PHILIPS

Information
PIT-SERVICE

15-2-1969	PM 3330/04	Cd 616

Apparatuses of the -/04 version are identical to the -/03 version except for the following points:

1. Resistor R435 (100 kΩ, 0.5 W, 10 %) is connected parallel to R437 (8k2, $5\frac{1}{2}$ W) so as to improve the control range of R440 "TRIGG. SENS."
2. R593 (100 kΩ) is changed to 110 kΩ in order to improve the control range of R3 "STAB."
3. In order to improve the control range of R589 "AUT. TRIGG. LEVEL", R588 (47 kΩ) is changed to 43 kΩ.
4. Type BZY88C12 is provided, because Zener diode type BZY69 (GR1032) is no longer available.
5. In order to improve the stability of the +6.3 V, -6.3 V and the -24 V supplies in the case of a short circuit in the +24 V supply,
   R1163 (22 kΩ) is changed to 3.9 kΩ and connected to +6.3 V,
   R1183 (22 kΩ) is changed to 3.9 kΩ and connected to ⏚, and
   R1204 (56 kΩ) is changed to 18 kΩ and connected to ⏚
6. The value of R1434 (510 Ω) is increased to 560 Ω in order to obtain a 500 mV pulse at BU6 "AMP. CAL."
7. As the diodes BYX21-200 and BYX21-200R are no longer available, type BYX28-400 and BYX28-400R have been provided.

The following changes have already been made in the -/03 version, but they are also valid for the -/04 version.

8. C33 is no longer a choice capacitor, and a 60 pF trimmer is used instead. (order number 4822 125 50017)
9. C26 and C29 must be identical within 1 %; thus moulded polyester types are provided (order number 4822 121 50075)
10. R48 and R49 (22 Ω) are changed to 15 Ω.
11. Diodes GR1303, GR1304, GR1305 of type BY140 replace vacuum-diodes of type 5642. This implies that a simpler transformer T1301 is used and can be replaced by the old type (code number 4822 142 60062). The order number of the revised type is 4822 142 60116.

N.V. PHILIPS' GLOEILAMPENFABRIEKEN, Eindhoven, Holland

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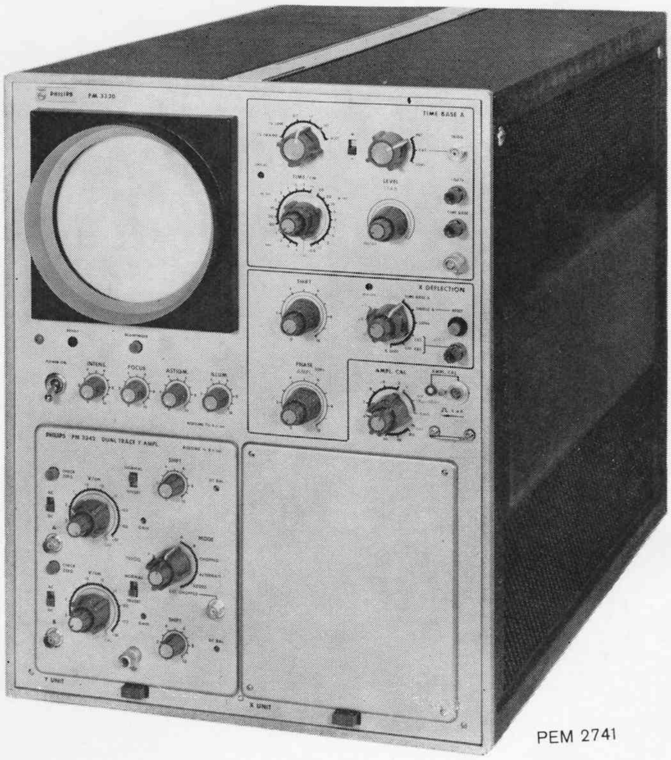

PEM 2741

PM 3330 LABORATORY PLUG-IN OSCILLOSCOPE

66 405 16.1-10 1/366/01

IMPORTANT

In correspondence concerning this apparatus, please quote the type number and the serial number as given on the type plate at the back of the apparatus.

Contents

List of figures

GENERAL INFORMATION

INTRODUCTION

The PHILIPS PM 3330 is a cathode-ray oscilloscope with a wide range of applications.
This is obtained by providing the apparatus with plug-in units which cover various application facilities.
The basic oscilloscope contains a vertical (Y) amplifier with a constant bandwidth and gain.
The total gain and bandwidth of the vertical (Y) channel are dependent on the type of plug-in units used.
The horizontal (X) channel contains a time-base generator and an amplifier.

Plug-in units for horizontal (X) deflection permit the connection of a second time-base generator (which also can be used as a delay unit for the time-base generator of the basic oscilloscope) or an amplifier unit with which the PM 3330 can function as an X-Y oscilloscope.

The cathode-ray tube gives a clearly defined display. An internal graticule guarantees parallax-free measurements.

Tolerance

Properties, expressed in numerical values with statement of tolerances are guaranteed by the factory. Numerical values without tolerances are intended for information purposes only and indicate the properties of an average apparatus. The numerical values hold good for nominal mains voltages unless otherwise stated.

Characteristics (I)

CATHODE-RAY CIRCUIT

Tube

a. type	D13–16/1GH, flat screen. Screen diameter 13 cm
b. phosphor	Medium short persistance, green (GH). The screen types BE (short persistance, blue) and GP (long persistance, blue-green) are optionally supplied.
c. usable viewing area	6 cm vertical × 10 cm horizontal
d. accelerating potential	10000 V
e. graticule	internal, marked in 6 vertical and 10 horizontal 1-cm divisions with 2-millimeter markings on the center lines. Graticule illumination is continuously variable.
Unblanking	DC-coupled
Z-Modulation	external
a. voltage required	15 V_{p-p} for frequencies from 300 c/s.
b. input impedance	25 kΩ//35 pF
c. input RC-time	0.5 ms

Y-DEFLECTION

Final amplifier

a. type	DC-amplifier
b. rise time	5 ns
c. bandwidth	0...70 Mc/s
d. delay	by means of an internal delay line. Effective delay ≥ 60 ns.
Plug-in unit	see the relevant manual.

X-DEFLECTION

Optional	a. Time base A b. Single (time base A) c. 50 Hz (adjustable phase and amplitude) d. EXT. (1 : 1) e. EXT. (1 : 10) f. X-plug-in unit

TIME-BASE GENERATOR

a. Time co-efficient	adjustable to 23 calibrated values: viz. 50, 100, 200, 500 etc. ns/cm up to 1 s/cm. Tolerance: ± 3%. Continuous control between the steps is possible (non-calibrated).
b. Magnification	1, 2 and 5×. Tolerance: ± 2%
c. Operation	triggered, free running, single (not possible with automatic triggering).
d. Triggering source	internal, external, internal by means of a voltage with the mains frequency (adjustable phase).
Slope	+ or —
Operation	AUT.: 10 c/s...1 Mc/s ("LEVEL" and "STAB". switched off) HF : RC–time 80 μs. LF : RC–time 56 ms. DC TV LINE : "LEVEL" and "STAB". switched off. TV FRAME : "LEVEL" and "STAB". switched off.
e. Required trace height for internal triggering	See the manual of the relevant plug-in unit.
f. Required voltage for extrenal triggering	0.4 V_{p-p} up to 50 Mc/s; 1 V_{p-p} up to 100 Mc/s. In the positions "TV FRAME" and "TV LINE" 1 V_{p-p} positive video. 1 V_{p-p} in the position "AUT." at 1 Mc/s.
g. Input impedance	1 MΩ//55 pF for the positions "AUT"., "HF", "LF" and "DC".
h. Trigger level	
internal	adjustable over 6 cm trace-height
external	adjustable over 6 V_{p-p}.

X-INPUT

a. amplifier	DC-amplifier
b. input	asymm. – 4 mm socket
input impedance	1 MΩ//55 pF
c. deflection co-efficient	0.5 V/cm ("EXT") 5 V/m ("1 : 10 EXT")
d. amplitude characteristic	0...1 Mc/s
e. deflection	10 cm
Plug-in unit	See the manual of the relevant plug-in unit.

CALIBRATION UNIT

a. Voltage	square-wave voltage with frequency of 2 kc/s, adjustable to 18 values, viz. 0.2, 0.4, 0.8, 2 etc. mV_{p-p} up to 80 V_{p-p}. Tolerance: 1% Ro in mV-range: 50 Ω
b. Current	square-wave current with frequency of 2 kc/s, 4 mA_{p-p}. Tolerance: 1%

Output voltages

a. Gate voltage	+ 35 V_{p-p} starting at 0-level synchronous with the time-base voltage.
b. Sawtooth voltage	+ 90 V_{p-p} starting at 0-level
c. Calibration voltage	see calibration unit

Power supply

By means of a voltage adapter adjustable to mains voltages of 110 V – 125 V – 145 V – 200 V – 220 V and 245 V.
Mains frequency: 40 – 100 c/s. With mains frequencies < 50 c/s, the mains voltage should not exceed the nominal value.

Power consumption

500 W at maximum (plug-in units included).

Mechanical details

Cast aluminium front and rear frame.
Two-piece cabinet (skin plate).

Dimensions and weight

Height	: 46 cm
Width	: 34.5 cm
Depth	: 68 cm (knobs and air filter included)
Weight	: 42 kg

OPERATING CONDITIONS

Ambient temperature: 0...35° C.
At too high an internal temperature, the instrument is switched off by means of a thermal relay.

ACCESSORIES

- manual
- mains flex
- 4 air filters
- cable (BNC-4mm)
- adapter plug BNC-4mm (PM 9051)

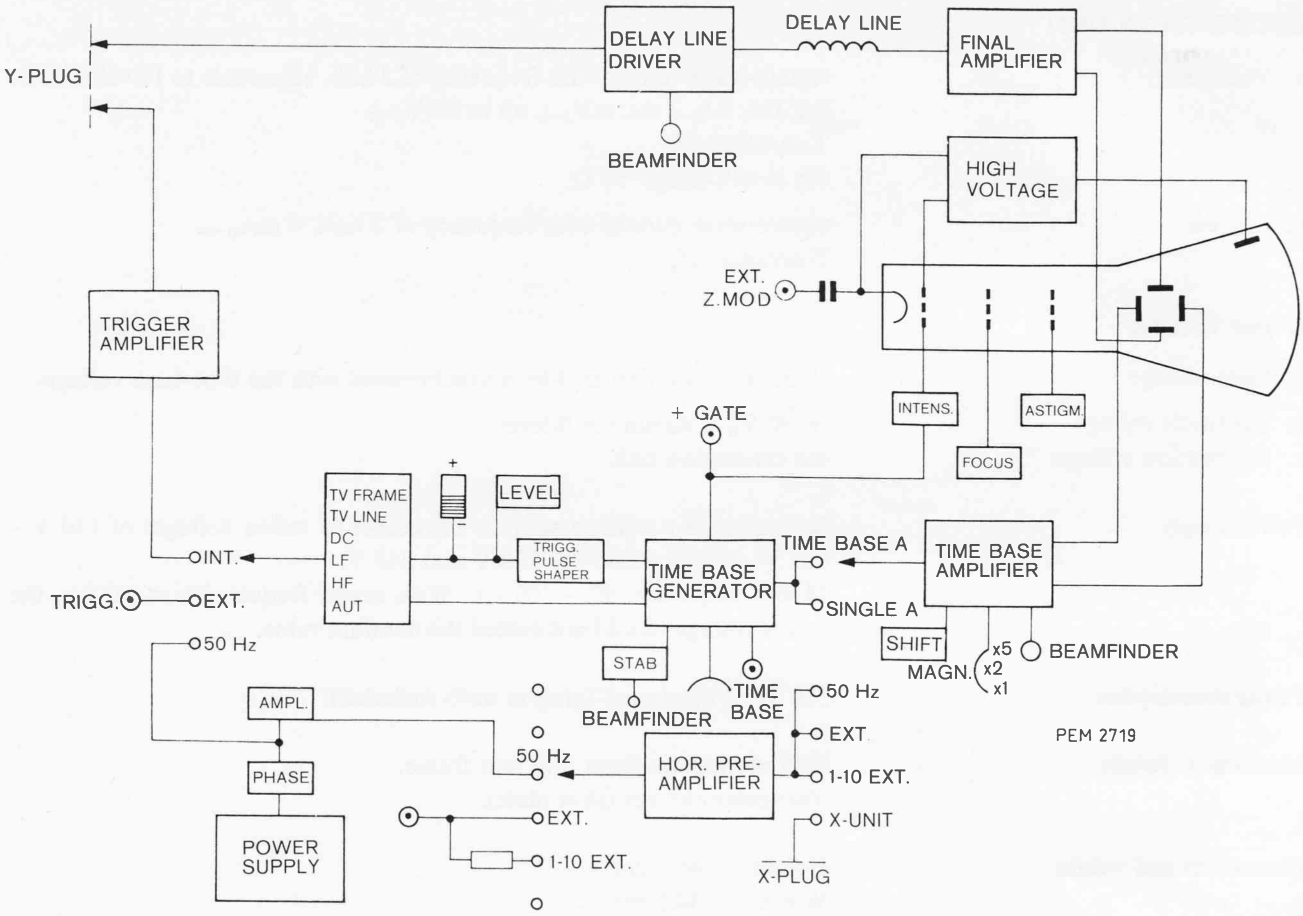

Fig. 1. Schematic survey of the controls

Description of the block-diagram II

Y-AMPLIFIER

The Y-amplifier is a symmetrical DC-amplifier, which consists of:

a. a delay-line driver

b. a delay line

c. a final stage which supplies the deflection voltage for the cathode-ray tube.

The Y-deflection plates have been divided in four sections, included in a lumped line, which forms the anode impedance of the output valves.

TIME-BASE GENERATOR

The time-base generator is of the Miller-integrator type. Here the charging capacitors and resistors which are selected by means of the knob TIME/cm, have been included.
The STAB. control regulates whether or not the time-base generator operates.

X-AMPLIFIER

The X-amplifier consists of a pre-amplifier, a magnifier circuit and a time-base amplifier.
The pre-amplifier is a DC-amplifier, which is used for the amplification of an external signal or an internal voltage with the mains frequency.
The magnifier circuit contains the X-shift control and the magnification switch.
The time-base amplifier supplies a symmetrical voltage for the deflection plates of the cathode-ray tube.

TRIGGER AMPLIFIER

The trigger amplifier amplifies the trigger signal from the Y-plug-in unit.

TRIGGER UNIT

The trigger unit contains the trigger-pulse shaper which supplies the trigger pulse for the starting of the sawtooth generator.
The signal is taken from an internal or external source and, via selectable high-pass filters is fed to the trigger-pulse shaper.
The polarity and the level of the trigger signal can be adjusted.
In the trigger unit also a synchronization separator for TV signals has been included, by which triggering on these signals is possible.

CATHODE-RAY TUBE

The controls "INTENS.", "FOCUS" and "ASTIGM." regulate the voltages on the several electrodes of the cathode-ray tube.
An HT unit supplies the positive post-accelerating voltage and the negative voltages for the cathode and the Wehnelt-cylinder.
The cathode of the cathode-ray tube is via a coupling capacitor accessible for external Z-modulation, on the rear of the instrument.

CALIBRATION UNIT

The calibration unit consists of an astable multivibrator the output of which is connected via a voltage divider with a socket on the front plate.
A selector enables selection of 18 different voltages and a calibrated current.

POWER SUPPLY

The mains voltage, via a transformer and rectifier circuit, is applied to a number of control circuits, which supply the stabilized voltages for the various circuits.
These supplies are electronically protected against overloading or short-circuiting.

BEAMFINDER

By depressing the beamfinder, the amplification of the X- and Y-final amplifiers is considerably reduced and the sawtooth generator obtains the free-running position.

DIRECTIONS FOR USE

Installation

III

A. AIR FILTER

The instrument is cooled by means of two fans.
The air is drawn in via an air filter at the rear.
To assure free circulation of the air, the instrument must be placed so, that the air intake is not blocked; moreover it is recommended to clean the air filter at regular intervals (see chapter IX).

B. ADJUSTING TO THE LOCAL MAINS VOLTAGE

By means of a voltage adapter at the rear of the instrument, adjustment to one of the mains voltages 110 V, 125 V, 145 V, 200 V, 220 V and 245 V is possible. The voltages adjusted can be read through opening "C" in the cover plate. (See Fig. 2).

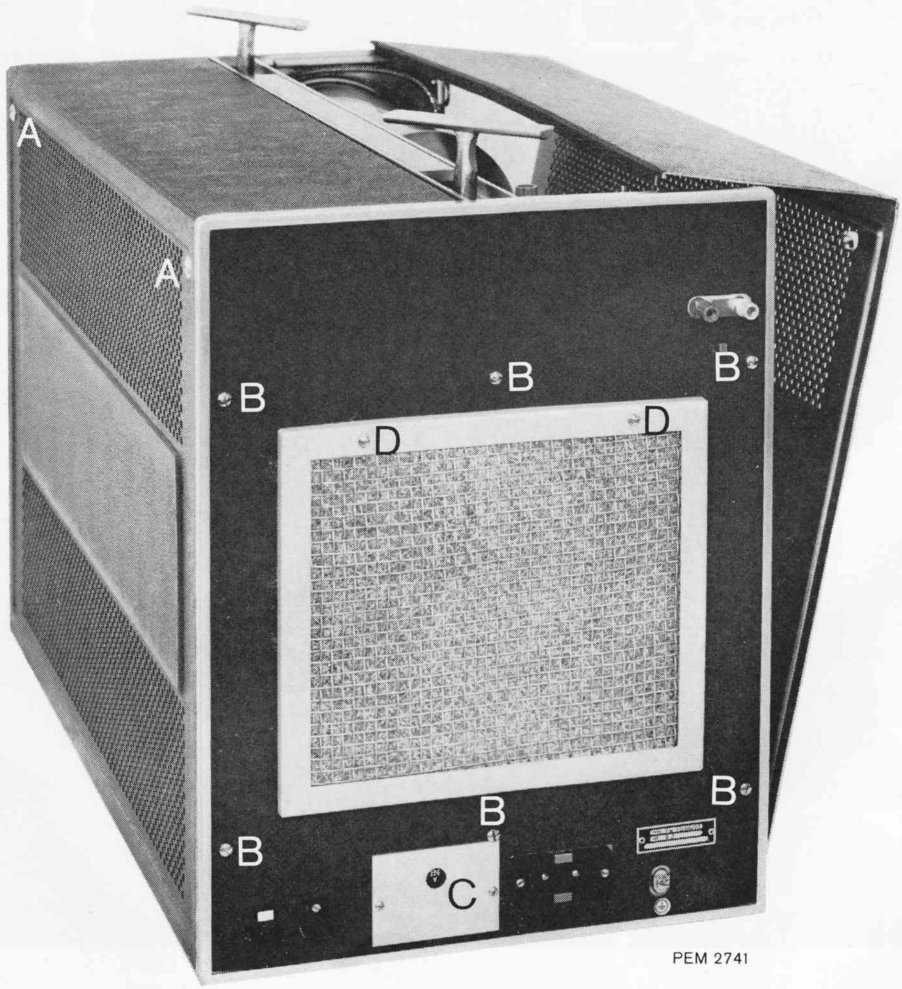

Fig. 2. Rear side of the apparatus

C. FUSES

On the rear side of the instrument two 4–A fuses have been fitted. If the instrument is connected to a mains voltage of less than 200 V, the 8–A fuses included with the oscilloscope should be mounted. These fuses can be found in the instrument on the screening partition over the X-plug-in compartment. (See Fig. 3).

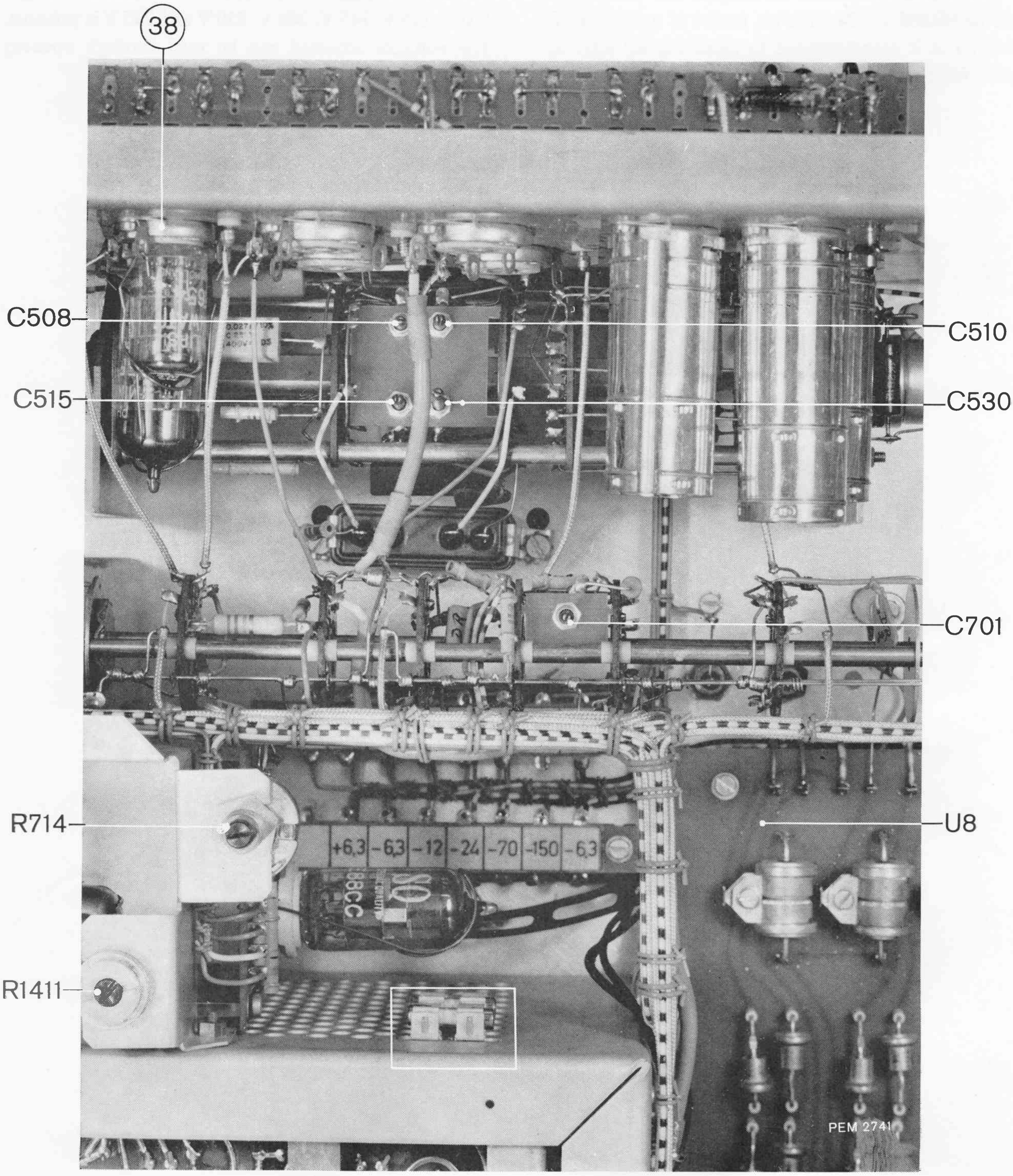

Fig. 3. Fuses on X-plug-in compartment

D. EARTHING

The instrument may be earthed via one of the terminals ⏚ on the front or the rear side, or via the mains flex if this has a plug with rim-earthing contacts. Double earthing may cause hum and must be avoided.

E. PLUG-IN UNITS

The instrument only operates if at least one plug-in unit ("Y-UNIT") has been inserted.

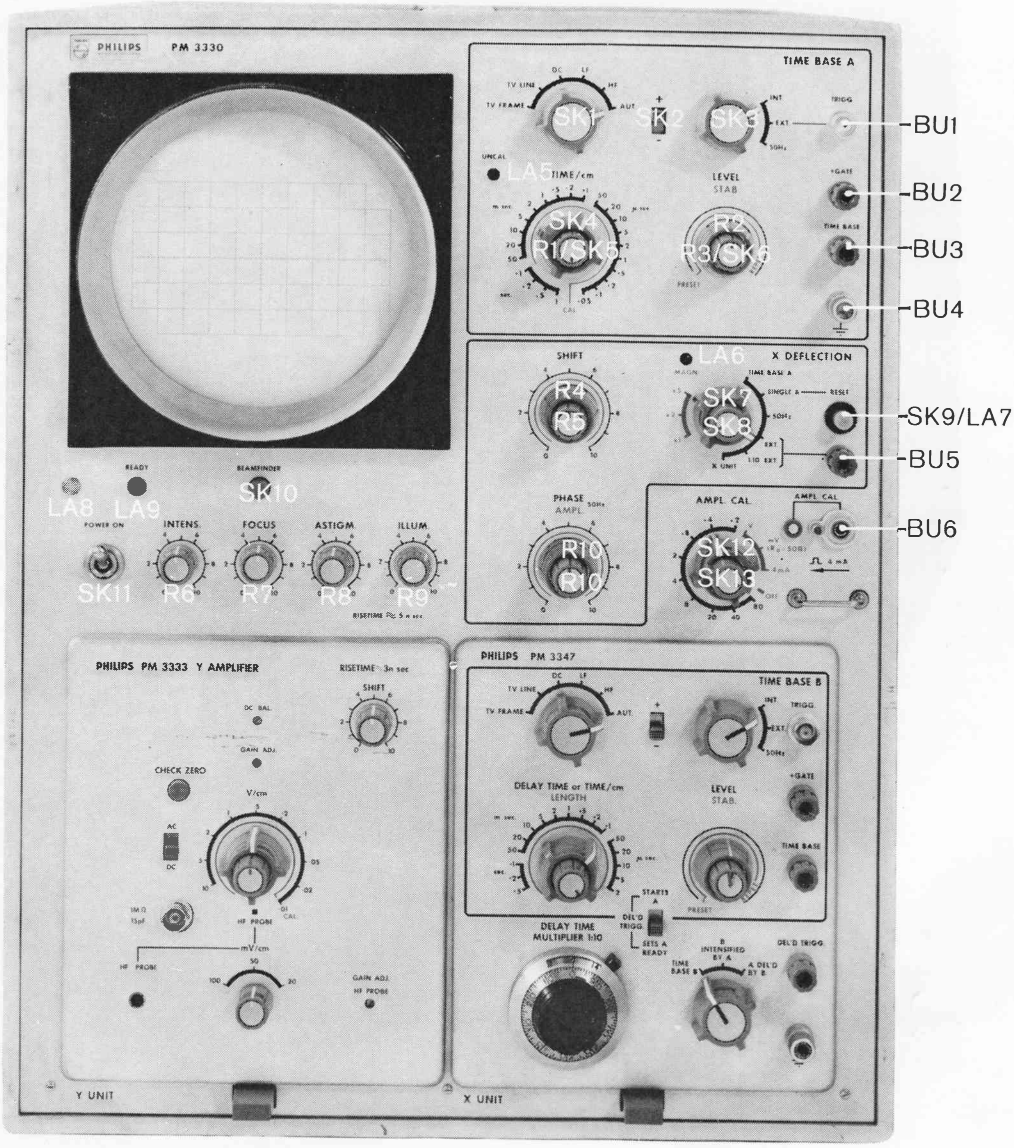

Fig. 4a. Front-view with coded controls and lamps

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F. SWITCHING-ON

The instrument is switched on by means of the "POWER ON" switch. The white pilot lamp will light up. The supply voltages are applied via a time-delay relay to allow a brief valve-warm-up period. If after approximately 30 seconds the "READY" lamp starts glowing, the instrument is ready for use.

If, when using the oscilloscope, the Y-plug-in unit is detached from the instrument, the relay releases ("READY" lamp extinguishes).
When a Y-plug-in unit is inserted again, a brief warming-up period follows, after which the "READY" lamp lights up. The instrument then is ready for use again.

Fig. 4b. Rear view with Z-modulation input terminals and switch

Controls and their functions IV

A. CATHODE-RAY TUBE CIRCUIT

The brightness of the oscilloscope display is adjusted with the "INTENS." control.

A stationary picture of maximum brightness, left on the screen for too long may damage the screen.

The "FOCUS" and "ASTIGM." controls adjust the definition of the oscilloscope display.

To obtain an optimum adjustment, both controls should be rotated simultaneously.
The cathode-ray tube is provided with an internal graticule.
The graticule can be illuminated. The illumınation can be controlled by knob "ILLUM".

The graticule illumination is particularly important for photography. For this refer to the manual of the camera.

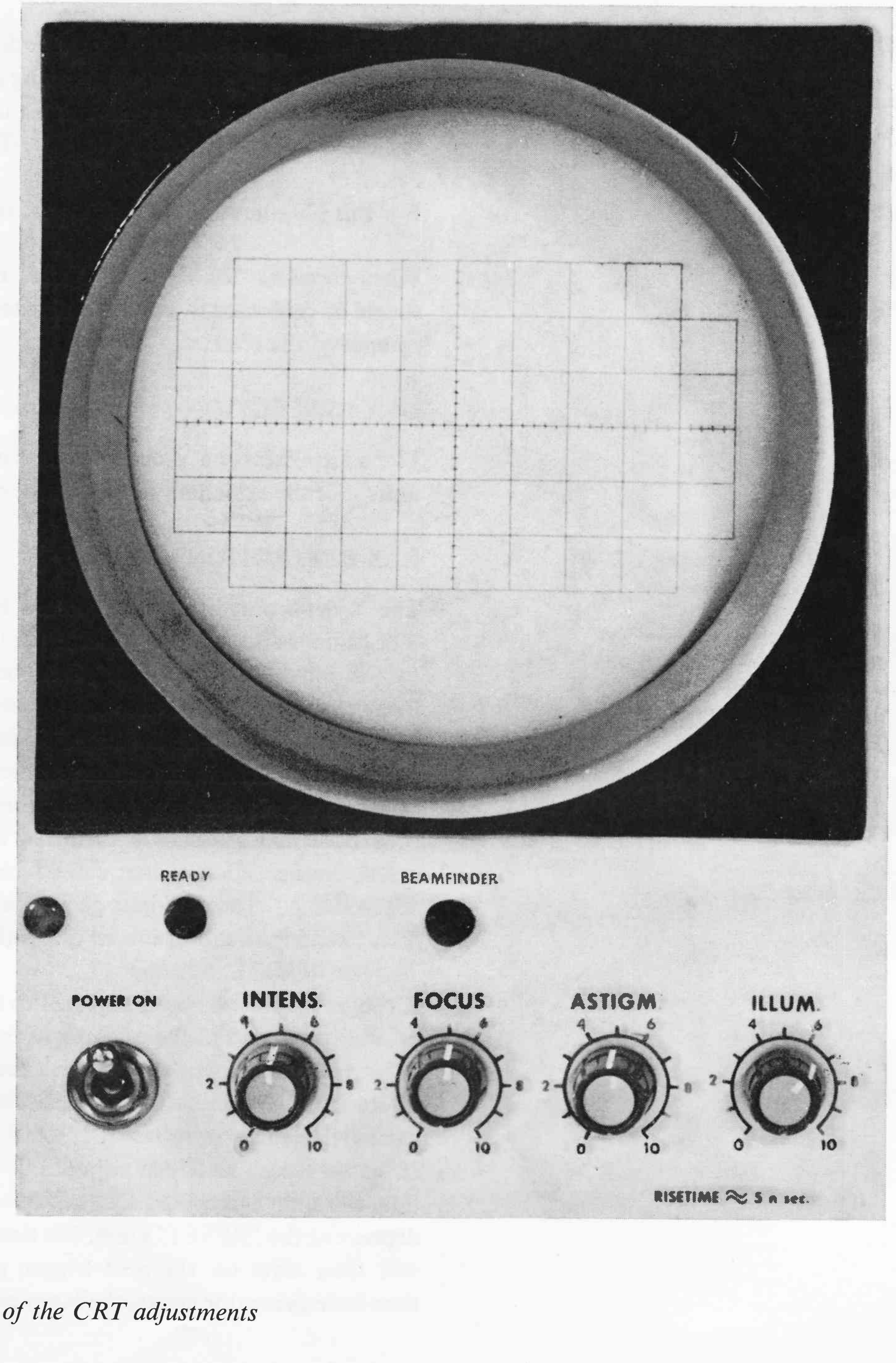


Fig. 5. Controls of the CRT adjustments

B. BEAMFINDER

By depressing the button "BEAMFINDER", the display is considerably reduced. Owing to this the electron beam will be visible on the screen in spite of the magnitude of the input signal or the position of the shift controls. During the depression of the "BEAMFINDER" button, the display can be centred by means of the shift controls.

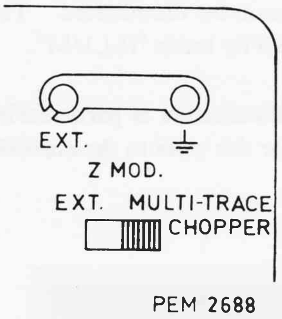


Fig. 6. Z-modulation busses

C. Z-MODULATION

The intensity of the CRT display can be modulated by connecting an alternating voltage to the terminals "EXT." and "⏚" on the rear of the apparatus.
For this purpose, the earthing bar should be disconnected and the switch should be set to position "EXT."
The voltage is connected to the cathode of the CRT; an increasing voltage causes a decreasing intensity.
When a multi-trace plug-in unit is used, the switch should be set to position "MULTI-TRACE CHOPPER."
For this plug-in unit, see the manual concerned.

When terminal "EXT." is not used, the earthing bar should be connected to avoid interference voltages on the cathode of the CRT.

D. Y-DEFLECTION

The controls for the Y-deflection are on the Y-plug-in units. For the explanation, refer to the relevant manual.

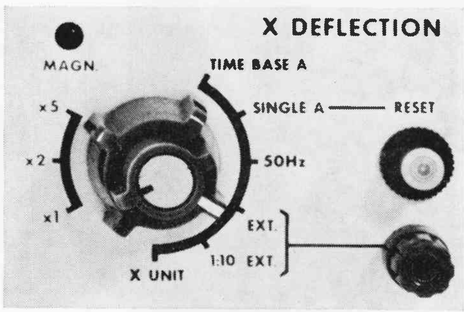


Fig. 7. X-deflection selector

E. X-DEFLECTION

The X-deflection voltage is selected by means of the 6-position switch in the "X-DEFLECTION" frame. In position "TIME BASE A", deflection is effected by means of the internal time-base generator. With the controls in the "TIME BASE A" frame, the time-base generator is started and the time coefficient is adjusted. With non-periodical signals, a continuously working time base may produce a distorted display. In such cases, the deflection switch should be set to position "SINGLE A". The time-base generator is then blocked. This blocking situation can be discontinued by depressing the "RESET" button.
If the time base had been adjusted to the free running position (with aid of the controls in the "TIME BASE A" frame) it will complete one cycle and will be blocked afterwards. A next sweep of the time-base generator can be effected by depressing the "RESET" button again.
If the time-base had been adjusted to the trigger position, the lamp in the "RESET" button will light up after depressing the "RESET" knob. The time-base generator will then start on the next trigger pulse. When the time-base generator starts, the lamp extinguishes.

After having completed one cycle, the time-base generator will be blocked again.
A new sweep can be effected by depressing the "RESET" knob and by applying a new trigger pulse.

The time-base voltage and a gate voltage which is synchronous with it are available from sockets "TIME BASE" and "+ GATE" via a low resistance.

In the "50 Hz" position, deflection is effected by a sine-wave voltage with the mains frequency. This voltage can be varied in amplitude and phase by means of the double control knob "PHASE, AMPL. 50 Hz."

In the "EXT." and "1 : 10 EXT." positions a voltage should be applied to the relevant terminals in order to deflect the trace in X-direction. The deflection coefficient is "0.5 V/cm" in the "EXT." position and "5 V/cm" in the "1 : 10 EXT." position.

In the "X-UNIT" position the deflection is effected by an X-plug-in unit (see for this unit the relevant manual).

F. X-SHIFT

The trace can be shifted in X-direction by means of the "SHIFT" controls. The smallest knob has a small control range and is intended for fine-adjusting the position of the display on the X-axis, particularly when the time-base is magnified.

G. TIME-BASE A

1. Adjusting the time coefficient

By means of the "TIME/cm" double knob, the various time coefficients of the sawtooth generator can be adjusted. With the continuous control in the fully clockwise position (marked "CAL") the time coefficients are calibrated. When rotating the continuous control, the "UNCAL" lamp indicates that the time-basegenerator is not calibrated any longer.

2. Magnification

The gain of the X-amplifier is controlled with the magnifier switch in the "X-DEFLECTION" frame.
With this switch the time-base length can be magnified by a factor 2 or 5. In the positions "×2" and "×5" the "MAGN." lamp glows.

The magnification only works for sawtooth voltages obtained from "TIME-BASE A" or "TIME-BASE B" (PM 3347).

The time coefficient of the whole system is obtained by dividing the value indicated by the magnification factor of the "TIME/cm" switch.

Fig. 8. Gate and time-base output

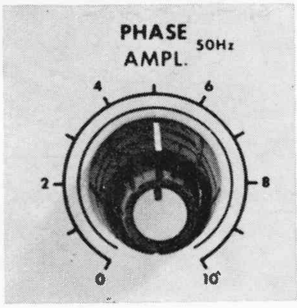


Fig. 9. X-deflection by mains frequency

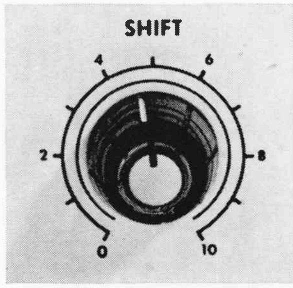


Fig. 10. X-deflection shift controls

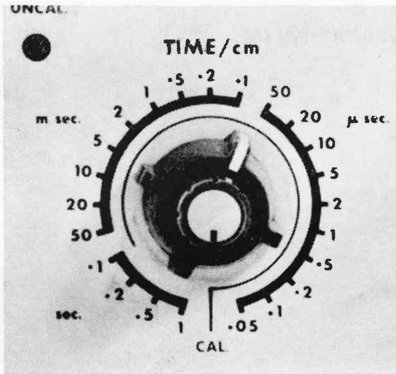


Fig. 11. Time-coefficient control

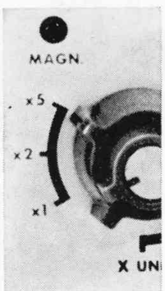


Fig. 12. Magnifier of X-deflection

Example

time coefficient: $\frac{20\ \mu\text{sec./cm}}{5} = 4\ \mu\text{sec./cm.}$

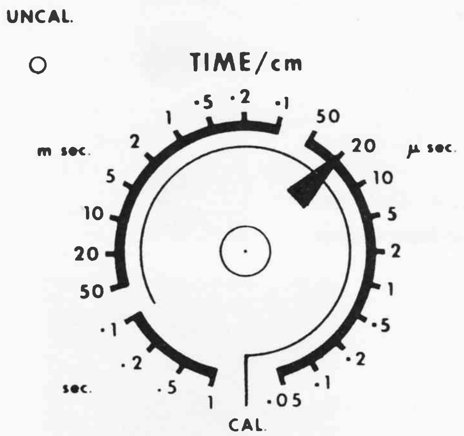
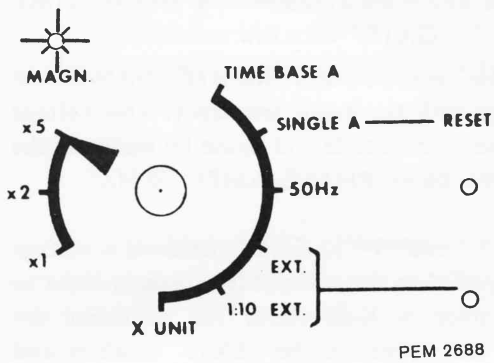


Fig. 13. Computation of time-coefficient



3. Stability

With a triggered time-base, it is sufficient in most cases to set the ″STAB.″ control in the ″PRESET″ position (switch anti-clockwise).
If it is impossible to obtain a stable triggering in this way, the trigger position can be accurately adjusted by means of the ″STAB.″ control.
To this end, remove the input signal of the Y-amplifier (with ″EXT.″ triggering, remove the trigger signal).
Turn the ″STAB.″ control from the right-hand stop anti-clockwise until the display just disappears from the screen.
This is the most sensitive trigger position of the time-base generator.
With the ″STAB.″ control turned to the right-hand stop (″REPET.″), the time-base generator is free-running.

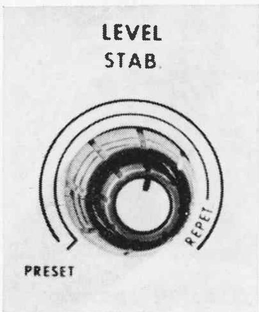


Fig. 14. Stability-control

H. TRIGGER UNIT

1. Trigger source

The trigger pulse, required to start the time-base generator is derived from a signal which is applied via the ″INT.-EXT.-50 Hz″ switch.

INT. The trigger signal is obtained from the Y-plug-in unit.

EXT. The trigger signal is derived from a voltage applied to the ″TRIGG.″ terminal.

50 Hz The trigger signal is derived from an internal voltage with the mains frequency. The phase of this voltage can be varied with the ″PHASE″ control in the ″X-DEFLECTION″ frame.

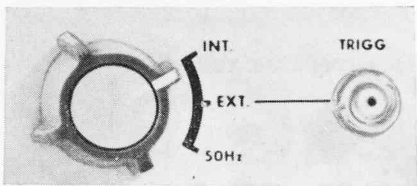


Fig. 15. Trigger source selection

2. Polarity and trigger level

The point in a period at which the time-base starts (and at which the signal becomes visible on the screen) is selected with the ± polarity switch and the "LEVEL" control.
When the polarity switch is in the "+" position, the sawtooth generator starts on the positive-going edge of the signal. With the "LEVEL" control the level on the positive-going edge can be adjusted.
When the polarity switch is in the "—" position, the starting point can be adjusted to the negative-going edge by means of the "LEVEL" control.

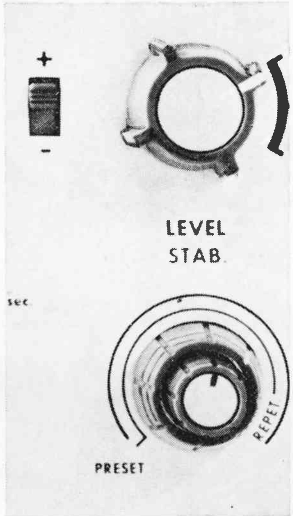


Fig. 16. Trigger polarity selection

3. Trigger mode

The coupling between the trigger-signal input and the trigger-pulse shaper is selected by means of the "TRIGGER MODE" switch.

AUT. The trigger unit is then AC-coupled.
The starting of the time-base is automatically controlled. When a trigger signal is present, the time-base is triggered.
When no signal is applied, the time-base generator is automatically adjusted to its free-running position, so that there is always a line visible on the screen.
In this position, the "LEVEL" and "STAB." controls are inoperative.
The "AUT." position is suitable for normal use of the time-base only. For "SINGLE A" display one of the other positions of the mode switch should be used.

HF. The AC-coupling is now so, that l.f. interference such as hum, does not influence the triggering.

LF. In this position triggering takes place for sine-wave signals from approx. 3 c/s.

DC. The trigger is DC-coupled.
The time-base can then be triggered with a very slowly varying voltage.

TV LINE and **TV FRAME**
The "TV LINE" and "TV FRAME" positions are used for the triggering on TV signals.
In the first case the time-base is started by a pulse with the line frequency. In the "TV FRAME" position the time base is started with a pulse with the frame frequency.

With "INT. TRIGGERING" the polarity switch should be in the "+" position, when the amplifier is driven with a video signal with positive going sync. pulses and in the "—" position, when a video signal with negative-going sync. pulses is used.

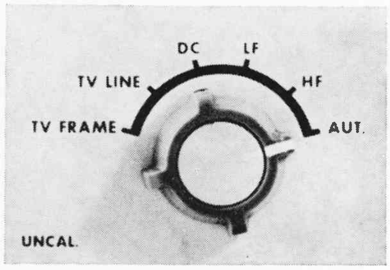


Fig. 17. Trigger mode selection

With "EXT. TRIGGERING" the trigger unit only works when a video signal with negative-going sync. pulses is applied to the socket "TRIGG." The polarity switch should be in the "—" position in this case.
The knobs "LEVEL" and "STAB." are inoperative in both of the TV positions.

J. CALIBRATION UNIT

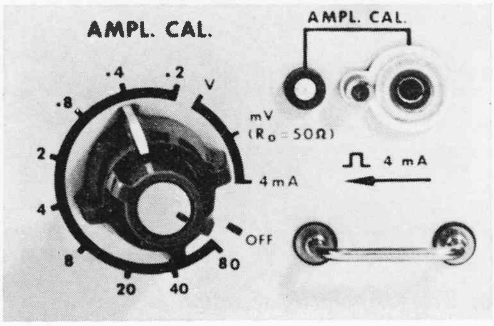


Fig. 18. Calibration unit

With switch "AMPL. CAL." a calibration voltage respectively calibration current can be adjusted.
They are intended for checking and, if necessary, correcting the horizontal or vertical deflection system.
The voltage is taken off between the 4-mm socket or the measuring-probe contact, and the relevant earthing socket.
Especially with the small calibration voltages it is important to use this earthing socket.
The voltage values have been adapted to the deflection coefficients of the units, so that always a trace height of 4 cm can be obtained.
The current bracket can be used for checking a current measuring probe.

SERVICE DATA

Explanation of the circuit diagram V

A. CATHODE-RAY TUBE CIRCUIT (Fig. 84)

The CRT, which is provided with an internal graticule, has its cathode at a potential of 1440 Volts negative with respect to earth. The post-deflection accelerator is at a potential of 8600 Volts positive with respect to earth.
Potentiometer R6 ″INTENSITY″ controls the beam current, R7 ″FOCUS″ and R8 ″ASTIGMATISM″ focus the spot at the screen.
The following potentiometers are placed inside the apparatus: R318 to compensate for cushion and bar distorsions, R320 adjusts the potential of the internal electrical screen to be equal to the average value of the vertical plates. R314 centers the beam through the deflection plates to obtain an equal light distribution over the screen.

In order to let the horizontal deflection of the spot exatly coincide with the internal graticule, a magnetic field is generated by a coil which is mounted inside the mu-metal magnetic screen around the tube. The direction and intensity of this magnetic field can be adjusted by R319 – R321.
A pair of coils are fitted to the neck of the CRT, for adjusting the deflections due to the X- and Y-systems. Correct adjustment of the currents through these coils by R327 and R328 will make the deflections exactly perpendicular and center the useful scan for uniform overlap of the graticule.
If it is desired to intensity-modulate the beam, the modulating signal can be connected to BU9, which is connected to the cathode via blocking capacitor C303 and switch SK14.
Normally BU9 is earthed to BU10 by a bus-bar to decouple the cathode (via C303).
Switch SK14 must be thrown when a multitrace plug-in unit is used, connecting the cathode to a single-transistor amplifier.
The latter receives blanking pulses from the unit which are generated during switching over when operating in the chopped mode.
Unblanking pulses generated by time-base A or time-base B during the sweeps of the spot are DC-coupled to the grid of the CRT via a floating grid supply (Fig. 19) located at the HT supply. The positive terminal of this supply is directly coupled to the cathode-follower B502″ of the time-base circuit. At fast sweep-rates it is difficult to push up this supply fast enough to unblank the CRT in the required time. Therefore an AC-path is provided via C301.

B. POWER SUPPLY

1. General

The power supplies up to 400 Volts are constructed with solid state elements; the high-tension supply (10 kV) is regulated by vacuum-tubes.

2. Mains transformer

The primary side of the mains transformer is provided with the 110 Volts windings, a 15 Volts winding and a 20 Volts winding, the latter two connected in series. In this way it is possible to adapt the transformer to one of the line-voltages 110 V – 125 V – 145 V – 200 V – 220 V – 245 V.
The motors of the two cooling-fans are permanently connected to the two 110 Volts windings.
They are connected so that their stray magnetic fields counteract each other.
A thermal cut-out (RE1003) protects the apparatus from overheating. It switches off the mains supply at a temperature of approximately 60°C. The transformer is protected by 2 fuses (slow-blow); the mains is switched by a double pole switch (SK11).
Some of the windings delivering a filament supply are connected to a DC-supply, namely:
S15 to 12 V pos., S16 to 70 V neg., S17 to 70 V pos., S18 to 1440 V neg., S13 and S14 are earthed.

3. Solid state power supplies

a. Negative 150 Volts (Fig. 91)

The voltage delivered by winding S2 is rectified by a full-wave bridge-type rectifier consisting of 4 diodes BY100S (GR1021 ... GR1024) and smoothed by capacitor C1021 (200 μF). The series elements of the voltage regulator consist of four power transistors ASZ15 (TS1032 ... TS1035) which are connected in series.

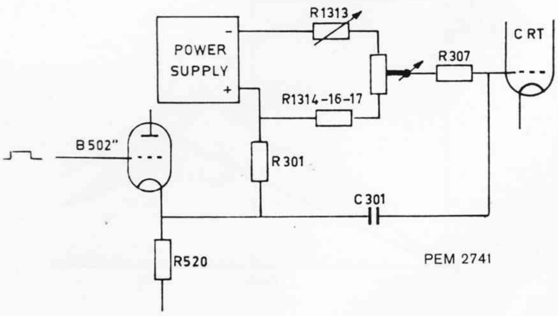


Fig. 19. Grid-circuit of the CRT

b. Positive 130 Volts

This supply is built like the negative 150 Volts supply. The very value of the output voltage is determined by the precision metal-film resistors R1071 – R1072 – R1076 – R1077. No adjustment is needed if the 150 Volts supply gives exactly its nominal voltage. A reference voltage derived from this supply is fed to the base of TS1031. The base of TS1030 receives the error signal and a signal which is proportional to the ripple over C1016. The amplitude of the latter signal can be adjusted to a minimum ripple at the output by changing the value of R1062.
Diode GR1031 is essential for the protection and resetting of the power supply in case of a short circuit.

c. Positive 200 Volts

A tension of 200 Volts is obtained by connecting a 70 Volts supply on top of the 130 Volts supply, the operation being the same as the latter one.

d. Positive 330 Volts

The supply of 330 Volts is obtained by adding 130 Volts to the 200 Volts supply.

e. Positive 400 Volts

The supply of 400 Volts is obtained by adding 70 Volts to the 330 Volts supply.

f. Positive 70-24-12-6.3 Volts.
Negative 70-24-12-6.3 Volts

These tensions are supplied by separate power supplies except the 12 Volts positive and negative, which are derived from the 24 Volts supplies merely by using a resistor and a Zener diode for each.
The circuits including the overload protection are constructed according to the principles mentioned in the description of the negative 150 Volts supply and the positive 130 Volts supply.

g. Time delay

A time delay is built in to allow the filaments of the vacuum tubes to warm up before applying the voltages of the various power supplies.
It consists of the bi-metal relay RE1001 which closes a contact after about 30 seconds upon switching on. The contact energises relay RE1002 which keep itself energised over a change-over contact and an interconnection to earth via two interconnected terminals at the left-hand plug-in unit. When changing over, the contact of RE1002 breaks the energising circuit of RE1001.
Immediately upon switching on the mains lamp LA8 "POWER ON" lights. When relay RE1002 is energised lamp LA9 "READY" lights.
The time delay also operates after changing the left-hand plug-in unit; removing the right-hand plug-in unit has no influence.

h. High voltage power supply (see Fig. 93)

The high tension is obtained by transforming and rectifying the output voltage of a 40 kc Hartley oscillator. The oscillator circuit consists of the S1 and S2 and the tube B1301.
At the secondary side, S3 delivers tension to the half-wave rectifier GR1301 –2 –3 which is followed by a smoothing filter consisting of C1307, resistor R1312 and capacitor C1308. A tension of 1800 Volts must be present over capacitor C1308. The positive side of this floating power-supply is connected to cathode-follower B502" via R301, receiving the "unblanking" pulse of the time-base generator A. The negative side is connected via R1313 to R6 which is the intensity control of the cathode-ray tube.
It is possible to adjust the range of R6 by adjusting R1313. The other side of potentiometer R6 is connected via R1314, R1316 and R1317 to the positive side of the power-supply. S4 and S5 deliver a tension to the voltage tripler consisting of three 10 kV rectifiers B1303 – 4 – 5 and capacitors C1309 – 11 – 12. It provides 8600 Volts positive for the post deflection accelerator anode. A half-wave rectifier GR1304 – 5 – 6 connected to S4 provides 1440 Volts negative for the cathode-supply of the cathode-ray tube. Part of this tension according to the setting of potentiometer R1326 ("HT ADJ.") is compared with the stabilised 150 Volts negative supply by the right-hand triode of B1302. If variations in load should tend to change the 1440 Volts negative tension, an error-signal will exist between the cathode and grid of this triode. This signal is amplified once more by the left-hand triode of B1302. The output of the latter triode varies the screen-grid voltage of the oscillator tube B1301, thereby controlling its output.
As the output of the floating bias supply and the 8600 Volts positive supply are proportional to the output of the oscillator these two supplies are indirectly stabilised.

