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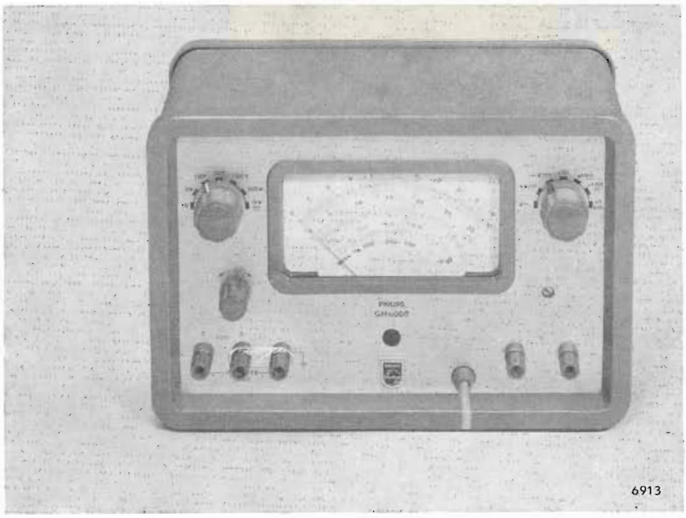
GM 6000 HAR
UTGÅTT UR
PROGRAMMET



PHILIPS ***Manual***

VOLT-OHM METER
GM 6000

66 401 98.2-10 1/1261

Contents

List of figures

Important

In all correspondence about this apparatus please mention the type number and the serial number, which will be found on the type plate at the back of the apparatus.

General part

I. Introduction

The electric voltmeter GM 6000 is suitable for measuring D.C. and A.C. voltages and resistances.

The instrument is suitable for measuring D.C. voltages from 100 mV to 1000 V and A.C. voltages from 100 mV to 300 V in the frequency range from 50 c/s to 100 Mc/s. The measuring range for resistances is 10 Ω to 5 MΩ. In principle the valve voltmeter consists of a bridge circuit of two triodes connected as a cathode follower.

D.C. voltages are passed directly to the grid of the first triode via the input attenuator. A.C. voltages are first rectified in the probe. For the detector-diode and the rectifying valve for the supply voltage a double triode is used which is fitted in the probe.

When measuring resistances the valve-voltmeter unit is cut out; the D.C. voltage required is obtained from the supply unit.

As the supply voltages are not stabilized, a calibration circuit has been provided, by means of which a change in the adjustment of the valves, for instance due to mains-voltage variations, can be compensated.

Thanks to its small dimensions and robust construction the voltmeter is eminently suitable for servicing purposes.

II. Technical data

A. Tolerances

Properties expressed in numerical values for which a tolerance is indicated are guaranteed by us. Numerical values without tolerances indicate the properties of the average instrument and are only given for guidance. (Unless otherwise stated, the numerical values apply to nominal mains voltages.)

B. D.C. voltages

Measuring ranges : 1, 3, 10, 30, 100, 300 and 1000 V full-scale value; when the H.T. probe GM 6070 is used: op to 30 kV.
If voltages are measured free from earth, the voltage between socket "0" and the chassis ("⏚") must not exceed 100 V.

Maximum error (after calibration) : + or − 3 % of the full-scale value.

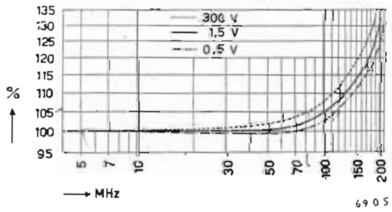
Input resistance : 10 MΩ

C. A.C. voltages

Measuring ranges : 1, 3, 10, 30, 100 and 300 V full-scale value

Maximum error (after calibration) : + or − 3 % of the full-scale value in the flat part of the frequency response curve.

Frequency response curve : Flat from 100 c/s up to 5 Mc/s. At 50 c/s the error is − 3.5 % or less. The figure gives an impression of the indication of the instrument at high frequencies (registered by means of a coaxial measuring set-up).



Input damping : at 1 Mc/s: 1.2 MΩ
at 10 Mc/s: 0.25 MΩ
at 40 Mc/s: 50 kΩ
measured in an LC-circuit at voltages ⩾ 10 V

Input capacitance : 8 pF

Maximum permissible voltage of the probe	:	700 V (D.C. voltage + peak value of A.C. voltage)

D. Resistances

Measuring ranges	:	10 Ω—5 MΩ in 4 measuring ranges: 200 Ω, 2 kΩ, 20 kΩ and 200 kΩ (middle-scale value)
Maximum error	:	+ or − 10 % in the middle of the scale

E. Calibration

The instrument can be calibrated by means of an internal voltage. The maximum error is + or − 1 %

F. Influence of mains-voltage variations of ± 5%

Drift of the zero point:
at D.C. voltage measurements <2.5 % of the full-scale value;
at A.C. voltage measurements <5 % of the full-scale value;
The maximum variation of the sensitivity is 2 %. This can be fully compensated by recalibration.

G. Supply

The instrument can be connected to mains voltages of 110, 127 or 220 V. The mains frequency may be 40—100 c/s (at frequencies below 50 c/s the voltage must not exceed the nominal value).
The power consumption is 9 W.

H. Dimensions

width 23.5 cm
height 16 cm, including the studs
depth 11.5 cm, including the controls

J. Weight

2.5 kg

III. Accessories

short-circuiting strip
manual
instructions chart

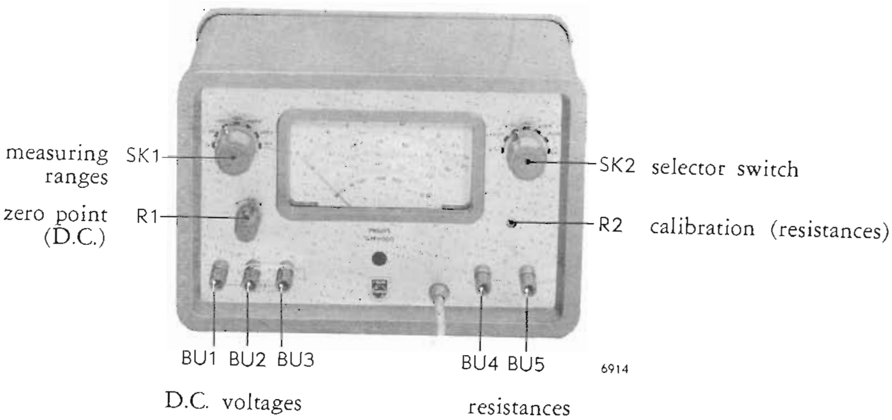


Fig. 1. Front view

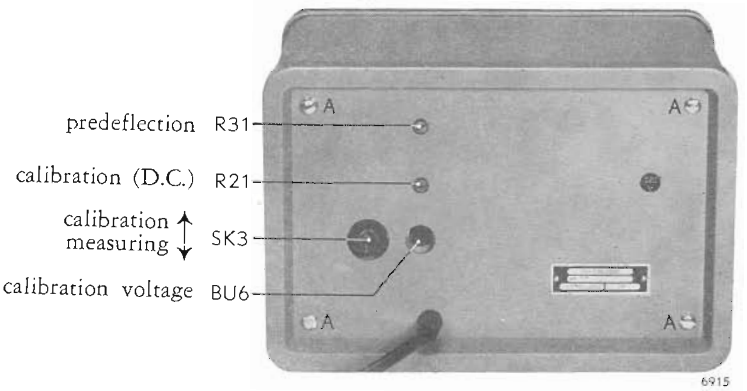


Fig. 2. Back view

Directions for use

I. Installation

A. Adjusting to the local mains voltage

By means of a voltage selector the instrument can be adjusted to mains voltages of 110, 127 and 220 V. The adjusted mains voltage can be read off through the circular opening in the rear wall.

