

# **PHILIPS**

## **Service manual**

### **PM 3210    25 MHz Dual-trace oscilloscope**

9444 032 10011

### 3. ERRATA IN MANUAL 9499 440 07611

#### 3.1. Chapter II. section Y AXIS

The drift specification should read:

Maximum drift at maximum gain

Typical values at constant ambient temperature  
(measurements began half an hour after switching in)  
Short term over 1 minute 0.5 cm  
Long term over 1 hour 0.5 cm

Temperature drift

Typical values at 1 mV/cm : 0.1 cm/°C  
at 10 mV/cm : 0.01 cm/°C

#### 3.2. Chapter VII. section Preliminary Settings of the Controls:

- Set SHIFT (R13/R14)... should read Set POSITION (R14/R15)...

- Set AMPL. (R8/R9) and TIME/cm (R13)... should read

Set AMPL. (R8/R13) and TIME/cm (R4)...

Section General Check of the same chapter:

- AC-0-DC (SK9)... should read AC-0-DC (SK11)...

#### 3.3. Chapter XIII. section Selected Transistor Pairs:

TS401 - 1 & 2 should read TS401, TS402

TS1401 - 1 & 2 should read TS1401, TS1402

TS403 - 1 & 2 should read TS403, TS404

TS1403 - 1 & 2 should read TS1403, TS1404

#### 3.4. The connection numbers of transformer T1201 as indicated in Fig. 68 of the manual are wrong. The correct numbers are given at the transformer outline in circuit diagram Fig. 69 and in the enclosed Fig. 68.

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## VIII. Circuit description

### A. CHANNEL A VERTICAL PRE-AMPLIFIER UNIT (printed-wiring board 1, Fig. 54)

#### General

The pre-amplifier unit provides control of the input coupling, Y deflection co-efficient and gain. Furthermore, a drift reduction circuit and a trigger pickoff stage are part of the pre-amplifier circuitry. The circuit diagram is shown in Fig. 55.

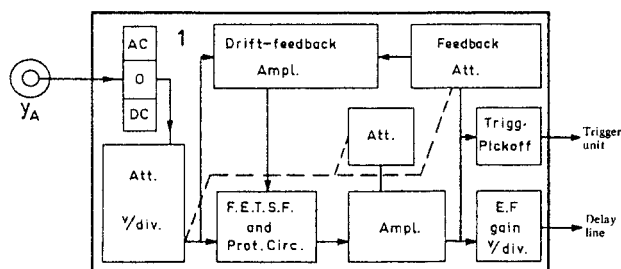


Fig. 15. Vertical pre-amplifier unit

#### A1. Input coupling

Input signals connected to socket  $Y_A$  BU3 can be a.c. coupled, d.c. coupled or internally disconnected. In position DC of switch AC-O-DC SK9, the input signal is coupled directly to the step attenuator. In the AC position, there is a capacitor (C26) in the signal path. This capacitor prevents the d.c. component of the input signal from being applied to the amplifier. In position 0, the signal path between the input socket and the amplifier input is interrupted, the latter being earthed. At the same time blocking capacitor C26 is discharged via R26, to prevent a possible high charge from damaging the circuit under test.

#### A2. Input attenuator

This attenuator is a frequency compensated, high-ohmic voltage divider with fourteen positions. The attenuator consists of four groups of three sections and one group of two sections. The first two groups (mV ranges) are identical and every next one increases the attenuation by a factor of ten.

Each attenuator section contains trimmers which can be adjusted for optimum square-wave response and others that maintain the same input impedance ( $1\text{ M}\Omega/15\text{ pF}$ ) for each position of switch AMPL. (SK12). The attenuator works in conjunction with a gain control in the pre-amplifier. The pre-amplifier comprises two stages. The first one provides step control of the gain in 1–2–5 sequence (see also section A4) and the second one in 1–10 sequence (see also section A5). The gain of the pre-amplifier is selected together with the relevant attenuator section, by means of switch AMPL. SK12.

#### A3. Input source follower

Input source follower TS26-1 and emitter follower TS28 provide a high input impedance to the step attenuator and a low impedance source to the first amplifier stage.

The attenuator, B26, GR26, GR27, R53 and R46 (Fig. 16) protect the input source follower stage.

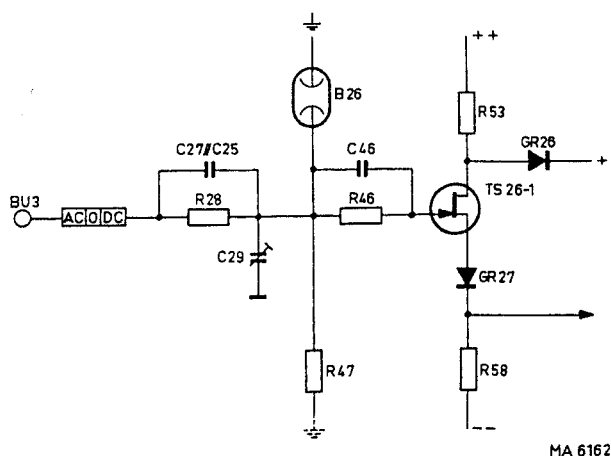


Fig. 16. Input-protection circuit

The attenuator keeps the capacitance between socket  $Y_A$  BU3 and the gate of the field-effect transistor very low in all positions of switch AMPL. SK12.

A rapid maximum voltage change on socket Y<sub>A</sub> will, therefore, only produce a slight change in the charge of this capacitance. If there is a positive-going change, the f.e.t. can deal with it. If the change goes negative, there will be a zener voltage between the gate and the drain of the f.e.t.

As a result of this, the drain voltage drops below the cathode voltage of diode GR26 which turns off. Thus, the drain impedance will be increased with the value of resistor R53 and the discharge current through the f.e.t. is limited.

Neon bulb B26 together with resistor R46 limits the gate current in the event of a continuous input overload voltage. Capacitor C46 in parallel with R46 keeps the h.f. path clear.

Diode GR27 prevents the amplifier from being damaged when the source voltage goes negative.

#### A4. Amplifier with gain control in 1, 2, 5 sequence

The non-driven part of the amplifier (TS26-2) is decoupled for high frequencies, by capacitor C47. GR28 keeps the emitter potentials of transistors TS28 and TS29 on approximately the same level, when the gate of f.e.t. TS26-2 is earthed.

The signal on the emitter of transistor TS28 is amplified by transistors TS31 and TS32 and symmetrically applied to emitter followers TS33 and TS34.

Resistors R75, R76, R77 and R78 between the emitters of long-tailed pair circuit TS31-TS32 determine the amplification ratio as dictated by switch AMPL SK12.

The changes in dissipation that occur when transistors TS31 and TS32 are being driven, are limited by the RC combinations R73//C48 and R81//C51.

To suppress possible common mode disturbance, the values of collector resistors R72 and R82 are small with respect to those of the emitter bias resistors R74 and R79.

#### A5. Amplifier with gain control in 1, 10 sequence

This is an emitter coupled amplifier TS36-TS37 with resistors R97 (10) and R98 (1) as amplification determining components.

The current through both transistors is determined by transistor TS38 together with zener diode GR29 and resistors R108, R109 and R110. It is, therefore, possible to adjust the emitter voltage of emitter follower TS39 to earth level by means of preset potentiometer R109.

Filter R96-C52 in parallel with R97 ensures a correct step response. The changes in dissipation that occur when transistors TS36 and TS37 are being driven, are limited by RC combinations R102//C53 and R92//C54. The collectors of TS36 and TS37 are biased by resistors R91 and R103.

#### A6. Continuous attenuator and gain preset control

Via emitter follower TS39 whose emitter is on earth potential, and resistor R117, the signal is fed to continuous attenuator AMPL. R8.

The gain preset control GAIN ADJ. R9 in parallel with potentiometer AMPL. R8 and resistor R116 provides control of the voltage drop across resistor R117 and so of the overall gain of the pre-amplifier.

After attenuation by potentiometer AMPL. R8, the signal is fed to delay-line termination resistor R122 and via the delay-line to the vertical amplifier unit. Diode GR35 brings the d.c. level of the delay-line to earth potential.

#### A7. Trigger pick-off

The triggering signal is obtained from transistor TS39, i.e., before the continuous attenuator and the delay line. The triggering signal is fed to the trigger amplifier via transistor TS42. Protection zener diode GR31 provides transistor TS42 with collector voltage when another trigger source is used. Capacitor C60 is a peaking capacitor.

#### A8. Drift-reduction circuit

In the event of no drift phenomena in the amplifier, attenuator R131 ... R139 provides at the top of resistor R141 a voltage which is exactly equal to, but in anti-phase with, the voltage at the gate of f.e.t. TS26-1 (top of resistor R47).

This is true because attenuator R133 ... R139 is switched over together with the 1-2-5 and 1-10 amplifier, and because potentiometer R132 compensates for the tolerances of the collector resistors in the amplifier. The junction of resistors R141 and R47 will then be on earth level.

When there is a drift phenomenon, the junction of resistors R141 and R47 carries half the drift voltage. This voltage is amplified by transistors TS43-1 and -2 and, in the correct phase, applied to f.e.t. TS26-1. The resulting feedback brings the output level of the amplifier back to 0 V.

The d.c. level of this feedback is adjusted by means of potentiometer DC BAL R10.

In order to prevent the base-current of transistor TS43-1 and -2 from flowing through high-ohmic resistors R141 and R47, it is compensated for by means of potentiometer R143 and resistors R144 and R146. Resistor R147 keeps the base-impedance of transistors TS143-1 and -2 to almost equal values. Capacitors C57 and C47 limit the drift feedback to d.c. and l.f. so that the step response of the pre-amplifier will not be affected.

## B. CHANNEL B VERTICAL PRE-AMPLIFIER UNIT

As this channel is identical to channel A, the description of channel A also holds good for channel B. Components are assigned in the 200-299 range (corresponding to numbers in the 1-99 range for channel A) and in the 300-399 range (corresponding to range 100-199 in channel A).

## C. DELAY LINES

The delay lines have been incorporated between the pre-amplifiers of channels A and B, and the vertical amplifier.

In order to prevent that return currents flow via the chassis of the instrument, h.f. transformers T401 and T402, and T1401 and T1402 have been provided at the beginning and the end of the delay lines.

## D. VERTICAL AMPLIFIER UNIT (printed-wiring board 4, Figs. 58 & 58A)

The vertical amplifier unit comprises two identical amplifier stages, one for channel A and one for channel B, the latter of which is described.

Furthermore an electronic switch, a common amplifier stage and an output stage are part of the vertical-amplifier unit. The circuit diagram is shown in Figs. 59 & 60.

## D1. Principle of series and shunt feedback amplifier

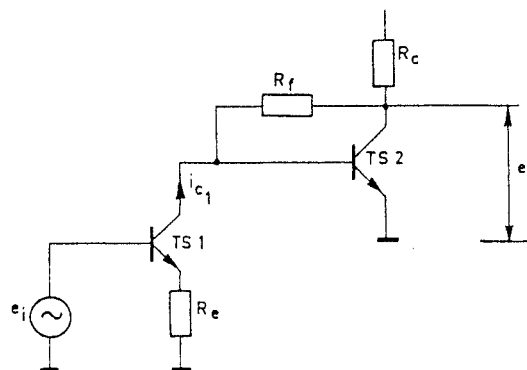


Fig. 18. Feedback amplifier

A typical example of an amplifier stage with series and shunt feedback is shown in Fig. 18.

If we neglect the base current of TS2, it will be clear that the current through  $R_e$  also flows through  $R_f$ .

The transfer ratio  $\frac{i_c}{e_i}$  in a series feedback amplifier stage is approximately  $\frac{1}{R_e}$ .

The transfer ratio  $\frac{e_o}{i_c}$  in a shunt feedback amplifier stage is approximately  $R_f$ .

So the voltage gain of the whole amplifier stage is near enough:

$$A_v = \frac{e_o}{e_i} = \frac{R_f}{R_e}$$

Thus, the gain depends only on the passive elements  $R_f$  and  $R_e$ .

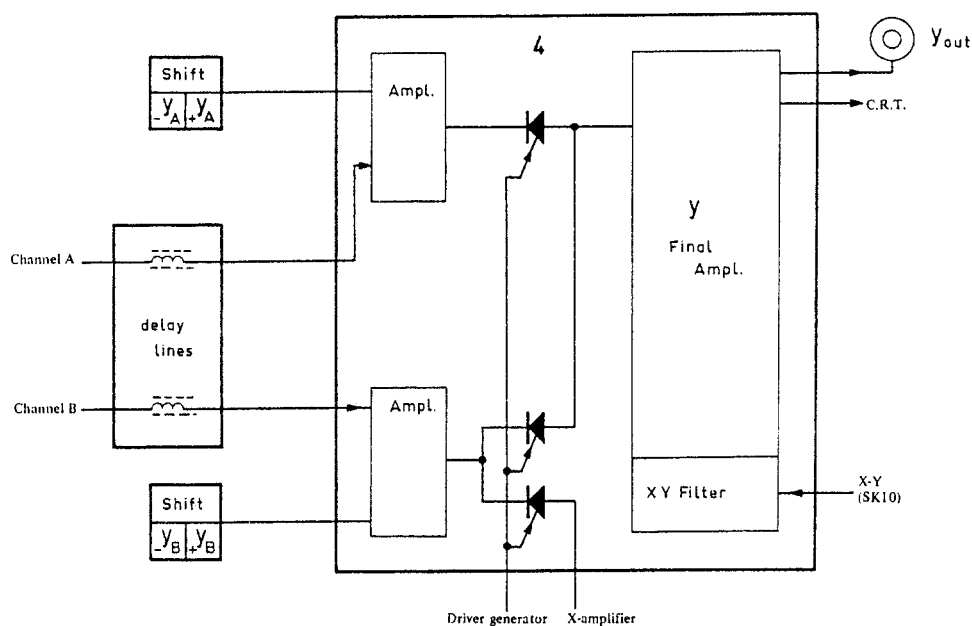


Fig. 17. Vertical amplifier unit



Note that the input impedance of the shunt feedback stage is very low due to resistor  $R_f$ , so that this stage is driven by a signal current.

Because the input of the second stage is virtually earthed, this is the ideal place to introduce an electronic switch and to apply currents of a position control without affecting the behaviour of the circuit.

## D2. Amplifier stage for channel B (series-feedback amplifier)

The signal across delay-line termination resistor R401 is fed to the base of transistor TS403, via emitter follower TS401.

Transistor TS403 forms together with transistor TS404 and transistors TS414 and TS416 a symmetrical series and shunt feedback amplifier, the gain of which is determined by resistors R428 and R456 & R459. Details of the series-feedback amplifier will be discussed in this paragraph, whereas details of the shunt-feedback stage will be dealt with in paragraph D4.

Possible step-response errors caused by the delay line are eliminated by correction elements C402/R429, C403/R431, C404/R435 and C406/R432.

The changes in dissipation that occur when transistors TS403 and TS404 are being driven, are limited by the RC combination R426//C411 and R436//C412.

Emitter follower TS402 transfers the shift voltage provided by potentiometer POSITION R15 to the base of transistor TS404. The polarity of the shift voltage can be inverted by means of switch SK15.

Potentiometer R407 allows equalization of the quiescent emitter voltages of transistors TS403 and TS404.

The signal current from the collectors of transistors TS403 and TS404 is fed to the electronic switch via either transistors TS406 & TS409, or transistors TS407 & TS408, as dictated by the position of switch SK15.

Transistors TS406 & TS409 and TS407 & TS408 allow polarity inversion of the signal and can be switched on and off in pairs, with the aid of switch SK15 which is followed by two voltage dividers (R413-422-423 and R414-419-421). Polarity inversion incurs inversion of the polarity of the shift voltage.

Preset potentiometer R407 prevents jumping of the trace when switch SK15 is operated.

## D3. Electronic switch

The electronic switch, which is driven by the switch-driver unit (printed-circuit board 5), is a diode switch. Therefore, all signal voltages must be converted into signal currents in the previous amplifier stage, and the input impedance of the common amplifier must be very low.

The electronic switch offers various possibilities, as there are two signal-current channels: A and B.

These currents can be fed to either the common amplifier or the horizontal amplifier, depending on the driving voltage which opens or closes the diode switch.

The driving voltages of the switch-driver unit are applied to emitter followers TS411 & 412 and TS1411.

If the voltage on the emitters of TS411 & 412 is low with respect to the input voltage of the common amplifier, diodes GR407 & 408 are cut off. Then the signal current is fed to the input of the common amplifier via the conducting diodes GR406 & 409 (Fig. 19).

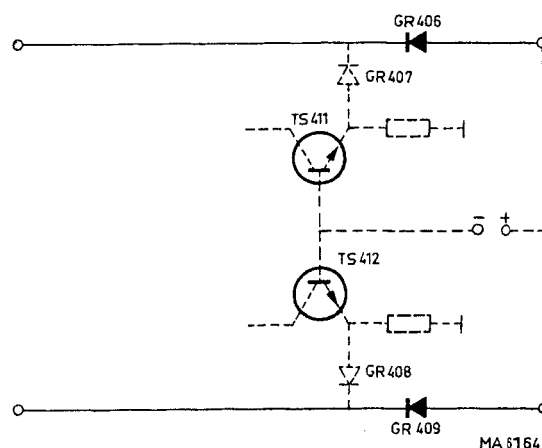


Fig. 19.

The same applies to the emitter voltage of transistor TS411. If this voltage is low, the signal currents reach the input of the common amplifier (Fig. 20).

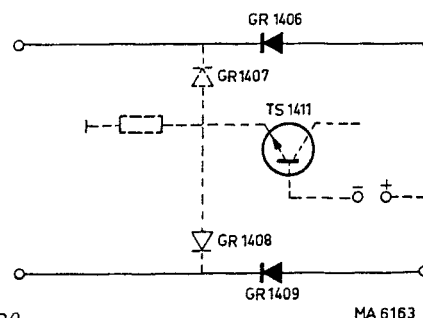


Fig. 20.

However, if the base voltage of transistor TS1411 exceeds the input voltage of the common amplifier, diodes GR1406 and GR1409 are cut off and diodes GR1407 and GR1408 are conductive. The signal current of channel A cannot reach the input of the common amplifier any longer.

The conducting diodes GR1407 & 1408 short-circuit this signal (Fig. 21).

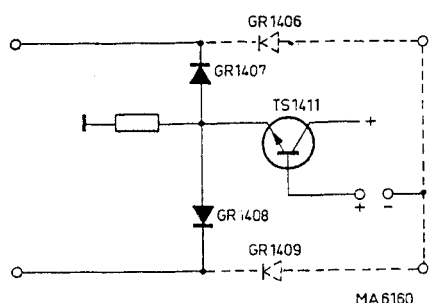


Fig. 21.

The same explanation applies, roughly speaking, to channel B. If the base voltages of transistors TS411 & 412 exceed the input voltage of the common amplifier, diodes GR406 & GR409 are cut off and no signal current is fed to the common amplifier.

The signal current then flows via conducting diodes GR407 & 408 through transistors TS411 & 412.

Depending on the anode voltage of diodes GR403 & 404 the signal can be either short-circuited via these diodes, or applied to the horizontal amplifier via resistors R446 & 447.

If the anode voltage exceeds the input voltage of the horizontal amplifier, the signal is short-circuited. If there is no voltage applied via point 25 of switch SK10, resistor R444 causes the anode voltages of diodes GR403 & 404 to be negative and the signal current is fed to the horizontal channel (Fig. 22).

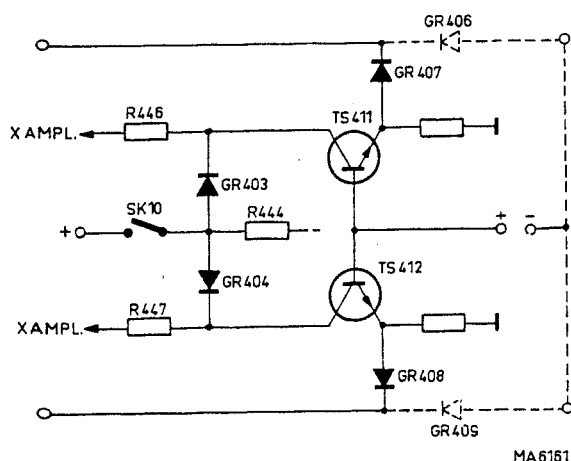


Fig. 22.

Summarizing there are the following possibilities:

1. Base TS411 negative (Fig. 20):  
signal current channel A fed to vertical output stage.
2. Base TS411 positive (Fig. 21):  
signal current channel A short-circuited.
3. Bases TS411 & 412 negative (Fig. 19):  
signal current channel B fed to vertical output stage.
4. Bases TS411 & 412 positive (Fig. 22):  
signal current channel B does not reach the vertical output stage, and can, depending on the voltage at point 25 SK10:
  - a. be short-circuited via conducting diodes GR403 & 404 (25 SK10 positive).
  - b. be fed to the horizontal amplifier via R446 & 447 (25 SK10 negative).

#### D4. Common amplifier stage (shunt-feedback amplifier)

This amplifier comprises transistors TS413 ... TS417.

The use of transistors TS413 & 417 which act as emitter followers, also provide a low-ohmic output impedance. This enables an efficient driving of the output stage and the possibility of presenting the signal on socket YOUT BU7.

The input signal for the common amplifier stage can be obtained as described in para. D2 from pre-amplifier A, pre-amplifier B, or from A and B.

In position A or B, the input of the common amplifier receives both the signal current and the quiescent current of the relevant channel.

In position A + B, the quiescent current will reach double the value and also the output capacitance of the electronic switch will increase slightly. To eliminate errors caused by this phenomenon, resistors R453 & 454 are, via point 24 of switch SK10, connected to the positive voltage that supplies the quiescent current of the 2nd channel.

As resistor R455 is then also connected to the positive voltage, diode GR411 is cut off and the output capacitance of the electronic switch will decrease with the value of capacitor C409.

#### D5. Output stage

The output signal of the common amplifier is fed to the vertical deflection plates via the output stage. This stage is a series and shunt-feedback amplifier of the type described in para. D1. The gain determining components are R616 and R623 & R632.

- a. The series-feedback stage, consists of two emitter-coupled transistors TS602 & 603. The series-feedback is adjusted with potentiometer R616 so that the gain of the output amplifier can be adapted to the sensitivity of the c.r.t.

The bias current is supplied by transistor TS601 and adjusted with potentiometer R602. Diodes GR601 and GR602 prevent cutting off of the transistors at large driving signals.

b. The shunt-feedback stage, consists of p.n.p. transistors TS606 & TS 607 and complementary n.p.n. transistors TS604 & 608. The shunt-feedback is obtained with resistors R623 & 632.

The current in this stage is determined by the base-bias resistors R618 & 619 of transistor TS608, together with emitter resistors R621 & 637.

These transistors work for a.c. voltages only and receive their driving via capacitors C606 & 612. Resistor R627 determines the emitter voltage and thus the base voltage of transistors TS606 & 607.

c. An XY filter, has been included between the series- and shunt-feedback stage and consists of resistors R617, R628 and R614, and of capacitors C603 and C604.

The XY filter is switched in by means of reed relay RE601 which is energized via resistor R615, when the XY push-button of switch SK10 is operated.

The XY filter equalizes the frequency and phase response of the vertical amplifier to that of the horizontal amplifier when the oscilloscope is used for XY measurements.

## E. TIME-BASE UNIT (printed-wiring board 3, Fig. 61)

### General

This unit comprises the following circuits: the trigger-pulse shaper, the time-base generator and the trigger auto circuit. The circuit diagram is shown in Figs. 62 & 63.

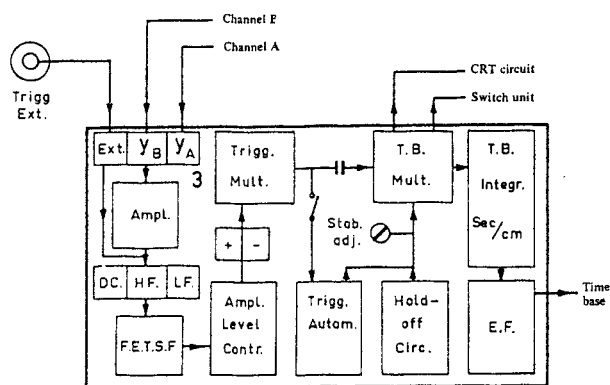


Fig. 23. Time-base unit

## E1. Trigger-Pulse shaper

### E1a. Input amplifier

The triggering signal from either channel A or channel B can be fed to the emitter of transistor TS702 via switch  $Y_A - Y_B$ -EXT SK4. As no signal current is lost in the base of transistor TS702, the amplified input signal is available across resistors R719 and R721.

### E1b. Filters

In position  $Y_A$  or  $Y_B$  of switch  $Y_A - Y_B$ -EXT SK4 the signal is via emitter follower TS703, applied to the high-ohmic filters that are switched in by means of switch LF-HF-DC SK2 (Fig. 24).

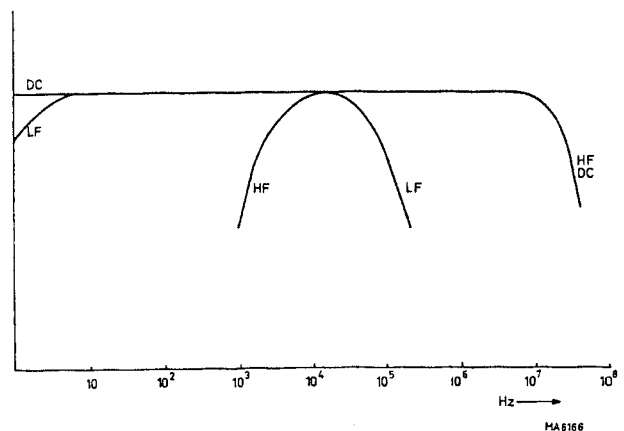


Fig. 24. Frequency response of the trigger amplifier

In the LF position, the triggering signal is coupled via filter C706 - R727 - C707 which forms a bandpass filter for frequencies from 10 Hz to 10 kHz.

In the HF position, the triggering signal is coupled via high-pass filter C708 - R728 which blocks frequencies below 10 kHz.

In the DC position, the triggering signal is directly coupled to the differential amplifier.

In the AUTO position of switch LEVEL SK5, the triggering signal is a.c. coupled as capacitor C709 is in the signal path.

In position EXT of switch  $Y_A - Y_B$ -EXT SK2, the triggering signal is not taken from emitter follower TS703, but from input socket EXT. TRIGG. BU1. The high-ohmic filters followed by f.e.t. source follower TS704-1 provide a high input impedance so that the triggering-signal source is neither loaded nor affected. Diodes GR701 and GR702 protect the input circuit by limiting too high an external triggering signal.

### E1c. Differential amplifier

Via impedance transformer TS704-1, the triggering signal is fed to the base of transistor TS706. This results in voltages with equal amplitude but in anti-phase on the collectors of transistors TS706 and TS707. Selecting one of these voltages by means of switch  $\pm$ -SK3 allows triggering on either the positive- or the negative-going edge of the signal.

Potentiometer LEVEL R1 allows, via f.e.t. source follower TS704-2, continuous control of the d.c. level on the base of transistor TS707. The level setting determines which part of the triggering signal will be amplified. Thus, the trigger level is determined by the setting of potentiometer LEVEL R1.

In the AUTO position (switch LEVEL SK5 pulled) the voltage range on the base of transistor TS707 is limited by connecting R758 in parallel to potentiometer LEVEL R1.

### E1d. Pulse-shaper

The amplified triggering signal switches trigger pulse-shaper TS711 & 712. In the event of a repeating triggering signal, there will be a square-wave voltage with a constant amplitude and rise-time on the collector of transistor TS712 (Fig. 25). By means of capacitor C801 and resistor R802, this voltage is differentiated into positive and negative pulses.

Transistor TS801, which is normally cut off, blocks the negative pulses, whereas the positive pulses are converted into negative spikes which are applied to the time-base generator via capacitor C804.

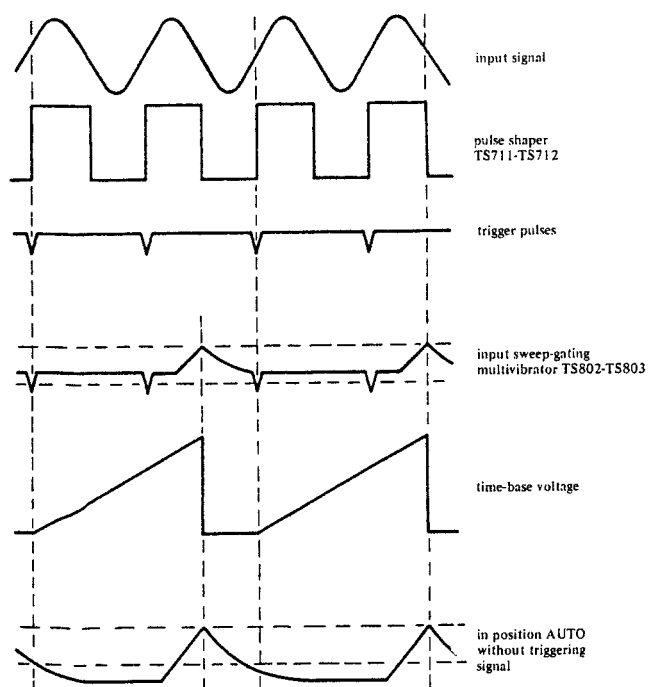


Fig. 25. Pulse shapes

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### E2. Time-base generator

The time-base generator consists of a bootstrap integrator driven by sweep gating multivibrator (s.g.m.) TS802 & 803.

For the explanation of the diagram, we assume the following condition of the s.g.m.:

- transistor TS802 cut off
- transistor TS803 conductive

Discharge transistor TS804 is blocked and time-base capacitor C832 is charged with a constant current which is determined by resistor R871.

The constant charging current is obtained by feedback in the bootstrap integrator via transistors TS808 & 809; as a result the voltage across resistor R871 has a constant value.

The direct current through transistor TS808 can be adjusted with both potentiometer TIME/cm R4 and potentiometer R803. In this way it is possible to vary the constant voltage across resistor R871 and thus the time-coefficient. Potentiometer TIME/cm R4 is the continuous time-coefficient control, whereas R803 is an internal pre-set potentiometer.

Via transistors TS806 & 807, diode GR801 and transistor TS811, the linearly increasing voltage across capacitor C832 is fed back to s.g.m. TS802 & 803, causing the latter to switch over to the state:

- transistor TS802 conductive
- transistor TS803 cut off

Transistor TS804 becomes conductive and capacitor C832 is discharged. The voltage at the input of the s.g.m. drops to a level on which the s.g.m. just does not switch over. This level is adjusted by means of potentiometer STAB R6.

The decrease of the voltage level on the s.g.m. input is delayed by hold-off capacitor C821, so that capacitor C832 can discharge completely. Thus the s.g.m. can switch over only if capacitor C832 has been completely discharged.

On arrival of the next trigger pulse, the s.g.m. switches over, transistor TS804 is cut off and capacitor C832 is charged.

With the aid of switch TIME/cm SK6, 21 different time-coefficients can be set by selecting different capacitors from the range C823 ... C832 and charging resistors from the range R861 ... 871. The time-coefficient is calibrated when potentiometer TIME/cm R4 is in the fully clockwise position.

The sawtooth voltage is taken off via voltage divider R838-839 across zener diode GR801, so that the voltage lies around zero level.

The unblanking voltage is taken off from the collector of transistor TS802.

In position XY of the mode selector SK10, the +23 V supply of both pulse generator and time-base generator is replaced by a negative voltage.

As the supply of resistor R854 ceases, the input voltage of the s.g.m. drops, so that transistor TS802 is cut off and its collector supplies the unblanking signal.

Because the base voltage of transistor TS807 cannot exceed its collector voltage and the voltage on the time-base capacitor cannot become positive, the s.g.m. is not switched back.

On the collector of transistor TS803 the signal is taken off, which switches the vertical output amplifier at every time-base sweep between pre-amplifier A and B, in position ALTERNATE of mode selector switch SK10.

### E3. Automatic trigger circuit

In the level position of switch LEVEL SK5, the base of transistor TS812 is connected to the -23 V supply, so that transistor TS812 is cut off.

In the automatic position, transistor TS812 draws base current via resistor R849, in the event of no trigger pulses. The collector current lowers the level at the input of s.g.m. TS802 & 803, so that the s.g.m. switches over after the fly-back of the time-base: the time-base generator is free-running.

In the event of a triggering signal, the base of transistor TS812 becomes negative again as a result of the square-wave voltage on its collector, which is rectified by circuit C813, GR806, GR804 and C814. Consequently, transistor TS812 is cut off. Thus, the time-base generator is not free-running any longer and will only be started by a trigger pulse, applied via C804.

## F. HORIZONTAL AMPLIFIER UNIT (printed-wiring board 7, Fig. 64)

### General

The horizontal amplifier unit comprises a pre-amplifier and an output amplifier. The circuit diagram is shown in Fig. 65.

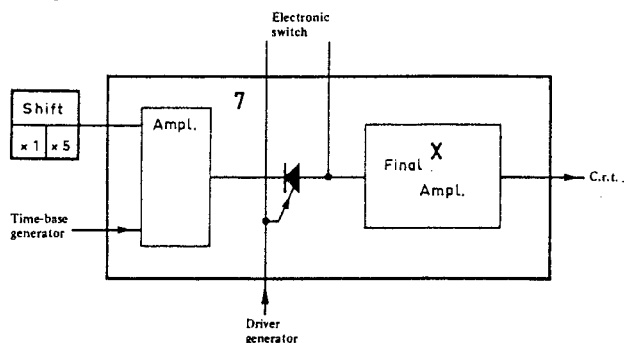


Fig. 26. Horizontal amplifier unit

### F1. Pre-amplifier

The pre-amplifier is a series and shunt-feedback amplifier of the type described in para. D1. Gain determining elements are R917 and R924 & 931. The pre-amplifier is driven on the base of transistor TS901 by the output signal of the time-base generator.

A d.c. voltage, adjustable with potentiometer POSITION R7, is applied to the base of transistor TS902.

If switch MAGN. SK8 is pulled to the x 5 position, diodes GR901 & 902 which are normally cut off, start conducting via switch SK8. Consequently resistor R904 is connected in parallel to R917, resulting in a gain increase of 5 x.

If diodes GR906 & 907 are cut off and diodes GR908 & 909 are conductive, the series-feedback stage is connected to shunt-feedback stage TS903-906 & TS904-909. Resistors R924 and R931 are the feedback resistors.

In position XY of mode selector SK10, resistor R922 is connected to the +23 V supply so that diodes GR906 & 907 start conducting and diodes GR908 & 909 are cut off.

Amplifier stage TS903 & 906 and TS904 & 909 is then via diodes GR911 & 912 connected to channel B of the vertical amplifier.