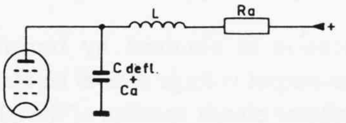


Fig. 23. Inductance reducing the effect of deflection-plate capacitance

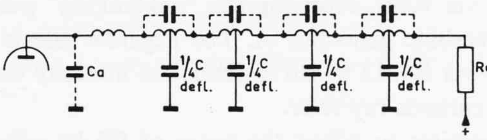


Fig. 24. Deflection-plate capacitancies forming part of a lumped-line

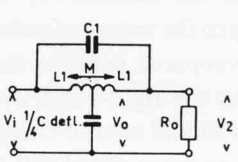


Fig. 25. Individual LC-section

C. Y-AMPLIFIER

1. Coupling to the cathode-ray tube

If the deflection plates of the cathode-ray tube (CRT) were connected directly to the anodes of the output stage, the pass-band would be too low due to the capacitive load of the deflection plates. This is known from the equation for the cut-off frequency which is

$$f_{3dB} = \frac{1}{2\pi RC}$$

where C is the total effective capacitance between the anodes and earth, and R is the anode load (600 Ω). It has been common practice, to reduce the effect of the deflection plate capacitance by the addition of some inductance to the anode circuit (see Fig. 23). However in this instrument the idea has been taken a stage further by dividing the vertical deflection plates into 4 sections.

The four plates are then interconnected externally to form a lumped-constant line, which is terminated by a network of inductors and resistors providing a purely ohmic termination. Thus the input impedance is virtually purely resistive (Fig. 24). This system has the advantage over past practice, in that the pass-band of the individual LC sections (Fig. 25) is much higher when the C is $\frac{1}{4}$ of the total capacitance, as it is here, than if all the plate capacitance is present in one unit.

Coils L31 and L34 form the inductance of the lumped-line, which is terminated by the network between L32 to L35. The relevant inductors and resistor R75 have to be adjusted for optimum step-response. R99 must be adjusted so that the DC-potential of the vertical deflection plates is equal to the DC-potential of the horizontal deflection plates.

$$\frac{|V_i|}{|V_2|} = 1 \qquad \frac{V_o}{V_i} = \frac{1}{1 - \left(\frac{f}{f_c}\right)^2 + j\alpha\left(\frac{f}{f_c}\right)}$$

α = constant, depending on M

f_c = cut-off frequency

2. Output stage

The lumped-line is connected via L30 and L37 to the anodes of two tubes E55L (B5, B6) which form the push-pull output stage.

At the cathode side a frequency-dependent network R90-C55 reduces the negative feedback at high frequencies to compensate the losses at the anode-circuit and deflection system.

The quiescent plate-current of both output-tubes must be equal which can be achieved by adjusting R82. The gain of this stage can be adjusted by changing R89.

Because of the high capacitance (28 pF) between grid and cathode of the high slope output-tubes E55L, the drive must be supplied from a low impedance source. This is done by a cross-coupled cathode-follower (B4′, B4″) E188CC, which has the property that the output impedance at the higher frequencies is about half the impedance of an ordinary cathode-follower.

3. Delay line

The cross-coupled cathode-followers receive their signals from a 150 nano-second delay line, which is incorporated to make it possible to display the part of thie signal which triggered the time-base.
To avoid reflections, both ends of the delay line are terminated with a resistance of 270 Ω, the characteristic impedance. The delay line is coupled to the grids of the cross-coupled cathode-follower via coils L27 and L29 to provide an ohmic termination in conjunction with the input capacity of the cathode-follower. The anodes of the driver-stage are coupled to the input of the delay line via coils L26 and L28 for the same reason.

4. Driver stage

The driver stage of the delay line consists of two tubes E810F (B2, B3) operating as a push-pull amplifier.
An RC network of a relatively long time-constant (R66–C38, R71–C39) is connected in parallel to the terminating resistors to compensate for the thermal effects in the tubes.
At the cathode side a network is provided giving a frequency-dependent negative feedback. It comprises the resistors R51, 52, 54, 56, 60, coil L38 and the capacitors C30, 33, 34, 35, 36, 37, and compensates for the losses due to the skin-effect in the delay-line.
Normally the cathodes are fed by a negative supply of 24 Volts. When pushing button SK10, termed the ″BEAMFINDER″, the cathode-resistors are connected to earth via R64, thereby limiting the anode current in such a way that the spot cannot be deflected off the screen.
The driver-stage is fed by a cross-coupled cathode-follower similar to the one preceeding the output-stage. The quiescent anode currents of B2 and B3 can be made equal by adjustment of R39. With R31 the rise-time can be adjusted.
To avoid coupling via the filament-cathode capacities, all filaments are fed by decoupled H.F. coils.

D. CALIBRATION UNIT (Fig. 26)

The calibration unit generates a square-wave signal with a repetition frequency of about 2000 c.p.s. and an accurately known amplitude. Its output is available at BU6 with an amplitude which is selectable in steps between 80 V and 200 micro-Volts.
An a-stable multivibrator formed by the triode and pentode parts of B1401 (E80CF) switches the plate voltage of the pentode between an adjustable positive tension of about 80 Volts and a negative tension of about 50 Volts.
When the penthode is conducting cathode-follower B1402 (5718) is entirely cut off. The tension of its cathode rests at earth potential.
When the penthode is cut-off, the grid voltage of B1402 is determined by the setting of potentiometer R1411 which can be adjusted so that the cathode is lifted to a potential of exactly 80 Volts.
The precision attenuator R1417... R1427 divides this tension into steps of 80–40–20–8–4–2–0.8–0.4–0.2 Volts. If switch SK13 is in the position "V" the amplitude of the output signal is expressed in Volts, the actual height being selected by SK12 out of the above-mentioned range. If SK13 is in the position "mV", a 1 : 1000 attenuator, converts the range to millivolts. In the "mV" position the output resistance is fixed at 50 Ω.
If switch SK13 is put in the position "4 mA" no signal is available at the output terminal BU6 but a square-wave current with an accurately known value of 4 mA flows through a loop at the front panel. The fourth position of SK13 switches the unit off.

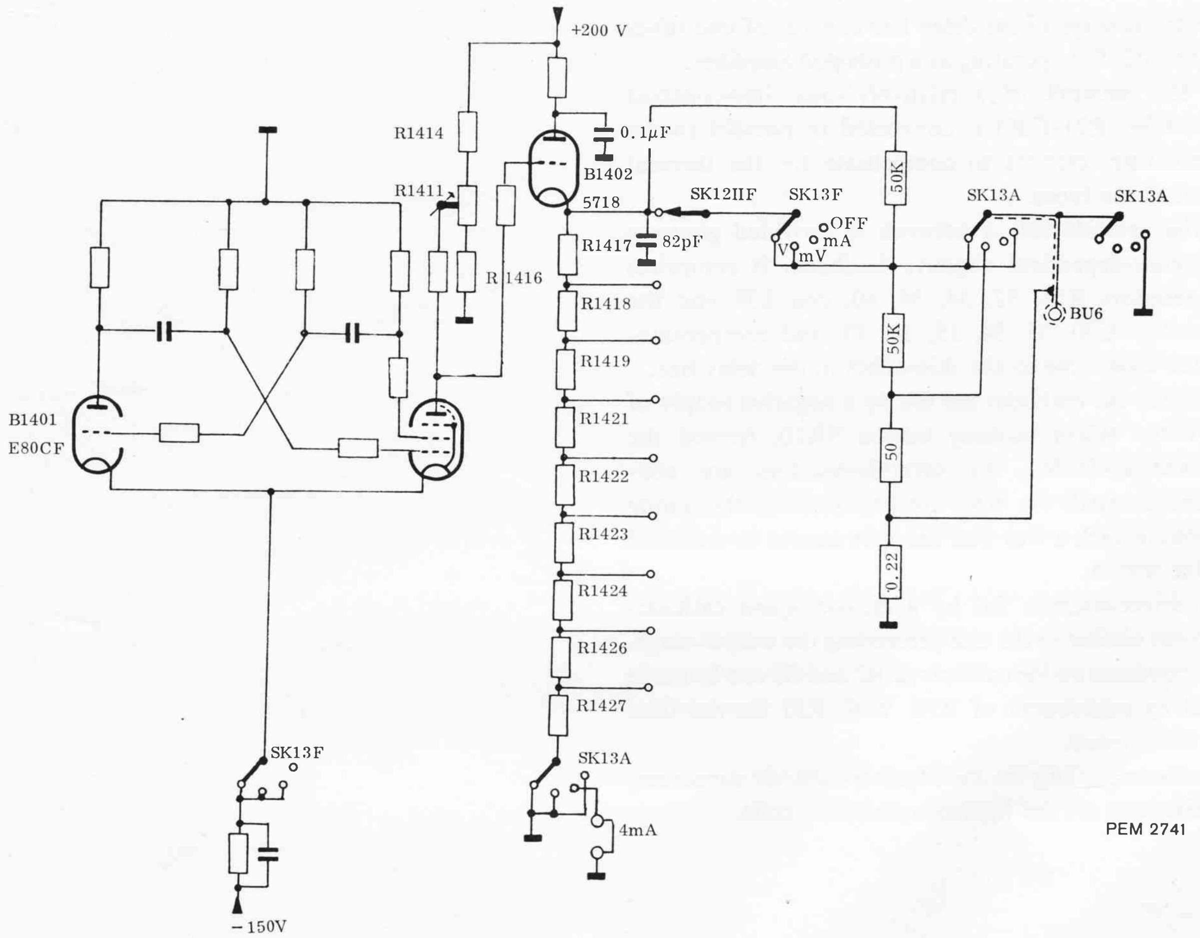


Fig. 26. Calibration unit circuit

E. X-AMPLIFIER

The horizontal amplifier can be divided roughly into a pre-amblifier, a magnifier circuit and a time-base amplifier.
These circuits are interconnected by mode switch SK7, having the positions: "TIME-BASE A", "SINGLE A", "50 Hz", "EXT.", "1 : 10 EXT.", "X UNIT". A survey is given at Fig. 27.
Switch SK8 is coaxial to this switch. It switches the magnifier circuit in the positions: "×1", "×2", "×5".

1. Time-base amplifier

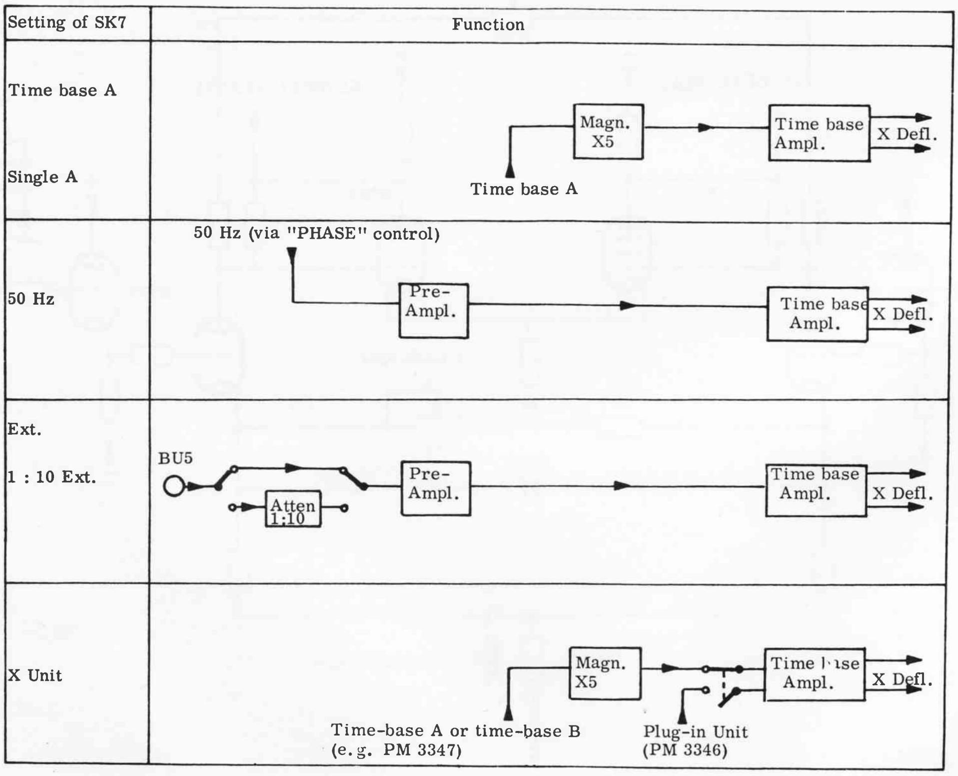
The whole circuit (Fig. 28) is a para-phase amplifier, which is driven at one grid whilst the other grid is earthed, so that a symmetrical output waveform is produced from a non-symmetrical input. The time-base generator output is applied to the grid of cathode follower B705 (left-hand triode).
The high stability of the amplifier is obtained by using shunt feedback at the two penthodes B703 and B704, as well as series feedback at the right-hand triode of B705 and the left-hand triode of B702. In this way the gain of the amplifier is nearly independent of valve characteristics. The overall gain is adjusted at R738 "X-GAIN ADJ." DC-balance of the complete amplifier and the CRT is adjusted at R731 "X DC-BAL."

A contact of SK10 "BEAMFINDER" normally shorts R735. If push-button SK10 is operated this resistor limits the current through the time-base amplifier in such a way, that the electron beam cannot be deflected off the screen.

2. Magnifier circuit

This circuit (Fig. 29) consists of a cathode-follower B701 with a fixed attenuator with 3 positions: "×1", "×2", "×5" in its cathode-circuit. The attenuation is maximal at the "×1" position of SK8 and minimal at the "×5" position.
When SK8 is at the positions "×2" and "×5" the lamp "MAGN." glows. In position "×5" sweep linearity is adjusted at C709 (located at the time-base amplitude), in position "×2" at C711 and in position "×1" at C710.
Horizontal positioning of the trace is effected by front panel controls R4 and R5 "SHIFT" which vary the DC-level at B701 grid. Resistor R717 isolates the grid circuit from the preceeding stages; frequency compensation is carried out by C707.

In positions "50 Hz", "EXT." and "1 : 10 EXT." of SK7 the range of the controls is made five times smaller by switching in resistor R721. At the same time magnifier-switch SK8 is made inoperative.



PEM 2741

Fig. 27. Survey of functions of the horizontal amplifier circuit

3. Pre-amplifier

If it is desired to use an externally generated waveform for horizontal deflection this voltage may be connected to the horizontal input terminal BU5. When SK7 is at "EXT." this signal is amplified at B706 (Fig. 30) and used to drive the time-base amplifier.

"LEVEL ADJ." R714 ensures that without an input signal the DC-level at the anode of B706 is such that the spot is in the middle of the screen. For large input signals at BU5, switch SK7 is set at "1 : 10 EXT." so that a 1 : 10 attenuator (compensated by C701) is interposed between the signal and the pre-amplifier B706.

Horizontal deflection with an externally generated waveform can also be carried out by using X-amplifier unit PM 3346. The signal is then injected at the grid of B702 right-hand tube (Fig. 28) whilst the grid of B705 left-hand tube is earthed via SK7 at the PM 3346 unit, so that the shift controls R4 and R5 are inoperative.

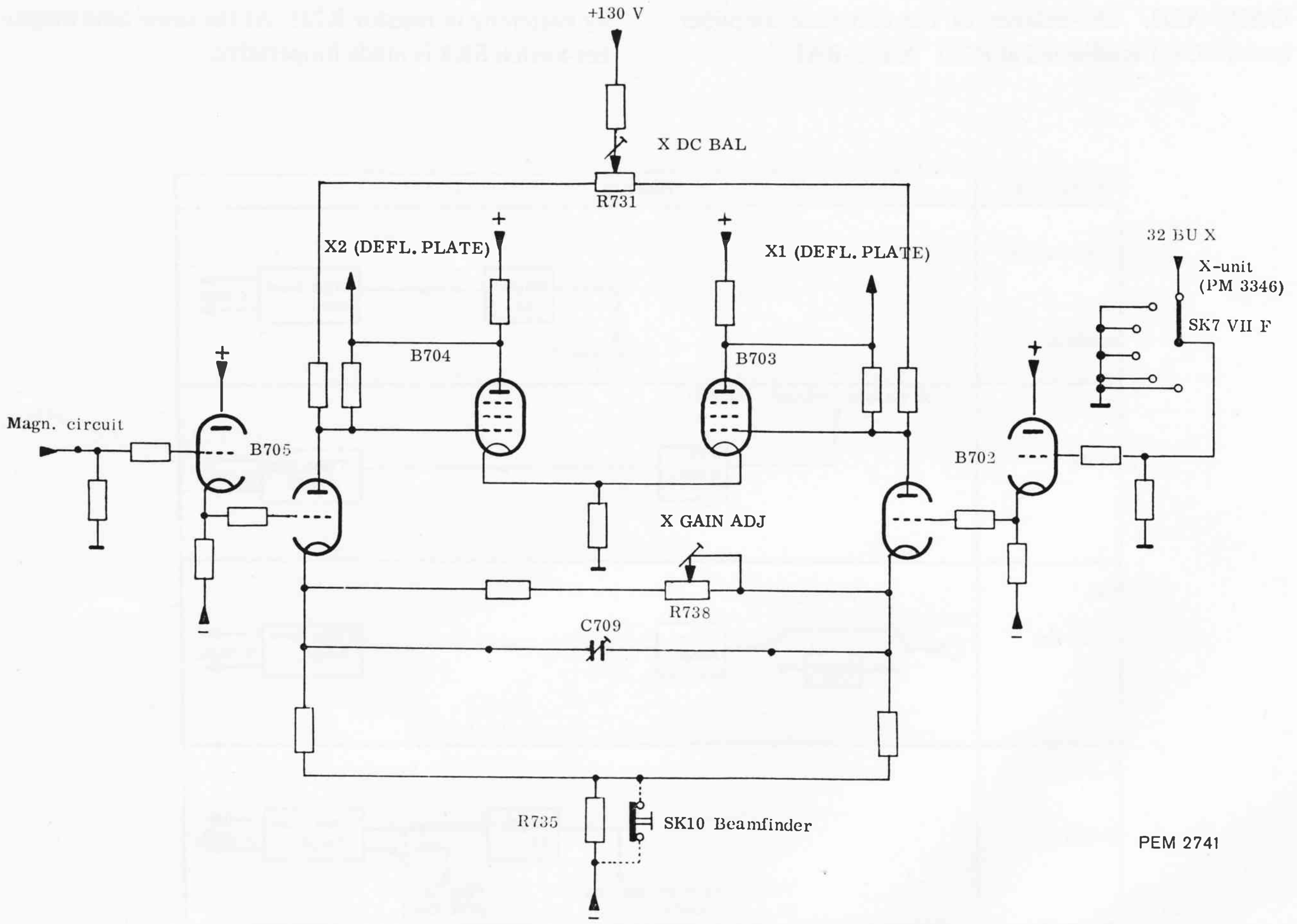


Fig. 28. Simplified diagram of the time-base amplifier

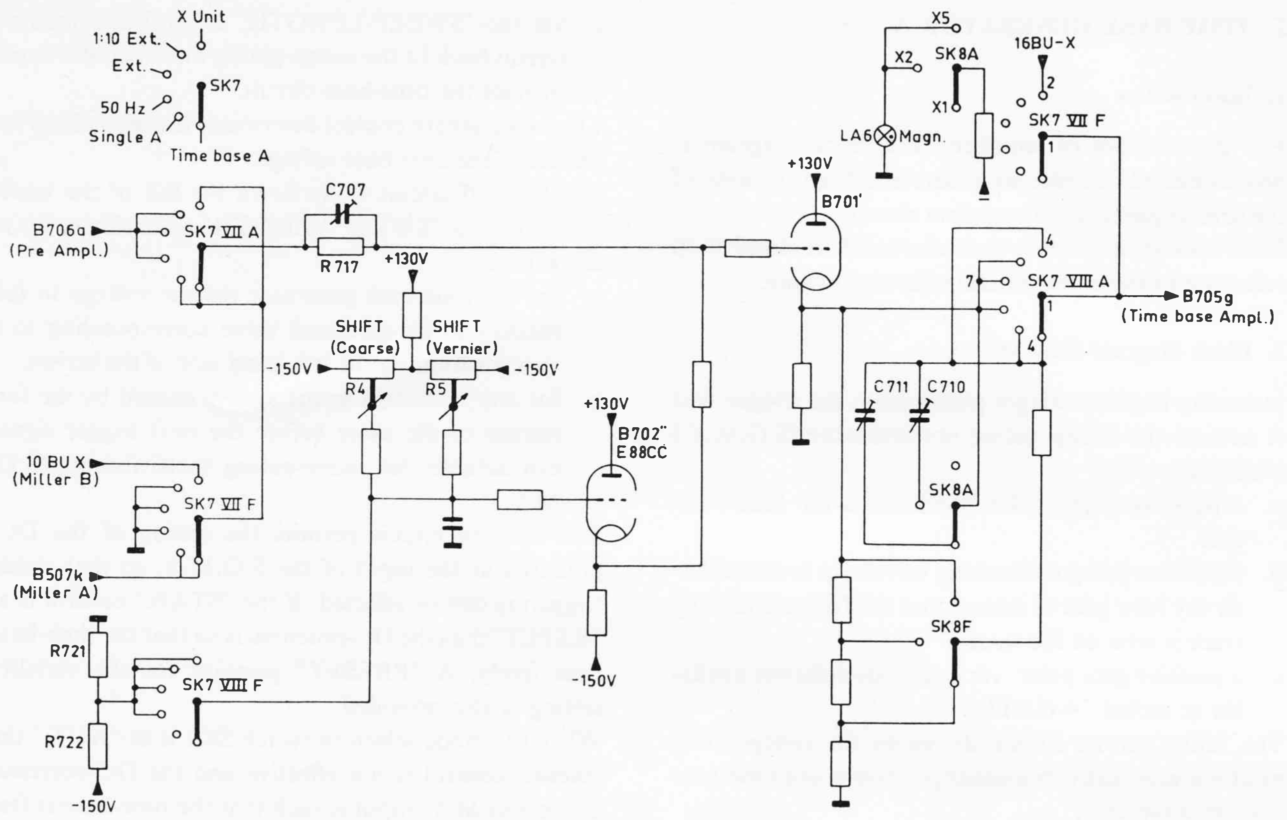


Fig. 29. Magnifier circuit

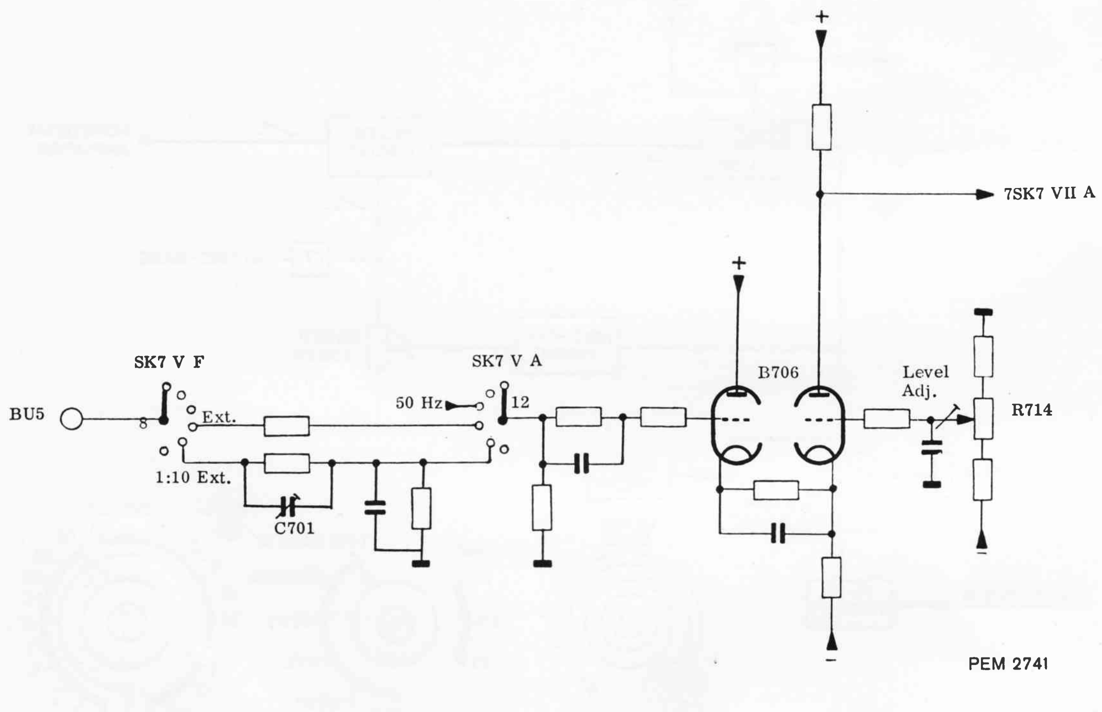


Fig. 30. Pre-amplifier circuit

F. TIME-BASE GENERATOR A

1. Introduction

For the purpose of simplicity the block diagram is first discussed in order to understand the functions of the several parts of the complete circuit.
Each individual part is then discussed in detail with reference to the corresponding circuit drawing.

2. Block diagram (Fig. 31)

Incoming negative trigger pulses from the trigger unit A actuate the sweep gating multivibrator (S.G.M.V.) which delivers:

a. a negative going pulse which starts the Miller-circuit
b. a positive going unblanking waveform to the cathode ray tube grid to ensure that the forward moving trace is seen on the screen.
c. a positive gate pulse, via a cathode-follower available at socket "+GATE".

The Miller run-up circuit, driven by the sweep-gating multivibrator, delivers a linear positive-going time-base voltage waveform;

a. to the horizontal amplifier to provide spot deflection
b. via a cathode-follower to socket "TIME-BASE" for external use.
c. via the "SWEEP-LENGTH" control and hold-off circuit back to the sweep-gating multivibrator input to reset the time-base circuit.

The sweep-length control determines the moment of the retrace of the time-base voltage.
The hold-off circuit slows down the fall of the waveform from the "SWEEP-LENGTH" control in order to allow time:

a. for the time-base generator output voltage to fall entirely to its quiescent value corresponding to a spot position on the left-hand side of the screen.
b. for any transients in the system caused by the fast retrace to die away before the next trigger signal can actuate the sweep-gating multivibrator (S.G. M.V.).

The stability circuit permits the setting of the DC-potential at the input of the S.G.M.V. so that stable triggering can be effected. If the "STAB." control is at "REPET" then the DC-potential is so that the time-base runs freely. A "PRESET" position for the stability setting is also provided.
When the mode selection switch SK1 is at "AUT." the stability-control is not effective and the DC-potential at the S.G.M.V. input is such that the time-base is free running when no trigger signal is present. If a trigger signal arrives the auto-stability circuit supplies a DC-voltage which brings the time-base circuit into the normal triggered mode of operation.

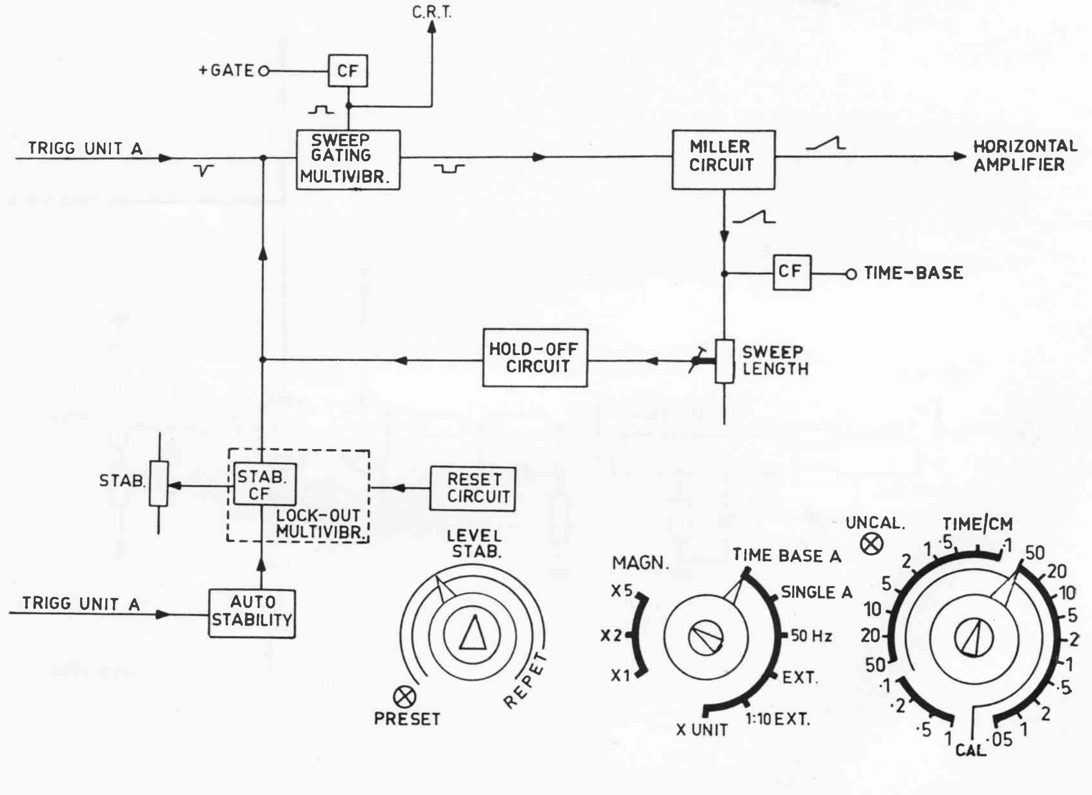


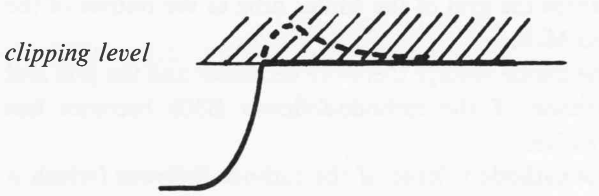
Fig. 31. Block-diagram of time-base A

The lock-out multivibrator provides the stability circuit with single sweep facilities:

a. in the "free running" mode; after a sweep of the time-base, the "RESET" button must be depressed in order to initiate the next sweep.
b. in the "triggered" mode, the "RESET" button must be depressed and then the sweep occurs upon the arrival of a trigger pulse at the S.G.M.V.

3. Sweep-gating multivibrator (Fig. 32)

The circuit consists of a bi-stable multivibrator B501 – B503 (Schmitt-trigger) with a cathode-follower B502′ interposed between these two valves.
The quiescent condition (valve B501 conducting and B503 cut-off) is known as the first stable state.
When a negative trigger pulse arrives at the grid of B501 from trigger unit A (via pulse-transformer T401) the Schmitt-trigger circuit is driven in its second stable state: B501 is cut-off, B503 is conducting.
The voltage rise at the anode of B501 is "speeded-up" by the shunt-peaking circuit L601 – R503, which results in some overshoot.



The overshoot is "clipped" by diode GR506 so that a clean fast-rising pulse appears at the anode of B501. Cathode-follower B502′ is interposed to improve the switching-time.
The positive-going pulse is fed from the cathode of cathode-follower B502′ via switch SK7 and cathode-follower B502″ to the Wehnelt-cylinder for the un-blanking pulse (Fig. 33) and to the "GATE" output socket via cathode follower B508′. The "GATE" and unblanking pulse lasts as long as a time-base sweep.

4. Miller run-up circuit (Fig. 34)

In the quiescent condition both diodes B504 are conducting. The current flowing from the 150 Volts negative supply through R_L and the upper diode is low and this diode clamps the grid of B506 at about —2 Volts with respect to earth. More current flows through the lower diode so that the cathode of B507 is at about —3 Volts with respect to earth. Thus the voltage across the timing capacitor C_L is only about 1 Volt.
The neon tube B514 provides a DC-coupling between the Miller-anode B506 and cathode-follower B507. C517 acts as a by-pass capacitor across the neon tube; resistor R532 prevents the neon tube circuit from oscillating. C516 improves the development of the run-up wave-form at faster sweep-speeds. The cathode-follower B507 provides a low impedance to speed-up the recovery time.

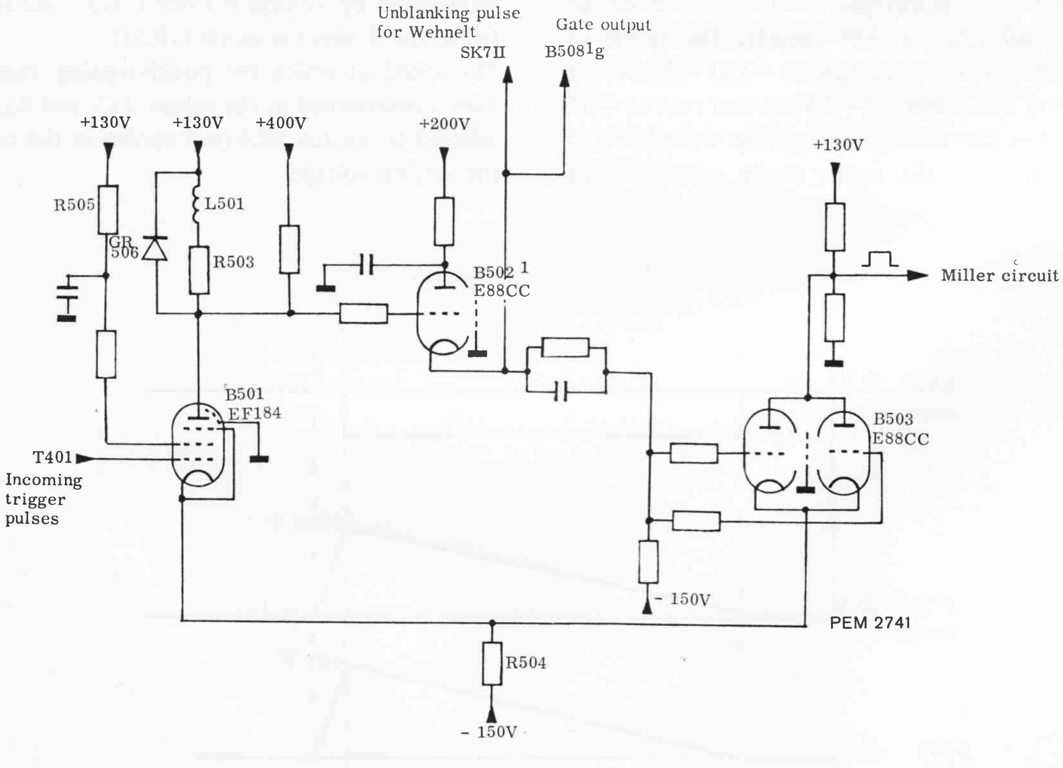


Fig. 32. Sweep-gating multivibrator

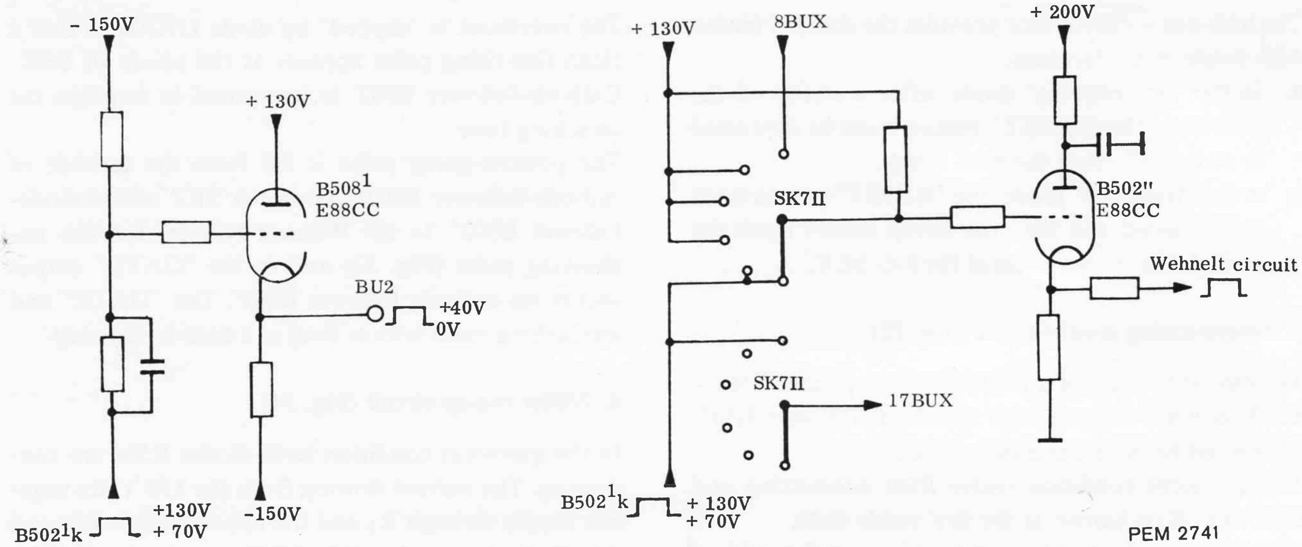


Fig. 33. Gate output and unblanking circuit

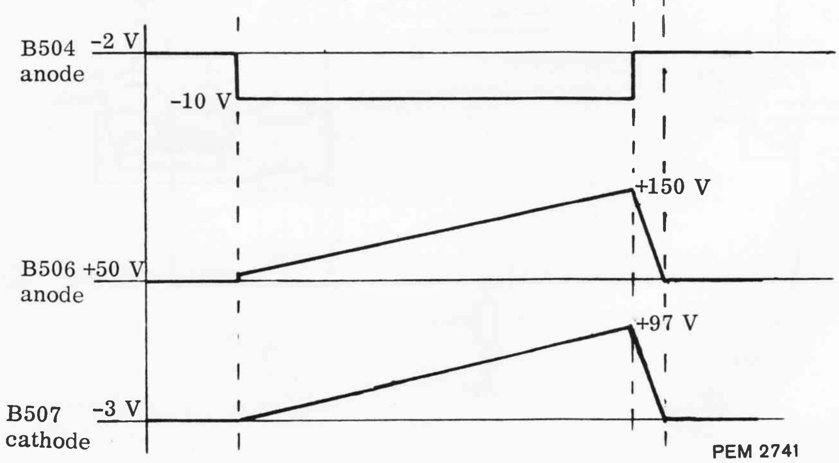
When the sweep-gating multivibrator is switched to its second stable state the incoming negative step cuts off both diodes. Consequently the grid of B506 tries to go negative but is prevented from doing so by the negative feedback.

The gain of B506 is about 100 so that any feed-back variation through the timing capacitor keeps the grid-voltage virtually constant thus the current through R_L is constant and C_L is charged linearly. Therefore the voltage at B507 cathode rises linearly. The anode of B506 starts at +50 Volts and runs to +150 Volts, whilst the cathode of B507 starts at —3 Volts and runs to +97 Volts. To stop the run-up, the gating wave-form is made positive, thus the upper diode conducts and clamps the grid of the Miller tube to the output of the S.G.M.V.

The anode voltage therefore decreases and the grid and cathode of the cathode-follower B506 becomes less positive.

The cathode voltage of the cathode-follower (which is the output of the time-base generator) falls to a fixed level and is then "clamped" to that level as the lower diode begins to conduct at —3 Volts. This voltage is established by voltage divider R523 - R524 and it is fed to the diodes via diode GR501.

The speed at which the positive-going ramp voltage rises is determined by the values of C_L and R_L, which are selected by switch SK4 (not shown in the circuit) and the aiming voltage.



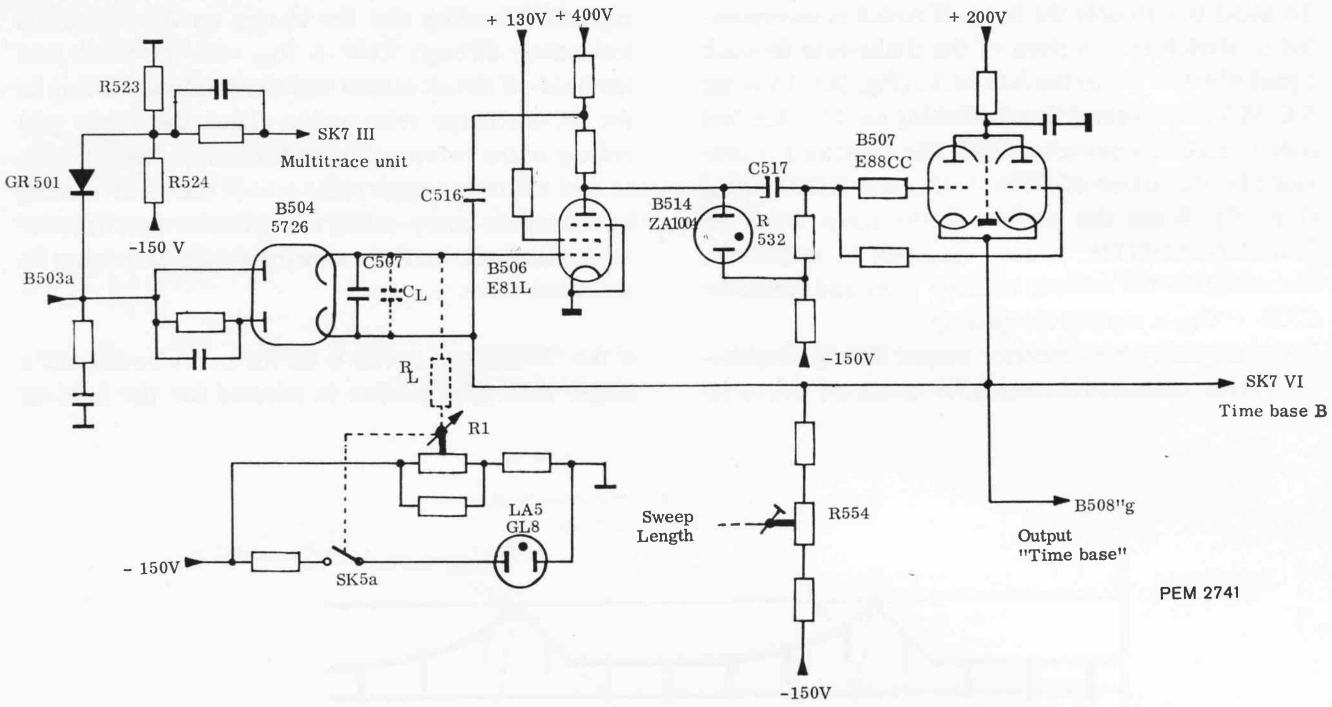


Fig. 34. Miller-circuit

Intermediate (uncalibrated) sweep speeds, slower than the calibrated ones, can be selected by control R1. This is done by connecting the timing resistor to other voltages than —150 Volts so that the charging current in the capacitor can be continuously varied. Immediately R1 is rotated anti-clockwise, SK5a closes and the lamp ″UNCAL″ lights. An external sawtooth output is available at socket BU3 ″TIME-BASE″ via cathode-follower B508″. To control a multi-trace plug-in unit when operated in the ″alternate″ mode a part of the S.G.M.V. output is routed to this unit via SK7.

5. Hold-off circuit

Potentiometer R554 ″SWEEP LENGTH″ (preset adjustment) provides an adjustable portion of the time-base generator output to the hold-off circuit.

This tension is ultimately fed back to the sweep-gating multivibrator grid so that when the sample amplitude exceeds the upper hysteresis limit of the sweep-gating multivibrator the latter returns to its first stable state.

It will be seen (Fig. 35) that the portion of the time-base generator output voltage (V_{tb}), which is fed to the S.G.M.V., is clipped so that only the most positive part is used.

Thus it is possible for the input to the S.G.M.V. to cross the lower threshold value before V_{tb} has reached its quiescent level. When this occurs the fly-back will not be complete for all successive sweeps and it will be impossible to obtain the desired static display.

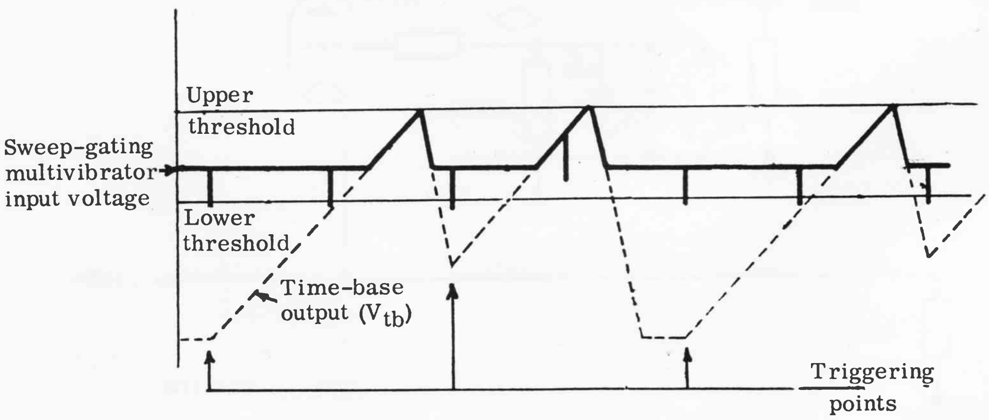


Fig. 35. Triggering of the Miller run-up circuit without Hold-off circuit

To avoid this trouble the hold off circuit is incorporated to stretch that portion of the timbe-base fly-back signal which is fed to the S.G.M.V. (Fig. 36). Thus the S.G.M.V. is prevented from switching until V_{tb} has had time to reach its quiescent level. The stretching is provided by the action of C536 + C_{ho} and R607 + R_{ho} (Fig. 37). When the portion of the ramp from the "SWEEP-LENGTH" control increases in amplitude, the voltage at the cathode of B509′ rises and capacitor C536 + C_{ho} is rapidly charged up.
When the time-base generator output falls to its quiescent value, cathode-follower B509′ is cut off due to its capacitive loading and the charge on the capacitors leaks away through R607 + R_{ho} with the result that the hold-off circuit output waveform falls according to the RC-discharge relationship. Thus the input grid voltage of the sweep-gating multivibrator drops slowly, so that a further trigger pulse cannot start a new sweep by driving the sweep-gating multivibrator past its lower hysteresis limit, until the time-base voltage reaches its quiescent value.

If the "TIME/cm" switch is set for a slow sweep rate a larger R.C. combination is selected for the hold-off

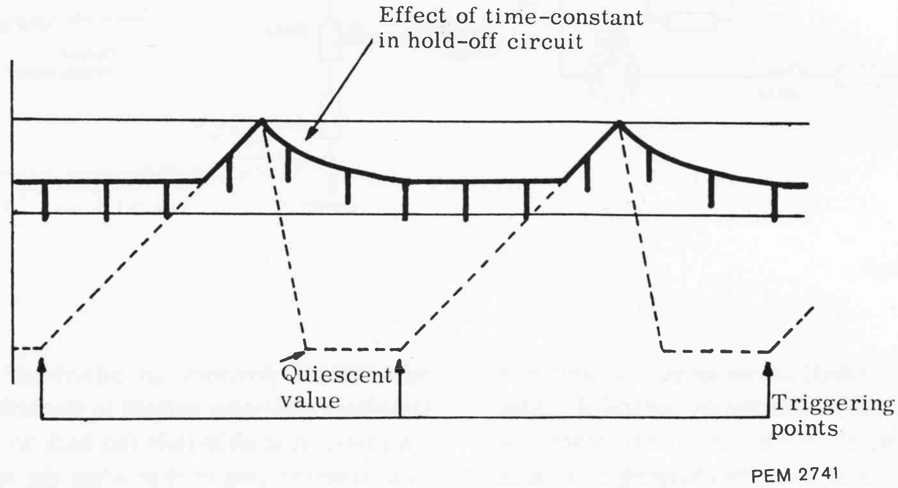


Fig. 36. Effect of Hold-off circuit

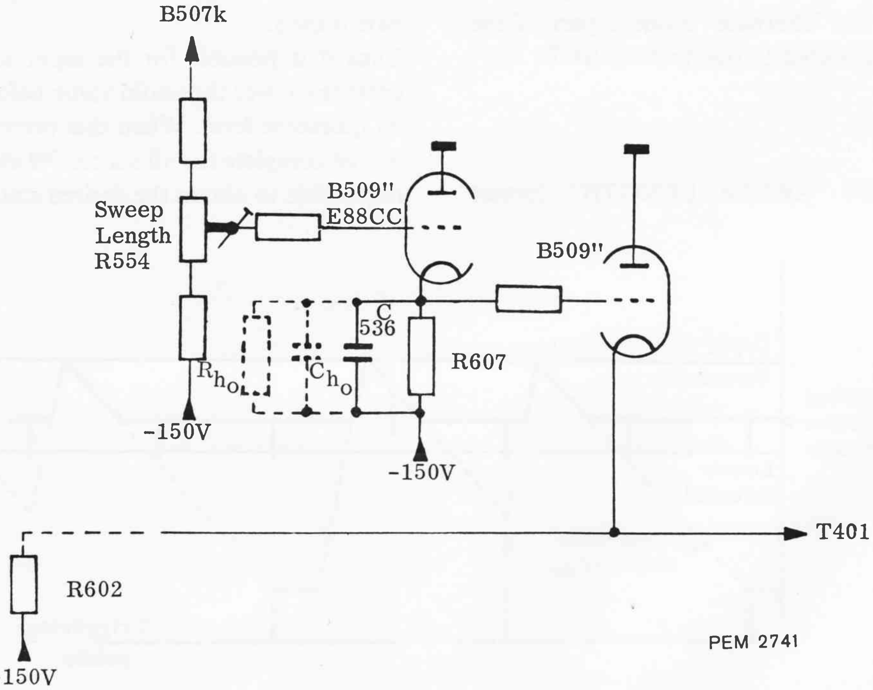


Fig. 37. Hold-off circuit

circuit in order to increase the hold-off intervals which must overlap the fly-back intervals.
Coupling of the hold-off circuit to the sweep-gating multivibrator is effected via cathode-follower B509″ and the secondary winding of T401 directly to B501 control grid.