Adjustment to a different mains voltage is effected as follows:

1. Remove the 4 screws "A" (Fig. 2) and remove the rear wall.
2. Pull out the selector a little, turn it till the correct voltage value is visible at the top and push the selector back again.
3. Refit the rear wall and check whether the value of the adjusted voltage is visible through the opening.

B. Earthing

Earth the instrument according to the local regulations.

This can be effected as follows:

* Via the earthing socket "⏚" (BU3) at the front of the instrument;
* via the mains cable if the instrument is provided with a 3-core mains cable fitted with a plug with rim-earthing contacts;
* in the case of A.C. voltage measurements, via the earthing flex on the probe if the circuit under test is already earthed.

To prevent measuring errors due to hum, double earth connections must be avoided.

C. Connection to the mains

1. Check whether the pointer indicates zero; if necessary, readjust by means of the black screw at the front of the instrument (mechanical zero adjustment, see Fig. 1).
2. Check whether the voltage selector is properly adjusted.
3. Earth the instrument.
4. Switch on the instrument by connecting it to the mains.

   After approximately 5 minutes the instrument has attained the required degree of stability and is ready for use.

II. Operation

For the functions of controls and sockets, see Figs. 1 and 2.

A. Predeflection

1. Set the measuring-range selector switch SK1 at position "1 V", the selector switch SK2 at position "+V⎓" or "–V⎓" and move down the calibrating switch SK3 (at the rear).
2. Adjust the deflection of the pointer exactly to zero with the aid of potentiometer "←0→" (R1).
3. Subsequently set switch SK2 at position "V∼".
4. Adjust the deflection of the pointer exactly to zero with the aid of potentiometer R31 (screw adjustment at the rear).

B. Calibrating

a. For voltage measurements

1. Set the measuring range selector switch SK1 at position "10 V" and the selector switch SK2 at position "+V⎓".
2. Move up the calibrating switch SK3 at the back and note down the indication.
3. Subsequently move down switch SK3 and connect socket BU6 (at the rear) to socket "±" (BU1).
4. So adjust the instrument by means of potentiometer R21 at the rear that it is equal to the value noted down in point 2.

During calibration no voltage must be connected to the D.C. voltage sockets BU1 and BU2.

Since the correct adjustment of the valve voltmeter is influenced by mains-voltage variations, it is recommended to repeat the calibration at regular intervals.

b. For resistance measurements

1. Set the selector switch SK2 at position "× 1 Ω".
2. Short-circuit the sockets "Ω" (BU4 and BU5).
3. Adjust the deflection of the pointer exactly to 0 Ω with the aid of potentiometer "Ω" (R2).

C. Measuring

1. *D.C. voltages*

Direct voltages are measured via the sockets "±" (BU1) and "0" (BU2). The selector switch SK2 must be set at position "+V⎓" for measuring positive voltages and at position "–V⎓" for negative voltages. It is also possible to measure voltages free from earth. The connecting bracket between the sockets BU2 and BU3 must then be removed. However, the potential difference between socket "0" (BU2) and the chassis (BU3) must never exceed *100 V.*

When measuring oscillators the capacitance of the test cable can greatly influence the measurements.

To prevent this, a resistor of 200 kΩ should be mounted between the test cable and the voltage under test. In this case the indication of the meter will be 2 % below normal.

When measuring very high frequencies the GM 6000 can be used in combination with the VHF-diode probe GM 6050. Then the voltmeter can measure voltages with frequencies up to 400 Mc/s (up to 800 Mc/s, when using T-connector GM 6050-T). The probe should be connected to the D.C.-input sockets (BU1 and BU2). When using the probe, the input impedance of the GM 6000 should be decreased to 1 MΩ. This can be effected by mounting a resistor of 1.1 MΩ between the sockets "I" (BU1) and "0" (BU2).

2. *A.C. voltages*

Alternating voltages are measured via the A.C. voltage probe. The selector switch SK2 must then be at position "V∼". The earthing flex of the probe must be connected to the earthed side of the voltage under test.

The maximum permissible alternating voltage on the probe is 500 $V_{r.m.s.}$. When alternating voltages are measured, no voltage must be connected to the D.C.-voltage input sockets BU1 and BU2.

Note:

Though the deflection of the pointer is proportional to the average value of the rectified voltage, the scale of the meter is calibrated in the r.m.s. value of purely sinusoidal voltagee. It is therefore impossible to measure the r.m.s. value of non-sinusoidal voltages by means of the GM 6000. The meter is suitable, however, for comparative measurements of non-sinusoidal voltages of the same shape.

In that case the value found may differ from the one indicated by, for instance, a thermocouple voltmeter measuring the actual r.m.s. value.

3. *Resistances*

Resistances are measured via the sockets "Ω" (BU4 and BU5). Switch SK2 is set at position "×1 kΩ" and then turned anti-clockwise until the meter gives a clearly readable deflection (reading from right to left).

The resistance value measured is now the value indicated on the meter multiplied by the factor indicated by switch SK2.

Service documentation

Properties expressed in numerical values for which a tolerance is indicated are guaranteed by us. Numerical values without tolerances indicate the properties of the average instrument and are only given for guidance. (Unless otherwise stated, the numerical values apply to nominal mains voltages.)

I. Description of the functioning

A. The valve voltmeter

Fig. 3 shows the simplified circuit diagram of the valve voltmeter. The valves B2 and B2′, together with the resistors R14 and R26, form a Wheatstone bridge that can

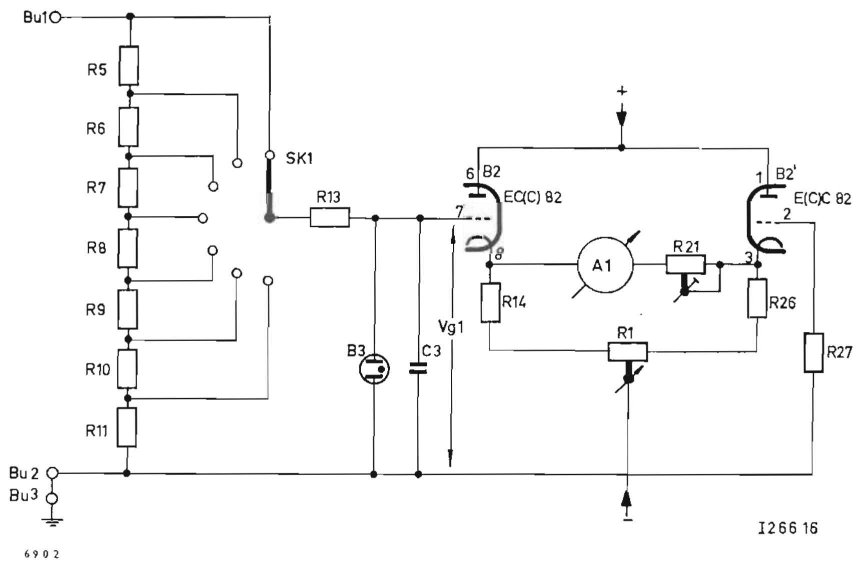


Fig. 3. Simplified circuit diagram

be balanced by means of the variable resistor R1. In that case the valve currents, and hence the cathode voltages, are equal, so that the meter does not deflect.

