PHILIPS

CATHODE-RAY OSCILLOSCOPE GM 5659/01

66 400 81.1-10 15/1158

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DIRECTIONS FOR USE

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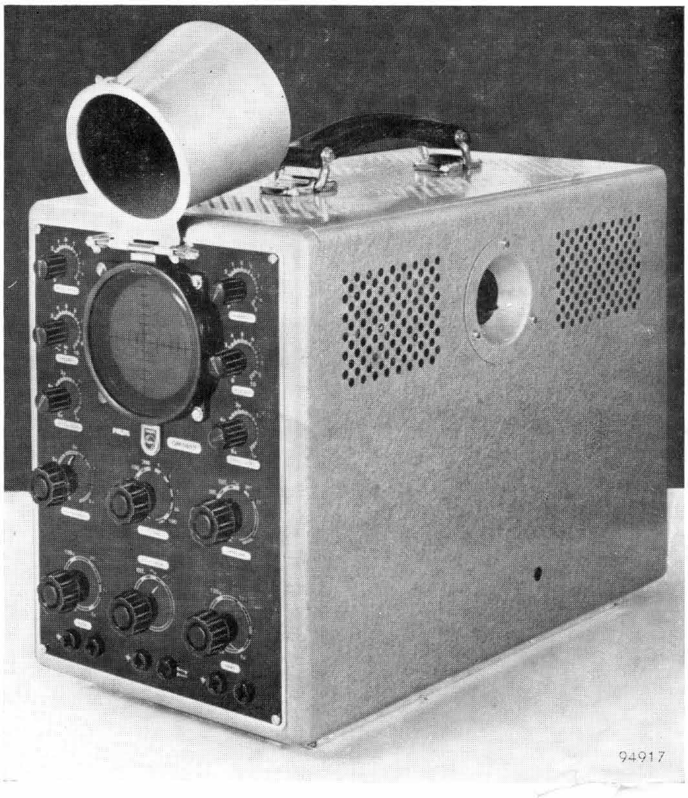

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CONTENTS

Where in these directions for use the properties are expressed in numerical values with statement of tolerances, these are guaranteed values. The data without statement of tolerances are only given for guidance and apply to the properties of the average apparatus.
In case of correspondence regarding this apparatus, always refer to the type number and the serial number, stated on the type plate at the rear of the apparatus.

Scanned from an original 'Directions for Use' manual in June 2020
The waveform photos have been scanned to provide as much detail as possible
This scan is provided free of chagre

INTRODUCTION

PURPOSE

The PHILIPS Cathode-ray Oscilloscope GM 5659/01 is destined for measuring alternating voltages in the frequency range of 1 c/s up to 1 Mc/s (700 kc/s —3 dB, 1 Mc/s —6dB). Both periodic and aperiodic phenomena can be made visible, as well as phase relationships between two electric phenomena. The apparatus is suitable for measurements in laboratories and workshops and for application in radio-telecommunications service and in general electrical engineering work.

FEATURES

The cathode-ray tube (with symmetrical deflection system) has a screen diameter of 7 cm and produces a bright-green image. By the application of the appertaining transparent lattice before the screen, the instrument can be used as a peak-voltage meter. This lattice absorbs the greater part of the daylight falling on to the screen, but transmits the green light emitted by the screen. This, together with a special light-screening cover, makes it easy to observe the oscillogrammes even in broad daylight.
The amplifiers for horizontal and vertical deflection are suitable for reproducing pulse-shaped and rectangular voltages. They have the same amplification and bandwidth.
The sensitivity of the apparatus is adjustable by means of frequency-independent attenuators (both in steps and continuously).
The time-base generator has a wide frequency range (3—250,000 c/s) and can be synchronized in various ways. The time-base voltage is externally available.
The automatic flyback suppression of the electron beam can be switched off. The apparatus also has a provision for external beam modulation.
An external voltage can be connected to the plates for horizontal and vertical deflection via a built-in RC-network.

APPLICATIONS

This cathode-ray oscilloscope makes it possible to examine e.g.:
L.F. electric phenomena: the shape of L.F. voltages and currents, the voltage and current characteristics occurring upon the breaking and making of automatic contacts, relays and switches and upon the breaking-down of safety fuses.
H.F. electric phenomena: in radio and in telecommunications service.
Mechanical vibrations: the location and examination of vibrations in factories, printing shops and workshops, on ships, in electric motors, engines, machines, etc.
Magnetic fields: the shape and trend of the magnetic field in the vicinity of transformers and in the air gap of choke coils (by means of a measuring coil or small frame).
Acoustic vibrations: these can be made visible by means of a microphone.
Light-intensity variations: the observation of rapid light-intensity variations which permits of the examination of these variations for projection purposes (with the aid of a photo-electric cell); the measurement of speeds by the interruption of a light beam, etc.

The opening time of camera shutters can be checked by photographing sines of accurately known frequency.

The apparatus can, furthermore, be used for examining rapid temperature fluctations, air turbulence, etc.

MECHANICAL CONSTRUCTION

This oscilloscope has been especially constructed with a view to small size and low weight. The apparatus consists of a number of constructional units, mounted in a framework of metal plating, which ensures a good screening. Where possible, horizontal partitions have been avoided, so that the generated heat can be very well carried off. The two amplifiers are placed in the middle compartment, each mounted on an insulating panel. These panels are provided with pressed-in pins, to which are soldered the electrical components at the front, and the wiring at the rear. By this method a firm, compact assembly, with short connections, has been obtained, mounting has become easier, and the whole wiring can be more readily surveyed.

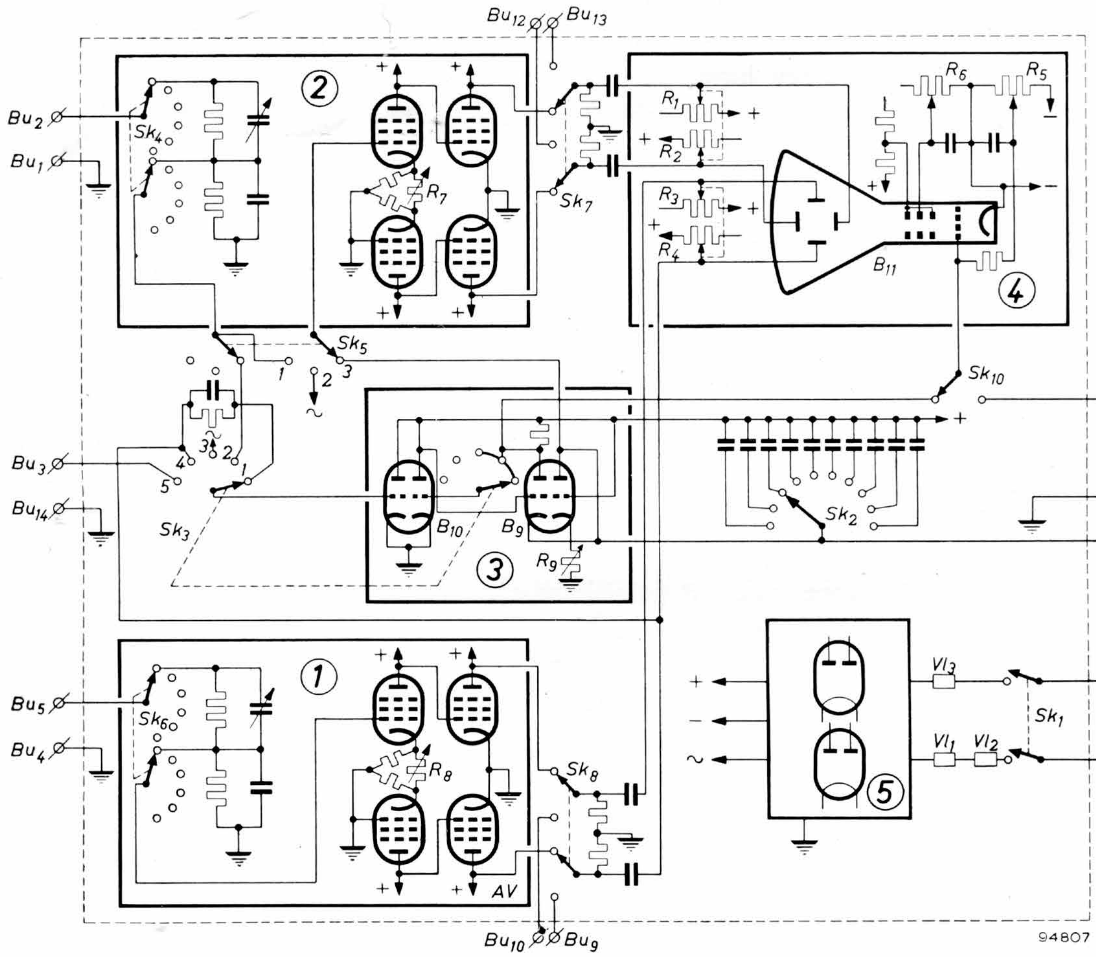


Fig. 1. Simplified circuit diagram

DESCRIPTION

PRINCIPLE

The apparatus comprises the following main components (fig. 1):

1. Amplifier for vertical deflection with the appertaining attenuator

The voltage to be examined is connected to the sockets Bu_5 and Bu_4 (earth). The voltage is then applied to the step-attenuator, the attenuation of which is adjustable by means of switch Sk_6. The voltage thus attenuated is applied to the asymmetrical input of the amplifier. The amplification is adjustable with the potentiometer R_8. The amplified voltage is applied to the vertical-deflection plates via Sk_8.