6. Stability circuit

The stability control circuit (Fig. 38) comprising cathode-follower B511p and associated switches, permits the setting of the DC-level at the sweep-gating multivibrator (S.G.M.V.) input grid so that incoming negative trigger pulses can drive the S.G.M.V. into its second stable state thus starting the sweep (triggered mode). A ″PRESET″ position for the triggered mode is also provided (fully anti-clockwise setting of R3 ″STAB.″ operates switch SK6). The ″PRESET″ potentiometer (R577) is preadjusted for stable triggering.

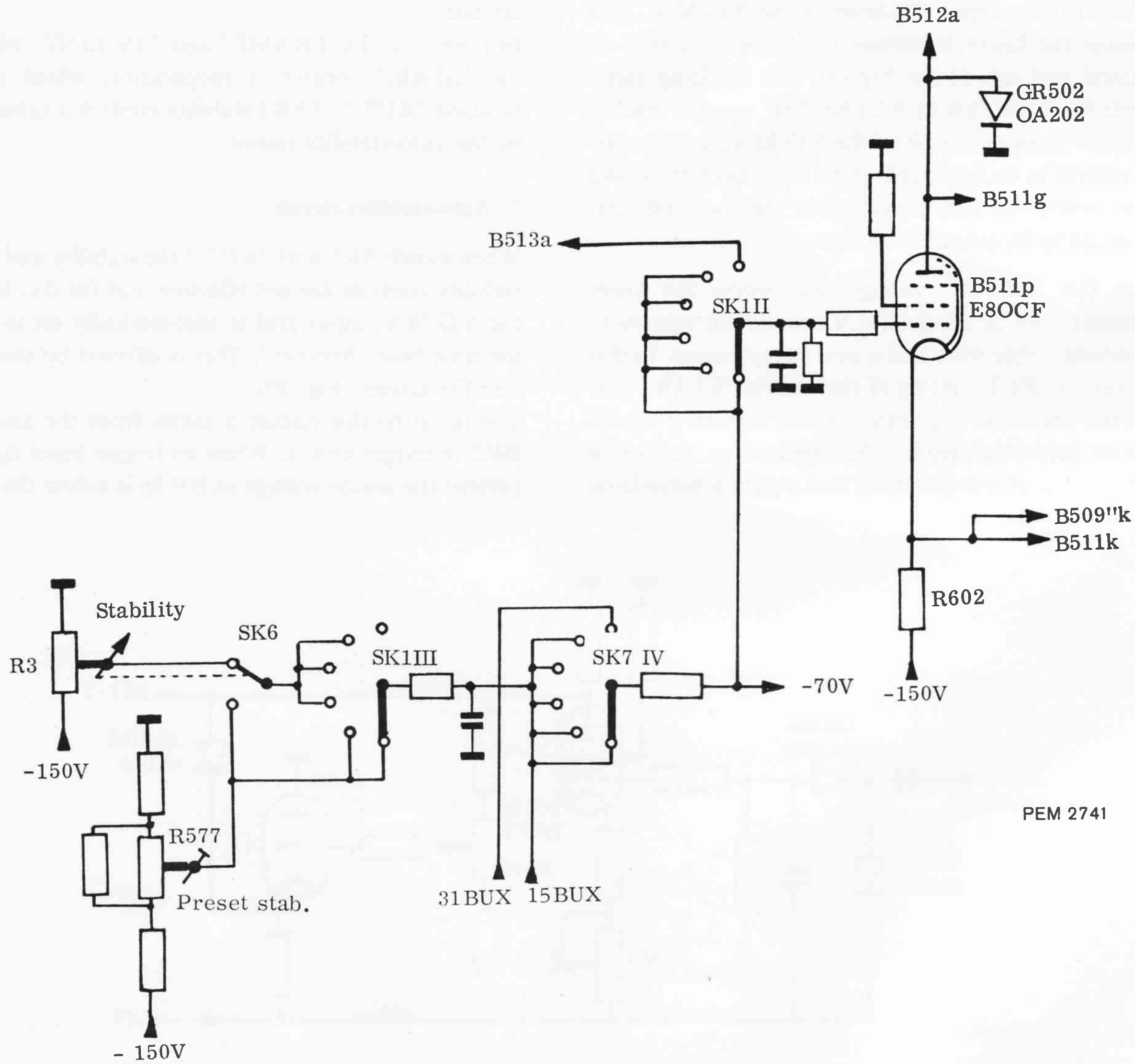
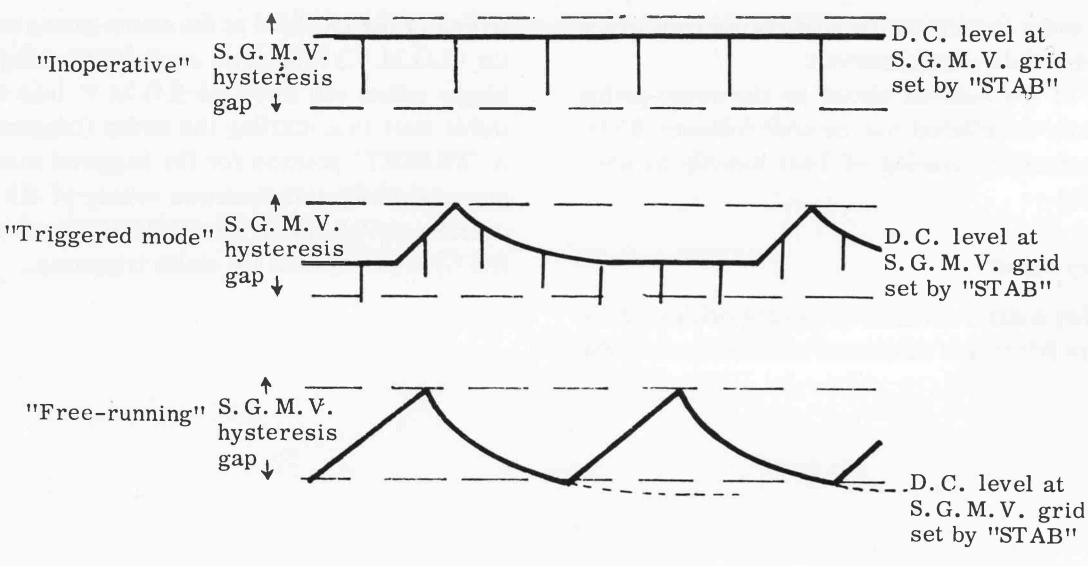


Fig. 38. Stability control circuit



When the stability ("STAB.") control is set clockwise ("REPET") the input DC-level at the S.G.M.V. grid is below the lower hysteresis limit, the S.G.M.V. is actuated and the sweep begins. The resulting ramp sample from the "SWEEP-LENGTH" control reaches the upper hysteresis limit of the S.G.M.V. and the circuit returns to its first stable state. The sweep stops and consequently the output voltage of the "hold-off" circuit drops to its quiescent voltage.

When the "hold-off" voltage falls below the lower hysteresis limit of the S.G.M.V. the circuit returns to the second stable state and a new sweep begins. In this way the "REPET" setting of the control "STAB." permits the circuit to "free-run" so that a trace is shown without incoming signal. The oscilloscope delivers a sawtooth waveform (at BU3) and a gating wave-from (at BU2) which can be used for driving external circuits.

In positions "TV FRAME" and "TV LINE" of SK1, the "STAB." control is inoperative, whilst in the position "AUT." of SK1 stability control is taken over by the auto-stability circuit.

7. Auto-stability circuit

When switch SK1 is at "AUT." the stability and preset stability controls are not effective, but the d.c. level at the S.G.M.V. input grid is automatically set to make the time base "free-run". This is effected by the auto-stability circuit (Fig. 39).

The input to this circuit is taken from the anode of B402 in trigger unit A. When no trigger input signal is present the anode voltage at B513p is below the lower

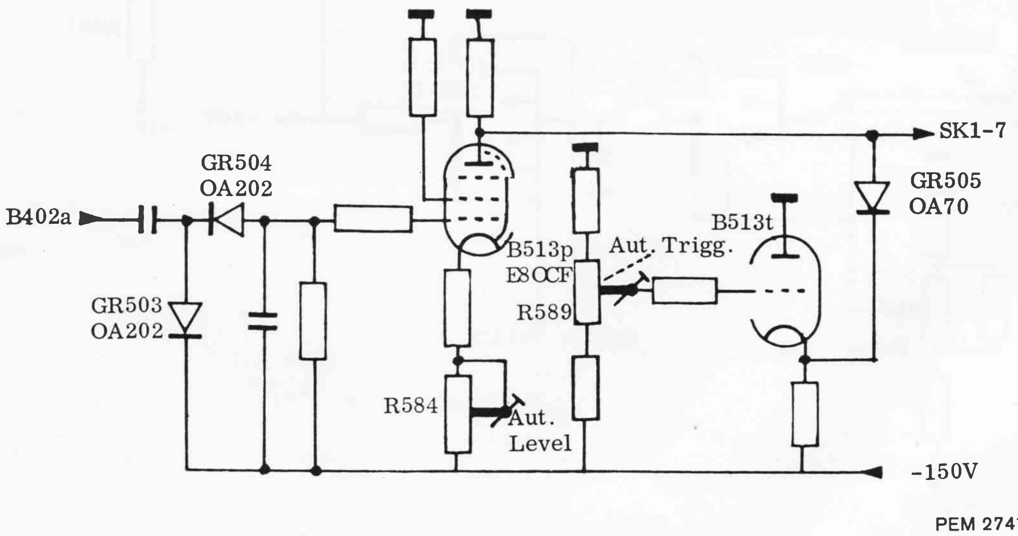


Fig. 39. Auto-stability circuit

hysteresis level of the S.G.M.V. (thus the time-base free-runs).
This voltage level is set by means of preset potentiometer R584 "AUT. LEVEL".

Incoming trigger signals are rectified by GR503 and GR504, smoothed and applied to the grid of B513p, thus causing the anode voltage to rise. The S.G.M.V. input (coupled to B531p in the auto-stability position) will also rise so that the time-base will no longer free-run but will respond to trigger pulses. However, as the trigger signal can vary over a wide range of amplitude while the trigger pulses to the S.G.M.V. are of fixed amplitude, GR505 is used as a catch diode to prevent the anode of B513p going so positive that the time-base can no longer trigger. The bias-voltage for GR505 is adjusted by R589 "AUT. TRIGG".

8. Lock-out multivibrator circuit

Normally valve B511t is inoperative and cathode-follower B511p functions as a part of the stability control circuit (Fig. 38). However, when switch SK7 is set to "SINGLE" or "X-UNIT", tube B511t receives an anode-supply and thus the circuit is modified so that B511p and B511t together form a bi-stable circuit known as the lock-out multivibrator (Fig. 40)
On pressing the reset-button, or when a pulse from the X-unit arrives, B511t is cut off whilst B511p functions as a simple cathode-follower; lamp LA7 glows (not applicable when the position "X-UNIT" is used). This we will call stable state A of the lock-out multivibrator.
When the "STAB" control is set to "REPET." the input grid voltage of the S.G.M.V. is set below its lower hysteresis limit and a sweep commences.

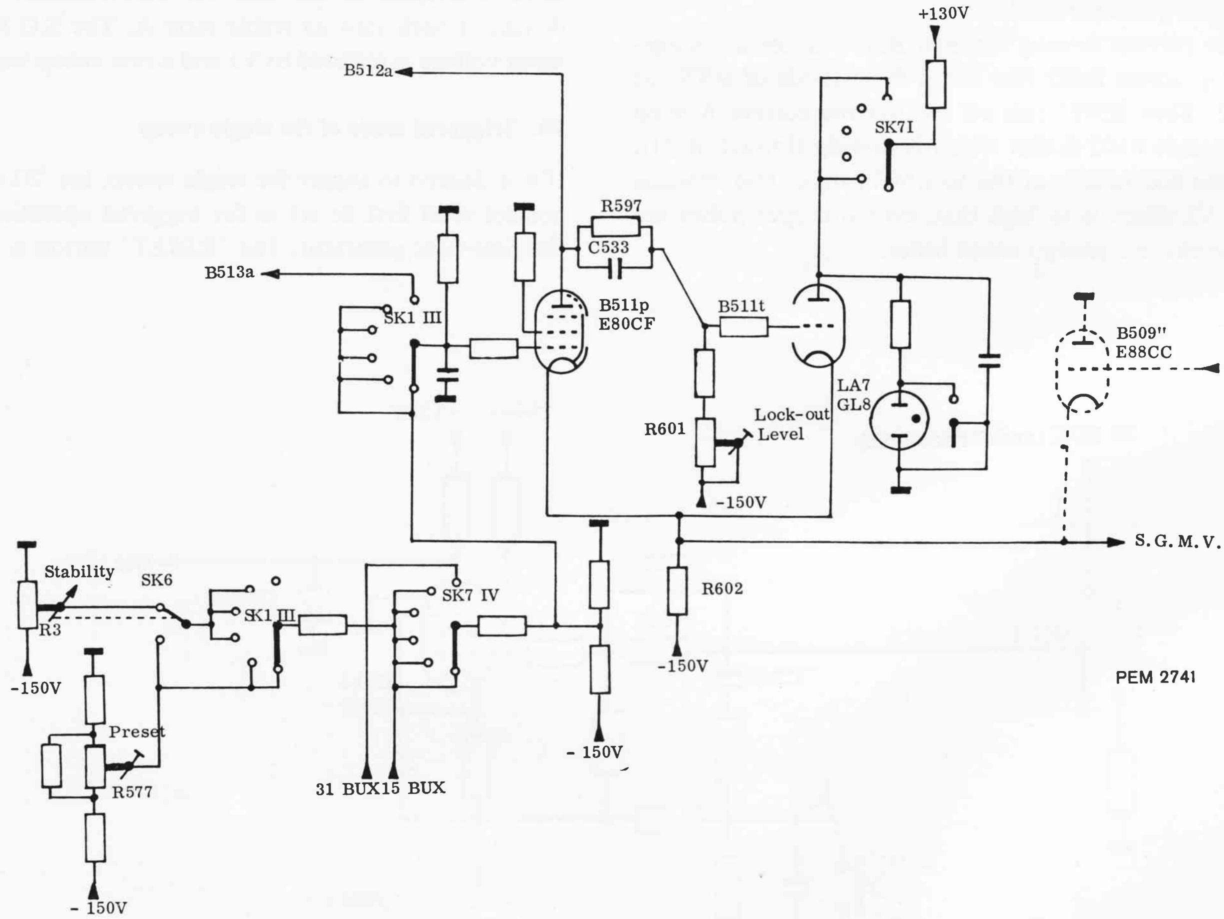
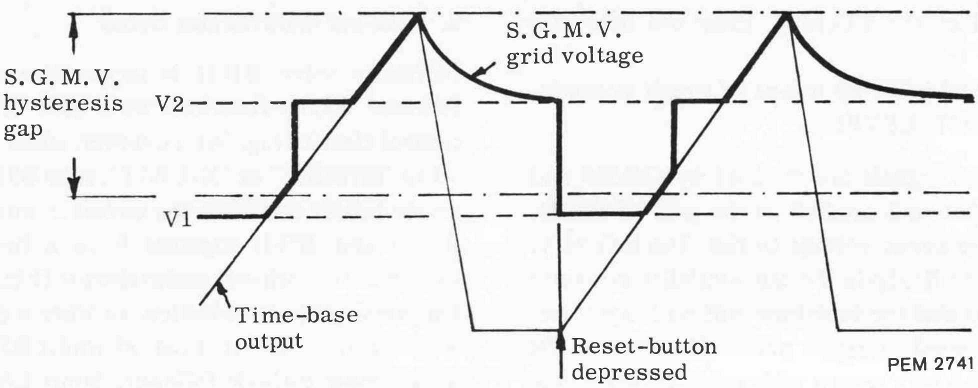


Fig. 40. Lock-out multivibrator



When the ramp-sample at the hold-off cathode-follower grid (B509″) rises above V1 the cathodes of B509″ and B511p also rise and tube B511t is cut-off. The lock-out multivibrator switches into its second stable state, state B (V2) i.e. B511t conducts and B511p is cut off (lamp LA7 is extinguished).

The ramp voltage continues to rise and when the output voltage of the hold-off circuit rises to the S.G.M.V. upper hysteresis limit, the latter reverts to its first stable state.

Consequently the time-base generator waveform returns to the quiescent level.

The current flowing through B511t causes a voltage-drop across R602 that keeps the cathode of B509″ at V2. Thus B509″ cuts off so that the current flowing through R602 is that which is flowing through B511t. Thus the voltage at the S.G.M.V. input grid remains at V2 which is so high that, even if trigger pulses are present, the sweep cannot occur.

This situation can be maintained indefinitely until cancelled by operation of the ″RESET″ button in the reset circuit.

9. Reset circuit (Fig. 41)

When the push-button ″RESET″ is depressed or a pulse arrives from a plug-in unit e.g. PM 3347, capacitor C527 couples the resulting positive voltage step to the grid of tube B512.

The resulting negative voltage step at the anode of B512 is coupled to the lock-out multivibrator, thus driving it back into its stable state A. The S.G.M.V. input voltage is restored to V1 and a new sweep begins.

10. Triggered mode of the single sweep

If it is desired to trigger the single sweep, the ″STAB.″ control must first be set as for triggered operation of the time-base generator. The ″RESET″ button is then

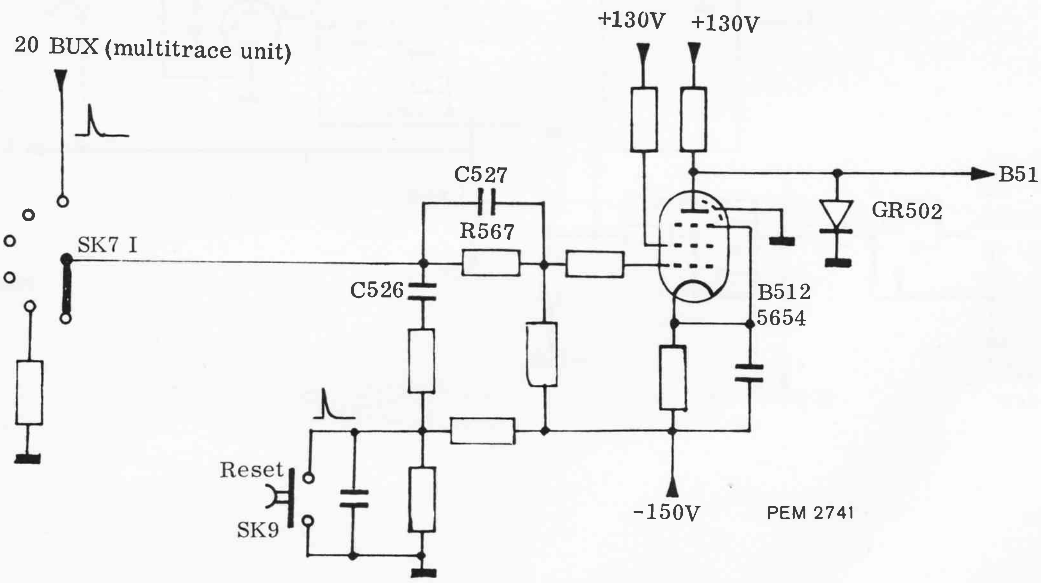


Fig. 41. Reset circuit

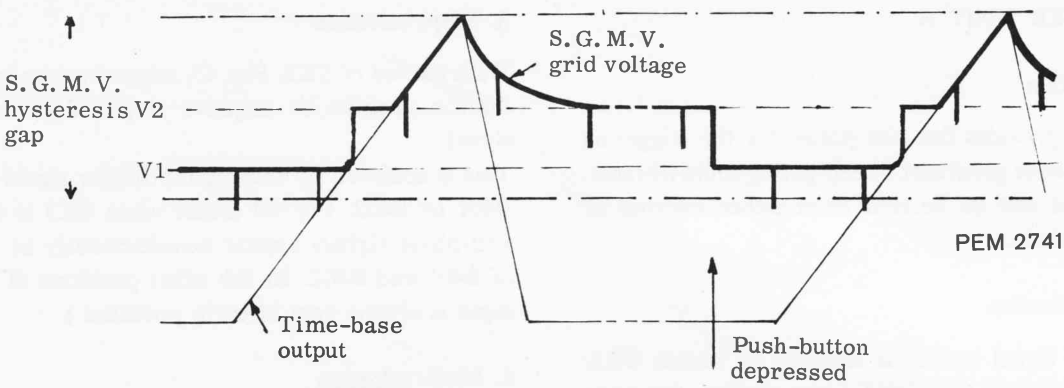


Fig. 42. Reset circuit operating in a "triggered" mode

operated and the next trigger pulse starts the sweep. The operation of the circuit is virtually the same as for that described above, with the exception that, after the depression of the "RESET" button, the S.G.M.V. input falls to the DC-level selected for triggered operation (Fig. 42). When the trigger pulse appears the sweep commences and the lamp is extinguished after the lock-out multivibrator has gained stable state B. The level of V2 can be adjusted with potentiometer R601 "LOCK-OUT LEVEL".

G. TRIGGER UNIT A

1. Introduction

The circuit provides fast-rise pulses for the triggering of the time-base generator sweep-gating multivibrator. These pulses can be derived from either internal or external sources.

2. Source selection

The trigger signal source is selected by switch SK3, Fig. 43. In the position "INT." two similar, but anti-phase, signals are "picked-off" from the trigger amplifier.

In the position "EXT." the trigger signal is derived from a signal connected to socket BU1 "TRIGG." and in position "50 Hz" from a mains frequency signal derived from a winding of the mains transformer.

3. Slope selection

With the aid of SK2, Fig. 43, triggering can be effected on the positive or negative slope of the displayed signal.
This is achieved by routing the trigger signal to either B401 or B402, Fig. 49 (note: when SK3 is at "INT" anti-phase signals appear simultaneously at the grids of B401 and B402. In the other positions of SK3 one input is always kept at earth potential.)

4. Mode selection

Mode selection is effected by switch SK1, Fig. 43.
This permits the time-base to trigger on the frame or line pulses of a television video signal, on low or high frequency signals; while in the position "AUT" the time-base will "free-run" in the absence of a signal (horizontal line on the CRT) and triggers as soon as there is a signal.

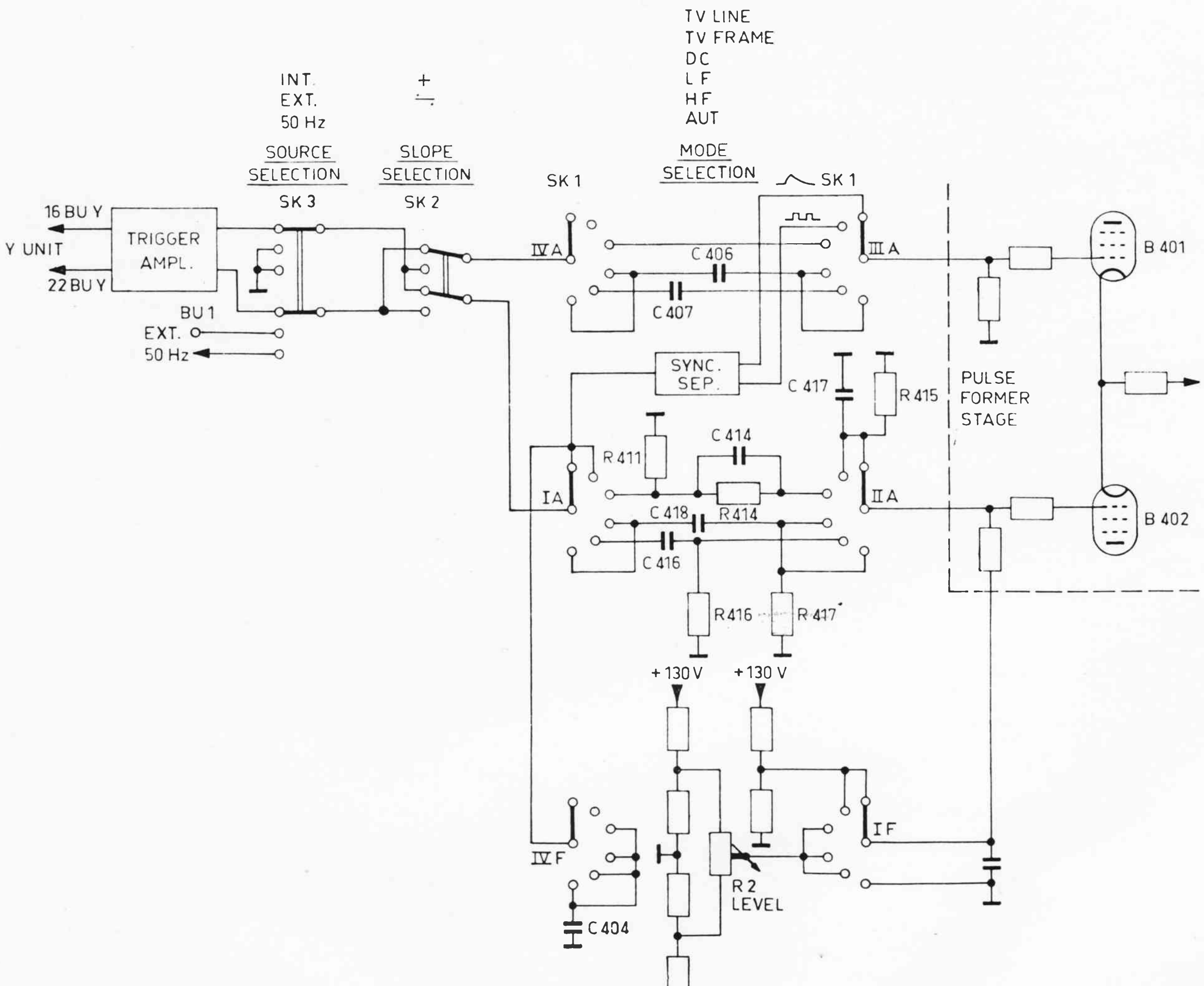


Fig. 43. Trigger unit A

a. TV Line and TV Frame

When a TV video signal is fed to the input terminal of the Y-amplifier two anti-phase signals are "picked-off" via switch SK3 (at position "INT.") and fed via switch SK2 "±" to the Synchronisation Separator see Fig. 44. The latter works only for negative synchronisation pulses (positive video signal) and the connections are so arranged that if a positive video signal is present at the Y-amplifier input, then SK2 must be set to "—" in order to select the appropriate signal.
The Synchronisation separator also works for an external signal (i.e. SK3 at "EXT.") provided that it is a positive video signal.
Diode GR401 fixes the base of the synchronisation pulse at earth potential and diode GR404 clips all signal pulse above 2 V. Signals with an amplitude of less than 2 V. pass through undisturbed but are later clipped.
The signal passes to the emitter-follower stage (TS401) and then to the clipping stage TS402. The resulting pulse is fed to emitter-follower TS403, which provides a low impedance output to the following stage.

The resulting positive-going line pulse is fed by C413 to the pulse former stage when SK1 is at "TV-LINE".
In the position "TV-FRAME" of SK1 the synchronisation pulses are integrated and clipped. This removes the line-pulses leaving the frame-pulses which are fed to the pulse former stage (see Fig. 49).
When the TV positions are not selected the input of the synchronisation separator is earthed to prevent crosstalk.
When SK1 is at the TV positions the "LEVEL" control is switched-out and the level is determined by a voltage divider at the grid of B402, in order to obtain stable triggering under these conditions.
The stability control in the time-base A circuit is at the "PRESET" position (the continuous control is not effective).

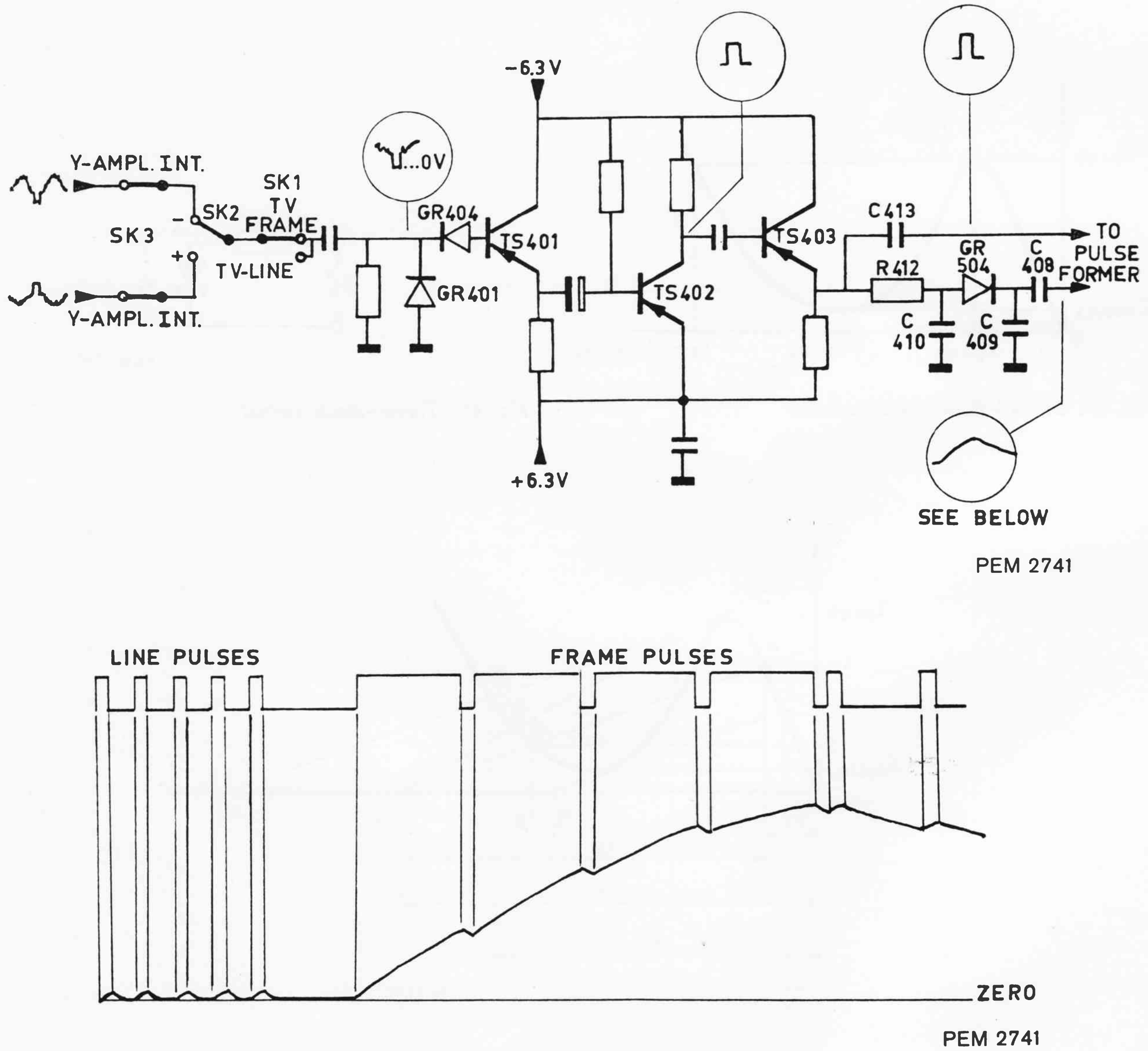


Fig. 44. Synchronisation separator

b. DC

In position "DC" of SK1 the signal "picked-off" from the Y amplifier or external trigger signal is DC-coupled through the unit to the pulse former-stage.

When SK3 is at "INT." the two outputs from the Y-amplifier are fed to the balanced amplifier and assist in keeping hum and drift to a minimum.

In this mode the control "LEVEL" is effective in changing the DC-level at B402 grid and hence the anode level at B401 (see Fig. 43).

Resistors R414 – R417 – R416 ensure that the impedance, against which the level control voltage has to work, is the same for both AC and DC-coupling of the trigger. Thus the level range in all positions of SK1 will remain the same.

c. LF

Coupling from the trigger source is via C418 and C406, with a time constant of 56 milli-seconds.

d. HF

As for low frequencies but with coupling via C416 and C407 and therefore rejects the lower frequencies. The time constant is 80 micro-seconds.

e. AUT

In this position of SK1 both valve grids are at earth potential. The auto-stability detector in the time-base A circuit is coupled-in by SK1 to ensure that the time-base free-runs when no input is present at the trigger unit thus giving rise to a line on the CRT.

With an input to the trigger unit (resulting in a trigger signal) the auto-stability circuit responds to the signal at the anode of B402 and sets the S.G.M.V. for triggered operation.

Controls "STAB" and "LEVEL" are not effective.

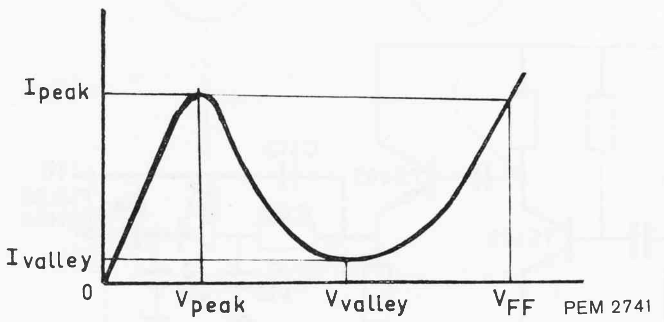


Fig. 45. Tunnel-diode characteristics

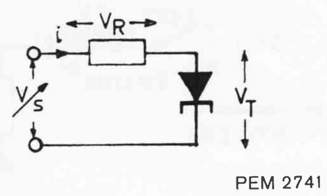


Fig. 46. Tunnel-diode circuit

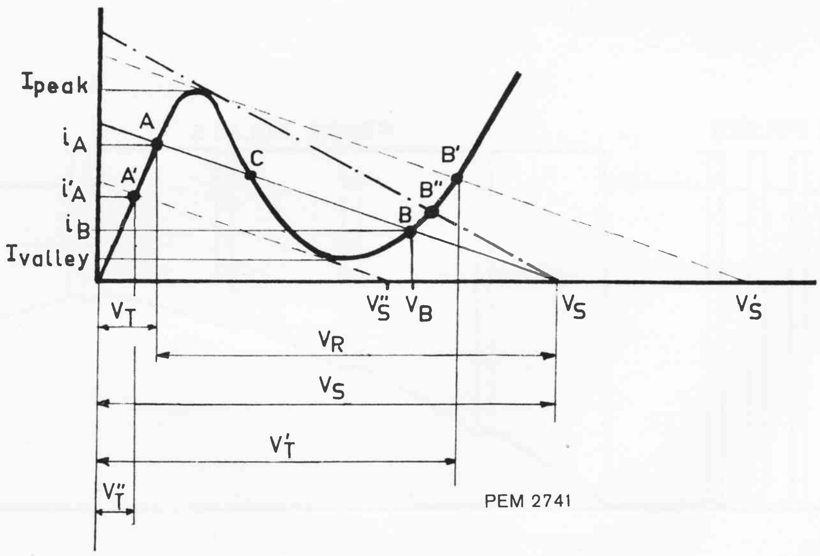


Fig. 47. Load-lines

5. Pulse former circuit and tunnel diode

The anode circuit of B401 comprises a tunnel diode to deliver fast-switching pulses for the triggering of the time-base generator. The characteristic of the tunnel diode is shown at Fig. 45. Typical values for V_{peak} and V_{valley} resp. are 60 mV and 350 mV at I_{peak} = 10 mA and I_{valley} = 1,3 mA. An other important point is V_{ff} (500 mV), at which the current is again I_{peak}.
Consider a voltage-source V_s connected to the tunnel diode via resistor R, Fig. 46. V_s and R can be selected so that the load-line crosses the characteristic at 3 points viz. A, B, C, Fig. 47. A and B are stable points of adjustment, C is not stable. If the voltage increases to V_s, the load-line will shift parallel to itself until it cuts the characteristic only at one point, B′. A decrease of V_s gives V_s'' and A′. A single point of intersection can also be obtained by decreasing R, so that B″ is gained.
Suppose the voltage-source and series-resistor to be adjusted so that point A of the load-line ABC is obtained. The current ″i″ through the circuit equals ″i_A″, the voltage-drop over the tunnel diode amounts to V_T and the voltage-drop over the resistor to V_R.
If V_s increases to V_s' point A will follow the diode characteristic until ″i″ just surpasses I_{peak}. Than the voltage-drop over the tunnel diode will suddenly increase from V_{peak} to V_T' due to the characteristics of the diode.
The transition from V_T to V_T' happens very fast, about 1 nano-second, and is a property of the tunnel-diode itself.
If V_s decreases again, point B′ will follow the diode characteristic until ″i″ equals I_{valley}. Then the diode switches from V_{valley} to V_T''.
When an alternating voltage is superimposed on the DC-bias V_s, the voltage over the tunnel-diode will be an alternating voltage with very steep sides. This effect can be extended by providing an AC-impedance formed by an inductance (see Fig. 48). The L/R time-constant must be high compared with the speed of transition but low compared with the applied AC. Then the diode switches from V_{peak} to V_{ff}.

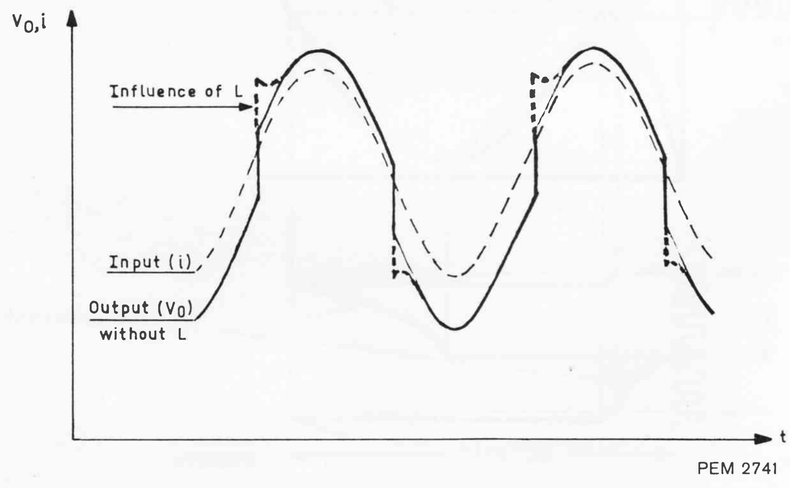


Fig. 48. Transient peaking

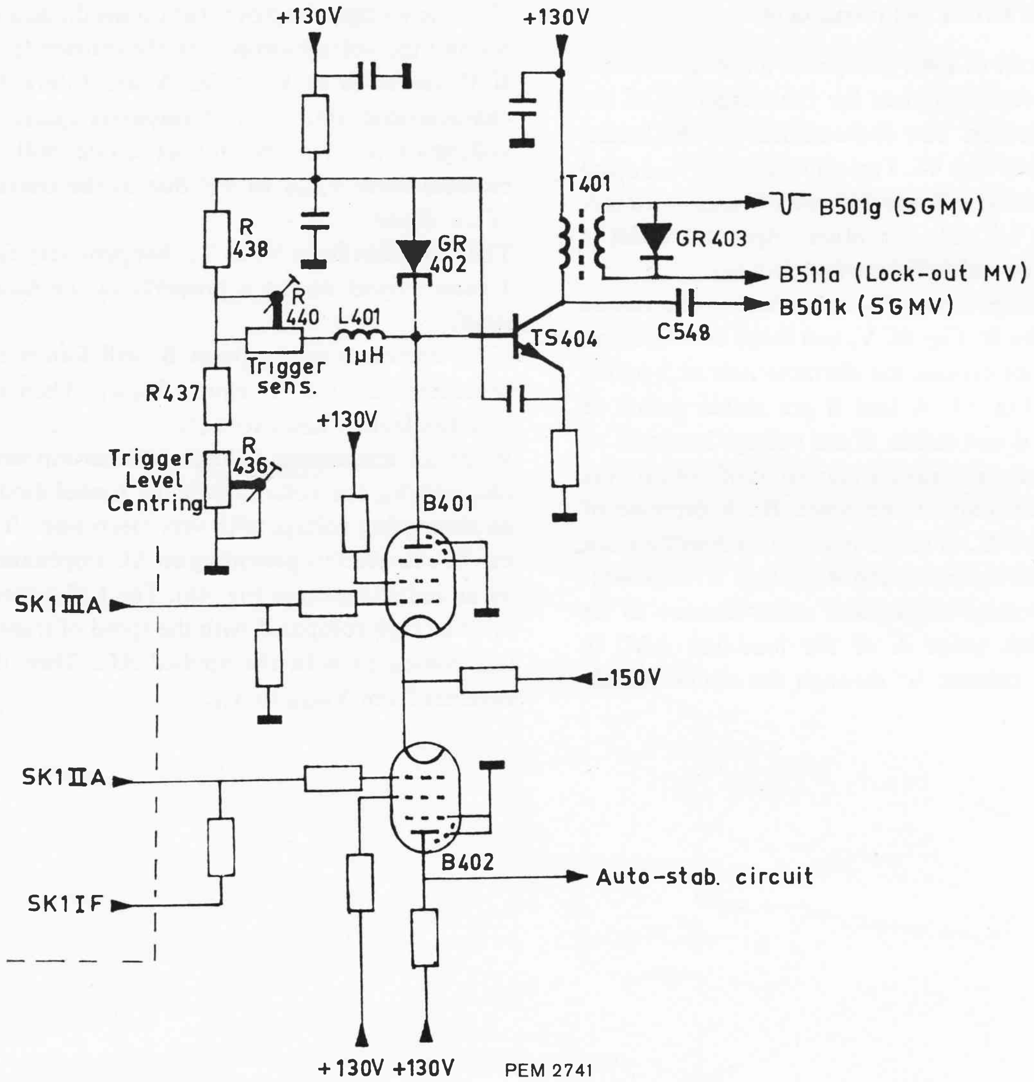


Fig. 49. Pulse former stage

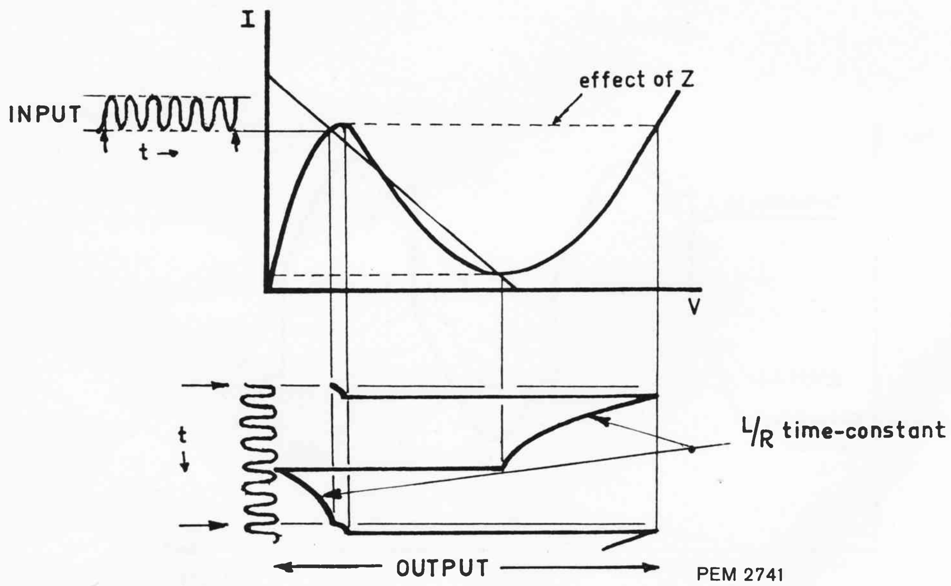


Fig. 50. Frequency dividing

In the actual circuit, Fig. 49, V_s is formed by the voltage drop over R438, the load resistance R is represented by R440 ″TRIGGER SENS″.
The voltage drop over R438 is adjustable by R436 ″TRIGGER LEVEL CENTRING″ (Fig. 49) and indirectly via tube B402 grid adjustment R2 ″LEVEL″ (Fig. 43). Together with R440 (Fig. 49) it is possible to adjust the load-line so that it intersects the diode characteristic close to V_{peak} and V_{valley} which results in a very sensitive triggering.
The circuit also acts as a frequency divider for very high repetition rate trigger inputs as the diode has a maximum switching rate due to its L/R time-constant. See also Fig. 50.

As the voltage drop over the tunnel-diode amounts to about 0.5 Volts and the S.G.M.V. needs about 2 Volts an NPN transistor TS404 is inserted for amplification. At the collector side a 1 : 1 transformer T401 transfers the signal to S.G.M.V. input circuit.

The transformer also differentiates the signal, but the positive going spikes are short-circuited by diode GR403 (see Fig. 51).
The negative going spikes are used to trigger the S.G.M.V.
These spikes occur during the V_{peak}-to-V_{ff} transitions.

6. Trigger level selection

After a preliminary adjustment with controls ″TRIGG SENS″ and ″TRIGG LEVEL CENTRING″ the position of the DC-load line can be shifted by means of the ″LEVEL″ potentiometer. This causes the potential at B402 grid to vary, thus altering the current through valve B401 and the tunnel diode. Thus it is possible to start the sweep at any desired point of the displayed waveform.
Throwing switch SK2 (+/—) routes a counterphase signal to the grid of B401 so the starting point can be shifted over approximately 180°.

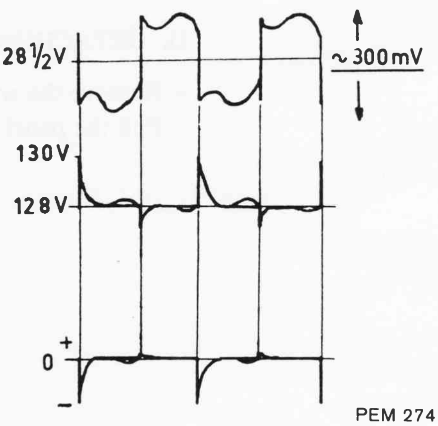


Fig. 51. Output of pulse former stage

H. TRIGGER AMPLIFIER (Fig. 85)

The trigger amplifier is fitted to provide the trigger unit A with signals having an adequate amplitude to control it. As the control-signals are in counterphase with each other the trigger amplifier is carried out entirely in push-pull.

The first stage consists of the cathode-followers B451′ and B451″. They feed directly into the grids of B452′ and B452″ which are connected as an ordinary amplifying stage. The inductors L451 and L452 improve the high-frequency response of this stage.
The output of the second stage is DC-coupled to the input of the third stage, which consists of the cross-coupled cathode-followers B454′ and B454″. The DC-coupling is carried out by the voltage-divider R464 and the combination of R466-B453″-R468 (respectively R458 and the combination R474-B453′-R469). The tubes B453′ and B453″ are a high-mu double triode which provide a high dynamic impedance Z in combination with their cathode-resistor Rk ($Z \approx \mu$ Rk). In this way the reduction in amplitude of the control signals is made comparatively low.
On the other hand it is possible to vary the potential of the interconnection R464-R466 (resp. R458-R474) without disturbing the ratio of the voltage divider by varying the anode current of the tubes. This is done by adjusting the grid potentials at potentiometers R484 and R485. Thus the output of the third stage can be adjusted so that its quiescent level is at earth potential.

Gaining access to the parts VI

A. DETACHING THE SIDE PANELS

Caution!

Very high voltages are generated in this instrument, so that, when effecting repairs to the inside of the instrument, great care should be taken.
The instrument has one plate on each side, each fixed with two fasteners A Fig. 2.
Loosen the fasteners and pull the panels away from the frame.

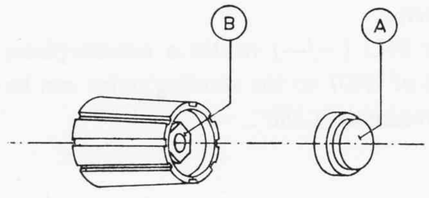


Fig. 52. Removing the knobs

B. REMOVING THE KNOBS (see Fig. 52)

1. Single knobs

- Remove cap A
- Loosen screw B
- Pull the knob of the spindle

2. Double knobs

- Remove cap A
- Remove screw B
- Remove the inner knob
- Loosen nut C
- Pull the outer knob of the spindle

C. REMOVING THE BEZEL

- Grip the bezel and pull back the lower part
- Remove the bezel

D. DETACHING THE REAR PANEL (see Fig. 2)

- Remove the six fixing screws B
- Pull the panel away from the frame

Maintenance

VII

A. AIR FILTER (see Fig. 70)

In particular when the instrument is used in a dusty environment the filtermats should be replaced or cleaned at regular intervals. Cleaning is done in the easiest way with the aid of a vacuum cleaner. The filter holder can be bent downwards after removing the two fixing screws D. (see Fig. 2)
The filtermat can then be easily replaced.

B. SEGMENT SWITCHES

If, due to soiling, these switches should not function properly any longer, they can be lubricated with switch oil, (code nr.: 971/71).
This oil has cleaning and lubricating properties.
After lubricating, the switch should be set to all positions a few times.

C. CABINET PLATES

If the plastic-covered cabinet plates are dirty, they can be washed with water and soap; if necessary with some abrasive powder.

D. PREVENTIVE INSPECTION

Due to the complicated character of the instrument, it is advised to check its operation at regular intervals e.g. every 500 working hours.