If a positive D.C. voltage is connected to BU1-BU2, the current through B2 and the cathode voltage will increase. The cathode voltage of B2′, however, remains constant, so that a current will start flowing through the meter.

The size of this current is a measure of the D.C. voltage connected to the input, so that the voltage can be directly indicated on the meter scale.
By operating in the linear part of the Ia-Vg curve of B2 the meter scale will be linear.

By means of the variable resistor R21 the sensitivity of the meter can be adjusted. The adjustment of R21 is such that full deflection is obtained with the aid of a voltage of 1 V at the control grid of B2.

To be able to measure higher voltages as well, an input attenuator (R5 - R11) is used, which is so dimensioned that the pointer fully deflects at voltages (connected to BU1) of 1 - 3 - 10 - 30 - 100 - 300 and 1000 V, in the consecutive positions of SK1. This attenuator, the total resistance value of which is 10 MΩ, also forms the grid leakage resistor of B2. Since this valve is circuited as a cathode follower, the high leakage resistance has no decrimental effects.

B. Measuring n e g a t i v e D.C. voltages

If a negative D.C. voltage is connected to the sockets BU1 and BU2, the current through B2, and hence the cathode voltage, will decrease, so that the meter connections should be exchanged to obtain a deflection again. This is effected by setting switch SK2 at position "−V⎓".

In view of the curcature of the valve char-

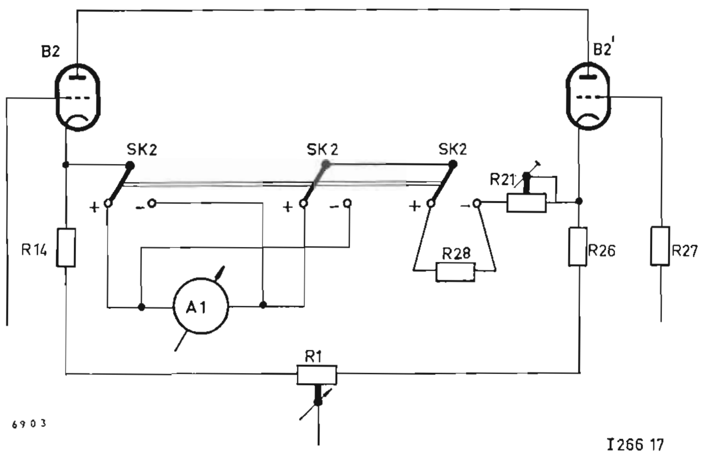


Fig. 4. Measuring positive voltages

acteristic the meter indication for a negative voltage will, in the circuit used here, be smaller than for a positive value of the same size.
To be able to use the same meter scale a resistor (R28) is connected in series with the meter in the position "+V⎓" of SK2 (Fig. 4). The value of this resistor is so chosen that the same deflection is obtained for a given voltage, either positive or negative.

C. The protective circuit

To prevent the voltmeter from being damaged by excessive overloads, a protective circuit is included in the input circuit; it consists of R13, B3 and C3 (Fig. 3).

For negative voltages the meter is protected against overloading by B3. This valve has an operating voltage of approx. 60 V, so that the voltage of the control grid of B2 cannot exceed 60 V. For positive voltages the valve B2 itself ensures limitation by means of the grid current and the voltage drop across R13 resulting from this.

High pulse-shaped voltages might perhaps fail to ignite the neon tube B3, so that an extra protection is required in the form of C3. This capacitor constitutes in the first instance a short-circuit for pulse-shaped voltages, so that these voltages are also applied across R13 and are not directly connected to the control grid of B2.

D. Measuring alternating voltages

For measuring alternating voltages use is made of a detector probe (Fig. 5). The capacitor C1 is charged to the peak value of the alternating voltage connected by the diode B1. The direct voltage thus obtained is negative with respect to zero and is further measured in the same way as a negative direct voltage connected to BU1-BU2. (In the position "V∿" of SK2 the circuit of the valve voltmeter is therefore identical to that in position "–V⎓".)

As a result of the maximum permissible voltage on the diode the highest A.C. voltage range covers 300 V.

If, as in the circuit used in this case, the load on the rectifier circuit is small, the D.C. voltage obtained exceeds the r.m.s. value of the A.C. voltage connected.

To be able to use the same scale for A.C. and D.C. voltages the rectified voltage is attenuated $\sqrt{2}$ × by resistors connected in series with the input attenuator (R12, R16, R3 and R15).

Due to the curvature of the diode characteristic the detection efficiency decreases at lower A.C. voltages. For the 10-V A.C. range this is compensated by short-circuiting R3. For the ranges covering "3 V∿" and "1 V∿" the curvature of the diode charac-

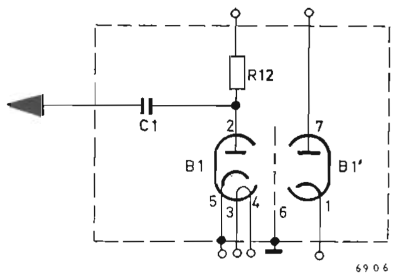


Fig. 5. Diagram of the detector probe

teristic becomes too large, however, so that in this case separate scales will be necessary. R3 remains short-circuited for these ranges.

In the case of a diode with heated cathode a small rest current starts flowing at 0 V anode voltage, as a result of which the meter would also show a deflection without input voltage. This pre-deflection is compensated by applying a small positive counter-voltage to the input via R4; this counter-voltage is obtained with the aid of the voltage divider formed by R30 and R31. This voltage can be adjusted by means of the potentiometer R31.

E. Measuring resistances (Fig. 6)

The valve-voltmeter unit is not used for measuring resistances. The moving-coil instrument acts as an indicator. The voltage required is supplied by the supply unit of the valve voltmeter.

If the sockets BU4 and BU5 are short-circuited, the meter can be adjusted to full-scale deflection (0 Ω) with the aid of R2.

An arbitrary resistance, connected to the sockets BU4 and BU5 will decrease the current through the meter and the deflection of the meter will be a measure for the value of the unknown resistance.

The resistance values in the circuit have been so selected that for the 4 measuring ranges the same scale can be used.

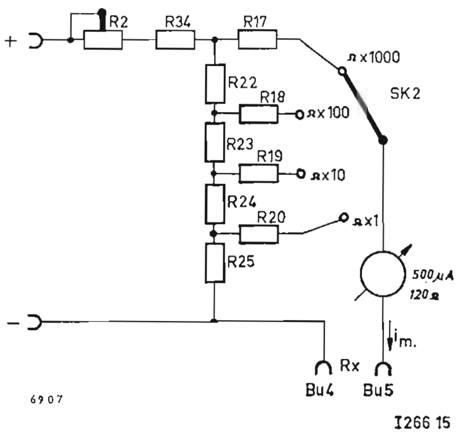


Fig. 6. Measuring resistances

F. The calibration circuit (Fig. 7)

To be able to compensate the influence of varying or deviating mains voltages a calibration circuit has been provided.

In Fig. 7 SK3 is set at position "measuring". If R21 is properly adjusted, the meter will accurately indicate the size of a voltage connected to BU1.

A potentiometer circuit consisting of R35, R36//R37 and R32 ensures that a positive voltage is obtained on BU6. This voltage can be adjusted to a given value by means of the choice resistor R37 and can be measured in the usual way by connecting BU1 to BU6.