2. Amplifier for horizontal deflection with the appertaining attenuator

These are identical to the amplifier and the attenuator for vertical deflection.
With Sk_5 in position 1, the amplifier input is directly connected to the attenuator. In this position it is possible to observe a voltage as a function of any other voltage. The voltage for the horizontal deflection is connected to Bu_2 and Bu_1 (earth); the attenuation can be selected by means of Sk_4 and R_7. With Sk_5 in position 2, a voltage can be observed as a function of a sinusoidal voltage having the mains frequency. In position 3 of Sk_5 the time-base generator is switched on. Now a voltage can be observed as a function of time.
The amplification is adjustable by means of R_7. The amplified voltage is applied to the horizontal-deflection plates, via Sk_7.

3. Time-base generator

This contains two double-triodes, three triodes of which generate the saw-tooth voltage, whilst the fourth serves as a synchronization separator and as an auxiliary tube for triggering the time base. The frequency range is selected by switching-on a certain value of the charging capacitor, by means of Sk_2. The value of the charging current is controlled by R_9; the position of R_9 thus determines the time-base frequency within the selected range. The synchronization possibilities can be selected by means of Sk_3.
If a stationary image is desired, the time-base generator has to be synchronized with the frequency of the voltage to be observed or with a multiple of it. With Sk_3 in position 1, internal synchronization is used: the synchronizing voltage is taken up from the output of the amplifier for vertical deflection. In position 2 external synchronization is possible. The synchronizing voltage, to be connected to Bu_1 and Bu_2, is attenuated by means of Sk_4. A voltage having the mains frequency can also be used as external synchronization voltage (Sk_3 in pos. 3). With Sk_3 in position 4, the time base is automatically triggered by a voltage taken from the output of the amplifier for vertical deflection. The positive part of each cycle of the voltage connected to Bu_5 is then visible on the screen.
The time base also be triggered externally (position 5) for which purpose Bu_3 and Bu_{14} (earth) are provided. One of the various possibilities is then a visual reproduction of the negative part of each cycle of the signal.
The saw-tooth voltage produced by the time-base generator is available at Bu_7.

4. Cathode-ray tube

If desired, direct connection to the deflection plates (via an RC network) is possible. If a voltage is connected to Bu_9 and Bu_{10} at the rear of the oscilloscope and Sk_8 is switched over, this voltage is applied to the vertical-deflection plates. The horizontal-deflection plates are electrically accessible via Bu_{12} and Bu_{13}, for which Sk_7 has to be switched over.
The position of the image on the screen can be shifted in horizontal direction with R_1/R_2, and in vertical direction with R_3/R_4. The brightness of the image can be adjusted by means of R_5, focussing by means of R_6.
For suppressing the electron beam during the flyback of the time base, a negative pulse,

produced by the time-base generator, is applied, via Sk_{10}, to the control grid of B_{11}. The control grid is externally accessible via Bu_6, in which case Sk_{10} is automatically switched-over by the plug inserted in this socket.

5. Supply part

The necessary supply voltages are available via a transformer and two rectifying tubes. The transformer is protected by a thermal fuse (Vl_1) and by two fuses in series with the primary windings of the transformer (Vl_2 and Vl_3).

AMPLIFIERS

As has been mentioned earlier, the apparatus contains two identical amplifiers, the principle of which is shown in fig. 2. The voltage amplification is obtained by a two-stage push-pull amplifier with feedback. Since most voltages occurring in practice are asymmetrical with respect to earth, and the cathode-ray tube of this apparatus possesses a symmetrical deflection system, the amplifier is provided with an asymmetrical input and a symmetrical output.

The phase inversion at the input of the amplifier is effected as follows: the tubes B_1 and B_2 possess a common, high-ohmic cathode resistance and the control grid of B_2 is earthed, so that the anode of B_2 obtains a voltage of the same amplitude as the voltage on the anode of B_1, but with a difference of 180° in phase.

Since the amplification without feedback is high compared with the amplification with feedback, the latter is determined by the ratio of the feedback resistances. The desired amplification is therefore obtained by adjusting the degree of feedback by means of R_8.

R_8 can be varied without shifting the image on the screen (see fig. 14).

The feedback is not only used for adjusting the amplification, but also for correction of the frequency-response curve.

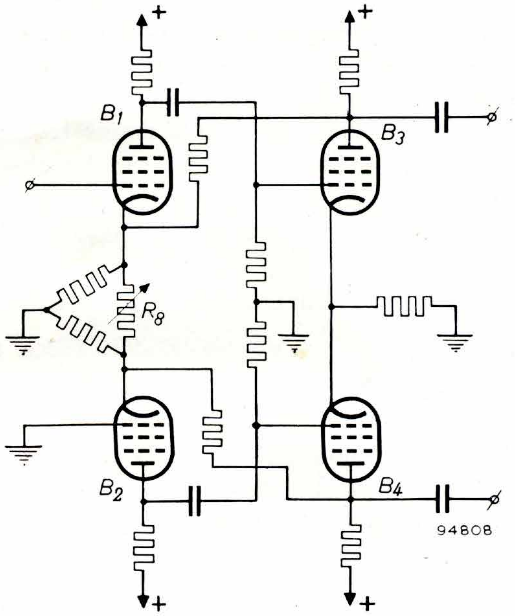


Fig. 2. Amplifier

In order to obtain the correct frequency-response curve, the feedback has been made frequency-dependent. For this purpose each amplifier has been provided with two feedback networks, as shown in fig. 3.

For the high frequencies C_{30} acts as a short-circuit, in which case the filter consists of the parallel arrangement of the resistors R_{46} and R_{47} and the trimmer C_{11} (C_p represents the parasitic capacitance between cathode and earth of the pre-amplifying tubes). C_{11} has been adjusted in the factory in such a way that the time constants of the two impedances are equal, so that the feedback is frequency-independent in the high-frequency range and consequently

$$\frac{R_{47} \times R_{46}}{R_{47} + R_{46}} \times C_{11} = R_k \times C_p.$$

For the lower frequencies the impedance of C_{30} increases, so that the feedback is reduced and the amplification increases. This provides a compensation for the drop in the frequency characteristic at low frequencies, and the result of this particular feedback is a frequency-response curve which is nearly straight from 1 c/s.

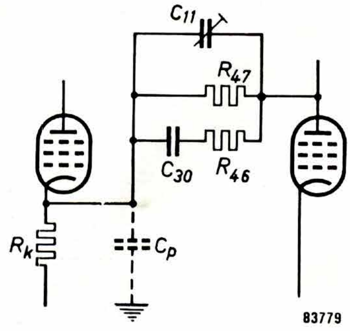


Fig. 3. Feedback circuit

ATTENUATORS

The two step attenuators are, likewise, identical. Both attenuator switches have 6 positions, by means of which one of the six RC networks (which are similar for each of the attenuators) is switched into the circuit. The principle is shown in fig. 4.

Here C_1 is a trimmer and C_{16} a fixed capacitor (whose value includes the input capacitance and the wiring capacitance of the attenuator). C_1 is so adjusted in the factory that $R_{19} \times C_1 = R_{14} \times C_{16}$, which ensures a frequency-independent attenuation.

The input resistance always amounts to 1 megohm, irrespective of the position of the attenuator.

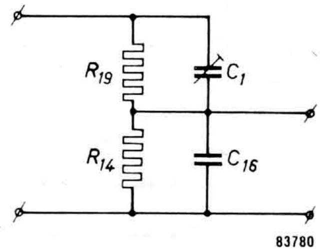


Fig. 4. Attenuator

TIME-BASE GENERATOR

The time-base generator covers a frequency range of 3 c/s—250,000 c/s. The frequency is selected by means of a ten-step switch and adjusted by means of a continuous control (1 : 6). The principle of the time-base generator is shown in fig. 5.

The triode B_5' operates as a charging tube and charges the capacitor (in this case C_{71}), switched-on by means of Sk_2, with a constant current during the forward sweep. The value of this current, which can be adjusted with R_9, and the capacitance of C_{71} determines the frequency.

