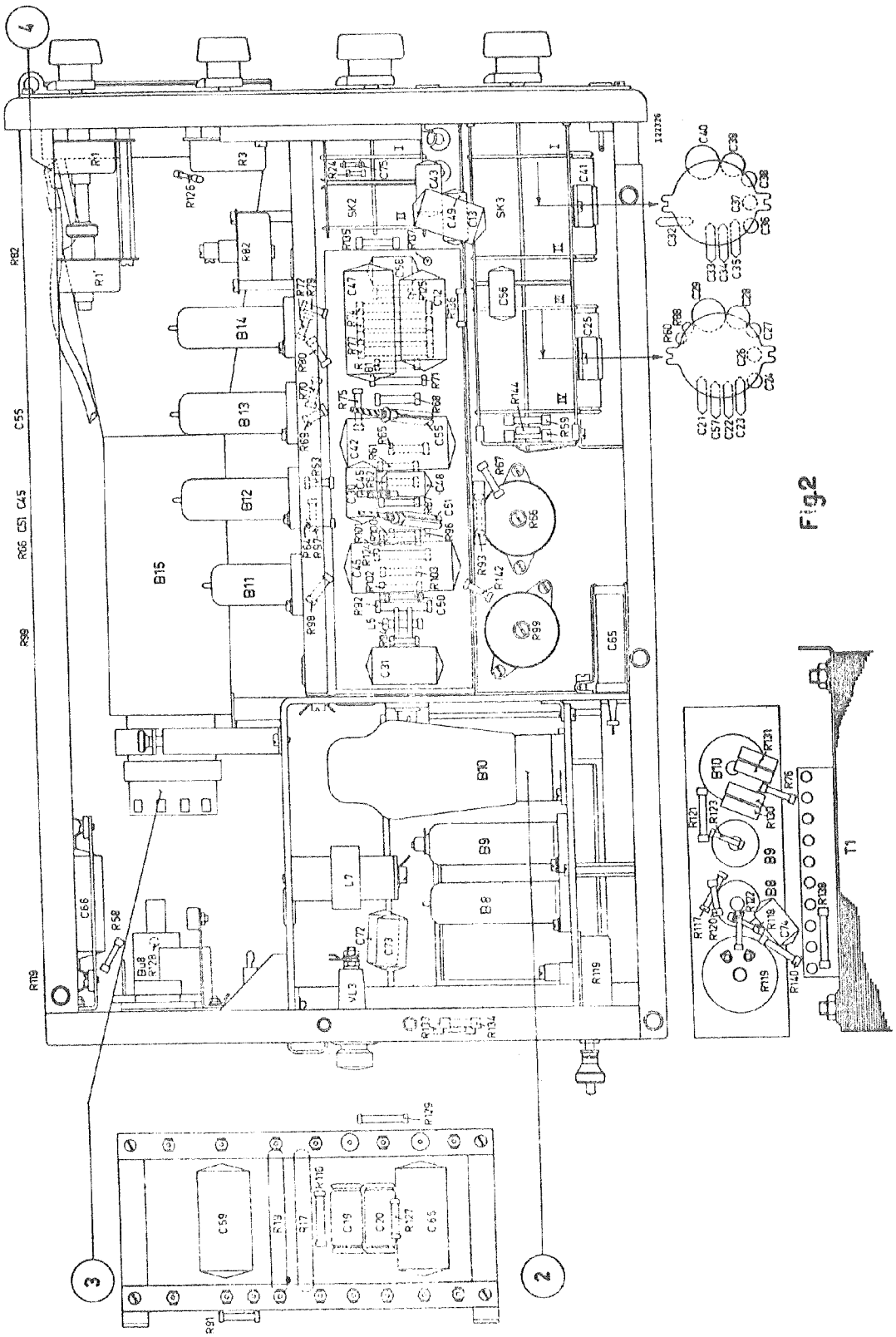


Fig2

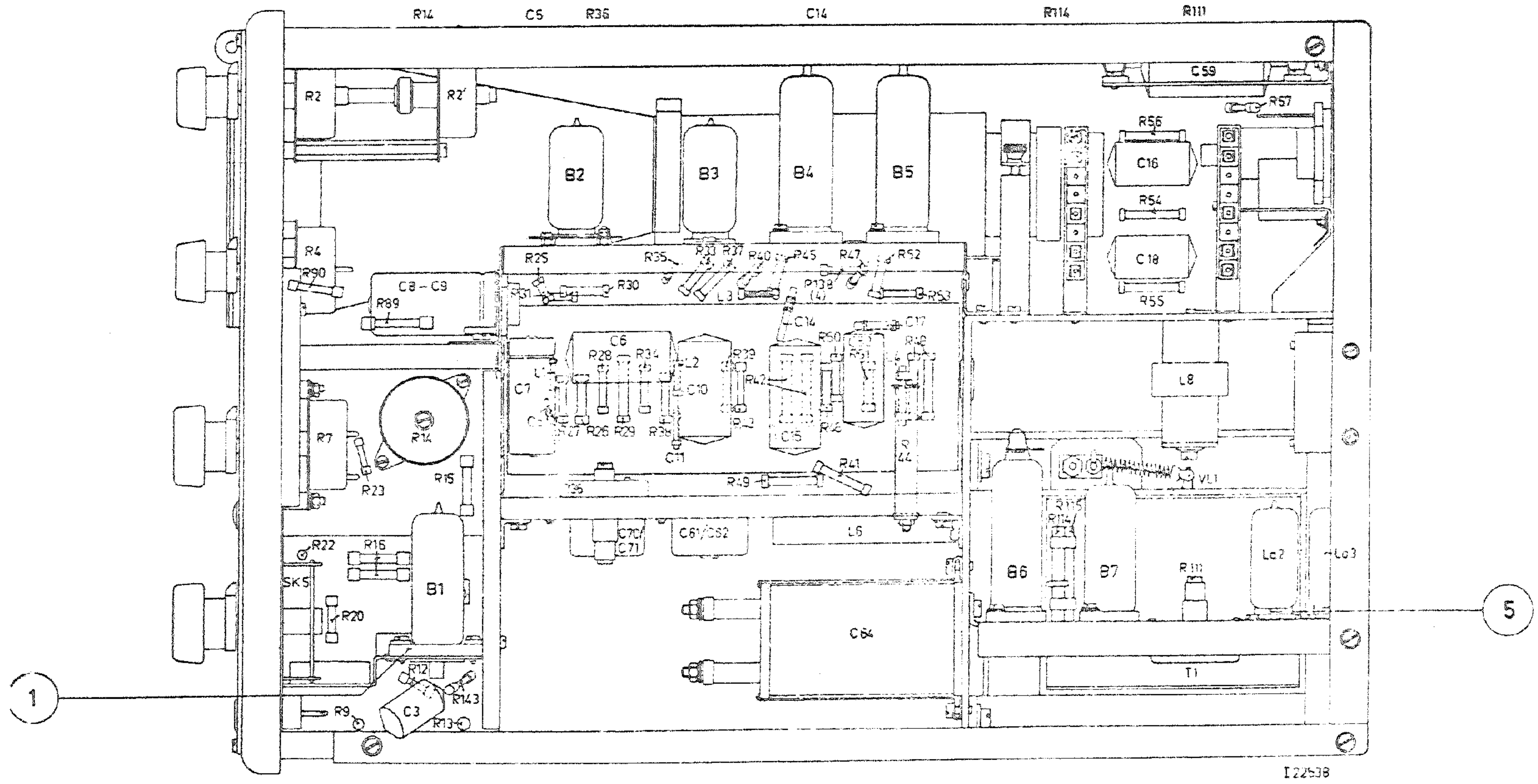
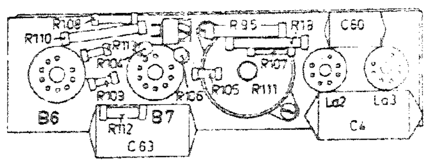