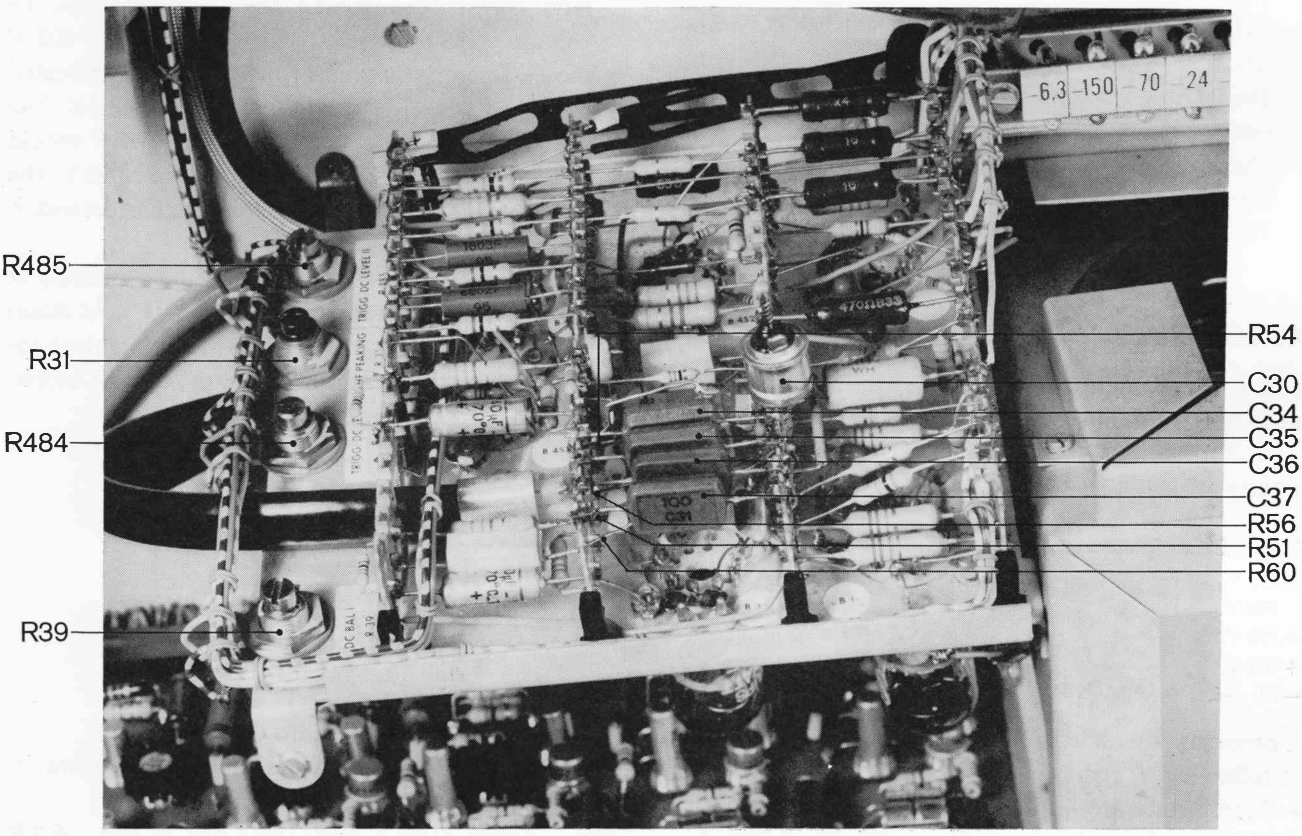


Fig. 53. Close-up of the input stage of the Y-amplifier Unit 13

Checking and adjusting VIII

The tolerances mentioned are factory tolerances; they apply when the apparatus is readjusted completely. They may differ from the data given in chapter I.

A. GENERAL INFORMATION

With the aid of these data, it is possible to carry out all the adjustments of the basic oscilloscope and to check the proper working of the instrument. For checking and adjusting, a test-unit (PM3361) is available.
In this chapter is described how it should be used. Various adjustments are interconnected. If such an adjustment is described prior to this an indication will be given as to which previous adjustment is dependent on that adjustment.
It is then necessary to check that previous adjustment. For a complete adjustment of the instrument the sequence as described in this chapter is to be preferred.

B. SWITCHING-ON

With the mains voltage adapter the instrument should be adjusted to the local mains voltage.

- Plug any Y-plug-in unit into the Y-plug-in compartment.
- Switch on the instrument with the switch ""POWER ON".
  The white pilot lamp LA8 should light up and both fans should rotate.
- Check that after 25... 35 seconds, the supply voltages are switched on by relay RE1002.
  The "READY" lamp should light up.

C. LOW SUPPLY VOLTAGES

If it is necessary to readjust the supply voltages, then the adjustments of the time-coefficients, the calibration voltage and the high supply voltages should be checked again.
The low supply voltages may be checked with test-unit PM3361; the latter should be plugged into the Y-plug-in compartment. By this, the power supplies can be nominally loaded.

- Set switch "X-DEFLECTION" (SK7) to "SINGLE" and "AMPL. CAL" (SK13) to "OFF".
- Set the test-selector of the test-unit to "POWER SUPPLY" and adjust the measuring range to "—150".

R 1098 (Fig. 62)

- By means of the adjusting potentiomcter "—150 V" (R1098) precisely adjust the voltage to the correct value. At the meter of the test-unit this is indicated by the figure 0.
- Check the ripple voltage on the —150 V voltage with an oscilloscope, connected to the terminals "RIPPLE" and "⏚" of the test-unit
  At full load of the power supply (test-selector on the test-unit set to "HIGH LOAD") and at mains voltage fluctuations of + and —10%, the ripple voltage may not exceed 5 mV_{p-p}.
- Furthermore, check all the other supply voltages up to the +400 V voltage.
  After correct adjustment of the —150 V voltage, the voltages +130 V, +200 V, +330 V and +400 V should be correct within a tolerance of 4%, indicated by the figures 4 on the meter of the test-unit. The voltages +70 V, +6.3 V, —6.3 V and —70 V should be correct within 2%, indicated by the figures 2. The voltages +12 V and —12 V should be correct within 6%, indicated by the figures 6.
- Measure the ripple voltage of every power supply at full-load (test-selector to "HIGH LOAD"). At mains voltage fluctuations of + and —10%, the peak-to-peak value of the ripple voltage should not exceed the value indicated in the table below.

R1025 - R1045 - R1059 - R1062 (fig. 78)

Power supply	*Ripple voltage*	*If necessary, adjust with*
+130 V	20 mV_{p-p}	R1062
+200 V	40 mV_{p-p}	R1059
+330 V	75 mV_{p-p}	R1045
+400 V	80 mV_{p-p}	R1025
—70, —6.3, +6.3, +70 V	10 mV_{p-p}	—

If necessary, the short-circuit protection can be checked as follows.

- Short-circuit the +400 V and the —150 V voltage.
- Measure the voltage of the +400 V, +300 V, +200 V, +130 V and —150 V power supplies with respect to earth. These must almost be equal to 0 V.
- Disconnect the short-circuit.
- Measure the +400 V voltage. It should have its normal value again.

The + and —70 V, + and —24 V and + and —6.3 V voltages should also regain their normal values after having been short-circuited to earth.

D. HIGH SUPPLY VOLTAGE

This voltage determines the deflection sensitivity of the CRT.
If the high voltage is readjusted, it is necessary to check the horizontal and vertical sensitivity of the basic oscilloscope.

- Turn "INTENS" (R6) fully anti-clockwise.
- Measure the –1440 V voltage with respect to earth on winding S18 of the mains transformer. If necessary, adjust this voltage with potentiometer "HT ADJ." (R1326).

R 1326 (Fig. 54)

- The voltage on junction R1318-C1313 in the HT-unit should have a value between +8300 and +8900 V with respect to earth, after adjustment of the –1440 V voltage.

E. MAINS CURRENT

At a mains voltage of 200 V, 220 V or 245 V, the current consumption of the basic oscilloscope with Y-plug-in unit should not exceed 2.5 A, and at a mains voltage of 110 V, 125 V or 145 V it should not exceed 5.5 A.

F. CATHODE-RAY TUBE CIRCUIT

1. Level X-Y-plates

- Interconnect the X-deflection plates and the Y-deflection plates.

R 99 (Fig. 55)

- Measure the voltage difference between both pairs of plates. The voltage difference, which is adjustable with variable resistor R99, should not exceed 5 V.

R 320 (Fig. 54)

- The voltage difference between the interconnected Y-deflection plates and point g7 of the CRT (connection point 7 of the tube holder) should be adjusted to 0 V with potentiometer "SHIELD" (R320).
- Remove the interconnections.

2. Beam centring R314 (Fig. 54)

- Set "X-DEFLECTION" (SK7) to "50 Hz".
- With "INTENS" (R6) adjust for a line with low brightness.
- Adjust potentiometer "BEAM CENT." (R314) so that the brightness is uniform across the entire displayed line.

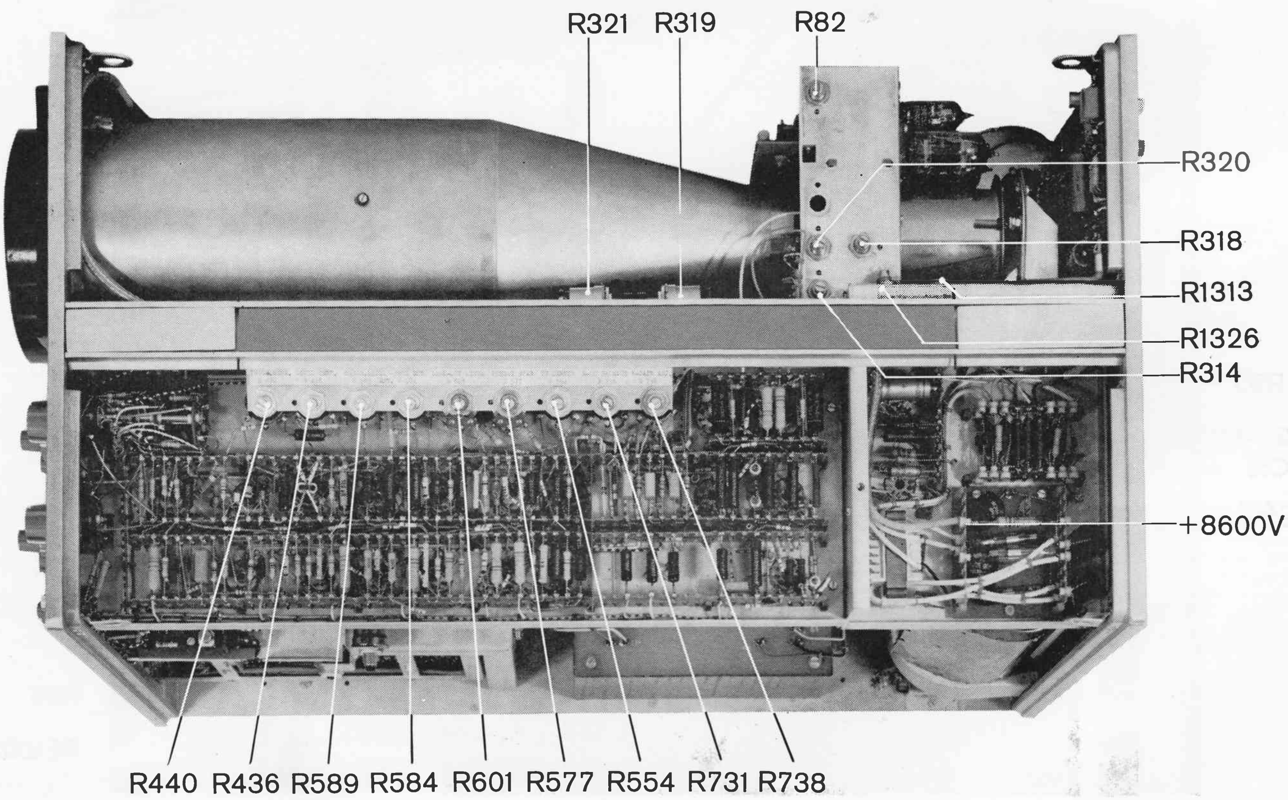


Fig. 54. Top-view of the interior

3. Intensity

R1313 (Fig. 54) R302 (Fig. 56)

- ″X-DEFLECTION″ (SK7) to ″50 Hz″.
- ″INTENS″ (R6) to point 3 of the scale.
- Adjust potentiometer ″INTENS″ (R1313) so that the time-base line is just not visible.
- Turn ″INTENS″ (R6) fully clockwise.
- Select such a value for resistor R302 that the voltage over R308 (Fig. 80) is 8 Volts (cathode current is 300 μA).
- After selecting the correct value for R302, check the adjustment of R1313; if necessary readjust this potentiometer.

4. Trace rotation

R319-R321 (Fig. 54)

- Check that the measuring graticule alignment is correct. If necessary the CRT can be rotated until the graticule is in the correct position.
- Display a time-base line and adjust the potentiometers ″TRACE ROTATION″ (R319-R321) so, that the time-base line is written parallel to the horizontal lines of the graticule.

5. Focus and astigmatism

R324 (Fig. 56)

- Insert a Y-plug-in unit into the Y-plug-in compartment. (Any unit except the test-unit will do).
- Apply a sine-wave voltage to the Y-unit.
- Adjust time-base A for a triggered display and adjust the trace height to 6 cm.
- It should be possible to adjust for a clearly defined trace with potentiometers ″FOCUS″ (R7) and ″ASTIGMATISM″ (R8).
  The potentiometer ″FOCUS″ should be approximately in its centre position. If necessary, select a different value for R 324.

6. CRT Geometry (Fig. 58)

R318 (Fig. 54)

This adjustment slightly influences the deflection sensitivity of the CRT.
If the geometry is readjusted, it is necessary to check the horizontal and vertical deflection sensitivity of the basic oscilloscope.
Apply a square-wave voltage (e.g. the calibration voltage) to the Y-plug-in unit and adjust the peak-to-

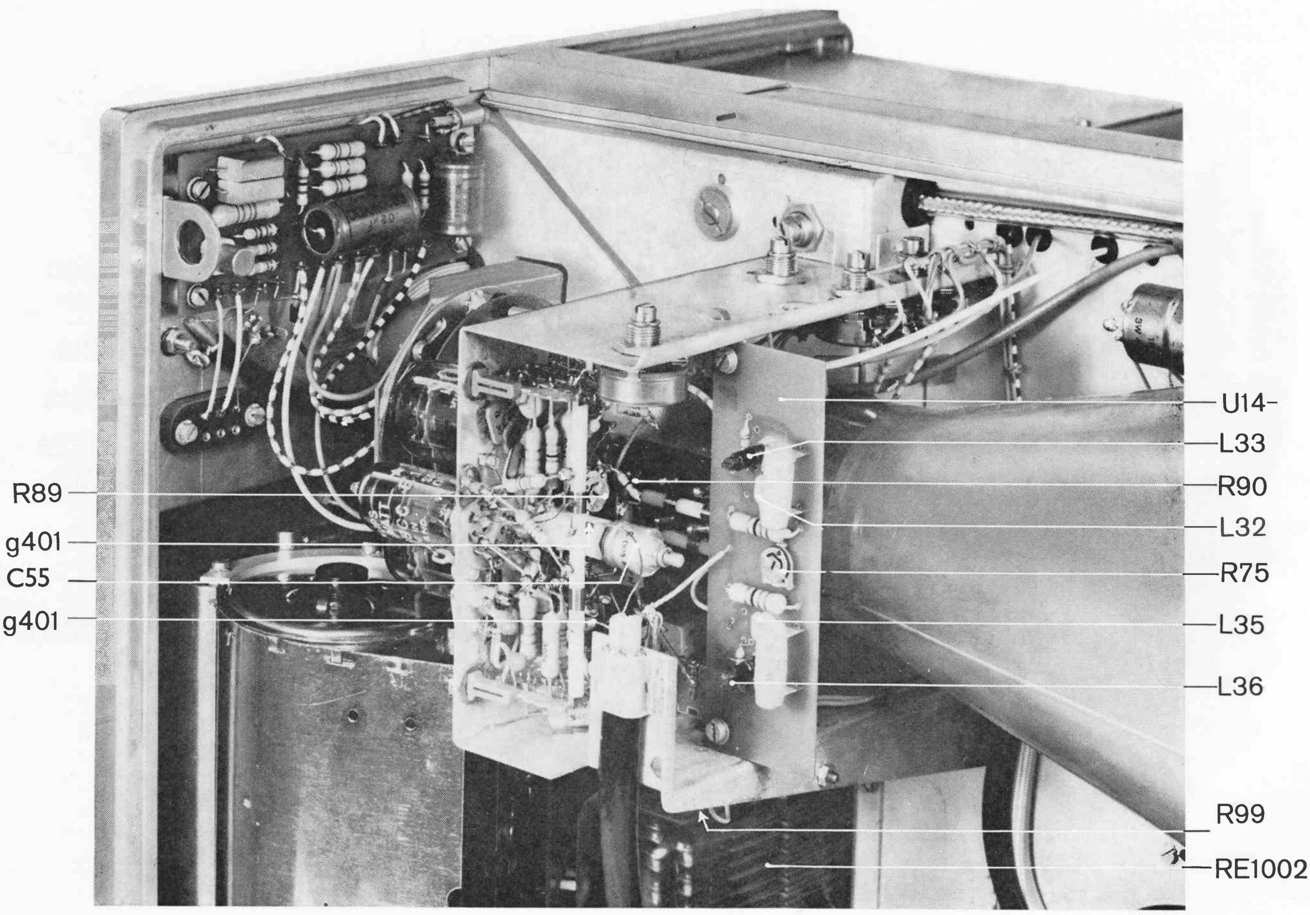


Fig. 55. Close-up of the final stage of the Y-amplifier (U14)

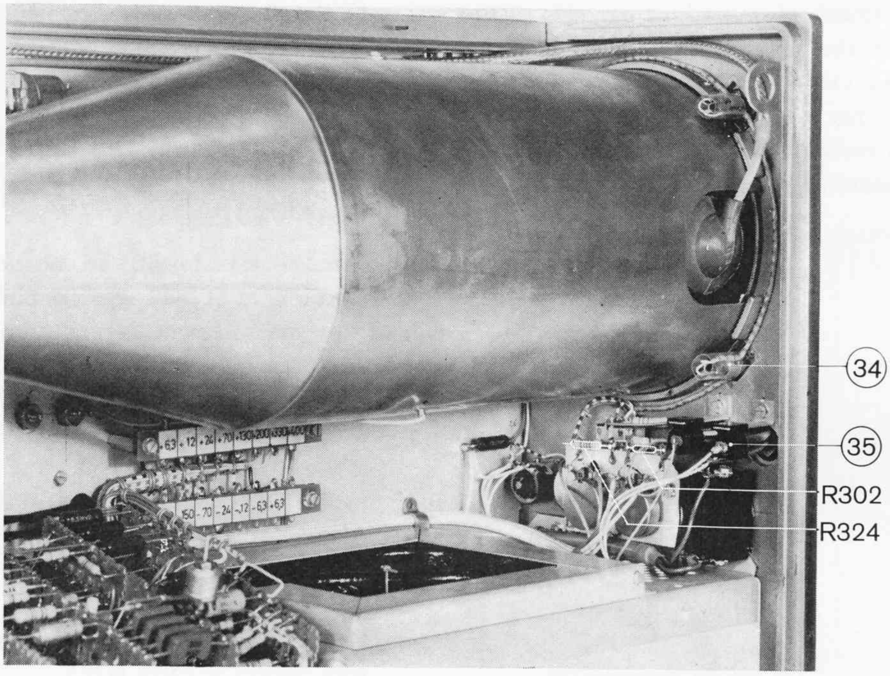


Fig. 56. Close-up of the rear of the CRT controls

peak value of this voltage so that a vertical deflection of ≥ 18 cm is obtained.
Potentiometer "PATT. DIST." (R318) should then be adjusted for minimum curvature of the vertical lines.

7. Symmetrical deflection

R328 (Fig. 57)

- Set "X-DEFLECTION" (SK7) to "50 Hz" and turn "AMPL." (R10) fully clockwise.
- Apply a sine-wave voltage with a frequency of 100 kc/s and a peak-to-peak value for 10 cm deflection to the Y-plug-in unit.
- Adjust "SYMMETR." (R328) so, that in vertical direction the display is symmetrical with respect to the measuring graticule.

8. Orthogonality

R327 (Fig. 57)

Before this adjustment is carried out, it is necessary that the geometry has been well-adjusted (see point F6).
Set switch "X-DEFLECTION" (SK7) to "50 Hz" and adjust the horizontal deflection to 6 cm with "AMPL." (R10).
Apply a sine-wave voltage with a frequency of 100 kc/s to the Y-plug-in unit and also adjust the deflection to 6 cm.
Adjust potentiometer "PERPENDICULARITY" (R327) so, that the sides of the display are perpendicular to each other. Check this with the aid of the measuring graticule on the CRT.

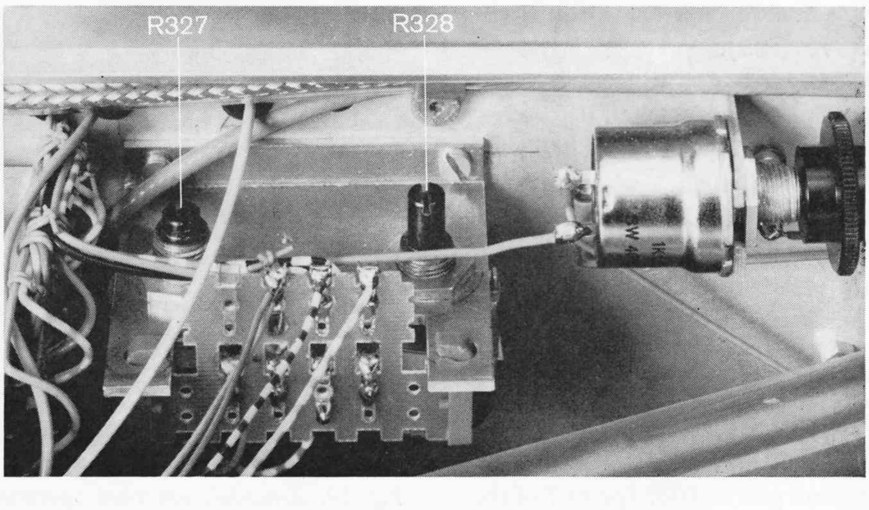


Fig. 57. Close-up of the "Perpendicular" and "Symmetry" control

During the adjustment, always adjust one side of the display parallel to the horizontal graticule lines with "TRACE ROTATION" (R319-R321) and adjust the deviation of the other side of the display to minimum with R327. After correct adjustment of R327, all sides of the display should be parallel to the graticule lines.

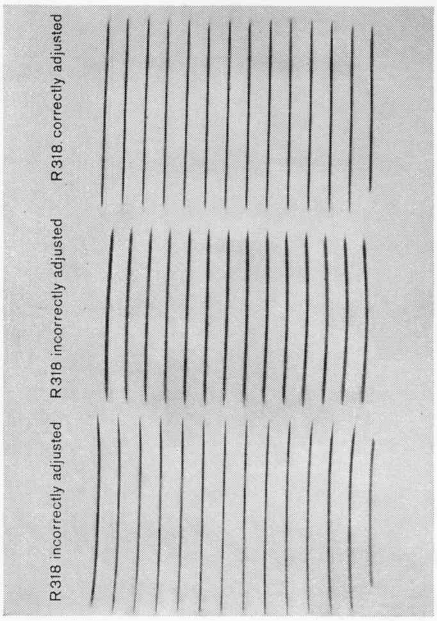


Fig. 58. Adjustment of "Pattern distortion" control

G. ADJUSTING THE DC BALANCE OF THE Y-AMPLIFIER

R82 (Fig. 54) R39 (Fig. 53)

Before carrying out this adjustment, first make sure that the "TRACE ROTATION" (point F4) and the X–Y (point F5) adjustment are correctly adjusted.

- Set the knobs mentioned below to the following positions: "X-DEFLECTION" (SK7) to "50 Hz"
  "STABILITY" to "PRESET"
  "50 Hz AMPL." (R10) "CLOCKWISE"
- Interconnect the control grids of B4 and B4"
- Adjust "INTENS." (R6) for normal intensity.
- Centre the time-base line on the screen with potentiometer "DC-BAL. II" (R82).
- Remove the interconnection
- Interconnect the control grids of B1 and B1".
  When using the test-unit PM3361 this can be effected by depressing button "DC-BAL." while the test selector is in position "POWER SUPPLY".
- Centre the time-base line on the screen with potentiometer "DC-BAL. I" (R39).
- Remove the interconnection.

H. ADJUSTING THE DC BALANCE OF THE X-AMPLIFIER

R731 (Fig. 54)

- Short-circuit the control grid of B705 (point 7 of the valve support) to earth.
- Centre the spot on the screen with potentiometer "X.DC-BAL." (R731).
- Remove the interconnection.

J. ADJUSTING THE DC BALANCE OF THE TRIGGER AMPLIFIER

R484-R485 (Fig. 53)

Before this adjustment, the voltage levels on the symmetrical input of the trigger amplifier should be equal. If this measurement is not adjusted with test-unit PM3361 in the basic oscilloscope, it is necessary to interconnect the control grids of B451 and B451'.

- Measure the cathode voltage of B454 with respect to earth and adjust this voltage to 0 V with potentiometer "TRIGG. DC. LEVEL I" (R484).
- Also adjust the cathode voltage of B454 with aid of potentiometer "TRIGG. DC. LEVEL II" (R485) to 0 V.
- Repeat both adjustments until the voltage difference with respect to earth is 0 V.

K. INTENSITY MODULATION

1. External

- Remove the earthing bar between the terminals "EXT." (BU9) and "⏚" (BU10) on the rear of the instrument.
- Set switch "Z.MOD." (SK14) to position "EXT.".
- Apply a sine-wave voltage of 15 V_{p-p}, frequency 10 kc/s, to terminal "EXT.".
- Apply the same voltage to the input of the Y-plug-in unit.
- Adjust "TIME-BASE A" for a triggered display. With correct adjustment of potentiometer "INTENS" (R6) an intensity-modulated trace should be visible.
- Remove the applied voltage from BU9 and the Y-input and connect the earthing bar again.

2. Multi-trace chopper

This check can be carried out with the aid of test-unit

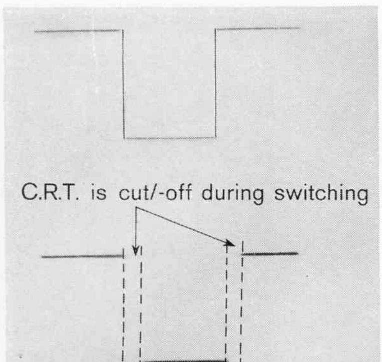


Fig. 59. Z-modulation when operating in the "chopped" mode

PM3361, the test-selector of which should be in position "BLANKING" (CHOPPED).

- Adjust "TIME-BASE A" so that it triggers on the chopper frequency.
- Set "Z.MOD." (SK14) to position "MULTI-TRACE CHOPPER". The edges of the switching pulses should not be visible.

  If this measurement is carried out with a multi-trace plug-in unit (e.g. PM 3342), it is not possible to trigger on the chopper frequency internally. In this case the blanking can be checked by making sure that the haze between both time-base lines disappears in position "MULTI-TRACE CHOPPER" of SK14. (Fig. 2).
- Set switch "Z.MOD." to position "EXT." again.

L. ALTERNATE

This check can be carried out with test-unit PM3361 the test-selector of which should be in position "ALTERNATE". If a multi-trace plug-in unit is used, this should also be set to position "ALTERNATE–.

- Set "TIME-BASE A" to free-running with a time-coefficient of .5 sec./cm.
- Check that the chopper is controlled by a pulse from "TIME-BASE A". In this case two complete time-base lines should be displayed.

M. Y-AMPLIFIER

For adjusting the Y-amplifier two square-wave voltages in anti-phase, having a value of 600 mV_{p-p} on an 18 V d.c. level and a rise-time of 2.5 nsec. are required.

These voltages are supplied by test-unit PM3361.

The frequency of the test-unit signal should be adjusted to 100 kc/s.

1. Deflection coefficient

R89 (Fig. 55)

- Set the test-selector to position "CAL./4 cm".
- Adjust "TIME BASE A" to its free-running position; time coefficient .2 µsec./cm.
- The sensitivity should be so that a vertical deflection of 4 cm is obtained; tolerance 2.5%. This can be adjusted with potentiometer R89.

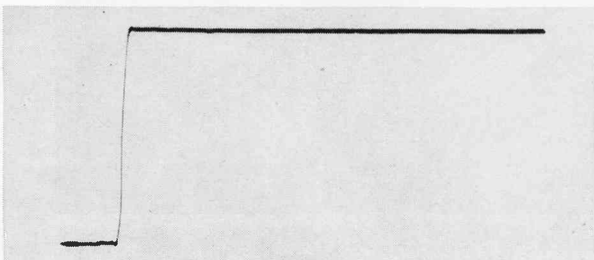


Fig. 60. Vertical amplifier correctly adjusted

2. Square-wave response

- Set the test-selector to position "RISE TIME".
- Adjust "TIME-BASE A" for a triggered display; time coefficient .05 µsec./cm.
- The reproduced square-wave voltage should have a flat top. The overshoot should not exceed 1% and the rise time should be minimum.

If the amplifier does not meet the above requirements, it can be readjusted as follows.

- Set the frequency of the test-unit signal to 500 kc/s.

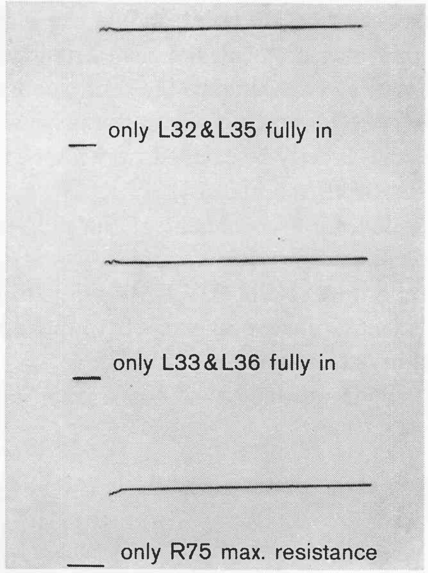


Fig. 61. Y-amplifier maladjusted

R31 (Fig. 53) C55–L32, 33, 35, 36 – R75 – R90 (Fig. 55)

- Adjust "TIME-BASE A" for a triggered display. Time coefficient: 1 µsec./cm.
- Turn "HF PEAKING" (R31) fully anti-clockwise and C55 fully clockwise.
- Adjust for minimum distortion owing to reflections with L32, 33, 35, 36 and R75.
- Select such a value for R90 that it is possible to adjust for some overshoot with potentiometer "HF PEAKING" (R31).
- Adjust R31 and C55 so that the rise time of the reproduced square-wave is minimum, that the top is flat and that the overshoot does not exceed 1%.
- Set the frequency of the test-unit to 100 kc/s.

R51, 52, 54, 56, 60 – C30, 34, 35, 36, 37 (Fig. 53)

- Check that the top of the reproduced square wave is flat. Possible sag can be corrected with R52/C30, R54/C34, R56/C35, R51/C36 and R60/C37.

  In this case check the previous adjustments.
- Replace the test-unit by a Y-plug-in unit.
- Apply square-wave voltages with frequencies of 10 kc/s and 10 c/s to the vertical amplifier.
- Check at these frequencies the square-wave response; the top should be flat.

3. Frequency-response curve

After the Y-amplifier has been adjusted for correct square-wave response (see L2) the frequency response curve of the basic amplifier together with Y-plug-in unit PM3333 should be so that the –3dB point lies at a frequency which exceeds 60 Mc/s.
The frequency response curve can be measured with, for instance, the PHILIPS AM-FM generator GM2621 and the PHILIPS HF millivoltmeter GM6025.
The voltages with the reference frequency and the 60 Mc/s frequency, which are applied to the Y-plug-in unit to check the —3 dB point, should be exactly equal.
During this measurement the measuring pin of the probe should be connected to the centre contact of the "AC–DC" switch in the plug-in unit; the housing of the probe should directly be earthed, so without the use of an earthing cable (see Fig. 63).

- Set the deflection coefficient of the plug-in unit to 10 mV/cm.
- Connect output socket "HF II" of the auxiliary generator via a terminated 50–Ω cable to the input of the Y-plug-in unit.
- Adjust the frequency to 4.5 Mc/s.
- Adjust the generator voltage for a 6 cm deflection.
- Increase the frequency to 60 Mc/s; with the same value of the input voltage, the vertical deflection should exceed 4.2 cm.

4. Deflection and shift

- Insert the Y-plug-in unit PM3333 into the plug-in compartment of the basic oscilloscope and adjust its "GAIN ADJ." and "DC–BAL.".
- Adjust the deflection coefficient to "10 mV/cm".
- Apply a triangular or sine-wave voltage with a value of 180 mV_{p-p} and a frequency of approximately 2 kc/s to the input.
- With the vertical SHIFT control it must be possible to display the upper and lower peaks of the signal within the measuring graticule.
- With this triple over-driving no distortion of the trace should occur.

N. CALIBRATION VOLTAGE AND CURRENT

R1411 (Fig. 3)

- Set "AMPL. CAL." (SK12) to position "80" and SK13 to position "OFF".

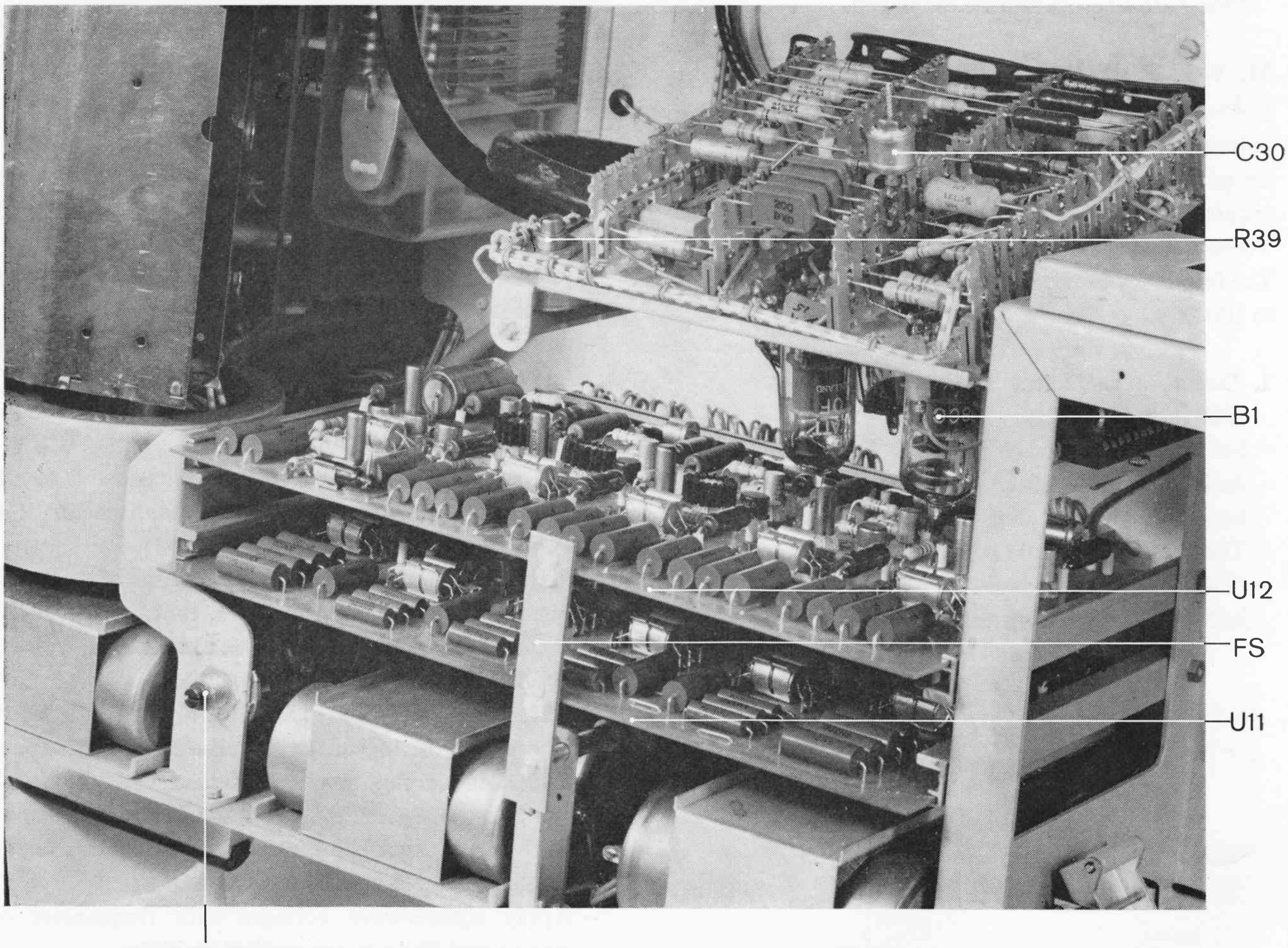


Fig. 62. Close-up of the stabilising circuits of the power supplies

- Measure the DC-voltage at junction R1410–R1417 with respect to earth and with ″CAL. AMPL.″ (R1411) adjust this voltage to 80 V; tolerance < 0.5%
- Set ″AMPL. CAL.″ (SK13) to position ″V″ and measure the calibration voltage.

The accuracy of the calibration voltages and of the calibration current are, after adjusting the 80 V, determined by the precision resistors of the attenuator.

- In all positions of SK12, check that on socket ″AMPL. CAL.″ (BU6) a square-wave voltage is available with a frequency of 2 kc/s.
  In one of the positions of SK12, also check the calibration voltage on BU6 with SK13 in position ″mV″. When a sensitive DC-voltmeter is used (e.g. PHILIPS GM6020) all values of the calibration voltage between BU6 and the corresponding earthing socket can be measured in position ″mV″ of SK13.
- Measure the symmetry of the square-wave voltage by connecting a DC-voltmeter to BU6 and measuring the average value.
  This should be equal to half the peak-to-peak value (within 10%) of the calibration voltage which is indicated on the text plate.
- Set SK13 to position ″4 mA″.
  A square wave current should flow through the current bracket with the same frequency and pulse shape as the calibration voltage.
- Set SK13 to position ″OFF″.
  There should be no voltage on output socket BU6.

O. X-AMPLIFIER

The sensitivity of the time-base amplifier is so adjusted, that, when driving this amplifier with the time-base generator, the correct time coefficient is obtained.
To measure the time coefficient, a number of voltages with accurately known frequencies are required.

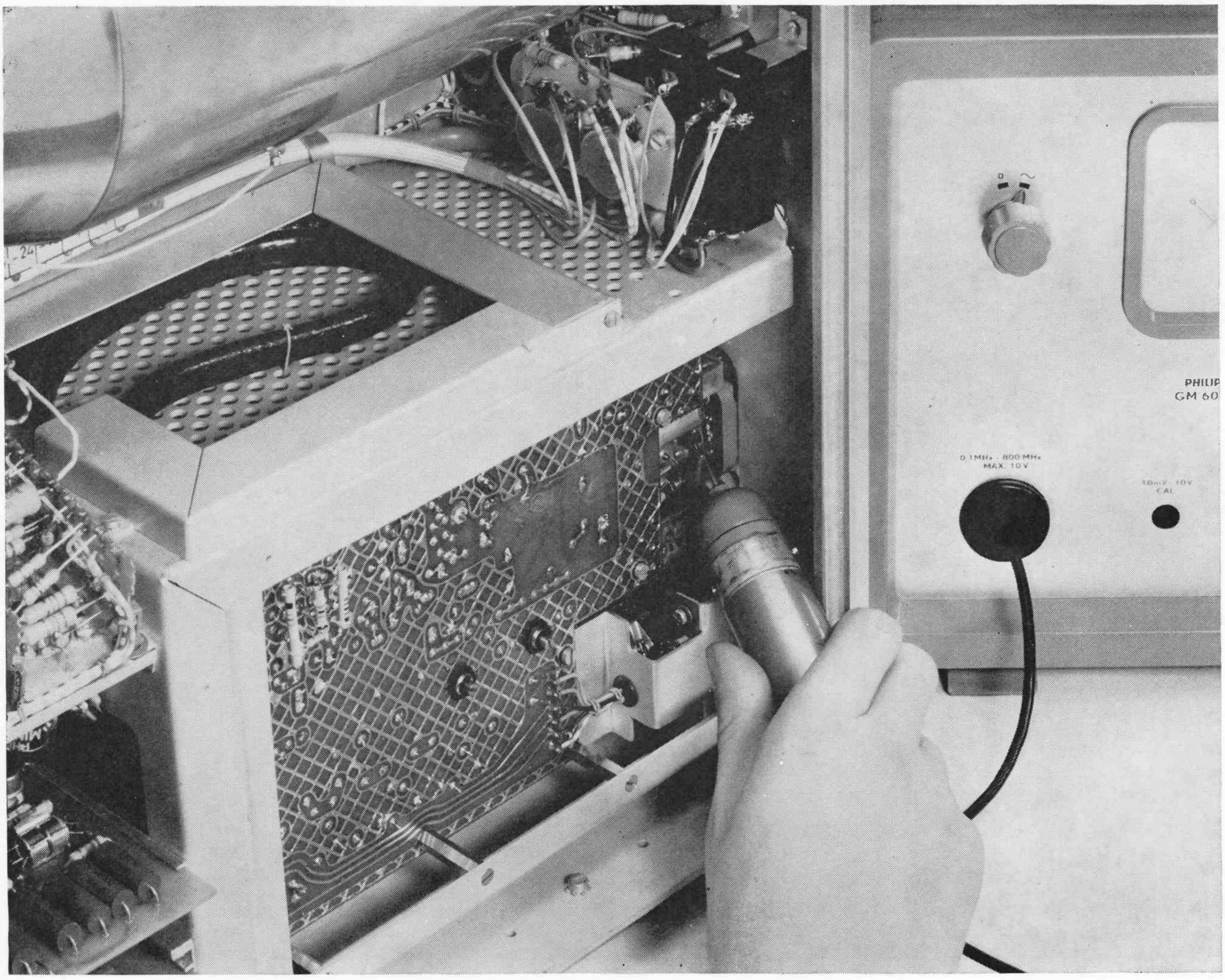


Fig. 63. Measuring the frequency characteristic

1. Deflection coefficient

R738–R554 (Fig. 54)

- Insert unit PM3333 into the Y-plug-in compartment; apply time markers at intervals of precisely 2 msec. to the input of the Y-unit.
- Set the following knobs to the indicated positions:
  "TIME/cm" (SK4) to "2 msec./cm".
  "MAGNIFIER" (SK8) to "×1".
  "TIME/cm" (R1) to "CAL."
- Adjust "LEVEL" (R2) for a stationary display.
- Adjust the sensitivity with potentiometer "X-GAIN ADJ." (R738) so, that 8 pulses have a width of exactly 8 cm (symmetric with respect to the centre of the screen).

For the following points 2 and 3 it is necessary that the potentiometer "TB LENGTH" (R54) has been properly adjusted (see point Q7).

2. Output preamplifier

R714 (Fig. 3)

- Set time-base A to its free-running position and adjust the time-base line symmetrically with respect to the centre of the screen with "SHIFT" (R4–R5)
- Set "X-DEFLECTION" (SK7) to position "EXT." and connect socket "EXT." (BU5) to earth.
- With "X-PREAMPL LEVEL" (R714) adjust the output level of the preamplifier so, that the spot is in the centre of the screen.
- Remove the earthing connection from BU5.

3. Horizontal shift

- Set time-base A to its free-running position and adjust "MAGNIFIER" (SK8) to position "×1".
- With "SHIFT" (R4–R5) it should be possible to place the beginning and the end of the time-base line over the centre of the screen.
- With "VERNIER" (R5) it should be possible to shift the trace approximately 1.5 cm.

4. Square-wave response

C707 (Fig. 64) C701 (Fig. 3)

- Set the time-coefficient of time-base A to ".2 msec/-cm".
- Apply the sawtooth voltage from time-base A (BU3) to the Y-plug-in unit, the deflection coefficient of which has been adjusted to "20 V/cm".

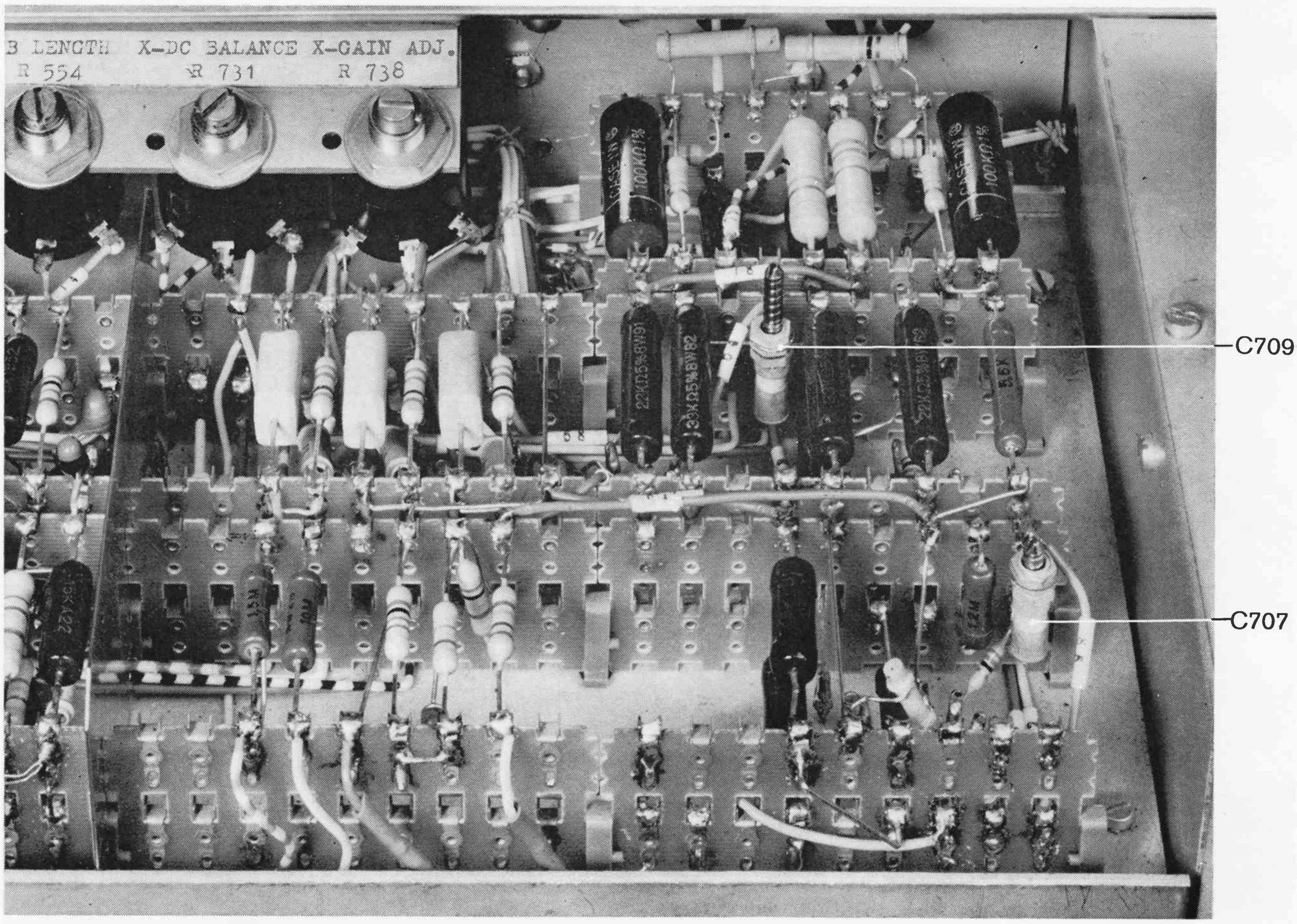


Fig. 64. Close-up of the X-amplifier

- Apply a square-wave voltage of 4 V_{p-p} to the X-amplifier by connecting calibration voltage socket BU6 to terminal "EXT." (BU5).
- Apply this voltage also to terminal "TRIGG." (BU1) for triggering time-base A externally.
- Set "X-DEFLECTION" (SK7) to position "EXT."
- After having adjusted for a stationary display, trimmer C707 should be adjusted for optimum reproduction of the square-wave.
- The deflection coefficient on socket "EXT." (BU5) should amout to .5 V/cm; tolerance 10%.
  So the length of the time-base line amounts to 7.2 ... 8.8 cm.

Fig. 65. X-amplifier step-response

Horizontal deflection with voltage of 4 V and 40 V resp. applied to "EXT." (BU5); SK7 in positions "EXT." and "1 : 10 EXT." respectively.

- Set "X-DEFLECTION" (SK7) to position "1 : 10 EXT.".
- Increase the input voltage to 40 V_{p-p} and adjust trimmer C701 for optimum reproduction of the square-wave voltage.
- In position "1 : 10 EXT." the deflection coefficient on terminal "EXT." (BU5) should amount to 5 V/cm; tolerance 10% (the length of the time-base line should anount to 7.2 ... 8.8 cm). "MAGNIFIER" (SK8) should have no influence on the display in both positions of SK7.

5. Frequency-response curve of the preamplifier.

- Set "X-DEFLECTION" (SK7) to position "EXT.".
- Apply a sine-wave voltage with a frequency of 10 kc/s to terminal "EXT." (BU5) with such an amplitude that a horizontal deflection of 8 cm is obtained.
- Increase the frequency of the input voltage to 1 Mc/s (keep the amplitude constant); the horizontal deflection should then exceed 5.6 cm.

6. 50 Hz X-deflection

- Set "X-DEFLECTION" (SK7) to position "50 Hz".
- It should be possible to adjust for a horizontal deflection from 0 to > 8 cm with potentiometer R10.

In this position of SK7, "MAGNIFIER" (SK8) should have no influence on the display.

P. BEAMFINDER

Before carrying out this check, it is necessary that the sensitivity of the X- and Y-amplifier has been correctly adjusted (see points L1 and N1).

Y-direction

- Turn the "SHIFT" control of the Y-plug-in unit fully clockwise and fully anti-clockwise, resp.
- Without an input signal, check that by depressing "BEAMFINDER" (SK10), the sensitivity of the Y-amplifier is decreased so, that in both extreme positions of the "SHIFT" control the time-base line is displayed within the measuring graticule.

X-direction

- Set "X-DEFLECTION" (SK7) to "TIME BASE A".
- Set "STABILITY" (R3) to "PRESET" and "TRIGGER MODE" (SK1) to "HF".
  Without an input signal on the Y-plug-in unit, no trace may be visible.
- Check that by depressing "BEAMFINDER" (SK10) the time-base generator is set to its free-running position and that the time-base line is displayed on the screen.
  At the same time, the horizontal sensitivity should be so reduced that the deflection does not exceed 5 cm.

Q. TIME-BASE A AND TRIGGER UNIT

For the next checking and adjusting points, the below-mentioned switches should be set to the following positions.

"TRIGGER MODE" (SK1) to "HF"
"TRIGGER SOURCE" (SK3) to "INT."
"X-DEFLECTION" (SK7) to "TIME-BASE A"
"MAGNIFIER" (SK8) to "×1"
"STABILITY" (R3) to "PRESET"

If a different position is required, this is indicated in the description of the regarding check-up or adjustment.

1. Stability

R577 (Fig. 54)

- Set "LEVEL" (R2) to the centre position.
- Apply a sine-wave voltage with a frequency of 10 kc/s to Y-plug-in unit PM3333 and adjust the trace-height to 3 cm.
- Set "TIME/cm" (SK4) to position "1 μsec/cm".
- Turn potentiometer "PRESET STAB." (R577) fully clockwise. From this position, turn anti-clockwise till a well-triggered display is obtained.
- Check the triggering with different time coefficients: no dual traces should occur. If necessary R577 should be slightly readjusted.