During the charging period of C_{71} the triode B_9 is cut off and thus conducts no current. The anode of B_9', which is connected to the cathode of B_9, drops during the charging period of C_{71}, so that also the grid bias (cathode potential) of B_9 is reduced, as a result of which this system eventually becomes conductive. By this a negative pulse is created across R_{152}, which reaches, via the coupling capacitor C_{82} and the switch Sk_{3a}, the grid of the triode B_{10}'. B_{10}', which was up to then conductive, is now cut-off, so that the anode potential of B_{10}' rises. The potential increase is transferred to the grid of B_9. This causes a considerable increase in the anode current of B_9, which rapidly discharges capacitor C_{71} (flyback of the saw-tooth voltage). When the discharge is completed the current through B_9 decreases, and the anode potential of B_9 rises. This potential rise reaches the grid of B_{10}', rendering this tube conductive again, which causes the anode potential to drop. This negative pulse is

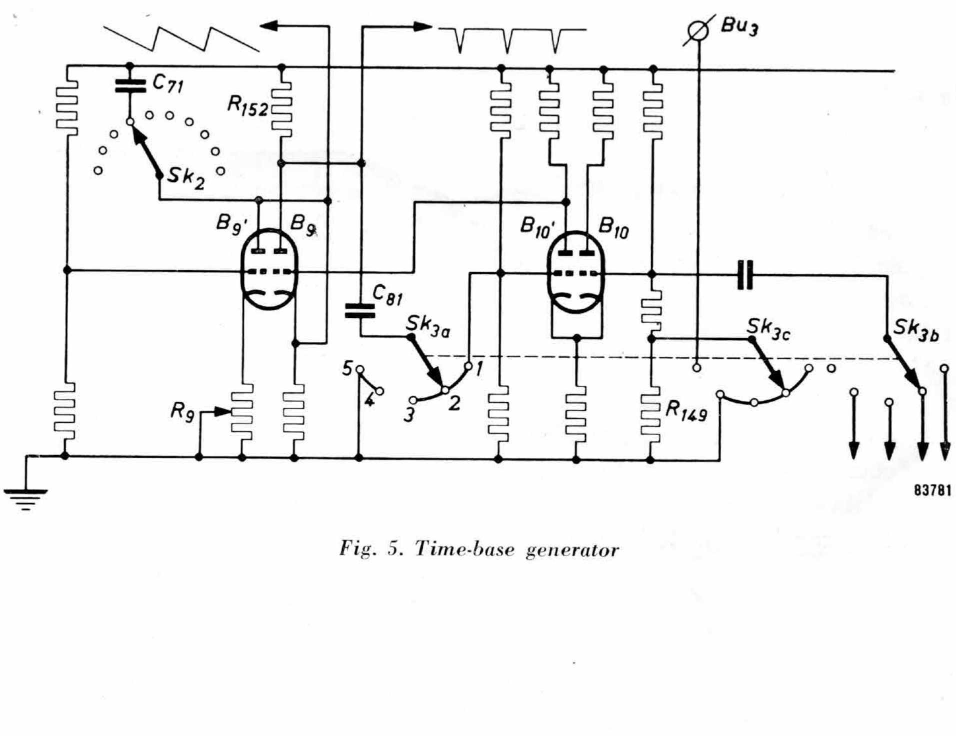


Fig. 5. Time-base generator

transferred to the grid of B_9, and B_9 cuts-off. The initial condition has thus been restored and the charging of C_{71} can start anew.

The system B_{10} is used as a synchronization separator. Since B_{10} and B_{10}' possess a common high-ohmic cathode resistor, the current through B_{10}' increases as the current through B_{10} decreases, and vice versa. If a voltage is applied to the grid of B_{10}, the anode potential of B_{10}' changes and this change is transferred to the grid of B_9. The initial discharge point of C_{71} is influenced in this way.

Synchronization can take place, either with a voltage from the amplifier for vertical deflection, or with an externally applied voltage. There is, however, also the possibility of synchronization with a signal taken from the power transformer (Sk_{3b}).
B_{10} is also used if the time base is automatically synchronized. The anode of B_9 is then earthed via C_{81} (Sk_3 in pos. 4). Because of the fact that the connection between the anode of B_9 and the grid of B_{10}' is now interrupted, B_{10}' remains conductive: the capacitor remains charged.

If a sufficiently high positive voltage (from the amplifier for vertical deflection) is applied to the grid of B_{10} this tube is cut-off. This causes B_9 to become conductive, as a result of which the capacitor is discharged: the flyback takes place. If the signal applied to the grid of B_{10} becomes negative, then B_{10}' becomes conductive again. This has to take place more quickly than can be followed by the cathode of B_9. Thus the forward sweep is effected. Since the trigger signal is derived from B_4, a voltage variation at the grid of B_{10}, corresponds to a voltage variation of opposite polarity at Bu_5. The light spot on the screen thus moves from left to right during the positive part of each cycle of the input signal applied to Bu_5.

The time base can also be externally driven (Sk_3 in position 5). Then the anode of B_9 is connected to earth again, whilst the short-circuit across R_{149} has been obviated by Sk_{3c}, so that the grid potential of B_{10} rises and this tube begins to conduct a greater current. B_{10}' is then cut-off, so the capacitor remains in the discharge condition. By earthing Bu_3, R_{149} is short-circuited again: B_{10}' becomes conductive again and B_9 is cut-off. The result is that the light-spot moves from left to right. The flyback takes place as soon as the short-circuit is removed.

CATHODE-RAY TUBE

In the tube circuit (see fig. 6) applied in this oscilloscope, the cathode potential of the cathode-ray tube is approx. —520 and the voltage at the grids g_2—g_2 + 285 V. (Potential of 805 V with respect to the cathode.)
A circuit with two potentiometers (R_1 and R_2, or R_3 and R_4) serves for shifting the image in the horizontal or the vertical direction respectively. By means of such a circuit each one of the relevant pair of plates can be given a bias of the same potential, but of opposite polarity. The voltage at the plates can thus be adjusted in such a way that the image can be moved across the screen. The potential in the centre between the plates thus remains equal to the potential at g_4.
In order to obtain a good image quality, symmetrical control of the deflection plates is used.
The voltage at g_1 can be adjusted by means

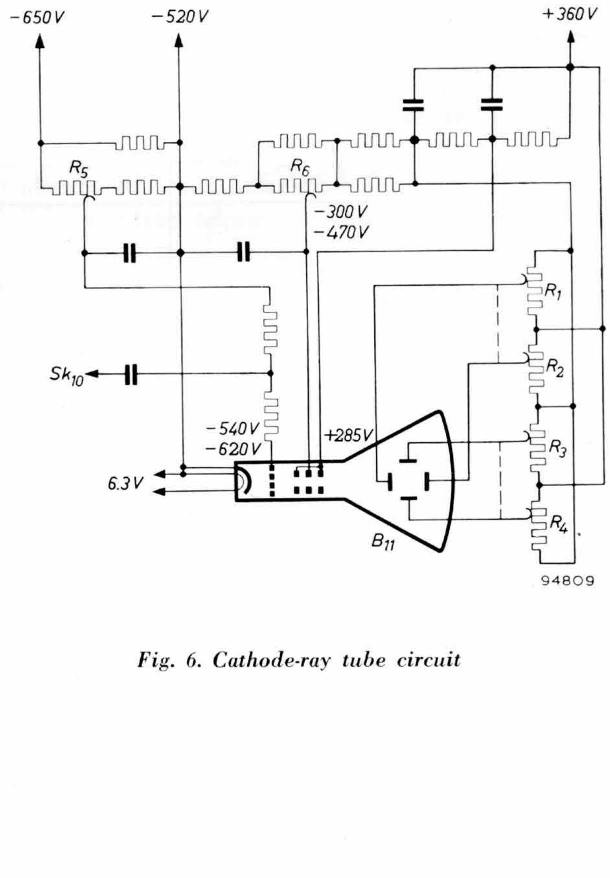


Fig. 6. Cathode-ray tube circuit

of R_5; in this way the electron current and thus the intensity of the light spot on the screen can be varied. Focussing takes place by altering the voltage at g_3. This voltage can be adjusted by means of R_6.

SUPPLY

The supply part consists of two full-wave rectifier circuits with rectifying tubes of the type AZ 41 (see fig. 7). The circuit with tube B_{12} supplies a filtered voltage of + 360 V for feeding the amplifiers, the time-base generator and g_2—g_4 of B_{11}. The circuit of B_{13} supplies voltages of —520 V and 650 V at g_1 and g_3 of the cathode-ray tube.