### F2. Output amplifier

The gain of emitter-coupled amplifier stage TS907 & 908 is determined by potentiometer R944 and resistor R947.

By means of potentiometer R944, the gain of the horizontal amplifier is adapted to the sensitivity of the c.r.t. The phase- and frequency response of the horizontal amplifier can be corrected with filter C906-R946.

The bias current for this stage is supplied by transistor TS911 and can be adjusted by potentiometer R959.

Zener diodes GR916 & 917 bridge the difference in voltage level between amplifier stage TS907 & 908 and the output stage with transistors TS912 ... 914 and TS916 ... 918.

The voltage feedback of the output stage is obtained from resistors R961 & 967. The current in this stage is determined by the base biases of transistors TS914 (by resistors R968 & 969) and TS918 (by resistors R976 & 977), in conjunction with emitter resistors R983 & 984. These transistors work for a.c. voltages only and obtain their signal via capacitors C911 & 912.

Resistor R985 determines the emitter voltage and thus the base voltage of transistors TS916, TS912, TS917 and TS913.

## G. SWITCH UNIT (printed-wiring board 5, Fig. 66)

### General

The switch unit comprises a blocking oscillator, a multivibrator and the mode selector switch SK10. The circuit diagram is shown in Fig. 67.

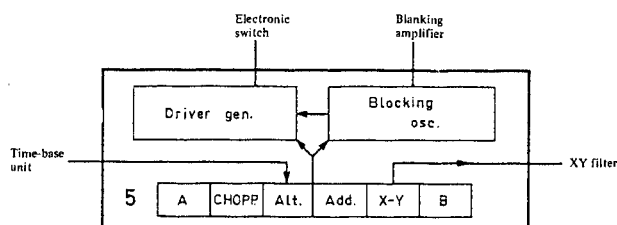


Fig. 27. Switch unit

### G1. Blocking oscillator

The blocking oscillator consists of transformer T501 in conjunction with transistor TS506. Winding S1 of the transformer (in the collector circuit of transistor TS506) is coupled to the winding S4 in the base circuit of TS506.

If the potential of the base winding is sufficiently negative to open the transistor, the current in the transistor and the voltage across C514/R537 increases as a result of the forward coupling.

This process continues until transformer T501 is saturated and the base drive ceases. Then there flows no current in the transistor any longer until capacitor C514 has discharged via resistor R537. Thus, this capacitor and resistor determine the frequency of the oscillator.

It is possible to switch the blocking oscillator on or off via voltage divider R527-528. When R527 is connected to earth via point 11SK10, the base of transistor TS905 becomes negative with respect to its emitter and the oscillator is operative.

If resistor R527 is not connected to earth, the base potential of transistor TS506 is equal to its emitter potential and the oscillator becomes operative only at incoming pulses which are large enough to open the transistor. These pulses are supplied by winding S3 of the transformer in conjunction with transistor TS507.

The base of the latter receives a positive pulse via resistor R816 at each fly-back of the time-base, and the transistor then starts conducting. The collector current which flows through winding S3 drives the blocking oscillator.

To prevent the time-base generator from affecting the frequency when the oscillator is free-running, the emitter of transistor TS507 is, in that event, connected to the positive supply voltage via resistor R529 and point 14 of switch SK10. Consequently, transistor TS507 is blocked to such an extent that the time-base pulses have no influence on it at all.

Transformer winding S3 supplies in all above-mentioned events a negative pulse which is via resistors R535 and R530 fed to the blanking system and the cathode of the c.r.t. The blanking system suppresses the electron beam in the c.r.t. during the switching over of the blocking oscillator.

Summarizing there are the following possibilities.

#### 1. The oscillator is free-running

Point 11SK10 is connected to earth and point 14SK10 is connected to the positive supply voltage. Across resistor R530 there are negative blanking pulses (GR511 clips the positive side).

#### 2. The oscillator is inoperative

Point 11SK10 is connected to earth and point 14SK10 is connected to the positive supply voltage.

#### 3. The oscillator is driven by the time-base generator

Point 11SK10 is disconnected from earth. Each time-base fly-back pulse opens transistor TS507 so that the oscillator becomes operative.

Winding S2 of transformer T501 supplies the output pulse of the oscillator to the multivibrator via a phase delaying network. This network consists of L501, R525 and C505, and makes sure that the blanking pulses suppress the electron beam at the correct moment.

### G2. Multivibrator

The bistable multivibrator comprises the transistors TS502 and TS503. Both transistors are coupled by means of resistors R511 & 517 and R514 & 513, which make sure that the conducting transistor keeps the non-conducting transistor in the cut-off state.

Assume that transistor TS502 is conducting. Then its collector voltage almost equals its base voltage. Consequently, diode GR504 is on the verge of conducting, whereas diode GR506 is hard off owing to the positive collector voltage of transistor TS503.

A negative pulse applied to the blocking oscillator will reach the diodes via capacitors C504 and C506.

Diode GR506 remains cut off and GR504 starts conducting so that the negative pulse arrives at the base of transistor TS502 and turns this transistor off. Consequently, the collector voltage of transistor TS502 becomes positive and transistor TS503 starts conducting.

This process is repeated at each entering pulse of the blocking oscillator.

Zener diodes GR507 and GR508 bring the d.c. level on the collector of transistors TS502 & 503 and thus on the emitters of transistors TS501 & 504, on the value required for the electronic switch.

Diodes GR501 & 502 prevent top errors of the output square-wave voltage, as these errors might adversely affect the proper working of the electronic switch.

Resistors R518 & 519 at the bases of transistors TS502 & 503 enable selection of a preference state for the bistable multivibrator.

If point 35 of switch SK10 is connected to the positive voltage, transistor TS503 starts conducting and transistor TS502 is cut off. This means that the output conditions of the switch unit are such that the signal of channel B is displayed.

If, on the other hand, point 6 or point 29 of switch SK10 is connected to the positive voltage, channel A will be displayed.

If point 23 of switch SK10 becomes positive, diodes GR508 & 509 which were cut off via resistor R521, start conducting. Both transistors TS502 and TS503 draw current so that the output voltages of transistors TS501 and TS504 will be equal and negative. This occurs in position ADDED of switch SK10: both channel A and channel B are connected to the vertical output amplifier.

### G3. Mode selector switch SK10

By means of mode selector switch SK10, the desired channel or channel combination can be displayed.

Summarizing, together with the previous descriptions of the electronic switch, multivibrator, horizontal and vertical amplifier, this means that:

a. In position **A**, the blocking oscillator is blocked, no blanking pulse is fed to the c.r.t. and the multivibrator is set to the correct position.

b. In position **CHOPPED**, the blocking oscillator becomes operative and is not affected by the time-base generator. The electronic switch is driven by the blocking oscillator via the multivibrator and the electron beam is suppressed during the switching over.

c. In position **ALTERNATE**, the blocking oscillator is driven by the fly-back of the time-base, so that signals of both vertical channels are displayed in turns.

d. In position **ADDED**, the blocking oscillator is inoperative and no blanking pulse is applied to the c.r.t. Both multivibrator transistors are conductive so that both channel A and channel B supply their signals via the common amplifier to the output amplifier. At the

same time, the quiescent current for the extra amplifier is supplied via point 24 of switch SK10, and the capacitive change in the electronic switch is eliminated.

e. In position **XY**, the blocking oscillator is inoperative and no blanking pulse is applied to the c.r.t. The time-base generator cannot operate any longer as its power supply is interrupted via point 25 of switch SK10. Channel A is connected to the vertical output amplifier and channel B to the horizontal amplifier.

f. In position **B**, the blocking oscillator is inoperative and no blanking pulse is applied to the c.r.t. The multivibrator is set to the correct position.

## H. C.R.T. CIRCUITRY & POWER SUPPLY (printed-wiring boards 8 & 6, Figs. 70 & 68)

### General

The c.r.t. circuitry provides control of the intensity, focus and astigmatism, and correction possibilities for barrel and pin-cushion distortion and the position of the trace.

The blanking circuit is also part of the c.r.t. circuitry. The power supply comprises the mains transformer, stabilized supply and converter, the calibration voltage generator and the circuit for the graticule illumination. The circuit diagrams are shown in Figs. 69, 71 & 73.

### H1. Mains transformer

Mains transformer T1101 has four primary windings which, by means of voltage adapter SK16, can be combined in such a way that the instrument can be used with voltages of 245, 220, 200, 145, 125, and 110 V. The mains input is provided with an interference suppression filter.

The voltage on secondary winding 9-10 is full-wave rectified. The resulting positive d.c. voltage is applied to the voltage stabilizer and the converter.

In addition, transformer winding 11-12 supplies the heater voltage for the c.r.t. This voltage lies on approximately the same d.c. level ( $-1600$  V) as the cathode, in order to prevent flashover between cathode and filament.

### H2. Voltage stabilizer

The output voltages of the converter are stabilized. The stabilization is effected by comparing a voltage which is proportional to the  $+23$  V converter voltage, with a reference voltage supplied by zener diode GR1106, in a differential amplifier. The difference, if any, is applied to the series regulator TS1102 which compensates for the difference.

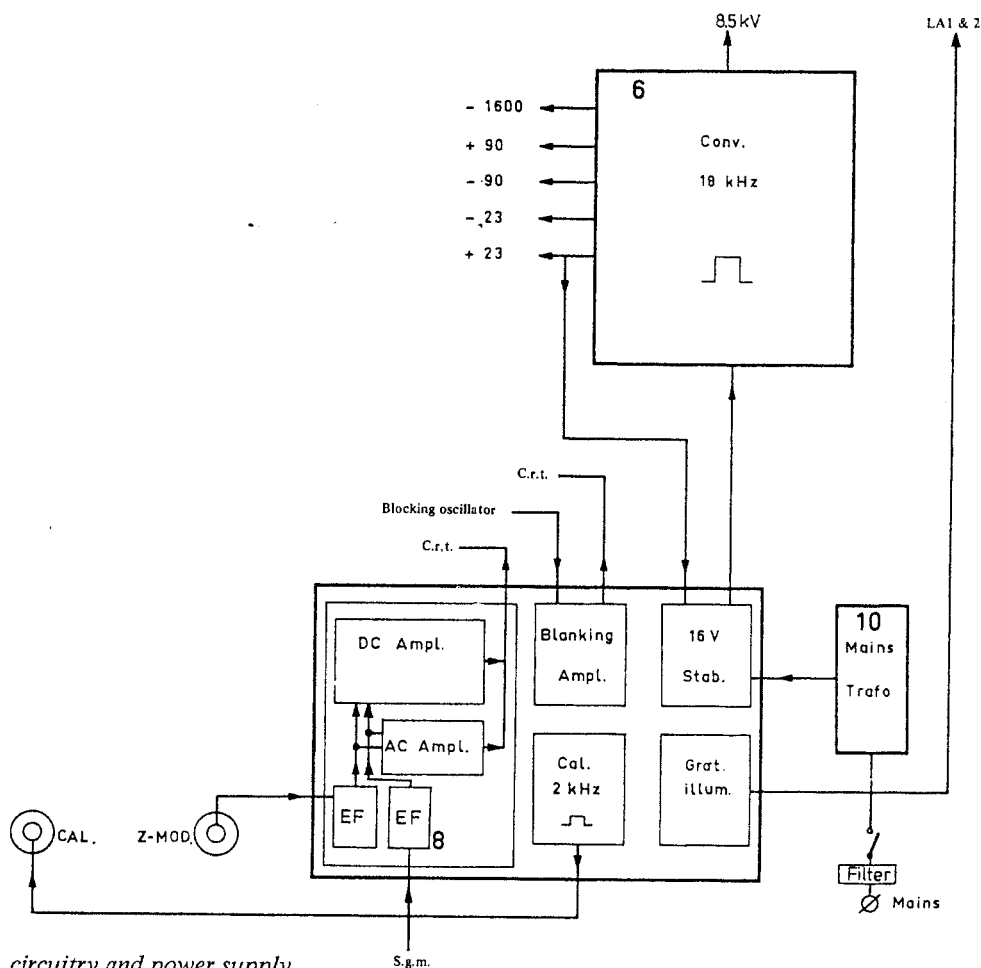


Fig. 28. C.r.t. circuitry and power supply

Potentiometer R1114 allows accurate adjustment of the +23 V converter voltage. The hum can be minimized by means of potentiometer R1118.

The converter consists of an inductive multivibrator (transistors TS1101 & 1102 and the primary of transformer T1201) operating at a frequency of approx. 18 kHz. After rectifying the secondary voltages of transformer T1201, the stabilized voltages +23 V (reference voltage), -23 V, +85 V, -85 V, -1600 V and the high voltage +8500 V are obtained.

If one of the supply voltages is short-circuited, the converter comes into a safe state of power consumption. Thus, the power supply of the instrument is protected against short-circuits.

### H3. Calibration voltage

The calibration voltage generator consists of free-running multivibrator TS1108 & 1109. The generator frequency is approximately 2 kHz. The amplitude of the generated square-wave voltage is kept at a constant value by means of zener diode GR1107. The exact value of the calibration voltage is set with the aid of select-in-test resistors R1136 & 1138.

### H4. Illumination circuit

The graticule of the c.r.t. can be illuminated by means of bulbs LA1 and LA2.

The intensity can be varied with the aid of potentiometer ILLUM R5 which controls the collector current (which is the current through the bulbs) of transistor TS1104.

### H5. C.r.t. circuit

By means of potentiometer INTENS R2 the brightness of the display can be continuously controlled. The maximum beam current is set by potentiometer R1021. The control range of both potentiometers is set with select-in-test resistors R1018 & 1019.

The display can be focussed by potentiometer FOCUS R3, the control range of which is set by select-in-test resistor R1013.

Astigmatism is corrected with the aid of potentiometer R1044.

With the aid of potentiometer R1047 barrel and pin-cushion distortion is corrected.

Potentiometer R1048 provides trace rotation control and allows the time-base line to be accurately aligned with the horizontal graticule lines.



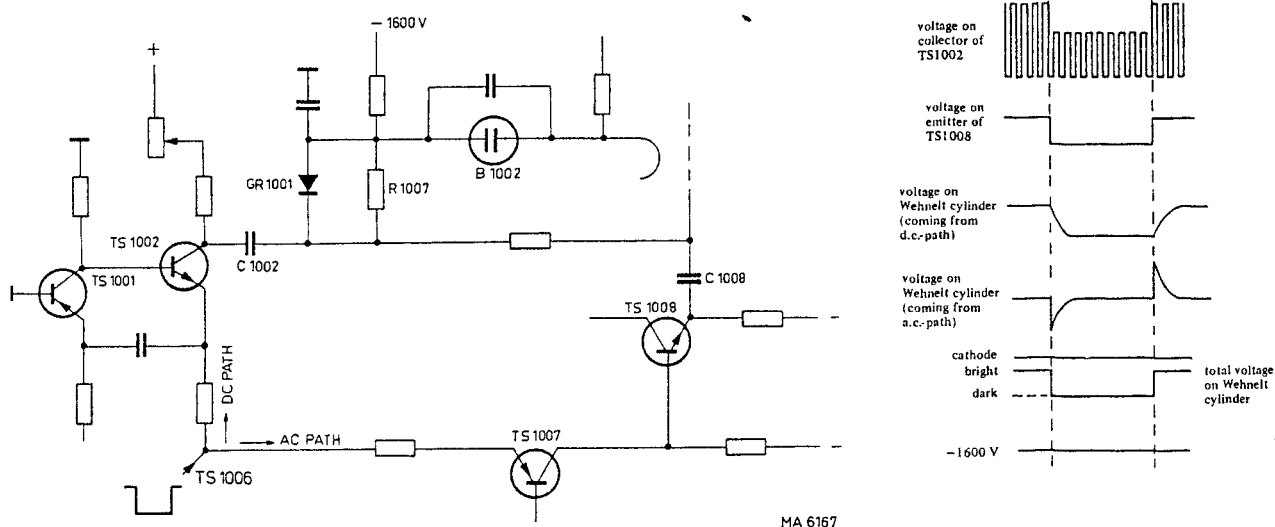


Fig. 29. Simplified diagram of the blanking circuit

### H6. Blanking circuit (see Fig. 29)

The blanking circuit blanks the c.r.t. during the fly-back of the time-base and unblanks the c.r.t. constantly in position XY of mode selector switch SK10.

The blanking circuit also enables external Z modulation, and intensity control.

is modulated with the d.c. component (current drive from transistor TS1006). The amplified modulated signal on the collector of transistor TS1002 is via capacitor C1002 fed to demodulator GR1001-R1007. The a.c. and d.c. amplifications are equalized by means of potentiometer R1001.

#### H6.1. Blanking of the time-base fly-back

The blanking circuit operates on a low voltage level and comprises an a.c. and a d.c. path.

- The a.c. components of the blanking signal are fed directly to the Wehnelt cylinder of the c.r.t. via H.T. capacitor C1008.
- The d.c. components are modulated on a carrier and via H.T. capacitor C1002 transferred to demodulator circuit GR1001-R1007 in the c.r.t. circuit.

#### H6.2 Unblanking of the time-base sweep

Transistor TS1006 is driven on its base by the collector signal of transistor TS802 in the s.g.m. Transistor TS1006 operates in the emitter-follower configuration.

- **A.C. Path:** Transistor TS1006 drives transistor TS1007 on its emitter. The amplified blanking signal on the collector of TS1007 is passed to the Wehnelt cylinder of the c.r.t. via emitter follower TS1008 and capacitor C1008.
- **D.C. Path:** For the d.c. component of the blanking signal, the signal of oscillator TS1001 & 1002 is used. The oscillator signal (frequency approx. 150 kHz)

#### H6.3 External Z modulation

Input socket Z MOD. BU8 is d.c. coupled to the blanking circuit via emitter follower TS1004.

This emitter follower drives transistors TS1007 & 1002 in the same way as described above.

The input transistor TS1004 is protected against overload, by means of resistor R1039 which limits the base current in the event of too high a positive input voltage, and by diode GR1004 which starts conducting at negative input voltages exceeding  $-24$  V.

#### H7. Intensity control

Potentiometer INTENS. R2 allows control of the current through oscillator transistor TS1002 so that the oscillation amplitude on its collector varies. After demodulation by GR1001-R1007, a variable positive d.c. voltage is produced which drives the Wehnelt cylinder of the c.r.t.

R1021 allows adjustment of the maximum beam current when potentiometer INTENS R2 is set to maximum. B1002 in the c.r.t. circuit is connected in such way that the c.r.t. is blanked if the oscillator TS1001 & 1002 becomes inoperative (between the cathode and the Wehnelt cylinder of the c.r.t. there is the working voltage of neon bulb B1002).

#### H8. Blanking during switching in position **CHOPPED**

Transistor TS1003 is driven by a negative pulse from blocking transformer T501.

The positive pulse which then arises on the collector of TS1003 is applied to the c.r.t. circuit by means of

transformer T1001.

Level diode GR1003 makes sure that the cathode level of the c.r.t. is not affected by the positive pulses of the blanking circuit and also that possible negative ringings of transformer T1001 are not transferred.

## IX. Dismantling the instrument

### IMPORTANT:

- In this instrument very high voltages are generated so that you must take due care when you are working

on the interior of the instrument.

- Switch off the instrument at least one minute before you start replacing parts.

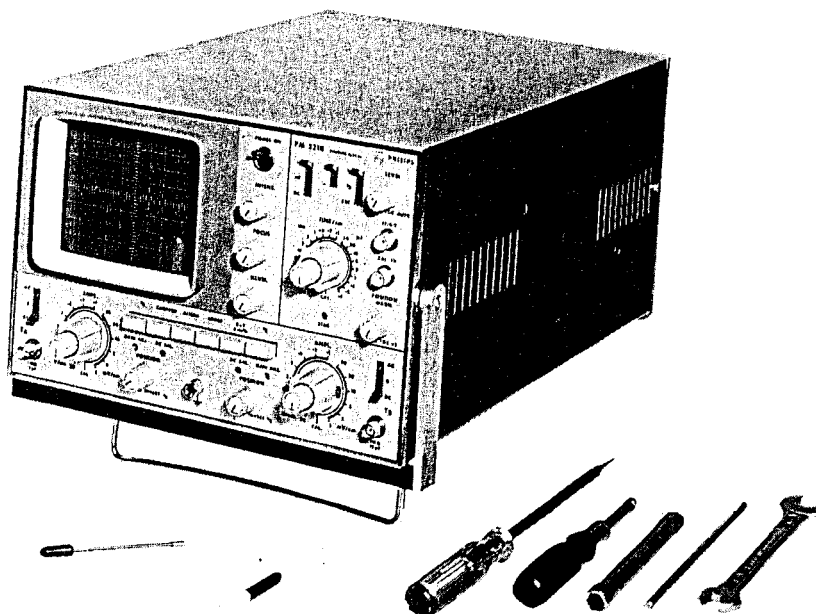


Fig. 30. Dismantling

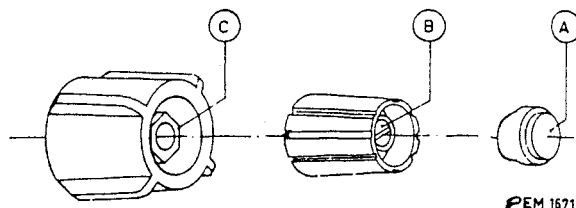
### A. REMOVING THE BEZEL AND THE MEASURING GRATICULE

- Pull the lower part of the bezel back and lift it off the hinge.
- Subsequently the contrast filter and the measuring graticule can be removed.

### B. REMOVING THE KNOBS

1. The knobs of R2, R3 and R5 can be pulled off the shaft.
2. Single knobs (Fig. 31)
  - Remove cap A.
  - Slacken screw B.
  - Pull the knob off the shaft.

3. Double knobs (Fig. 31.)
  - Remove cap A and screw B.
  - Pull the inner knob off the shaft.
  - Slacken nut C.
  - Pull the outer knob off the shaft.



PEM 1671

Fig. 31. Removing the knobs

### C. REMOVING THE TOP COVER

- Remove the two screws with which the handle is attached and the two screws near the rear panel.
- Lift off the cover.

### D. REMOVING THE BOTTOM PLATE

- Remove the five screws on the bottom plate.
- Lift off the bottom plate.

### E. REMOVING PRE-AMPLIFIER UNIT 1 (Fig. 32)

- Remove the knobs of R8 and SK12 (see para. B).
- Remove the fixing nut of the shaft of SK12.
- Slacken screw 2.
- Unplug the five connectors 3.
- Remove the unit.

Pre-amplifier unit 2 can be removed in a similar way.

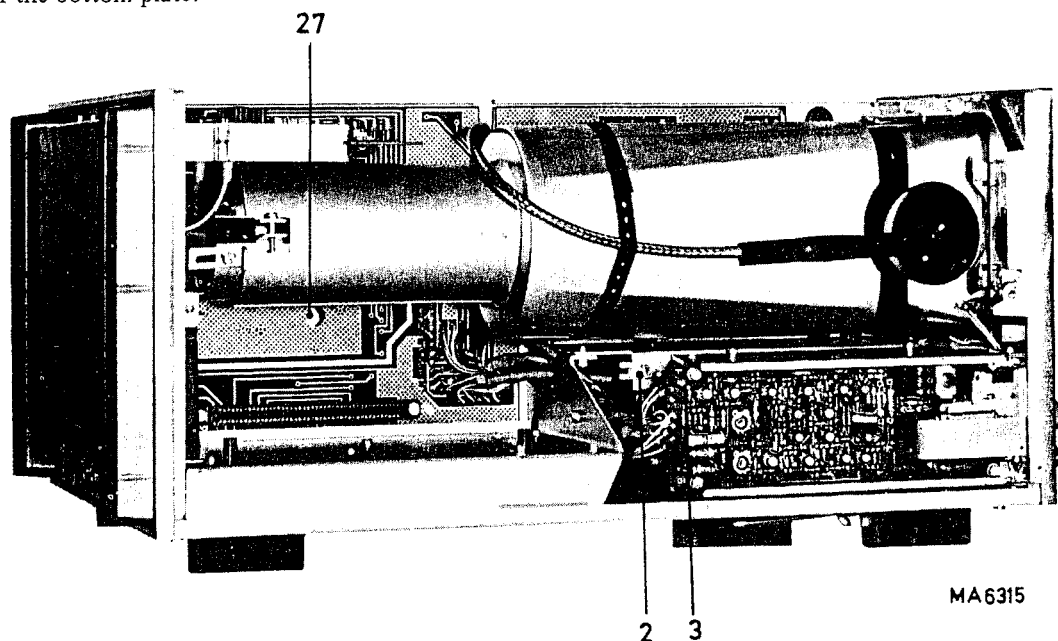


Fig. 32. Dismantling; left-hand side view

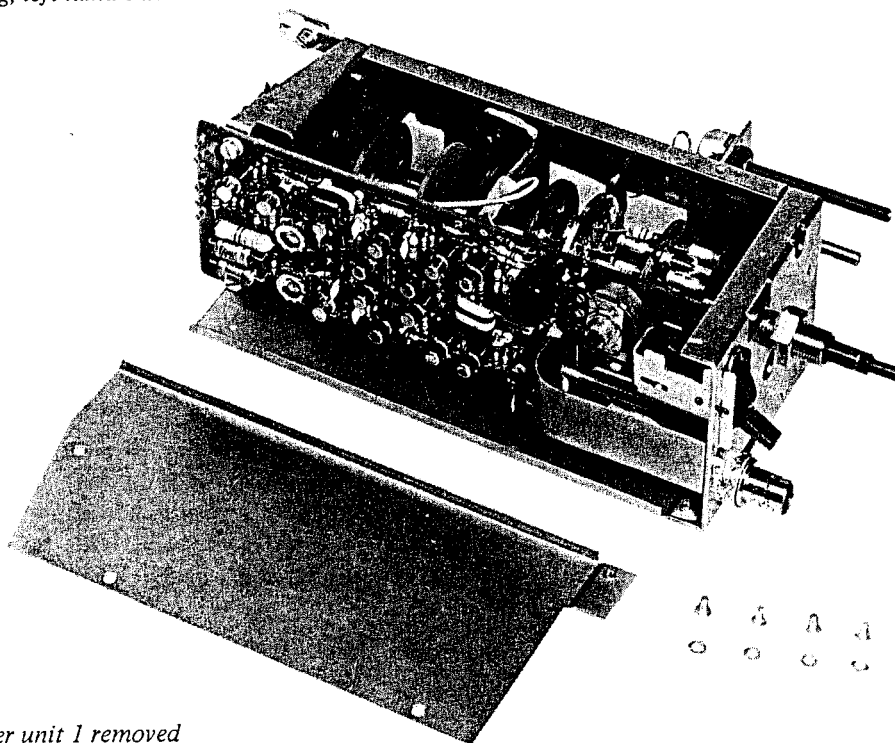


Fig. 33. Pre-amplifier unit 1 removed

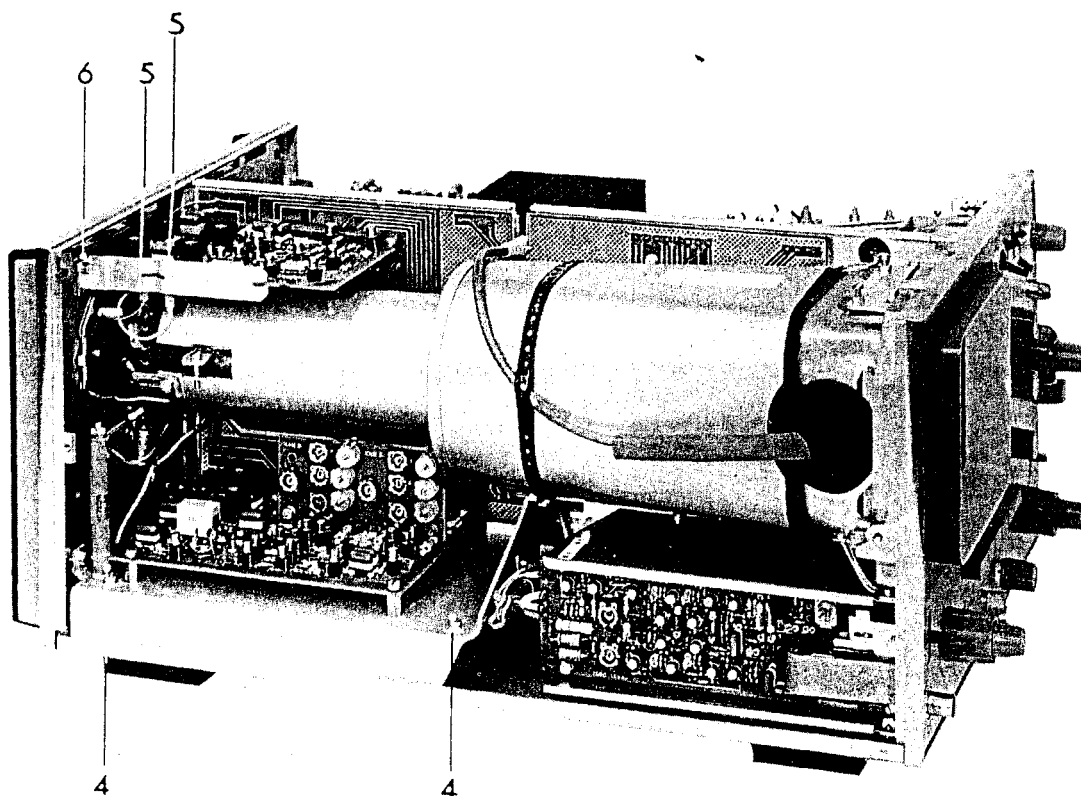


Fig. 34. Dismantling: left-hand side view

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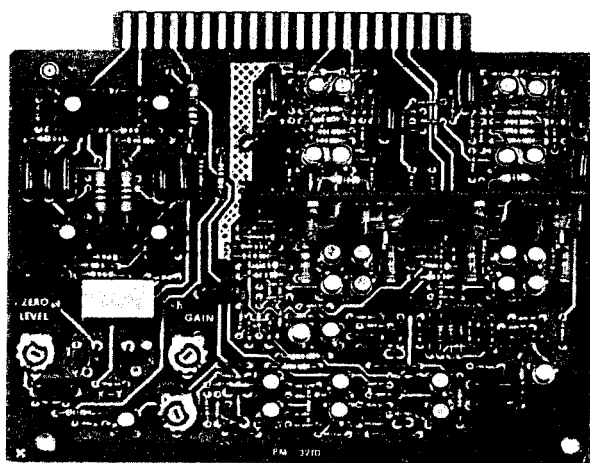


Fig. 35. Vertical amplifier unit 4 removed

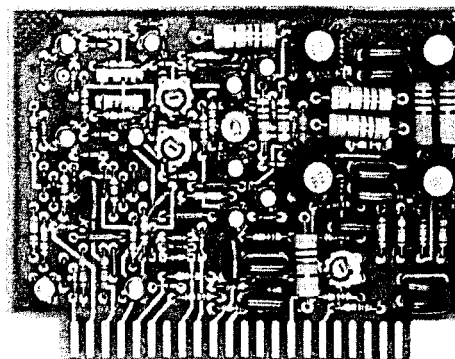


Fig. 36. Horizontal amplifier unit 7 removed

#### F. REMOVING VERTICAL AMPLIFIER UNIT 4 (Fig. 34)

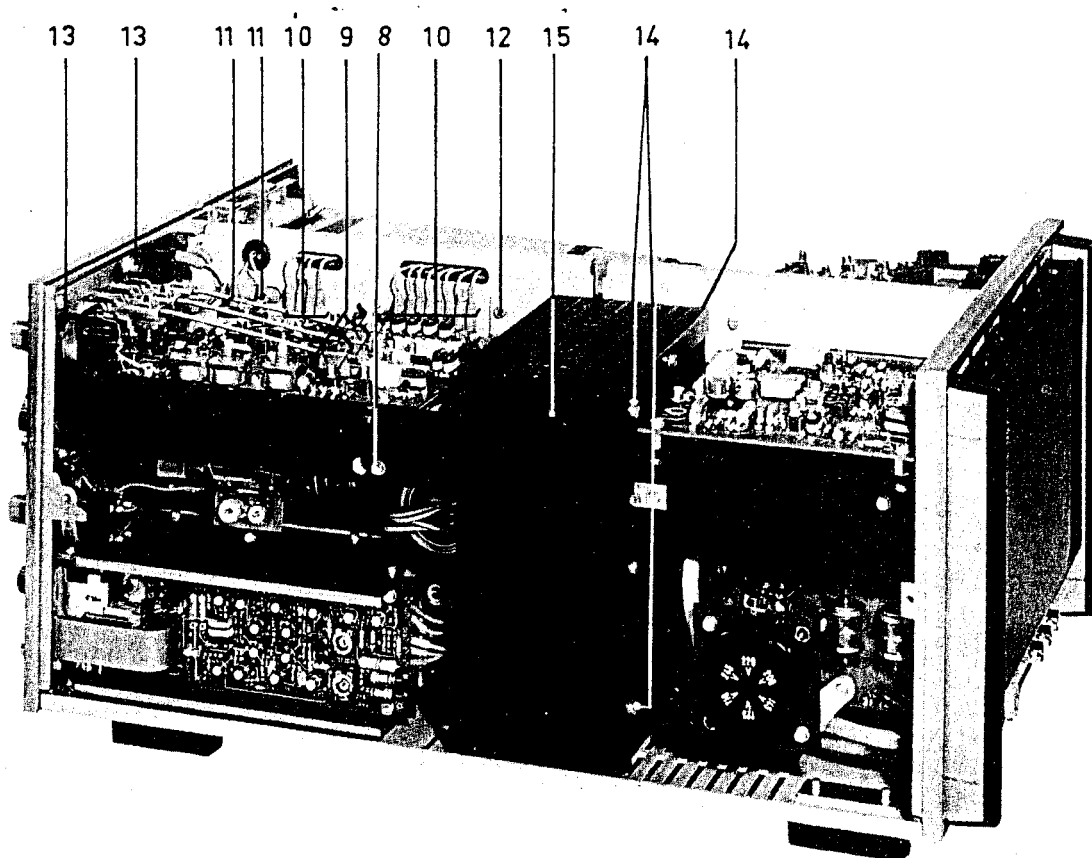
- Remove the two screws 4
- Remove the unit.

#### G. REMOVING HORIZONTAL AMPLIFIER UNIT 7 (Fig. 34)

- Unplug the two connectors 5.
- Slacken screw 6.
- Remove the unit.

#### H. REMOVING TIME-BASE UNIT 3 (Fig. 37)

- Remove the knobs of R4, R1 and SK6 (see para. B).
- Remove screw 8 and strip 9.
- Unplug the twelve connectors 10 and the two connectors 11.
- Remove screw 12 and the two screws 13.
- Remove the unit.