R14
C5
R36
C14
R114
R111
C59
R57
R56
C16
R54
C18
R55
R2
R2'
B2
B3
B4
B5
R4
R90
C8 - C9
R89
R25
R30
R35
R37
R40
R45
R47
R52
R53
L3
C6
R28
R34
L2
C10
C7
R26
R29
C11
R42
C15
C14
C17
R50
R51
R41
R49
R44
L8
VL1
R7
R14
R23
R15
R22
R16
B1
SK5
R20
R12
R143
C3
R9
R13
C70/ C71
C61/C62
L6
C64
B6
R115
R114
B7
R111
La2
La3
T1
1
5
I 22538

R110
R109
R95
R13
C60
R104
R107
R105
R111
R103
R106
B6
B7
R112
C63
La2
La3
C4

Fig.3

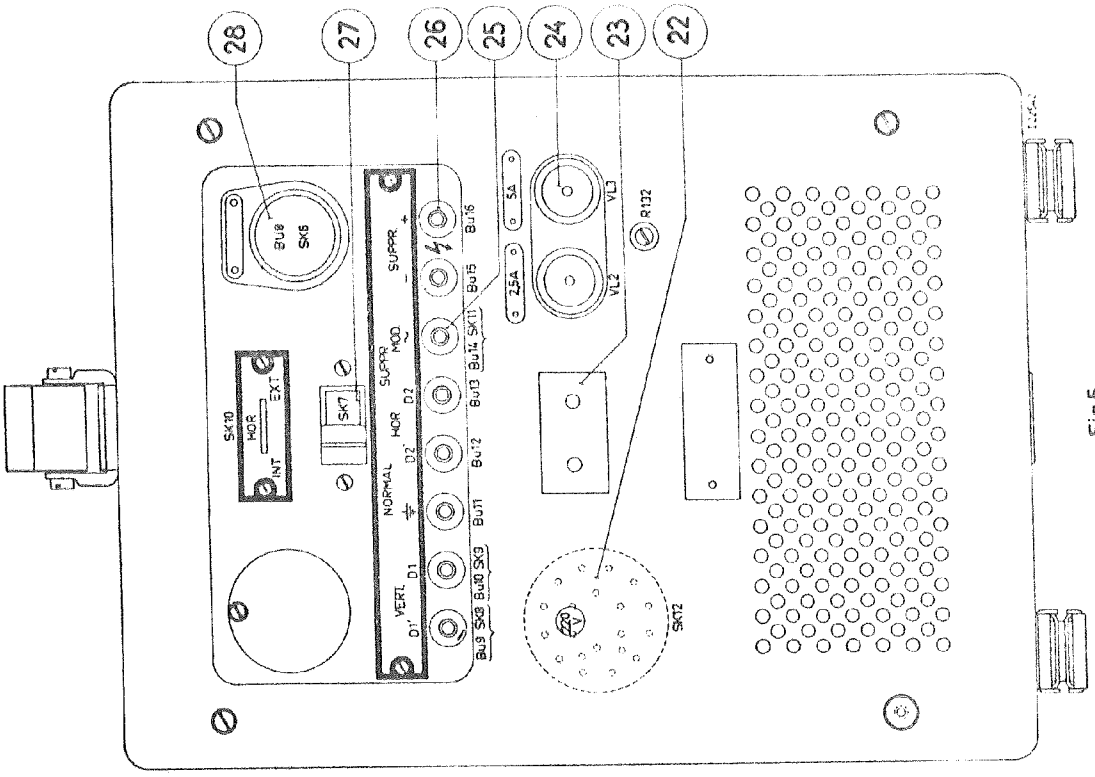

28
27
26
25
24
23
22
BU8
SK6
SK10
EXT
INT
HOR
SK7
SUPPR
MOD
SUPPR
NORMAL
HOR
VERT
D1
D2
D1'
D2'
BU9
SK8
BU10
SK9
BU11
BU12
BU13
BU14
SK11
BU15
BU16
2,5A
5A
VL2
VL3
R132
SK12
220 V