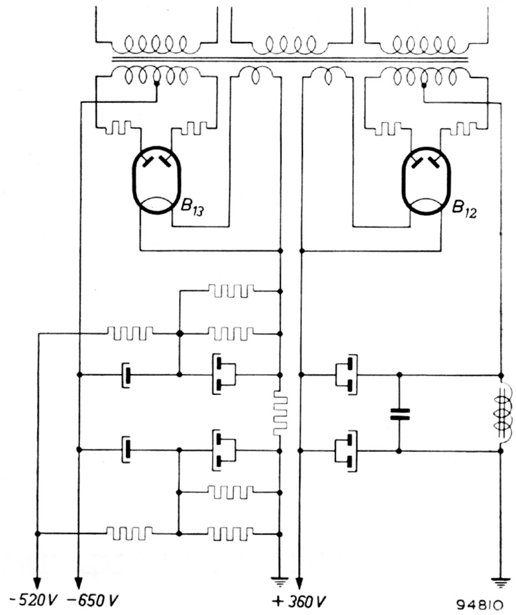


Fig. 7. High-tension supply

TECHNICAL DATA

AMPLIFIERS	*Two amplifiers, each consisting of two push-pull stages, with feedback*
Sensitivity	of the amplifier for vertical deflection: better than 60 mV_{p-p}/cm of the amplifier for horizontal deflection: better than 90 mV_{p-p}/cm
Frequency-response curve	for sinusoidal voltages: 1 c/s—1 Mc/s (—6 dB), 0.7 Mc/s (—3 dB)
Input voltage	max. 500 $V_{r.m.s.}$
Hum and noise	negligible
ATTENUATORS	*Two frequency-independent step attenuators*
Attenuation	1 × ; 5 × ; 25 × ; 125 × ; 600 × ; 3000 ×
Input impedance	of the attenuator for vertical deflection: 1 megohm; 15—35 pF of the attenuator for horizontal deflection: 1 megohm; 15—40 pF (The input capacitance depends on the attenuation selected and is 15 pF in the position of lowest sensivity.) *Two continuous attenuators, control ratio approx. 5 : 1*
TIME BASE	
Saw-tooth voltage	available between Bu_7 and Bu_8 (earth), amplitude 60 V_{p-p} with the exception of the highest frequency ranges, for which the voltage is lower)

Frequency-range — 3 c/s—250,000 c/s, adjustable in ten steps (Sk_2):

Sk_2 in position	Frecuency range	Sk_2 in position	Frecuency range
1	3— 15 c/s	6	1— 5 kc/s
2	10— 50 c/s	7	3— 15 kc/s
3	30— 150 c/s	8	10— 40 kc/s
4	100— 400 c/s	9	30—110 kc/s
5	300—1500 c/s	10	100—250 kc/s

All ranges overlap. In each range the frequency can be continuously controlled by R_9. The data on the text plate regarding Sk_2 and R_7 are only for orientation.

SYNCHRONIZATION AND TRIGGERING

1. Internal synchronization — with voltage of the amplifier for vertical deflection for frequencies between 20 c/s and 700 kc/s the minimum image height required is 2 cm
2. External synchronization — with voltage via the attenuator for horizontal deflection
   input impedance 1 MΩ; 15—50 pF (The input capacitance depends on the attenuation selected and is 15 pF in the position of lowest sensitivity)
   voltage required: 1—300 V (dependent upon the position of the step attenuator)

   Synchronizing voltage: 0.4—300 $V_{r.m.s.}$
3. Internal synchronization — with voltage of the mains frequency
4. Internally triggered — with voltage of the amplifier for vertical deflection
5. Externally triggered
   a) by a voltage of 20 $V_{r.m.s.}$ between Bu_3 and earth
   b) by a mechanically operated contact between Bu_3 and earth; the repetition frequency has to be at least 5 $\times$ per second

CATHODE-RAY TUBE DG 7-32

Screen diameter — 7 cm

Deflection — symmetrical

Sensivity (direct connection to the plates) — Y-plates: better than 48 V_{p-p}/cm
X-plates: better than 78 V_{p-p}/cm

Input impedance — for X- and Y-plates of each input terminal to earth 2 MΩ; 35 pF

Voltage between the deflection plates — max. 400 V (= direct voltage + peak value of the alternating voltage)

Lattice — before the screen there is a green calibrated lattice with a shield against incident light (both removable)

BEAM SUPPRESSION DURING FLYBACK

During flyback the beam is suppressed, at the highest time base frequencies this suppression is less effective.

BRIGHTNESS MODULATION

Voltage required at Bu_6 and Bu_8: 15 $V_{p.p}$
Input impedance: 0.3 MΩ; 80 pF

TUBES

Indication	Description	Type number
B_1 —B_8	Pentode	EF 80
B_9 —B_{10}	Double-triode	ECC 40
B_{11}	Cathode-ray tube	DG 7—32
B_{12}—B_{13}	Rectifying tube	AZ 41

SUPPLY

Mains voltage: 110, 125, 145, 200, 220 or 245 V
Mains frequency: 40—100 c/s, at frequencies lower than 50 c/s the oscillograph must only be connected to the rated mains voltage
Power consumption: 80 W
Protection: Thermal fuse 125 °C (code No. 08 100 97)
Fuse 4 A (code No. 08 141 52)
Fuse 2 A (code No. 08 140 49)

DIMENSIONS AND WEIGHT

Height: 30 cm (12″) (incl. carrying handle)
Width: 21 cm (8¼″)
Depth: 40 cm (16″) (incl. knobs)
Weight: 17 kg (38 lbs)

OPERATION

The nomenclature of the controls on the front panel is given in fig. 15 on the folding sheet.

MAINS-VOLTAGE ADJUSTMENT

The rear panel is provided with an aperture for checking whether the rotary voltage adaptor is set to the correct mains voltage. If the number thus read does not correspond to the local mains voltage, then the apparatus has to be taken out of its case. After this the voltage selector has to be so adjusted (remove bracket) that the required voltage is read in top position.

CONNECTION

Before the apparatus is connected to the A.C.-mains, the earth terminal at the lower part of the rear of the apparatus must be properly earthed (terminal K of fig. 11).
After this the countersunk pin socket at the rear can be connected to the mains by means of the mains cable supplied with the apparatus. The mains switch (knob R_5/Sk_1) then must be in position "0".

SWITCHING-ON

The apparatus is switched on by setting knob R_5/Sk_1 to position "∼". After approximately 1 minute the tubes have reached their operating temperature and the apparatus is ready for use.

ADJUSTING THE IMAGE

The brightness of the image can be adjusted with R_5 and the definition of the image with R_6.
It should be avoided that a sharply focussed, stationary image of too great brightness remains on the screen for a long period. This might cause burning-in and thus permanent damage to the screen.
The perception of the image can, if necessary, be improved by using the screening cover with the appertaining green lattice, which can be fastened to the upper part of the screen frame by means of the hinge pin.
The position of the image on the screen can be adjusted in the horizontal direction by means of R_1/R_2 and in the vertical direction by means of R_3/R_4.

VERTICAL DEFLECTION

VIA THE BUILT-IN AMPLIFIER

First of all, make sure that Sk_8 is set to the lower position. Then connect the voltage to be observed (which must not exceed 500 $V_{r.m.s.}$) to the sockets Bu_4 (earth) and Bu_5. The image height can be adjusted in steps with Sk_6 and continuously by means of R_8. If the magnitude of the input voltage is unknown, a quick adjustment can best be obtained by beginning with maximum attenuation.
For frequency-response curve and input impedance, refer to "Technical data".

Notice

Should it be found that, upon turning R_8, the image point is moving too much over the screen, then this can be remedied by adjusting potentiometer R_{12} (see fig. 12). The spindle of R_{12} is accessible with a screwdriver through an aperture in the side panel. Sk_5 is set to position "ΛΛΛ" and Sk_3 to position "∼". Sk_6 must, furthermore, be set to position "1 ×". Now R_{12} is to be adjusted so that, when R_8 is turned up and down near the position of maximum amplification, the image point remains stationary.
This adjustment has also to be carried out in the event of substitution of the first tubes (B_1 and B_2) of the amplifier for vertical deflection.

SIGNAL DIRECTLY APPLIED TO THE DEFLECTION PLATES

For the reproduction of phenomena e.g. having frequencies in excess of the upper frequency limit of the amplifier, and in those cases where the PHILIPS Electronic Switch GM 4580/02 is used, the signal can be applied to the vertical-deflection plates via an RC network ($R = 3.3$ megohms, $C = 0.1\ \mu F$) by using the sockets Bu_9 and Bu_{10} (see fig. 11). For this, Sk_8 is to be set to the upper position.
In this case also, internal synchronization can be applied, which is important for the simultaneous reproduction of two voltages by means of the GM 4580.
See also under "Technical data".

Notice

If the connection between the vertical-deflection plates and the amplifier is interrupted by means of Sk_8, and a high input voltage is applied to this amplifier, then, especially at high frequencies, the apparatus may be overloaded. It is, therefore, recommended to remove the voltage from the amplifier input it a direct connection to the plates is to be used.

HORIZONTAL DEFLECTION

VIA THE BUILT-IN AMPLIFIER

Notice

If the amplifier for horizontal deflection is used, the image width can be continuously adjusted by means of knob R_7. If it should be found that, upon turning R_7, the image point is moving too much over the screen, then this can be remedied by adjusting potentiometer R_{11} (see fig. 13). R_{11} is likewise accessible with a screwdriver through an aperture in the side panel.
Sk_5 is to be set to position "EXT." and Sk_4 to position "1 ×". Now R_{11} is to be so adjusted that, when R_7 is turned up and down near the position of maximum amplification, the image point remains stationary.
This adjustment has also to be carried out in the event of substitution of the first tubes of the amplifier for horizontal deflection (B_5 and B_6).