2. Trigger sensitivity
R440–R436 (Fig. 54)

- Set ″STABILITY″ (R3) to ″PRESET″.
- Switch ″LEVEL″ off by short-circuiting the contact on switch SK1F to earth.
- Apply such a voltage to Y-plug-in unit PM3333 that the trace-height amounts to 1 mm. This can be easily done by applying the 200 mV calibration voltage to the input of the amplifier, the deflection coefficient of which should be adjusted to ″2 V/cm″.
- Turn ″TRIGG. SENS.″ (R440) fully anti-clockwise and adjust ″LEVEL SENS.″ (R436) for a running display.
- Turn R440 slowly clockwise till a stationary display is obtained.
- With R436 adjust for a running display again and turn R440 clockwise till a stationary trace is obtained
- Repeat the adjustments of R436 and R440 till it is no longer possible to adjust for a running or dual trace with R436.
- Next set R436 to the centre of the control range where triggering occurs.
- Remove the earthing connection from SK1F.

3. Trigger slope and level

- Apply a sine-wave voltage of 10 kc/s to the Y-plug-in unit and adjust for a trace-height of 6 cm.
- Set the trigger slope switch (SK2) to position ″+″. The time-base should start on the positive-going edge of the sine-wave. With SK2 in position ″—″, starting should occur on the negative-going edge.
- It must be possible to shift the starting point continuously across the entire trace-height of 6 cm with potentiometer ″LEVEL″ (R2).
- With ″LEVEL″ (R2) fully clockwise as well as anti-clockwise, the time-base generator should not operate.

4. Internal triggering
TV FRAME

- Set ″TRIGGER MODE″ (SK1) to ″TV FRAME″.
- Apply a positive video signal to the Y-plug-in unit PM3333.
- Set ″TRIGGER SLOPE″ (SK2) to ″—″.
- Check that, with a trace-height of 2 cm minimum, a trace is displayed, which is triggered on the frame synchronization pulses.
  In this case the trace will start with a frame synchronization pulse.

In the position ″TV FRAME″, ″LEVEL″ and ″STAB.″ should have no influence.

TV LINE

- Set ″TRIGGER MODE″ (SK1) to ″TV LINE″.
- Apply a positive video signal to the Y-plug-in unit PM3333.
- Set ″TRIGGER SLOPE″ (SK2) to ″—″.
- Check that, with a trace height of 2 cm minimum, a trace is displayed, which is triggered on the line synchronization pulses.
  In this case the trace will start with a line-synchronization pulse.

In the position ″TV LINE″ ,″LEVEL″ and ″STAB.″ should have no influence.

DC
R484 (Fig. 53)

Before this measurement is carried out, it is necessary that the balance of the Y-amplifier and the trigger amplifier has been correctly adjusted (see points G and I).

- Set ″TRIGGER MODE″ (SK1) to ″LF″
- Apply a sine-wave voltage with a frequency of 10 kc/s to Y-plug-in unit PM3333 and adjust for a trace height of 3 mm.
- Adjust ″LEVEL″ (R2) so, that when switching ″TRIGGER SLOPE″ (SK2) from + to —, the time-base generator keeps operating, without requiring readjustment of ″LEVEL″ (R2).
- With ″Y-SHIFT″ adjust the trace symmetrically around the centre of the screen.
- Set ″TRIGGER MODE″ (SK1) to ″D.C.″ and leave ″LEVEL″ and ″SHIFT″ in the above-mentioned positions.
- Adjust potentiometer ″TRIGG. DC LEVEL I″ (R484) so that in both positions of the ″TRIGGER SLOPE″ (SK2) a triggered display is obtained.
  Set R484 to the centre of the control range in which triggering occurs.
- When shifting the trace vertically, the starting point of the time-base line should shift smoothly over the the edge of the sine wave, but should remain at the same place on the screen.

LF

- Set ″TRIGGER MODE″ (SK1) to ″LF″.
- Apply a sine-wave voltage with a frequency of 3 c/s to the Y-plug-in unit PM3333 and adjust for a trace height of 3 mm.
- It must be possible to trigger the time-base generator with this input voltage by means of ″LEVEL″ (R2).

Note: It is easier to preset ″LEVEL″ (R2) with a higher frequency of the input voltage.

- ″Y-SHIFT″ of the Y-plug-in unit may have no influence on the trigger level which has been adjusted with ″LEVEL″ (R2).

HF

- Set ″TRIGGER MODE″ (SK1) to ″HF″.
- Apply a sine-wave voltage with a frequency of 3 c/s to the Y-plug-in unit PM3333 and adjust for a trace height of 6 cm.
  With this l.f. voltage no triggered display should be obtained.
- Increase the frequency of the input voltage to 2kc/s and 3 Mc/s respectively and adjust for a trace height of 3 mm.
  It must be possible to trigger the time-base generator with the input voltage by means of ″LEVEL″ (R1).
- With an input voltage having a frequency of 30 Mc/s it must be possible to trigger the time-base generator at a trace height of 8 mm.

AUT.

R584–R589 (Fig. 54)

- Set ″TRIGGER MODE″ (SK1) to ″AUT.″
- Turn potentiometers ″AUT. TRIGG. LEVEL″ (R589) and ″AUT. FREE-RUN″ (R584) fully anti-clockwise.
- Without input voltage on the Y-plug-in unit, potentiometer ″AUT. FREE-RUN.″ (R584) should be turned so far clockwise, that a time-base line just appears; then turn R584 15° further clockwise.
- Apply a voltage with a frequency of 10 kc/s to Y-plug-in unit PM3333 and adjust for a trace height of 3 cm.
- Turn potentiometer ″AUT. TRIGG. LEVEL″ (R589) fully clockwise; next anti-clockwise until the time-base generator triggers. Check this on all positions of ″TIME cm″ (SK4).
- Vary the trace-height from 0 to 6 cm.
  From maximum 5 mm up to 6 cm trace-height the time-base generator should be triggered with the input voltage.
  With a trace-height lower than the trigger limit the time-base generator should remain free-running. Without input voltage the time-base line should remain visible.
- Check that the time-base generator is triggered at a trace height of 8 mm at maximum with frequencies of 10 c/s and 1 Mc/s.

In position ″AUT.″, ″LEVEL″ and ″STAB.″ should have no influence.

5. External triggering

- Set ″TRIGGER SOURCE″ (SK3) to ″EXT.″
- Apply to ″EXT.″ (BU1) a sine-wave voltage of 0.3 V_{p-p} from the same source as the voltage which has been connected to the Y-plug-in unit.
- Adjust the frequency of the input voltage to 10 kc/s and set ″TRIGGER MODE″ SK1 to ″HF″.
- After correct adjustment of ″LEVEL″ (R2) the time-base generator should be triggered by the external voltage on terminal ″EXT.″ (BU1).
- Now remove the voltage from ″EXT.″ (BU1), The time-base generator should not be triggered any longer and consequently the time-base line should not be visible.

6. 50 Hz Triggering

- Set ″TRIGGER SOURCE″ (SK3) to ″50 Hz″.
- Apply a sine-wave voltage with the mains frequency to the Y-plug-in unit.
- Set ″TRIGGER MODE″ (SK1) to ″LF″.
- With ″LEVEL″ (R2) the time-base generator should be triggered on the internal voltage with the mains frequency.
- It should be possible to shift the starting point of the time-base generator over the edge of the sine-wave for more than 150° with potentiometer ″50 Hz PHASE″ (R10).

7. Time-base amplitude

R554 (Fig. 54)

- Plug unit PM3333 into the Y-plug-in compartment and apply time markers at intervals of precisely ″2 msec.″ to the Y-unit.
- Set ″TIME/cm″ (SK4) to ″2 msec./cm″ and adjust for a triggered display.
- Adjust potentiometer ″TB LENGTH″ (R554) for a length of the time-base line to 10 cm.
- In all positions of SK4 the length of the time-base line line should exceed 9.5 cm.

8. Time-coefficient and linearity.

C510, 508, 515, 530 (Fig. 3), C709 (Fig. 64), C710, C711, (Fig. 69)

Before this check and adjustment is carried out, it is necessary that the sensitivity of the time-base amplifier has been correctly adjusted (see point N1).

- Apply a sine wave voltage of precisely 10 Mc/s to the Y-unit and set the control knobs to the following positions:
  ″TIME/cm″ (SK4) to ″.05 μsec/cm″
  ″MAGNIFIER″ (SK8) to ″×1″
  ″TIME/cm″ (R1) to ″CAL.″
- Adjust ″LEVEL″ (R2) for a triggered display.
- With trimmer C510 adjust the time coefficient so, that the last three periods together have a width of 6 cm.
- Apply a sine-wave voltage of precisely 50 Mc/s to the Y-unit and set ″MAGN.″ (SK8) to ″×5″.
- With C709, optimally adjust the linearity.
- Repeat the adjustment of C510 with ″MAGN. (SK8) to ″×5″.
- Apply a sine-wave voltage of precisely 50 Mc/s to the Y-unit.

- With C710 optimally adjust the linearity and then check the time-coefficient.
- Adjust C510 so that 4 periods have a width of 8 cm; tolerance 1%.
- Measure the time-coefficient and the linearity over 8 cm (symmetrically around the centre of the screen).
- Apply a sine-wave voltage of precisely 50 Mc/s to the Y-unit and set "MAGN." (SK8) to "×5"
  4 periods should have a width of 8 cm, tolerance 4%.
- Set "MAGN." (SK8) to position "×2".
- With C711 optimally adjust the linearity and then check the time coeffiecient:
  10 periods should have a width of 8 cm; tolerance 4%.
- Set "MAGN." (SK8) to position "×1".
- Apply a sine-wave voltage of precisely 10 Mc/s to the Y-unit.
- Set "TIME/cm" (SK4) to ".1 μsec./cm".
- With C508 adjust the time-coefficient so, that 8 periods have a width of 8 cm; tolerance 1%.
- Apply time markers at intervals of precisely 1 μsec. to the Y-unit and set "TIME/cm" (SK4) to "1 μsec./cm".
- With C530, adjust the time-coefficients so, that 8 periods have a width of 8 cm, tolerance 1%.
- Apply time markers at intervals of precisely 100 μsec. to the Y-unit and set "TIME/cm" (SK4) to ".1 msec./cm".
- With C515, adjust the time-coefficients so, that 8 periods have a width of 8 cm; tolerance 1%.
- Check the time-coefficients in all remaining positions of "TIME/cm" (SK4), with "MAGN." (SK8) in position "×1".
  Always select the time intervals so that they correspond to the time, selected by "TIME/cm" (SK4). In each position 8 periods should have a width of 8 cm; tolerance 2.5 %.
- Set "TIME/cm" (SK4) to position "2 msec./cm" and check the time coefficient with "MAGN." (SK8) to positions "×2" and "×5".
  For position "×2" of "MAGN." (SK8) time markers at intervals of precisely 1 msec. should be applied to the Y-unit.
  Check the time coefficients as follows:
  8 periods should have a width of 8 cm; tolerance 4%.
  For position "×5" of "MAGN." (SK8) time markers at intervals of precisely .2 msec. should be applied to the Y-unit.
  Check the time-coefficients as follows: 16 periods should have a width of 8 cm; tolerance 4%.

In the positions "×2" and "×5", the lamp "MAGN." (LA6) should be aglow.

9. Continuous control of the time-coefficients.

When "TIME/cm" (R1) is turned fully anti-clockwise from its "CAL" position, the time-coefficient should continuously be increased up to > 2.5 times the value in position "CAL".

10. Single time-base

R601 (Fig. 54)

- Set the knobs to the following positions:
  "X-DEFLECTION" (SK7) to "TIME-BASE A"
  "MAGN." (SK8) to "×1"
  "STAB." (R3) to "PRESET"
  "TRIGG. SOURCE" (SK3) to "INT."
  "LOCK OUT LEVEL" (R601) anti-clockwise
- Apply a sine-wave voltage with a frequency of 1 kc/s to the Y-plug-in unit.
- Adjust "LEVEL" (R2) for a triggered display.
- Then set "X-DEFLECTION" (SK7) to "SINGLE A"
- Adjust "LOCK OUT LEVEL" (601) so, that when depressing "RESET" (SK9) repeatedly, the trace is always written just once across the entire time-base length; then turn R601 about 15° further clockwise.
- Set "TRIGGER SOURCE" (SK3) to "EXT." and depress "RESET" (SK9). Lamp B516 in the push-button should light up.
- When SK3 is reset to position "INT.", the trace should be written once and B516 should extinguish.

11. Output terminals "+GATE" (BU2) and "TIME-BASE A" (BU4)

- Set time-base A to its free-running position, with a time-coefficient of ".1 msec./cm".
- The synchronous voltages of Fig. 66 should be available on output terminals BU2 and BU3.

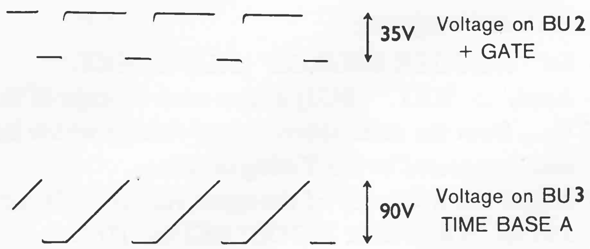


Fig. 66. Output wave-form of "+Gate" and "Time-base" busses

Replacing parts IX

A. FUSES

The instrument is protected by two fuses.
When one or both fuses have blown, first locate the cause.
Note:
If the instrument is used for mains voltages of 110, 125 or 145 V, fuses of 8 A should be fitted.

B. MAINS TRANSFORMER

- Remove the cabinet plates
- Unsolder the transformer connections
- Remove both screws at the rear side.
- Remove the four fixing screws at the bottom of the instrument.

The transformer is then free and can be taken from the instrument.

C. FANS

- Detach the rear panel
- Remove the three fixing screws of the retaining ring at the upper side of the fan
- Unsolder the motor connections

The fan can then be taken from the frame by bending it outwards

Caution!

When remounting the fan care should be taken that the connection wires to the motor are soldered to the same connection points of the motor. Interchanging the wires causes magnetic hum.

D. POWER TRANSISTORS ON THE REAR PANEL

- Remove the rear panel
- Remove the unit with the power supply resistors
- As the connections of the power transistors are made by means of contact springs, it is possible to remove the transistors after unscrewing the fixing screws.
  When remounting the transistors, ensure that the two insulation plates are fitted underneath.
  The screws should be tightened with a torque of 8 kgcm.

E. CATHODE-RAY TUBE

- Remove the protective cap
- Remove the anode cap
- Remove the tube sockle
- Remove the four connection wires between the power amplifier and filter
- Remove the four connection wires from the deflection coils
- Remove both connection wires from the X-deflection plates (marked yellow and grey)
- Remove the grey-white connection wire of the geometry adjustment.

The tube then can be removed from the instrument by pushing it out of the screening pipe in forward direction.

F. TEXT PLATE

- Remove the kobs
- Remove the terminals and the sockets
- Remove the current bracket
- Remove the central fixing nuts of the "POWER ON" and the "RESET" switches
- Remove the central fixing nut of the switch "AMPL. CAL'"
- Remove the bezel
- Unscrew the four fixing screws of the mounting plate of the bezel
- Remove the plastic sleeves from the fittings of the graticule illumination lamps
- Pull the mounting plate of the bezel slightly from the instrument and unsolder the connection wires of the fittings of the lamps
- Remove the mounting plate
- Remove the three screws at the bottom of the text plate
- Remove the text plate from the frame

G. PRINTED-WIRING BOARDS U11 AND U12, Fig. 62

- Pull the fixing strip FS outwards and turn it downwards
- Pull the printed wiring boards from the instrument (plug-in connection)

H. HT UNIT

After removing the two fixing screws, the screening plate can be removed. The components of the HT unit can then be easily replaced.

J. VALVES AND SEMI-CONDUCTORS

All valves and semi-conductors are normal production types.
After replacement of valves and semi-conductors it may be necessary to readjust the relevant circuits.
For this see chapter VIII "Checking and adjusting".
New valves can be aged by switching on the instrument for 100 hours.
Aging can also be carried out separately from the instrument by connecting the valves as a diode.
(In case of a pentode connect the grids and in case of a triode connect the grid to the anode.)
The anode voltage must be so selected that at a normal filament voltage the quiescent current through the valve is 1/6 of the maximum permissible cathode current.

Information for assistance in faultfinding

X

A. MAINS TRANSFORMER VOLTAGES

The available unloaded voltage tappings are listed in Fig. 67 in the form of a table.
The loaded transformer voltages are indicated in the circuit diagram.
They are measured across the windings with a voltmeter GM6012.

B. VOLTAGES AND WAVEFORMS IN THE APPARATUS

The DC-voltage levels in the power supplies are measured under the following conditions:

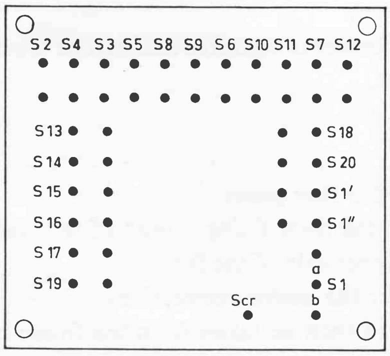
- Switch "X-DEFLECTION" to "SINGLE A"
- Switch "AMPL. CAL." to "OFF"
- PM3342 plugged into the Y-plug-in compartment
- PM3347 plugged into the X-plug-in compartment

They are measured with the voltmeter GM6020. The values may differ between various apparatuses.
The ripple voltages are measured with the voltmeter GM6012.
The voltages in the HT unit are measured with respect to earth, except the voltage on C1307 which is measured free from earth.
The voltages in the Y-amplifier are measured with the voltmeter GM6020 with respect to earth. The DC-balance has been well-adjusted and the trace is centered on the screen.
The voltages in the trigger-amplifier are measured with the voltmeter GM6020 with respect to earth.
The "MODE" switch of unit PM3342 should be set to position "ADDED".
The trace should be centered on the screen.
The voltages in the horizontal amplifier are measured with voltmeter GM6020 with respect to earth.

C. REMARKS

Whenever it is desired to sent the instrument to a PHILIPS workshop, the following points should be observed:

- carefully pack the apparatus in the original packing, or, if not available, in a wooden crate.
- indicate as completely as possible the symptoms of the faults,
- tie on a lable bearing name and address of sender,
- send the instrument to the appropriate PHILIPS address provided by the local organisation.



CODE	S1a	S1b	S1′	S2	S3	S4	S5	S6	S7	S8		
TURNS	34	45	246	187	161	65	34	34	65	161		
VOLTS	15	20	110	83,5	72	29	15,2	15,2	29	72		
CODE	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
TURNS	337	178	155	161	15	15	15	15	15	15	59	59
VOLTS	150,5	79,5	69,2	72	6,7	6,7	6,7	6,7	6,7	6,7	26,5	26,5

PEM 2731

Fig. 67. Mains-transformer data

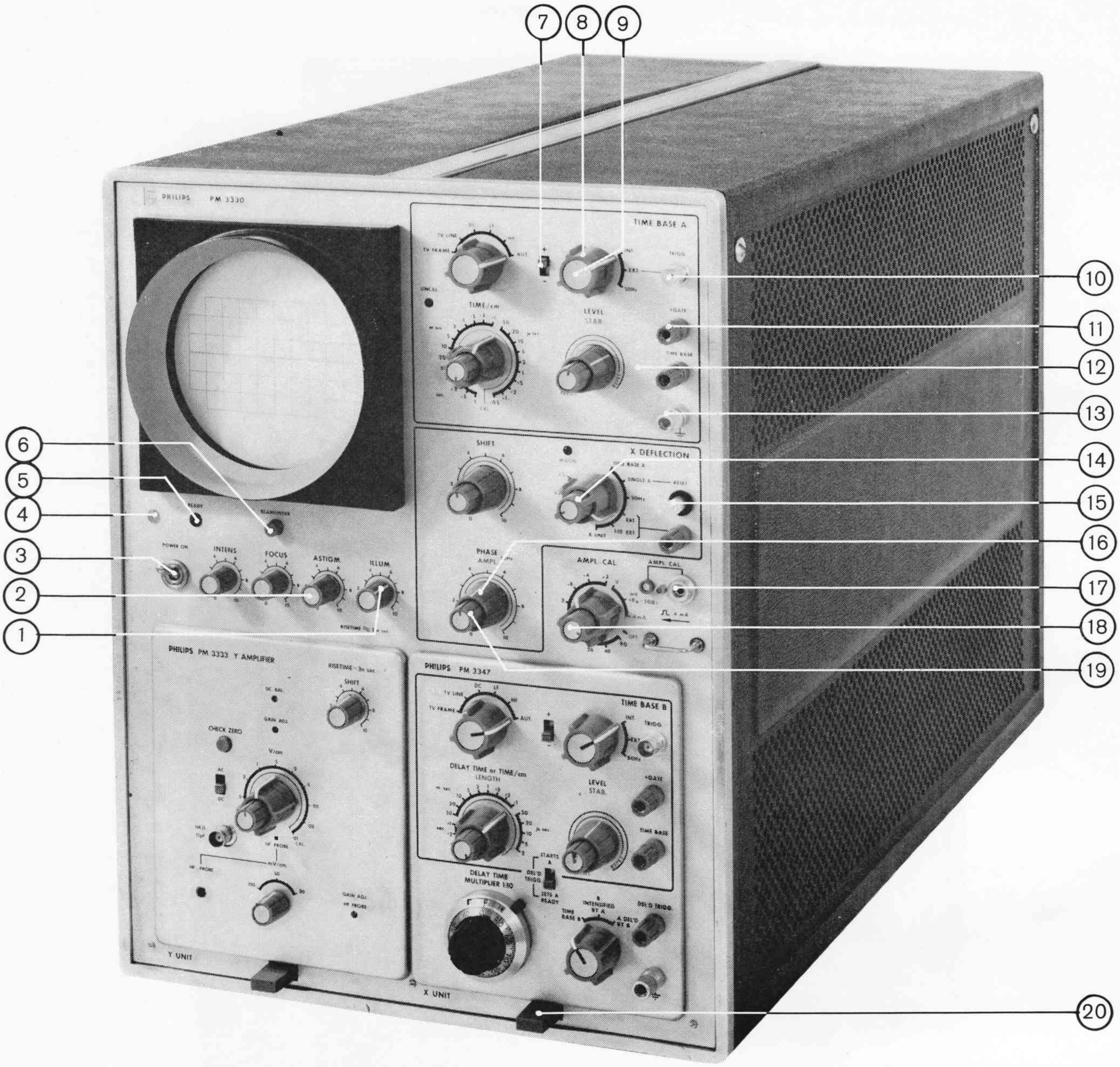


Fig. 68. Components at the front

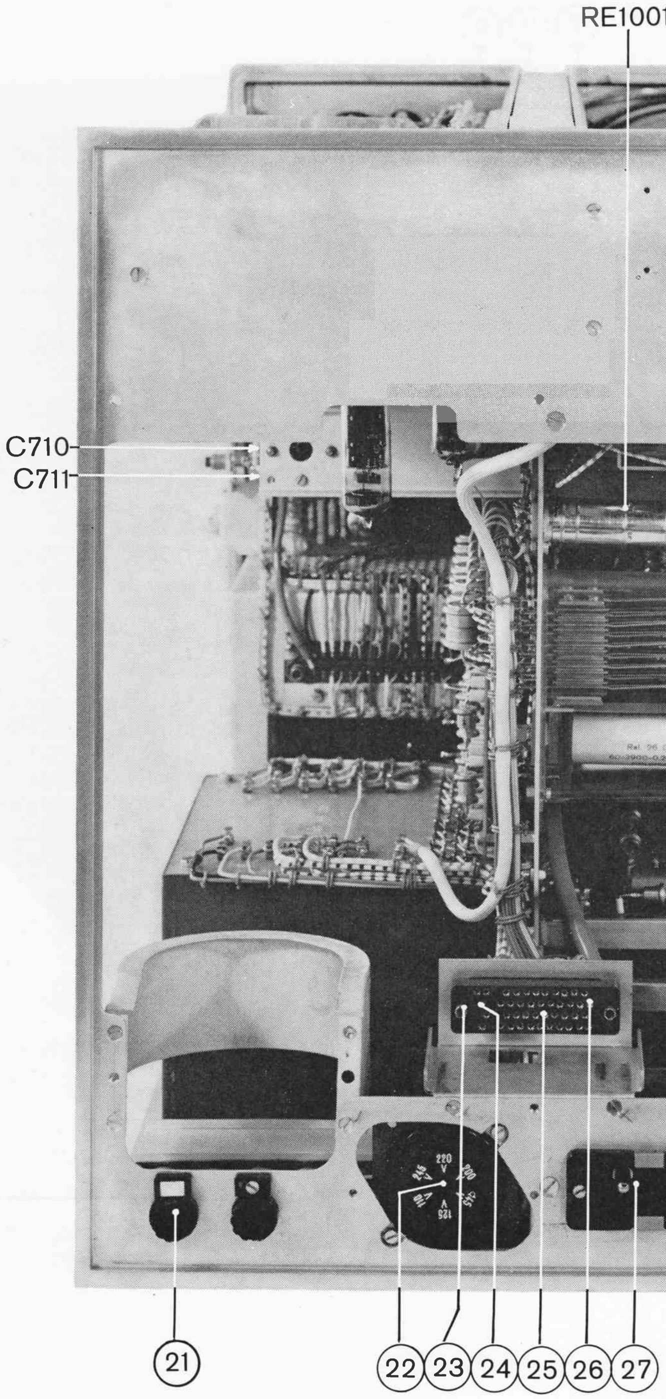


Fig. 69. Components at the rear

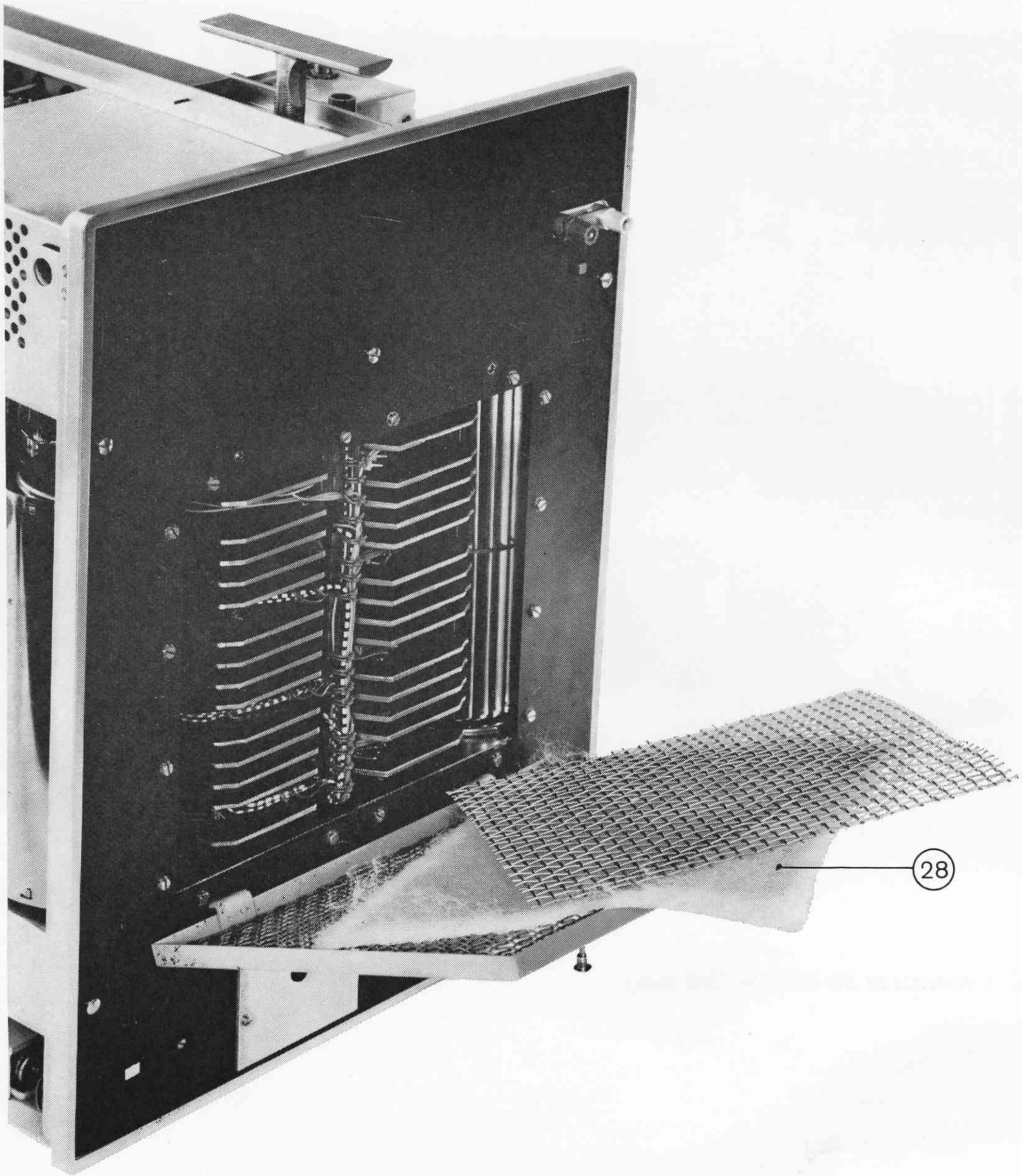


Fig. 70. Filter-mat

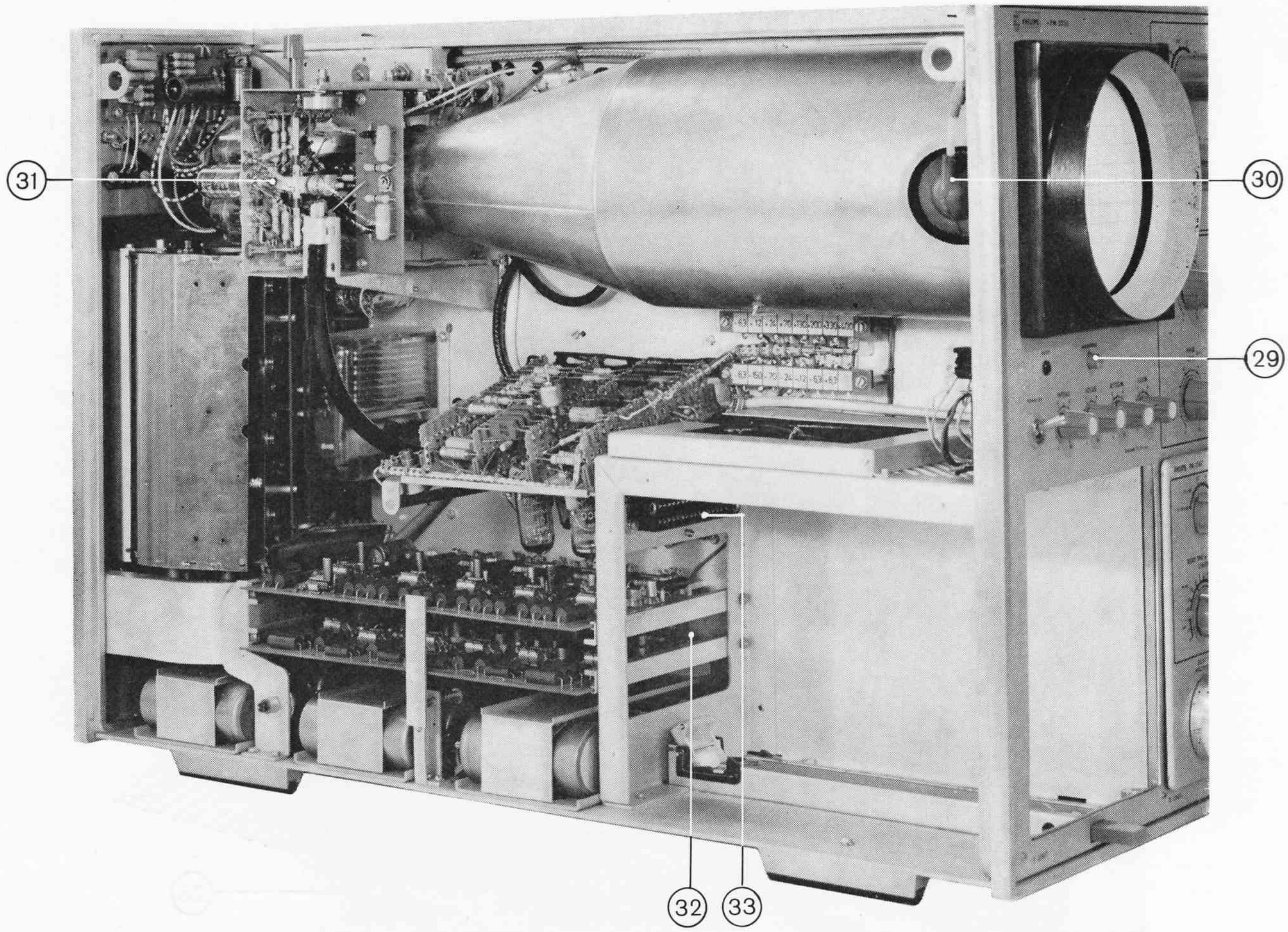


Fig. 71. Components at the interior (left side)

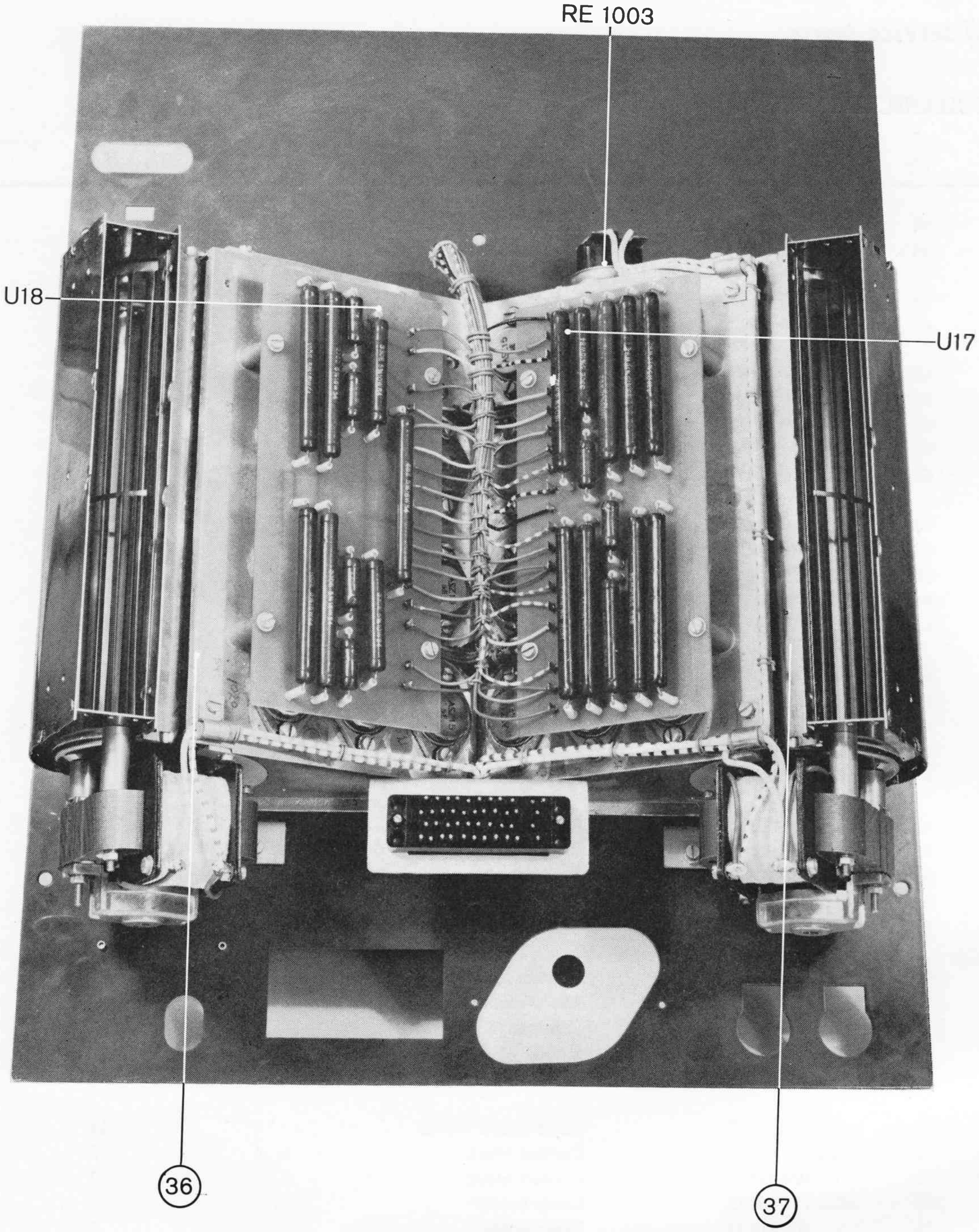


Fig. 72. Components at the interior (rear panel)

List of service parts

XI

A. MECHANICAL PARTS

Item	*Fig.*	*Code number*	*Description*	*Qty.*	*S*
1	68	4822 159 00315	Knob 14Ø, shaft 6Ø	4	**
2	68	4822 159 00314	Cover, white	4	**
3	68	V3 578 72	Mains switch	1	**
4	68	4822 159 00449	Lens, white	1	**
5	68	4822 159 00451	Lens, green	1	**
6	68	4822 276 10095	Push button switch	1	**
7	68	4822 159 00421	Sliding switch, 2pos.	2	**
8	68	4822 159 00318	Knob 23Ø, shaft 6Ø	5	**
9	68	4822 159 00364	Cover, white	2	**
10	68	4822 158 00421	BNC-Connector	1	**
11	68	4822 158 00416	Terminal	4	*
12	68	4822 159 00452	Text plate	1	**
13	68	4822 159 00366	Terminal	2	*
14	68	4822 159 00321	Knob 14Ø, shaft 4Ø	2	**
15	68	4822 157 00359	Push button switch	1	**
16	68	4822 159 00363	Knob 23Ø, shaft 4Ø	3	**
17	68	4822 216 00496	Socket	1	*
18	68	4822 159 00358	Cover, red	6	**
19	68	4822 159 00359	Knob 14Ø, shaft 4Ø	4	**
20	68	4822 159 00446	Push button	2	**
21	69	F101AA/001	Fuse holder	2	*
22	69	M7 757 11	Voltage adapter	1	**
23	69	4822 044 00501	Centre bush	2	**
24	69	4822 136 00058	Contact socket	5	**
25	69	4822 044 00507	Contact block	1	**
26	69	4822 136 00058	Contact socket	38	*
27	69	978/M2×19	Mains connecter	1	*
28	70	4822 159 00459	Filtermat	1	*
29	71	4822 159 00445	Knob	1	*
30	71	M7 289 49	Anode-cap	1	*
31	71	976/9×12	Valve holder Noval	18	*
32	71	4822 072 00092	Contact block	2	**
33	71	W4 125 74	Contact block	2	*
34	56	4822 157 00732	Lamp holder	4	*
35	56	A3 311 15	Lamp holder	2	*
36	72	4822 044 00505	Ventilator, left	1	*
37	72	4822 044 00506	Ventilator, right	1	*
38		976/7×10	Valve holder Min.	2	*
39		4822 159 00458	Valve holder	8	*
40		4822 195 00266	Valve holder for CRT	1	*
41		4822 159 00454	Calibration switch	1	**
42		4822 159 00455	Trigger switch	1	**
43		4822 159 00456	Sweep time switch	1	**
44		4822 159 00457	Deflection switch	1	**

Purpose of the columm "S"

– Components not marked

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

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

– Components marked with one star

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

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

– Components marked with two stars

These components have a long or unlimited service-life and they are not essential for the correct working of the apparatus. Generally they are not stocked locally.

B. ELECTRICAL PARTS

No standard parts are included in this parts list with the exception of choice resistors.
The standard parts in the circuit diagrams are indicated with symbols from which the service code number can be derived.
The key to the code is given below:

Carbon resistor	0.25 W	≤ 1 MΩ : 5 % > 1 MΩ : 10 %	902/K...
Carbon resistor	1 W	≤ 2.2 MΩ : 5 % > 2.2 MΩ : 10 %	900/P...
Carbon resistor	0.5 W	≤ 10 MΩ : 1 % > 10 MΩ : 2 %	901/...
Wire-wound resistor	0.4–1.8 W	0,5%	901/W...
Carbon resistor	0.5 W	≤ 1,5 MΩ : 5 % > 1,5 MΩ : 10 %	902/P...
Wire-wound	5.5 W	≤270 Ω : 10 % >270 Ω : 5 %	938/A...
Wire-wound resistor	10 W	5%	938/B...
Carbon resistor	0.125 W	5 %	902/A...
Ceramic capacitor	500–700 V		904/...
Ceramic pin-up capacitor	500 V		904/P...
Styroflex capacitor	500 V	1 %	905/D...
Polyester capacitor	400 V	10 %	906/...
Paper capacitor	1000 V	10 %	906/V...
Wire-wound trimmer			907/...
Ceramic trimmer (≤22E) Air trimmer (≥30E)			908/...
Air trimmer (for printed-wiring boards)			908/P...

Example:

120K — Code number 901/120K

4.7 — Code number 904/4E7

The correct values of the choice-resistors and capacitors are determined during factory adjustment. All resistors are vaporized carbon resistors, unless otherwise specified.

RESISTORS

No.	*Code number*	*Value*	*Watts*	*%*	*Description*
R1	4822 071 00845	100 kΩ			Potentiometer lin
R2	4822 071 01035	100 kΩ			Dual potentiometer lin
R3	4822 071 01035	100 kΩ			Dual potentiometer lin
R4	4822 071 01039	200 kΩ			Dual potentiometer lin
R5	4822 071 01039	200 kΩ			Dual potentiometer lin
R6	916/GE1M	1 MΩ			Potentiometer lin
R7	916/GE2M	2.2 MΩ			Potentiometer lin
R8	916/GE500K	470 kΩ			Potentiometer lin
R9	M7 637 17	30 Ω			Potentiometer
R10	4822 071 01043	lin 1 MΩ log 20 kΩ			Dual potentiometer
R31	4822 071 00879	2.2 kΩ	3		Wire wound potentiometer
R39	916/GE2K	2.2 kΩ			Potentiometer lin
R55	0...902/A33E	0...33 Ω	0.125	5	Choice resistor
R57	0...902/A33E	0...33 Ω	0.125	5	Choice resistor
R59	4822 140 00379	1 kΩ	4		Carbon
R75	4822 140 00381	250 Ω			Wire wound potentiometer lin
R76	4822 140 00382	3300 Ω	4		Carbon
R79	4822 140 00383	1200 Ω	4		Carbon
R82	916/GE10K	10 kΩ			Potentiometer lin
R87	4822 140 00379	1 kΩ	4		Carbon
R89	902/A...		0.125	5	Choice resistor
R91	4822 140 00379	1 kΩ	4		Carbon
R98	4822 140 00384	560 Ω	4		Carbon
R99	931/A1K	820 Ω	16		Wire wound
R100	4822 140 00384	560 Ω	4		Carbon
R302	902/P2M2...902/P10M	2.2...10 MΩ	0.5	10	Carbon choice
R314	916/GE100K	100 kΩ			Potentiometer lin
R318	916/GE500K	470 kΩ			Potentiometer lin
R319	4822 071 00716	1 kΩ	3		Wire wound potentiometer
R320	916/GE100K	100 kΩ			Potentiometer lin
R324	902/P1M...902/P5M6	1...5.6 MΩ	0.5	10	Carbon choice
R327	914/2.5	2.2 kΩ	3		Wire wound potentiometer
R328					Tandem potentiometer
R436	E199AA/B13B10K	10 kΩ	1		Wire wound potentiometer
R440	E199AA/C21A25E	25 Ω	1		Wire wound potentiometer
R473	901/180K	180 kΩ	0.25	1	Metal film
R484	916/GE20K	22 kΩ			Potentiometer lin
R485	916/GE20K	22 kΩ			Potentiometer lin
R535	4822 071 00966	750 kΩ	0.5	1	Metal film
R540	4822 071 00967	300 kΩ	0.5	1	Metal film
R541	4822 071 00776	150 kΩ	0.5	1	Metal film
R542	4822 071 00779	500 kΩ	0.5	1	Metal film (2 in par.)
R543	4822 071 00968	200 kΩ	0.5	1	Metal film
R544	4822 071 00969	100 kΩ	0.5	1	Metal film
R545	4822 140 00385	15 MΩ	0.5	0.7	Carbon
R546	4822 140 00385	7.5 MΩ	0.5	0.7	Carbon (2 in par.)
R547	B8 305 27E/3M	3 MΩ	0.5	0.7	Carbon
R548	B8 305 27E/1M5	1.5 MΩ	0.5	0.7	Carbon
R554	E199AA/B13B500E	500 Ω	1		Wire wound potentiometer
R584	E199AA/B13B5K	5 kΩ	1		Wire wound potentiometer

No.	Code number	Value		Watts	%	Description
R589	E199AA/B13B10K	10	kΩ	1		Wire wound potentiometer
R601	916/GE100K	100	kΩ			Potentiometer lin
R702	901/1K8	900	Ω	0.25	1	Carbon (2 in par.)
R703	901/1M5//901/120K	111	kΩ	0.25	1	Carbon (in par.)
R714	4822 071 00892	10	kΩ	3		Wire wound potentiometer
R731	E199AA/B13B500E	500	Ω	1		Wire wound potentiometer
R738	E199AA/B13B5K	5	kΩ	1		Wire wound potentiometer
R742	4822 071 00968	100	kΩ	1	1	Metal film (2 in par.)
R753	4822 071 00968	100	kΩ	1	1	Metal film (2 in par.)
R1005	902/K82E...902/K2K7	82...2700	Ω	0.25	5	Choice resistor
R1006	4822 071 01011	4.7	Ω	2		Wire wound resistor
R1008	4822 071 00971	33	kΩ	0.5	1	Metal film
R1009	901/W5K6	5.6	kΩ	0.5	1	Wire wound
R1014	4822 071 00971	33	kΩ	0.5	1	Metal film
R1016	4822 071 00972	76.7	kΩ	0.5	1	Metal film
R1017	931/A330E	330	Ω	16	5	Wire wound
R1018	931/A330E	330	Ω	16	5	Wire wound
R1019	931/A330E	330	Ω	16	5	Wire wound
R1023	902/K82E...902/K2K7	82...2700	Ω	0.25	5	Choice resistor
R1024	4822 071 01009	2.7	Ω	2		Wire wound
R1025	902/K...			0.25	5	Choice resistor
R1027	4822 071 00973	68	kΩ	0.5	1	Metal film
R1028	901/W5K6	5.6	kΩ	0.5	1	Wire wound
R1033	4822 071 00973	68	kΩ	0.5	1	Metal film
R1034	4822 071 00974	44.7	kΩ	0.5	1	Metal film
R1036	931/A270E	220	Ω	16	5	Wire wound
R1037	931/A270E	220	Ω	16	5	Wire wound
R1041	902/K82E...902/K2K7	82...2700	Ω	0.25	5	Choice resistor
R1042	4822 071 01009	2.7	Ω	2		Wire wound
R1044	4822 071 00971	33	kΩ	0.5	1	Metal film
R1045	902/K...			0.25	5	Choice resistor
R1046	901/W5K6	5.6	kΩ	0.5	1	Wire wound
R1051	4822 071 00971	33	kΩ	0.5	1	Metal film
R1052	4822 071 00972	76.5	kΩ	0.5	1	Metal film
R1053	931/A180E	180	Ω	16	5	Wire wound
R1054	931/A180E	180	Ω	16	5	Wire wound
R1056	931/A180E	180	Ω	16	5	Wire wound
R1057	931/A180E	180	Ω	16	5	Wire wound
R1059	902/K...			0.25	5	Choice resistor
R1062	902/K...			0.25	5	Choice resistor
R1067	902/K82E...902/K2K7	82...2700	Ω	0.25	5	Choice resistor
R1068	4822 071 01009	2.7	Ω	2		Wire wound
R1071	4822 071 00973	68	kΩ	0.5	1	Metal film
R1072	901/W5K6	5.6	kΩ	0.5	1	Wire wound
R1076	4822 071 00973	68	kΩ	0.5	1	Metal film
R1077	4822 071 00975	89.6	kΩ	0.5	1	Metal film
R1083	902/K82E...902/K2K7	82...2700	Ω	0.25		Choice resistor
R1084	4822 071 01009	2.7	Ω	2		Wire wound
R1096	4822 071 00971	33	kΩ	0.5	1	Metal film
R1097	B8 305 83E/40K	20	kΩ	0.5	1	Metal film
R1098	4822 071 00878	4.7	kΩ	3		Wire wound potentiometer
R1111	902/K82E...902/K2K7	82...2700	Ω	0.25		Choice resistor

No.	Code number	Value	Watts	%	Description
R1113	4822 071 01011	4.7 Ω	2		Wire wound
R1117	4822 071 00971	33 kΩ	0.5	1	Metal film
R1118	901/W5K6	5.6 kΩ	0.5	1	Wire wound
R1122	4822 071 00971	33 kΩ	0.5	1	Metal film
R1123	4822 071 00976	87.6 kΩ	0.5	1	Metal film
R1127	931/A68E	68 Ω	16	5	Wire wound
R1133	902/K82E...902/K2K7	82...2700 Ω	0.25	5	Choice resistor
R1136	4822 071 01008	1.1 Ω	2		Wire wound
R1139	B8 305 83E/10K	10 kΩ	0.25	1	Metal film
R1141	4822 071 00789	2.2 kΩ	0.25	1	Metal film (2 in par.)
R1144	B8 305 83E/10K	10 kΩ	0.25	1	Metal film
R1146	4822 071 00977	77.7 kΩ	0.5	1	Metal film
R1152	48 768 05/18E	18 Ω	16	5	Wire wound
R1154	4822 071 01007	0.27 Ω	2		Wire wound
R1159	4822 071 00789	2.2 kΩ	0.25	2	Metal film (2 in par.)
R1161	901/W820E	820 Ω	0.25	1	Wire wound
R1164	4822 071 00789	2.2 kΩ	0.25	2	Metal film (2 in par.)
R1166	4822 071 00978	72.1 kΩ	0.5	1	Metal film
R1172	48 768 05/18E	18 Ω	16	5	Wire wound
R1174	4822 071 01007	0.27 Ω	2		Wire wound
R1179	4822 071 00789	2.2 kΩ	0.25	2	Metal film (2 in par.)
R1181	901/W820E	820 Ω	0.25	1	Wire wound
R1184	4822 071 00789	2.2 kΩ	0.25	2	Metal film (2 in par.)
R1186	4822 071 00979	69.1 kΩ	0.5	1	Metal film
R1188	931/A68E	68 Ω	16	5	Wire wound
R1194	902/K82E...902/K2K7	82...2700 Ω	0.25	5	Choice resistor
R1197	4822 071 01008	1.1 Ω	2		Wire wound
R1201	B8 305 83E/10K	10 kΩ	0.25	1	Metal film
R1202	4822 071 00789	2.2 kΩ	0.25	2	Metal film (2 in par.)
R1206	B8 305 83E/10K	10 kΩ	0.25	1	Metal film
R1207	901/W5K6	5.6 kΩ	0.5	1	Wire wound
R1213	902/K82E...902/K2K7	82...2700 Ω	0.25	5	Choice resistor
R1216	4822 071 01011	4.7 Ω	2		Wire wound
R1217	4822 071 00971	33 kΩ	0.5	1	Metal film
R1218	901/W5K6	5.6 kΩ	0.5	1	Wire wound
R1223	4822 071 00971	33 kΩ	0.5	1	Metal film
R1224	4822 071 00981	49.3 kΩ	0.5	1	Metal film
R1313	916/GE1M	1 MΩ			Potentiometer lin
R1326	916/GE200K	200 kΩ			Potentiometer lin
R1410	4822 071 00969	50 kΩ	0.5	0.7	Metal film (2 in par.)
R1411	4822 071 00892	10 kΩ	3		Wire wound potentiometer
R1412	4822 071 00969	50 kΩ	0.25	0.7	Metal film (2 in par.)
R1415	4822 071 00783	50 Ω	0.25	1	Metal film
R1417	B8 305 83E/10K	10 kΩ	0.5	1	Metal film
R1418	4822 071 00982	5680 Ω	0.25	1	Metal film
R1419	4822 071 00983	2780 Ω	0.25	1	Metal film
R1421	901/W1K6	801 Ω	0.25	1	Wire wound (2 in par.)
R1422	4822 071 00984	378 Ω	0.25	1	Metal film
R1423	901/W220E	220 Ω	0.25	1	Metal film
R1424	4822 071 00985	72.3 Ω	0.25	1	Metal film
R1426	4822 071 00986	35.9 Ω	0.25	1	Metal film
R1427	4822 071 00986	35.9 Ω	0.25	1	Metal film
R1428	4822 071 00987	0.22 Ω	1		Transistor resistor

CAPACITORS

No.	*Code number*	*Value*	*Volts*	*Description*
C27	4822 069 01103	68 nF	500	Plate capacitor
C31	4822 069 01103	68 nF	500	Plate capacitor
C38	909/W40	40 µF	16	Electrolytic
C39	909/W40	40 µF	16	Electrolytic
C40	4822 069 01064	100 nF	250	Polyester
C55	C 005 AA/25E	25 pF		Trimmer
C301	4822 140 00375	8.2 nF	2000	HV Capacitor
C303	4822 140 00376	20 nF	2000	HV Capacitor
C411	909/W20	20 µF	16	Electrolytic
C415	4822 069 01093	10 nF	250	Plate capacitor
C511	4822 141 00242	1 µF		Box capacitor
C512	4822 141 00242	100 nF		Box capacitor
C513	4822 141 00242	10 nF		Box capacitor
C514	905/D430E + 905/D560E	990 pF	250	Styroflex (in parallel)
C539	4822 069 01064	100 nF	250	Polyester
C543	4822 069 01064	100 nF	250	Polyester
C1001	4822 218 00224	200 µF	325	Electrolytic
C1003	911/L50	50 µF	200	Electrolytic
C1008	911/L50	50 µF	200	Electrolytic
C1006	4822 218 00224	200 µF	325	Electrolytic
C1011	4822 218 00224	200 µF	325	Electrolytic
C1013	911/L50	50 µF	200	Electrolytic
C1016	4822 218 00224	200 µF	325	Electrolytic (in parallel)
C1018	911/L50	50 µF	200	Electrolytic
C1021	4822 218 00224	200 µF	325	Electrolytic
C1022	909/Z100	100 µF	64	Electrolytic
C1023	911/L50	50 µF	200	Electrolytic
C1026	4822 069 00622	1 µF	250	Electrolytic
C1027	4822 069 01071	47 nF	250	Polyester
C1031	4822 218 00224	200 µF	325	Electrolytic
C1033	911/L50	50 µF	200	Electrolytic
C1036	4822 069 00698	4,000 µF	40	Electrolytic
C1038	4822 069 00703	50 µF	40	Electrolytic
C1041	4822 069 00905	10,000 µF	16	Electrolytic
C1044	909/C50	50 µF	25	Electrolytic
C1046	4822 069 00905	10,000 µF	16	Electrolytic
C1049	909/C50	50 µF	25	Electrolytic
C1051	4822 069 00698	4,000 µF	40	Electrolytic
C1053	4822 069 00703	50 µF	40	Electrolytic
C1056	4822 218 00224	200 µF	325	Electrolytic
C1057	911/L50	50 µF	200	Electrolytic
C1302	909/C12½	12.5 µF	25	Electrolytic
C1303	909/M8	8 µF	350	Electrolytic
C1307	4822 140 00377	5 nF	3,000	HV Capacitor
C1308	4822 140 00377	5 nF	3,000	HV Capacitor
C1309	4822 140 00378	500 pF	10,000	HV Capacitor
C1311	4822 140 00378	500 pF	10,000	HV Capacitor
C1312	4822 140 00378	500 pF	10,000	HV Capacitor
C1313	4822 140 00378	500 pF	10,000	HV Capacitor
C1314	3822 140 00377	5 nF	3,000	HV Capacitor
C1316	4822 140 00377	5 nF	3,000	HV Capacitor
C1317	4822 140 00377	5 nF	3,000	HV Capacitor
C1404	4822 069 01064	100 nF	250	Polyester
C1406	4822 069 01064	100 nF	250	Polyester

COILS

No.	Code number	Description
L26	4822 159 00492	Coil
L27	4822 159 00493	Coil
L28	4822 159 00492	Coil
L29	4822 159 00493	Coil
L30	4822 159 00462	Coil
L31	4822 159 00494	Coil
L32	4822 156 20284	Coil
L33	4822 156 20283	Coil
L34	4822 159 00494	Coil
L35	4822 156 20284	Coil
L36	4822 156 20283	Coil
L37	4822 159 00462	Coil
L38	4822 158 00462	Coil
L40...L49	4822 061 00079	Coil
L401	4822 128 00272	Coil
L402	4822 061 00079	Coil
L451	4822 159 00464	Coil
L452	4822 159 00464	Coil
L453...L459	4822 061 00079	Coil
L501	4822 159 00463	Coil
L502... L505	4822 061 00079	Coil

MISCELLANEOUS

No.	Code number	Description
T401	K3 004 07	Transformer (furnished by Com Dept. Elcoma)
T1001	4822 159 00461	Mains transformer
T1301	4822 117 00409	HT transformer
VL1	974/V4000	Fuse
VL2	974/V4000	Fuse
RE1001	4822 159 00447	Relay
RE1002	4822 159 00465	Thermal delay switch
RE1003	4822 159 00466	Thermostat
Unit 5	4822 159 00467	Calibration unit
Unit 6	4822 159 00468	TV sync. unit
Unit 7	4822 159 00469	X-defl. pre-amplifier
Unit 8	4822 159 00471	Rectifier unit
Unit 11	4822 159 00472	Power supply 1
Unit 12	4822 159 00473	Power supply 2
Unit 13	4822 159 00474	Final amplifier
Unit 16	4822 159 00475	CRT unit
Unit 17	4822 159 00476	Power supply resistor unit
Unit 18	4822 159 00477	Power supply resistor unit

VALVES, SEMI-CONDUCTORS ETC.