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Fig. 37. Dismantling; right-hand side view

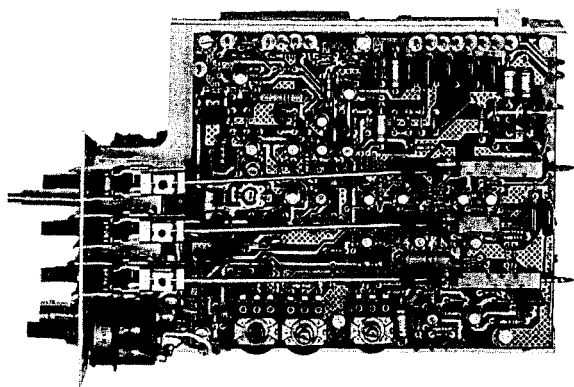


Fig. 38. Time-base unit 3 removed (unit side)

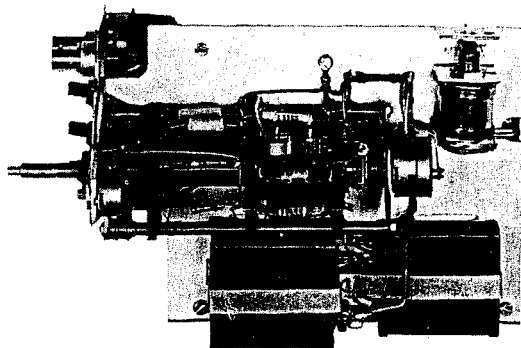
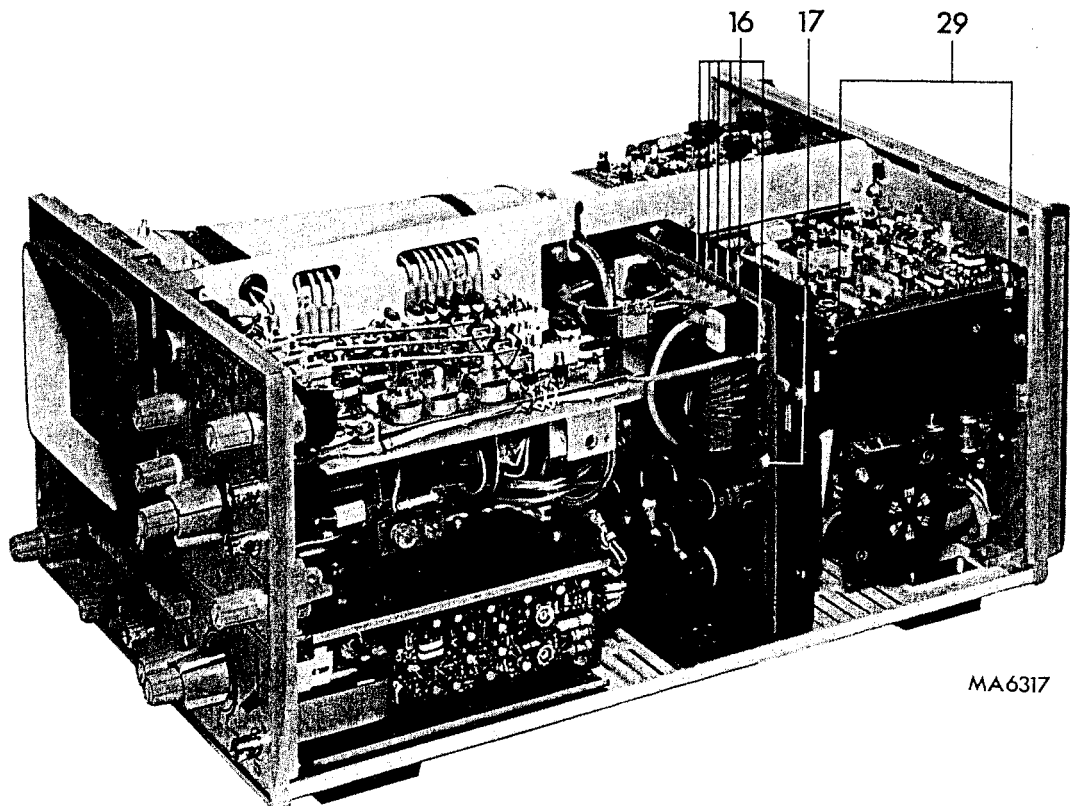


Fig. 39. Time-base unit 3 removed (switch side)

# J. REMOVING CONVERTER UNIT 6 (see Figs. 37 & 40)

- Remove screw 8 and strip 9.
- Remove the three screws 14.
- Remove H.T. unit cover 15.
- Release the H.T. connection on the c.r.t. and discharge cable and connection point.
- Unplug six connectors 16.
- Remove screw 17.
- Remove the unit.



MA6317

Fig. 40. Dismantling; view from the right

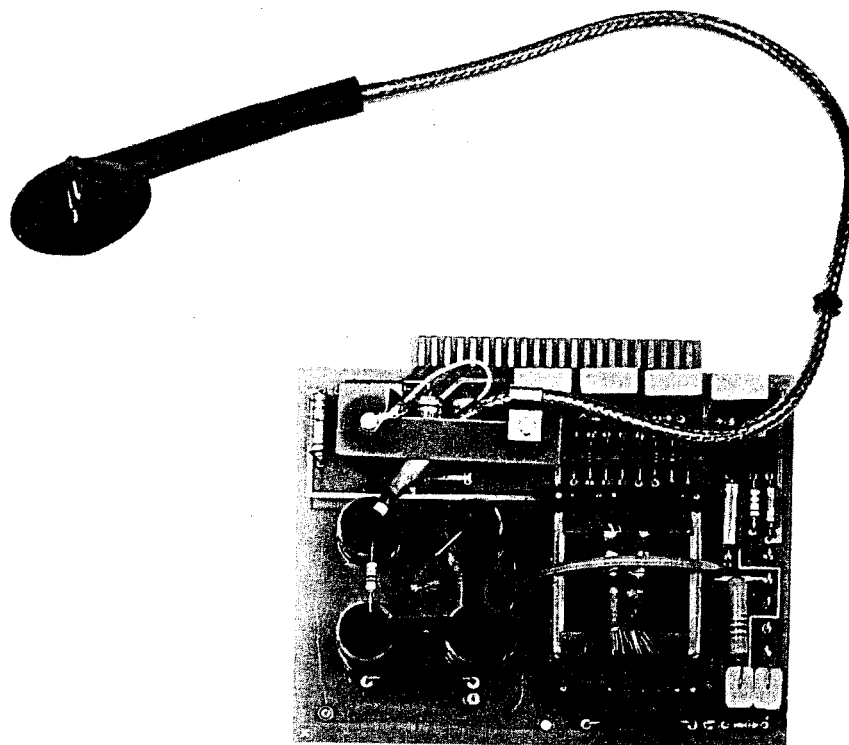


Fig. 41. Converter unit 6 removed

# K. REMOVING THE DELAY-LINE UNIT 11

(Figs. 32 & 42)

— Unplug connectors 3 on the pre-amplifier boards.

- Unscrew brackets 18.
- Unsolder the wiring (points 19).
- Remove the four screws 20.
- Remove the unit.

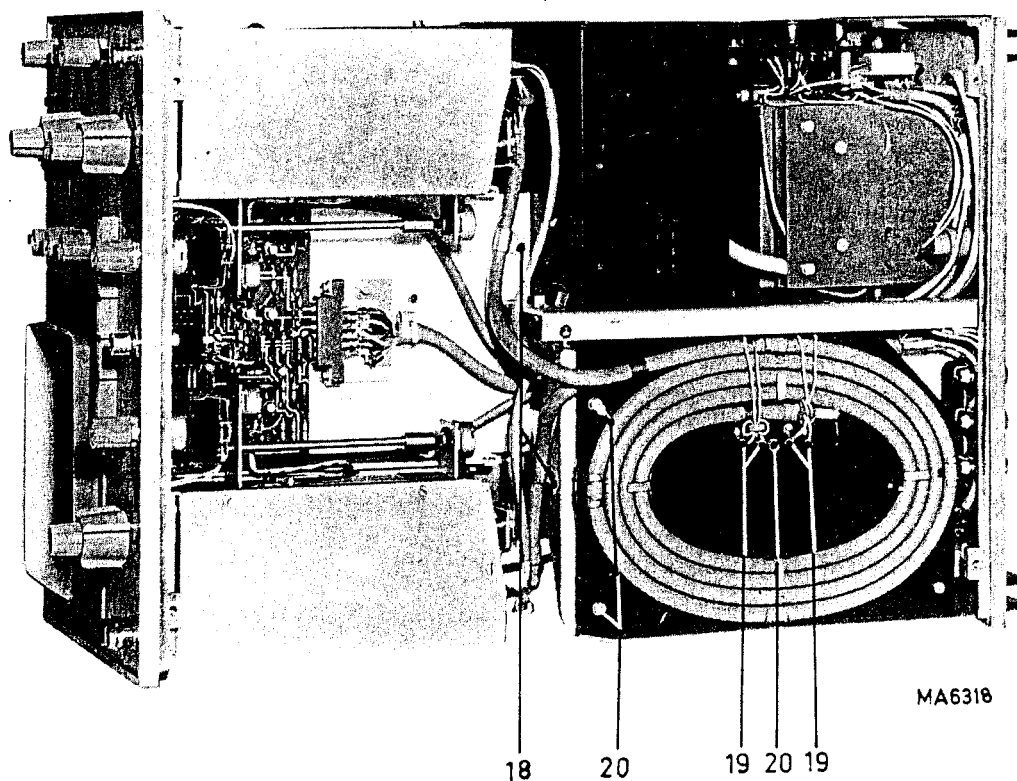


Fig. 42. Dismantling; bottom view

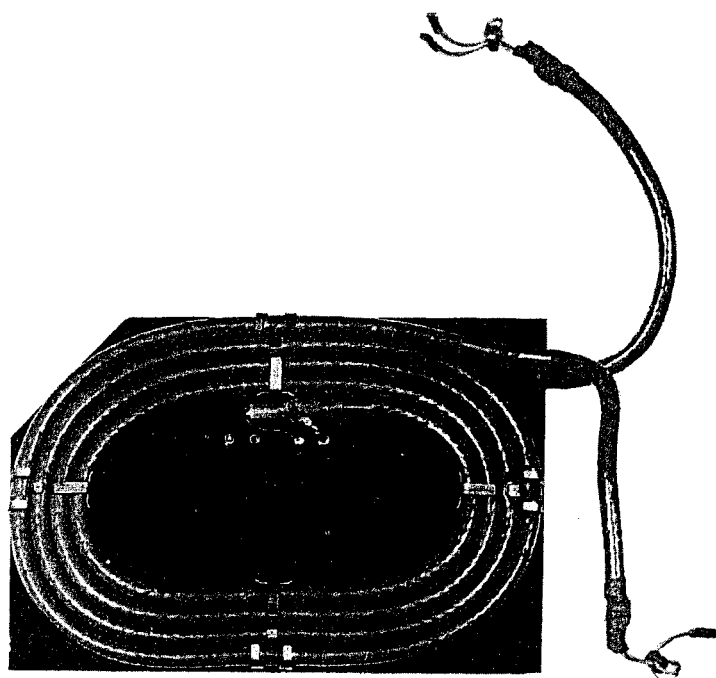


Fig. 43. Delay-line unit 11 removed



# L. REMOVING SWITCH UNIT 5 (Fig. 44)

- Remove screw 21 and the two screws 22.
- Slacken screw 24 (with an Allen key) and remove shaft 23.
- Slide the pilot lamp off the bracket.
- Remove the unit.

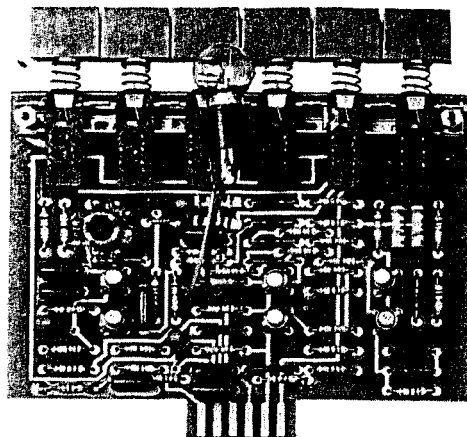
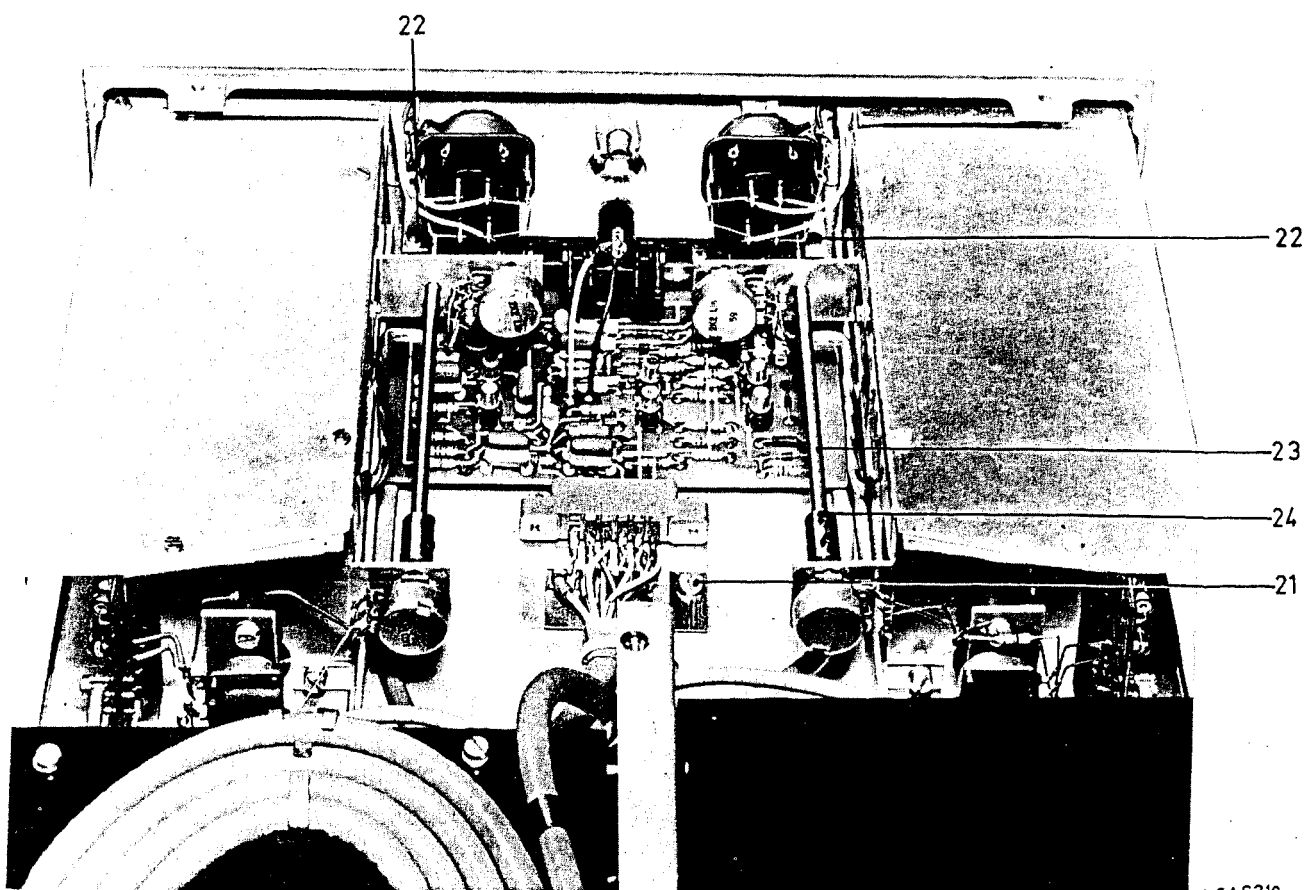


Fig. 45. Switch unit 5 removed

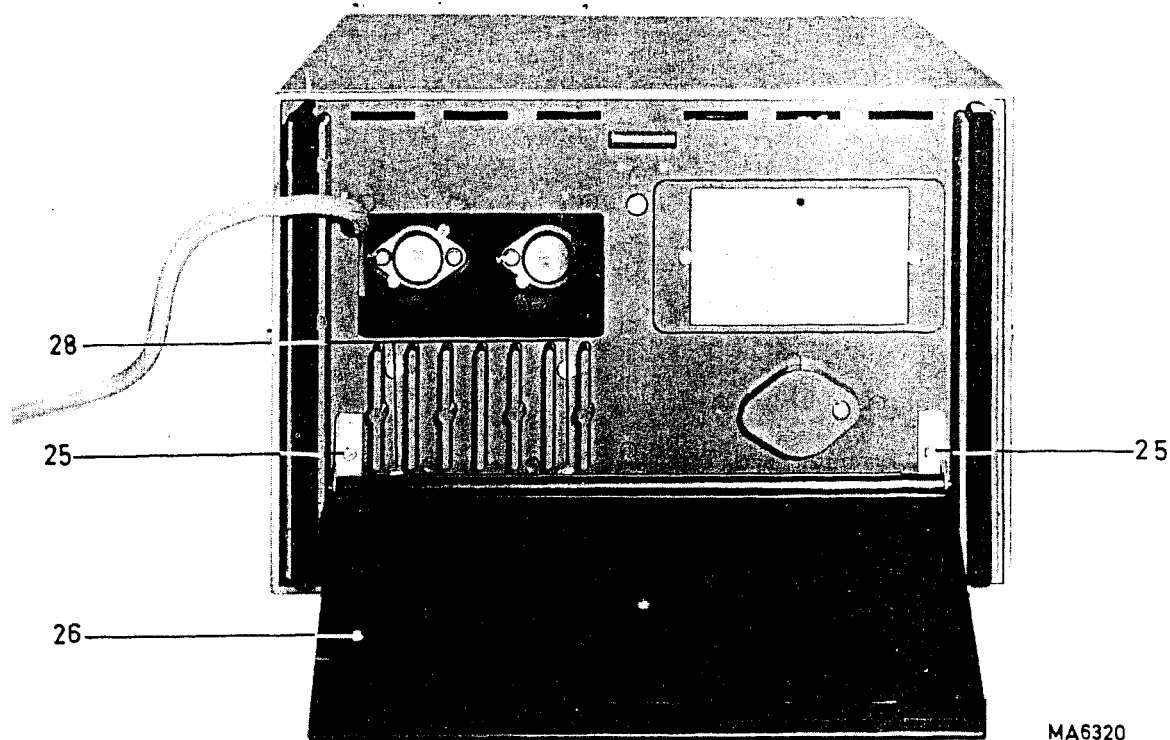


MA6319

Fig. 44. Dismantling; bottom view (detail)

### M. REMOVING MAINS TRANSFORMER UNIT 10 (Figs. 32 & 46)

- Remove the two screws 25 from rear lid 26.
- Unsolder the connection wires of the transformer.
- Remove screw 27 and the four screws 28.
- Remove the transformer.



MA6320

Fig. 46. Dismantling; rear view

### N. REMOVING COMBINATION UNIT 8 (Fig. 40)

- Remove the two screws 29.
- Remove the unit.

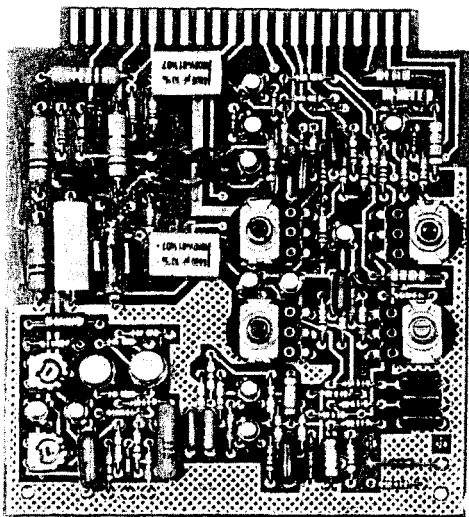


Fig. 47. Combination unit 8 removed

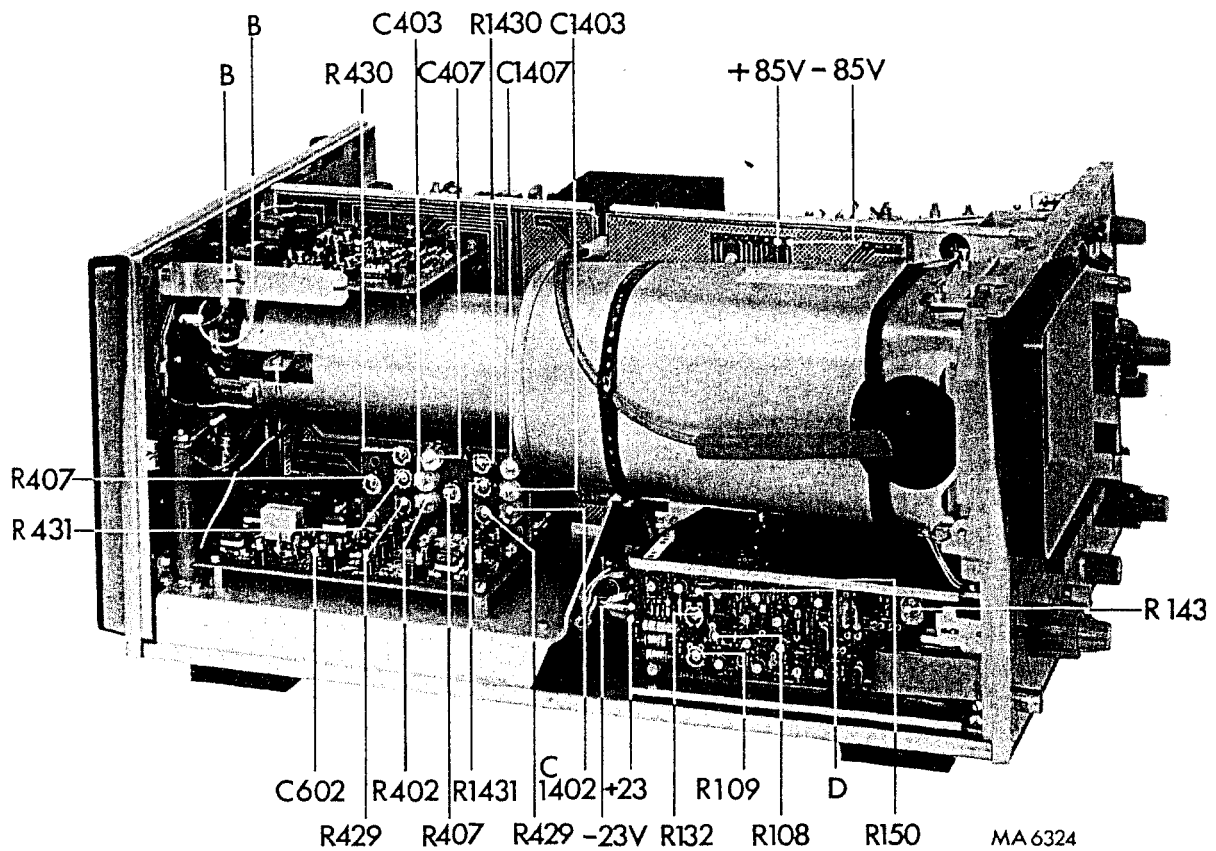


Fig. 49. Checking and adjusting; left-hand side view

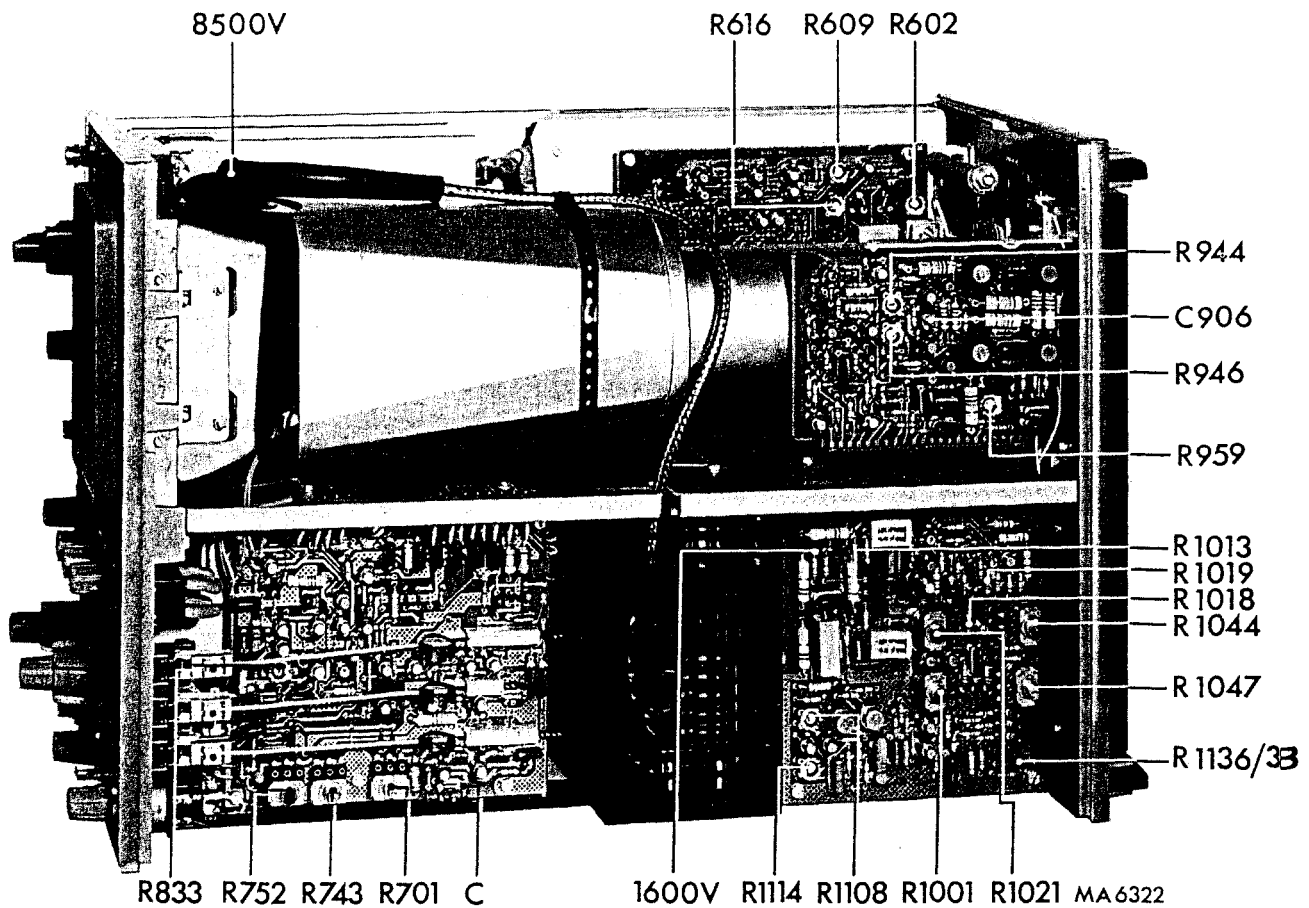
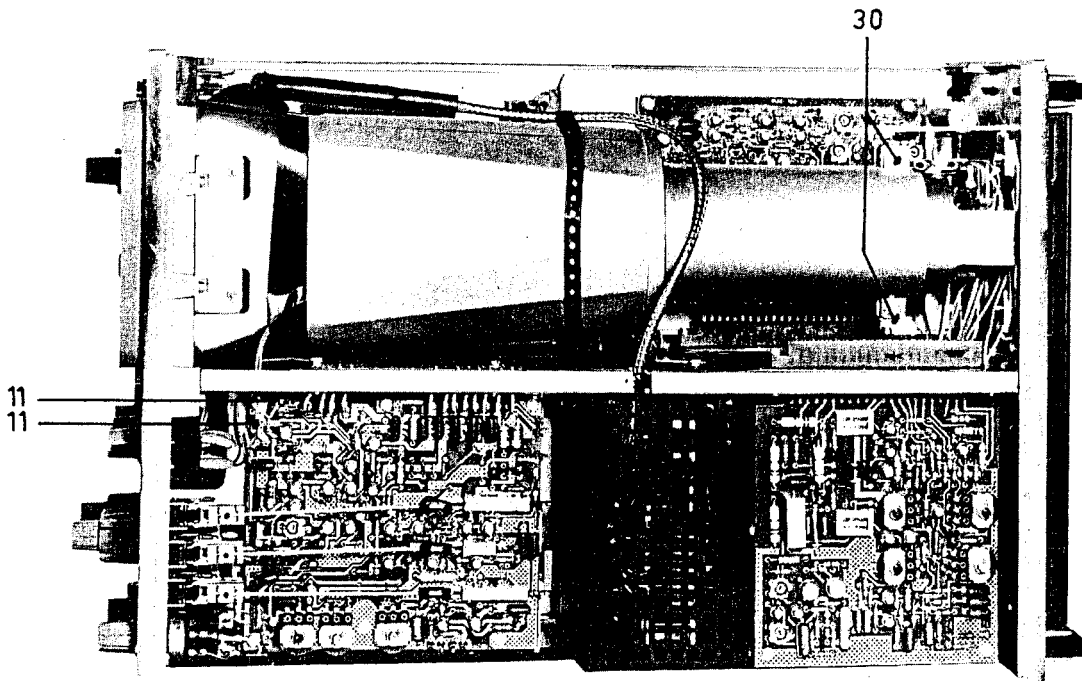


Fig. 50. Checking and adjusting; top view

### O. REMOVING THE C.R.T. (Fig. 48)

- Remove the horizontal amplifier unit (see para. F).
- Remove bezel with graticule and contrast filter.
- Release the H.T. connection on the c.r.t. and discharge the connection point and the cable.
- Remove the c.r.t. base.
- Slacken the two screws 30.
- Unplug the two connectors 11.
- Slide the c.r.t. together with the mu-metal tube towards the front of the instrument.
- Slide the c.r.t. out of the mu-metal tube.



MA6321

Fig. 48. Dismantling; top view

# X. Checking and adjusting

## A. GENERAL INFORMATION

All adjusting elements have been listed in the headings of the various sections.

The tolerances mentioned in the following text apply for newly adjusted instruments only. The values may differ from those given in chapter II. CHARACTERISTICS.

## B. POWER SUPPLY

### 1. Mains current

- Set selector switch SK10 to position CHOPPED.
- Turn potentiometer ILLUM. R5 clockwise.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Check that the mains voltage selector has been adjusted to 220 V and connect the instrument to such a voltage (frequency 50 Hz).
- Switch in the oscilloscope.
- Check that the power consumption does not exceed 550 mA (measured with a moving-iron meter).

### 2. +23 V Power supply (R1108, R1114)

- Check that the +23 V (Fig. 49) voltage is accurate within 0.5 % at nominal mains voltage. If necessary readjust R1114 (Fig. 50).
- Display the ripple on the +23 V power supply with the aid of an oscilloscope.
- Adjust R1108 (Fig. 50) for minimum ripple.
- Vary the a.c. voltage to which the instrument is connected between 198 V and 242 V. Check that the +23 V voltage does not vary more than 1 %. The ripple voltage should not exceed 10 mV<sub>p-p</sub>.
- Check the presence of the voltages –23 V, +85 V, –85 V, –1600 V and +8500 V, tolerance ±10 % (Figs. 49 & 50).

## C. CATHODE-RAY TUBE CIRCUIT

### C1. Unblanking (R1001)

- Pull potentiometer LEVEL R1/SK5 to position AUTO.

- Set TIME/cm SK6 to position 10 ms.
- Set selector switch SK10 to position Y<sub>A</sub>.
- Adjust potentiometer INTENS. R2 so, that the time-base line is just visible.
- Check that the intensity of the time-base line is constant along its entire length. If necessary readjust potentiometer R1001 (Fig. 50).

## C2. Deflection-plate potential

### a. Vertical (R602)

- Set selector switch SK10 to position Y<sub>A</sub>.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>A</sub>.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch AC-0-DC SK9 to position DC.
- Set AMPL. SK12 to position 50 mV.
- Apply a square-wave voltage of 200 mV, repetition rate 100 kHz and with a rise time of ≤ 10 ns, to input socket Y<sub>A</sub> BU3.
- Check that during shifting with potentiometer POSITION R14 the square-wave response does not change.
- If necessary readjust potentiometer R602 (Fig. 50).

### b. Horizontal (R959)

- Set selector switch SK10 to position Y<sub>A</sub>.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>A</sub>.
- Set switch AC-0-DC SK9 to position 0.
- Pull potentiometer LEVEL SK5 to position AUTO.
- Set potentiometer INTENS R2 for maximum intensity.
- Turn potentiometer POSITION R7 (in position x 1) fully clockwise and counterclockwise, and adjust potentiometer R959 (Fig. 50) so that there is just no bright not visible at the extremes of the time-base line.

## C3. Focus and astigmatism (R1044, R1013)

- Set selector switch SK10 to position Y<sub>A</sub>.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>A</sub>.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch AC-0-DC SK9 to position AC.
- Apply a sine-wave signal at a frequency of 2 kHz to socket Y<sub>A</sub> BU3. The trace height should be about 6 cm.

- Set TIME/cm SK6 to such a position that a few cycles of the input signal are displayed.
- Adjust potentiometer FOCUS R3 and astigmatism potentiometer R1044 (Fig. 50) for a clear definition along the entire trace. If the control range of potentiometer FOCUS R3 is not sufficient, select a different value for resistor R1013 (Fig. 50).

#### C4. Trace rotation (R1048)

- Set selector switch SK10 to position  $Y_A$ .
- Set switch AC-0-DC SK9 to position 0.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Centre the time-base line by means of potentiometer POSITION R14.
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule. If necessary, readjust trace-rotation potentiometer R1048 (Fig. 51).

#### C5. Intensity (R1021, R1018, R1019)

- Switch the instrument off.
- Connect a current meter ( $30 \mu A$ ) in series with the post-acceleration cable of the c.r.t.
- Switch in the instrument and wait 15 minutes.
- Set selector switch SK10 to position X-Y.
- Set AC-0-DC switches SK9 & 11 to position 0.
- Centre the display by means of potentiometers POSITION R14 & 15.
- Turn potentiometer INTENSITY R2 fully clockwise.
- Check that the current meter indicates  $15 \mu A$ . If necessary readjust potentiometer R1021 (Fig. 50). If the control range of R1021 is not sufficient, select a different value for R1018 (Fig. 50).
- Turn potentiometer INTENSITY R2 to about  $90^\circ$  from its anti-clockwise stop. The trace should disappear.
- If necessary select a different value for R1019 (Fig. 50).
- Repeat both adjustments.

#### C6. Intensity modulation

- Set selector switch SK10 to position  $Y_A$ .
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Check that the intensity of the time-base line is constant along its entire length.
- Set switch TIME/cm SK6 to position  $1 \mu s$ .
- Set potentiometer TIME/cm R4 to position CAL.
- Pull potentiometer POSITION R7/SK8 to position MAGN.  $\times 5$ . At the beginning of the time-base line, 0.5 cm at maximum may be dark.