1. **Deflection by means of an externally applied voltage**

If a voltage is to be observed as a function of another voltage, then the latter is to be connected to the sockets Bu_1 (earth) and Bu_2. Sk_5 is set to position "EXT.". Switch Sk_7 should be set to the lower position. The image width can be adjusted in steps with Sk_4 and continuously by means of R_7.

If both the horizontal- and the vertical-deflection voltages are sinusoidal functions of the time and if their frequencies are in the ratio of whole numbers to one another, then the well-known Lissajous figures can be obtained on the screen, with the aid of which phase and frequency measurements can be carried out.

2. **Deflection by means of a sinusoidal voltage having the mains frequency**

With Sk_5 in position "∼" a sinusoidal voltage with the mains frequency is applied to the input of the amplifier for horizontal deflection. In this case synchronization is not possible. The image width can only be adjusted continuously by means of R_7.
In this position phase and frequency measurements can be taken.

3. **Deflection by means of a saw-tooth voltage**

With Sk_5 in position "/\/\/\" the voltage produced by the time-base generator is applied to the input of the amplifier for horizontal deflection. The desired synchronization can now be selected by means of Sk_3 (see also "Synchronization"). The amplitude of the deflection voltage is adjusted with R_7.

Notice

At higher frequencies of the time-base generator the maximum obtainable image width is approx. 6 cm. This is due to the fact that the amplitude of the time-base signal decreases at higher frequencies.
In order to avoid distortion of the horizontal deflection, it is recommended not to set the amplitude control R_7 to maximum, but always to a position where the whole image falls within the screen diameter.
If the higher frequencies of the time-base generator are used, then it may occur that the picture in horizontal direction vibrates and that it is not sharply defined. This is caused by a parasitic voltage at the mains frequency.
This source can be adjusted to minimum by means of a potentiometer R_{10}. The spindle of R_{10} is accessible from the rear panel (screwdriver adjustment, see fig. 11).

SIGNAL DIRECTLY APPLIED TO THE DEFLECTION PLATES

With Sk_7 in the upper position, the signal which is applied to sockets Bu_{12} and Bu_{13} (fig. 11), reaches the deflection plates via an RC network.
For input impedance and sensitivity see under "Technical data".

Notice

If too high an input voltage is applied to the amplifier for horizontal deflection, overloading will take place if Sk_7 is set to the upper position. It is, therefore, recommended to remove the voltage from the amplifier input if a direct connection to the plate is to be used.

SYNCHRONIZATION

The synchronization switch Sk_3 offers the following possibilities:

1. **Position "INT."**

In this position the time-base generator is synchronized with a voltage taken from the output of the amplifier for vertical deflection. For frequencies between 20 c/s and 700 kc/s the required image height is 2 cm.

2. **Position "EXT."**

In this position the time-base generator can be synchronized with an external voltage, which is connected to sockets Bu_1 and Bu_2. Voltage required: 1—300 $V_{r.m.s.}$ (dependent upon the position of the step attenuator).
The signal strength can be adjusted by means of Sk_4. In order to avoid image distortion, the amplitude of the synchronizing signal should not be greater than necessary.

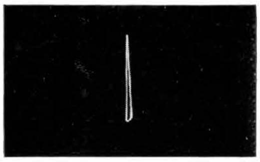


Fig. 8a

Fig. 8b

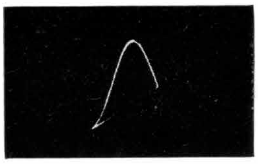


Fig. 8c

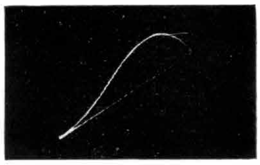


Fig. 8d

3. **Position "∼"**

In this position internal synchronization with the mains frequency is effected.

4. **Position "TR. INT."**

In the fourth position of Sk_3 the time base is synchronized automatically.
If in this position no voltage is applied to Bu_4 and Bu_5, the time base does not operate and the light spot remains stationary in the centre of the screen. If then a periodic signal is applied to the amplifier for vertical deflection a forward sweep and flyback of the lightspot will occur during the positive part of each period of this signal. The positive part of each period will thus become visible at a stationary image on the screen. This method has the advantage, where pulses are concerned whose width is relatively short compared to the whole period, that this width can be magnified over a great portion of the screen. Particularly in pulse techniques, it is useful that the front of steep pulses, as well as a considerable part of their further trends, can thus be observed in detail.
The speed at which the spot is moving over the screen depends on the positions of Sk_2 and R_9 (time-base frequency); this time-base frequency should be higher than the frequency of the voltage to be observed. The image height can be adjusted in the normal way by means of Sk_6 and R_8.
Fig. 8a shows the oscillogram for a sinusoidal voltage. The time-base frequency is lower than the frequency of the input voltage. If the time-base amplitude is increased, then the oscillograms shown in figs. 8b, 8c and 8d are successively made visible.

5. **Position "TR. EXT."**

In this position the time-base generator can be controlled by external means.
Two methods of controlling are possible:

Electrical controlling. When Bu_3 is connected to the input of the amplifier for vertical deflection (Bu_5), the spot will move from left to right during the negative part of each period of the input voltage. The voltage at Bu_3 required for this, is approx. 20 $V_{r.m.s.}$ The image thus obtained for a sinusoidal voltage is shown in fig. 9.

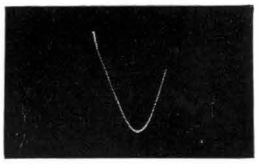


Fig. 9

Mechanical controlling. Each cycle of the time-base generator is controlled by a short-circuiting between Bu_3 and earth (Bu_{14}). This method can be useful for measurements at rotating machinery. The short-circuiting switch then can be operated by a cam on the shaft of the machine.
This should take place periodically, with a minimum repetition frequency of at least 5 × per second since in this case controlling of the tubes takes place at either side of the working point. For a non-recurring controlling, which would act at one side only of the working point, the active grid space of the tubes B_5 and B_6 is too small, so that then only part of phenomenon can be represented.

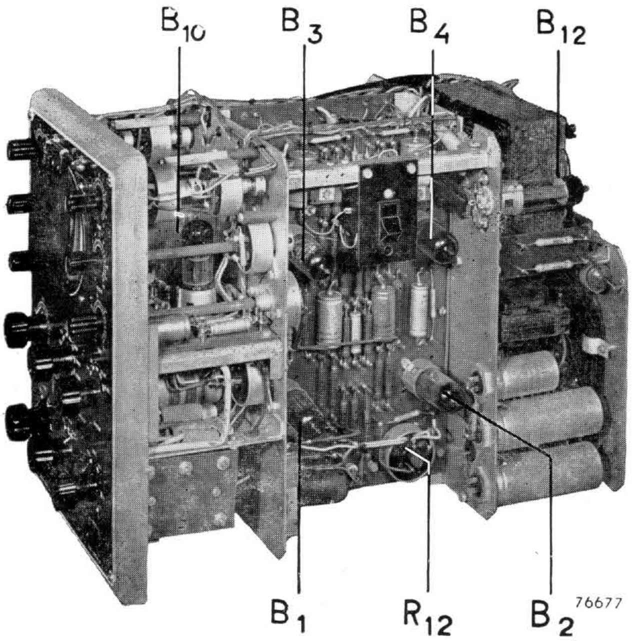


Fig. 12

FUSES

The power-transformer is provided with the thermal fuse Vl_1 (code number 08 100 97). A new thermal fuse is fitted by attaching it to the spiral spring and pulling it over the hook of the transformer.

The fuses

Vl_2 (4 A, code number 08 141 52) and

Vl_3 (2 A, code number 08 140 49)

are accessible on the rear panel (see fig. 11) and can be replaced easily.

TUBES

After replacement of the input tubes of the amplifiers (B_1 and B_2, or B_5 and B_6 respectively) the balance of the first push-pull stage has to be readjusted. This is done by means of R_{12} and R_{11} respectively (see page 17, figs. 12 and 13).

For the position of the tubes, see figs. 12 and 13.