Fig.5

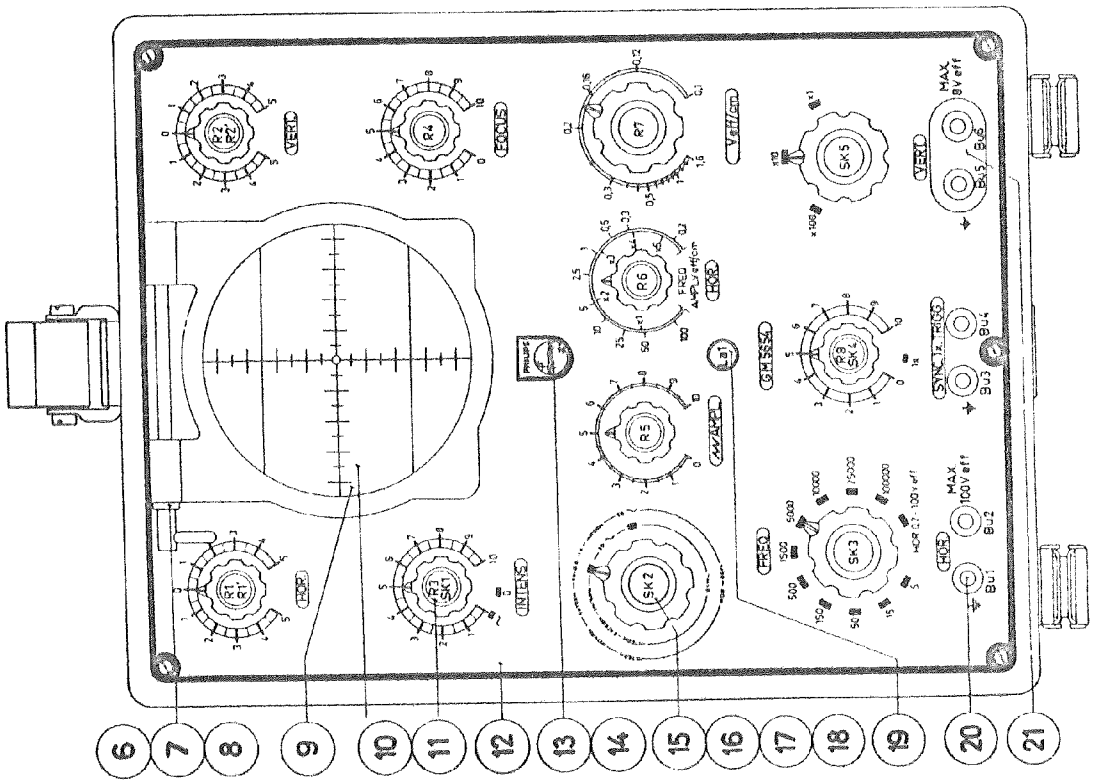

6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
VERT
FOCUS
HOR
INTENS
FREQ
SYNC
MAX
8V eff
100V eff
BU1
BU2
BU3
BU4
BU5 / BU6
SK1
SK2
SK3
SK4
SK5
R1
R2
R3
R4
R5
R6
R7
R8