#### C7. Distortion (R1047)

- Set selector switch SK10 to position X-Y.
- Set switches AC-0-DC SK9 & 11 to position AC.
- Apply a sine-wave signal with a frequency of about 50 kHz to socket  $Y_A$  BU3; trace height 7.5 cm.

- Apply a sine-wave signal with a frequency of about 50 Hz to socket  $Y_B$  BU5; trace width 9.5 cm.
- Adjust potentiometer R1047 (Fig. 50) so that the sides of the displayed oblong are as straight as possible.
- Check that no point of a display whose extreme points just touch the sides of an oblong of  $9.5 \times 7.5$  cm lies within a concentric oblong of  $9.28 \times 7.36$  cm.

### D. PRE-AMPLIFIERS CHANNEL A AND CHANNEL B

The adjustments of the pre-amplifiers channel A and channel B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

#### D1. Balance and gate current [R109 (309), R108 (308), R150 (350), R143 (343)]

- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch TIME/cm SK6 to position 1 ms.
- Set selector switch SK10 to position  $Y_A$  ( $Y_B$ ).
- Set switch AMPL. SK12 (SK13) to position 50 mV/cm.
- Set potentiometer POSITION R14 (R15) to the centre of its control range.
- Set switch AC-0-DC SK9 (SK11) to position 0.
- Adjust potentiometer R109, Fig. 49 (R309, Fig. 51) so that the trace does not move when potentiometer AMPL. R8 (R13) is rotated. If necessary select a different value for R108, Fig. 49 (R308, Fig. 51).
- Set switch SK12 (SK13) to position 1 mV/cm.
- Adjust potentiometer DC BAL. R10 (R11) so that the trace does not move when potentiometer AMPL. R8 (R13) is rotated. If necessary select a different value for R150, Fig. 49 (R350, Fig. 51).
- Adjust potentiometer R143, Fig. 49 (R343, Fig. 50) so that the trace does not move when switch AC-0-DC SK9 (SK11) is switched over from 0 to DC.
- Repeat the adjustments of this paragraph.

#### D2. Control amplifier [R132 (332)]

- Set switch LF-HF-DC SK2 to position DC.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$  ( $Y_B$ ).
- Set switch AC-0-DC SK9 (SK11) to position DC.
- Apply a square-wave voltage with an amplitude of 300 mV and a repetition rate of 10 Hz to socket  $Y_A$  BU3 ( $Y_B$  BU5).
- Set switch AMPL. SK12 (SK13) to position 50 mV/cm.
- Set switch TIME/cm SK6 to such a position that a few cycles of the input signal are displayed.
- Adjust potentiometer LEVEL R1 for a stationary display.
- Adjust potentiometer R132, Fig. 49 (R332, Fig. 51) for a straight top of the square-wave.
- Check the top in positions 1, 2, 5, 10 and 20 mV of switch AMPL. SK12 (SK13) at a trace height of 6 cm; the top errors should not exceed 1 %.

### D3. Normal-Invert balance[R1407 (407)]

- Set selector switch SK10 to position  $Y_A$  ( $Y_B$ ).
- Set switch AMPL. SK12 (SK13) to position 50 mV/cm.
- Set switch AC-0-DC SK9 (SK11) to position 0.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Adjust potentiometer R1407, Fig. 49 (R407, Fig. 49) so that the trace does not jump when switch SK14 (SK15) is pulled to the INVERT position.

## E. VERTICAL AND HORIZONTAL SENSITIVITY

*NOTE: For sensitivity adjustments always stick to the following sequence: Channel B, X amplifier, Channel A.*

### E1. Channel B (R616)

- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch TIME/cm SK6 to position 5 ms.
- Set switch AC-0-DC SK11 to position DC.
- Set switch AMPL. SK13 to position 200 mV/cm.
- Set switch LF-HF-DC SK2 to position LF.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_B$ .
- Set potentiometer AMPL. R13 to position CAL.
- Set selector switch SK10 to position  $Y_B$ .
- Interconnect sockets CAL. BU2 and  $Y_A$  BU5.
- Set potentiometer GAIN ADJ. R12 to the electrical centre of its control range.
- Adjust potentiometer R616, Fig. 50, for a trace height of 5 cm.
- Check that the control range of potentiometer AMPL. R13 is 1:2.6 to 1:3.5.

### E2. X-Amplifier (R944)

- Set selector switch SK10 to position X-Y.
- Adjust potentiometer R944, Fig. 50, for a trace

width of 5 cm.

- Check the time-base sweep speeds (section N).

### E3. Channel A

- Set selector switch SK10 to position ADDED.
- Set switch AC-0-DC SK9 to position DC.
- Set switch AMPL. SK12 to position 200 mV/cm.
- Set potentiometer AMPL. R8 to position CAL.
- Apply the same input signal to sockets  $Y_A$  BU3 and  $Y_B$  BU5.
- Pull potentiometer POSITION R14/SK14 to position INVERT and make sure that potentiometer POSITION R15/SK15 is in the depressed position.
- Adjust potentiometer GAIN ADJ. R9 to obtain one straight line on the screen.
- Set selector switch SK10 to position  $Y_A$ .
- Check that the control range of potentiometer AMPL. R8 is 1:2.6 to 1:3.5.

## F. INPUT ATTENUATOR

The adjustments of the input attenuators of channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

- Set selector switch SK10 to position  $Y_A$  ( $Y_B$ ).
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$  ( $Y_B$ ).
- Set switch AC-0-DC SK9 (SK11) to position DC.
- Set switch TIME/cm SK6 to position 50  $\mu$ s.
- Set potentiometer AMPL. R8 (R13) to position CAL.
- Apply a square-wave voltage with a repetition rate of about 10 kHz and a rise time of 200 ns to socket  $Y_A$  BU3 ( $Y_B$  BU5). The amplitude of the input signal is indicated in the table below.
- According to the following table, adjust the attenuator so that just neither overshoot nor undershoot occurs.

| AMPL. SK12 (SK13) | Input voltage | Adjust with (see Fig. 53) | Trace height   |
|-------------------|---------------|---------------------------|----------------|
| 1 mV/cm           | 6 mV          | C42 (C242)                | 6 cm $\pm 2\%$ |
| 2 mV/cm           | 12 mV         |                           | 6 cm $\pm 2\%$ |
| 5 mV/cm           | 30 mV         |                           | 6 cm $\pm 2\%$ |
| 10 mV/cm          | 60 mV         | C38 (C238)                | 6 cm $\pm 2\%$ |
| 20 mV/cm          | 120 mV        |                           | 6 cm $\pm 2\%$ |
| 50 mV/cm          | 300 mV        |                           | 6 cm $\pm 2\%$ |
| .1 V/cm           | .6 V          | C34 (C234)                | 6 cm $\pm 2\%$ |
| .2 V/cm           | 1.2 V         |                           | 6 cm $\pm 2\%$ |
| .5 V/cm           | 3 V           |                           | 6 cm $\pm 2\%$ |
| 1 V/cm            | 6 V           | C33 (C233)                | 6 cm $\pm 2\%$ |
| 2 V/cm            | 12 V          |                           | 6 cm $\pm 2\%$ |
| 5 V/cm            | 30 V          |                           | 6 cm $\pm 2\%$ |
| 10 V/cm           | 60 V          | C29 (C229)                | 6 cm $\pm 2\%$ |
| 20 V/cm           | 80 V          |                           | 4 cm $\pm 2\%$ |

Maximum top errors 2 %

- Apply the above mentioned input voltages via a dummy measuring probe, consisting of a 1 M $\Omega$  resistor and a 15 pF capacitor, to input socket Y<sub>A</sub> BU3 (Y<sub>B</sub> BU5).
- According to the following table, adjust the attenuator so that just no overshoot occurs.

| AMPL. SK12 (SK13) | Input signal on dummy probe | Adjust with (see Fig. 53) | Trace height   |
|-------------------|-----------------------------|---------------------------|----------------|
| 1 mV/cm           | 6 mV                        | C43 (C243)                | 3 cm $\pm 3\%$ |
| 2 mV/cm           | 12 mV                       |                           | 3 cm $\pm 3\%$ |
| 5 mV/cm           | 30 mV                       |                           | 3 cm $\pm 3\%$ |
| 10 mV/cm          | 60 mV                       | C39 (C239)                | 3 cm $\pm 3\%$ |
| 20 mV/cm          | 120 mV                      |                           | 3 cm $\pm 3\%$ |
| 50 mV/cm          | 300 mV                      |                           | 3 cm $\pm 3\%$ |
| .1 V/cm           | .6 V                        | C36 (C236)                | 3 cm $\pm 3\%$ |
| .2 V/cm           | 1.2 V                       |                           | 3 cm $\pm 3\%$ |
| .5 V/cm           | 3 V                         |                           | 3 cm $\pm 3\%$ |
| 1 V/cm            | 6 V                         | C32 (C232)                | 3 cm $\pm 3\%$ |
| 2 V/cm            | 12 V                        |                           | 3 cm $\pm 3\%$ |
| 5 V/cm            | 30 V                        |                           | 3 cm $\pm 3\%$ |
| 10 V/cm           | 60 V                        | C28 (C228)                | 3 cm $\pm 3\%$ |
| 20 V/cm           | 80 V                        |                           | 2 cm $\pm 3\%$ |

Maximum top errors 2 %



## G. STEP RESPONSE OF THE VERTICAL AMPLIFIERS

The adjustments of the step responses of channels A and B are identical.

The adjusting elements are:

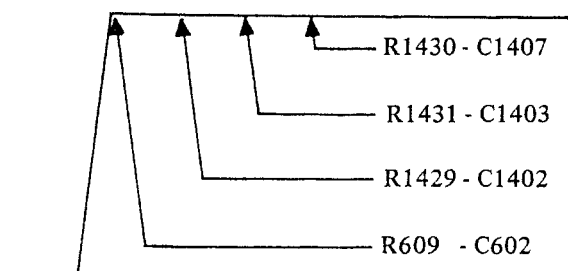
| Fig. 49      | Fig. 50 | Fig. 56 | Fig. 58 | Fig. 58A     | Fig. 59 |
|--------------|---------|---------|---------|--------------|---------|
| R429 (R1429) | R609    | R280    | C409    | R432 (R1432) | R80     |
| R430 (R1430) |         | C249    |         | R435 (R1435) | C49     |
| R431 (R1431) |         | C252    |         | C404 (C1404) | C52     |
| C402 (C1402) |         | R296    |         | C406 (C1406) | R96     |
| C403 (C1403) |         | C264    |         |              | C64     |
| C407 (C1407) |         |         |         |              |         |
| C602         |         |         |         |              |         |

The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

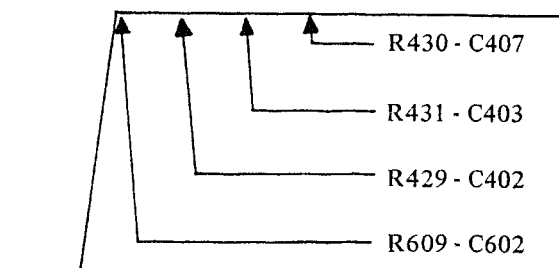
- Set switch AC-0-DC SK9 (SK11) to position DC.
- Set switch AMPL. SK12 (SK13) to position 50 mV/cm.
- Set potentiometer AMPL. R8 (R13) to position CAL.
- Set selector switch SK10 to position Y<sub>A</sub> (Y<sub>B</sub>).
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch LF-HF-DC (SK2) to position DC.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT (SK4) to position Y<sub>A</sub> (Y<sub>B</sub>).

- Apply a square-wave voltage of 300 mV with a repetition rate of 100 kHz and a rise time  $\leq 1$  ns to socket Y<sub>A</sub> BU3 (Y<sub>B</sub> BU5).
- Adjust the square-wave response so that the top is as straight as possible, the rise time minimum and the ringing as small as possible (see Fig. 42).

**ATTENTION:** Potentiometer R609 and capacitor C602 affect the square-wave response of both channel A and channel B.



Channel A



Channel B

Fig. 52. Square-wave response

- Check that the square-wave response does not change when potentiometer POSITION R14/SK14 (R15/SK15) is switched from the normal position to the INVERT position. The maximum difference in top error may be 2 %.
- Reduce the repetition rate to 50 kHz and check that the top of the pulse is straight. If necessary correct with network C1406 - R1432 (C406 - R432).
- Reduce the repetition rate to 20 kHz and check that the top of the pulse is straight. If necessary correct with network C1404 - R1435 (C404 - R435).
- Increase the repetition rate to 100 kHz.
- Set switch AC-0-DC SK11 to position 0.
- Check that the difference in top errors in positions Y<sub>A</sub> and ADDED of selector switch SK10 does not

- exceed 2 %. If necessary select a different value for capacitor C409 and readjust the square-wave response.
- Check the square-wave response in positions 20, 10, 5, 2 and 1 mV/cm of switch AMPL. SK12 (SK13) at an amplitude of 6 cm. The overshoot or undershoot should not exceed 2 %.
- In position 10 mV/cm of switch AMPL. SK12 (SK13) there is the possibility of correction by selection of a different value for capacitor C49 (C249) and resistor R44 (R244).
- In positions 5 and 2 mV/cm, correction is possible by adapting correction network R96-C52 (R296-C252).
- In position 1 mV/cm, correction is possible by adapting network C64-R80 (C264-R280).

## H. BANDWIDTH VERTICAL AMPLIFIERS

- Set switch AMPL. SK12 (SK13) to position 1 mV/cm.
- Check the bandwidth at a trace height of 8 cm according to the following table:

| FREQUENCY | INPUT SIGNAL | TRACE HEIGHT  |
|-----------|--------------|---------------|
| 100 kHz   | 40 mV        | 8 cm          |
| 25 MHz    | 40 mV        | $\geq 5.6$ cm |

## I. H.F. DEFLECTION

- Set selector switch SK10 to position  $Y_A$  ( $Y_B$ ).
- Set switch AMPL. SK12 (SK13) to position 50 mV/cm.
- Set potentiometer AMPL. R8 (R13) to position CAL.
- Set switch LF-HF-DC SK2 to position DC.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$ .
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch AC-0-DC SK9 (SK11) to position AC.
- Apply a sine-wave signal of 1.2 V and a frequency of 10 MHz to input socket  $Y_A$  BU3 ( $Y_B$  BU5).
- Check that the peaks of the signals can be displayed undistortedly within the graticule, both in depressed and pulled positions of switch INVERT SK14 (SK15).

## J. REFLECTION FACTOR

- Set switches AC-0-DC SK9 & 11 to position DC.
- Set switches AMPL. SK12 & 13 to position 50 mV/cm.
- Set selector switch SK10 to position ADDED.
- Depress switch INVERT SK14 to the normal position.
- Pull switch INVERT SK15 to position INVERT.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switch LF-HF-DC SK2 to position DC.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$  or  $Y_B$ .
- Apply equal sine-wave signals in the same phase to input sockets  $Y_A$  BU3 and  $Y_B$  BU5.
- Measure the rejection according to the following table. Always adjust for minimum trace height with potentiometers AMPL. R8 and R13, starting from their CAL. positions.

| FREQUENCY | REJECTION FACTOR | MAX. TRACE HEIGHT |
|-----------|------------------|-------------------|
| 50 Hz     | 100x             | 2.5 mm            |
| 1 MHz     | 100x             | 2.5 mm            |

## K. SIGNAL DELAY EQUALITY

(This check is only necessary if a new delay line has been fitted).

- Set switch LF-HF-DC SK2 to position HF.

- Set switch +/- SK3 to position +.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$ .
- Set switches AMPL. SK12 & 13 to position 50 mV/cm.
- Set potentiometers AMPL. R8 & 13 to position CAL.
- Set TIME/cm SK6 to position .1  $\mu$ s.
- Set potentiometer TIME/cm R4 to position CAL.
- Pull switch MAGN. SK8 to position x 5.
- Set selector switch SK10 to position CHOPPED.
- Set switches AC-0-DC SK9 & 11 to position AC.
- Apply a 300 mV pulse with a rise time of  $\leq 3$  ns to input socket  $Y_A$  BU3 and  $Y_B$  BU5.
- Check that there is no difference in delay time between the amplifiers of channels A and B (1 ns is acceptable). If necessary reduce the length of one of the delay lines.

## L. X-Y ADJUSTMENT (C906, R946)

- Depress switches INVERT SK14 & 15.
- Set selector switch SK10 to position X-Y.
- Set switches AC-0-DC SK9 & 11 to position AC.
- Set switches AMPL. SK12 & 13 to position 50 mV/cm.
- Set potentiometers AMPL. R8 and R13 to position CAL.
- Apply equal sine-wave signals of 300 mV in phase to input sockets  $Y_A$  BU3 and  $Y_B$  BU5.
- Check that at a signal frequency of 2 kHz a line under an angle of  $45^\circ$  with respect to the horizontal graticule lines is displayed. If not, readjust the sensitivity according to section E.
- Increase the signal frequency to 5 MHz and adjust the angle between the displayed line and the horizontal graticule lines to  $45^\circ$  by means of trimmer C906, Fig. 50.
- Adjust potentiometer R946, Fig. 50 for one straight line under an angle of  $45^\circ$ .
- Check at various frequencies between 2 kHz and 5 MHz that there are no phase errors. If necessary repeat the previous adjustments.
- Pull potentiometer INVERT R14/SK14 to position INVERT.
- Check that the phase error at frequencies up to 5 MHz does not exceed  $\pm 1^\circ$ .

Bandwidth in position X-Y of selector switch SK10:

- Set switch AC-0-DC SK9 to position 0.
- Check the frequency response at a trace width of 6 cm:

| FREQUENCY | INPUT SIGNAL | TRACE HEIGHT  |
|-----------|--------------|---------------|
| 2 kHz     | 300 mV       | 6 mm          |
| 5 MHz     | 300 mV       | $\geq 4.2$ mm |

- Check section N when C906 or R946 has been readjusted.

## M. TIME-BASE GENERATOR

### M1. Stability

- Set switch LF-HF-DC SK2 to position LF.
- Set potentiometers POSITION R7 & 14 to the centres of their control ranges.
- Set selector switch SK10 to position Y<sub>A</sub>.
- Set switch TIME/cm SK6 to 1 ms.
- Turn potentiometer LEVEL R1 fully clockwise (switch SK5 depressed).
- Adjust potentiometer STAB. R6 so that the time-base line is just not visible (do not adjust this too critically).
- Pull potentiometer LEVEL to position AUTO. There should be a time-base line visible.

### M2. Trigger level (R701)

- Set switch LF-HF-DC SK2 to position DC.
- Set switches AC-0-DC SK9 & 11 to position 0.
- Set switches AMPL. SK12 & 13 to position 50 mV/cm.
- Check, and readjust if necessary, the d.c. balance.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> -EXT SK4 to position Y<sub>A</sub>.
- Adjust potentiometer R701 (Fig. 50) so that the voltage on point C (emitter of transistor TS703) is 0 V  $\pm$  300 mV.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>B</sub>.
- Check that the voltage on point C is still 0 V  $\pm$  300 mV.

### M3. Trigger adjustment (R743, R752)

- Set switch LF-HF-DC SK2 to position LF.
- Depress potentiometer LEVEL R1/SK5 to the level position.
- Set switch +/-SK3 to position +.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>A</sub>.
- Set switch TIME/cm SK6 to position 1 ms.
- Set switches AC-0-DC SK9 & 11 to position AC.
- Set switches AMPL. SK12 & 13 to 50 mV/cm.
- Set potentiometers AMPL. R8 & 13 to position CAL.
- Depress potentiometers POSITION R14/SK14 & R15/SK15 to their normal positions.
- Set selector switch SK10 to position Y<sub>A</sub>.
- Apply a sine-wave signal of 300 mV and a frequency of 2 kHz to input socket Y<sub>A</sub> BU3.
- Adjust potentiometer LEVEL R1 for a stationary display.
- Without touching the level adjustment, adjust potentiometer R743, Fig. 51, so that the triggering point does not move when switch +/- SK3 is set from + to –.
- Reduce the input voltage until the trace height is 0.3 cm (do not use the AMPL. potentiometer to this end).

- Adjust potentiometer LEVEL for a stationary trace.
- Check that the triggering is not disturbed when switch +/- SK3 is set from + to –. If necessary readjust R743.
- Increase the input voltage until the trace height is about 8 cm.
- Check that triggering occurs on the positive - going edge when switch +/- SK3 occupies position +, and on the negative-going edge in position –.
- Check that the trigger point is shifted upwards when potentiometer LEVEL R1 is turned clockwise, and vice-versa.
- Pull potentiometer LEVEL R1/SK5 to position AUTO and turn it to the centre of its control range.
- Adjust potentiometer R752, Fig. 51, so that the time-base starts at the 0 level of the sine-wave.
- Check that the trigger point is still at the 0 level of the sine-wave when its amplitude has been reduced. If necessary readjust potentiometer R752.
- Check that the trigger point does not move when switch +/- SK3 is set from + to –.
- Repeat these adjustments until the amplitude of the input signal is as small as possible.
- Increase the input voltage to 800 mV.
- Depress potentiometer LEVEL R1/SK5 to the level position.
- Check that the time-base cuts out when potentiometer LEVEL R1 is turned fully clockwise and anti-clockwise.
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Check that the trigger point can be shifted over approximately 3 cm with potentiometer LEVEL R1.
- Set switch LF-HF-DC SK2 to position DC.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position EXT.
- Apply a sine-wave signal of 10 V, frequency about 2 kHz to socket TRIGG. BU1.
- Check that the time-base generator cuts out when potentiometer LEVEL R1 is turned fully clockwise and anti-clockwise.

### M4. Trigger sensitivity

- Set switches AC-0-DC SK9 & 11 to position DC.
- Set potentiometers AMPL. R8 & 13 to position CAL.
- Set potentiometer LEVEL R1 to obtain triggering.
- Set TIME/cm SK6 so that a reasonable number of cycles is displayed.
- Check the trigger sensitivity according to the following table in both position + and position – of switch +/- SK3.

| INPUT SIGNAL<br>ON | SELECTOR<br>SK10 TO | FREQUENCY<br>(SINE-WAVE) | LF-HF-DC<br>SK2 TO | Y <sub>A</sub> -Y <sub>B</sub> -EXT<br>SK <sub>4</sub> TO | LEVEL<br>R1/SK5<br>TO | TRIGGERING<br>AT |
|--------------------|---------------------|--------------------------|--------------------|-----------------------------------------------------------|-----------------------|------------------|
| Y <sub>A</sub> BU3 | Y <sub>A</sub>      | 10 Hz                    | LF                 | Y <sub>A</sub>                                            | AUTO<br>LEVEL         | 0.4 cm           |
|                    |                     | 10 Hz                    |                    |                                                           |                       | 0.4 cm           |
|                    |                     | 10 kHz                   |                    |                                                           |                       | 0.4 cm           |
|                    |                     | 1 MHz                    | HF                 |                                                           |                       | 4 cm no trigg.   |
|                    |                     | 50 Hz                    |                    |                                                           |                       | 4 cm no trigg.   |
|                    |                     | 5 MHz                    |                    |                                                           |                       | 0.4 cm           |
|                    |                     | 25 MHz                   | DC                 |                                                           |                       | 2 cm             |
|                    |                     | 1 Hz                     |                    |                                                           |                       | 0.4 cm           |
|                    |                     | 25 MHz                   |                    |                                                           |                       | 2 cm             |
| Y <sub>B</sub> BU5 | Y <sub>B</sub>      | 10 kHz                   | DC                 | Y <sub>B</sub>                                            | LEVEL                 | 0.4 cm           |
|                    |                     | 25 MHz                   |                    |                                                           |                       | 2 cm             |
| TRIGG.<br>BU1      |                     | 1 Hz                     |                    | EXT                                                       |                       | 400 mV           |
|                    |                     | 10 kHz                   |                    |                                                           |                       | 400 mV           |
|                    |                     | 25 MHz                   |                    |                                                           |                       | 800 mV           |

#### N. TIME COEFFICIENTS (R833, C823, C826)

- Check sections E. SENSITIVITY and L. X-Y ADJUSTMENT.
- Set switch HF-LF-DC SK2 to position HF.
- Set switch +/- SK3 to position +.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>A</sub>.
- Set selector switch SK10 to position Y<sub>A</sub>.
- Set potentiometer TIME/cm R4 to position CAL.
- Depress potentiometer MAGN. R7/SK8 to position x1.
- Set TIME/cm SK6 to position 1 ms.
- Apply a time-marker voltage with a repetition time of 1 ms to socket Y<sub>A</sub> BU3.
- Adjust potentiometer R833, Fig. 50, so that the 8 centre periods have a total width of 8 cm.
- Set switch TIME/cm SK6 to position 2  $\mu$ s.
- Change the repetition time of the input signal to 2  $\mu$ s.
- Adjust trimmer capacitor C826, Fig. 51 so that the 8 centre periods have a total width of 8 cm.
- Set TIME/cm SK6 to position .2  $\mu$ s.
- Change the repetition time of the input signal to .2  $\mu$ s.
- Adjust trimmer capacitor C823, Fig. 51 so that the 8 centre periods have a total width of 8 cm.
- Check that in the other positions of switch TIME/cm SK6 the 8 centre periods have a total width of 8 cm  $\pm 2$  %.
- Check that the length of the time-base line is 10.5 to 11.5 cm in all positions of switch TIME/cm SK6.
- Set TIME/cm SK6 to position 1 ms.
- Check that the control range of potentiometer TIME/cm R4 is 1:2.6 to 1:5.
- Set TIME/cm SK6 to position 1 ms.

- Set potentiometer TIME/cm R4 to position CAL.
- Pull switch MAGN. SK8 to position x5.
- Change the repetition time of the input signal to 1 ms.
- Shift every cycle on the screen by means of potentiometer POSITION R7 and check that each cycle has a width of 5 cm  $\pm 1.5$  % (do not take the first and last period into account).
- Check that with potentiometer POSITION R7 the beginning and the end of the time-base line can be displayed within the graticule.

#### O. DOUBLE TRACES AND JITTER

- Check that the trace is not doubled when the trace height and/or the frequency is varied and potentiometer LEVEL R1 is set for triggered display.
- Check that the time jitter does not exceed 10 ns.

#### P. MAINS VOLTAGE FLUCTUATIONS

- Vary the mains voltage + and –10 % with respect to the nominal mains voltage as indicated by the voltage adapter.
- Check that the vertical and horizontal deflection are not affected and that the brightness does not change.

#### Q. NOISE, CONVERTER INTERFERENCE, INSTABILITY AND DRIFT THESE MEASUREMENTS SHOULD BE MADE WITH THE CABINET PLATES FITTED.

- Set switches AMPL. SK12 & 13 to position 1 nV/cm.
- Set potentiometers AMPL. R8 & 13 to position CAL.
- Set switches AC-0-DC SK9 & 11 to position AC.

- Set the other controls for convenient reading.
- Acceptable values:
 

|                        |                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------|
| noise                  | : 0.2 cm                                                                                                    |
| converter interference | : 0.1 cm                                                                                                    |
| instability            | : 0.2 cm                                                                                                    |
| drift                  | : 1 cm at maximum, after a warming-up period of a quarter of an hour and at a constant ambient temperature. |

## R. CROSS TALK

The following procedure applies to the checking of the effect from channel A on channel B. The controls and sockets involved in the procedure for checking the effect from channel B on channel A are shown in brackets.

- Set switch LF-HF-DC SK2 to position DC.
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$  ( $Y_B$ ).
- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set switches AC-0-DC SK9 & 11 to position DC.
- Set selector switch SK10 to position CHOPPED.
- Apply a sine-wave voltage at a frequency of 25 MHz and an amplitude to obtain a trace height of 6 cm to input socket  $Y_A$  BU3 ( $Y_B$  BU5).
- Set switch AMPL. SK13 (SK12) to position 1 mV/cm.
- Set potentiometer AMPL. R13 (R8) to position CAL.
- Check that the cross talk does not exceed 0.3 cm.
- Decrease the frequency of the input signal to 10 MHz and increase the amplitude to an equivalent of 24 cm.
- Check that the cross talk does not exceed 0.3 cm.
- Apply a square-wave voltage with a repetition rate of 10 Hz and an amplitude equivalent to 24 cm to input socket  $Y_A$  BU3 ( $Y_B$  BU5).
- Check that the cross talk does not exceed 0.3 cm.

## S. BRIGHTNESS MODULATION (R1001)

- Pull potentiometer LEVEL R1/SK5 to position AUTO.
- Set TIME/cm SK6 to position 10 ms.
- Depress switch MAGN. SK8 to x1 position.
- Adjust potentiometer INTENS. R2 for the desired brightness.
- Check that the time-base line is equally bright over the whole length (no thickenings). If necessary correct with potentiometer R1001, Fig. 50.
- Check that the time-base line is equally bright over the whole length (no thickenings) in all other positions

of switch TIME/cm SK6.

- Set switch TIME/cm SK6 to position .1  $\mu$ s.
- Set potentiometer TIME/cm R4 to position CAL.
- Pull switch MAGN. SK8 to position x5.
- Check that of the whole time-base line no more than 0.5 cm is dark at a normal brightness of the trace.

## T. Z-MODULATION

- Apply a negative-going square-wave voltage of 5 V to socket Z MOD. BU6.
- Apply a signal which is synchronous with the former square-wave voltage to input socket  $Y_A$  BU3.
- Set switch AC-0-DC SK9 to position AC.
- Set selector switch SK10 to position  $Y_A$ .
- Set switch  $Y_A - Y_B - EXT$  SK4 to position  $Y_A$ .
- Set switch LF-HF-DC SK2 to position DC.
- Pull potentiometer LEVEL R1 to position AUTO.
- Check that at a pulse repetition rate of about 100 Hz and about 500 kHz, the trace is dark during the negative pulse, in positions 5 ms and 1  $\mu$ s of switch TIME/cm SK6.

## U. OUTPUT SOCKETS

### U1. Calibration voltage on socket CAL. 1 V BU2 (R1136, R1138)

- Measure the voltage on socket CAL. 1 V BU2 with the aid of an accurate peak-voltmeter. This voltage should be  $1\text{ V} \pm 0.7\%$ . If necessary select different values for resistors R1136 and R1138 (Fig. 50).
- Check that the pulse repetition rate is approximately 2 kHz.

### U2. Vertical output voltage on socket Y OUT BU7

- Set selector switch SK10 to position  $Y_A$ .
- Set switch AMPL. SK12 to position 50 mV/cm.
- Set potentiometer AMPL. R8 to position CAL.
- Set switch AC-0-DC SK9 to position AC.
- Apply a sine-wave voltage of 300 mV and a frequency of 2 kHz to input socket  $Y_A$  BU3.
- Check that the signal voltage on socket Y OUT BU7 is approximately 1.5 V.

### U3. Time-base voltage on socket TIME-BASE OUT BU6

- Check that there is a positive-going sawtooth of 6 V  $\pm 1$  V available on socket TIME-BASE OUT BU6.
- Check that the d.c. level of the sawtooth voltage is 0 V  $\pm 1$  V.

# XI. Information for assistance in fault finding

## A. VOLTAGE LEVELS AND WAVE FORMS

The d.c. levels and the wave forms on the most important points of the circuits have been indicated on the circuit diagram. These values may, however, slightly differ per instrument.

The measurements have been made under the following conditions:

- Mode selector SK10 in position Y<sub>A</sub>.
- Switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 in position Y<sub>A</sub>.
- Switch LEVEL SK5 to position AUTO.
- Potentiometer TIME/cm R4 in position CAL.
- Switch TIME/cm SK6 in position 1 ms.
- Potentiometers POSITION R14 & 15 in centre position.
- Switches AC-0-DC SK9 & 11 to position 0.

*NOTE: For measurements on the horizontal amplifier, set switch SK5 of the LEVEL potentiometer to the level position (time-base inoperative). Further set potentiometer POSITION R7 so that the potentials on both horizontal-deflection plates are equal.*

## B. POSSIBLE FAULTS

### B1. There is no light on the c.r.t.

- Check the supply voltages +23 V, –23 V, +85 V, –1600 V and +8500 V.

*Note: The –1600 V is present when neon tube B1002 on circuit board 8 lights up.*

- Set mode selector SK10 to position XY.
- Turn potentiometer INTENS R2 fully clockwise.
- Set potentiometers POSITION R14 & 15 to the centre position.
- Set switches AC-0-DC SK9 & 11 to position 0. If there is light now, the time-base generator does not work.
- If there is no light, check the potentials of the horizontal- and vertical-deflection plates. If these potentials are about 0 V, the fault is in the blanking circuit, or the c.r.t. is faulty.
- Check the emitter voltage of transistor TS1006.
- Check the emitter voltage of transistor TS1004.

- Check oscillator TS1001 & 1002.

### B2. There is only trace B visible

- Pull switch LEVEL SK5 to position AUTO.
- Set mode selector SK10 to position Y<sub>A</sub>.
- Set potentiometer POSITION R14 to its centre position.
- Set switch AMPL. SK12 to position 50 mV/cm.
- Set switch AC-0-DC SK9 to position 0.
- Measure the voltage on the emitter of transistor TS39 (test point D, Fig. 49). If this voltage is 0 V and the voltage on the delay line is 0 V, then the vertical intermediate amplifier is faulty.
- If the voltage on the emitter of transistor TS39 does not equal 0 V, the pre-amplifier is faulty.
- Connect junction R48-R51-R49 in the gate circuit of f.e.t. TS26-2 to earth. If the emitter voltage of TS39 is then about 0 V (±200 mV), the drift-control amplifier is faulty.
- If the voltage is not 0 V, the fault is in the vertical amplifier. Check the potentials of the various points in the amplifier.

### B3. There is only trace A visible

- Pull switch LEVEL SK5 to position AUTO.
- Set mode selector SK10 to position Y<sub>B</sub>.
- Set potentiometer POSITION R15 to its centre position.
- Set switch AMPL. SK13 to position 50 mV/cm.
- Set switch AC-0-DC SK11 to position 0.
- Measure the voltage on the emitter of transistor TS239 (test point E, Fig. 51). If this voltage is 0 V and the voltage on the delay line is 0 V, then the vertical intermediate amplifier is faulty.
- If the voltage on the emitter of transistor TS239 does not equal 0 V, the pre-amplifier is faulty.
- Connect junction R248-R251-R249 in the gate circuit of f.e.t. TS226-2 to earth. If the emitter voltage of TS239 is then about 0 V (±200 mV), the drift-control amplifier is faulty.
- If the voltage is not 0 V, the fault is in the vertical amplifier. Check the potentials of the various points in the amplifier.

### B4. Time base does not work

- Turn potentiometer INTENS R2 clockwise.
- Set AC-0-DC SK11 to position 0.