B_1 —B_8	EF 80 - 6BX6
B_9 —B_{10}	ECC 40
B_{11}	DG 7—32
B_{12}—B_{13}	AZ 41

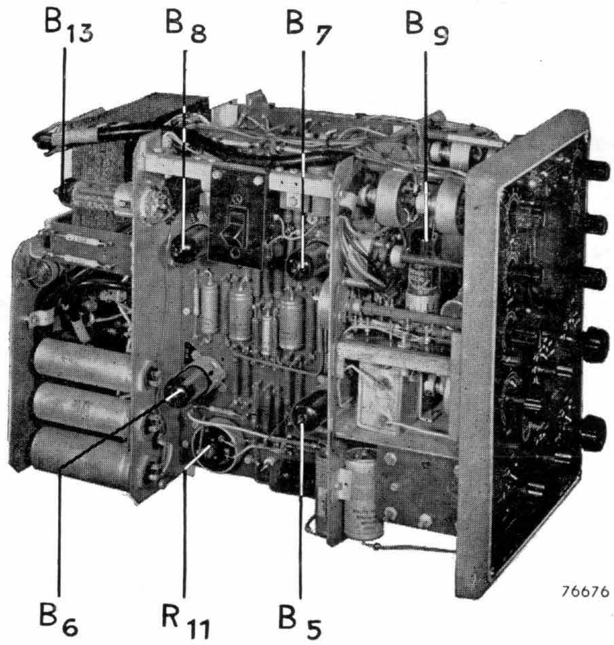


Fig. 13

LIST OF COMPONENT PARTS

(subject to alterations)

CAPACITORS

C_1	3 pF	C_{32}	470 pF	C_{65}	12.5 μF
C_2	3 pF	C_{33}	22 nF	C_{66}	12.5 μF
C_3	3 pF	C_{34}	220 nF	C_{67}	12.5 μF
C_4	3 pF	C_{35}	470 nF	C_{68}	12.5 μF
C_5	6 pF	C_{36}	220 nF	C_{69}	12.5 μF
C_6	3 pF	C_{37}	3.9 nF	C_{70}	12 pF
C_7	3 pF	C_{38}	33 nF	C_{71}	2 μF
C_8	3 pF	C_{39}	33 nF	C_{72}	680 nF
C_9	3 pF	C_{40}	100 nF	C_{73}	220 nF
C_{10}	6 pF	C_{41}	100 nF	C_{74}	68 nF
C_{11}	3 pF	C_{42}	470 pF	C_{75}	22 nF
C_{12}	3 pF	C_{43}	470 pF	C_{76}	6.8 nF
C_{13}	3 pF	C_{44}	100 nF	C_{77}	2.2 nF
C_{14}	3 pF	C_{45}	100 nF	C_{78}	680 pF
C_{15}	6 pF	C_{46}	3,3 pF	C_{79}	220 pF
C_{16}	6,8 nF	C_{47}	3,3 pF	C_{80}	47 pF
C_{17}	1.5 nF	C_{48}	100 nF	C_{81}	68 pF
C_{18}	220 pF	C_{49}	100 nF	C_{82}	470 pF
C_{19}	22 pF	C_{50}	100 nF	C_{83}	220 pF
C_{20}	6.8 nF	C_{53}	1 μF	C_{84}	330 nF
C_{21}	1.5 nF	C_{54}	100 nF	C_{85}	470 pF
C_{22}	220 pF	C_{55}	100 nF	C_{86}	47 pF
C_{23}	22 pF	C_{56}	100 nF	C_{87}	100 nF
C_{24}	220 nF	C_{57}	25 μF	C_{88}	22 nF
C_{25}	470 nF	C_{58}	25 μF	C_{89}	10 nF
C_{26}	220 nF	C_{59}	25 μF	C_{90}	10 nF
C_{27}	3.9 nF	C_{60}	25 μF	C_{91}	10 nF
C_{28}	33 nF	C_{61}	560 nF	C_{92}	100 nF
C_{29}	33 nF	C_{62}	25 μF	C_{93}	22 pF
C_{30}	100 nF	C_{63}	25 μF	C_{94}	100 nF
C_{31}	100 nF	C_{64}	12.5 μF	C_{95}	3.9 pF

1 μF = 10^{-6} F   1 nF = 10^{-9} F   1 pF = 10^{-12} F

RESISTORS

R_1	1 MΩ (lin.)	R_{14}	330 Ω	R_{27}	470 kΩ
R_2	1 MΩ (lin.)	R_{15}	1.6 kΩ	R_{28}	2.2 MΩ
R_3	1 MΩ (lin.)	R_{16}	8.2 kΩ	R_{29}	2.2 MΩ
R_4	1 MΩ (lin.)	R_{17}	43 kΩ	R_{30}	100 Ω
R_5	50 kΩ (lin.)	R_{18}	270 kΩ	R_{31}	6.8 kΩ
R_6	200 kΩ (lin.)	R_{19}	1 MΩ	R_{32}	6.8 kΩ
R_7	1 kΩ (lin.)	R_{20}	1 MΩ	R_{33}	100 Ω
R_8	1 kΩ (lin.)	R_{21}	1 MΩ	R_{34}	1 MΩ
R_9	500 kΩ (log.)	R_{22}	1 MΩ	R_{35}	1 MΩ
R_{10}	50 Ω	R_{23}	820 kΩ	R_{36}	100 Ω
R_{11}	1 MΩ (lin.)	R_{24}	1,8 MΩ	R_{37}	100 Ω
R_{12}	1 MΩ (lin.)	R_{25}	20 MΩ	R_{38}	100 Ω
R_{13}	500 kΩ (lin.)	R_{26}	470 kΩ	R_{39}	100 Ω

R_{40}	180 kΩ
R_{41}	120 kΩ
R_{42}	56 kΩ
R_{43}	56 kΩ
R_{44}	1 MΩ
R_{45}	1 MΩ
R_{46}	330 kΩ
R_{47}	100 kΩ
R_{48}	100 Ω
R_{49}	82 Ω
R_{50}	100 Ω
R_{51}	100 kΩ
R_{52}	330 kΩ
R_{53}	100 Ω
R_{54}	100 Ω
R_{55}	100/2=50 kΩ
R_{56}	18 kΩ
R_{57}	18 kΩ
R_{64}	330 Ω
R_{65}	1.6 kΩ
R_{66}	8.2 kΩ
R_{67}	43 kΩ
R_{68}	270 kΩ
R_{69}	1 MΩ
R_{70}	1 MΩ
R_{71}	1 MΩ
R_{72}	1 MΩ
R_{73}	820 kΩ
R_{74}	1.8 MΩ
R_{75}	20 MΩ
R_{76}	470 kΩ
R_{77}	470 kΩ
R_{78}	2.2 MΩ
R_{79}	2.2 MΩ
R_{80}	100 Ω
R_{81}	6.8 kΩ
R_{82}	6.8 kΩ
R_{83}	100 Ω
R_{84}	1 MΩ
R_{85}	1 MΩ
R_{86}	100 Ω
R_{87}	100 Ω
R_{88}	100 Ω
R_{89}	100 Ω
R_{90}	180 kΩ
R_{91}	120 kΩ
R_{92}	56 kΩ
R_{93}	56 kΩ
R_{94}	1 MΩ
R_{95}	1 MΩ
R_{96}	330 kΩ
R_{97}	100 kΩ
R_{98}	100 Ω
R_{99}	82 Ω
R_{100}	100 Ω
R_{101}	100 kΩ
R_{102}	330 kΩ
R_{103}	100 Ω
R_{104}	100 Ω
R_{105}	100/2=50 kΩ
R_{106}	18 kΩ
R_{107}	18 kΩ
R_{114}	2.2 MΩ
R_{115}	1 MΩ
R_{116}	120 kΩ
R_{117}	3.3 MΩ
R_{118}	3.9 MΩ*
R_{119}	3.9 MΩ*
R_{120}	100 Ω
R_{122}	470 kΩ
R_{123}	2.7 MΩ
R_{124}	680 kΩ
R_{125}	10 kΩ
R_{126}	3.3 MΩ
R_{127}	3.3 MΩ
R_{128}	3.9 MΩ*
R_{129}	3.9 MΩ*
R_{130}	2.7 MΩ
R_{131}	1 kΩ
R_{132}	820 kΩ
R_{133}	1 MΩ
R_{134}	100 Ω
R_{135}	100 Ω
R_{136}	10 MΩ
R_{137}	330 kΩ
R_{138}	680 kΩ
R_{139}	47 kΩ
R_{140}	47 kΩ
R_{141}	33 kΩ
R_{142}	270 kΩ
R_{143}	100 Ω
R_{144}	3.9 kΩ
R_{145}	100 Ω
R_{146}	47 kΩ
R_{147}	47 kΩ
R_{148}	560 kΩ
R_{149}	330 kΩ
R_{150}	6.8 MΩ
R_{151}	680 kΩ
R_{152}	1 kΩ
R_{153}	47 kΩ
R_{155}	120 kΩ
R_{156}	240 kΩ
R_{157}	39 kΩ
R_{158}	27 kΩ
R_{161}	12 kΩ
R_{164}	39 kΩ
R_{165}	82 kΩ
R_{166}	270 kΩ
R_{167}	2.2 kΩ
R_{168}	82 kΩ
R_{169}	270 kΩ
R_{170}	100 Ω
R_{171}	100 Ω
R_{172}	100 Ω
R_{173}	100 Ω
R_{174}	47 Ω
R_{175}	47 Ω
R_{176}	680 kΩ
R_{177}	1 MΩ
R_{180}	82 kΩ
R_{184}	270 kΩ
R_{186}	270 kΩ
R_{188}	100 Ω
R_{189}	1 MΩ
R_{190}	1 MΩ
R_{191}	1 MΩ
R_{192}	1 MΩ
R_{193}	1 MΩ
R_{200}	560 Ω*
R_{201}	560 Ω*
R_{202}	560 Ω*
R_{203}	560 Ω*

*) The actual value is chosen when the apparatus is being manufactured.