Fig.4

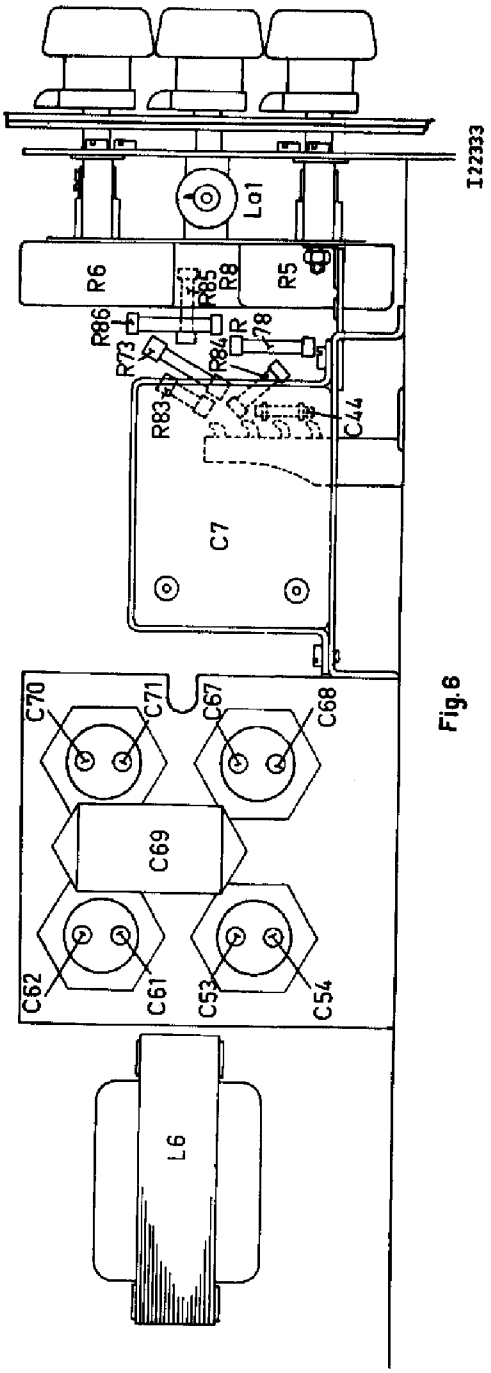

I22333
L01
R6
R5
R8
R85
R86
R73
R84
R83
C44
C7
C70
C71
C67
C68
C69
C62
C61
C53
C54
L6

Fig.6

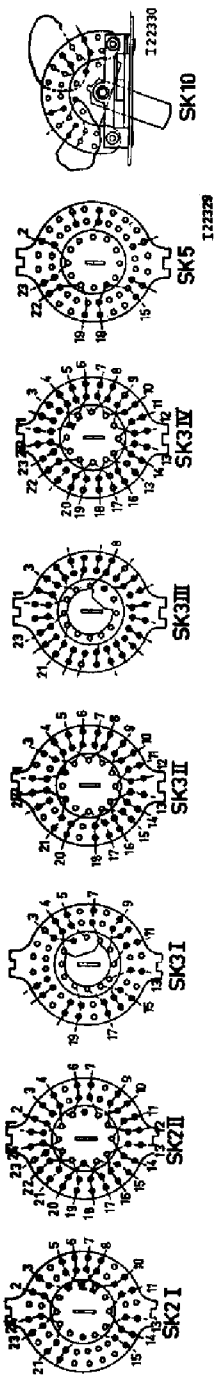

I22330
SK10
I22329
SK5
SK3IV
SK3III
SK3II
SK3I
SK2II
SK2I

Fig.7

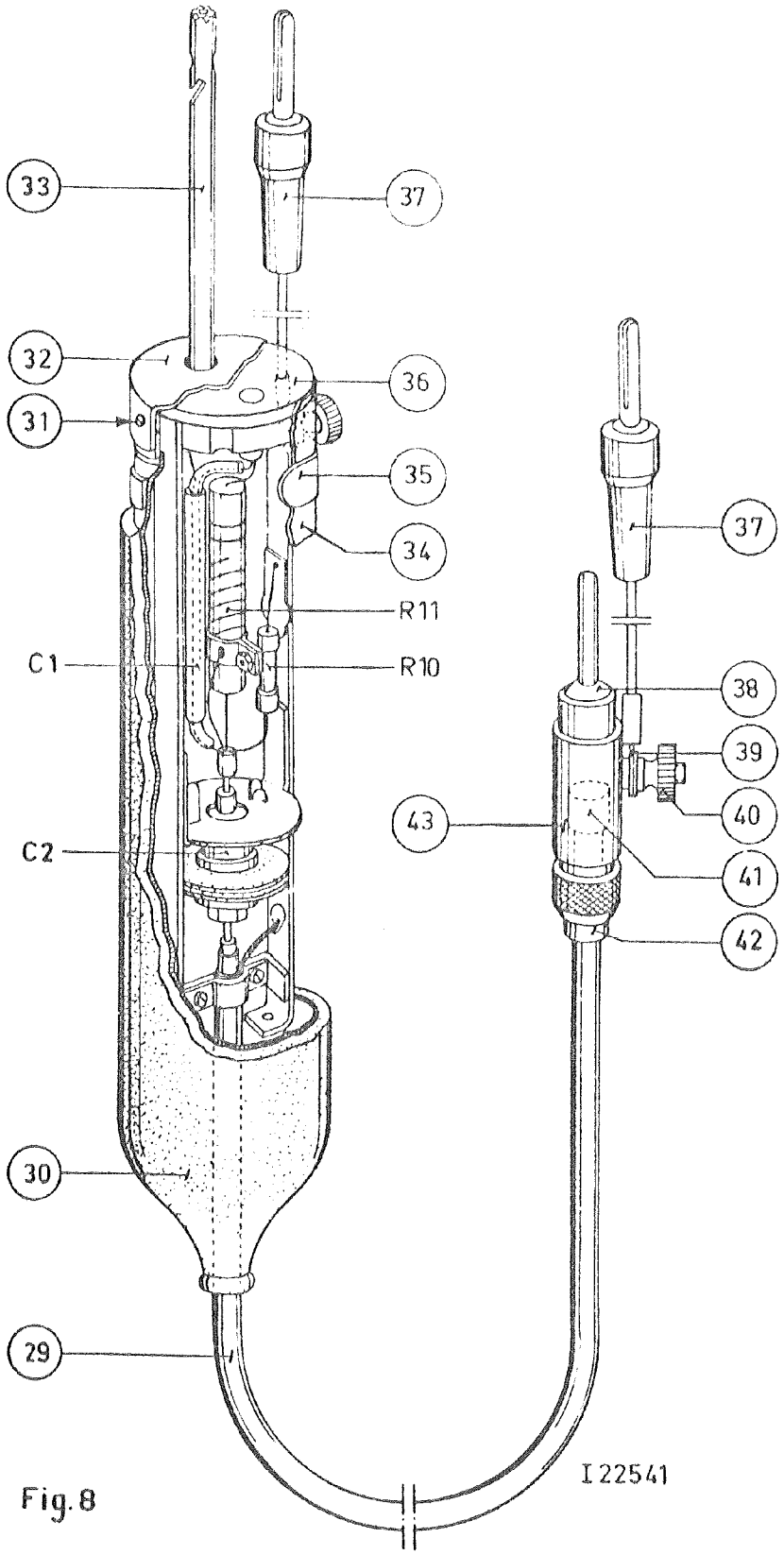
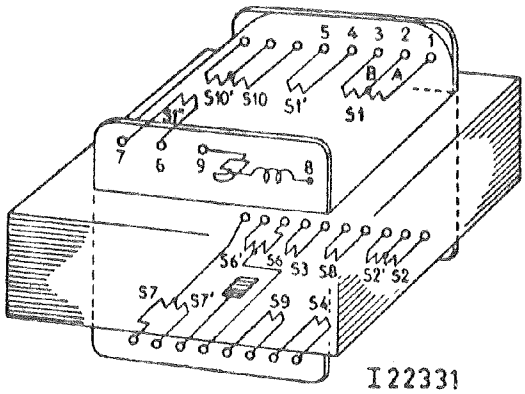