In position 2 of SK3 the moving-coil instrument is connected in series with R35 and R32 across the 120-V voltage, so that the current through the meter directly depends on the 120-V voltage and hence on the mains voltage.

The choice resistor R37 has been trimmed so that if the sensitivity is correctly ad-

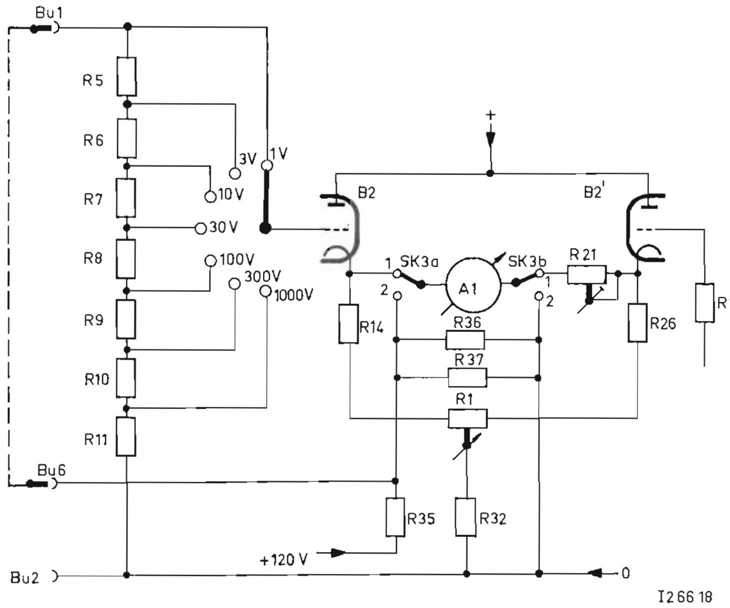


Fig. 7. Calibration circuit

justed by means of R21 (at nominal mains voltage; BU1 connected to BU6), the indication of the meter in the "measuring" position of SK3 is equal to that in the "calibrating" position.

If during use the instrument is connected to a mains voltage which, for instance, is 10 % higher than the nominal value, the indication of the meter in the "calibrating" position of SK3 will also be 10 % higher. In the "measuring" position of SK3 the voltage on BU6 will also be 10 % higher, so that an increase in the sensitivity of the valve voltmeter of, say, 3 %, will cause the indication of the meter to be 13 % higher if BU1 is connected to BU6.

By equalizing the indications of the meter in both positions of SK3 by means of the variable resistor R21, the higher degree of sensitivity caused by the higher mains voltage is fully corrected. In this way it is also possible to correct a change in the sensitivity, for instance on account of the ageing of the valves.

G. Supply unit

The D.C. voltage of approx. 120 V is obtained by half-way rectification by means of the diode B1′ (being one half of the double diode in the probe).

The primary side of the transformer consists of two windings of 110 V each connected in series for 220 V mains voltage. In the position "110 V" of the voltage selector both 110-V windings are in parallel and in the position "127 V" R33 is connected in series to this parallel circuit and the loading current thus causes the 17-V voltage drop required.

II. Making the parts accessible

A. Removing the case

1. *The rear panel*
   This can be removed together with the rear edge after loosening the 4 screws "A" (Fig. 2).

2. *The jacket*
   This can be slid off after loosening the 4 fixing screws at the bottom.

B. Removing the knobs

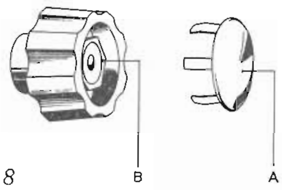


Fig. 8

* Remove the cap "A" (Fig. 8).
* Loosen the nut "B" slightly and tap it while holding the knob.
* The knob can now be removed from the spindle.

C. Removing the front panel

* Remove the knobs (II.B).
* Remove the rear panel and the jacket (II.A).
* Unsolder the wires connected to the 5 sockets.
* Loosen the 8 screws "C" (Fig. 9).

III. Maintenance

The jacket of the case consists of aluminium covered with a plasic layer and can, after being removed, be washed with water and soap without any objection.

For the proper functioning of the instrument it is recommended to grease the switches once a year with switch-oil, the code number of which is quoted in the mechanical-parts list (page 28).

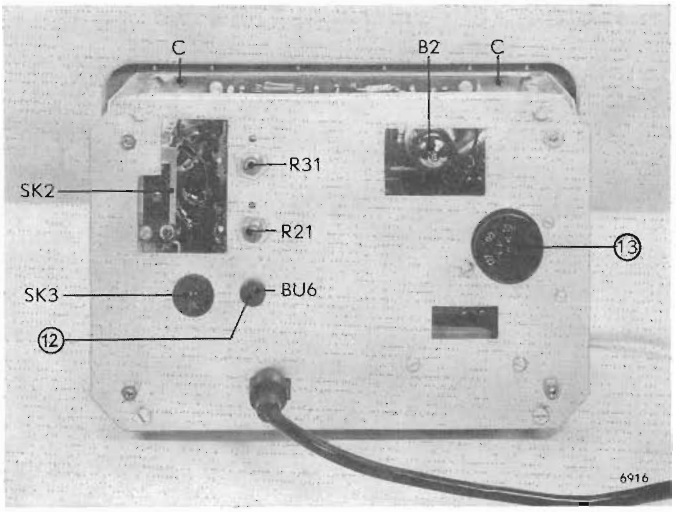


Fig. 9. Removing the front panel

IV. Survey of trimmings and the auxiliary equipment to be used

trimming point	trimming device	measuring equipment	recommended PHILIPS measuring equipment	page
zero point	R1 (Fig. 1)	none		20
zero point for Ω	R2 (Fig. 2)	none		22
zero point for ∼	R31 (Fig. 9)	none		20
sensitivity	R21 (Fig. 9)	supply unit + valve voltmeter	GM 4561/01 + GM 6009 or GM 6020 } calibrated	21
	choice resistor			
negative voltages	R28 (Fig. 10)	supply unit	GM 4561/01	20
A.C. voltages	R16 (Fig. 12)	generator + valve voltmeter	GM 2317 + GM 6012 (calibrated)	21
calibration	R37 (Fig. 12)	none		22

The trimming sequence shown above is arbitrary.
When more complete or extensive trimming or checking of the instrument is required, the sequence shown in chapter V must for preference be adhered to.

V. Checking and adjusting

A. General

The tolerances mentioned below are factory tolerances only applicable to renewed trimming of the instrument.

In the foregoing table all trimming devices and variable resistors are stated together with a description of their function and the equipment required.

B. Mains current

When the instrument is adjusted to 220-V mains voltage, the mains current consumption at 220 V, 50 c/s must be maximum 50 mA.

C. Zero adjustment (R1, R31)

When the instrument is switched off, the pointer must indicate 0 V. If necessary, adjust by means of the mechanical zero-adjusting device.

Set the selector switch SK2 at "+V⎓" or "–V⎓", the measuring-range selector switch SK1 at "1 V" and SK3 at "measuring". Keep the instrument switched on during at least 5 minutes.

Adjust the pointer to zero by means of the variable resistor R1 ("←0→").
Now set the selector switch SK2 at "V∿".

Adjust the pointer to zero by means of the variable resistor R31 (upper screw adjustment at the rear, see Fig. 9).

In the various positions of SK1 the zero point must not move more than ½ a scale division of the upper scale.