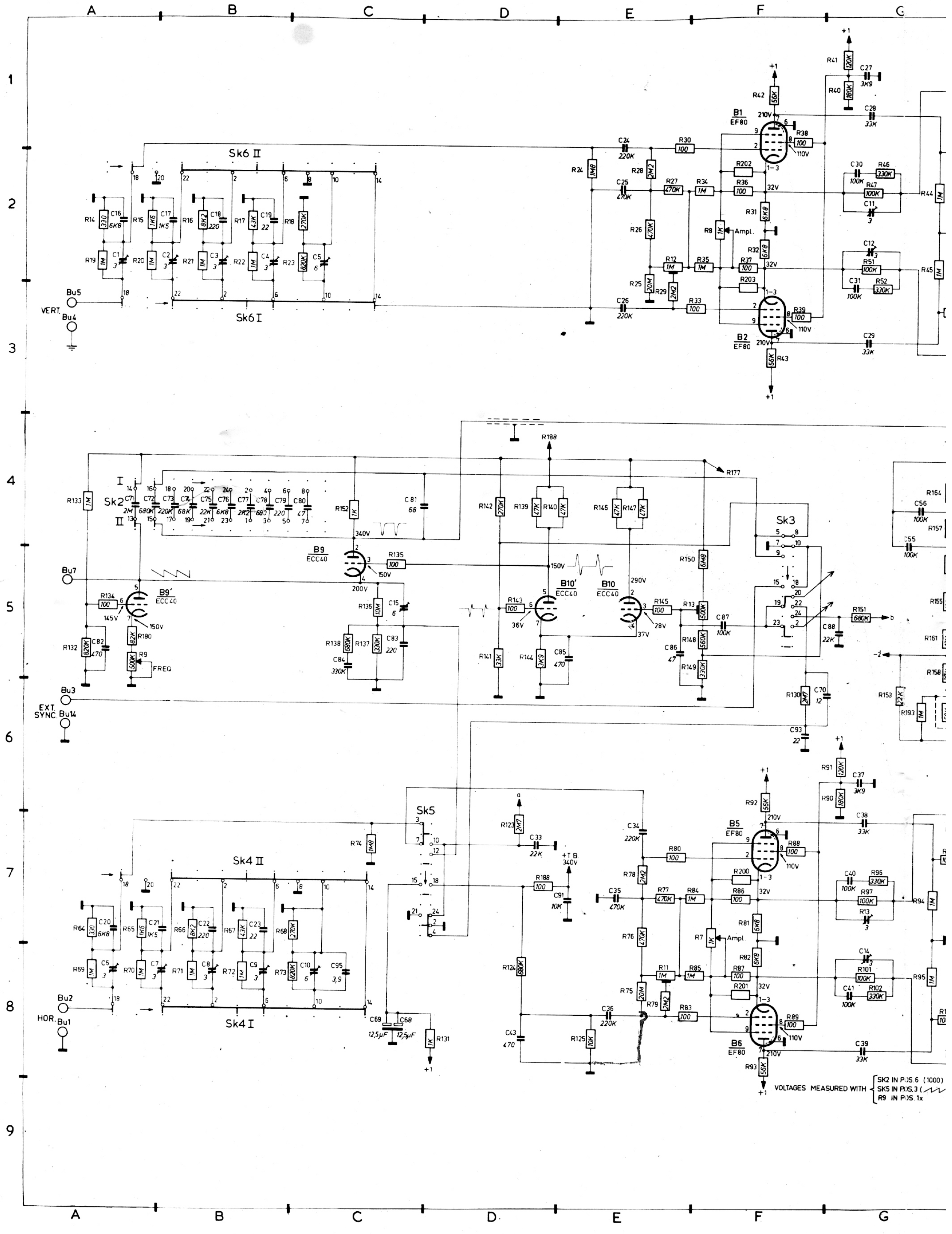
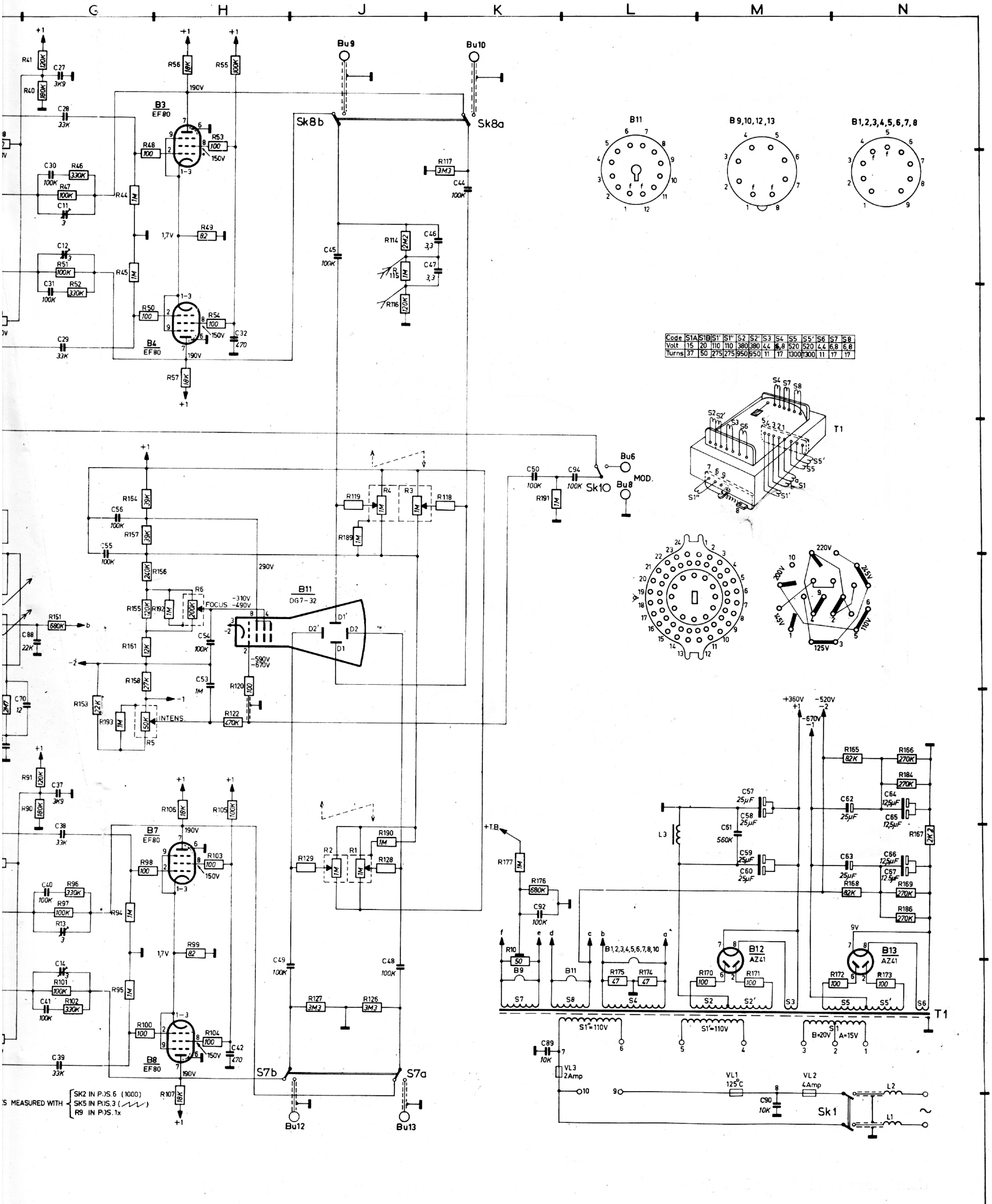


Fig. 14. Circuit diagram of the oscilloscope GM 5659/01 (subject to alt

The housings of the potentiometers (R1—R2—R3—R4) for the horizontal and vertical deflection and of t

The resistor R75 is connected to earth, not to C



659/01 (subject to alterations). At several points the circuit is connected to the case.

deflection and of the adjusting potentiometers R_{118}, R_{119}, R_{128}, R_{129} carry a voltage of 230 V with respect to earth.

ted to earth, not to C_{36} and R_{83} as given in the diagram.