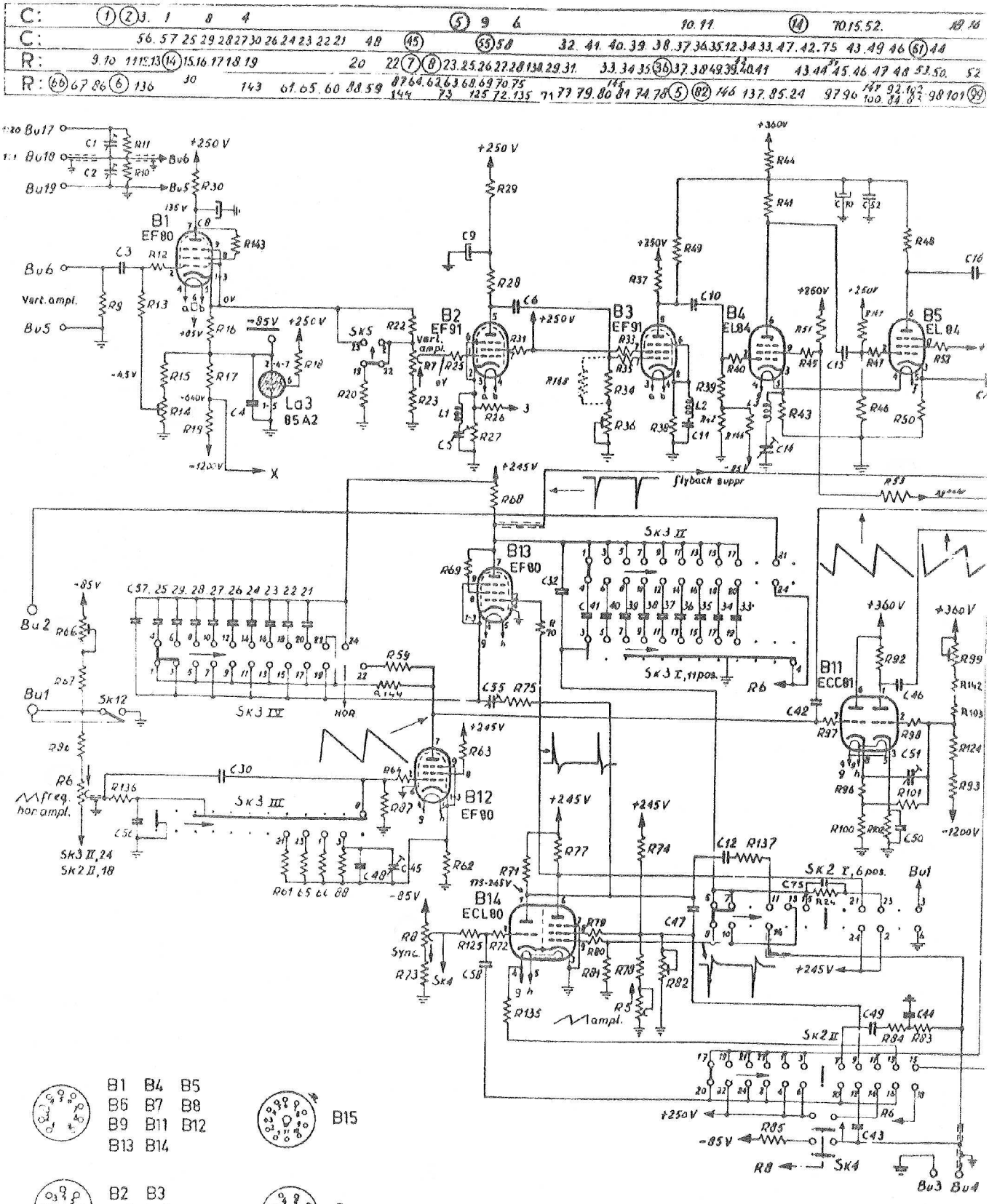
Fig. 8

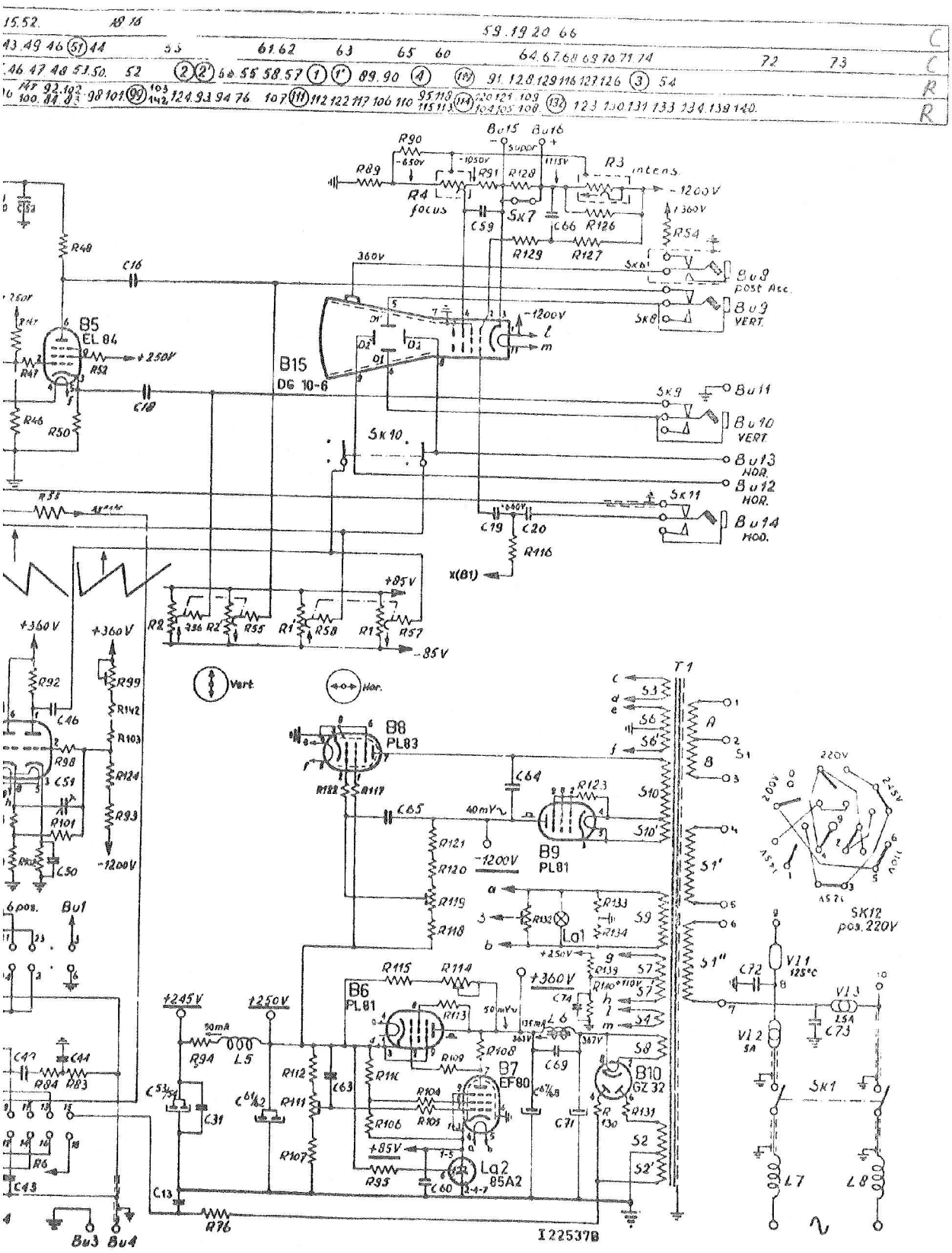


S1A	S1B	S1'	S1''	S2	S2'	S3	S4	S6	S6'	S7	S7'	S8	S9	S10	S10'	
15	20	110	110	368	368	23	6,8	8,3	8	3,2	3,6	5,5	6,8	1440	23	V
0,75		4,75	5,04	139		2,2	0,68	0,55		0,2		0,11	0,13	2567	2,7	Ω

Fig.9

GM5654X


B1 EF80
B2 EF91
B3 EF91
B4 EL84
B5 EL84
B11 ECC81
B12 EF80
B13 EF80
B14 ECL80
La3 85A2
Vert. ampl.
freq. hor ampl.
Sync
Sk3 I, 11pos.
Sk3 II
Sk3 III
Sk3 IV
Sk2 I, 6pos.
Sk2 II
Sk4
Sk5
Sk12
flyback suppr
+360V
+250V
+245V
-85V
-1200V
B1 B4 B5
B6 B7 B8
B9 B11 B12
B13 B14
B15
B2 B3
La2 La3
B


B5 EL 84
B15 DG 10-6
B6 PL81
B7 EF80
B8 PL83
B9 PL81
B10 GZ 32
La2 85A2
T1
SK12 pos. 220V
I22537B

N.V. PHILIPS GLOEILAMPEN-FABRIEKEN EINDHOVEN	Service Information	No. Cd16
		DATE 29-6-54
CENTRAL SERVICE DIVISION	GROUP: P.I.T. E.M.A. ARTICLE: Oscilloscope TYPE: GM 5654X	JM/MZ

RE: Modification of Service Notes

Owing to modifications in the circuit of the valves B3, B4 and B5 (vertical amplifier) the following changes have to be made in the Service Notes:

1. Text:

a) Page 3.

The second half of B1 should read:

Reproduction of the highest frequencies is improved by the correction coils L1, L2 and L3. With the aid of R36 in the grid circuit of B3 the RC product (R34+R36)xC6 can be varied, as a result of which the losses for the lowest frequencies can be compensated. Should the total resistance of R34+R36 in the turned back position of R36 still be too high, R34 can be reduced by parallel connection of R145.

The plate AC voltage of B4 is fed via R41, C15 and R47 to the control grid of B5. The anode- and cathode resistance of B5 (R48 and R50 resp.) are equal so that two equal but opposite voltages are obtained for the vertical deflector plates.
With the aid of C14 in the cathode lead of B4 the response curve for the high frequencies is corrected.
When applying internal synchronisation, the synchronisation signal for the time base generator is taken from the screen grid of B4.

b) Page 8, C3b.

All after "When B5 ....." must be deleted.

c) Page 8, C3c.

Add: The range of R36 should be shifted if necessary with the resistor R145.