D. Negative voltages (R28)

Set the selector switch SK2 at "+V⎓".
Connect a positive D.C. voltage to BU1, while the switch SK1 is set to such a measuring range that a deflection is obtained at the end of the scale. Set the switch SK2 at "–V⎓" and reverse the polarity of the D.C. voltage connected.

The indications must be equal within 1 %. If not, another value must be selected for R28 (Fig. 10).

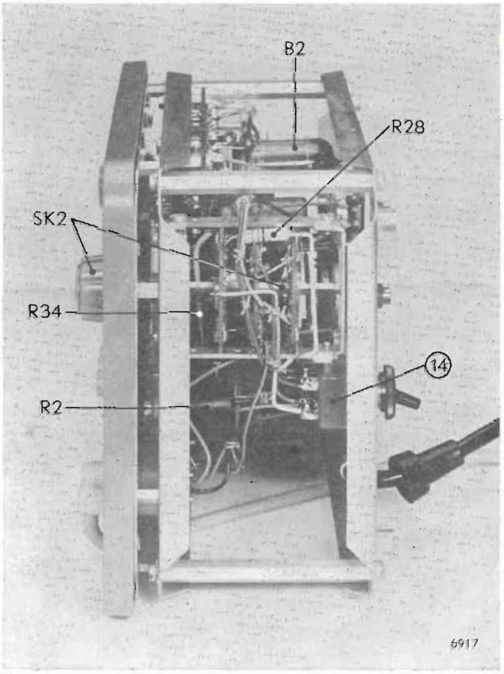


Fig. 10. Right-hand side view

E. Sensitivity and attenuation (R21)

Set the selector switch SK2 to "+V⎓" or "–V⎓", the measuring-range selector switch SK1 at "10 V" and SK3 at position "measuring".

Connect an accurate D.C. voltage of 10 V to BU1 and adjust the pointer to 10 V by means of R21 (lower screw adjustment at the rear, see Fig. 9).

Subsequently check all measuring ranges of SK1 by applying voltages corresponding to full-scale deflection.

The deviation may be maximum 1.5 % of the full-scale value. If the deviation exceeds this percentage, the attenuator resistors must be checked.

Set SK1 at position "1 V".
Apply a voltage of –100 V to BU1.
The neon tube B3 must now ignite.

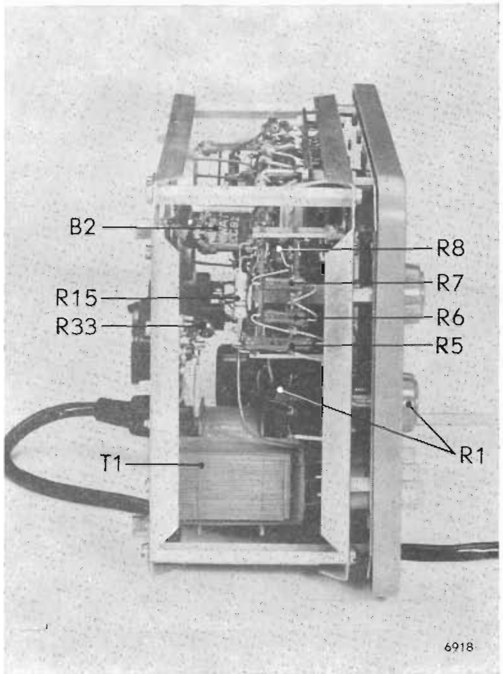


Fig. 11. Left-hand side view

F. A.C. voltages (R16)

Set the measuring-range selector switch SK1 at position "10 V", the selector switch SK2 at position "V∼" and the switch SK3 at position "measuring".

Connect a sinusoidal A.C. voltage of 10 V to the probe, frequency 10 kc/s.
The meter should now indicate 10 V; this can be adjusted by means of R16 (Fig. 12).

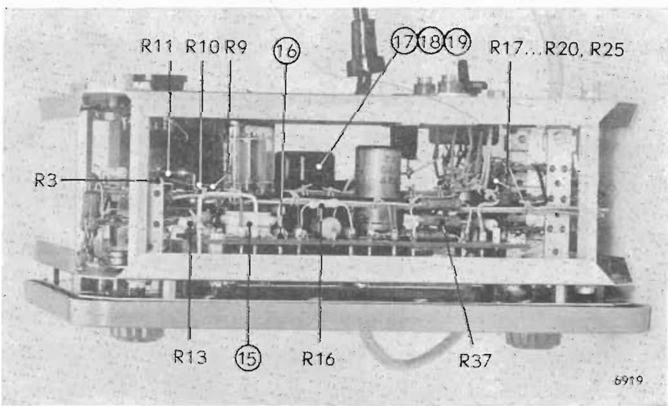


Fig. 12. Top view

Check all other measuring ranges at the end of the scale by applying the relevant voltages; tolerance always ± 1.5 %.

G. Scale character

adjust SK1 and SK2 to:	voltage to be applied:	
+10 V	+2, 4, 6 and 8 V (BU1)	
1 V∼	300 mV, frequency 10 kc/s	probe
3 V∼	1, 2 and 3 V, frequency 10 kc/s	probe

The scale deviation may be maximum 1.5 % of the full-scale value.

H. Calibrating (R37)

Set SK1, SK2 and SK3 at the positions for measuring 10 V⎓.

Connect a D.C. voltage of 10 V to BU1. Adjust variable resistor R21 (lower screw adjustment at the rear) so that the meter indicates 10 V exactly.

Disconnect the input voltage and connect BU1 to BU6.

Note down the indication of the meter and set switch SK3 at position "calibrating". The indication of the meter must now be equal to the former within 0.5 %.

If not, a different value must be selected for R37 (Fig. 12).

J. Resistance measurements

Interconnect BU4 and BU5.
Adjust the meter to full-pointer deflection by means of the potentiometer R2 ("Ω"). Check the middle value on the scale for the various measuring ranges by means of calibrating resistors of 200 Ω, 2 kΩ, 20 kΩ and 200 kΩ respectively. The maximum deviation may be ± 7.5 %. If the deviation exceeds this percentage, the values of resistors R17...R25 must be checked (see Figs. 9, 12 and 13).

K. Influence of mains-voltage variations

When the mains voltage is increased or decreased by 5 %, the zero point may have drifted max. 2.5 scale division of the upper scale after 1 minute.

L. Final check/total measuring inaccuracy

1. Check points C - K once more.
2. Checking the total measuring inaccuracy:

   Set SK1, SK2 and SK3 at their positions for measuring +10 V.
   Adjust the pointer to 0 by means of the variable resistor R1 ("←0→").
   Connect BU1 to BU6.

   Adjust R21 (lower screw adjustment at the rear) so that in both positions of SK3 the meter indicates the same value.

   Connect a D.C. voltage of +10 V to BU1. The total measuring inaccuracy may now be max. ± 2.5 % of the full-scale value.