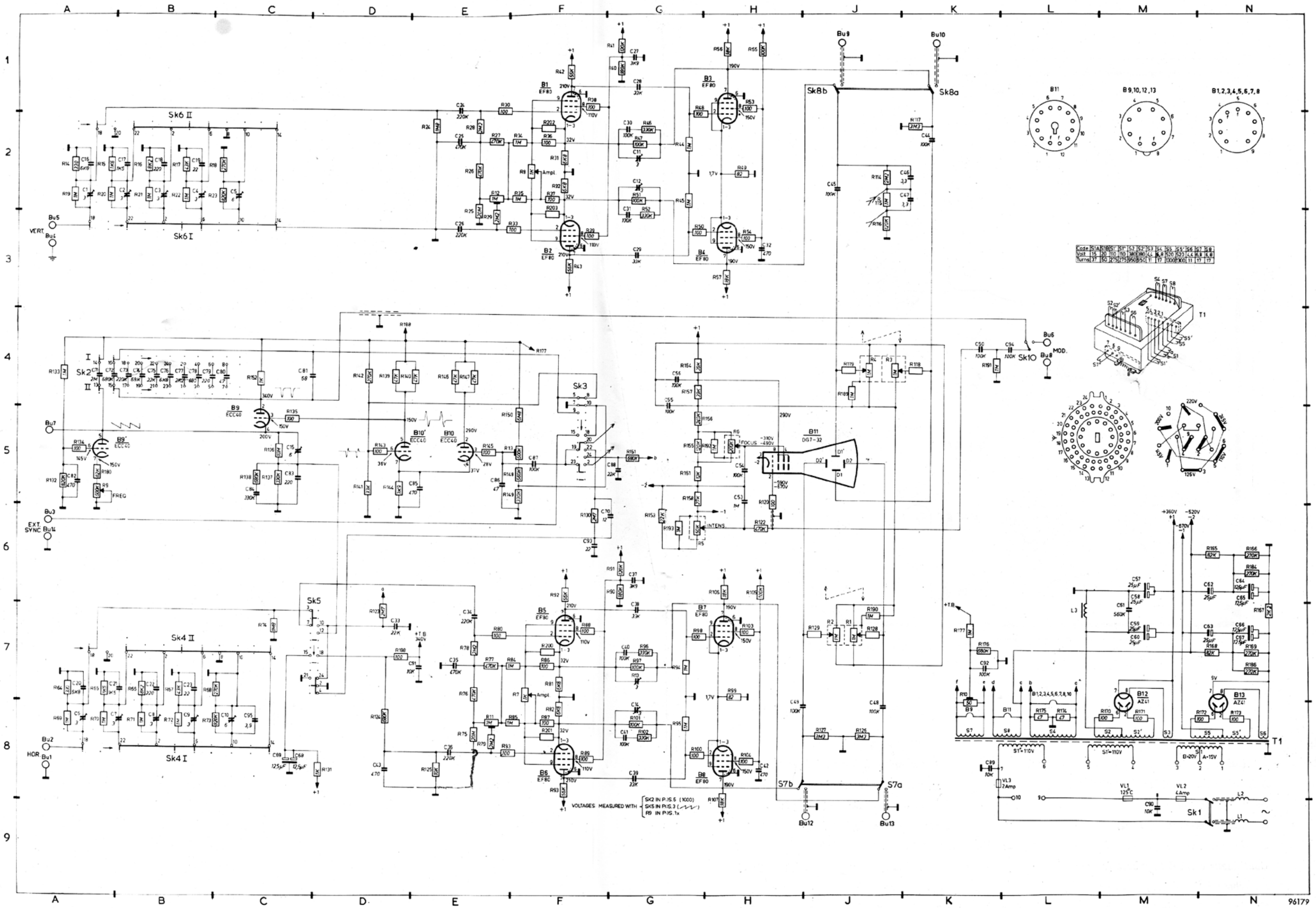


Fig. 14. Circuit diagram of the oscilloscope GM 5659/01 (subject to alterations). At several points the circuit is connected to the case.

The housings of the potentiometers (R_1—R_2—R_3—R_4) for the horizontal and vertical deflection and of the adjusting potentiometers R_{118}, R_{119}, R_{128}, R_{129} carry a voltage of 230 V with respect to earth.

The resistor R_{75} is connected to earth, not to C_{36} and R_{83} as given in the diagram.

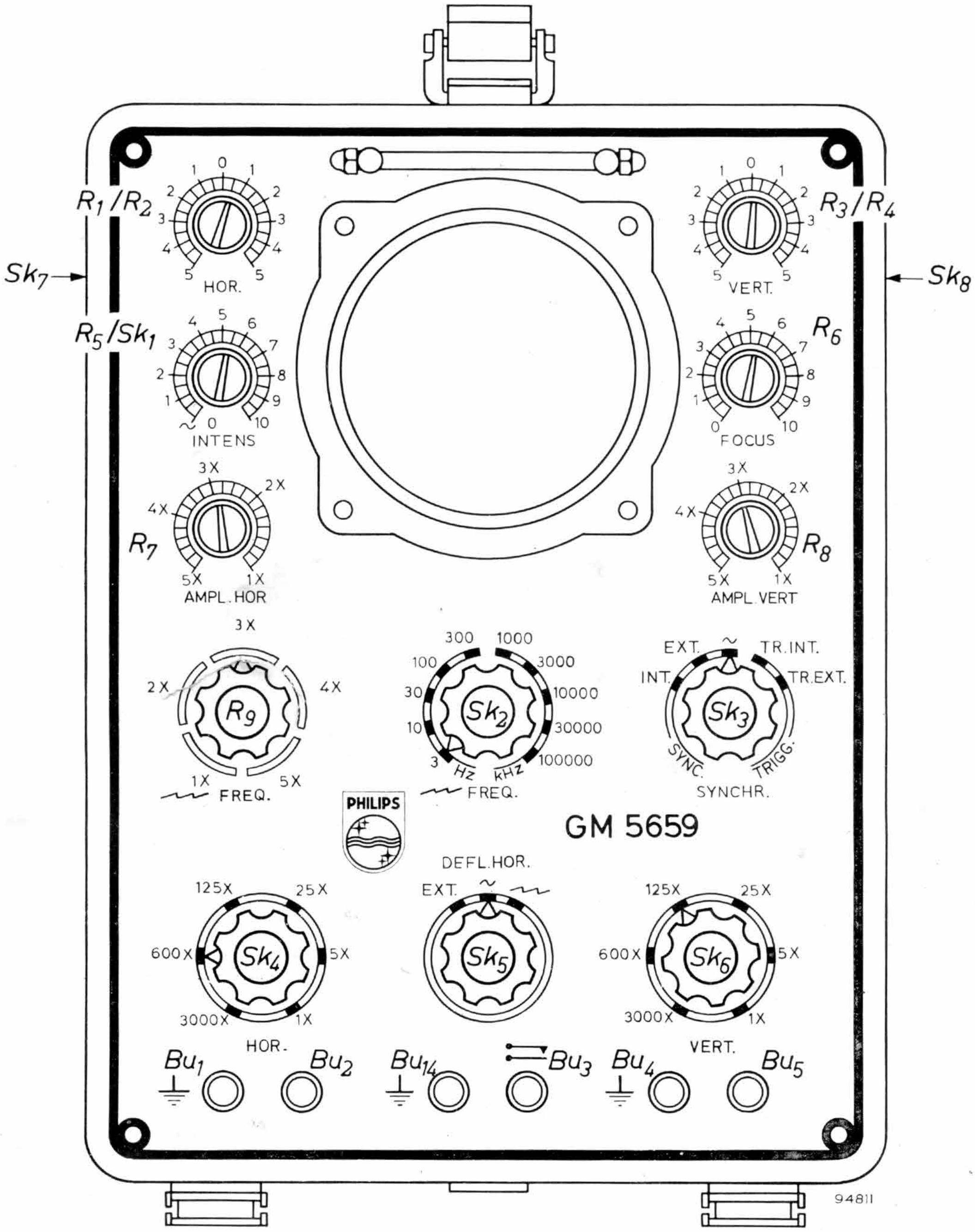


Fig. 15

Front view

R_1/R_2	*Horizontal shift*	Sk_4	*Step attenuator, horizontal*
R_3/R_4	*Vertical shift*	Sk_5	*Selector switch horizontal deflection*
R_5/Sk_1	*Brightness control + mains switch*	Sk_6	*Step attenuator, vertical*
R_6	*Focussing control*	Sk_7	*Switch, horizontal-deflection plates*
R_7	*Continuous attenuator, horizontal*	Sk_8	*Switch, vertical-deflection plates*
R_8	*Continuous attenuator, vertical*	Bu_1+Bu_2	*Input for horizontal deflection*
R_9	*Continuous control time-base frequency*	Bu_3+Bu_{14}	*Connection for external triggering of the time base*
Sk_2	*Step-control time-base frequency*		
Sk_3	*Synchronization selector switch*	Bu_4+Bu_5	*Input for vertical amplifier*

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