- Set potentiometers POSITION R7 & R15 to the centre position.
- Set mode selector SK10 to position Y<sub>B</sub>.
- Set switch Y<sub>A</sub> - Y<sub>B</sub> - EXT SK4 to position Y<sub>B</sub>.
- Pull the switch of potentiometer LEVEL R1 to AUTO.
- If the time-base generator works now, the trigger circuit is faulty:  
Check the stability setting and the potentials of the various points in the trigger circuit.
- If the time-base generator does not work yet, connect the collector of transistor TS804 to earth and check that the potentials of the various points in the time-base generator meet the values stated in the circuit diagram for the starting point of the time-base sweep.

### C. NOTES

In case of a defect it is always possible to apply to the world wide PHILIPS Service Organisation.

When the instrument is to be sent to a PHILIPS Service workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found.
- Use the original packing or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organisation.





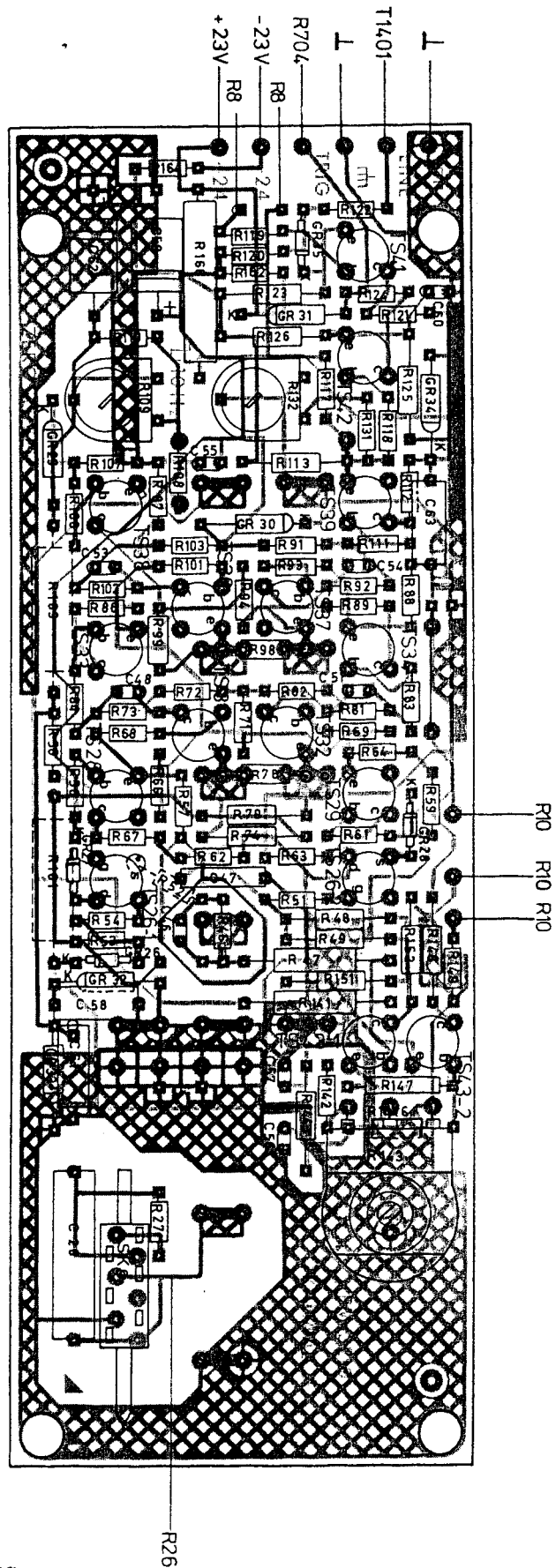


Fig. 54. Unit 1. Channel A vertical pre-amplifier

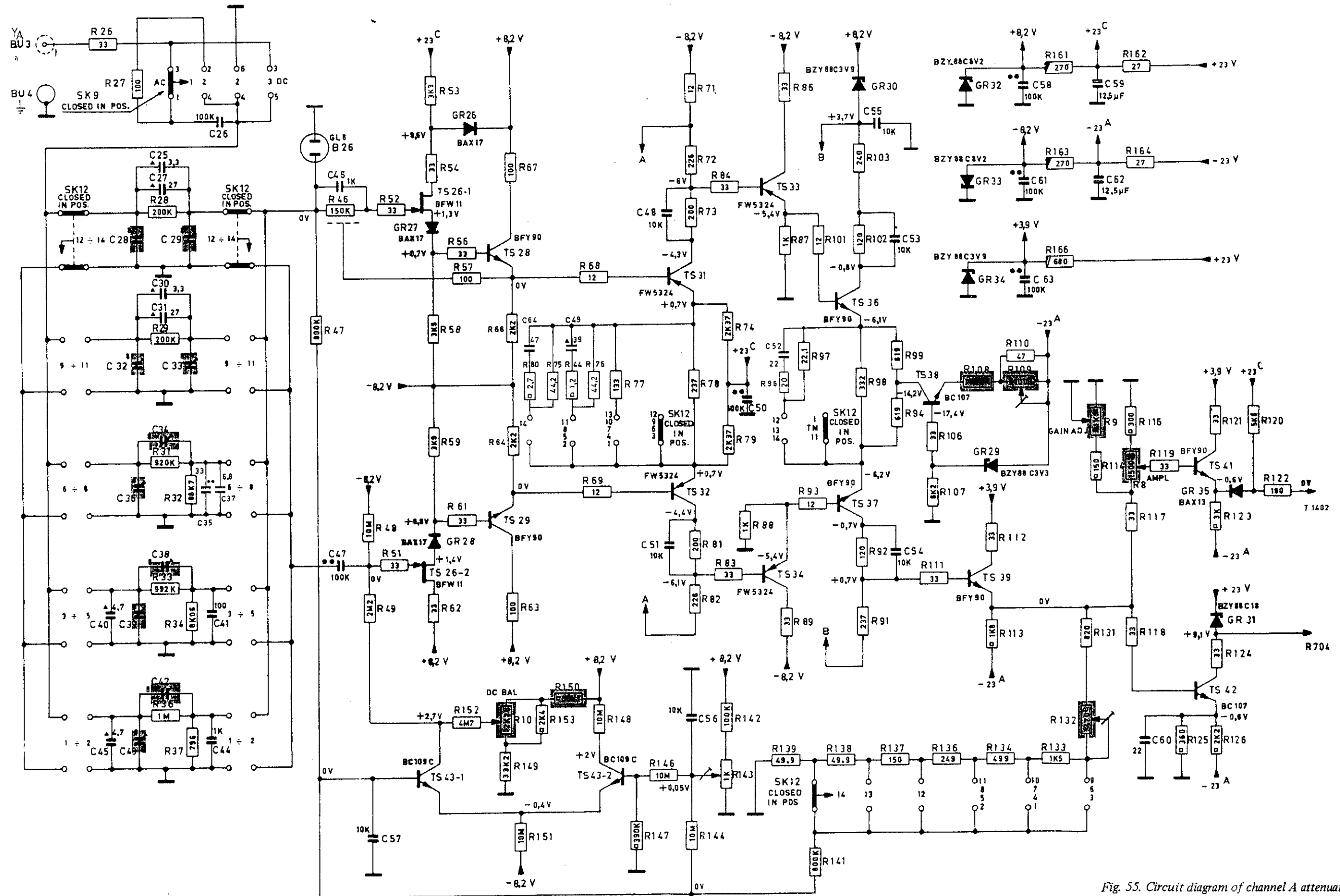


Fig. 55. Circuit diagram of channel A attenuator and pre-amplifier

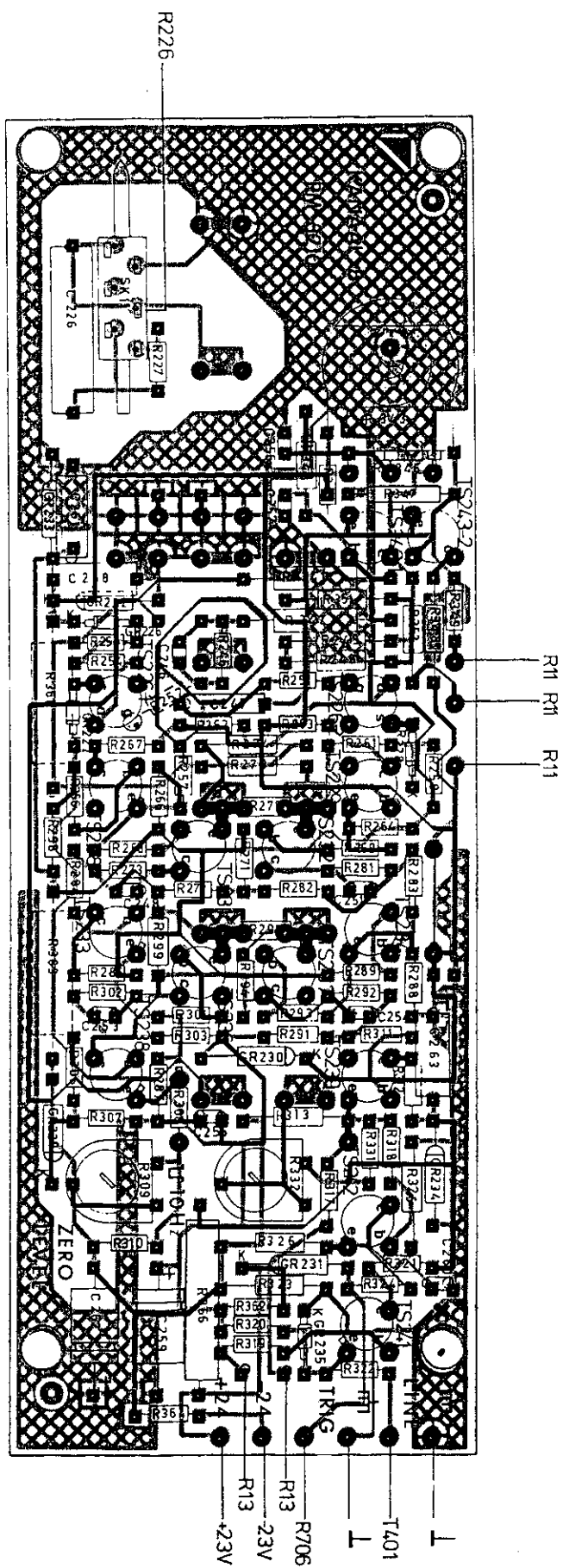


Fig. 56. Unit 2. Channel B vertical pre-amplifier

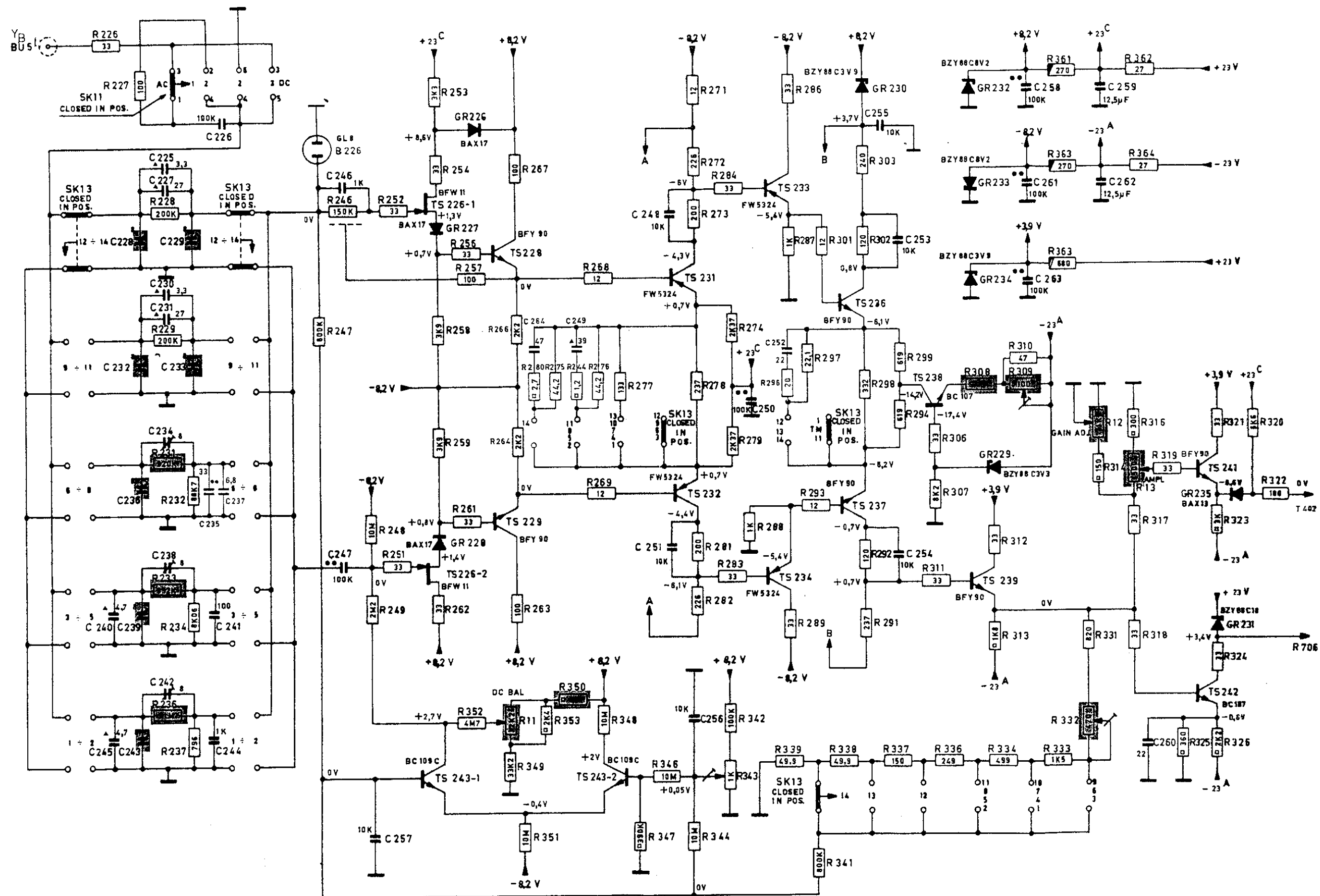


Fig. 57. Circuit diagram of channel B attenuator and pre-amplifier

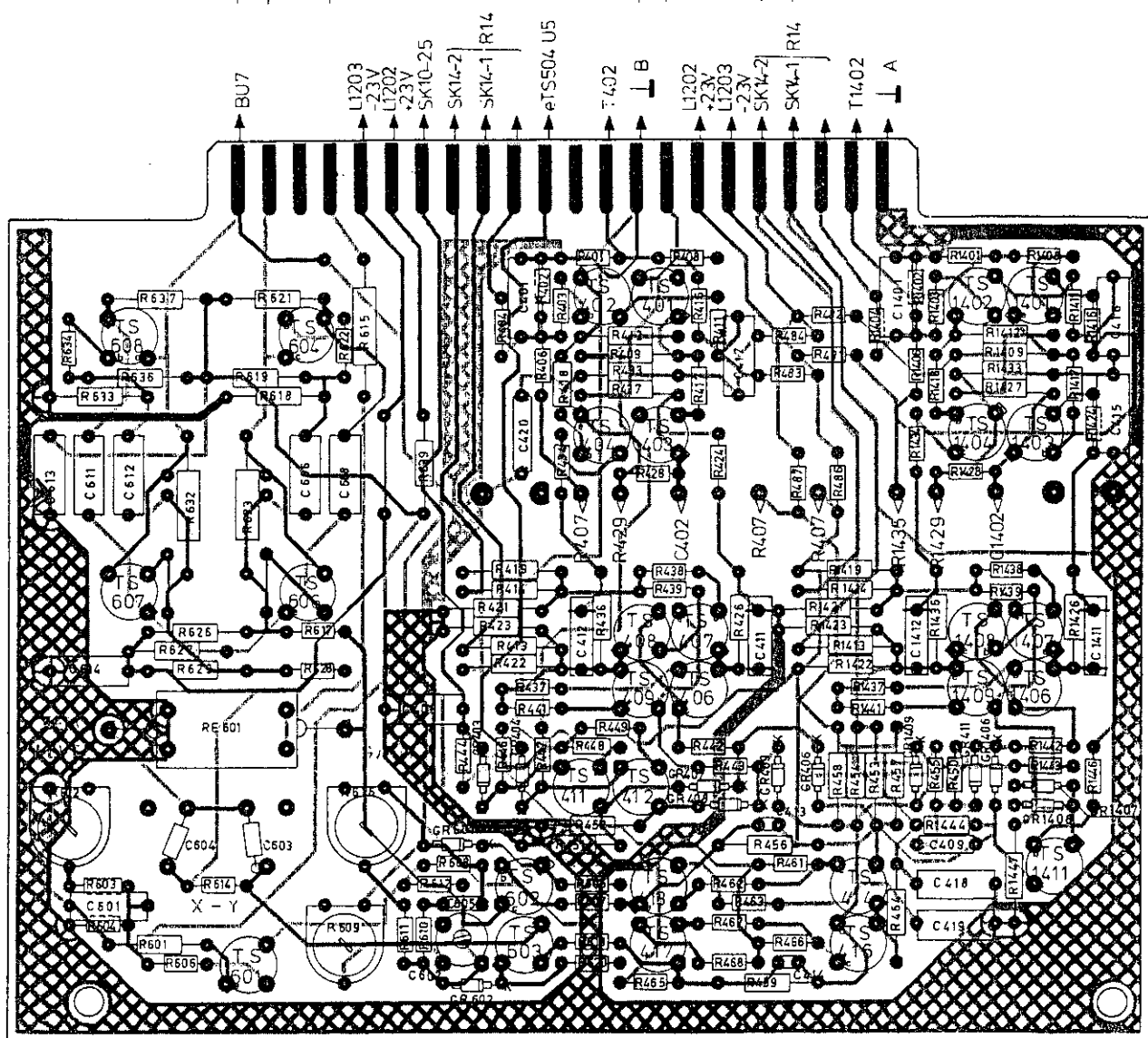


Fig. 58A. Unit 402. Adjusting unit

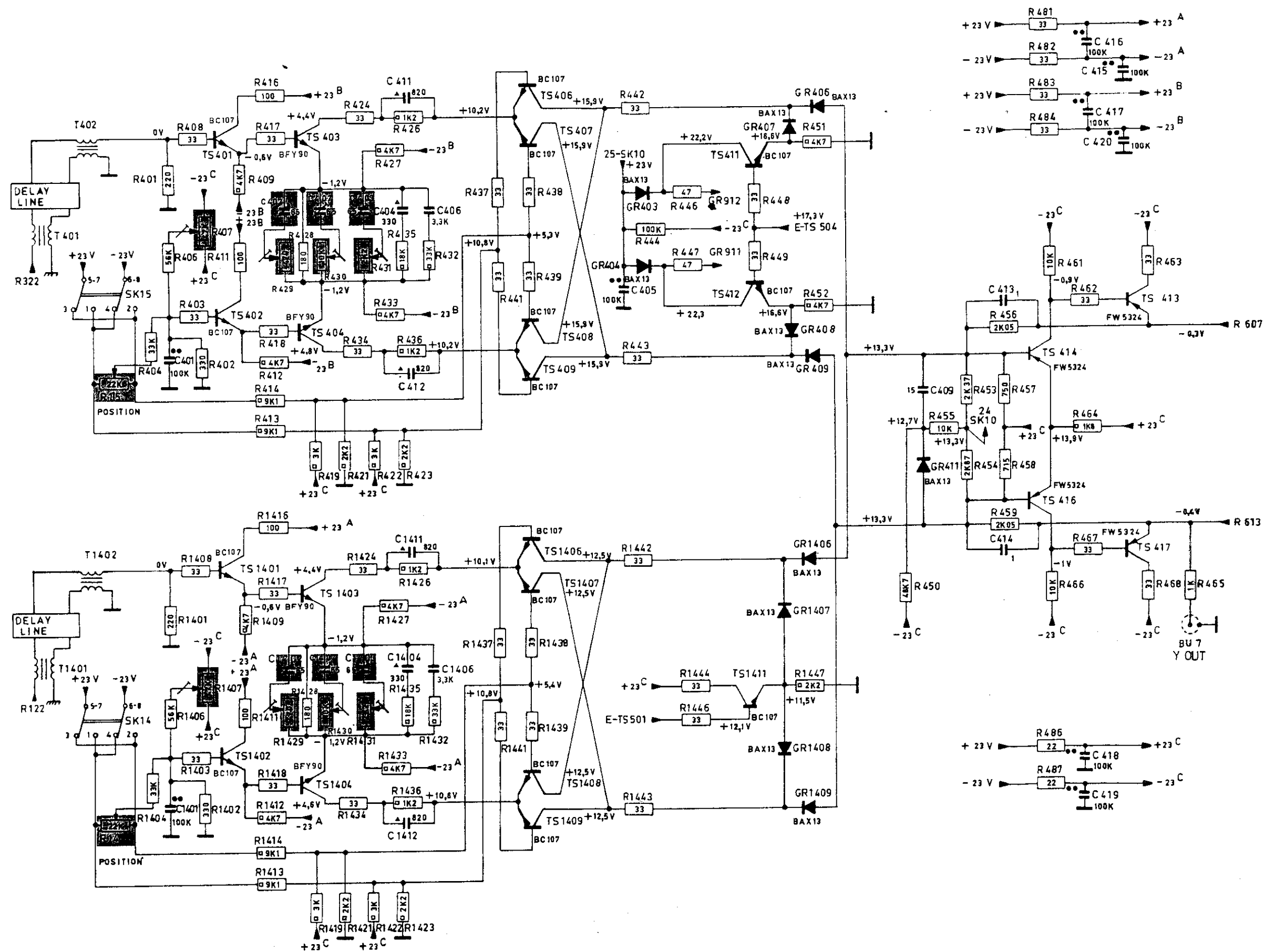


Fig. 59. Circuit diagram of the vertical amplifier

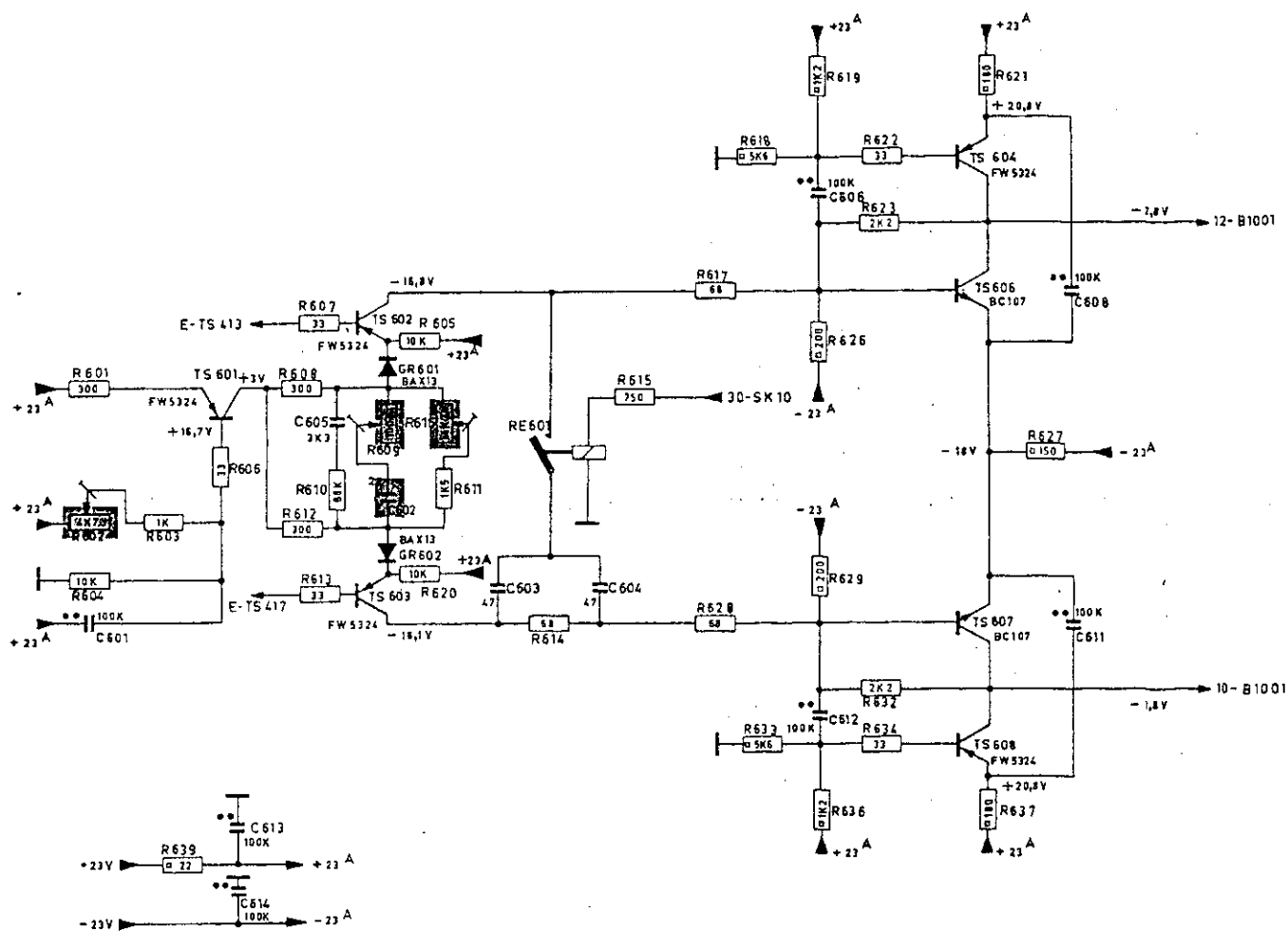


Fig. 60. Circuit diagram of the vertical output amplifier





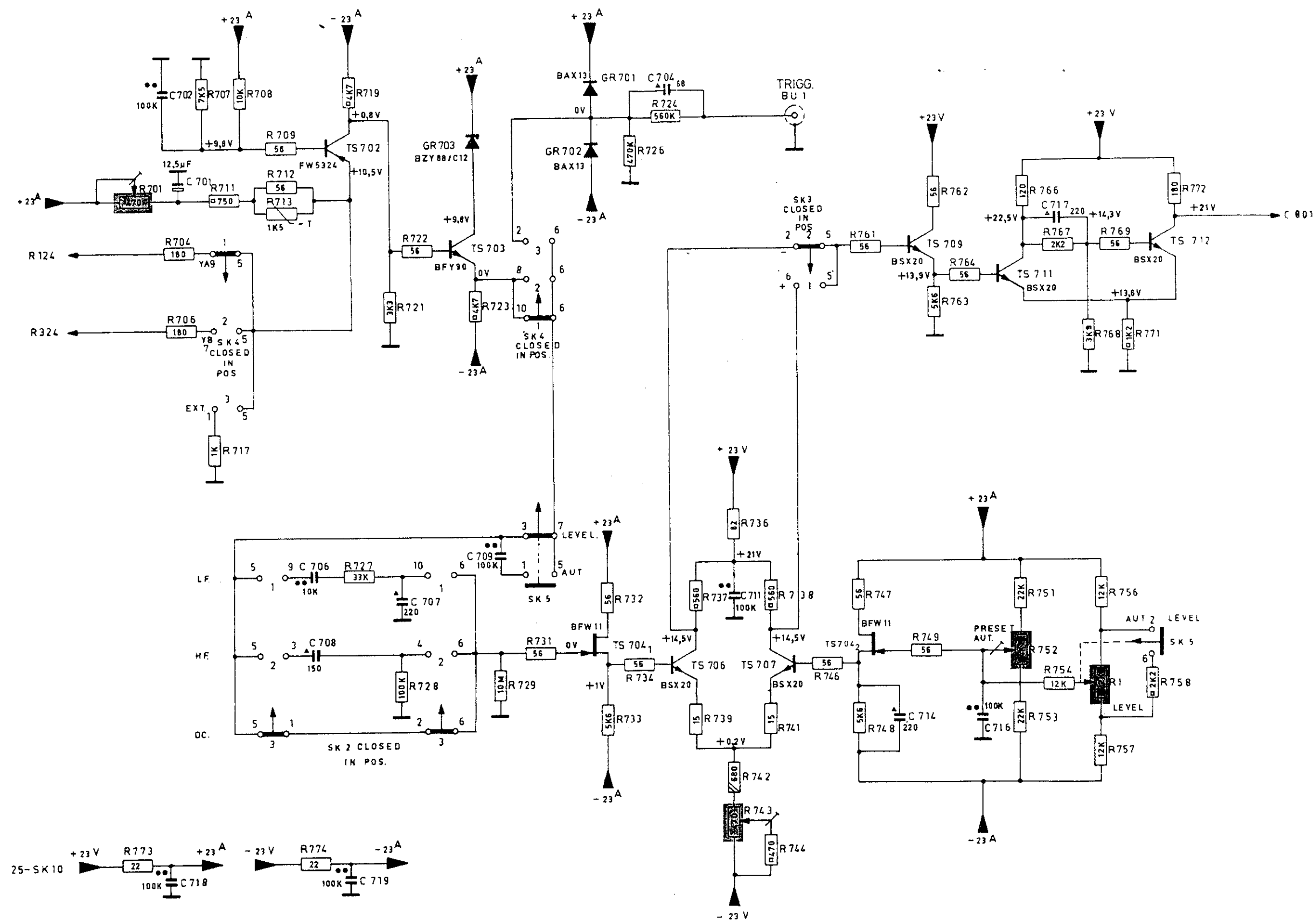
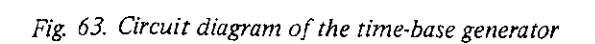