2. Figures.

a) Sheet I and II to be replaced by the enclosed sheet.

b) Sheet III: correct figure 4.
Switch SK5 has only two positions:
x10 (to the left) and x1 (to the right).
The middle position must be deleted.

3. List of electrical parts.

Delete		
L4	10 µH	M7 573 30.0
C7	10 µF	48 313 09/10
C17	220 pF	A9 999 04/220E

Change				
	old	new	old	new
R41	330 Ω	1,1 kΩ 2 W	A9 999 00/330E	2xA9 999 00/2K2par.
R42	600 Ω 2 W	60 kΩ	2xA9 999 00/1K2par.	2xA9 999 00/120Kpar.
R46	1 MΩ	1,2 MΩ	A9 999 00/1M	A9 999 00/1M2
R48	900 Ω 3 W	1,1 kΩ 2 W	3xA9 999 00/2K7par.	2xA9 999 00/2K2par.
R49	2,2 kΩ	2,7 kΩ	A9 999 00/2K2	A9 999 00/2K7
R50	150 Ω	1,1 kΩ 2 W	A9 999 00/150E	2xA9 999 00/2K2par.
C52	0,1 µF	0,1 µF	A9 999 06/100K	A9 999 06/V100K

Add		
R145	330 kΩ	A9 999 00/330K
R146	2,2 MΩ	A9 999 00/2M2
R147	10 MΩ	A9 999 00/10M

CENTRAL SERVICE DEPARTMENT

Ph. F. Salverda.

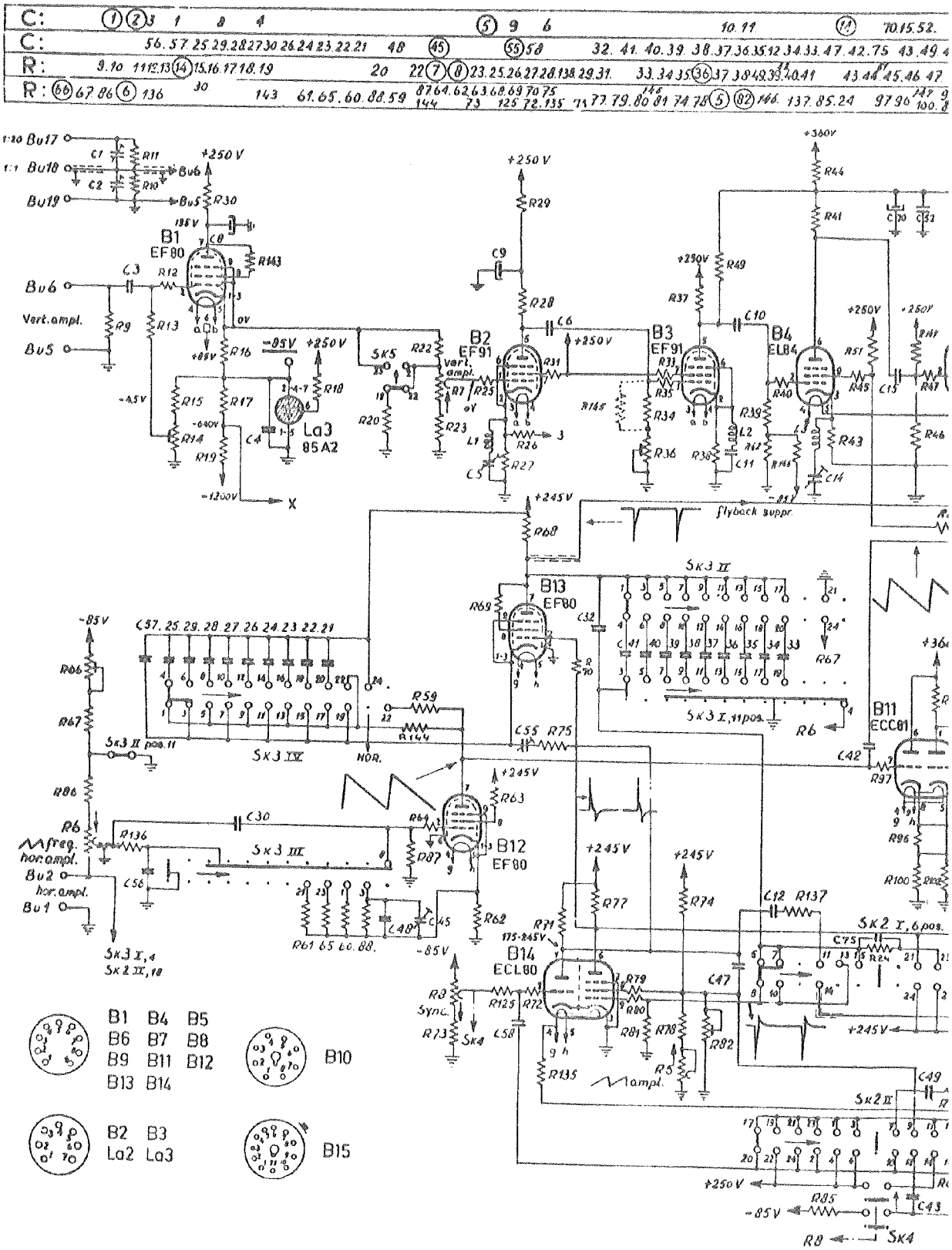

B1 EF80
B2 EF91
B3 EF91
B4 EL84
B11 ECC81
B12 EF80
B13 EF80
B14 ECL80
La3 85A2
+250 V
+360V
+245V
-85V
Vert. ampl.
flyback suppr.
Freq. hor. ampl.
Sync.
B1 B4 B5
B6 B7 B8
B9 B11 B12
B13 B14
B10
B2 B3
La2 La3
B15