The following parts are furnished by Com. Dept. Elcoma

DIODES

No.	Code number	Description
GR401	AAZ17	Germanium diode
GR402	4822 128 00613 (= 1N3149)	Tunnel diode (furnished by Central Service)
GR403	OA202	Silicon diode
GR404	OA85	Germanium diode
GR405	OA85	Germanium diode
GR501	OA85	Germanium diode
GR502	OA202	Silicon diode
GR503	OA202	Silicon diode
GR504	OA202	Silicon diode
GR505	OA70	Germanium diode
GR506	AAZ15	Germanium diode
GR701	BZY69	Zener diode
GR1001	BY100S	Silicon diode
GR1002	BY100S	Silicon diode
GR1003	BY100S	Silicon diode
GR1004	BY100S	Silicon diode
GR1005	OAZ204	Zener diode
GR1006	BY100S	Silicon diode
GR1007	BY100S	Silicon diode
GR1008	BY100S	Silicon diode
GR1009	BY100S	Silicon diode
GR1010	OAZ204	Zener diode
GR1011	BY100S	Silicon diode
GR1012	BY100S	Silicon diode
GR1013	BY100S	Silicon diode
GR1014	BY100S	Silicon diode
GR1015	OAZ204	Zener diode
GR1016	BYZ10	Silicon diode
GR1017	BYZ10	Silicon diode
GR1018	BYZ10	Silicon diode
GR1019	BYZ10	Silicon diode
GR1020	OAZ204	Zener diode
GR1021	BY100S	Silicon diode
GR1022	BY100S	Silicon diode
GR1023	BY100S	Silicon diode
GR1024	BY100S	Silicon diode
GR1025	OAZ204	Zener diode
GR1026	OAZ204	Zener diode
GR1027	BY100S	Silicon diode
GR1028	BY100S	Silicon diode

No.	Code number	Description
GR1029	BY100S	Silicon diode
GR1030	BY100S	Silicon diode
GR1031	BY100S	Silicon diode
GR1032	BZY69	Silicon diode
GR1036	BY100S	Silicon diode
GR1037	BY100S	Silicon diode
GR1038	BY100S	Silicon diode
GR1039	BY100S	Silicon diode
GR1041	BYY21	Silicon diode
GR1042	BYY21	Silicon diode
GR1043	BYY20	Silicon diode
GR1044	BYY20	Silicon diode
GR1045	BZZ22	Zener diode
GR1046	BYY21	Silicon diode
GR1047	BYY21	Silicon diode
GR1048	BYY20	Silicon diode
GR1049	BYY20	Silicon diode
GR1051	BYY21	Silicon diode
GR1052	BYY21	Silicon diode
GR1053	BYY20	Silicon diode
GR1054	BYY20	Silicon diode
GR1056	BYY21	Silicon diode
GR1057	BYY21	Silicon diode
GR1058	BYY20	Silicon diode
GR1059	BYY20	Silicon diode
GR1061	OAZ204	Zener diode
GR1062	BZZ22	Zener diode
GR1063	BY100S	Silicon diode
GR1064	BY100S	Silicon diode
GR1065	BY100S	Silicon diode
GR1066	BY100S	Silicon diode
GR1067	OAZ204	Zener diode
GR1301	BYX11	Silicon diode
GR1302	BYX11	Silicon diode
GR1303	BXY11	Silicon diode
GR1304	BYX11	Silicon diode
GR1305	BYX11	Silicon diode

TRANSISTORS

No.	Code number	Description
TS301	AF118	Germanium transistor
TS401	ASZ20	Germanium transistor
TS403	ASZ20	Germanium transistor
TS404	BSY39	Silicon transistor
TS1001	ASZ15	Germanium power transistor
TS1002	ASZ15	Germanium power transistor
TS1003	AC128	Germanium transistor
TS1004	ASY80	Germanium switching transistor
TS1005	BCY31	Silicon transistor
TS1006	BCY31	Silicon transistor
TS1007	ASZ15	Germanium power transistor
TS1008	ASZ15	Germanium power transistor
TS1009	ASZ15	Germanium power transistor
TS1010	AC128	Germanium transistor
TS1011	ASY80	Germanium switching transistor
TS1012	BCY31	Silicon transistor
TS1013	BCY31	Silicon transistor
TS1014	ASZ15	Germanium power transistor
TS1015	ASZ15	Germanium power transistor
TS1016	AC128	Germanium transistor
TS1017	ASY80	Germanium switching transistor
TS1018	BCY31	Silicon transistor
TS1019	BCY31	Silicon transistor
TS1020	ASZ15	Germanium power transistor
TS1021	ASZ15	Germanium power transistor
TS1022	ASZ15	Germanium power transistor
TS1023	ASZ15	Germanium power transistor
TS1024	BCY31	Silicon transistor
TS1026	BCY32	Silicon transistor
TS1027	BCY32	Silicon transistor
TS1028	AC128	Germanium transistor
TS1029	ASY80	Germanium switching transistor
TS1030	BCY31	Silicon transistor
TS1031	BCY31	Silicon transistor
TS1032	ASZ15	Germanium power transistor
TS1033	ASZ15	Germanium power transistor
TS1034	ASZ15	Germanium power transistor
TS1035	ASZ15	Germanium power transistor
TS1036	AC128	Germanium transistor
TS1037	ASY80	Germanium switching transistor
TS1038	ASY80	Germanium switching transistor
TS1039	BCY31	Silicon transistor
TS1041	ASZ15	Germanium power transistor
TS1042	ASZ15	Germanium power transistor
TS1043	AC128	Germanium transistor
TS1044	ASY80	Germanium switching transistor
TS1045	BCY31	Silicon transistor
TS1046	BCY31	Silicon transistor
TS1047	ASZ16	Germanium power transistor
TS1048	ASY80	Germanium switching transistor
TS1049	AC128	Germanium transistor
TS1050	ASY80	Germanium switching transistor
TS1051	BCY31	Silicon transistor
TS1052	BCY31	Silicon transistor
TS1053	ASZ16	Germanium power transistor
TS1054	ASY80	Germanium switching transistor
TS1055	ASY80	Germanium switching transistor
TS1056	AC128	Germanium transistor
TS1057	BCY31	Silicon transistor
TS1058	BCY31	Silicon transistor
TS1059	ASZ16	Germanium power transistor
TS1060	ASY80	Germanium switching transistor
TS1061	ASY80	Germanium switching transistor
TS1062	AC128	Germanium transistor
TS1063	BCY31	Silicon transistor
TS1064	BCY31	Silicon transistor
TS1065	ASZ16	Germanium power transistor
TS1066	ASY80	Germanium switching transistor
TS1067	AC128	Germanium transistor

No.	Code number	Description
TS1068	ASY80	Germanium switching transistor
TS1069	BCY31	Silicon transistor
TS1070	BCY31	Silicon transistor
TS1071	ASZ15	Germanium power transistor
TS1072	ASZ15	Germanium power transistor
TS1073	AC128	Germanium transistor
TS1074	ASY80	Germanium switching transistor
TS1075	BCY31	Silicon transistor
TS1076	BCY31	Silicon transistor

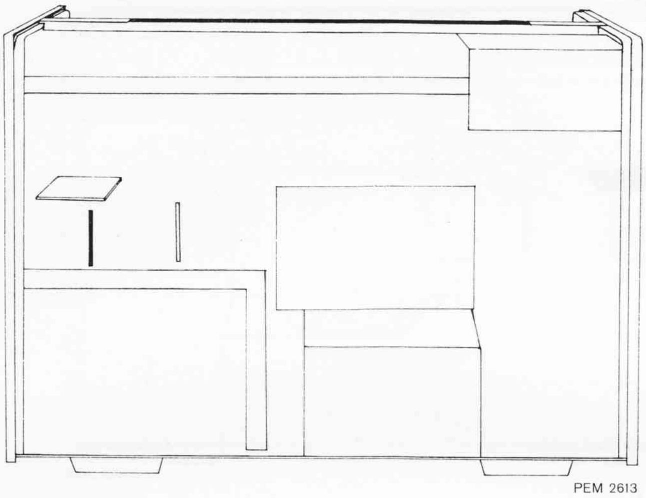
VALVES

No.	Code number	Description
B1	E188CC	Double triode
B2	E810F	Penthode
B3	E810F	Penthode
B4	E188CC	Double triode
B5	E55L	Penthode
B6	E55L	Penthode
B301	D13-16/1GH	Cathode-ray tube
B401	EF184	Penthode
B402	EF184	Penthode
B451	E188CC	Double triode
B452	E182CC	Double triode
B453	ECC83	Double triode
B454	E188CC	Double triode
B501	EF184	Penthode
B502	E88CC	Double triode
B503	E88CC	Double triode
B504	5726	Double triode
B506	E81L	Penthode
B507	E88CC	Double triode
B508	E88CC	Double triode

No.	Code number	Dhecription
B509	E88CC	Double triode
B511	E80CF	Triode penthode
B512	4654	Penthode
B513	E80CF	Triode penthode
B514	ZA1004	Neon stabiliser
B701	E88CC	Double triode
B702	E88CC	Double triode
B703	E810F	Double triode
B704	E810F	Penthode
B705	E88CC	Double triode
B706	E88CC	Double triode
B1001	ZZ1000	Stabiliser valve
B1301	EL86	Penthode
B1302	ECC82	Double triode
B1303	5642	Diode
B1304	5642	Diode
B1305	5642	Diode
B1401	E80CF	Triode penthode
B1402	5718	Triode

LAMPS

No.	Code number	Description
LA1	6828	6 V-0.6 W
LA2	6828	6 V-0.6 W
LA3	6828	6 V-0.6 W
LA4	6828	6 V-0.6 W
LA5	955/D10 × 200	10 V-200 mA (furnished by Central Service)
LA6	8108D	
LA7		
LA8	GL8	Neon tube
LA9	GL8	Neon tube
LA10	GL8	Neon tube



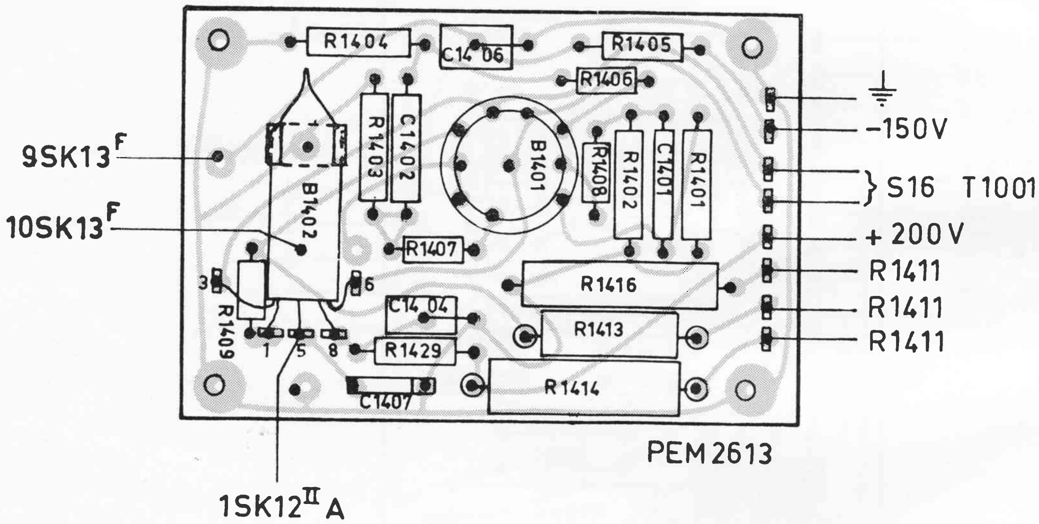
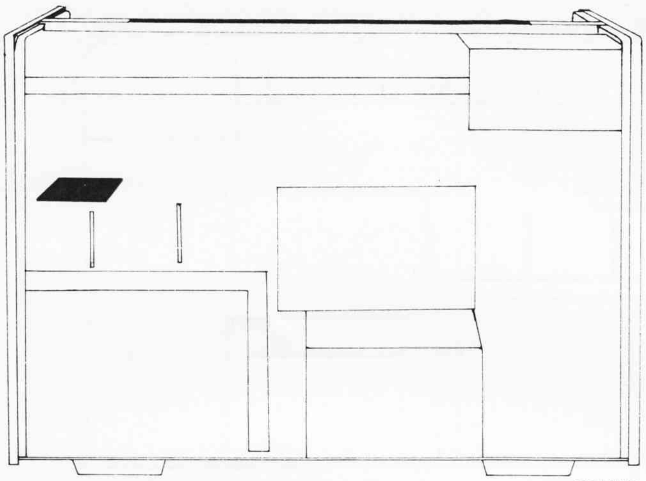


Fig. 73. Printed circuit board U5 (calibration voltage)



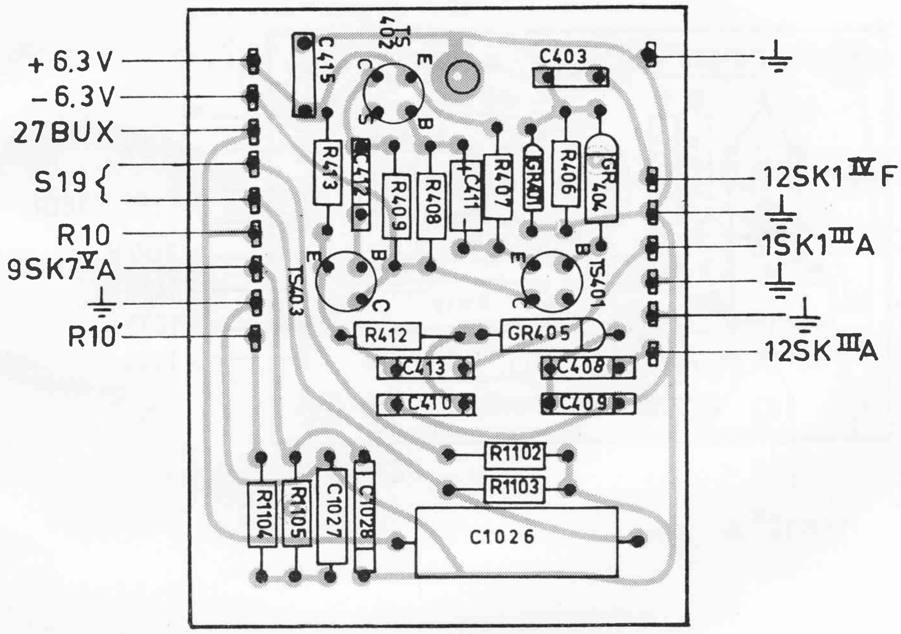
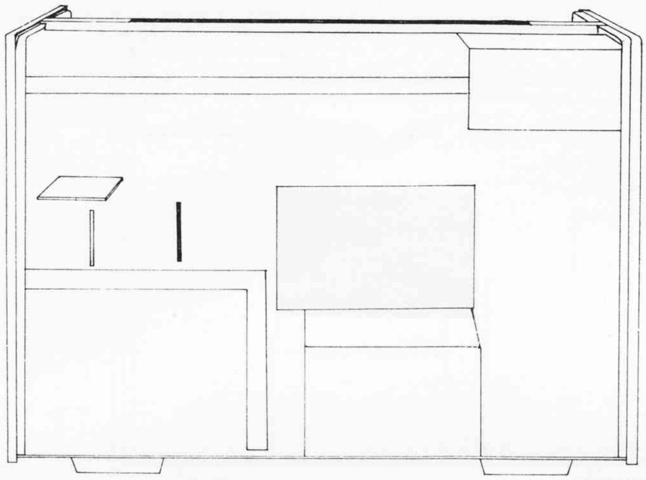


Fig. 74. Printed circuit board U6 (TV sync.)



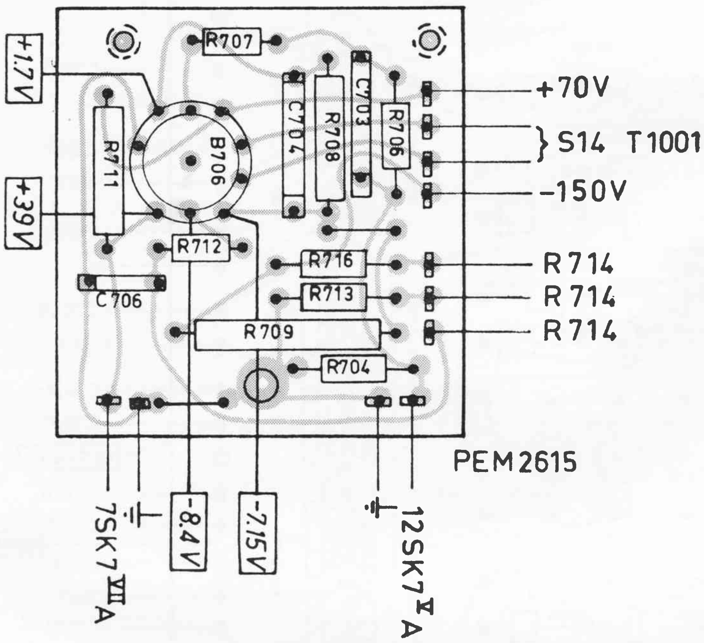
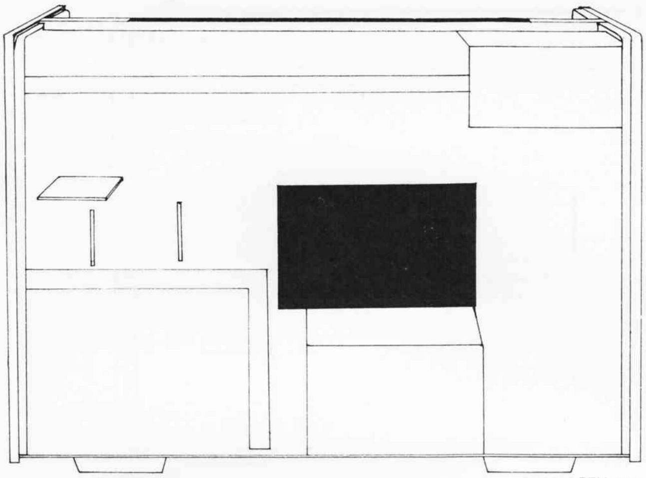


Fig. 75. Printed circuit board U7 (horizontal preamplifier)



PEM 2616

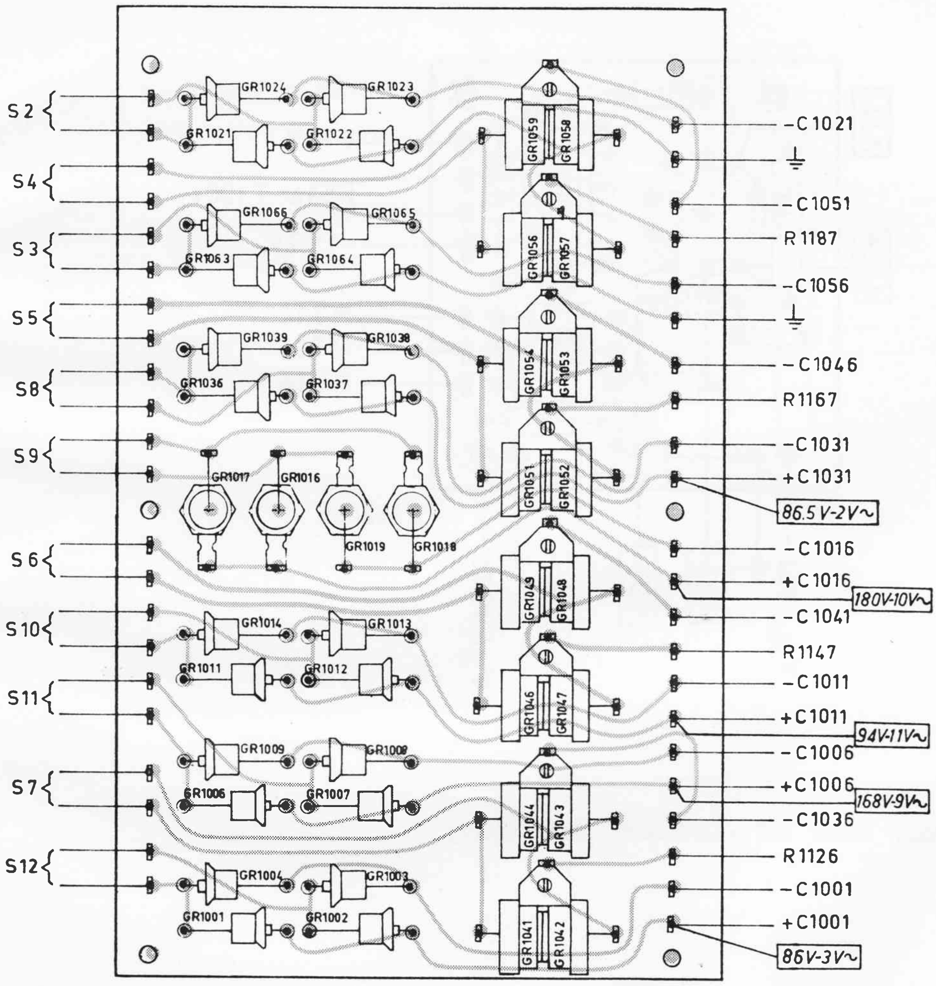
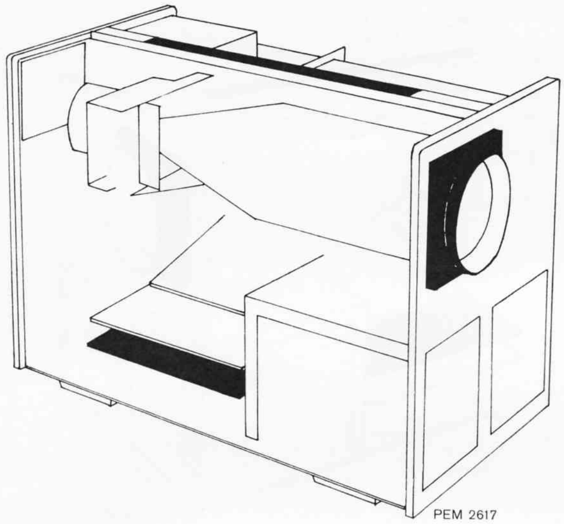


Fig. 76. Printed circuit board U8 (rectifiers)



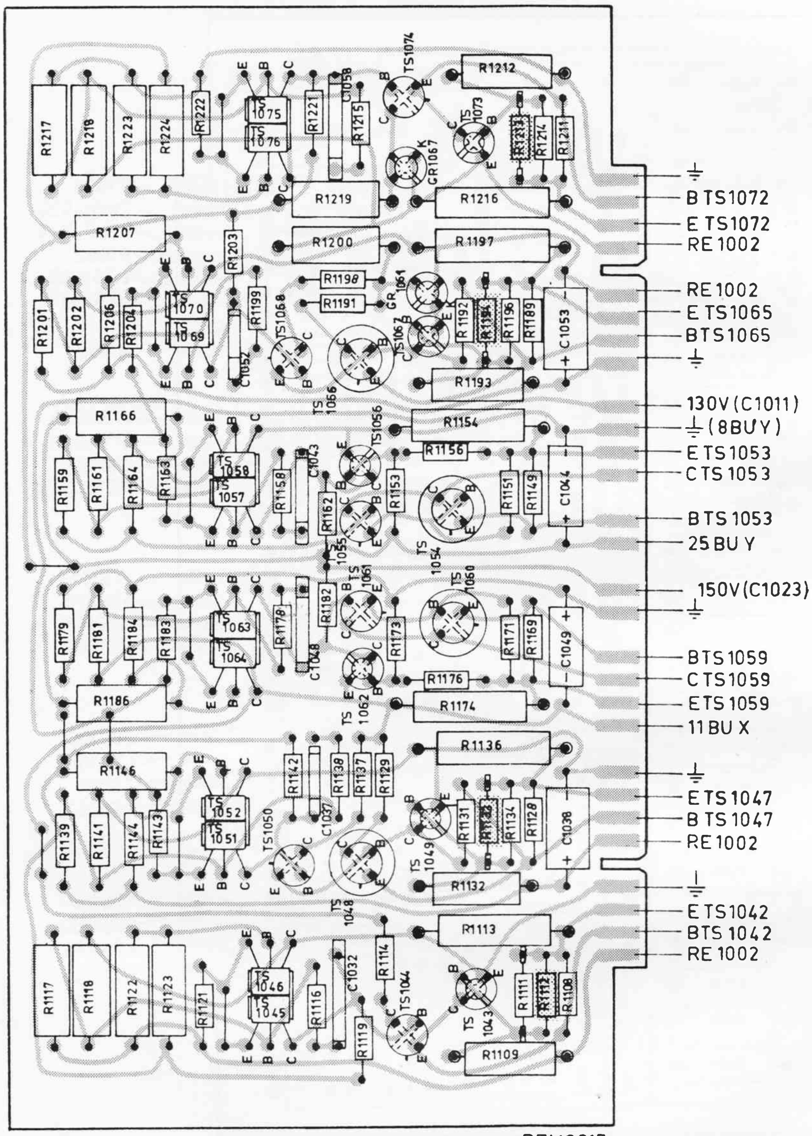
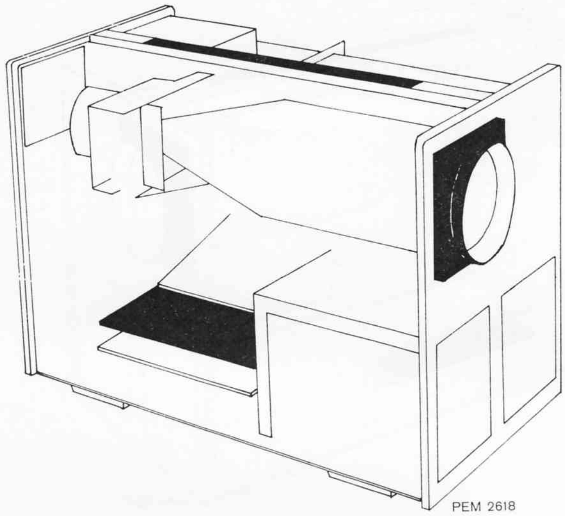


Fig. 77. Printed circuit board U11 (power supply I)



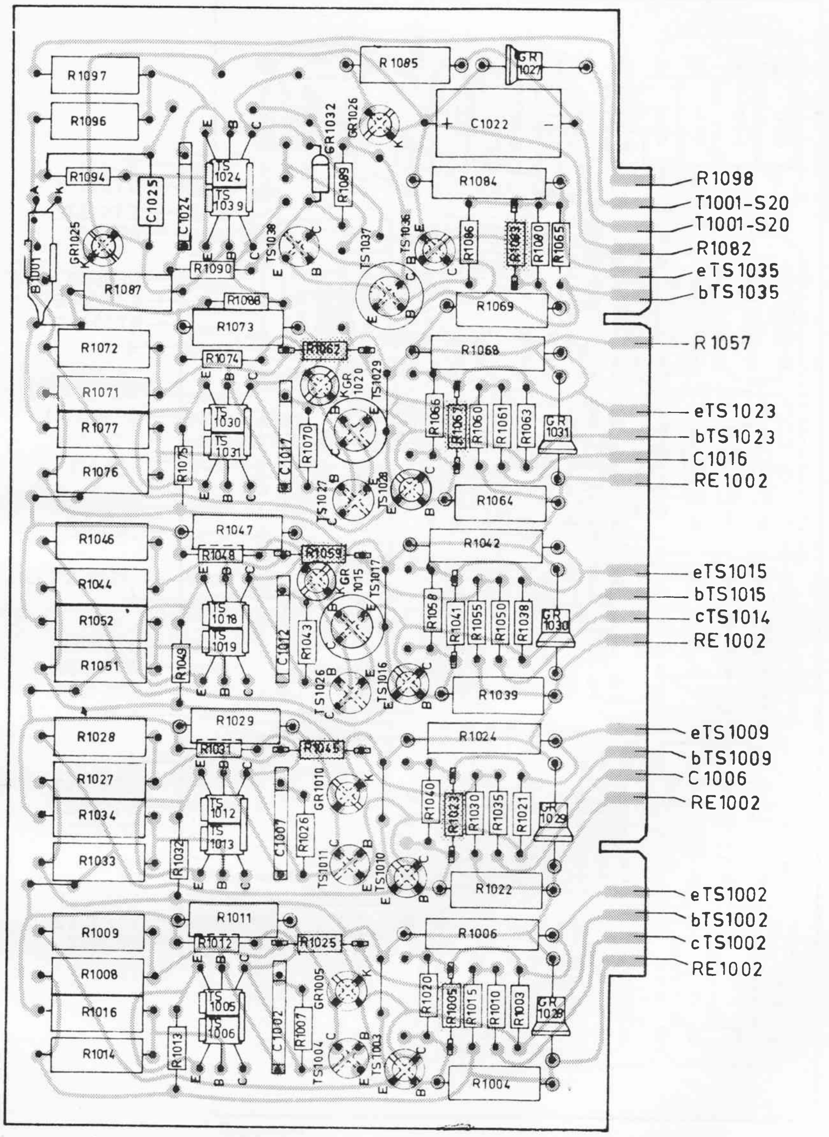
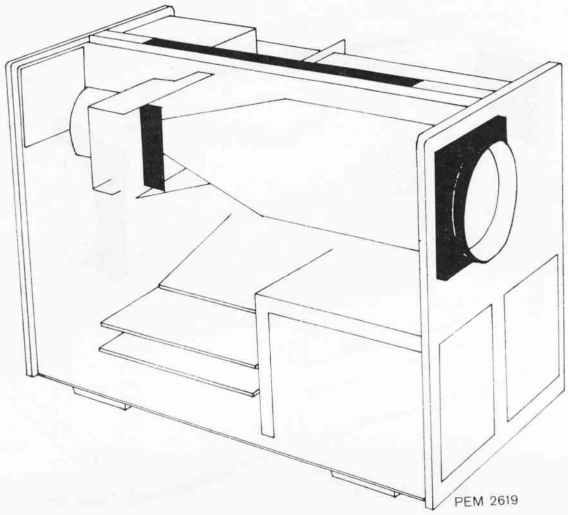


Fig. 78. Printed circuit board U12 (power supply II)



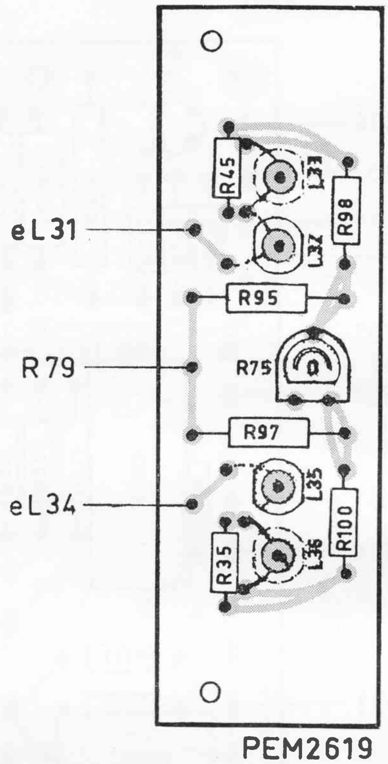
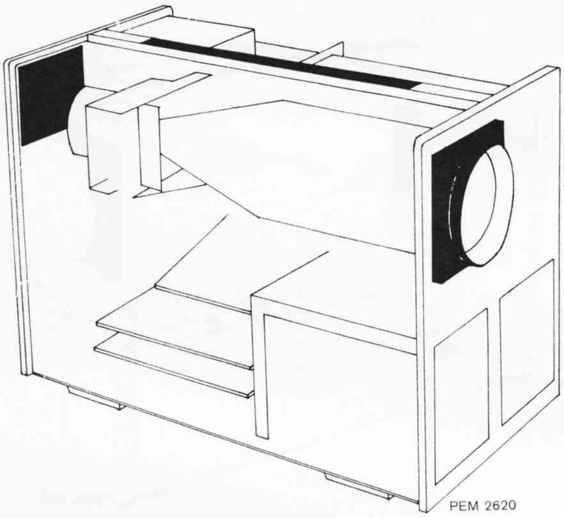


Fig. 79. Printed circuit board U14 (power amplifier)



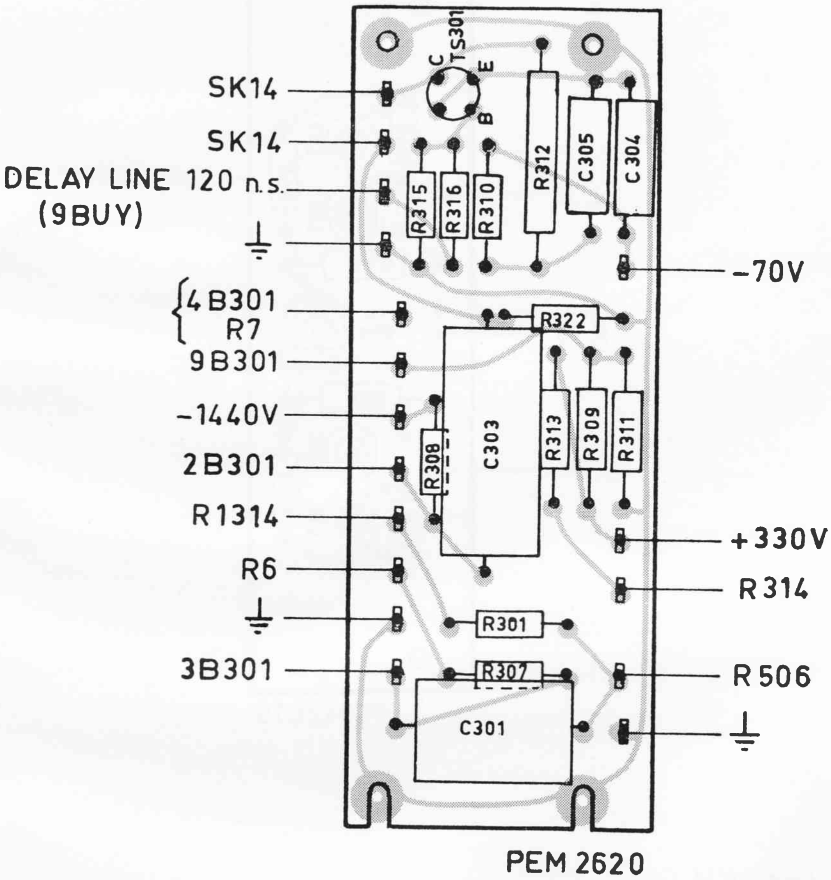
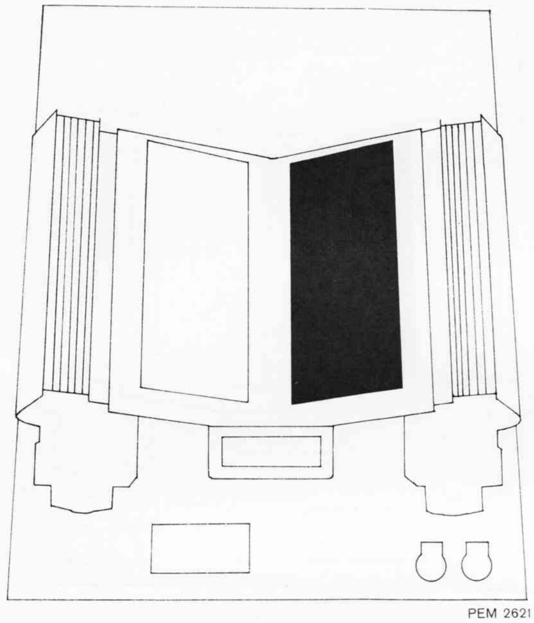


Fig. 80. Printed circuit board U16 (CRT circuit)



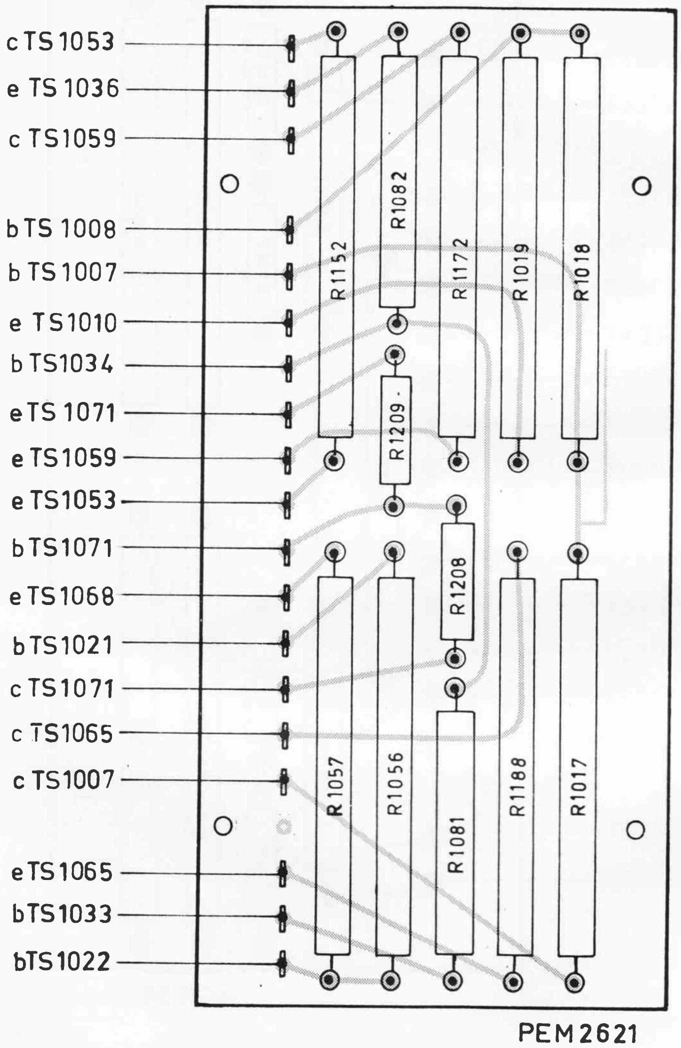
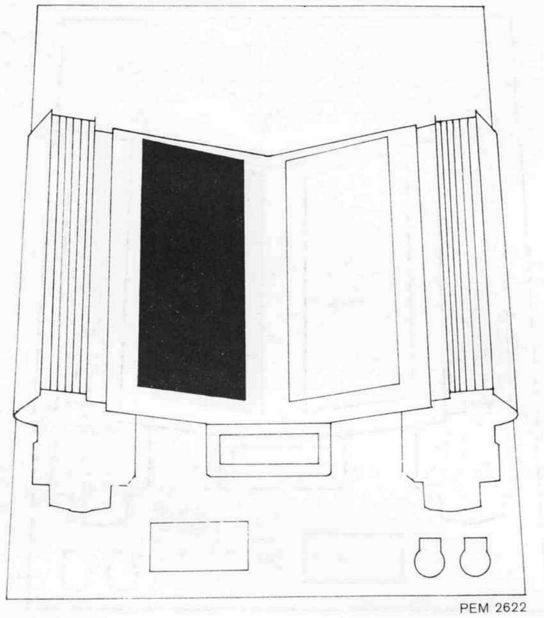


Fig. 81. Printed circuit board U17 (power supply resistors)



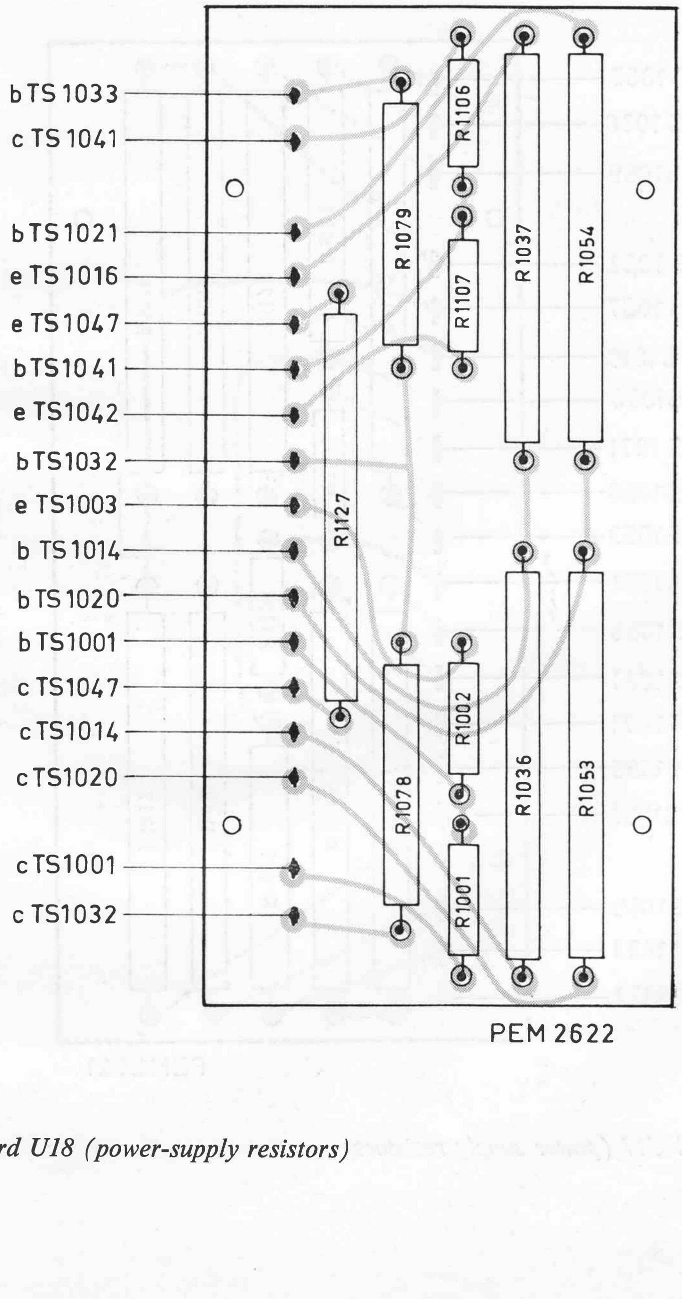
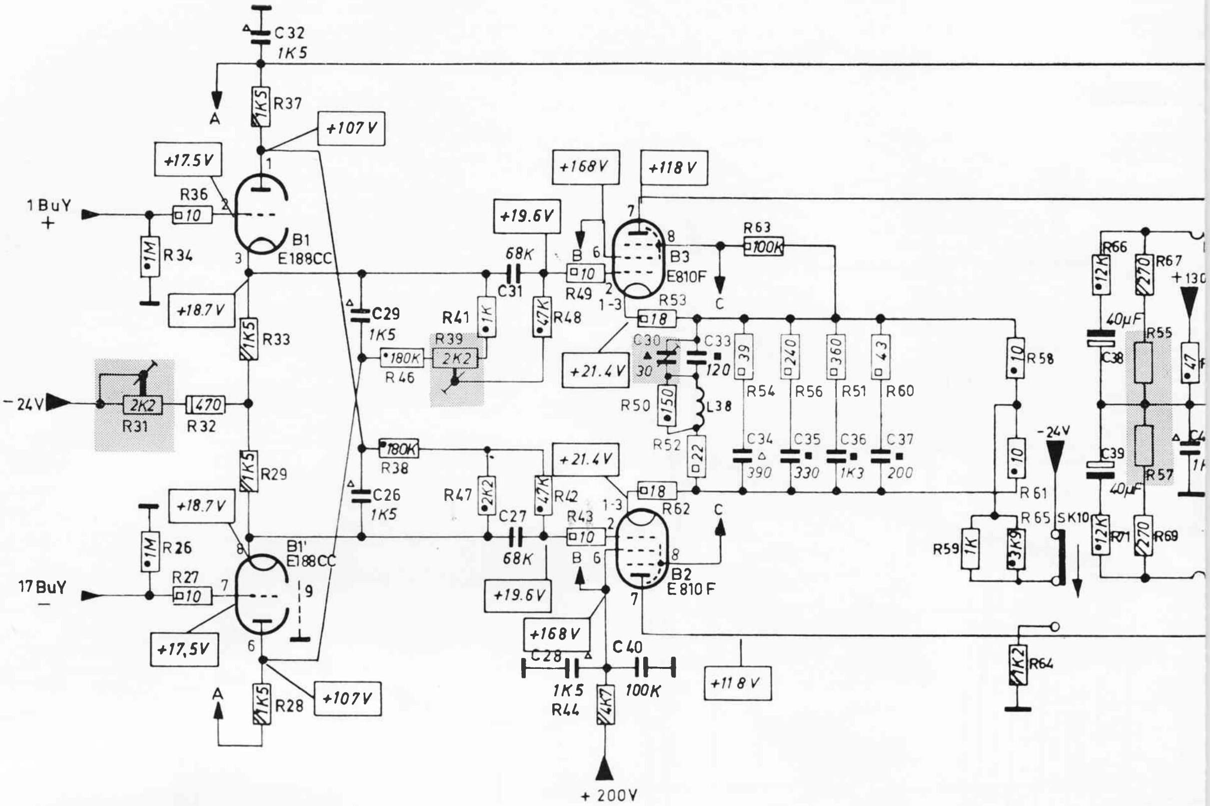
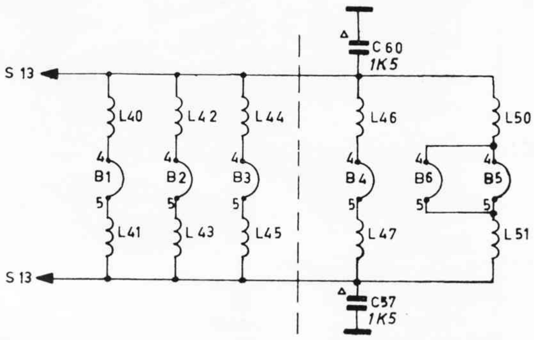
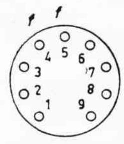


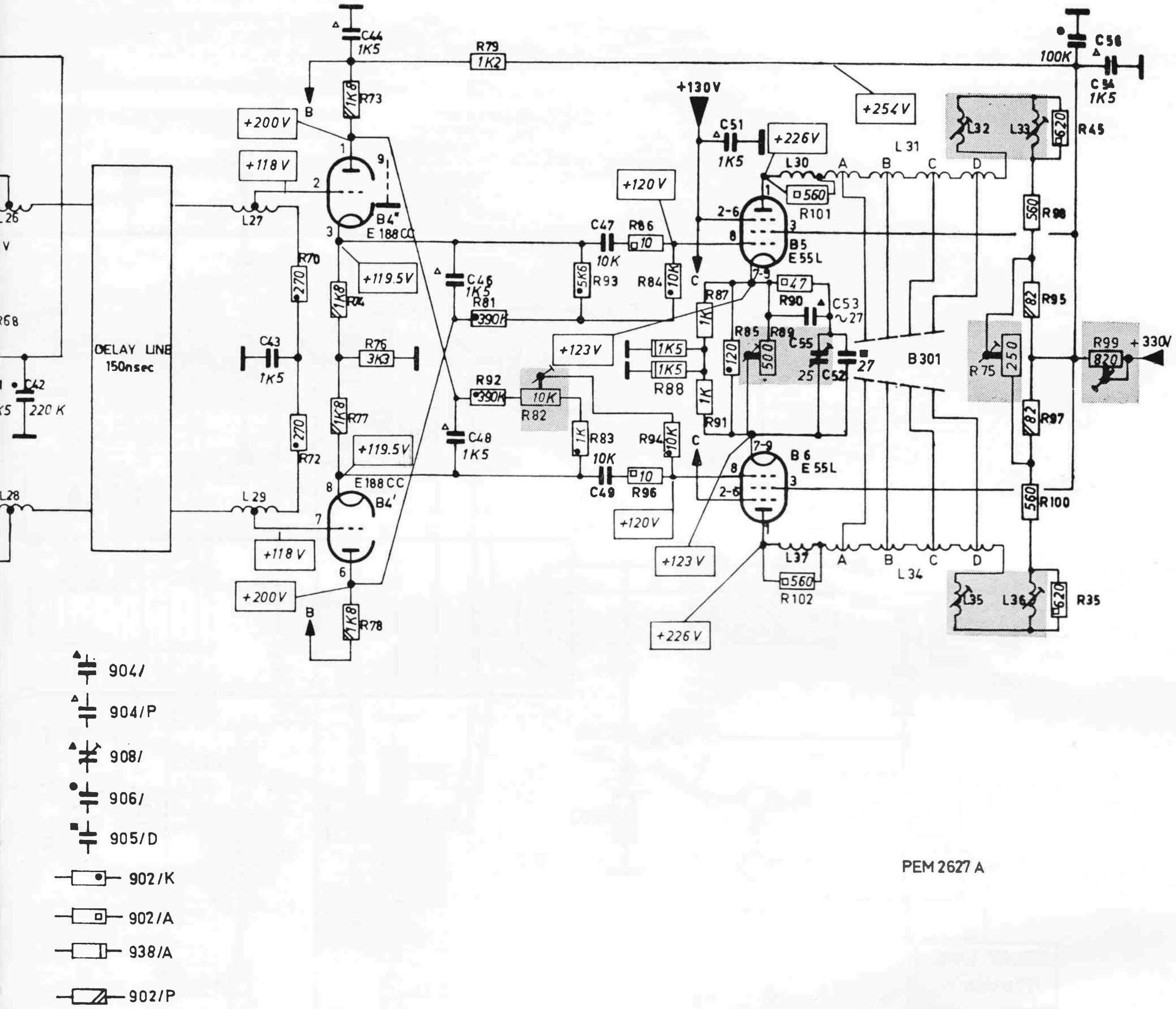
Fig. 82. Printed circuit board U18 (power-supply resistors)







B1, B2, B3,
B4, B6, B7.