Fig. 62. Circuit diagram of the trigger amplifier





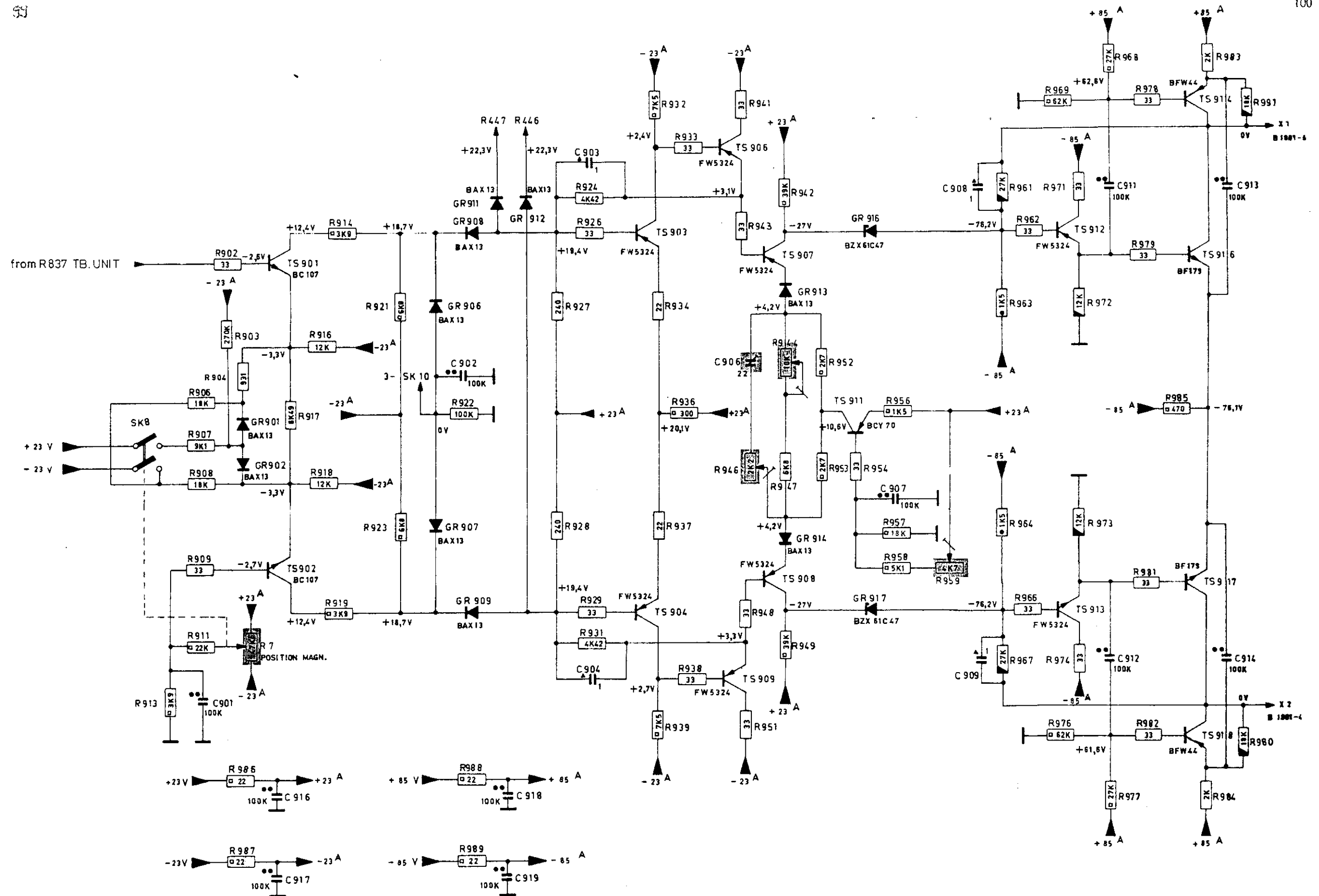


Fig. 65. Circuit diagram of the horizontal amplifier

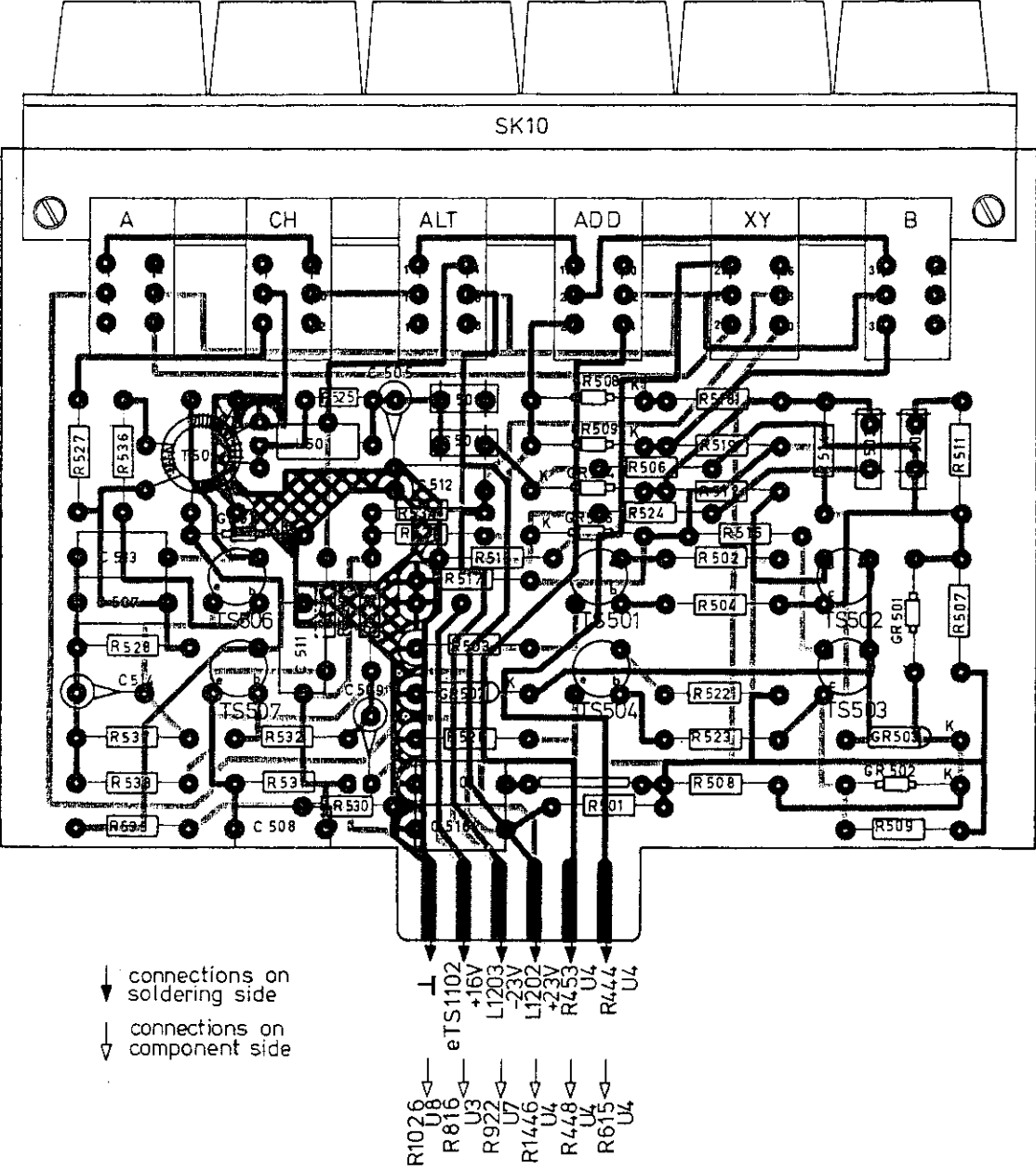


Fig. 66. Unit 5. Switch unit



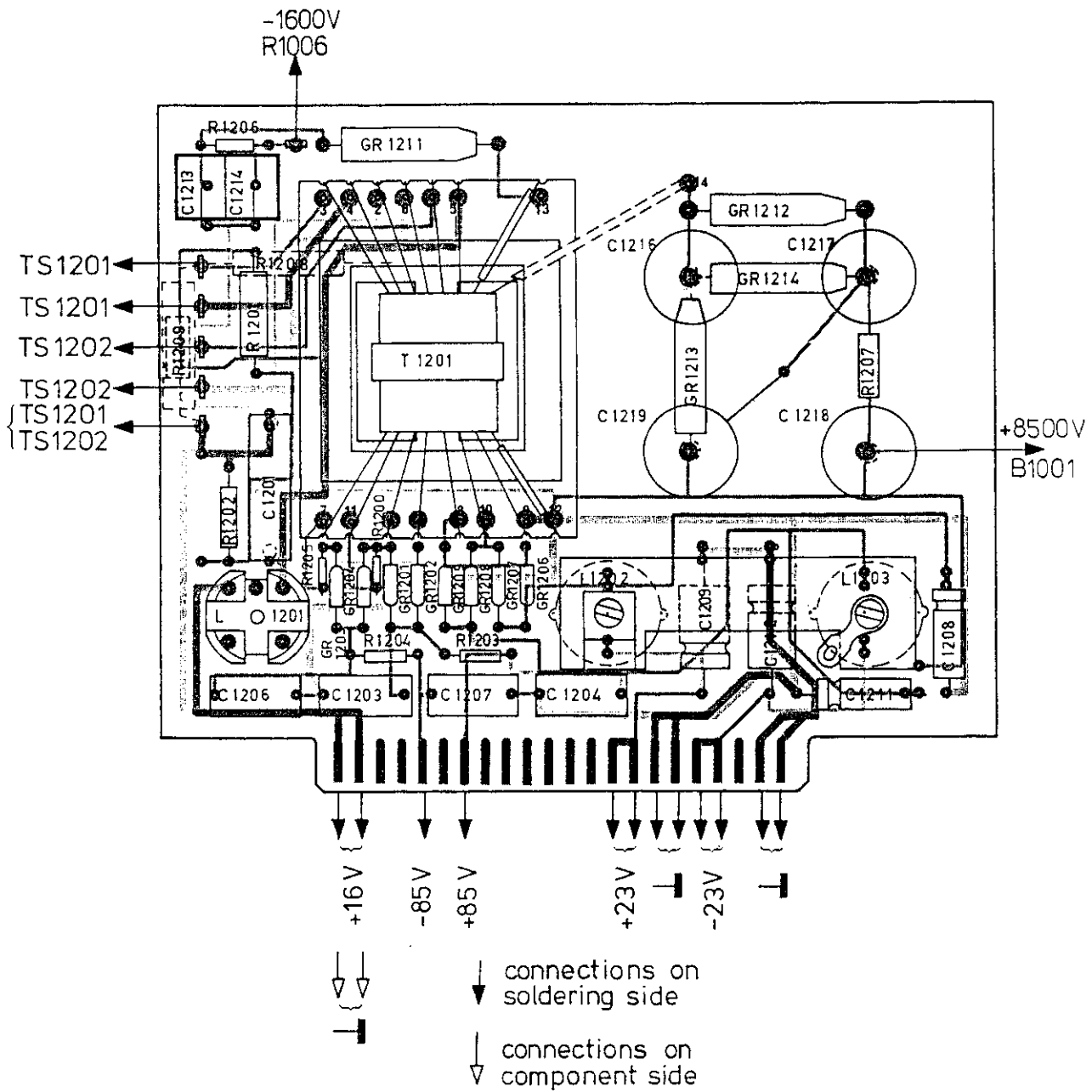


Fig. 68. Unit 6. Converter unit

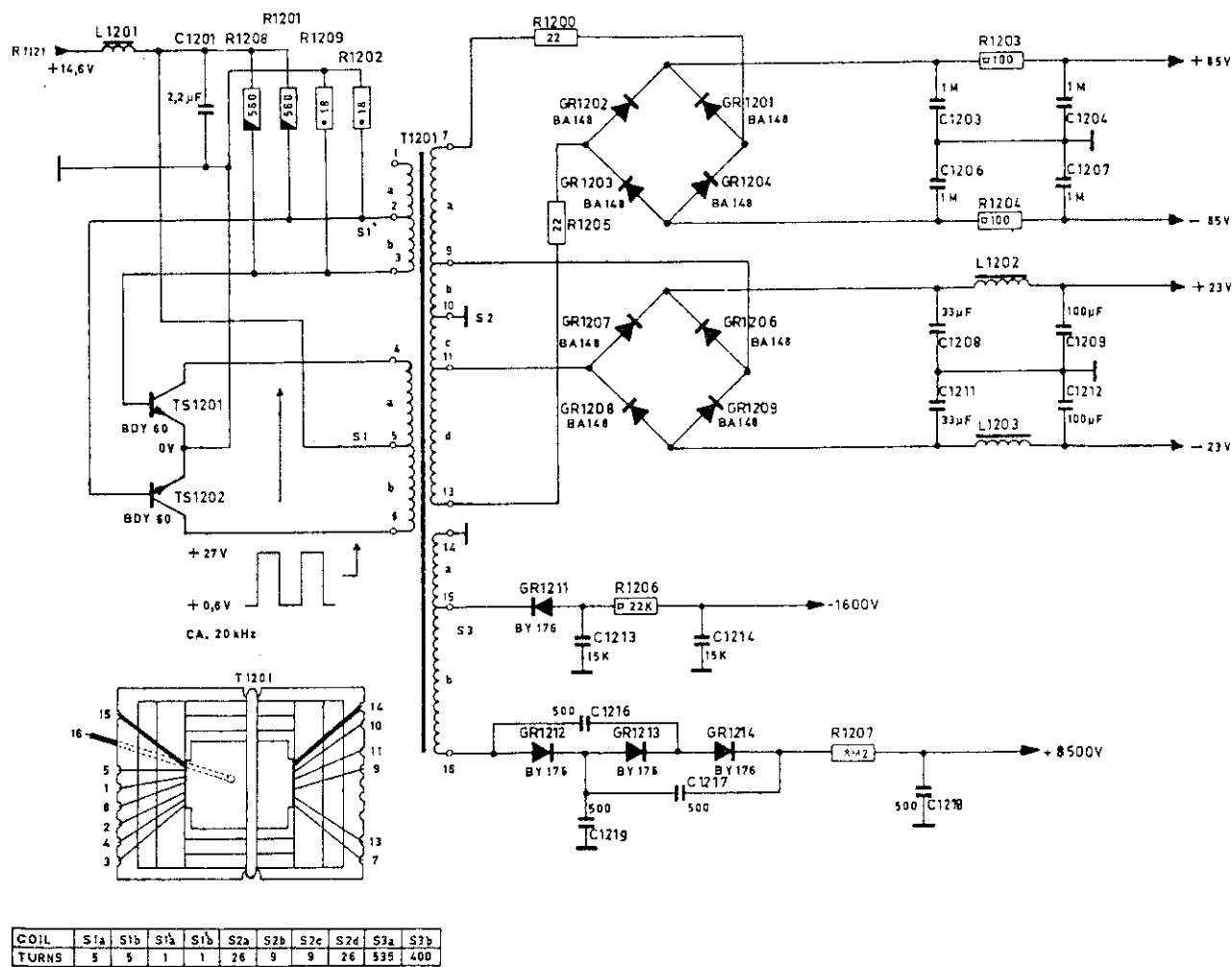


Fig. 69. Circuit diagram of the convertor unit





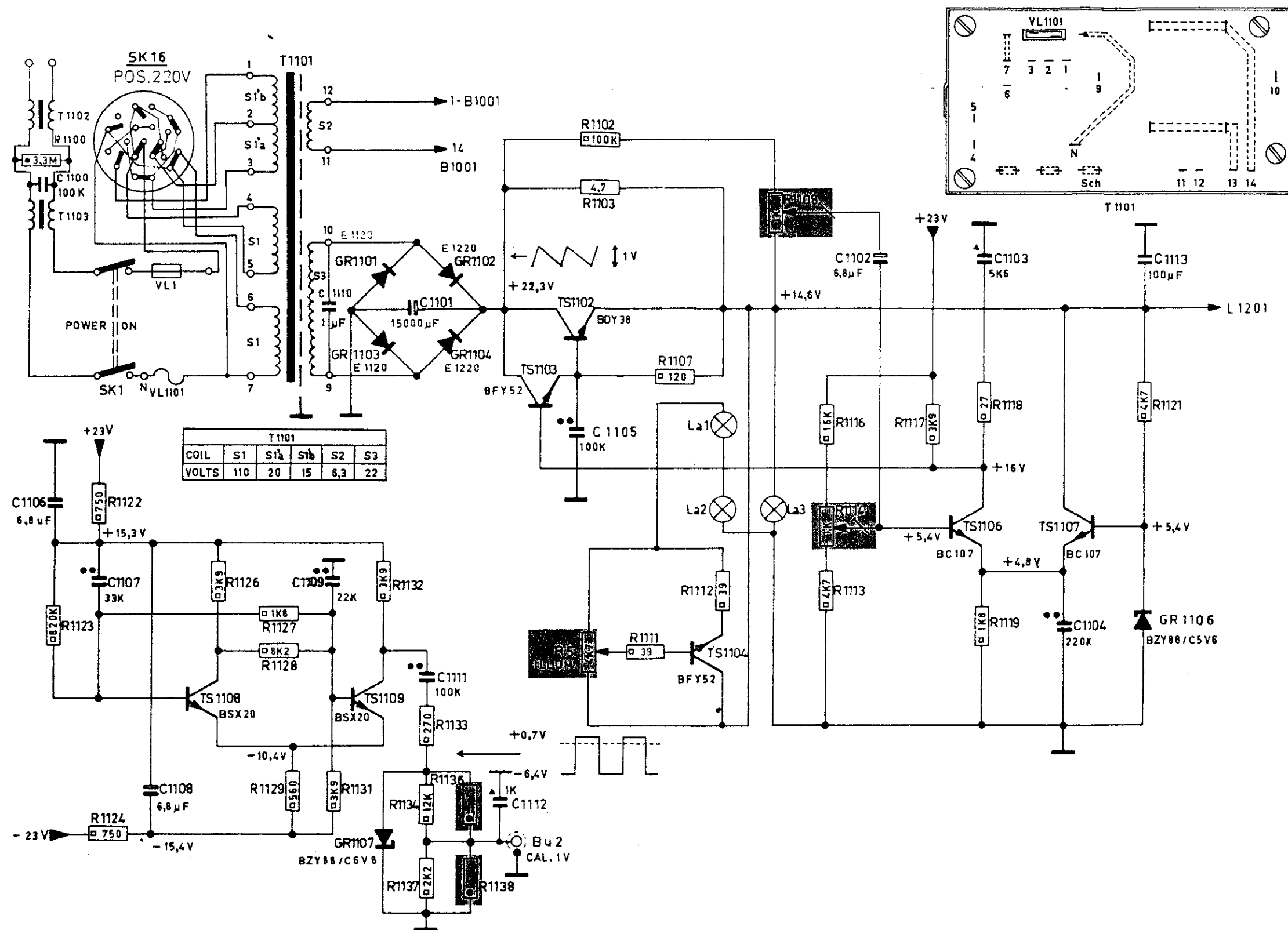


Fig. 71. Circuit diagram of the stabilized power supply and the calibration unit

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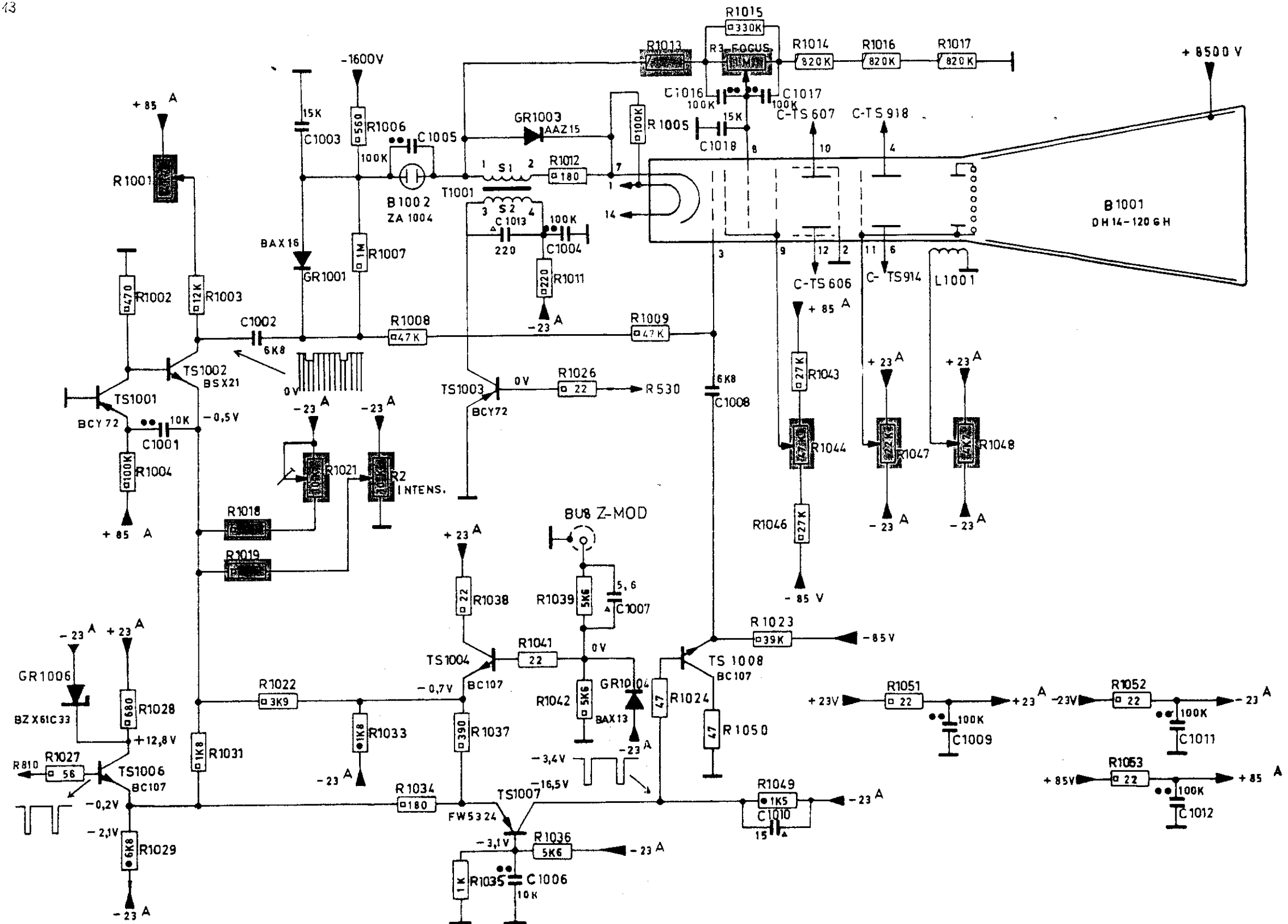


Fig. 73. Circuit diagram of the blanking and c.r.t. unit

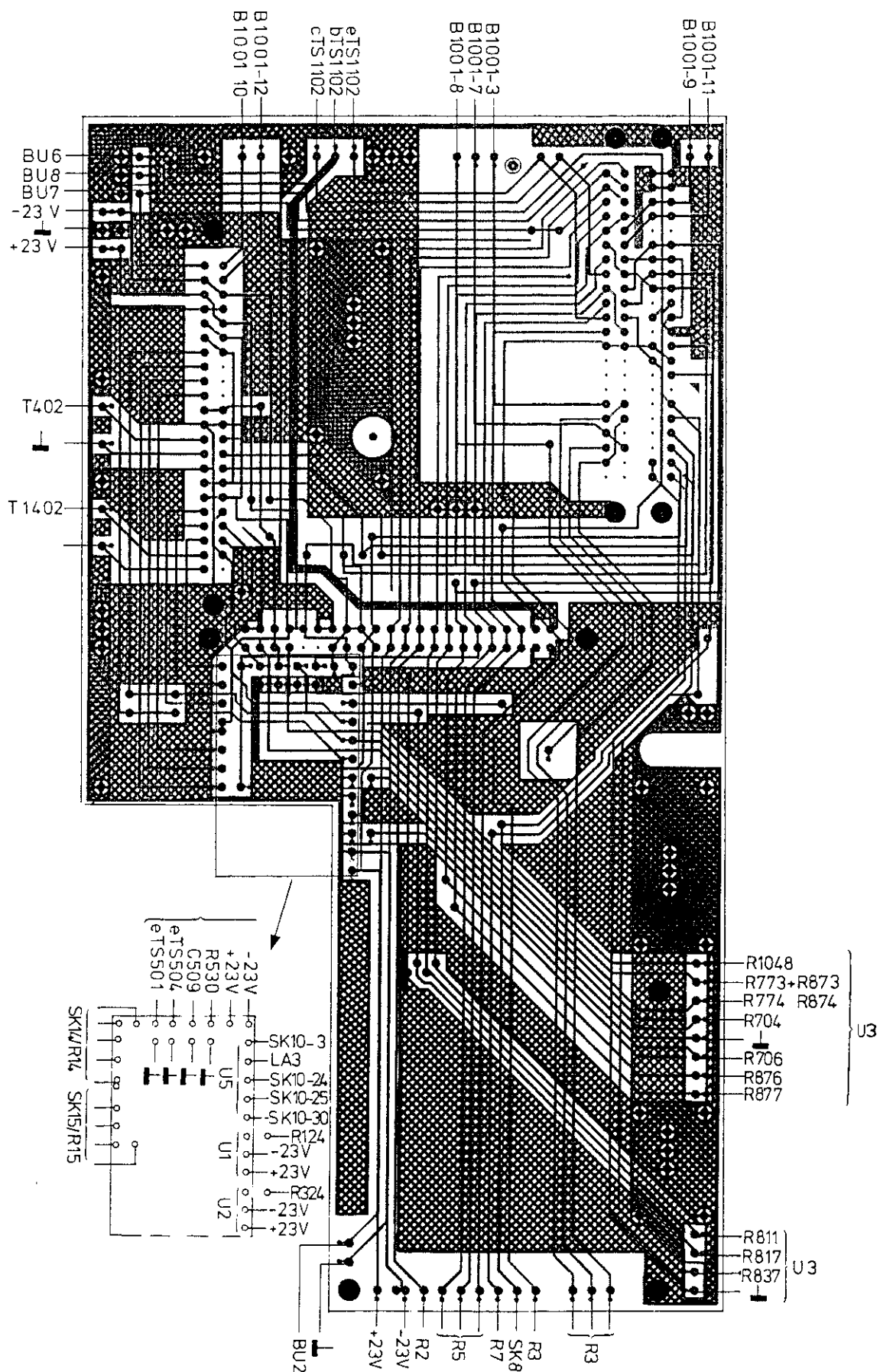


Fig. 72. Unit 9. Wiring unit

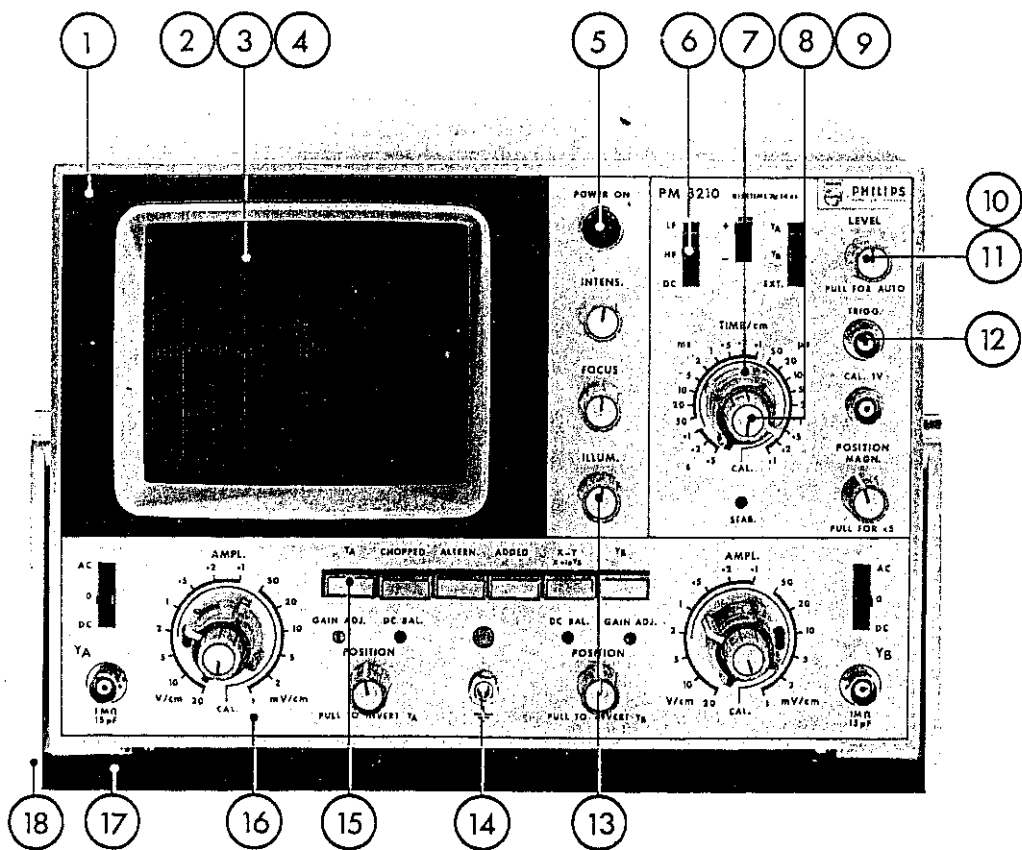


Fig. 74. Front view with item numbers

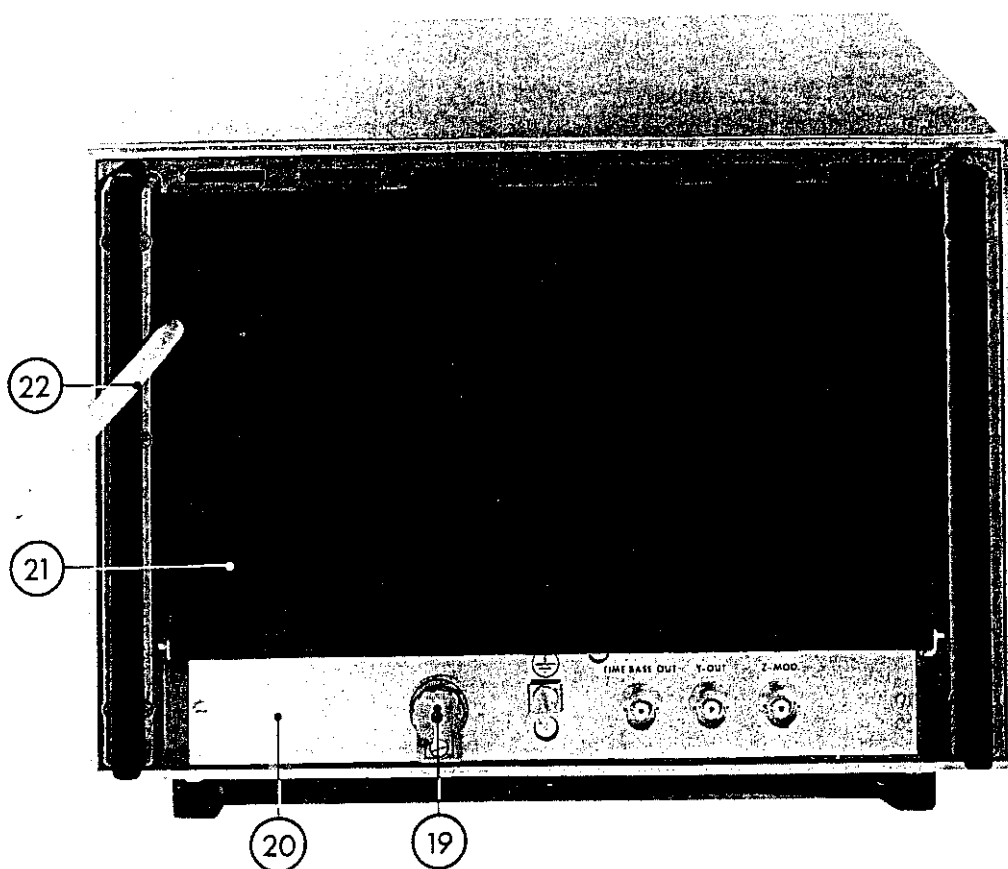


Fig. 75. Rear view with item numbers

# SERVICE

Electron optics / Nuclear and electrochemical  
equipment / X-Ray analysis / Cryogenic  
equipment / Test and measuring equipment /  
Process instrumentation /  
Industrial Data Processing Systems /  
Weighing / Welding / Numerical Control /  
Textile equipment

## industrial equipment division



1-3-1972

PM 3210/02/03

Cd 725

### TEST AND MEASURING INSTRUMENTS

#### 1. MODIFICATIONS INTRODUCED INTO PM 3210/02 and /03 MODELS

##### 1.1. General

A number of minor circuit modifications have been introduced, which appear from the enclosed circuit diagrams, circuit board drawings and parts list.

##### 1.2. Mains transformer

As from PM 3210/03, the mains transformer and the voltage adapter have been changed; see enclosed circuit diagram Fig. 71 for /03 model.

The new transformer unit, including mains transformer, voltage adapter, rectifier diodes and capacitor C1100, can also be used for previous models. Therefore, the mains transformer of the /01 and /02 models, 5322 146 20469, is obsolete and replaced by mains transformer unit 5322 146 24024 for all models. Also voltage adapter 5322 272 10003 is obsolete for all models PM 3210.

##### 1.3. H.T. Unit 6

If the H.T. unit is to be replaced by a unit supplied by the Concern Service Department, C1113 has to be removed. C1113, a 100  $\mu$ F electrolytic capacitor which is NOT present in all instruments, is located on the mounting plate of transistor TS1102 on the rear panel of the instrument, over the output sockets.

#### 2. MANUAL FOR PM 3210/02 AND /03 MODELS

For these instruments manual 9499 440 07611 of the PM 3210/01 model can be used, together with this modification sheet. The relevant circuit board drawings and circuit diagrams should be replaced by the ones enclosed with this modification sheet.

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*mem. H. K.*

# PHILIPS

## Parts lists

### **PM 3210    25 MHz Dual-trace oscilloscope**

9444 032 10011

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## XII. Mechanical parts list

| Item | Fig. | Qty. | Ordering code  | Description                          |
|------|------|------|----------------|--------------------------------------|
| 1    | 74   | 1    | 5322 459 40233 | Bezel                                |
| 2    | 74   | 1    | 5322 450 60089 | Graticule                            |
| 3    | 74   | 1    | 5322 450 60091 | Contrast filter, grey                |
| 4    | 74   | 1    | 5322 450 60092 | Contrast filter, green               |
| 5    | 74   | 1    | 5322 277 10226 | Mains switch                         |
| 6    | 74   | 5    | 5322 404 60058 | Switch lever for SK2, 3, 4, 9, 11    |
| 7    | 74   | 3    | 5322 413 40112 | Switch knob for SK6, 12, 13          |
| 8    | 74   | 3    | 5322 413 30085 | Control knob for R4, 8, 13           |
| 9    | 74   | 3    | 5322 413 70039 | Cap for item 8                       |
| 10   | 74   | 4    | 5322 413 30082 | Control knob for R1, 7, 14, 15       |
| 11   | 74   | 7    | 5322 413 70038 | Cap for items 10 and 13              |
| 12   | 74   | 7    | 5322 267 10004 | B.N.C. sockets BU1, 2, 3, 5, 6, 7, 8 |
| 13   | 74   | 3    | 5322 413 30346 | Control knob for R2, 3, 5            |
| 14   | 74   | 1    | 5322 535 80523 | Earth screw                          |
| 15   | 74   | 6    | 5322 276 60103 | Push-button switch for SK10          |
| 16   | 74   | 1    | 5322 455 80062 | Text plate, front                    |
| 17   | 74   | 1    | 5322 498 40324 | Grip                                 |
| 18   | 74   | 2    | 5322 498 70044 | Bracket                              |
| 19   | 75   | 1    | 5322 256 40026 | Fuse holder                          |
| 20   | 75   | 1    | 5322 455 80063 | Text plate, rear                     |
| 21   | 75   | 1    | 5322 255 40091 | Rear cover                           |
| 22   | 75   | 1    | 5322 321 10071 | Mains flex                           |
| 23   | 76   | 2    | 5322 255 20022 | Lamp holder                          |
| 24   | 76   | 2    | 5322 462 70827 | Cap                                  |
| 25   | 76   | 2    | 5322 255 40106 | Transistor clip                      |
| 26   | 76   | 16   | 5322 255 40057 | Transistor holder                    |
| 27   | 76   | 1    | 5322 320 20062 | H.T. Cable                           |
| 28   | 76   | 87   | 5322 255 40017 | Transistor holder                    |
| 29   | 76   | 4    | 5322 255 40105 | Heat sink                            |
| 30   | 76   | 3    | 5322 255 40085 | Transistor holder                    |
| 31   | 76   | 3    | 5322 255 40072 | Mica insulation plate                |
| 32   | 77   | 4    | 5322 267 60034 | Terminal                             |
| 33   | 77   | 4    | 5322 255 40054 | Heat sink                            |
| 34   | 77   | 6    | 5322 255 40015 | Transistor holder                    |
| 35   | 77   | 1    | 5322 277 30518 | Switch SK2                           |
| 36   | 77   | 1    | 5322 277 30519 | Switch SK3                           |
| 37   | 77   | 1    | 5322 277 30521 | Switch SK4                           |
| 38   | 78   | 2    | 5322 277 30517 | Switch SK9, SK11                     |
| 39   | 78   | 1    | 5322 273 60103 | Time-base switch SK6                 |
| 40   | 78   | 1    | 5322 532 80121 | Capacitor support                    |

| Item | Fig. | Qty. | Ordering code  | Description                      |
|------|------|------|----------------|----------------------------------|
| 41   | 78   | 1    | 5322 272 10003 | Voltage adapter                  |
| 42   | 79   | 1    | 5322 255 10007 | Lamp holder                      |
| 43   | 79   | 1    | 5322 267 40134 | Terminal                         |
| 44   | 79   | 1    | 5322 105,30068 | Attenuator unit 1, for channel A |
| 45   | 79   | 1    | 5322 105 30069 | Attenuator unit 2, for channel B |
| 46   | 79   | 1    | 5322 219 80241 | Rotor assembly for unit 1        |
| 47   | 79   | 1    | 5322 219 80242 | Rotor assembly for unit 2        |
| 48   | —    | 2    | 5322 492 61786 | Earthing spring for units 1 & 2  |
| 49   | 77   | 1    | 5322 216 50216 | Time-base unit 3                 |
| 50   | 76   | 1    | 5322 216 50217 | Y Amplifier unit 4               |
| 51   | 76   | 1    | 5322 216 50218 | Adjusting unit 402               |
| 52   | 79   | 1    | 5322 216 50219 | Switch unit 5                    |
| 53   | 78   | 1    | 5322 219 80243 | H.T. Unit 6                      |
| 54   | 77   | 1    | 5322 216 50221 | X Amplifier unit 7               |
| 55   | 77   | 1    | 5322 216 50222 | Blanking & calibration unit 8    |
| 56   | 79   | 1    | 5322 320 40041 | Delay line unit                  |
| 57   | —    | 1    | 5322 395 50104 | Trimming rod                     |