   Set selector switch SK2 at position

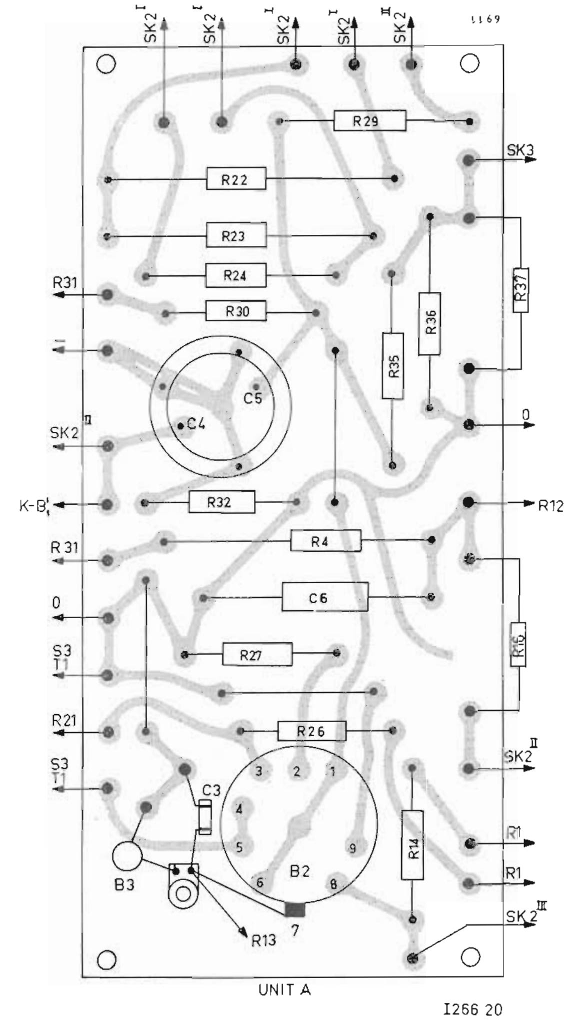


Fig. 13. Accessories and printed-wiring plate

"V∼". Adjust the zero point by means of R31 (upper screw adjustment at the rear).

Apply a voltage of 10 V, frequency 10 kc/s, to the probe.

The total measuring inaccuracy for A.C. voltages may also be max. ± 2.5 % of the full-scale value.

VI. Replacing valves and parts

The instrument does not contain selected valves or parts.
After replacing valves or parts it may be necessary to trim the relevant circuit again (see Chapter V *"Checking and adjusting"*).
When replacing valves or parts, the instrument must be switched off. For making parts accessible, see Chapter II.

A. Supply transformer

For removing the supply transformer the 4 wires at the bottom and the two wires at the rear of the transformer must be unsoldered after removing the rear panel and the jacket (chapter II, point A). Then unscrew the two bolts by means of which the transformer is fitted to the rear panel. By tilting the transformer slightly the 4 remaining wires can be removed.

B. Measuring instrument

This can by readily removed after taking off the controls and the front panel (Chapter II, points B and C).

C. Moving-coil system

The moving-coil systems supplied by the PHILIPS Service Organisation without magnet and scale, have a coil resistance of 80 Ω ± 15 % and are trimmed to 120 Ω ± 2 % by means of the appurtenant correction resistor.

The 2 protective cells circuited in anti-parallel across the moving coil and the correction resistor must not be excessively heated during soldering.

After placing the moving-coil system in the magnet the instrument should be trimmed to full-scale deflection, with the aid of a calibrated meter, at 500 μA ± 0.5 % by means of the magnetic shunt.

After mounting the meter in the apparatus check the scale character according to point V.G.

D. Switching segments SK1 and SK2

The segment of switch SK2 (Fig. 10) can be removed by:

* unsoldering the relevant wires and parts;
* unscrewing the metal strip with holes at the top;
* removing the brass spring at the rear;

* pushing the spindle backwards.

For the segments of SK1 both metal strips must be removed, since the spindle cannot be taken off.

E. Parts in the probe

Apart from C1 in the detachable cap, the probe also contains the valve B1 and the resistor R12. For replacing these parts the probe must be opened (Fig. 14).

* Remove the earthing flex, the cap with test pin and the rubber washer.
* Loosen the two screws *a,* the contact block of the earthing flex and the locking screw of the cable *b.*
* The interior of the probe can now be pulled out by pulling at the insulating piece *c.*

The valve B1 can now be replaced without any further measures being necessary.

The valve socket of B1 musr be removed before the replacement of the resistor R12. This can be done by unscrewing the threaded studs *d.*

F. The edges of the case and the text plate

Front edge and text plate

* Remove the front panel according to point II.C.
* Heat the flanged cams of the plastic edge by holding a hot soldering iron close to them (do not touch) and straighten the cams with the aid of a screwdriver.
* The front edge and the text plate can now be separated.

Rear edge

* Remove the rear plate together with the edge of the case according to point II.A.1.
* Separate the rear panel and the edge of the case in the way described above.

G. Rubber studs

When a rubber stud has to be replaced, the case must be removed according to II.A. The new cap is pulled through the hole with the pointed end facing the inside; subsequenrly it is pulled tight. The protruding part must now be cut to length.

H. Valves

New valves must be aged for 100 hours. This ageing can be done simply by placing the new valves in the instrument and by switching the latter on for 100 hours.

It can als be done outside the instrument, however, by giving the valves such an anode voltage at nominal heater voltage that the rest current through the valve is 1/6 of the maximum permissible cathode current.

With the ECC82 the grid must be connected to the anode.

For the EAA91 (B1) the rest current is 3 mA (both halves connected in parallel)

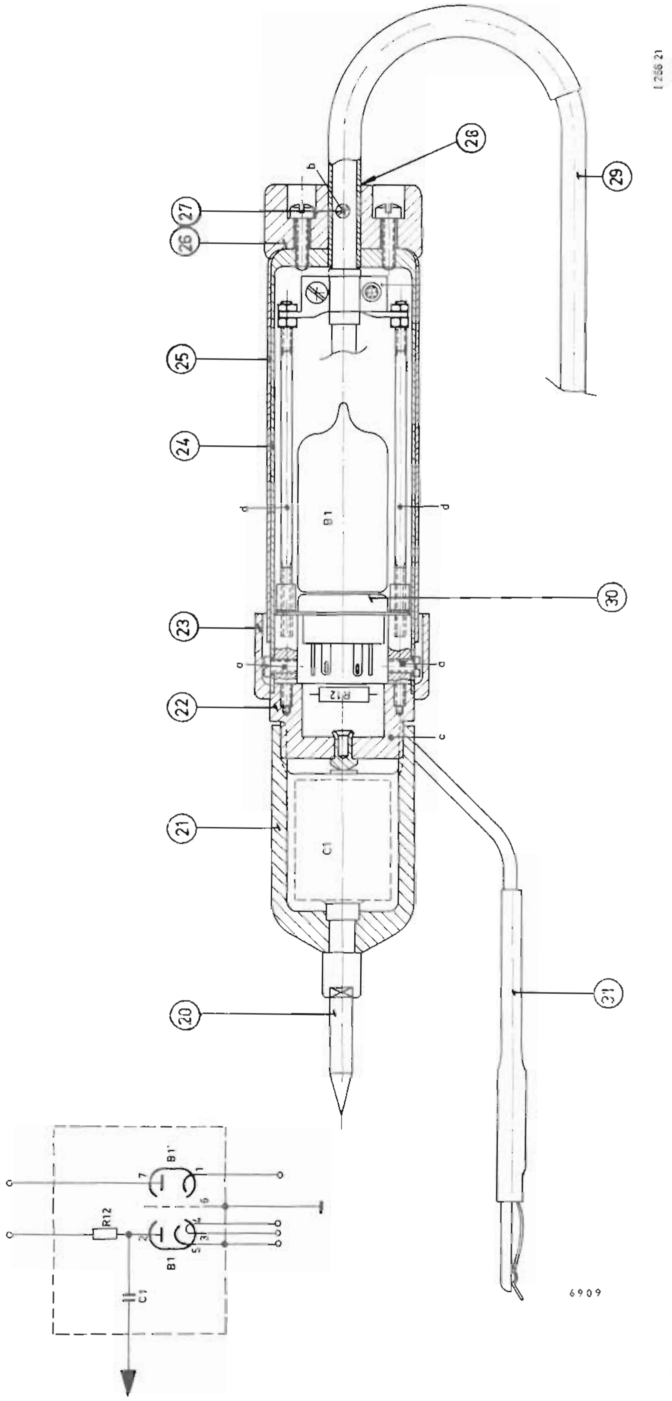


Fig. 14. The detector probe

and for the ECC82 (B2) 4 mA (both halves connected in parallel).
The neon tube GL8 (B3) need not be aged.