Fig.1

GM 5654 X

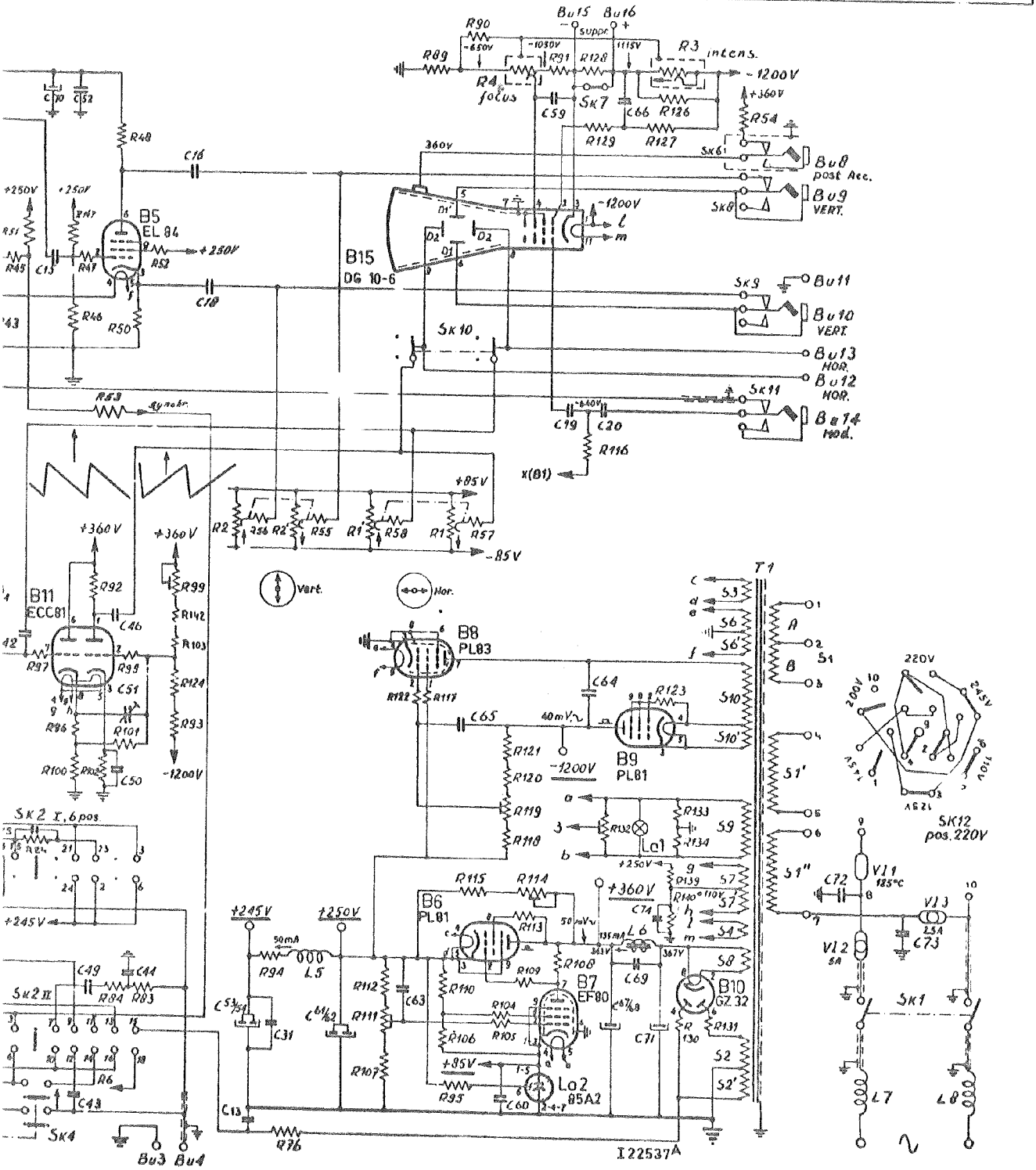


Fig.1

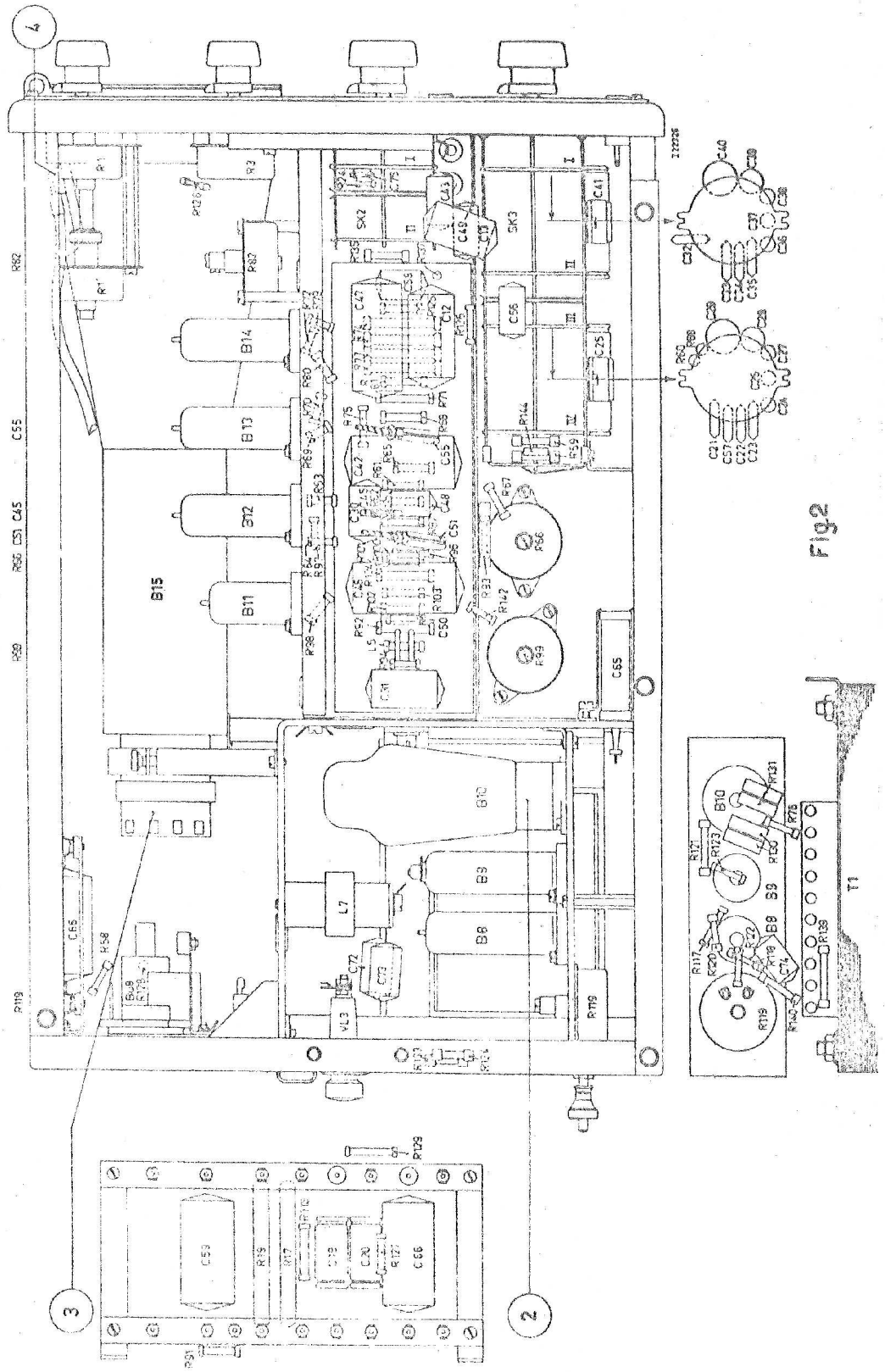


Fig2

GM 5654 X

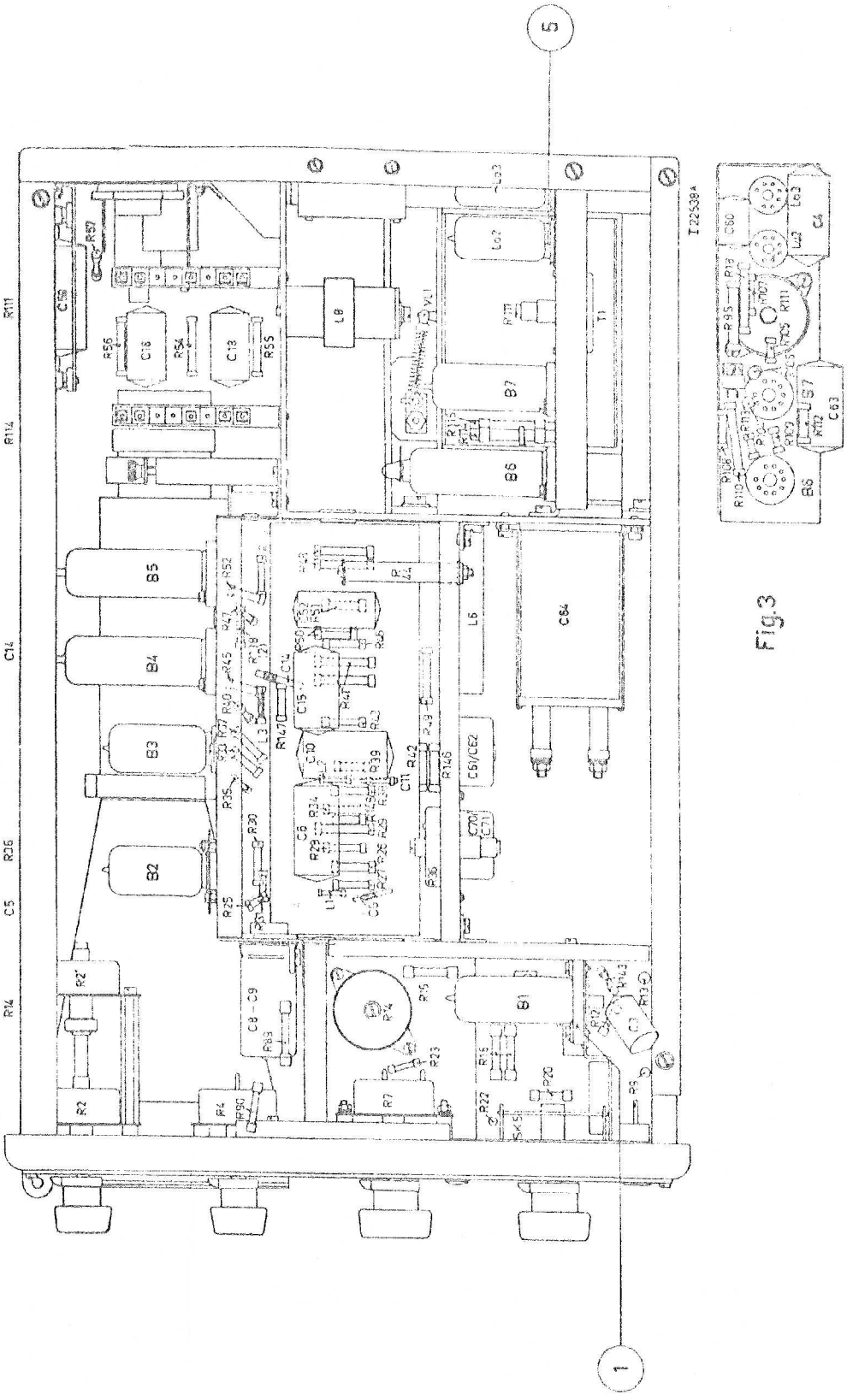


Fig.3

N.V. PHILIPS GLOEILAMPEN-FABRIEKEN EINDHOVEN	Service Information	No Cd36
		DATE 17-2-55
CENTRAL SERVICE DIVISION	GROUP: P.I.T. - E.M.A. ARTICLE: Measuring apparatus. TYPE: Oscillographe GM 5654 - GM 5654X.	JM/MZ

RE:

a) The capacitance of the mica capacitor C57 has been reduced from 15 pF to 10 pF, as it has appeared that the highest time base frequency is difficult to reach.
Also the length of the wires of C42 and C46 to SK10 exerts influence on it and this should be therefore as small as possible.

b) The resistance of R20 of the step attenuator is changed, as the attenuation attained was not 10x, but 12x.
For the apparatus GM 5654, R20 has increased from 560 to 680 Ω, for the apparatus GM 5654X from 220 to 270 Ω.

c) The input of the horizontal amplifier has been modified for the following reasons (see circuit diagram of the Service Notes).
In the positions 1 up to 10 included of SK3 (time base generator), the potentiometer R6 (and therefore also Bu2) is earthed via the switch contact SK3 I, 4; the time base frequenty is adjusted with the aid of R6.
In the position 11 of SK3 (horizontal amplifier) an input signal is connected to the socket Bu2 and the junction point R67/R86 is earthed. The amplitude of the input signal is adjusted with the aid of R6 and the signal is then fed via C30 to the control grid of B12.