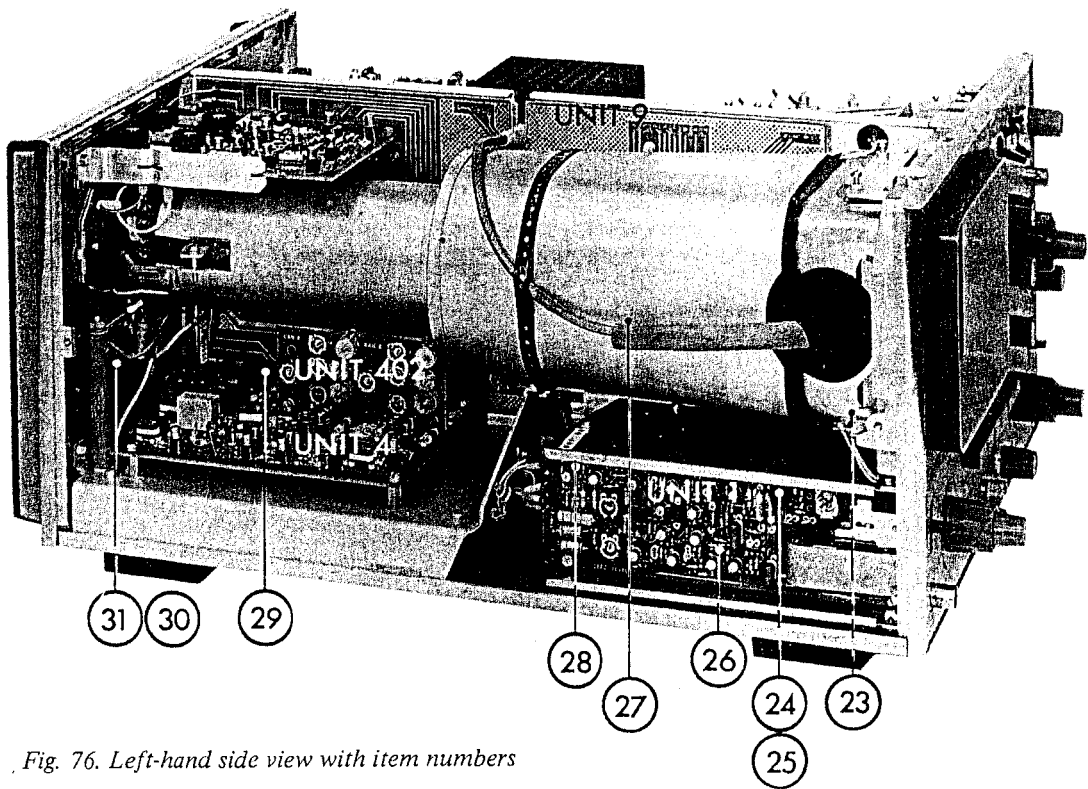


Fig. 76. Left-hand side view with item numbers

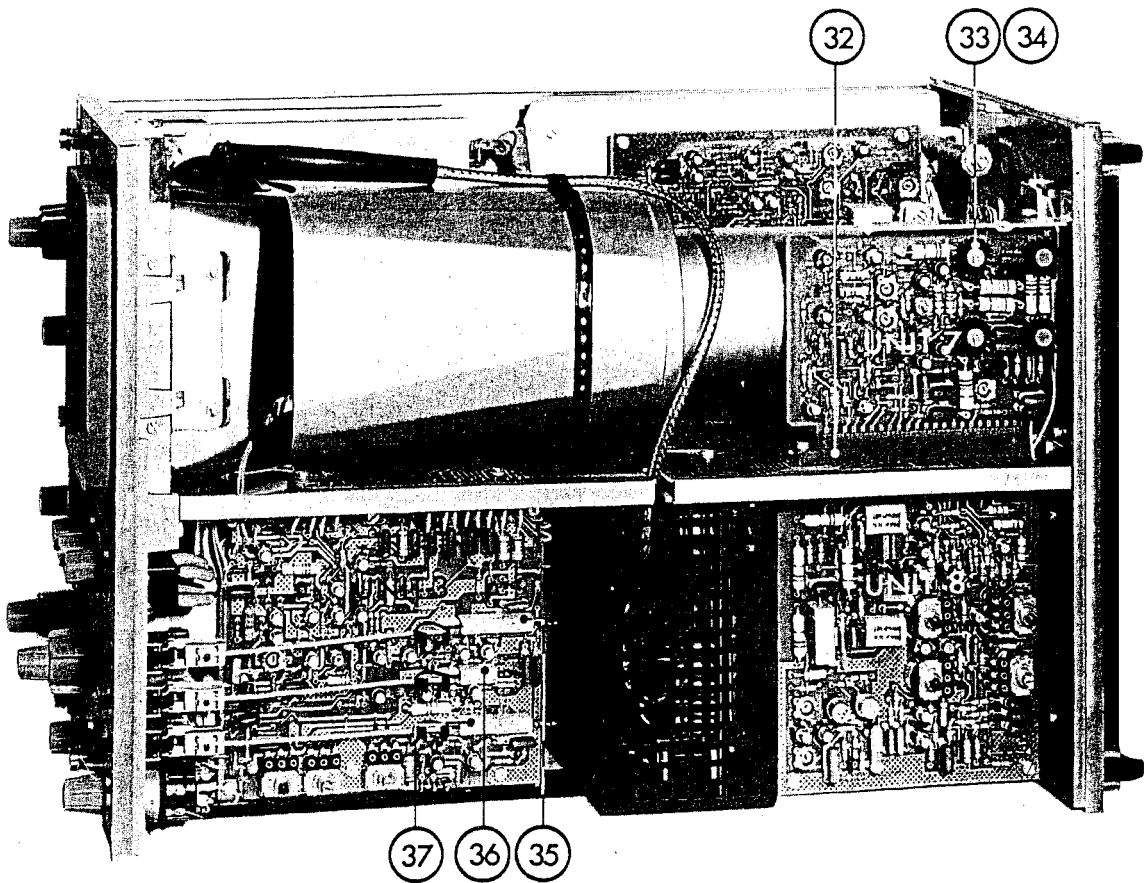


Fig. 77. Top view with item numbers

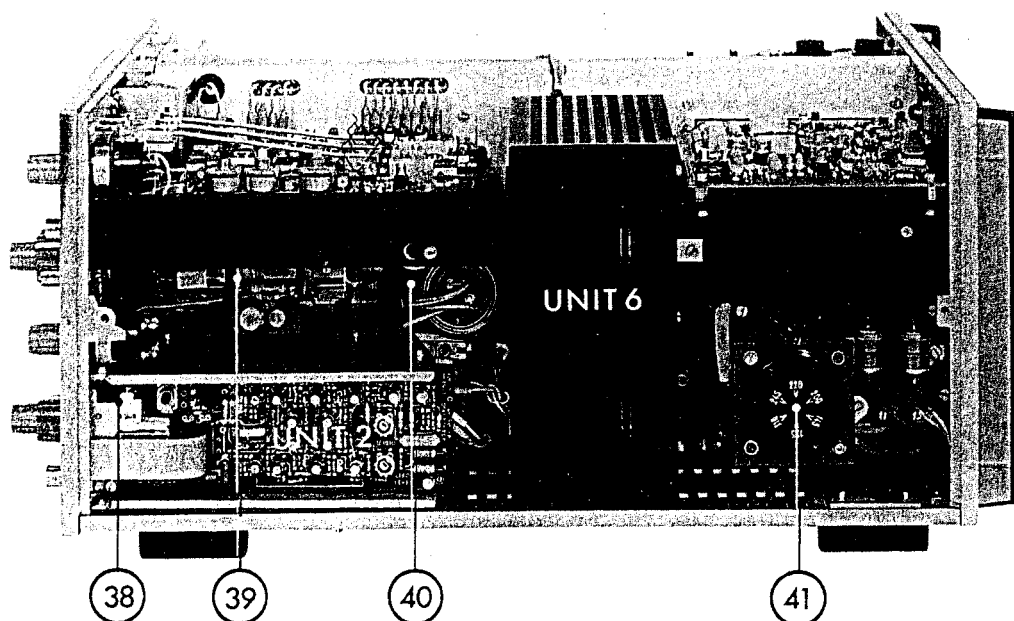


Fig. 78. Right-hand side view with item numbers

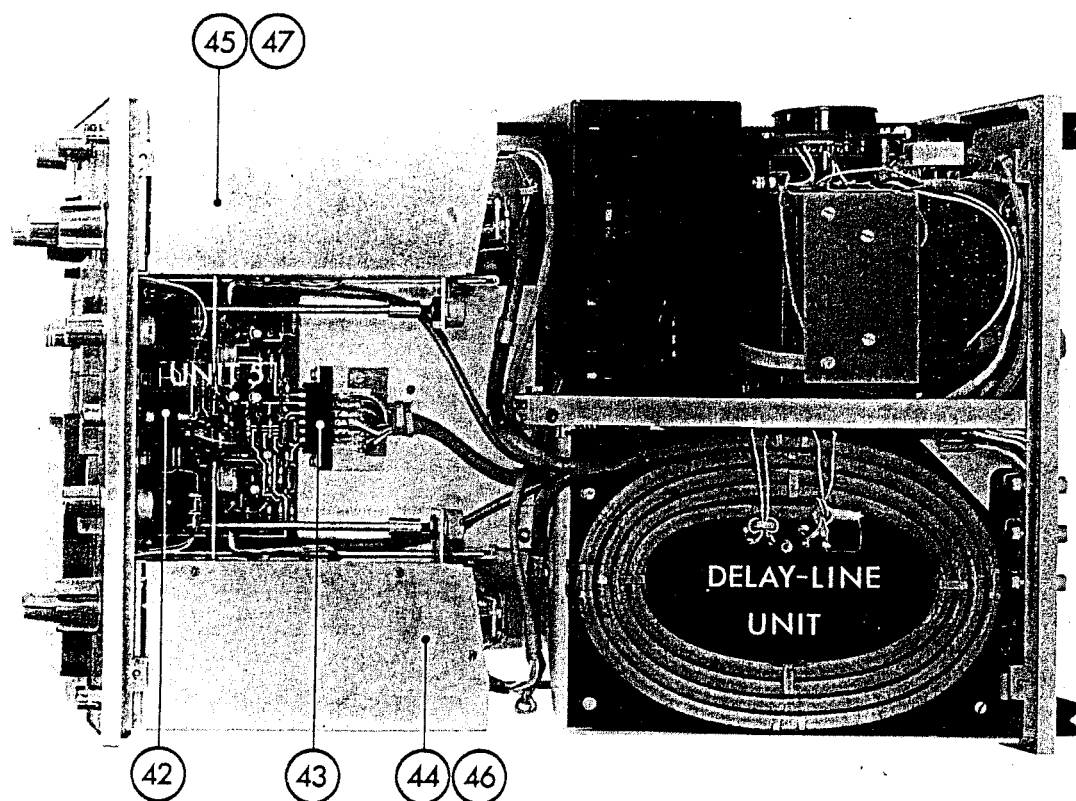


Fig. 79. Bottom view with item numbers

## XIII. Electrical parts list

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

|                                                                                                                                                                                                                                                                                   |                                                                                                                                                      |                                                                                                                                                                                                                                                                                            |                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
|  Carbon resistor E24 series<br>Kohleschichtwiderstand, Reihe E24<br>Koolweerstand E24 reeks<br>Résistance au carbone, série E24<br>Resistencia de carbón, serie E24                               | $\left. \begin{array}{l} 0,125 \text{ W} \\ 5\% \end{array} \right\}$                                                                                |  Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12                                       | $\left. \begin{array}{l} 1 \text{ W} \leq 2,2 \text{ M}\Omega, 5\% \\ > 2,2 \text{ M}\Omega, 10\% \end{array} \right\}$ |
|  Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12                               | $\left. \begin{array}{l} 0,25 \text{ W} \\ \leq 1 \text{ M}\Omega, 5\% \\ > 1 \text{ M}\Omega, 10\% \end{array} \right\}$                            |  Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12                                       | $\left. \begin{array}{l} 2 \text{ W} \\ 5\% \end{array} \right\}$                                                       |
|  Carbon resistor E24 series<br>Kohleschichtwiderstand, Reihe E24<br>Koolweerstand E24 reeks<br>Résistance au carbone, série E24<br>Resistencia de carbón, serie E24                               | $\left. \begin{array}{l} 0,5 \text{ W} \\ \leq 5 \text{ M}\Omega, 1\% \\ > 5 \text{ M}\Omega, 2\% \\ > 10 \text{ M}\Omega, 5\% \end{array} \right\}$ |  Wire-wound resistor<br>Drahtwiderstand<br>Draadgewonden weerstand<br>Résistance bobinée<br>Resistencia bobinada                                                                                          | $\left. \begin{array}{l} 0,4 - 1,8 \text{ W} \\ 0,5\% \end{array} \right\}$                                             |
|  Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12                               | $\left. \begin{array}{l} 0,5 \text{ W} \\ \leq 1,5 \text{ M}\Omega, 5\% \\ > 1,5 \text{ M}\Omega, 10\% \end{array} \right\}$                         |  Wire-wound resistor<br>Drahtwiderstand<br>Draadgewonden weerstand<br>Résistance bobinée<br>Resistencia bobinada                                                                                          | $\left. \begin{array}{l} 5,5 \text{ W} \\ \leq 200 \Omega, 10\% \\ > 200 \Omega, 5\% \end{array} \right\}$              |
|  Wire-wound resistor<br>Drahtwiderstand<br>Draadgewonden weerstand<br>Résistance bobinée<br>Resistencia bobinada                                                                               | $\left. \begin{array}{l} 10 \text{ W} \\ 5\% \end{array} \right\}$                                                                                   |                                                                                                                                                                                                                                                                                            |                                                                                                                         |
|  Tubular ceramic capacitor<br>Rohrkondensator<br>Keramische kondensator, buistype<br>Condensateur céramique tubulaire<br>Condensador cerámico tubular                                           | $\left. \begin{array}{l} 500 \text{ V} \end{array} \right\}$                                                                                         |  Polyester capacitor<br>Polyesterkondensator<br>Polyesterkondensator<br>Condensateur au polyester<br>Condensador polyester                                                                              | $\left. \begin{array}{l} 400 \text{ V} \end{array} \right\}$                                                            |
|  Tubular ceramic capacitor<br>Rohrkondensator<br>Keramische kondensator, buistype<br>Condensateur céramique tubulaire<br>Condensador cerámico tubular                                           | $\left. \begin{array}{l} 700 \text{ V} \end{array} \right\}$                                                                                         |  Flat-foil polyester capacitor<br>Miniatur-Polyesterkondensator (flach)<br>Platte miniatur polyesterkondensator<br>Condensateur au polyester, type plat<br>Condensador polyester, tipo de placas planas | $\left. \begin{array}{l} 250 \text{ V} \end{array} \right\}$                                                            |
|  Ceramic capacitor, "pin-up"<br>Keramikkondensator "Pin-up" (Perltyp)<br>Keramische kondensator "Pin-up" type<br>Condensateur céramique, type perle<br>Condensador cerámico, versión "colgable" | $\left. \begin{array}{l} 500 \text{ V} \end{array} \right\}$                                                                                         |  Paper capacitor<br>Papierkondensator<br>Papierkondensator<br>Condensateur au papier<br>Condensador de papel                                                                                            | $\left. \begin{array}{l} 1000 \text{ V} \end{array} \right\}$                                                           |
|  "Microplate" ceramic capacitor<br>Miniatur-Scheibenkondensator<br>"Microplate" keramische kondensator<br>Condensateur céramique "microplate"<br>Condensador cerámico "microplaca"              | $\left. \begin{array}{l} 30 \text{ V} \end{array} \right\}$                                                                                          |  Wire-wound trimmer<br>Drahttrimmer<br>Draadgewonden trimmer<br>Trimmer à fil<br>Trimmer bobinado                                                                                                       |                                                                                                                         |
|  Mica capacitor<br>Glimmerkondensator<br>Micakondensator<br>Condensateur au mica<br>Condensador de mica                                                                                         | $\left. \begin{array}{l} 500 \text{ V} \end{array} \right\}$                                                                                         |  Tubular ceramic trimmer<br>Rohrtrimmer<br>Buisvormige keramische trimmer<br>Trimmer céramique tubulaire<br>Trimmer cerámico tubular                                                                    |                                                                                                                         |



For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.

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## A. CAPACITORS

| Item | Code number    | Value        | Volt  | Description       |
|------|----------------|--------------|-------|-------------------|
| C26  | 5322 121 40145 | 100 nF       | 630 V | Polyester         |
| C28  | 5322 125 60067 | .8 pF        | 300 V | Trimmer           |
| C29  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C32  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C33  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C34  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C35  | 4822 122 30016 | 33 pF        | 63 V  | Miniature ceramic |
| C36  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C37  | 4822 122 70082 | 6.8 pF       | 350 V | Feed-through      |
| C38  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C39  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C41  | 5322 123 10197 | 100 pF       | 300 V | Disc              |
| C42  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C43  | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C44  | 5322 123 10236 | 1 nF         | 300 V | Disc              |
| C46  | 4822 122 30027 | 1 nF         | 100 V | Miniature ceramic |
| C48  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C51  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C52  | 5322 122 30022 | 22 pF        | 63 V  | Miniature ceramic |
| C53  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C54  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C55  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C56  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C57  | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C59  | 4822 124 20355 | 12.5 $\mu$ F | 25 V  | Electrolytic      |
| C60  | 5322 122 30022 | 22 pF        | 63 V  | Miniature ceramic |
| C62  | 4822 124 20355 | 12.5 $\mu$ F | 25 V  | Electrolytic      |
| C64  | 4822 122 30008 | 47 pF        | 63 V  | Miniature ceramic |
| C226 | 5322 121 40145 | 100 nF       | 630 V | Polyester         |
| C228 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C229 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C232 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C233 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C234 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C235 | 4822 122 30016 | 33 pF        | 63 V  | Miniature ceramic |
| C236 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C237 | 4822 122 70082 | 6.8 pF       | 350 V | Feed-through      |
| C238 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C239 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C241 | 5322 123 10197 | 100 pF       | 300 V | Disc              |
| C242 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C243 | 5322 125 60067 | 8 pF         | 300 V | Trimmer           |
| C244 | 5322 123 10236 | 1 nF         | 300 V | Disc              |
| C246 | 4822 122 30027 | 1 nF         | 100 V | Miniature ceramic |
| C248 | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C251 | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C252 | 5322 122 30022 | 22 pF        | 63 V  | Miniature ceramic |
| C253 | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C254 | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |
| C255 | 4822 122 30043 | 10 nF        | 40 V  | Miniature ceramic |



| Item  | Code number    | Value          | Volt   | Description       |
|-------|----------------|----------------|--------|-------------------|
| C256  | 4822 122 30043 | 10 nF          | 40 V   | Miniature ceramic |
| C257  | 4822 122 30043 | 10 nF          | 40 V   | Miniature ceramic |
| C259  | 4822 124 20355 | 12.5 $\mu$ F   | 25 V   | Electrolytic      |
| C260  | 5322 122 30022 | 22 pF          | 63 V   | Miniature ceramic |
| C262  | 4822 124 20355 | 12.5 $\mu$ F   | 25 V   | Electrolytic      |
| C264  | 4822 122 30008 | 47 pF          | 63 V   | Miniature ceramic |
| C402  | 4822 125 50017 | 65 pF          | 50 V   | Trimmer           |
| C403  | 4822 125 50017 | 65 pF          | 50 V   | Trimmer           |
| C404  | 5322 122 34005 | 330 pF         | 63 V   | Miniature ceramic |
| C406  | 4822 122 30099 | 3.3 nF         | 100 V  | Miniature ceramic |
| C407  | 4822 125 50017 | 65 pF          | 50 V   | Trimmer           |
| C409  | 4822 122 30097 | 15 pF          | 63 V   | Miniature ceramic |
| C413  | 4822 122 30104 | 1 pF           | 63 V   | Miniature ceramic |
| C414  | 4822 122 30104 | 1 pF           | 63 V   | Miniature ceramic |
| C602  | 4822 125 50045 | 22 pF          | 100 V  | Miniature ceramic |
| C603  | 4822 122 30008 | 47 pF          | 63 V   | Miniature ceramic |
| C604  | 4822 122 30008 | 47 pF          | 63 V   | Miniature ceramic |
| C605  | 4822 122 30099 | 3.3 nF         | 100 V  | Miniature ceramic |
| C701  | 4822 124 20355 | 12.5 $\mu$ F   | 25 V   | Electrolytic      |
| C813  | 4822 124 20095 | 2.5 $\mu$ F    | 64 V   | Electrolytic      |
| C814  | 4822 124 20095 | 2.5 $\mu$ F    | 64 V   | Electrolytic      |
| C817  | 4822 121 40171 | 22 nF          | 250 V  | Polyester         |
| C818  | 4822 121 40061 | 220 nF         | 250 V  | Polyester         |
| C821  | 5322 121 40176 | 1 $\mu$ F      | 100 V  | Polyester         |
| C822  | 4822 120 10089 | 220 pF         | 700 V  | Ceramic           |
| C823  | 4822 125 50045 | 22 pF          | 50 V   | Trimmer           |
| C826  | 4822 125 50017 | 65 pF          | 50 V   | Trimmer           |
| C828  |                | 10 nF          | 200 V  |                   |
| C829  | 5322 111 30192 | 100 nF         | 200 V  | Box-capacitor     |
| C831  |                | 1 $\mu$ F      | 200 V  |                   |
| C832  | 5322 121 10105 | 10 $\mu$ F     | 200 V  | Box-capacitor     |
| C833  | 4822 124 20355 | 12.5 $\mu$ F   | 25 V   | Electrolytic      |
| C836  | 4822 124 20355 | 12.5 $\mu$ F   | 25 V   | Electrolytic      |
| C906  | 4822 125 50045 | 22 pF          | 50 V   | Trimmer           |
| C1002 | 4822 121 40326 | 6.8 nF         | 1600 V | Polyester         |
| C1003 | 5322 121 40123 | 15 nF          | 1600 V | Polyester         |
| C1008 | 5322 121 40326 | 6.8 nF         | 1600 V | Polyester         |
| C1018 | 5322 121 40123 | 15 nF          | 1600 V | Polyester         |
| C1100 | 5322 121 20173 | 100 nF         | 250 V  | Paper/Polyester   |
| C1101 | 5322 124 70222 | 2x7500 $\mu$ F | 25 V   | Electrolytic      |
| C1102 | 4822 124 20351 | 6.8 $\mu$ F    | 40 V   | Electrolytic      |
| C1106 | 4822 124 20351 | 6.8 $\mu$ F    | 40 V   | Electrolytic      |
| C1108 | 4822 124 20351 | 6.8 $\mu$ F    | 40 V   | Electrolytic      |
| C1110 | 4822 121 40013 | 1 $\mu$ F      | 250 V  | Polyester         |
| C1113 | 5322 124 20337 | 100 $\mu$ F    | 40 V   | Electrolytic      |
| C1201 | 4822 121 40177 | 2.2 $\mu$ F    | 250 V  | Polyester         |
| C1203 | 5322 121 40197 | 1 $\mu$ F      | 100 V  | Polyester         |
| C1204 | 5322 121 40197 | 1 $\mu$ F      | 100 V  | Polyester         |
| C1206 | 5322 121 40197 | 1 $\mu$ F      | 100 V  | Polyester         |
| C1207 | 5322 121 40197 | 1 $\mu$ F      | 100 V  | Polyester         |

| Item  | Code number    | Value       | Volt   | Description       |
|-------|----------------|-------------|--------|-------------------|
| C1208 | 4822 124 20366 | 33 $\mu$ F  | 40 V   | Electrolytic      |
| C1209 | 5322 124 20337 | 100 $\mu$ F | 40 V   | Electrolytic      |
| C1211 | 4822 124 20366 | 33 $\mu$ F  | 40 V   | Electrolytic      |
| C1212 | 5322 124 20337 | 100 $\mu$ F | 40 V   | Electrolytic      |
| C1213 | 5322 121 40123 | 15 nF       | 1600 V | Polyester         |
| C1214 | 5322 121 40123 | 15 nF       | 1600 V | Polyester         |
| C1216 | 5322 121 30077 | 500 pF      | 10 kV  | High tension      |
| C1217 | 5322 121 30077 | 500 pF      | 10 kV  | High tension      |
| C1218 | 5322 121 30077 | 500 pF      | 10 kV  | High tension      |
| C1219 | 5322 121 30077 | 500 pF      | 10 kV  | High tension      |
| C1402 | 4822 125 50017 | 65 pF       | 50 V   | Trimmer           |
| C1403 | 4822 125 50017 | 65 pF       | 50 V   | Trimmer           |
| C1404 | 5322 122 34005 | 330 pF      | 63 V   | Miniature ceramic |
| C1406 | 5322 122 30099 | 3.3 nF      | 100 V  | Miniature ceramic |
| C1407 | 4822 125 50017 | 65 pF       | 50 V   | Trimmer           |

## B. RESISTORS

| Item | Code number    | Value           | Watt  | %   | Description                      |
|------|----------------|-----------------|-------|-----|----------------------------------|
| R1   | 5322 101 60048 | 22 k $\Omega$   | 0.125 | 20  | Potentiometer with switch (SK5)  |
| R2   | 4822 101 30229 | 10 k $\Omega$   | 0.125 | 20  | Potentiometer                    |
| R3   | 5322 101 20376 | 1 M $\Omega$    | 0.125 | 20  | Potentiometer                    |
| R4   | 5322 101 40072 | 22 k $\Omega$   | 0.125 | 20  | Potentiometer with switch (SK7)  |
| R5   | 5322 101 20341 | 4.7 k $\Omega$  | 0.125 | 20  | Potentiometer                    |
| R6   | 5322 101 20267 | 470 $\Omega$    | 0.1   | 20  | Potentiometer                    |
| R7   | 4822 101 60055 | 47 k $\Omega$   | 0.125 | 20  | Potentiometer with switch (SK8)  |
| R8   | 5322 101 20422 | 500 $\Omega$    | 0.125 | 20  | Potentiometer                    |
| R9   | 5322 101 20288 | 1 k $\Omega$    | 0.1   | 20  | Potentiometer                    |
| R10  | 4822 101 20424 | 2.2 k $\Omega$  | 0.1   | 20  | Potentiometer                    |
| R11  | 4822 101 20424 | 2.2 k $\Omega$  | 0.1   | 20  | Potentiometer                    |
| R12  | 5322 101 20288 | 1 k $\Omega$    | 0.1   | 20  | Potentiometer                    |
| R13  | 4822 101 20224 | 500 $\Omega$    | 0.125 | 20  | Potentiometer                    |
| R14  | 5322 101 60048 | 22 k $\Omega$   | 0.125 | 20  | Potentiometer with switch (SK14) |
| R15  | 5322 101 60048 | 22 k $\Omega$   | 0.125 | 20  | Potentiometer with switch (SK15) |
| R26  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R27  | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5   | Carbon resistor                  |
| R28  | 5322 116 50858 | 200 k $\Omega$  | 0.25  | 1   | Metal film resistor              |
| R29  | 5322 116 50858 | 200 k $\Omega$  | 0.25  | 1   | Metal film resistor              |
| R31  | 4822 111 20332 | 920 k $\Omega$  | 0.25  | 1   | Carbon resistor                  |
| R32  | 5322 116 50821 | 88.7 k $\Omega$ | 0.25  | 1   | Metal film resistor              |
| R33  | 4822 111 20333 | 992 k $\Omega$  | 0.25  | 1   | Carbon resistor                  |
| R34  | 5322 116 50914 | 8.06 k $\Omega$ | 0.25  | 1   | Metal film resistor              |
| R36  | 5322 111 20317 | 1 M $\Omega$    | 0.125 | 1   | Carbon resistor                  |
| R37  | 5322 116 50808 | 796 $\Omega$    | 0.1   | 0.5 | Metal film resistor              |
| R46  | 5322 111 30304 | 150 k $\Omega$  | 0.1   | 5   | Carbon resistor                  |
| R47  | 5322 111 20147 | 800 k $\Omega$  | 0.25  | 1   | Carbon resistor                  |
| R48  | 5322 111 30377 | 10 M $\Omega$   | 0.125 | 10  | Carbon resistor                  |
| R49  | 4822 111 30394 | 2.2 M $\Omega$  | 0.125 | 10  | Carbon resistor                  |
| R51  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R52  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R53  | 4822 111 30263 | 3.3 k $\Omega$  | 0.1   | 5   | Carbon resistor                  |
| R54  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R56  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R57  | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5   | Carbon resistor                  |
| R58  | 4822 111 30311 | 3.9 k $\Omega$  | 0.1   | 5   | Carbon resistor                  |
| R59  | 4822 111 30311 | 3.9 k $\Omega$  | 0.1   | 5   | Carbon resistor                  |
| R61  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R62  | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R63  | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5   | Carbon resistor                  |
| R64  | 4822 111 30265 | 2.2 k $\Omega$  | 0.1   | 5   | Carbon resistor                  |
| R66  | 4822 111 30265 | 2.2 k $\Omega$  | 0.1   | 5   | Carbon resistor                  |
| R67  | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5   | Carbon resistor                  |
| R68  | 5322 111 30354 | 12 $\Omega$     | 0.1   | 5   | Carbon resistor                  |
| R69  | 5322 111 30354 | 12 $\Omega$     | 0.1   | 5   | Carbon resistor                  |

| Item | Code number    | Value           | Watt | %    | Description         |
|------|----------------|-----------------|------|------|---------------------|
| R71  | 5322 111 30354 | 12 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R72  | 5322 116 50435 | 226 $\Omega$    | 0.25 | 1    | Metal film resistor |
| R73  | 5322 111 30378 | 200 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R74  | 5322 116 50595 | 2.37 k $\Omega$ | 0.25 | 1    | Metal film resistor |
| R75  | 5322 116 50818 | 44.2 $\Omega$   | 0.25 | 1    | Metal film resistor |
| R76  | 5322 116 50818 | 44.2 $\Omega$   | 0.25 | 1    | Metal film resistor |
| R77  | 5322 116 51065 | 133 $\Omega$    | 0.1  | 0.25 | Metal film resistor |
| R78  | 5322 116 51066 | 237 $\Omega$    | 0.1  | 0.25 | Metal film resistor |
| R79  | 5322 116 50595 | 2.37 k $\Omega$ | 0.25 | 1    | Metal film resistor |
| R81  | 5322 111 30378 | 200 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R82  | 5322 116 50435 | 226 $\Omega$    | 0.25 | 1    | Metal film resistor |
| R83  | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R84  | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R86  | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R87  | 4822 111 30269 | 1 k $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R88  | 4822 111 30269 | 1 k $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R89  | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R91  | 5322 116 50679 | 237 $\Omega$    | 0.25 | 1    | Metal film resistor |
| R92  | 5322 111 30298 | 120 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R93  | 5322 111 30354 | 12 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R94  | 5322 116 50584 | 619 $\Omega$    | 0.25 | 1    | Metal film resistor |
| R96  | 5322 111 30355 | 20 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R97  | 5322 116 50983 | 22.1 $\Omega$   | 0.25 | 1    | Metal film resistor |
| R98  | 5322 116 50788 | 332 $\Omega$    | 0.1  | 0.25 | Metal film resistor |
| R99  | 5322 116 50584 | 619 $\Omega$    | 0.25 | 1    | Metal film resistor |
| R101 | 5322 111 30354 | 12 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R102 | 5322 111 30298 | 120 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R103 | 4822 111 30397 | 240 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R106 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R107 | 4822 111 30303 | 8.2 k $\Omega$  | 0.1  | 5    | Carbon resistor     |
| R109 | 5322 100 10075 | 100 $\Omega$    | 0.1  | 20   | Potentiometer       |
| R110 | 4822 111 30401 | 47 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R111 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R112 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R117 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R118 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R119 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R120 | 4822 111 30313 | 5.6 k $\Omega$  | 0.1  | 5    | Carbon resistor     |
| R121 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R122 | 4822 111 30326 | 180 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R124 | 4822 111 30399 | 33 $\Omega$     | 0.1  | 5    | Carbon resistor     |
| R131 | 4822 111 30271 | 820 $\Omega$    | 0.1  | 5    | Carbon resistor     |
| R132 | 4822 100 10038 | 470 $\Omega$    | 0.1  | 20   | Potentiometer       |
| R133 | 5322 116 50752 | 1.5 k $\Omega$  | 0.1  | 0.25 | Metal film resistor |
| R134 | 5322 116 50847 | 499 $\Omega$    | 0.1  | 0.25 | Metal film resistor |
| R136 | 5322 116 51067 | 249 $\Omega$    | 0.1  | 0.25 | Metal film resistor |
| R137 | 5322 116 50751 | 150 $\Omega$    | 0.1  | 0.25 | Metal film resistor |
| R138 | 5322 116 51069 | 49.9 $\Omega$   | 0.1  | 0.25 | Metal film resistor |
| R139 | 5322 116 51069 | 49.9 $\Omega$   | 0.1  | 0.25 | Metal film resistor |
| R141 | 5322 111 20147 | 800 k $\Omega$  | 0.25 | 1    | Carbon resistor     |

| Item | Code number    | Value           | Watt  | %    | Description         |
|------|----------------|-----------------|-------|------|---------------------|
| R142 | 5322 111 30296 | 100 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R143 | 5322 101 20241 | 1 k $\Omega$    | 0.1   | 20   | Potentiometer       |
| R144 | 5322 111 30377 | 10 M $\Omega$   | 0.125 | 10   | Carbon resistor     |
| R146 | 5322 111 30377 | 10 M $\Omega$   | 0.125 | 10   | Carbon resistor     |
| R148 | 5322 111 30377 | 10 M $\Omega$   | 0.125 | 10   | Carbon resistor     |
| R149 | 5322 116 50482 | 33.2 k $\Omega$ | 0.25  | 1    | Metal film resistor |
| R151 | 5322 111 30377 | 10 M $\Omega$   | 0.125 | 10   | Carbon resistor     |
| R152 | 4822 111 30395 | 4.7 M $\Omega$  | 0.125 | 10   | Carbon resistor     |
| R162 | 4822 111 30348 | 27 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R164 | 4822 111 30348 | 27 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R226 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R227 | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5    | Carbon resistor     |
| R228 | 5322 116 50858 | 200 k $\Omega$  | 0.25  | 1    | Metal film resistor |
| R229 | 5322 116 50858 | 200 k $\Omega$  | 0.25  | 1    | Metal film resistor |
| R231 | 4822 111 20332 | 920 k $\Omega$  | 0.25  | 1    | Carbon resistor     |
| R232 | 5322 116 50821 | 88.7 k $\Omega$ | 0.25  | 1    | Metal film resistor |
| R233 | 4822 111 20333 | 992 k $\Omega$  | 0.25  | 1    | Carbon resistor     |
| R234 | 5322 116 50914 | 8.06 k $\Omega$ | 0.25  | 1    | Metal film resistor |
| R236 | 5322 111 20317 | 1 M $\Omega$    | 0.125 | 1    | Carbon resistor     |
| R237 | 5322 116 50808 | 796 $\Omega$    | 0.1   | 0.5  | Metal film resistor |
| R246 | 5322 111 30304 | 150 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R247 | 5322 111 20147 | 800 k $\Omega$  | 0.25  | 1    | Carbon resistor     |
| R248 | 5322 111 30377 | 10 M $\Omega$   | 0.125 | 10   | Carbon resistor     |
| R249 | 4822 111 30394 | 2.2 M $\Omega$  | 0.125 | 10   | Carbon resistor     |
| R251 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R252 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R253 | 4822 111 30263 | 3.3 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R254 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R256 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R257 | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5    | Carbon resistor     |
| R258 | 4822 111 30311 | 3.9 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R259 | 4822 111 30311 | 3.9 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R261 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R262 | 4822 111 30399 | 33 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R263 | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5    | Carbon resistor     |
| R264 | 4822 111 30265 | 2.2 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R266 | 4822 111 30265 | 2.2 k $\Omega$  | 0.1   | 5    | Carbon resistor     |
| R267 | 4822 111 30324 | 100 $\Omega$    | 0.1   | 5    | Carbon resistor     |
| R268 | 5322 111 30354 | 12 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R269 | 5322 111 30354 | 12 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R271 | 5322 111 30354 | 12 $\Omega$     | 0.1   | 5    | Carbon resistor     |
| R272 | 5322 116 50435 | 226 $\Omega$    | 0.25  | 1    | Metal film resistor |
| R273 | 5322 111 30378 | 200 $\Omega$    | 0.1   | 5    | Carbon resistor     |
| R274 | 5322 116 50595 | 2.37 k $\Omega$ | 0.25  | 1    | Metal film resistor |
| R275 | 5322 116 50818 | 44.2 $\Omega$   | 0.25  | 1    | Metal film resistor |
| R276 | 5322 116 50818 | 44.2 $\Omega$   | 0.25  | 1    | Metal film resistor |
| R277 | 5322 116 51065 | 133 $\Omega$    | 0.1   | 0.25 | Metal film resistor |
| R278 | 5322 116 51066 | 237 $\Omega$    | 0.1   | 0.25 | Metal film resistor |
| R279 | 5322 116 50595 | 2.37 k $\Omega$ | 0.25  | 1    | Metal film resistor |
| R281 | 5322 111 30378 | 200 $\Omega$    | 0.1   | 5    | Carbon resistor     |