After placing new valves in the instrument the following checking measurements must be carried out:

valve	chapter *"Checking and adjusting"*
B1	V.C., V.F., V.H
B2	V.D., V.E., V.H
B3	V.E - last line

VII. Trouble shooting

A. General

Figs. 9 . . . 14 show the arrangement of the valves and the parts.

To be able quickly to trace and to remedy troubles it is necessary to know the functioning and the adjusting of the instrument (Chapter I and V).

It is always possible to appeal to the PHILIPS Service Organisation for further assistance.

B. A few causes of trouble

1. The pointer does not deflect.

* Check if the mains voltage is applied to the supply transformer.
* Check the supply voltages.
* Check the valves.
  The arrangement of the valves is shown in Figs. 11 and 13. After replacing a valve the instrument must be recalibrated according to point VI.H.

2. The deflection is unstable.

* Check whether the instrument is thoroughly earthed.
* Check whether there is no powerful H.F. generator (for instance a transmitter) in operation in the vicinity of the instrument.
* Check the valves and, if necessary, the contacts of the valve socket.
* A strongly fluctuating mains voltage also causes instability.

VII. List of component parts

A. Mechanical-parts list

Fig.	Pos.	Number	Code number	Description	S	Minimum basis stock: number of apparatus 1	3	5	10
15	1	1	M7 191 80	instruction plate	**	—	—	—	—
15	2	5	M7 694 87	connecting terminal	*	1	2	3	5
15	3	2	P5 656 90	edge of the case	**	—	1	2	4
15	4	1	P5 656 91	ornamental edge of the meter	**	—	—	—	—
15	5	2	973/52	knob 22 mm ø with cap	*	—	1	2	3
15	6	(2)	973/D51	cap for knob 22 mm ø	**	—	—	—	—
15	7	2	973/P51	arrow for knob 22 mm ø	**	—	—	1	2
15	8	1	M7 773 52	knob 14 mm ø without cap	*	—	—	1	2
15	9	1	973/D54	cap for knob 14 mm ø	**	—	—	1	2
15	10	1	M7 291 97	short-circuiting strip	*	—	—	1	2
15	11	4	P5 675 05	rubber stud	**	1	2	3	4
9	12	1	979/11	plug socket	*	—	—	1	2
9	13	1	M7 431 86	voltage change-over	*	—	—	—	—
10	14	1	08 521 11	switch	—	—	1	1	2
12	15	1	976/PW 9×12	valve holder (Noval)	*	—	—	—	1
12	16	27	A3 320 36	soldering tag	**	—	—	—	—
12	17	1	P 829 40	moving-coil instrument	**	—	—	—	1
12	18	1	E6 220 68	moving-coil system	*	—	—	—	—
12	19	2	E6 102 82	protective cell in the meter	*	—	—	—	—
15	—	1	M7 875 38	measuring probe (complete)	**	—	—	—	1
14	20	1	M7 318 71	measuring pin	*	—	—	—	1
14	21	1	M7 701 34	cap with capacitor	—	—	1	2	2
14	22	1	M7 990 14	insulating piece	*	—	—	—	1
14	23	1	P5 656 29/08HA	ring	**	—	—	1	2
14	24	1	M7 697 42	case	**	—	—	1	2
14	25	80 mm	K 109zz/06PK	insulating sleeving	**	—	—	1	2
14	26	1	P5 656 16	insulating piece	**	—	—	1	2
14	27	1	P5 648 81/722	locking screw	**	—	—	1	2
14	28	1	M7 289 05	socket	**	—	—	—	—
14-15	29	135 cm	R 655 KA/06PP13	7-core cable	—	—	135 cm	135 cm	270 cm
14	30	1	976/7×10	valve holder (miniature)	*	—	—	—	1
14	31	1	M7 502 73	earthing flex	**	—	1	1	2
—	—	10 cm³	971/71	bottle with switch-oil	—	—	—	—	—

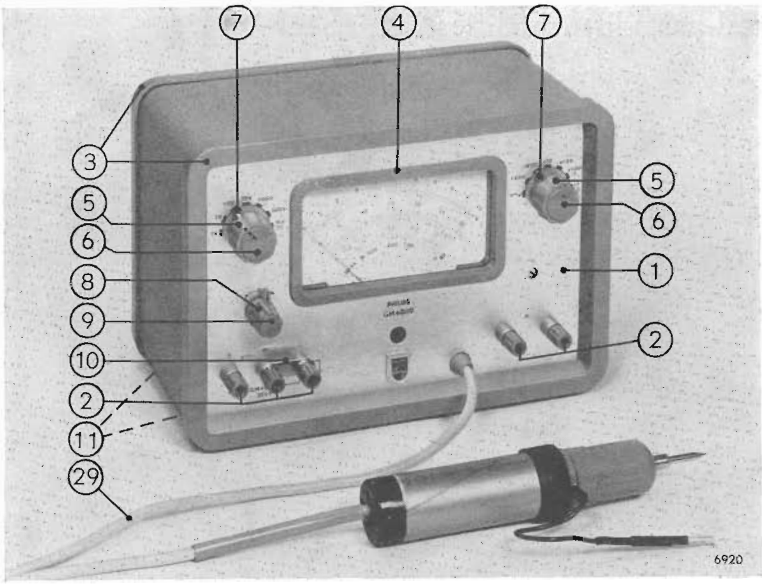


Fig. 15. Front view

Purpose of the column S

— **Components not marked**

They should be present at the Service Department in the country concerned or at the customer's who is using the apparatus.

They include:

a. nearly all electrical components;
b. mechanical parts which are vulnerable, or which are subject to wear.

* **Components marked with one star**

These components generally have a long or unlimited service-life, but their presence is essential for the correct working of the apparatus. Stocking up of a few of these components depends on the following factors:

a. the number of apparatus present in the country concerned;
b. the necessity of having the apparatus working continuously or not;
c. the time of delivery of the components with respect to the import restrictions in the country concerned and the duration of the transport.

** **Components marked with two stars**

These components have a long or unlimited service-life and they are not essential for the correct working of the apparatus. Generally there is not a local stock.

B. Electrical-parts list (modifications reserved)

Resistors (All resistors are vaporized carbon resistors, unless stated otherwise.)