If during the time that the voltage to be amplified remains connected to Bu2, SK3 is switched back from position 11 to one of the positions 10 to 1, the input signal is connected to earth, via the switch contact SK3I, 4 and the possibility exists that the thin flexible wire between the rotor contact disc of SK3 I and earth burns.
The modification comprises the following points (see circuit diagrams enclosed).
1. The soldering tags of the sockets Bu1 are no longer interconnected, but this socket is now used as switch socket (SK12) which takes over the function of the stator contacts 21 and 24 of SK3 II. Only when introducing a plug, Bu1 and the junction point R67/R86 are earthed.
2. The stator contacts 21 and 24 of SK3 II are used in position 11 to interconnect the socket Bu2 with R6. In the other positions of SK3, R6 remains earthed.
3. In the position 6 of SK2, the horizontal amplifier is fed with an internal alternating voltage (50 c/s) derived from the junction point C13/R67.
In order to be able to adjust this voltage with R6, the point R67/R86 should be earthed without having introduced a plug in Bu1. The stator contacts 3 and 6 of the wafer SK2 I take care of this.

The type number of this apparatus, in which the above modifications have been made, is provided with the letter C.

Nr.	Old code number	New code number
C57	A9 999 05/15E	A9 999 05/10E
R20	(A9 999 00/560E	A9 999 00/680E→GM 5654
	(A9 999 00/220E	A9 999 00/270E→GM 5654X

CENTRAL SERVICE DIVISION
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