| Item | Code number    | Value |            | Watt  | %    | Description         |
|------|----------------|-------|------------|-------|------|---------------------|
| R282 | 5322 116 50435 | 226   | $\Omega$   | 0.25  | 1    | Metal film resistor |
| R283 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R284 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R286 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R287 | 4822 111 30269 | 1     | k $\Omega$ | 0.1   | 5    | Carbon resistor     |
| R288 | 4822 111 30269 | 1     | k $\Omega$ | 0.1   | 5    | Carbon resistor     |
| R289 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R291 | 5322 116 50679 | 237   | $\Omega$   | 0.25  | 1    | Metal film resistor |
| R292 | 5322 111 30298 | 120   | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R293 | 5322 111 30354 | 12    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R294 | 5322 116 50584 | 619   | $\Omega$   | 0.25  | 1    | Metal film resistor |
| R296 | 5322 111 30355 | 20    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R297 | 5322 116 50983 | 22.1  | $\Omega$   | 0.25  | 1    | Metal film resistor |
| R298 | 5322 116 50788 | 332   | $\Omega$   | 0.1   | 0.25 | Metal film resistor |
| R299 | 5322 116 50584 | 619   | $\Omega$   | 0.25  | 1    | Metal film resistor |
| R301 | 5322 111 30354 | 12    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R302 | 5322 111 30298 | 120   | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R303 | 4822 111 30397 | 240   | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R306 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R307 | 4822 111 30303 | 8.2   | k $\Omega$ | 0.1   | 5    | Carbon resistor     |
| R309 | 5322 100 10075 | 100   | $\Omega$   | 0.1   | 20   | Potentiometer       |
| R310 | 4822 111 30401 | 47    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R311 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R312 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R317 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R318 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R319 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R320 | 4822 111 30313 | 5.6   | k $\Omega$ | 0.1   | 5    | Carbon resistor     |
| R321 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R322 | 4822 111 30326 | 180   | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R324 | 4822 111 30399 | 33    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R331 | 4822 111 30271 | 820   | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R332 | 4822 100 10038 | 470   | $\Omega$   | 0.1   | 20   | Potentiometer       |
| R333 | 5322 116 50752 | 1.5   | k $\Omega$ | 0.1   | 0.25 | Metal film resistor |
| R334 | 5322 116 50847 | 499   | $\Omega$   | 0.1   | 0.25 | Metal film resistor |
| R336 | 5322 116 51067 | 249   | $\Omega$   | 0.1   | 0.25 | Metal film resistor |
| R337 | 5322 116 50751 | 150   | $\Omega$   | 0.1   | 0.25 | Metal film resistor |
| R338 | 5322 116 51069 | 49.9  | $\Omega$   | 0.1   | 0.25 | Metal film resistor |
| R339 | 5322 116 51069 | 49.9  | $\Omega$   | 0.1   | 0.25 | Metal film resistor |
| R341 | 5322 111 20147 | 800   | k $\Omega$ | 0.25  | 1    | Carbon resistor     |
| R342 | 5322 111 30296 | 100   | k $\Omega$ | 0.1   | 5    | Carbon resistor     |
| R343 | 5322 101 20241 | 1     | k $\Omega$ | 0.1   | 20   | Potentiometer       |
| R344 | 5322 111 30377 | 10    | M $\Omega$ | 0.125 | 10   | Carbon resistor     |
| R346 | 5322 111 30377 | 10    | M $\Omega$ | 0.125 | 10   | Carbon resistor     |
| R348 | 5322 111 30377 | 10    | M $\Omega$ | 0.125 | 10   | Carbon resistor     |
| R349 | 5322 116 50482 | 33.2  | k $\Omega$ | 0.25  | 1    | Metal film resistor |
| R351 | 5322 111 30377 | 10    | M $\Omega$ | 0.125 | 10   | Carbon resistor     |
| R352 | 4822 111 30395 | 4.7   | M $\Omega$ | 0.125 | 10   | Carbon resistor     |
| R362 | 4822 111 30348 | 27    | $\Omega$   | 0.1   | 5    | Carbon resistor     |
| R364 | 4822 111 30348 | 27    | $\Omega$   | 0.1   | 5    | Carbon resistor     |

| Item | Code number    | Value          | Watt  | %  | Description         |
|------|----------------|----------------|-------|----|---------------------|
| R401 | 4822 111 30327 | 220 $\Omega$   | 0.1   | 5  | Carbon resistor     |
| R402 | 4822 111 30328 | 330 $\Omega$   | 0.1   | 5  | Carbon resistor     |
| R403 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R404 | 5322 111 30279 | 33 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R406 | 5322 111 30289 | 56 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R407 | 5322 100 10079 | 47 $k\Omega$   | 0.1   | 20 | Potentiometer       |
| R408 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R411 | 4822 111 30324 | 100 $\Omega$   | 0.1   | 5  | Carbon resistor     |
| R416 | 4822 111 30324 | 100 $\Omega$   | 0.1   | 5  | Carbon resistor     |
| R417 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R418 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R424 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R426 | 4822 110 60109 | 1.2 $k\Omega$  | 0.125 | 5  | Carbon resistor     |
| R428 | 4822 111 30326 | 180 $\Omega$   | 0.1   | 5  | Carbon resistor     |
| R429 | 4822 100 10038 | 470 $\Omega$   | 0.1   | 20 | Potentiometer       |
| R430 | 4822 100 10035 | 10 $k\Omega$   | 0.1   | 20 | Potentiometer       |
| R431 | 4822 100 10029 | 2.2 $k\Omega$  | 0.1   | 20 | Potentiometer       |
| R432 | 4822 111 30279 | 33 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R434 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R435 | 4822 111 30276 | 18 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R437 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R438 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R439 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R441 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R442 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R443 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R444 | 5322 111 30296 | 100 $k\Omega$  | 0.1   | 5  | Carbon resistor     |
| R446 | 4822 111 30401 | 47 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R447 | 4822 111 30401 | 47 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R448 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R449 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R450 | 5322 116 50442 | 48.7 $k\Omega$ | 0.25  | 1  | Metal film resistor |
| R453 | 5322 116 50595 | 2.37 $k\Omega$ | 0.25  | 1  | Metal film resistor |
| R454 | 5322 116 50414 | 2.87 $k\Omega$ | 0.25  | 1  | Metal film resistor |
| R455 | 4822 111 30273 | 10 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R456 | 5322 116 50664 | 2.05 $k\Omega$ | 0.25  | 1  | Metal film resistor |
| R457 | 5322 116 50554 | 750 $\Omega$   | 0.25  | 1  | Metal film resistor |
| R458 | 5322 116 50571 | 715 $\Omega$   | 0.25  | 1  | Metal film resistor |
| R459 | 5322 116 50664 | 2.05 $k\Omega$ | 0.25  | 1  | Metal film resistor |
| R461 | 4822 111 30273 | 10 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R462 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R463 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R465 | 4822 111 30269 | 1 $k\Omega$    | 0.1   | 5  | Carbon resistor     |
| R466 | 4822 111 30273 | 10 $k\Omega$   | 0.1   | 5  | Carbon resistor     |
| R467 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R468 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R481 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R482 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R483 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |
| R484 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5  | Carbon resistor     |

| Item | Code number    | Value         | Watt  | %  | Description     |
|------|----------------|---------------|-------|----|-----------------|
| R486 | 4822 111 30396 | 22 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R487 | 4822 111 30396 | 22 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R525 | 4822 111 30269 | 1 $k\Omega$   | 0.1   | 5  | Carbon resistor |
| R601 | 4822 111 30398 | 300 $\Omega$  | 0.125 | 5  | Carbon resistor |
| R602 | 5322 100 10036 | 4.7 $k\Omega$ | 0.1   | 20 | Potentiometer   |
| R603 | 4822 111 30269 | 1 $k\Omega$   | 0.1   | 5  | Carbon resistor |
| R604 | 4822 111 30273 | 10 $k\Omega$  | 0.1   | 5  | Carbon resistor |
| R605 | 4822 111 30273 | 10 $k\Omega$  | 0.1   | 5  | Carbon resistor |
| R606 | 4822 111 30399 | 33 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R607 | 4822 111 30399 | 33 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R608 | 4822 111 30398 | 300 $\Omega$  | 0.1   | 5  | Carbon resistor |
| R609 | 5322 100 10075 | 100 $\Omega$  | 0.1   | 20 | Potentiometer   |
| R610 | 5322 111 30291 | 68 $k\Omega$  | 0.1   | 5  | Carbon resistor |
| R611 | 4822 111 30267 | 1.5 $k\Omega$ | 0.1   | 5  | Carbon resistor |
| R612 | 4822 111 30398 | 300 $\Omega$  | 0.1   | 5  | Carbon resistor |
| R613 | 4822 111 30399 | 33 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R614 | 4822 111 30383 | 68 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R615 | 5322 116 50554 | 750 $\Omega$  | 0.25  | 5  | Carbon resistor |
| R616 | 5322 100 10036 | 4.7 $k\Omega$ | 0.1   | 20 | Potentiometer   |
| R617 | 4822 111 30383 | 68 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R620 | 4822 111 30273 | 10 $k\Omega$  | 0.1   | 5  | Carbon resistor |
| R622 | 4822 111 30399 | 33 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R623 | 4822 110 50116 | 2.2 $k\Omega$ | 0.25  | 5  | Carbon resistor |
| R628 | 4822 111 30383 | 68 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R632 | 4822 110 50116 | 2.2 $k\Omega$ | 0.25  | 5  | Carbon resistor |
| R634 | 4822 111 30399 | 33 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R701 | 4822 101 20426 | 470 $\Omega$  | 0.1   | 20 | Potentiometer   |
| R704 | 4822 111 30326 | 180 $\Omega$  | 0.1   | 5  | Carbon resistor |
| R706 | 4822 111 30326 | 180 $\Omega$  | 0.1   | 5  | Carbon resistor |
| R707 | 4822 111 30402 | 7.5 $k\Omega$ | 0.1   | 5  | Carbon resistor |
| R708 | 4822 111 30273 | 10 $k\Omega$  | 0.1   | 5  | Carbon resistor |
| R709 | 5322 111 30074 | 56 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R712 | 5322 111 30074 | 56 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R713 | 5322 116 30079 | 1.5 $k\Omega$ | 0.5   | 20 | NTC-resistor    |
| R717 | 4822 111 30269 | 1 $k\Omega$   | 0.1   | 5  | Carbon resistor |
| R721 | 4822 111 30263 | 3.3 $k\Omega$ | 0.1   | 5  | Carbon resistor |
| R722 | 5322 111 30074 | 56 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R724 | 5322 111 30261 | 560 $k\Omega$ | 0.1   | 10 | Carbon resistor |
| R726 | 5322 111 30259 | 470 $k\Omega$ | 0.1   | 10 | Carbon resistor |
| R727 | 5322 111 30279 | 33 $k\Omega$  | 0.1   | 5  | Carbon resistor |
| R728 | 5322 111 30296 | 100 $k\Omega$ | 0.1   | 10 | Carbon resistor |
| R729 | 5322 111 30342 | 10 $M\Omega$  | 0.125 | 10 | Carbon resistor |
| R731 | 5322 111 30074 | 56 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R732 | 5322 111 30074 | 56 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R733 | 4822 111 30313 | 5.6 $k\Omega$ | 0.1   | 5  | Carbon resistor |
| R734 | 5322 111 30074 | 56 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R736 | 4822 111 30352 | 82 $\Omega$   | 0.1   | 5  | Carbon resistor |
| R739 | 4822 111 30173 | 15 $\Omega$   | 0.1   | 5  | Carbon resistor |



| Item | Code number    | Value          | Watt | %  | Description     |
|------|----------------|----------------|------|----|-----------------|
| R741 | 4822 111 30173 | 15 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R743 | 4822 101 20426 | 470 $\Omega$   | 0.1  | 20 | Potentiometer   |
| R746 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R747 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R748 | 4822 111 30313 | 5.6 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R749 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R751 | 5322 111 30277 | 22 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R752 | 5322 101 20243 | 4.7 k $\Omega$ | 0.1  | 20 | Potentiometer   |
| R753 | 5322 111 30277 | 22 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R754 | 4822 111 30274 | 12 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R756 | 4822 111 30274 | 12 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R757 | 4822 111 30274 | 12 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R761 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R762 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R763 | 4822 111 30313 | 5.6 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R764 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R766 | 5322 111 30298 | 120 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R767 | 4822 111 30265 | 2.2 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R768 | 4822 111 30311 | 3.9 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R769 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R772 | 4822 111 30326 | 180 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R773 | 4822 111 30396 | 22 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R774 | 4822 111 30396 | 22 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R801 | 4822 111 30303 | 8.2 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R802 | 4822 111 30323 | 270 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R803 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R804 | 4822 111 30327 | 220 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R806 | 4822 111 30352 | 82 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R807 | 4822 111 30348 | 27 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R808 | 4822 111 30329 | 390 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R811 | 4822 111 30326 | 180 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R812 | 4822 111 30267 | 1.5 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R813 | 4822 111 30273 | 10 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R814 | 4822 111 30323 | 270 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R817 | 4822 111 30323 | 270 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R818 | 4822 111 30331 | 470 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R821 | 5322 111 30302 | 220 k $\Omega$ | 0.1  | 5  | Carbon resistor |
| R822 | 4822 111 30273 | 10 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R823 | 4822 111 30324 | 100 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R824 | 5322 111 30275 | 15 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R826 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R827 | 5322 111 30275 | 15 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R828 | 5322 111 30278 | 27 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R830 | 4822 111 30328 | 330 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R831 | 5322 111 30279 | 33 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R832 | 5322 111 30276 | 18 k $\Omega$  | 0.1  | 5  | Carbon resistor |
| R833 | 4822 100 10035 | 10 k $\Omega$  | 0.1  | 20 | Potentiometer   |
| R836 | 5322 111 30074 | 56 $\Omega$    | 0.1  | 5  | Carbon resistor |
| R837 | 4822 111 30327 | 220 $\Omega$   | 0.1  | 5  | Carbon resistor |
| R838 | 5322 111 34094 | 620 $\Omega$   | 0.1  | 5  | Carbon resistor |

| Item | Code number    | Value          | Watt  | %   | Description         |
|------|----------------|----------------|-------|-----|---------------------|
| R839 | 5322 111 30272 | 680 $\Omega$   | 0.1   | 5   | Carbon resistor     |
| R841 | 4822 111 30329 | 390 $\Omega$   | 0.1   | 5   | Carbon resistor     |
| R843 | 5322 111 30258 | 390 $k\Omega$  | 0.1   | 10  | Carbon resistor     |
| R844 | 4822 111 30273 | 10 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R846 | 4822 111 30272 | 680 $\Omega$   | 0.1   | 5   | Carbon resistor     |
| R847 | 5322 111 30279 | 33 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R848 | 5322 111 30277 | 22 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R849 | 4822 110 50198 | 2.7 $M\Omega$  | 0.125 | 10  | Carbon resistor     |
| R851 | 5322 111 30074 | 56 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R853 | 5322 111 30359 | 1.3 $k\Omega$  | 0.1   | 5   | Carbon resistor     |
| R854 | 5322 111 30278 | 27 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R856 | 5322 111 30270 | 18 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R861 | 5322 110 30173 | 300 $k\Omega$  | 0.25  | 1   | Carbon resistor     |
| R862 | 5322 116 50594 | 120 $k\Omega$  | 0.125 | 1   | Carbon resistor     |
| R863 | 5322 116 50626 | 60.4 $k\Omega$ | 0.125 | 0.5 | Metal film resistor |
| R864 | 5322 116 51068 | 33.2 $k\Omega$ | 0.125 | 0.5 | Metal film resistor |
| R866 | 5322 110 30189 | 1.2 $M\Omega$  | 0.25  | 1   | Carbon resistor     |
| R867 | 5322 111 20144 | 600 $k\Omega$  | 0.25  | 1   | Carbon resistor     |
| R868 | 5322 116 50594 | 120 $k\Omega$  | 0.125 | 1   | Carbon resistor     |
| R869 | 5322 116 50626 | 60.4 $k\Omega$ | 0.125 | 0.5 | Metal film resistor |
| R871 | 4822 111 40201 | 3 $M\Omega$    | 0.25  | 1   | Carbon resistor     |
| R873 | 4822 111 30383 | 68 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R874 | 4822 111 30383 | 68 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R876 | 4822 111 30328 | 330 $\Omega$   | 0.1   | 5   | Carbon resistor     |
| R877 | 4822 111 30328 | 330 $\Omega$   | 0.1   | 5   | Carbon resistor     |
| R902 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R903 | 5322 111 30256 | 270 $k\Omega$  | 0.1   | 5   | Carbon resistor     |
| R904 | 5322 116 51071 | 931 $\Omega$   | 0.1   | 0.5 | Metal film resistor |
| R906 | 5322 111 30276 | 18 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R907 | 5322 111 30133 | 9.1 $k\Omega$  | 0.1   | 5   | Carbon resistor     |
| R908 | 5322 111 30276 | 18 $k\Omega$   | 0.1   | 5   | Carbon resistor     |
| R909 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R916 | 4822 110 60136 | 12 $k\Omega$   | 0.125 | 2   | Carbon resistor     |
| R917 | 5322 116 50176 | 6.49 $k\Omega$ | 0.1   | 0.5 | Metal film resistor |
| R918 | 4822 110 60136 | 12 $k\Omega$   | 0.125 | 2   | Carbon resistor     |
| R922 | 5322 111 30296 | 100 $k\Omega$  | 0.1   | 5   | Carbon resistor     |
| R924 | 5322 116 50556 | 4.42 $k\Omega$ | 0.25  | 1   | Metal film resistor |
| R926 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R927 | 4822 110 60091 | 240 $\Omega$   | 0.125 | 2   | Carbon resistor     |
| R928 | 4822 110 60091 | 240 $\Omega$   | 0.125 | 2   | Carbon resistor     |
| R929 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R931 | 5322 116 50556 | 4.42 $k\Omega$ | 0.25  | 1   | Metal film resistor |
| R933 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R934 | 4822 111 30396 | 22 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R937 | 4822 111 30396 | 22 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R938 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R941 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R943 | 4822 111 30399 | 33 $\Omega$    | 0.1   | 5   | Carbon resistor     |
| R944 | 4822 100 10035 | 10 $k\Omega$   | 0.1   | 20  | Potentiometer       |
| R946 | 4822 100 10029 | 2.2 $k\Omega$  | 0.1   | 20  | Potentiometer       |

| Item  | Code number    | Value          | Watt | %  | Description         |
|-------|----------------|----------------|------|----|---------------------|
| R947  | 4822 111 30314 | 6.8 k $\Omega$ | 0.1  | 5  | Carbon resistor     |
| R948  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R951  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R954  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R959  | 5322 100 10036 | 4.7 k $\Omega$ | 0.1  | 20 | Potentiometer       |
| R962  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R966  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R971  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R974  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R978  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R979  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R981  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R982  | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R983  | 4822 110 30115 | 2 k $\Omega$   | 0.5  | 5  | Carbon resistor     |
| R984  | 4822 110 30115 | 2 k $\Omega$   | 0.5  | 5  | Carbon resistor     |
| R1001 | 5322 101 20243 | 4.7 k $\Omega$ | 0.1  | 20 | Potentiometer       |
| R1021 | 4822 101 20425 | 10 k $\Omega$  | 0.1  | 20 | Potentiometer       |
| R1024 | 4822 111 30401 | 47 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1035 | 4822 111 30269 | 1 k $\Omega$   | 0.1  | 5  | Carbon resistor     |
| R1036 | 4822 111 30313 | 5.6 k $\Omega$ | 0.1  | 5  | Carbon resistor     |
| R1041 | 4822 111 30396 | 22 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1044 | 5322 101 20279 | 47 k $\Omega$  | 0.1  | 20 | Potentiometer       |
| R1047 | 4822 101 20239 | 22 k $\Omega$  | 0.1  | 20 | Potentiometer       |
| R1048 | 4822 103 20091 | 4.7 k $\Omega$ | 3    | 5  | Potentiometer       |
| R1050 | 4822 111 30401 | 47 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1103 | 4822 115 40197 | 4.7 $\Omega$   | 16   | 5  | Wire wound resistor |
| R1108 | 5322 100 10037 | 1 k $\Omega$   | 0.1  | 20 | Potentiometer       |
| R1114 | 5322 100 10037 | 1 k $\Omega$   | 0.1  | 20 | Potentiometer       |
| R1200 | 4822 111 30396 | 22 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1205 | 4822 111 30396 | 22 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1207 | 5322 111 50345 | 8.2 M $\Omega$ | 1    | 5  | Carbon resistor     |
| R1401 | 4822 111 30327 | 220 $\Omega$   | 0.1  | 5  | Carbon resistor     |
| R1402 | 4822 111 30328 | 330 $\Omega$   | 0.1  | 5  | Carbon resistor     |
| R1403 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1404 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1406 | 5322 111 30289 | 56 k $\Omega$  | 0.1  | 5  | Carbon resistor     |
| R1407 | 5322 100 10079 | 47 k $\Omega$  | 0.1  | 20 | Potentiometer       |
| R1408 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1411 | 4822 111 30324 | 100 $\Omega$   | 0.1  | 5  | Carbon resistor     |
| R1416 | 4822 111 30324 | 100 $\Omega$   | 0.1  | 5  | Carbon resistor     |
| R1417 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1418 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1424 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1428 | 4822 111 30326 | 180 $\Omega$   | 0.1  | 5  | Carbon resistor     |
| R1429 | 4822 100 10038 | 470 $\Omega$   | 0.1  | 20 | Potentiometer       |
| R1430 | 4822 100 10035 | 10 k $\Omega$  | 0.1  | 20 | Potentiometer       |
| R1431 | 4822 100 10029 | 2.2 k $\Omega$ | 0.1  | 20 | Potentiometer       |
| R1432 | 4822 111 30279 | 33 k $\Omega$  | 0.1  | 5  | Carbon resistor     |
| R1434 | 4822 111 30399 | 33 $\Omega$    | 0.1  | 5  | Carbon resistor     |
| R1435 | 4822 111 30276 | 18 k $\Omega$  | 0.1  | 5  | Carbon resistor     |

| Item  | Code number    | Value       | Watt | % | Description     |
|-------|----------------|-------------|------|---|-----------------|
| R1437 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1438 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1439 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1441 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1442 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1443 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1444 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |
| R1446 | 4822 111 30399 | 33 $\Omega$ | 0.1  | 5 | Carbon resistor |

## C. DIODES

| Type       | Ordering code  | Item                                                                                                                                                                                                                                                                                            |
|------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AAZ15      | 4822 130 30229 | GR1003                                                                                                                                                                                                                                                                                          |
| BA148      | 4822 130 30256 | GR1201...GR1209                                                                                                                                                                                                                                                                                 |
| BAX13      | 4822 130 40182 | GR35, GR235, GR403, GR404, GR406, GR407,<br>GR408, GR409, GR411, GR501, GR502, GR504,<br>GR506, GR508, GR509, GR511, GR601, GR602,<br>GR701, GR702, GR804, GR806, GR808, GR901,<br>GR902, GR906, GR907, GR908, GR909, GR911,<br>GR912, GR913, GR914, GR1004, GR1406, GR1407,<br>GR1408, GR1409. |
| BAX16      | 4822 130 30273 | GR1001                                                                                                                                                                                                                                                                                          |
| BAX17      | 5322 130 30605 | GR26, GR27, GR28, GR226, GR227, GR228                                                                                                                                                                                                                                                           |
| BY176      | 4822 130 30588 | GR1211, GR1212, GR1213, GR1214                                                                                                                                                                                                                                                                  |
| BZX61/C33  | 4822 130 30786 | GR1006                                                                                                                                                                                                                                                                                          |
| BZX61/C47  | 5322 130 30565 | GR916, GR917                                                                                                                                                                                                                                                                                    |
| BZY88/C3V3 | 5322 130 30392 | GR29, GR229                                                                                                                                                                                                                                                                                     |
| BZY88/C3V9 | 4822 130 30411 | GR30, GR34, GR230, GR234                                                                                                                                                                                                                                                                        |
| BZY88/C4V7 | 4822 130 30264 | GR503                                                                                                                                                                                                                                                                                           |
| BZY88/C5V6 | 4822 130 30193 | GR801, GR1106                                                                                                                                                                                                                                                                                   |
| BZY88/C6V8 | 4822 130 30079 | GR1107                                                                                                                                                                                                                                                                                          |
| BZY88/C8V2 | 4822 130 30294 | GR32, GR33, GR232, GR233                                                                                                                                                                                                                                                                        |
| BZY88/C12  | 4822 130 30346 | GR507, GR703                                                                                                                                                                                                                                                                                    |
| BZY88/C18  | 4822 130 30304 | GR31, GR231                                                                                                                                                                                                                                                                                     |
| E1120      | 5322 130 30541 | GR1101, GR1103                                                                                                                                                                                                                                                                                  |
| E1220      | 5322 130 30542 | GR1102, GR1104                                                                                                                                                                                                                                                                                  |
| OF162      | 4822 130 30266 | GR807                                                                                                                                                                                                                                                                                           |

## D. TRANSISTORS

| Type   | Ordering code  | Item                                                                                                                                                                                                       |
|--------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BC107  | 4822 130 40357 | TS38, TS42, TS238, TS242, TS406, TS407, TS408, TS409, TS411, TS412, TS501, TS504, TS606, TS607, TS808, TS811, TS901, TS902, TS1004, TS1006, TS1008, TS1106, TS1107, TS1406, TS1407, TS1408, TS1409, TS1411 |
| BC109C | 4822 130 40144 | TS806, TS807, TS812                                                                                                                                                                                        |
| BCY70  | 5322 130 40324 | TS506, TS809, TS911                                                                                                                                                                                        |
| BCY72  | 5322 130 40486 | TS1001, TS1003                                                                                                                                                                                             |
| BDY38  | 4822 130 40524 | TS1102                                                                                                                                                                                                     |
| BDY60  | 4822 130 40852 | TS1201, TS1202                                                                                                                                                                                             |
| BF179  | 5322 130 40661 | TS916, TS917                                                                                                                                                                                               |
| BFW44  | 5322 130 40672 | TS914, TS918                                                                                                                                                                                               |
| BFY52  | 5322 130 40462 | TS1103, TS1104                                                                                                                                                                                             |
| BFY90  | 5322 130 40493 | TS28, TS29, TS36, TS37, TS39, TS41, TS228, TS229, TS236, TS237, TS239, TS241, TS703, TS801, TS802, TS803                                                                                                   |
| BSX20  | 5322 130 40417 | TS502, TS503, TS507, TS706, TS707, TS709, TS711, TS712, TS1002, TS1108                                                                                                                                     |
| BSX21  | 4822 130 40312 | TS1002                                                                                                                                                                                                     |
| BSY39A | 5322 130 40632 | TS804                                                                                                                                                                                                      |
| FW5324 | 5322 130 40142 | TS31, TS32, TS33, TS34, TS231, TS232, TS233, TS234, TS413, TS414, TS416, TS417, TS601, TS602, TS603, TS604, TS608, TS702, TS903, TS904, TS906, TS907, TS908, TS909, TS912, TS913, TS1007.                  |

## E. SELECTED TRANSISTOR PAIRS

| Type   | Ordering code  | Item                                 |
|--------|----------------|--------------------------------------|
| BFW11  | 5322 130 44031 | TS26-1 & 2, TS226-1 & 2, TS704-1 & 2 |
| BC107  | 5322 130 44029 | TS401-1 & 2, TS1401-1 & 2            |
| BC109C | 5322 130 40662 | TS43-1 & 2, TS243-1 & 2              |
| BFY90  | 5322 130 44035 | TS403-1 & 2, TS1403-1 & 2            |

## F. MISCELLANEOUS PARTS

| Item   | Code number               | Description              |
|--------|---------------------------|--------------------------|
| B1001  | 5322 131 20037            | C.r.t. D14-120GH         |
| B1002  | 5322 131 90024            | Neon stabilizer ZA1004   |
| B26    | 4822 134 20016            | Neon stabilizer GL8      |
| B226   | 4822 134 20016            | Neon stabilizer GL8      |
| LA1    | 5322 134 40054            | Lamp 6828                |
| LA2    | 5322 134 40054            | Lamp 6828                |
| LA3    | 5322 134 40212            | Lamp 6226                |
| VL1    | 4822 253 30021            | Fuse, 1 A delayed action |
|        | 4822 253 30025            | Fuse, 2 A delayed action |
| VL1101 | 4822 252 20001            | Thermal fuse             |
| L501   | 5322 158 10243            | Coil 100 $\mu$ H         |
| L1001  | 5322 157 50708            | Trace rotation coil      |
| L1201  | 5322 158 20342            | Coil                     |
| L1202  | 4822 157 50308            | Coil                     |
| L1203  | 4822 157 50308            | Coil                     |
| T401   | 5322 526 14001            | Ferroxcube ring          |
| T402   | 5322 526 14001            | Ferroxcube ring          |
| T501   | 5322 158 10361            | Blocking transformer     |
| T1001  | 5322 158 10359            | Blanking transformer     |
| T1101  | 5322 146 <del>20469</del> | Mains transformer        |
| T1102  | 5322 158 14006            | Suppression transformer  |
| T1103  | 5322 158 14006            | Suppression transformer  |
| T1201  | 5322 142 60133            | Converter transformer    |
| T1401  | 5322 526 14001            | Ferroxcube ring          |
| T1402  | 5322 526 14001            | Ferroxcube ring          |
| RE601  | 5322 280 20042            | Relay contacts           |
|        | 5322 157 50093            | Relay coil               |

## G. LIMIT VALUES OF SELECT-IN-TEST COMPONENTS

| Item  | Power rating | Limit values                      |
|-------|--------------|-----------------------------------|
| R108  | 0.1 W        | 39 $\Omega$ ... 82 $\Omega$       |
| R150  | 0.125 W      | 1 k $\Omega$ ... 5.6 k $\Omega$   |
| R308  | 0.1 W        | 39 $\Omega$ ... 82 $\Omega$       |
| R350  | 0.125 W      | 1 k $\Omega$ ... 5.6 k $\Omega$   |
| R1013 | 0.5 W        | 220 k $\Omega$ ... 1.2 M $\Omega$ |
| R1018 | 0.125 W      | 4.7 k $\Omega$ ... 47 k $\Omega$  |
| R1019 | 0.125 W      | 10 k $\Omega$ ... 39 k $\Omega$   |
| R1136 | 0.25 W       | 100 k $\Omega$ ... 330 k $\Omega$ |
| R1138 | 0.25 W       | 8.2 k $\Omega$ ... 15 k $\Omega$  |

## QUALITY REPORTING

### CODING SYSTEM FOR FAILURE DESCRIPTION

The following information is meant for Philips service workshops only and serves as a guide for exact reporting of service repairs and maintenance routines on the workshop charts.

For full details reference is made to Information G1 (Introduction) and Information Cd 689 (Specific information for Test and Measuring Instruments).

#### LOCATION



Unit number

e.g. 000A or 0001 (for unit A or 1; not 00UA or 00U1)

or: Type number of an accessory (only if delivered with the equipment)

e.g. 9051 or 9532 (for PM 9051 or PM 9532)

or: Unknown/Not applicable  
0000

#### COMPONENT/SEQUENCE NUMBER



Enter the identification as used in the circuit diagram, e.g.:

|        |                               |
|--------|-------------------------------|
| GR1003 | Diode GR1003                  |
| TS0023 | Transistor TS23               |
| IC0101 | Integrated circuit IC101      |
| R0.... | Resistor, potentiometer       |
| C0.... | Capacitor, variable capacitor |
| B0.... | Tube, valve                   |
| LA.... | Lamp                          |
| VL...  | Fuse                          |
| SK.... | Switch                        |
| BU.... | Connector, socket, terminal   |
| TO.... | Transformer                   |
| LO.... | Coil                          |
| X0.... | Crystal                       |
| CB.... | Circuit block                 |
| RE.... | Relay                         |
| ME.... | Meter, indicator              |
| BA.... | Battery                       |
| TR.... | Chopper                       |

#### CATEGORY



- 0 Unknown, not applicable (fault not present, intermittent or disappeared)
- 1 Software error
- 2 Readjustment
- 3 Electrical repair (wiring, solder joint, etc.)
- 4 Mechanical repair (polishing, filing, remachining, etc.)
- 5 Replacement
- 6 Cleaning and/or lubrication
- 7 Operator error
- 8 Missing items (on pre-sale test)
- 9 Environmental requirements are not met

Parts not identified in the circuit diagram:

|        |                                                                   |
|--------|-------------------------------------------------------------------|
| 990000 | Unknown/Not applicable                                            |
| 990001 | Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.) |
| 990002 | Knob (incl. dial knob, cap, etc.)                                 |
| 990003 | Probe (only if attached to instrument)                            |
| 990004 | Leads and associated plugs                                        |
| 990005 | Holder (valve, transistor, fuse, board, etc.)                     |
| 990006 | Complete unit (p.w. board, h.t. unit, etc.)                       |
| 990007 | Accessory (only those without type number)                        |
| 990008 | Documentation (manual, supplement, etc.)                          |
| 990009 | Foreign object                                                    |
| 990099 | Miscellaneous                                                     |