No.	Code number	Value		Tolerance	Power	Type
R1	E 199 AA/C21 B10K	10	kΩ	10 %	1 W	potentiometer, wire-wound
R2	E 199 AA/B13 B20K	20	kΩ	5 %	1 W	potentiometer, wire-wound
R3	901/220 K	220	kΩ	5 %	¼ W	
R4	B8 305 20 B/82M	82	MΩ	5 %	½ W	
R5	B8 305 20 D/6M67	6.67	MΩ	1 %	½ W	
R6	B8 305 17D/2M33	2.33	MΩ	1 %	¼ W	
R7	B8 305 17D/667K	667	kΩ	1 %	¼ W	
R8	B8 305 17D/233K	233	kΩ	1 %	¼ W	
R9	B8 305 17D/66K7	66.7	kΩ	1 %	¼ W	
R10	B8 305 17D/23K3	23.3	kΩ	1 %	¼ W	
R11	901/10K	10	kΩ	1 %	¼ W	
R12	B8 305 23D/2M7	2.7	kΩ	1 %	1/10 W	
R13	901/220K	220	kΩ	5 %	½ W	
R14	901/15K	15	kΩ	5 %	¼ W	
R15	901/560K	560	kΩ	5 %	½ W	
R16*	901/220K.../820K	220-820	kΩ	5 %	¼ W	choice resistor
R17	B8 305 17D/185K	185	kΩ	1 %	¼ W	
R18	B8 305 17D/17K7	17.7	kΩ	1 %	¼ W	
R19	B8 305 17D/1K65	1.65	kΩ	1 %	¼ W	
R20	901/56E	56	Ω	1 %	¼ W	
R21	E 098 CG/00A02	2	kΩ			potentiometer, carbon
R22	E 003 AG/D15K	15	kΩ	1 %	1 W	
R23	901/1K5	1.5	kΩ	1 %	½ W	
R24	901/150E	150	Ω	1 %	¼ W	
R25	B8 305 17D/16E6	16.6	Ω	1 %	¼ W	
R26	901/15K	15	kΩ	5 %	¼ W	
R27	901/1M	1	MΩ	10 %	¼ W	
R28*	901/22E.../56E	22-56	Ω	5 %	¼ W	choice resistor
R29	901/5K6	5.6	kΩ	5 %	½ W	
R30	901/33K	33	kΩ	5 %	¼ W	
R31	E 098 CG/00A08	100	kΩ			potentiometer, carbon
R32	901/68K	68	kΩ	5 %	¼ W	
R33	938/A200E	200	Ω	5 %	5 W	wire-wound resistor
R34	901/2K7	2.7	kΩ	5 %	¼ W	
R35	901/150K	150	kΩ	1 %	¼ W	
R36	901/24K	24	kΩ	1 %	¼ W	
R37*	901/100K.../390K	100-390	kΩ	5 %	¼ W	choice resistor

* The correct value has been fixed when adjusting the apparatus in the factory.

Capacitors

No.	Code number	Value	Tolerance	Voltage	Type
C3	904/12K	12 nF	20-50 %	500 V	ceramic capacitor
C4	AC 8208/8+8	8 µF		350 V	electrolytic capacitor
C5	8 µF of C4	8 µF		350 V	electrolytic capacitor
C6	906/47K	47 nF	10 %	400 V	polyester capacitor

Miscellaneous

Mains transformer T1	Code no. M7 615 06
Valves B1	type number EAA91
B2	type number ECC82
B3	type number GL8

Recommended minimum stock of electrical spare parts

Description	Code number	Stock for 1, 3, 5 or 10 instruments Number of instruments 1	3	5	10
Mains transformer	M7 615 06	—	—	—	1
Valves B1	EAA91	1	1	1	2
B2	ECC82	1	1	1	2
B3	GL8	—	—	—	1
Potentiometers R1	E199AA/C21B10K	—	—	—	1
R2	E199AA/B13B20K	—	—	—	1
R21	E098CG/00A02	—	—	—	1
R31	E098CG/00A08	—	—	—	1
Electrolytic capacitor	AC 8208/8+8	—	—	—	1

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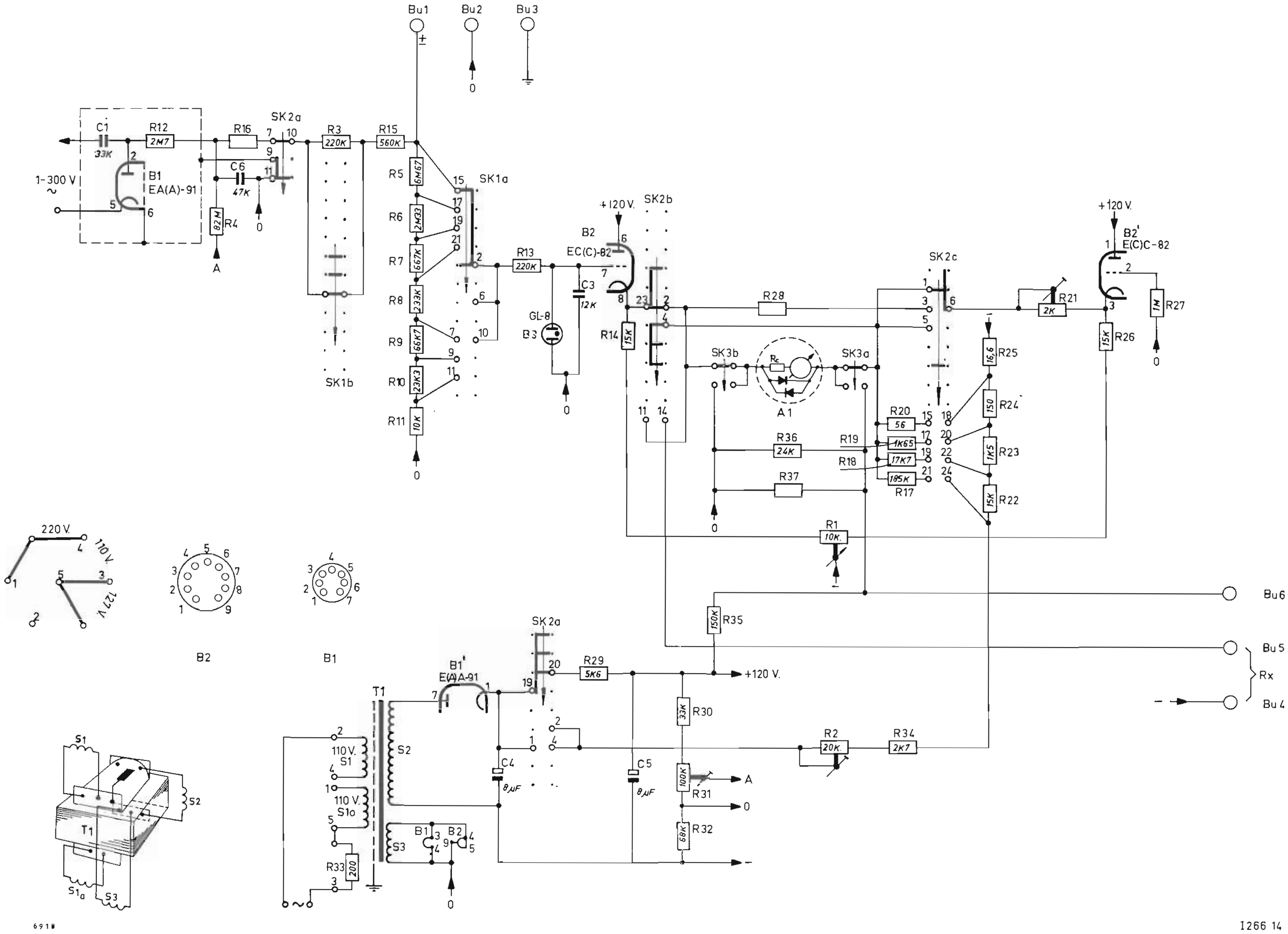

Fig. 16. Diagram of the GM 6000 (modifications reserved)