PEM 2627 A

Fig. 83. Circuit diagram of the vertical amplifier

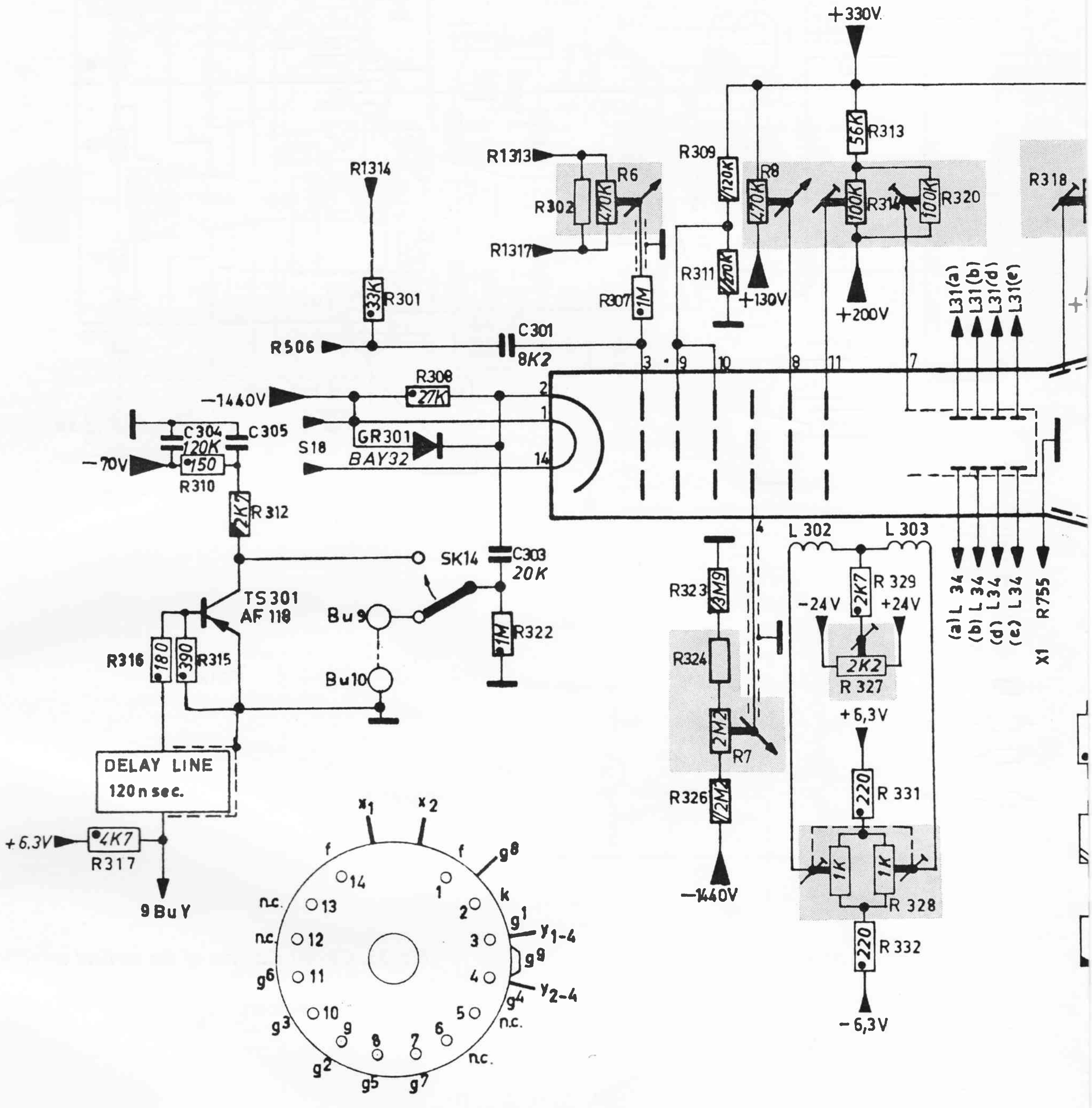
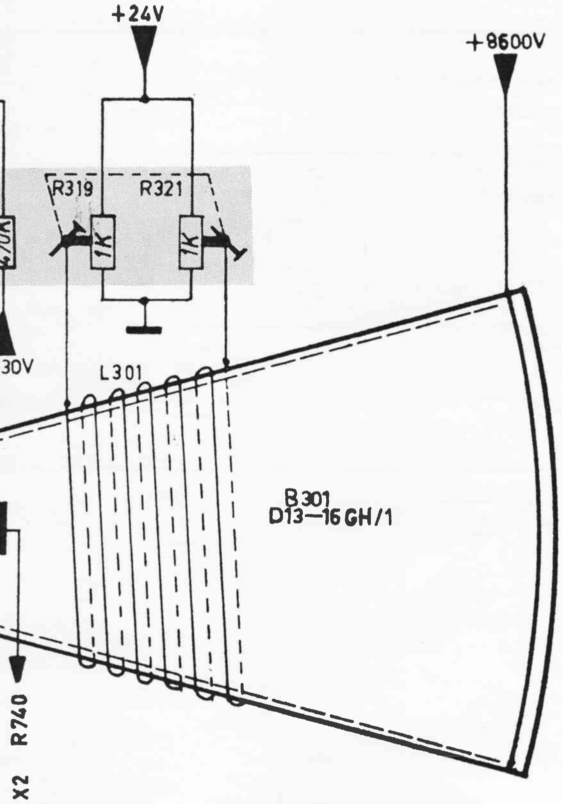


Fig. 84. Circuit diagram of the CRT circuit

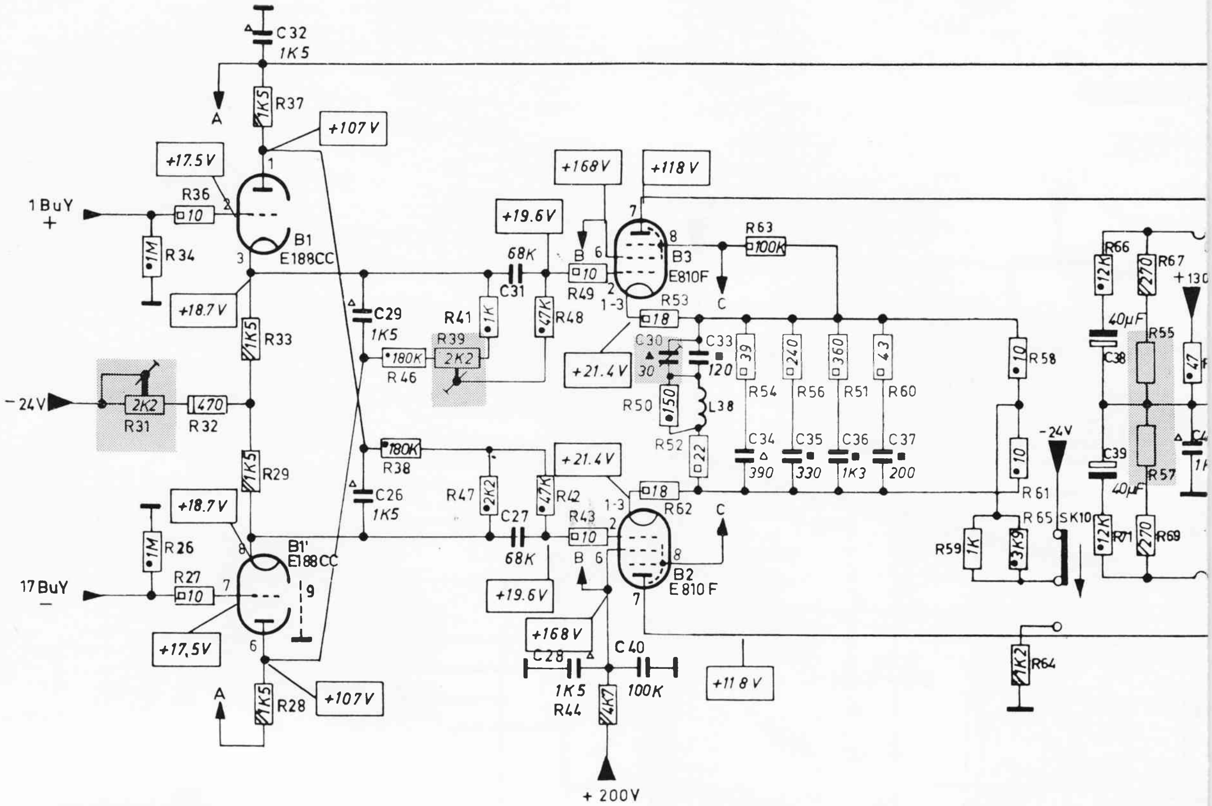


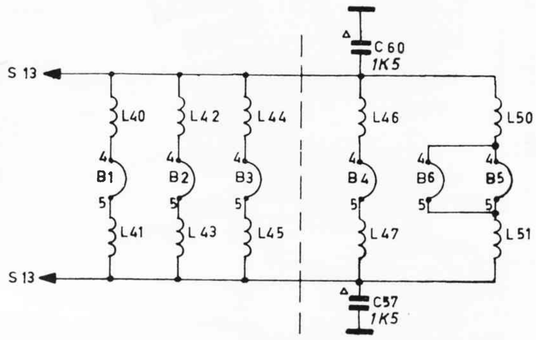
902/K...

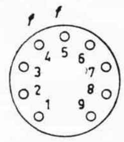
901/W...

900/P...

PEM 2730







B1, B2, B3,
B4, B6, B7.

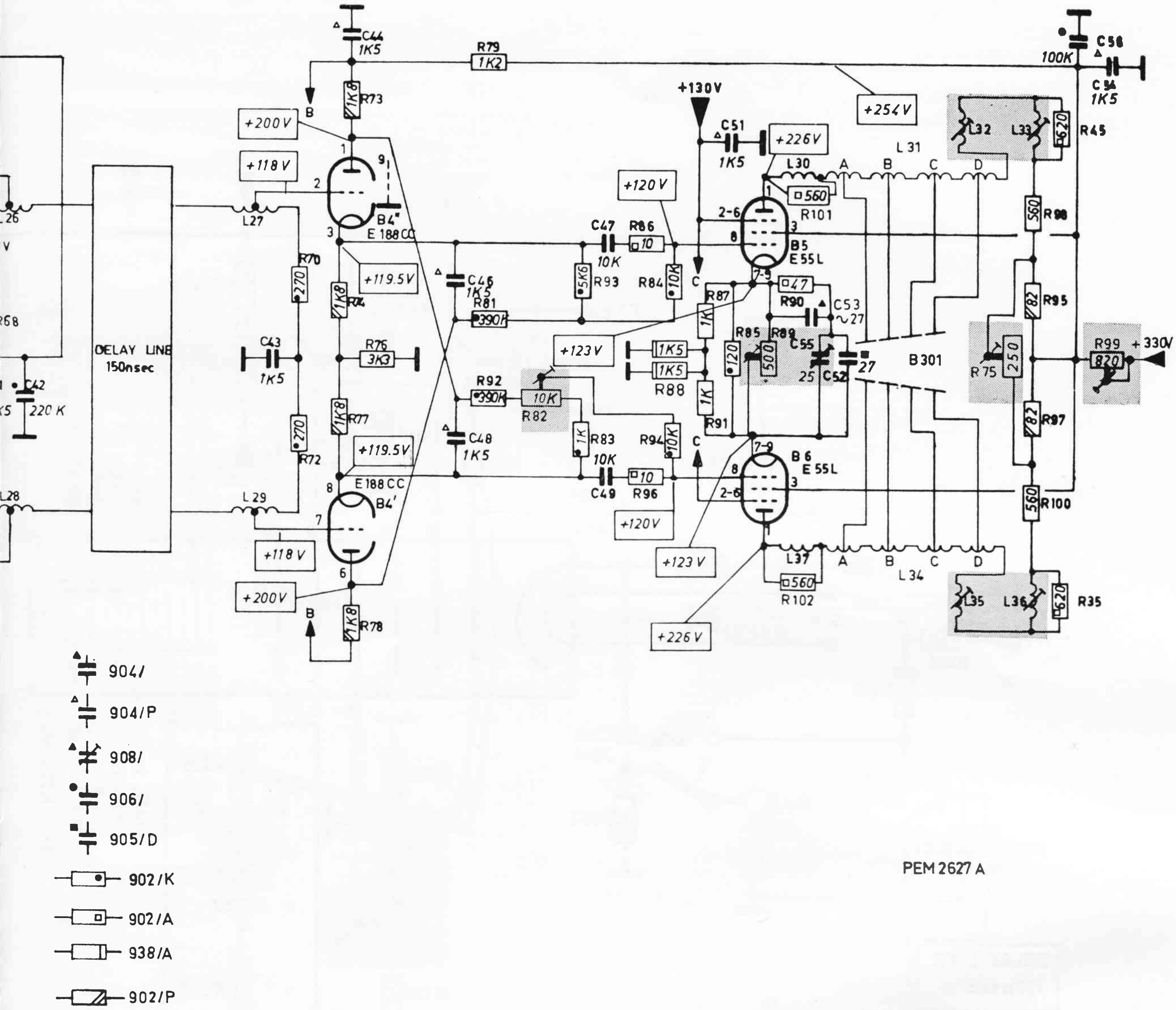
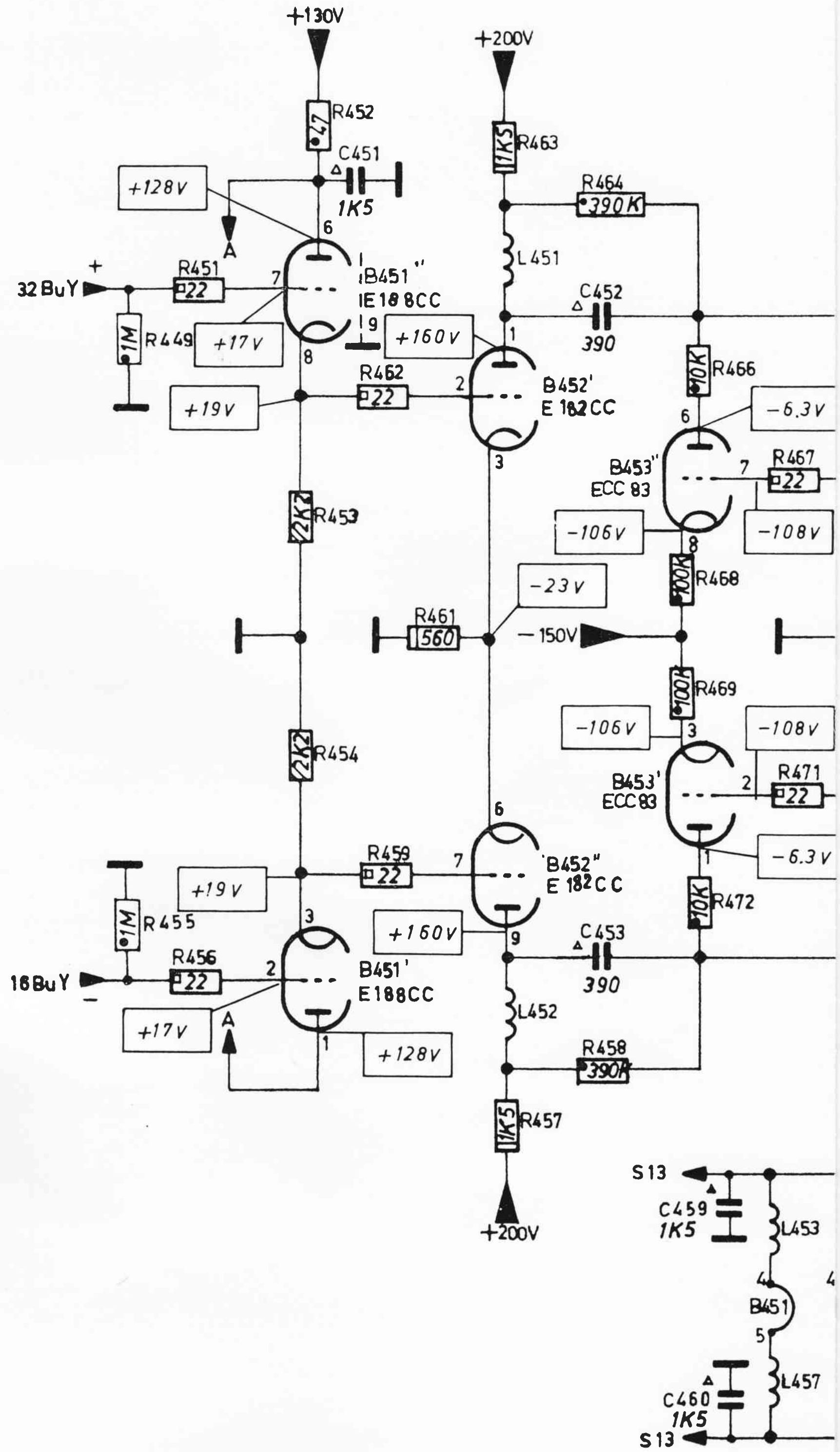


Fig. 83. Circuit diagram of the vertical amplifier



+130V
+200V
R452
47
C451
1K5
+128V
R463
1K5
R464
390K
6
A
B451"
E188CC
L451
32 BuY
R451
22
7
C452
390
R449
1M
+17V
9
+160V
1
8
R462
22
2
B452'
E182CC
R466
10K
+19V
-6.3V
3
B453"
ECC83
R467
22
R453
2K2
-106V
-108V
R468
100K
-23V
R461
560
-150V
R469
100K
-106V
-108V
R454
2K2
B453'
ECC83
R471
22
6
R459
22
B452"
E182CC
-6.3V
R472
10K
+19V
R455
1M
+160V
C453
390
R456
22
B451'
E188CC
16 BuY
+17V
+128V
L452
R458
390K
R457
1K5
+200V
S13
C459
1K5
L453
B451
L457
C460
1K5
S13

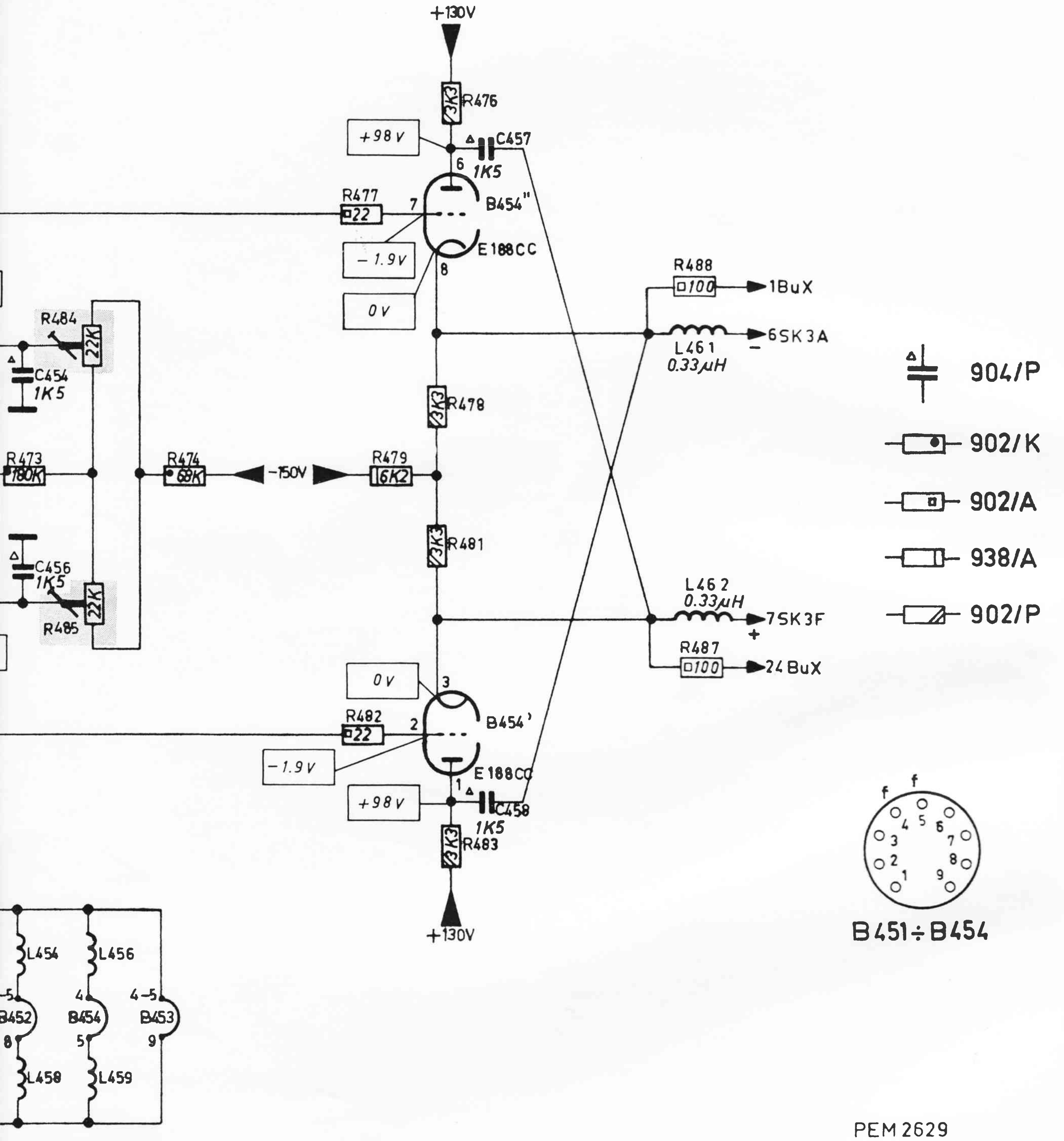
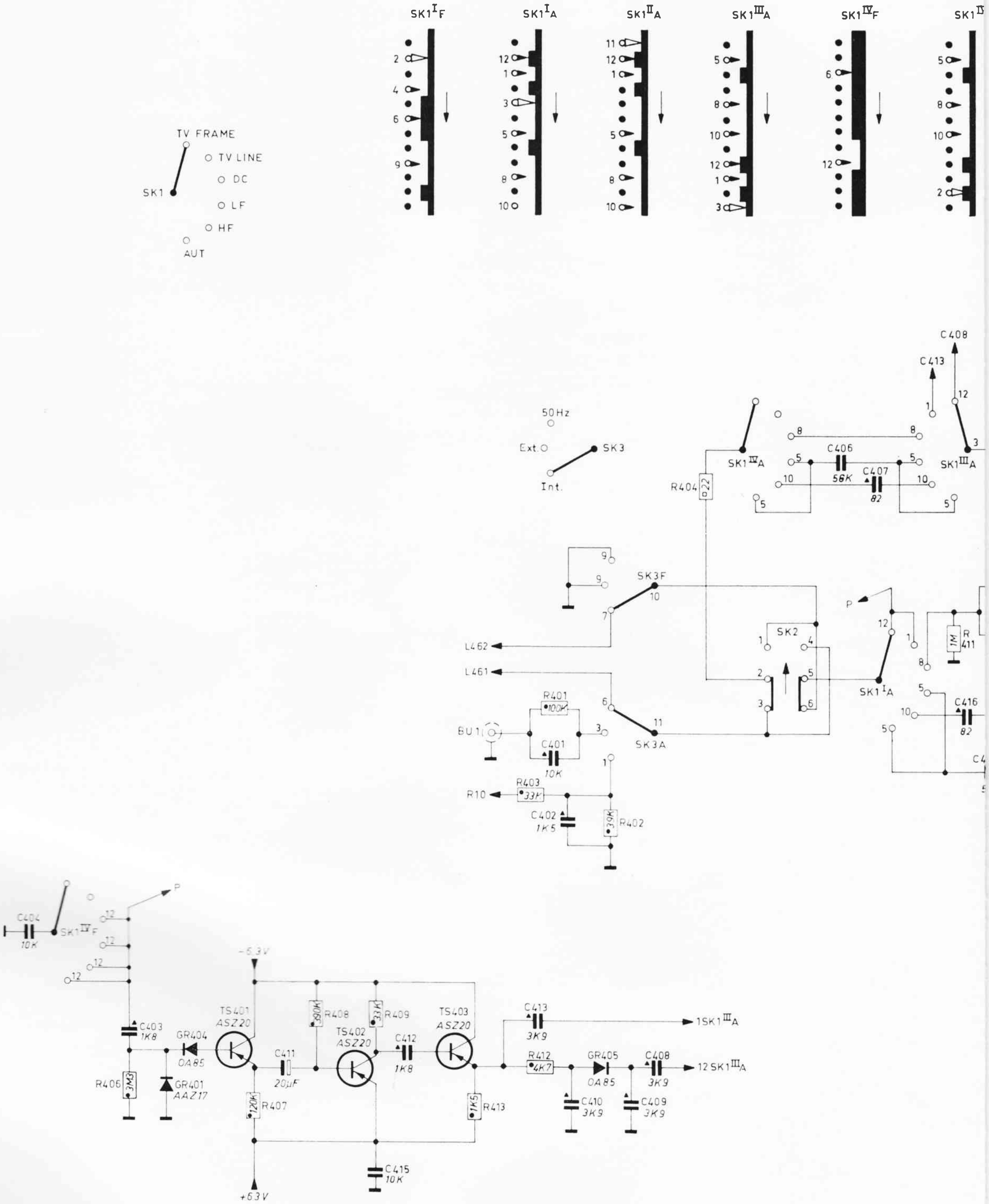


Fig. 85. Circuit diagram of the trigger amplifier


SK1^I F
SK1^I A
SK1^II A
SK1^III A
SK1^IV F
TV FRAME
TV LINE
DC
LF
HF
AUT
SK1
50Hz
Ext.
Int.
SK3
C408
C413
R404
SK1^IV A
C406 56K
C407 82
SK1^III A
SK3F
SK2
SK1^I A
P
R 411 1M
L462
L461
R401 100K
BU1
C401 10K
SK3A
C416 82
R10
R403 33K
C402 1K5
R402 39K
C404 10K
SK1^IV F
-6,3V
+6,3V
C403 1K8
GR404 OA85
TS401 ASZ20
R406 3M3
GR401 AAZ17
R407 120K
R408 180K
C411 20µF
TS402 ASZ20
R409 33K
C412 1K8
TS403 ASZ20
C415 10K
R413 1K5
C413 3K9
1SK1^III A
R412 4K7
GR405 OA85
C408 3K9
12 SK1^III A
C410 3K9
C409 3K9

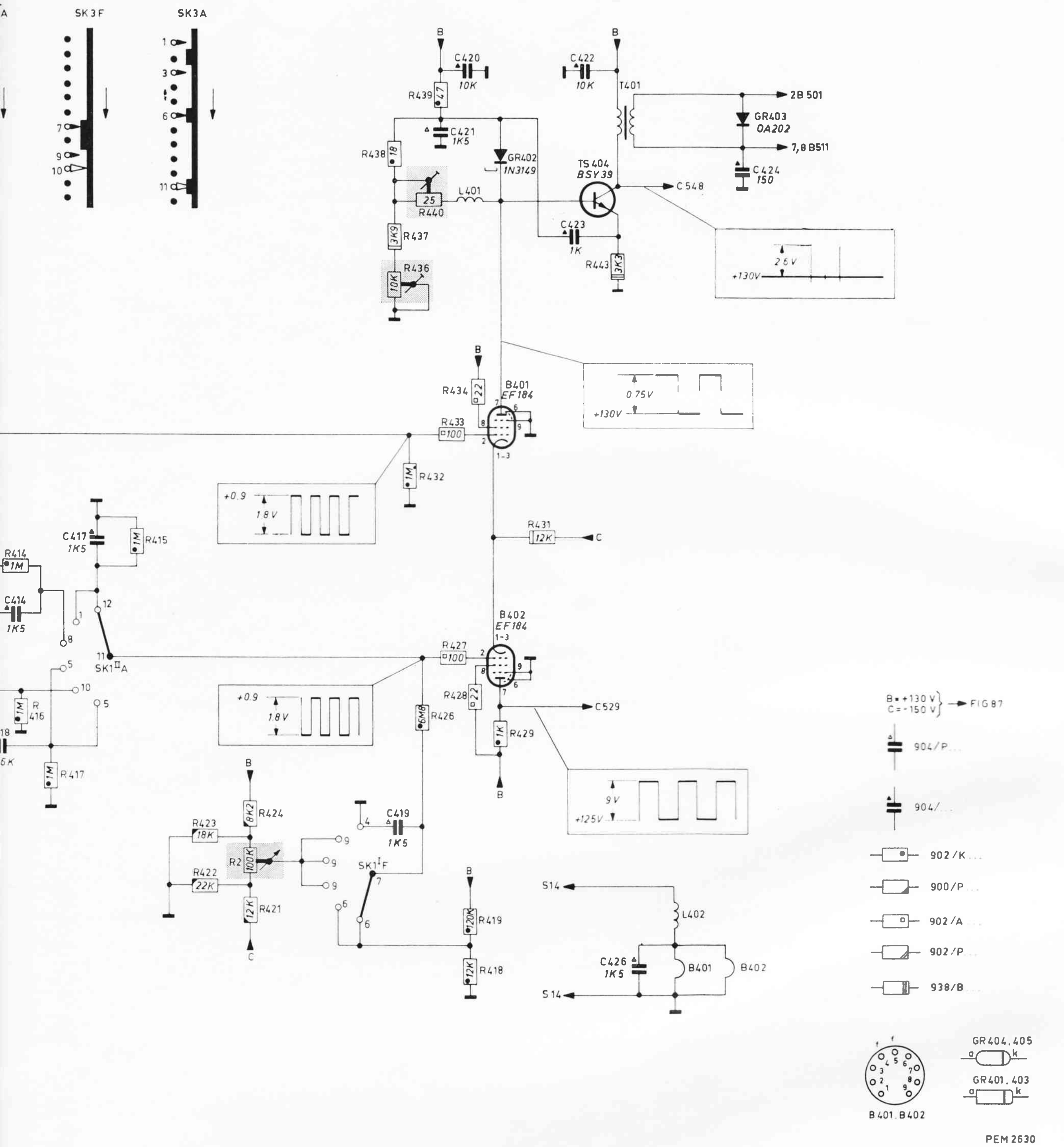


Fig. 86. Circuit diagram of the trigger unit

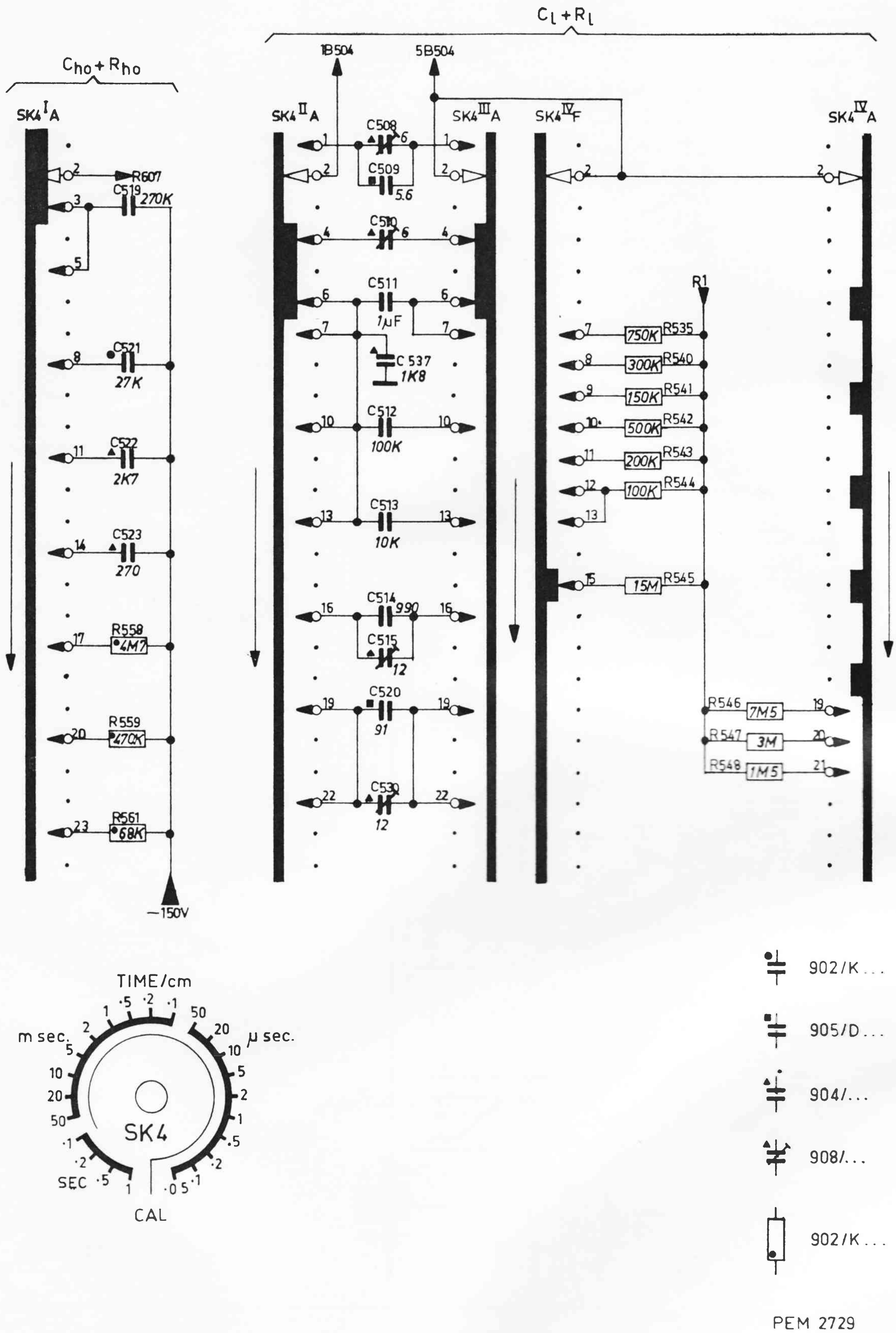
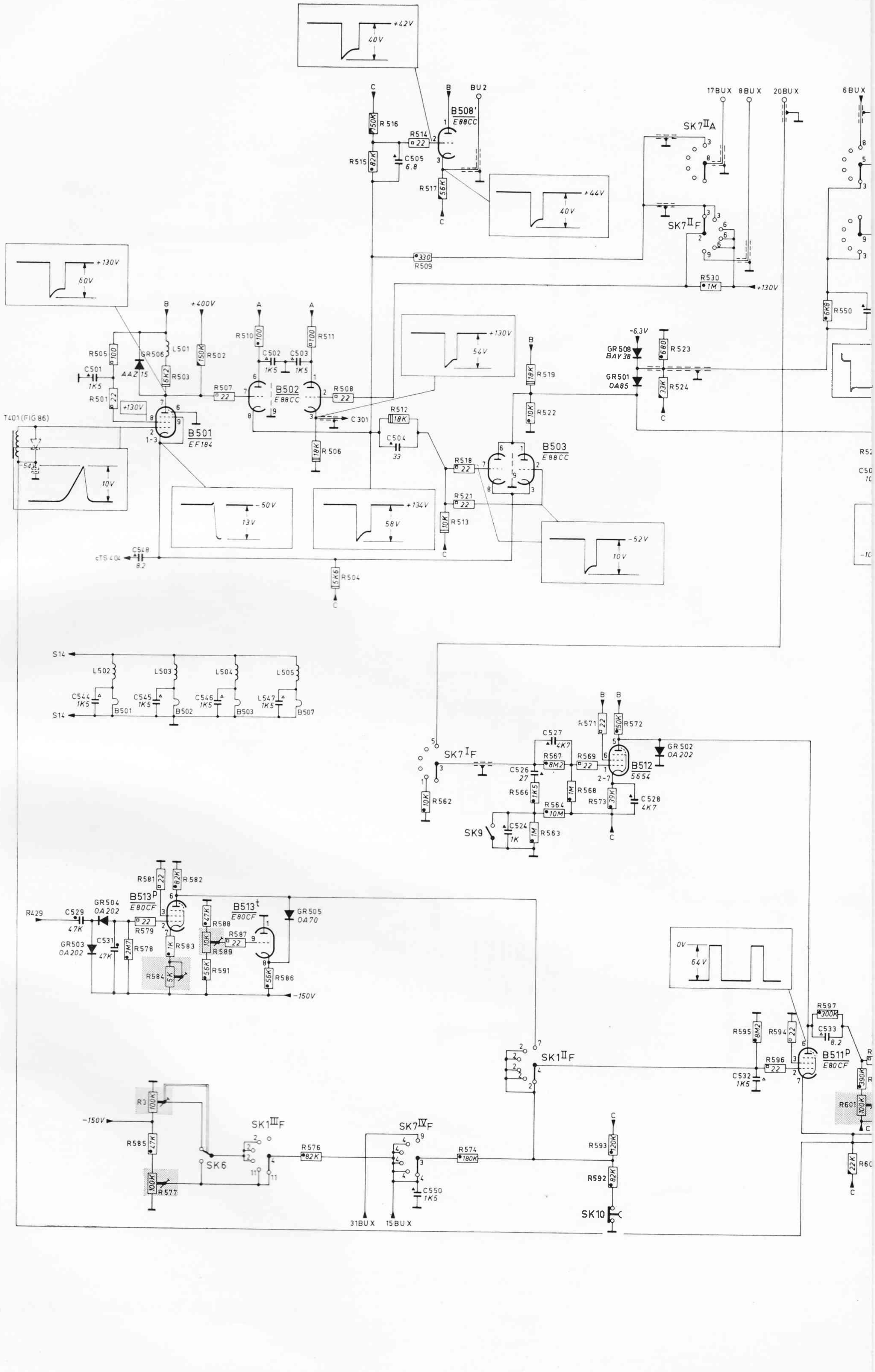


Fig. 88. Circuit diagram of the time-coefficient switch



B508' E88CC
R514 22
R516 150K
R515 82K
C505 6.8
R517 56K
+42V
40V
+44V
R509 330
17BUX
8BUX
20BUX
6BUX
SK7IIA
SK7IIF
R530 1M
+130V
R550 6K8
+130V
60V
+400V
R505 100
GR506 AAZ15
L501
R503 6K2
R502 150K
C501 1K5
R501 22
B501 EF184
T401 (FIG 86)
10V
R510 100
R511 100
C502 1K5
C503 1K5
R507 22
B502 E88CC
R508 22
C301
R506 18K
54V
R512 18K
C504 33
R519 18K
R522 10K
B503 E88CC
R518 22
R521 22
R513 10K
-6.3V
GR508 BAY38
R523 680
GR501 OA85
R524 33K
-50V
13V
+134V
58V
-52V
10V
C548 8.2
R504 5K6
S14
L502
L503
L504
L505
C544 1K5
C545 1K5
C546 1K5
L547 1K5
B501
B502
B503
B507
SK7IF
R562 10K
C527 4K7
R571 22
R572 50K
GR502 OA202
R567 8M2
R569 22
B512 5654
C526 27
R566 1K5
R568 1M
R573 39K
C528 4K7
R564 10M
SK9
C524 1K
R563 1M
R581 22
R582 82K
B513P E80CF
B513t E80CF
GR505 OA70
R429
C529 47K
GR504 OA202
R579 22
R588 47K
R587 22
R589 10K
GR503 OA202
C531 47K
R578 2M7
R583 1K
R584 5K
R591 56K
R586 56K
-150V
0V
64V
R597 300K
C533 8.2
R595 8M2
R594 22
B511P E80CF
SK1IIF
R596 22
C532 1K5
R601 100K
R3 100K
-150V
R585 47K
R577 100K
SK6
SK1IIIF
R576 82K
SK7IVF
R574 180K
C550 1K5
31BUX
15BUX
R593 20K
R592 82K
SK10

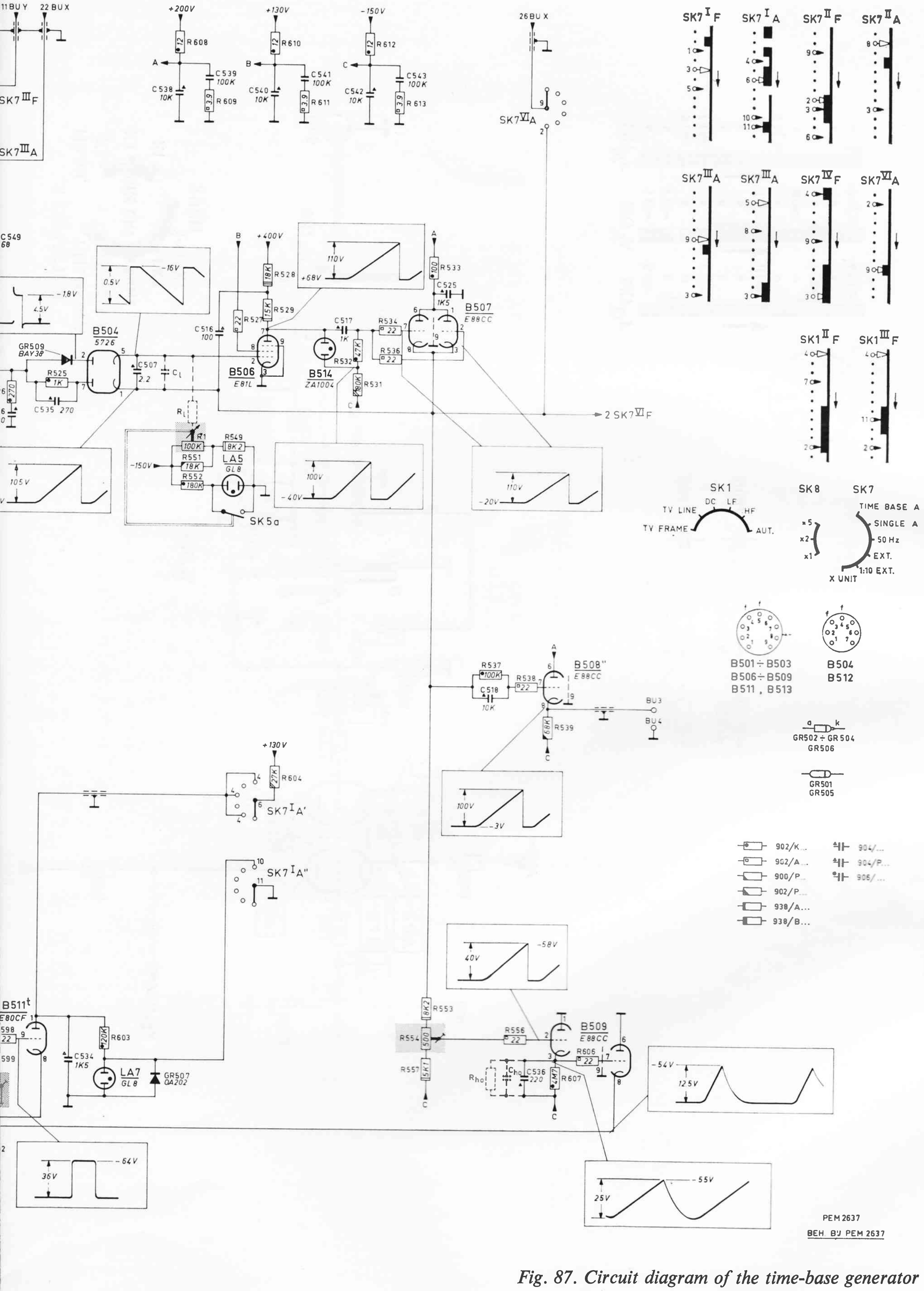


Fig. 87. Circuit diagram of the time-base generator A

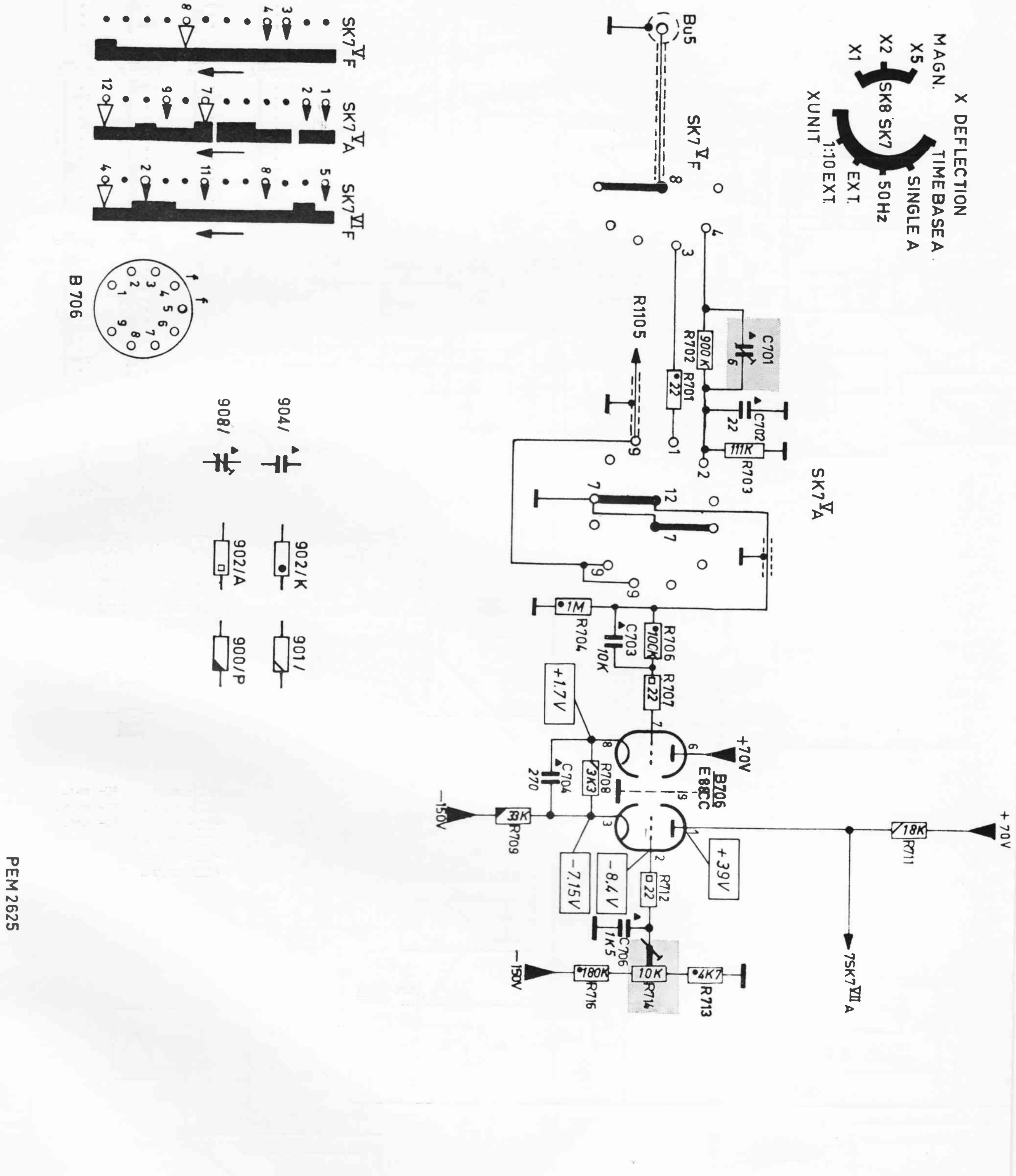
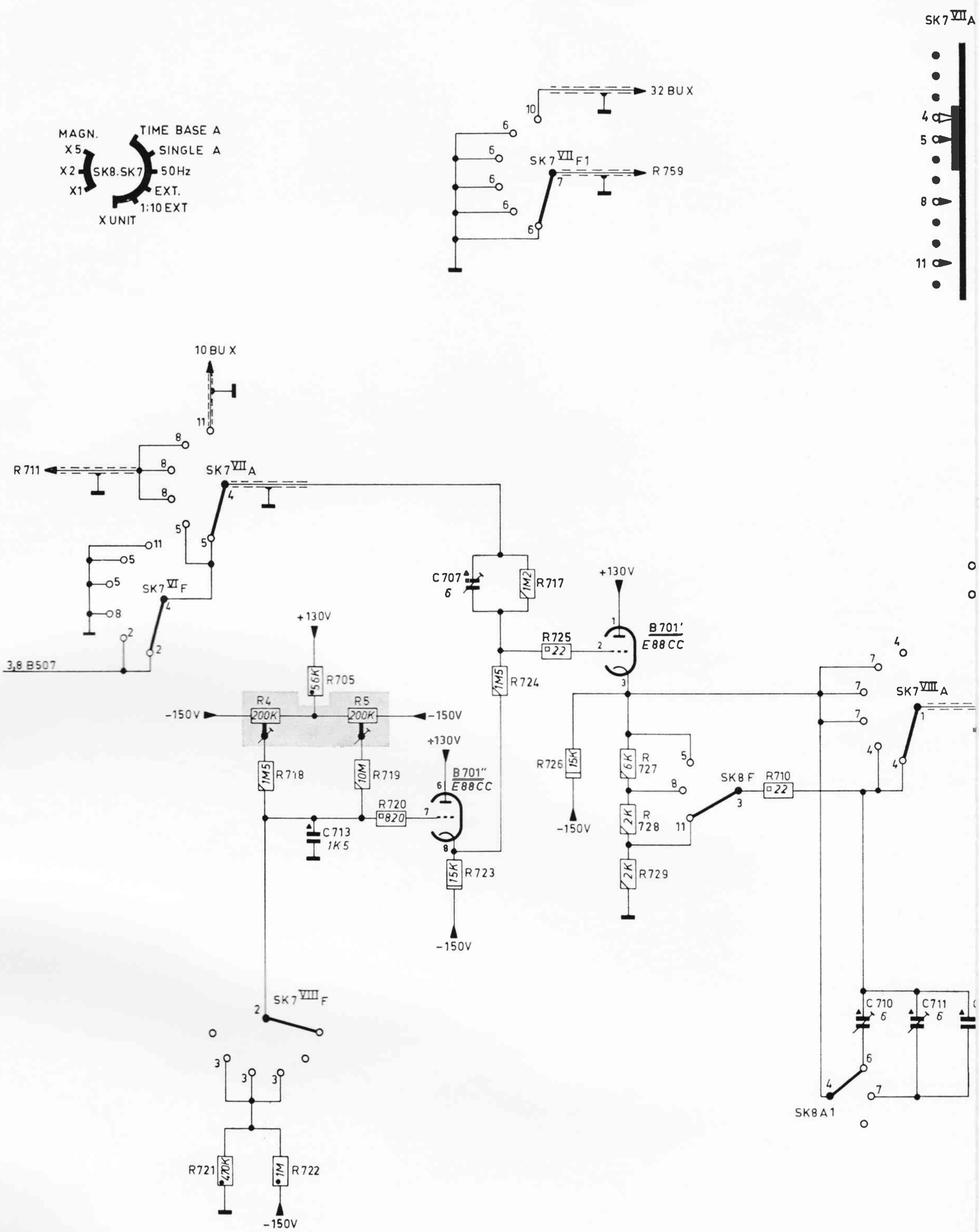


Fig. 89. Circuit diagram of the pre-amplifier



MAGN.
X5
X2
X1
SK8.SK7
TIME BASE A
SINGLE A
50Hz
EXT.
1:10 EXT
X UNIT
32 BU X
SK7 VII F1
R 759
SK7 VII A
10 BU X
R 711
SK7 VII A
SK7 VI F
3,8 B507
C 707 6
R717
1M2
+130V
R725
22
B 701'
E88CC
R 724
1M5
+130V
R705
56K
R4
200K
R5
200K
-150V
-150V
R718
1M5
R719
10M
R 720
820
C 713
1K5
+130V
B 701''
E88CC
R 723
15K
-150V
R726
15K
-150V
R 727
6K
R 728
2K
R729
2K
SK8 F
R710
22
SK7 VIII A
SK7 VIII F
R721
470K
R 722
1M
-150V
C 710 6
C 711 6
SK8 A1

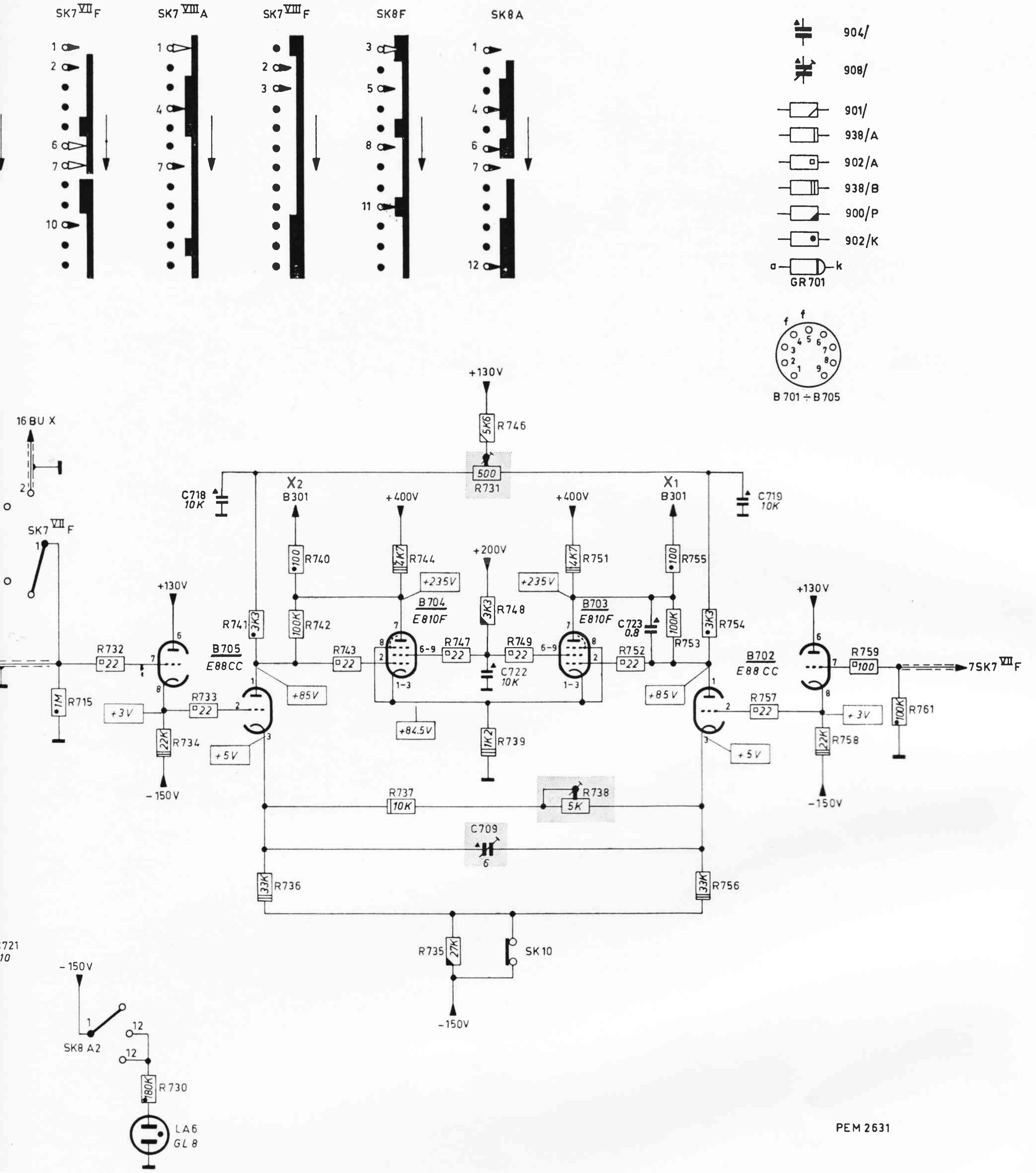
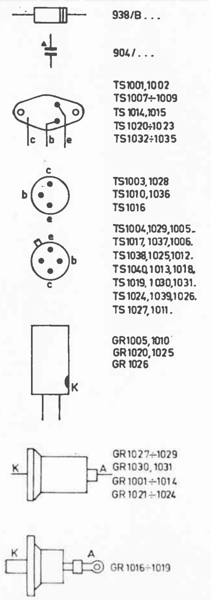
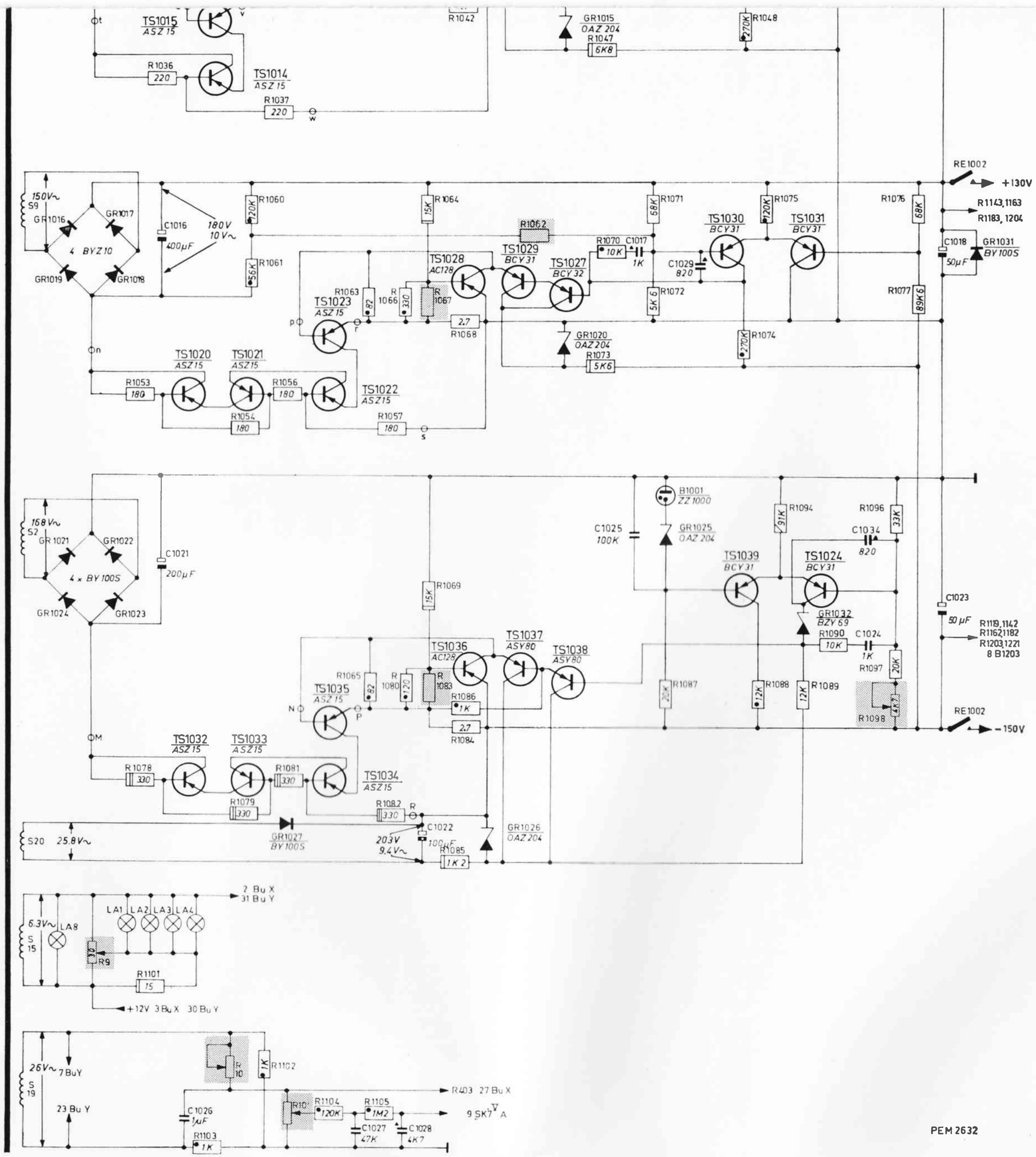


Fig. 90. Circuit diagram of the horizontal amplifier


938/B . . .
904/ . . .
TS1001,1002
TS1007÷1009
TS 1014,1015
TS 1020÷1023
TS1032÷1035
TS1003,1028
TS1010,1036
TS1016
TS1004,1029,1005.
TS1017, 1037,1006.
TS1038,1025,1012.
TS1040,1013,1018,
TS1019, 1030,1031.
TS1024,1039,1026.
TS 1027,1011.
GR1005,1010
GR1020,1025
GR 1026
GR1027÷1029
GR1030, 1031
GR 1001÷1014
GR 1021÷1024
GR 1016÷1019


TS1015
ASZ15
TS1014
ASZ15
R1036
R1037
R1042
GR1015
OAZ 204
R1047
R1048
RE1002
+130V
R1143,1163
R1183, 1204
150V~
S9
4 BYZ10
C1016
400μF
180V
10V~
TS1020
TS1021
TS1022
TS1023
TS1028
AC128
TS1029
BCY31
TS1027
BCY32
TS1030
BCY31
TS1031
BCY31
C1018
50μF
GR1031
BY100S
158V~
S2
4 x BY100S
C1021
200μF
B1001
ZZ1000
GR1025
OAZ 204
C1025
100K
TS1039
BCY31
TS1024
BCY31
GR1032
BZY69
C1023
50μF
R1119,1142
R1162,1182
R1203,1221
8 B1203
TS1036
AC128
TS1037
ASY80
TS1038
ASY80
TS1035
ASZ15
TS1032
ASZ15
TS1033
ASZ15
TS1034
ASZ15
RE1002
-150V
S20
25.8V~
GR1027
BY100S
C1022
100μF
20.3V
9.4V~
GR1026
OAZ 204
2 Bu X
31 Bu Y
6.3V~
S15
LA8
LA1
LA2
LA3
LA4
R9
R1101
+12V 3 Bu X 30 Bu Y
26V~
S19
7 BuY
23 Bu Y
R1102
R403 27 Bu X
9 SK7 A
C1026
C1027
C1028
R1103
R1104
R1105

PEM 2632

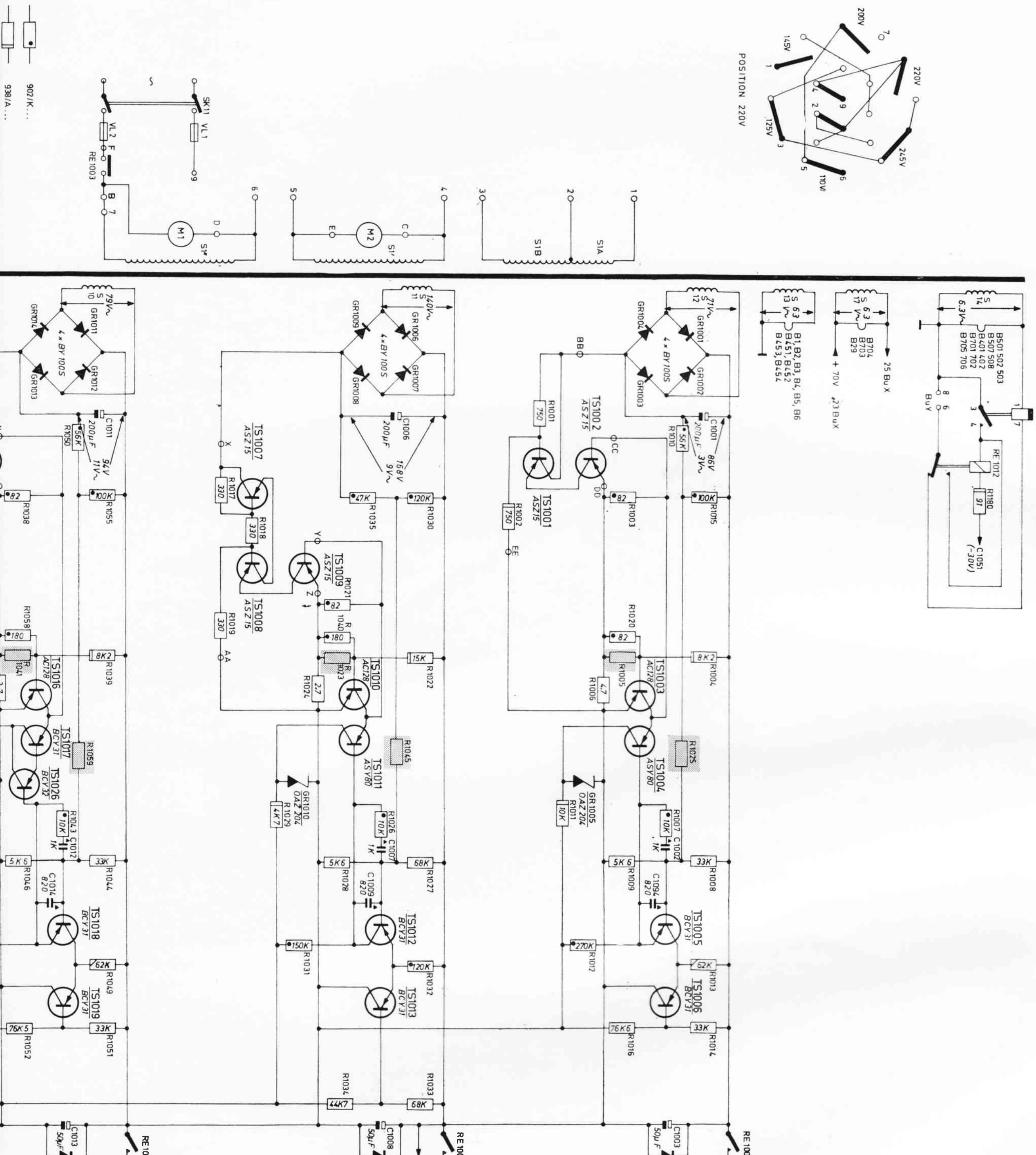
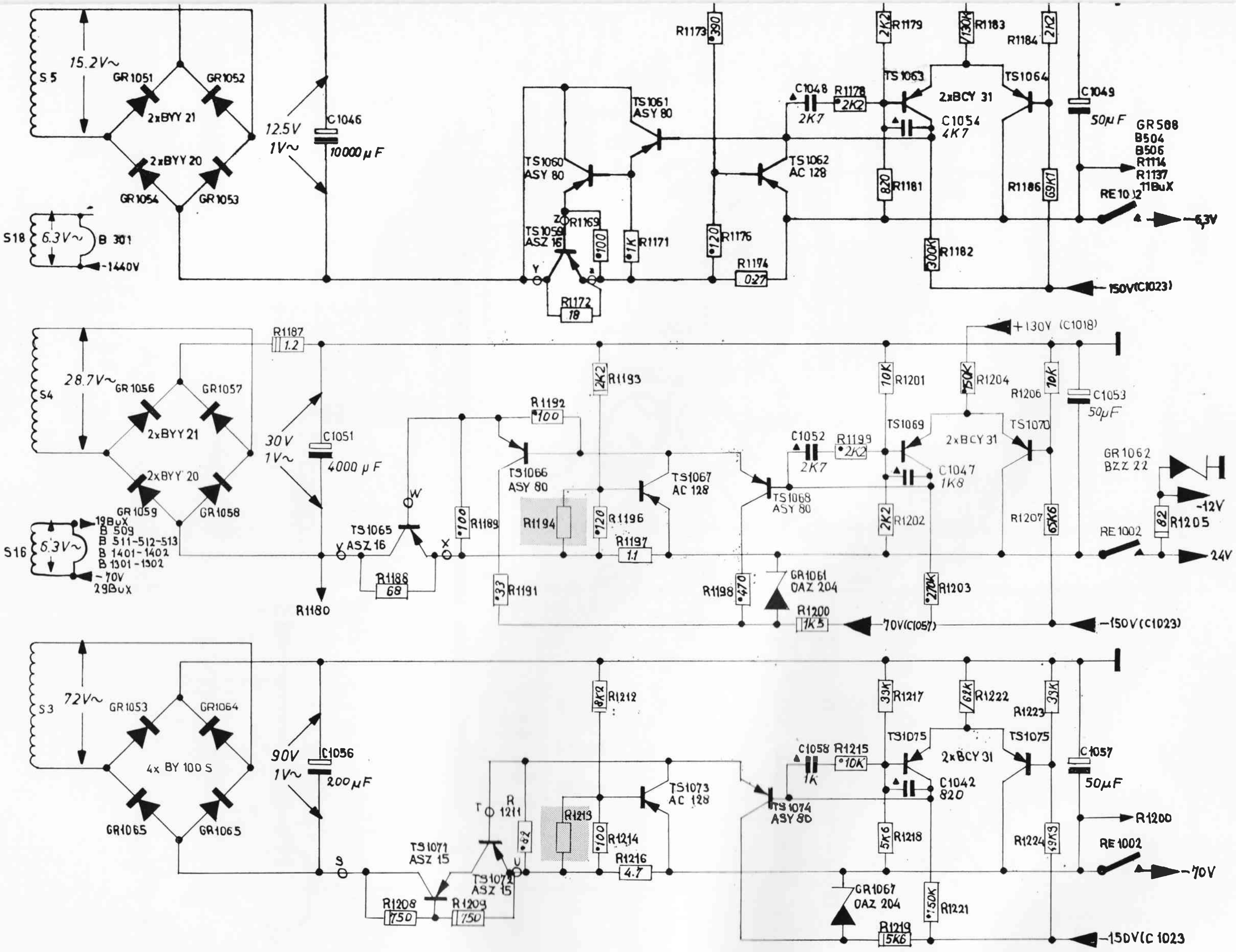


Fig. 91. Circuit diagram of the power supply I

PEM 2626



S5
15.2V~
GR1051
GR1052
2xBYY 21
2xBYY 20
GR1054
GR1053
S18
6.3V~
B 301
-1440V
12.5V
1V~
C1046
10000 μF
R1173
390
TS1061
ASY 80
TS1060
ASY 80
TS1059
ASZ 16
R1169
100
R1171
1K
R1172
18
Y
Z
R1176
120
R1174
0.27
TS1062
AC 128
C1048
2K7
R1178
2K2
R1179
2K2
TS1063
2xBCY 31
C1054
4K7
R1183
130K
TS1064
R1184
2K2
C1049
50μF
GR508
B504
B506
R1114
R1137
11BuX
R1181
820
R1186
69K1
R1182
300K
RE1012
-6.3V
150V(C1023)
S4
28.7V~
GR1056
GR1057
2xBYY 21
2xBYY 20
GR1059
GR1058
S16
6.3V~
19BuX
B 509
B 511-512-513
B 1401-1402
B 1301-1302
-70V
29BuX
R1187
1.2
30V
1V~
C1051
4000 μF
R1180
TS1065
ASZ 16
V
W
X
R1188
68
R1189
100
R1192
100
TS1066
ASY 80
R1193
2K2
R1194
R1196
120
R1197
1.1
TS1067
AC 128
R1191
33
R1198
470
TS1068
ASY 80
GR1061
OAZ 204
R1200
1K5
70V(C1057)
C1052
2K7
R1199
2K2
R1201
10K
TS1069
2xBCY 31
C1047
1K8
R1202
2K2
R1203
270K
R1204
150K
+130V (C1018)
R1206
10K
TS1070
R1207
65K6
C1053
50μF
GR1062
BZZ 22
-12V
R1205
82
RE1002
24V
-150V(C1023)
S3
72V~
GR1053
GR1064
4x BY 100 S
GR1065
GR1065
90V
1V~
C1056
200μF
S
TS1071
ASZ 15
R1208
750
R1209
750
TS1072
ASZ 15
T
R
1211
U
82
R1212
8K2
R1213
R1214
100
R1216
4.7
TS1073
AC 128
TS1074
ASY 80
C1058
1K
R1215
10K
R1217
33K
TS1075
2xBCY 31
C1042
820
R1222
62K
R1223
33K
TS1075
C1057
50μF
R1200
R1218
5K6
GR1067
OAZ 204
R1221
150K
R1219
5K6
R1224
49K3
RE1002
-70V
-150V(C1023)

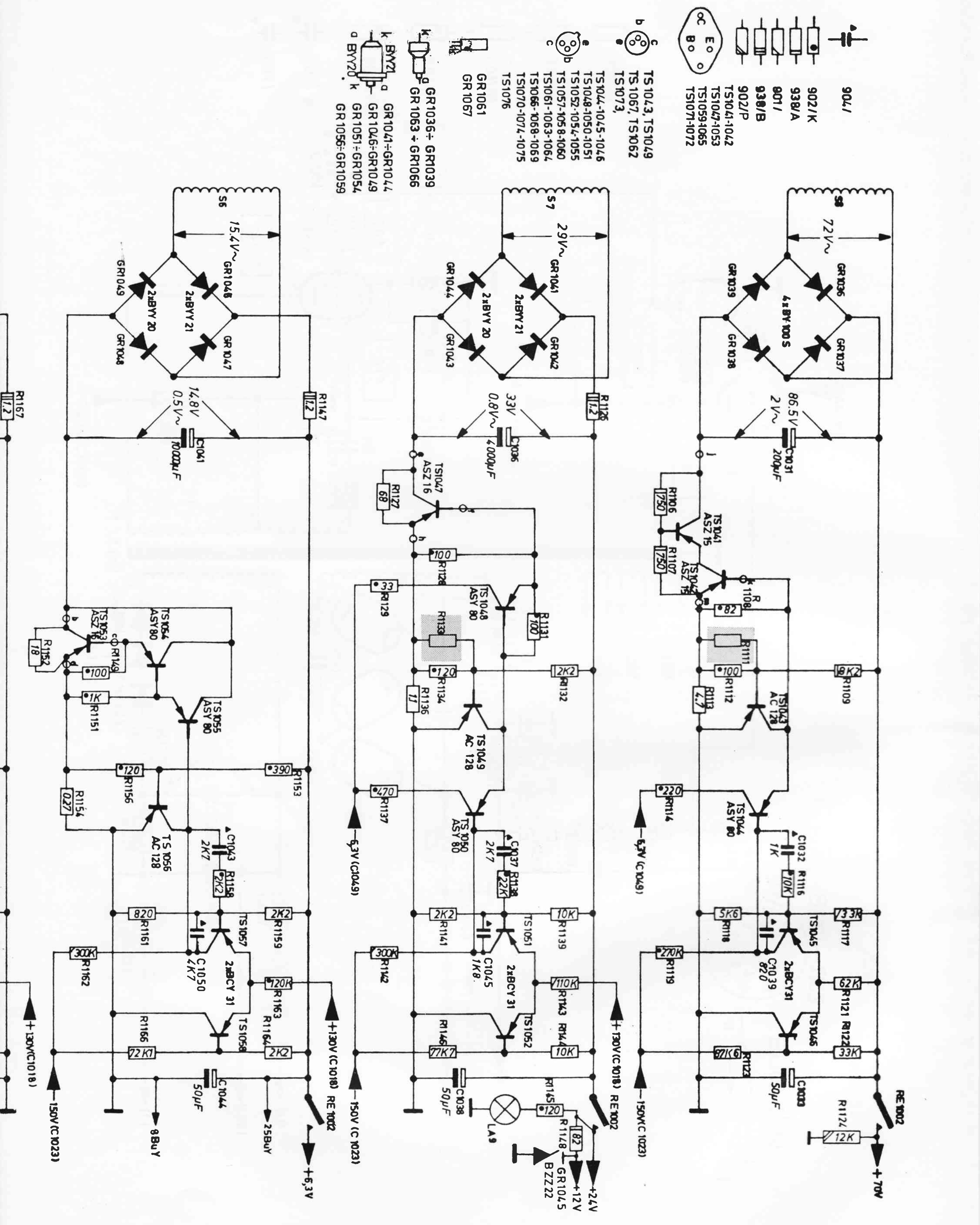
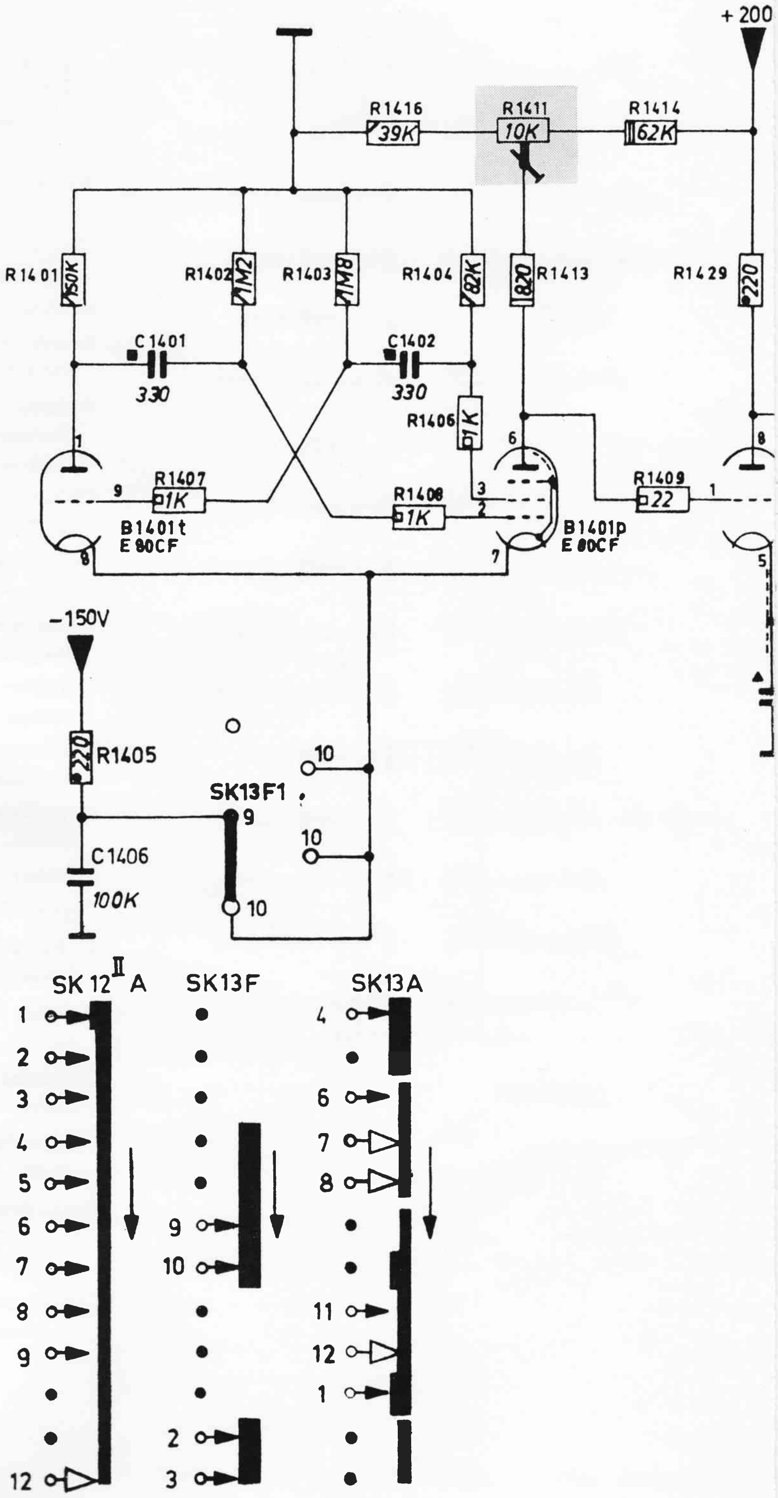


Fig. 92. Circuit diagram of the power supply II


+200
R1416
39K
R1411
10K
R1414
62K
R1401
150K
R1402
1M2
R1403
1M8
R1404
82K
R1413
820
R1429
220
C1401
330
C1402
330
R1406
1K
R1407
1K
R1408
1K
R1409
22
B1401t
E 80CF
B1401p
E 80CF
-150V
R1405
220
C1406
100K
SK13F1
SK 12 II A
SK13F
SK13A

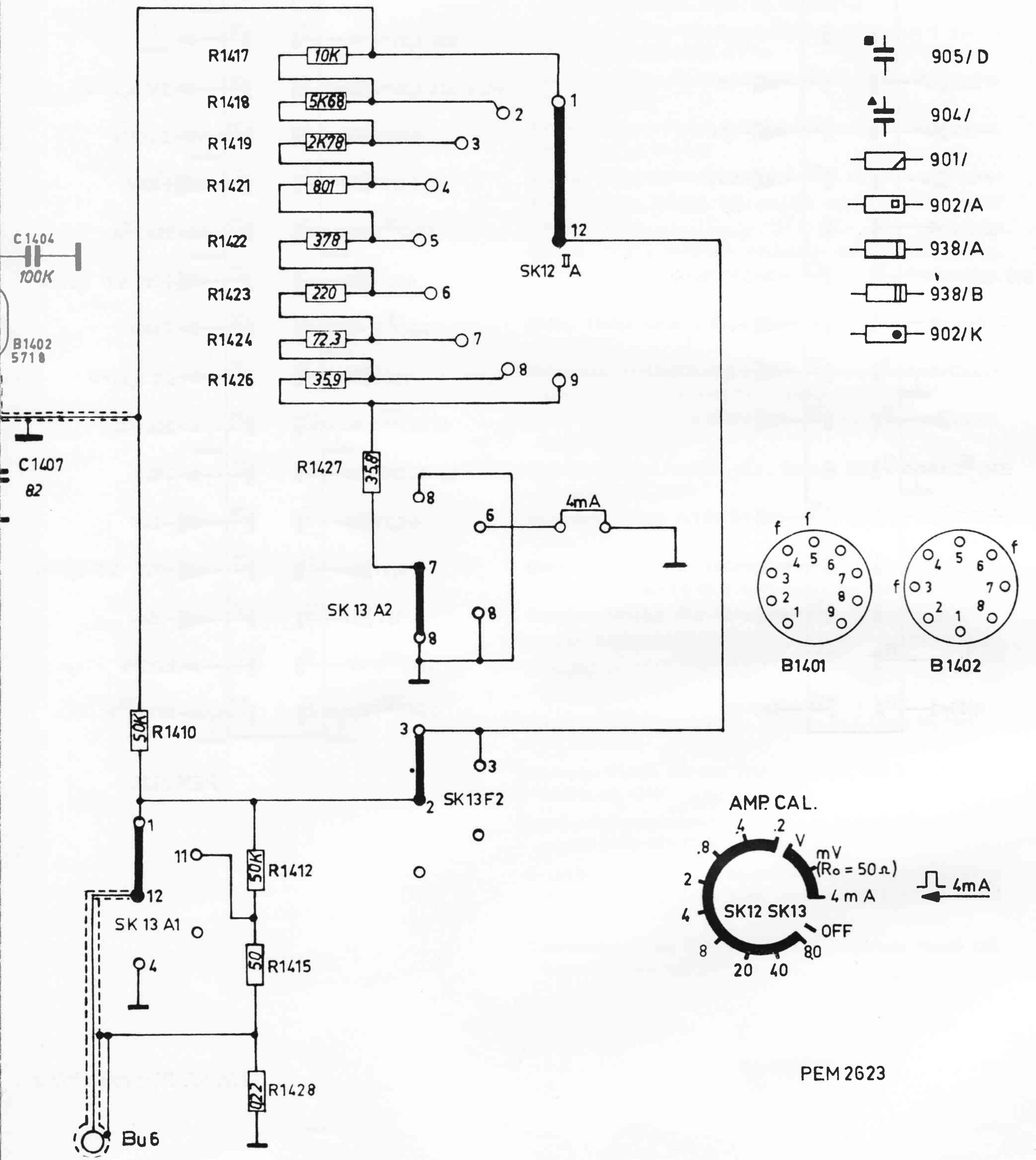


Fig. 94. Circuit diagram of the calibration unit

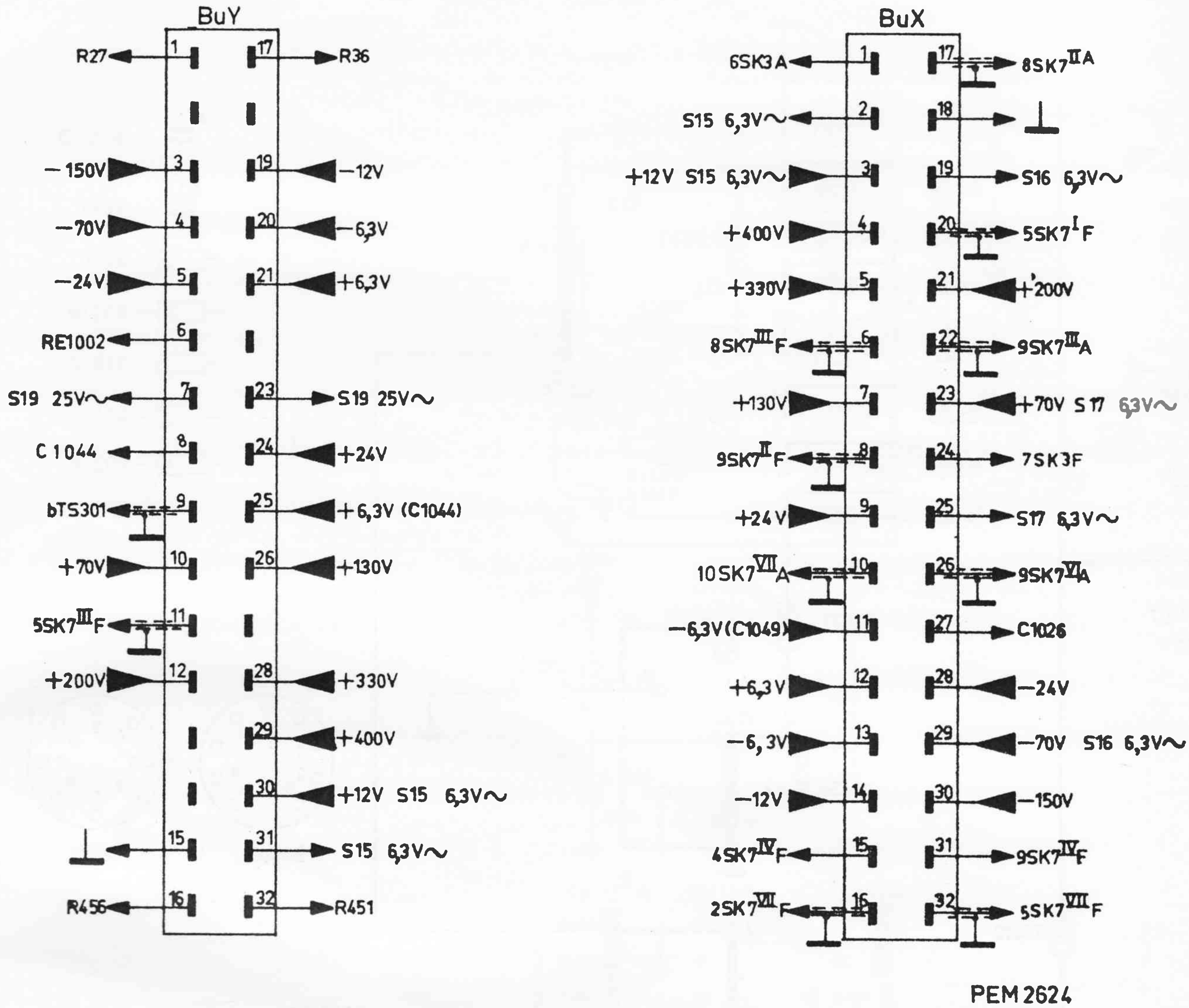


Fig. 95. Plug connections

PM 3330 ACCESSORIES

Fig. 1

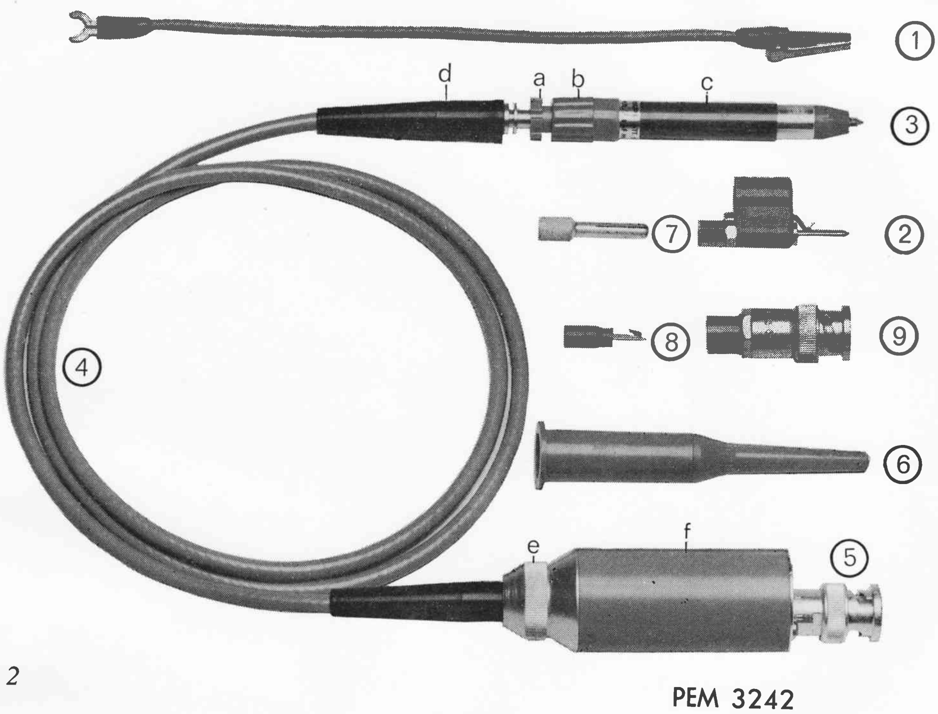


Fig. 2

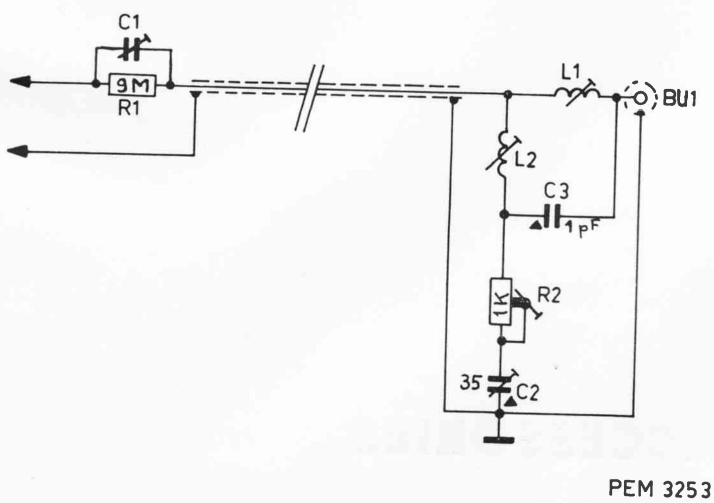


Fig. 3

ACCESSORIES

A. ADAPTOR PM 9051 (Fig. 1)

This adaptor is used for the connection of 4 mm banana-plugs to a BNC connector.

B. MEASURING PROBE PM 9331

This attenuator probe provides an attenuation of ten times.

A complete set (Fig. 2) consists of:

1. Earthing lead with alligator clip
2. Spring-loaded earthing pin
3. 1 : 10 Attenuator probe (green)
4. 45″ Coaxial cable
5. Correction network
6. Pincer tip
7. 4 mm Bananatip
8. Hook tip
9. Bush converting the probe-tip into a BNC-plug.
   The set can be ordered mentioning code-number PM 9331A/10.

Technical data

Attenuation	1 : 10 (± 3%)
Input impedance	10 MOhm // 8 pF
Maximal voltage	1000 V peak to peak
Length of cable	45″ (115 cm)

Adjustment

— Plug the correcting network to the input terminal of a Y-plug in unit and apply a suitable square wave (e.g. the "Ampl. Cal.") to the probe tip.
— Grasp the serrated end "a" and loosen bush "b" (See fig. 2).
— Holding "a" steady, turn "c" until the square wave is displayed optimally.
— Lock "c" in this position tightening "b".

Replacing the cable

— Holding sleeve "d", remove probe "3" by pulling firmly.
— Pull off earthing cable "1".
— Unscrew knurled nut "e" and push back screening "f".
— Unsolder the inner conductor of the cable from the correction network and remove the cable.
— Wire the cable operating in the reversed order.

Note: Do not try to repair a damaged cable by shortening its length, as the length is critical regarding capacitance and reflections.

Adjustment of the correction network

— Unscrew knurled nut "e" (Fig. 2) and push back screening "f".
— Connect the cable to a Y-plug in unit (e.g. PM 3333) and apply the calibration voltage at a convenient amplitude.
— At the correction network adjust C2 (Fig. 3) to its electrical midposition.
— Interconnect a pulse shaper having a 1.5 nanosecond rise-time (e.g. Tektronix cat.nr. 015-0038-00, adapted by connecting a 2700 Ohm resistor, 0.1 Watt 5%, parallel to its 3300 Ohm resistor).

Terminate the pulse shaper by a 50 Ohm pad (e.g. XE101.96).

— Increase the speed of the X-deflection to 25 nsec./cm. ("Time/cm" at 0.05 sec./cm and "Magn" at X2).
— Turn potentiometer R2 counterclockwise to its end stop. Some ringing will be visible.
— With R2 for ringing and L1 (leading pip) L2 (reflections) adjust for optimum square wave response.
— Enclose the correction network.
— At a lower speed of X-deflection, adjust the probe as explained earlier.

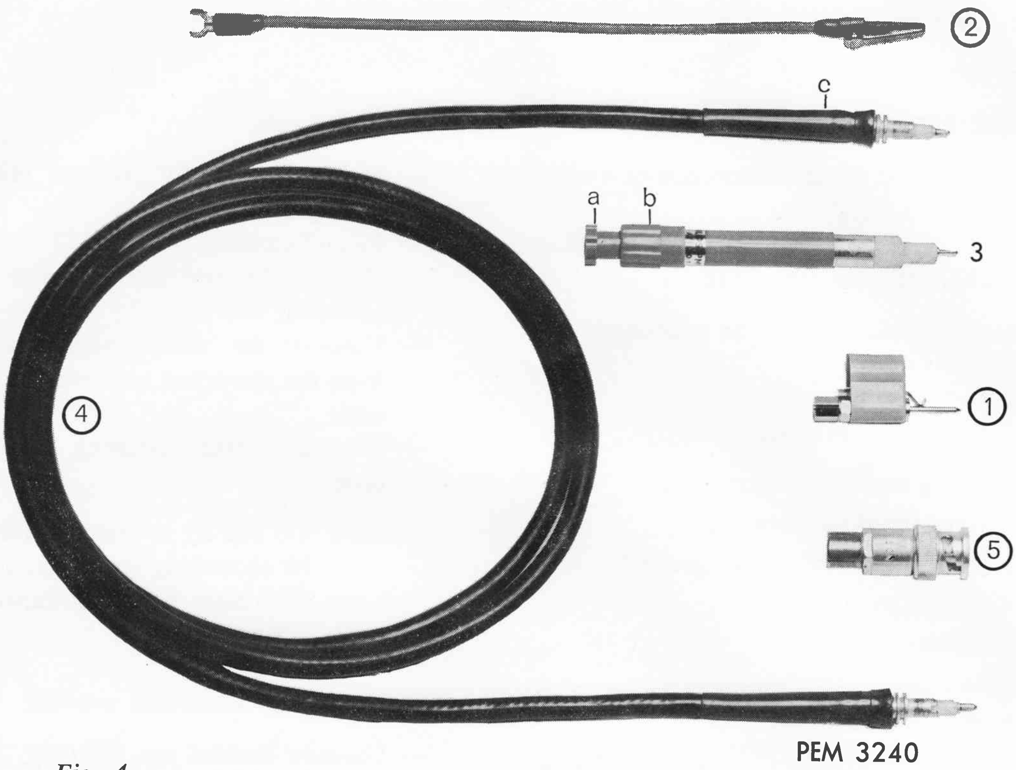


Fig. 4

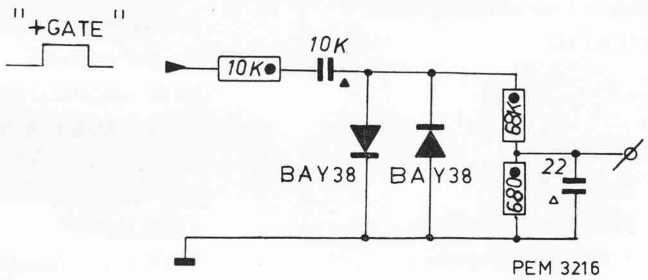


Fig. 5

Fig. 6

PARTS LIST OF MEASURING PROBE PM 9331

Pos.	*Description*	*Codenumber*	*S*	*Necessary for* 1	2	5	*10 App.*
1	Earthing lead with alligator clip	4822 321 20096	+	1	2	2	4
2	Earthing pin	4822 265 20029	+	1	1	1	2
3	From Attenuator probe						
	Stator	4822 159 00444	+	1	1	1	2
	Rotor	M7 149 05	+	1	1	1	2
	Bush	M7 698 27	+	1	1	1	2
	Spring (coiled)	M7 216 05	+	1	1	1	2
	Resistor 9 MOhm	M7 632 58	+	1	1	1	2
4	45″ cable (complete)	4822 321 20085	+	1	2	2	4
	with insulating sleeve	4822 325 50039	+	1	2	2	4
5	From correction network						
	Knurled nut	4822 506 40012	+	1	1	1	2
	BNC connector	4822 044 00468	+	1	1	1	2
	Contact pin	4822 268 10049	+	1	1	1	2
	Insulating piece	4822 159 00593	+	1	1	1	2
	Coil 0.3 μH (L1)	4822 156 20285	+	1	1	1	2
	Coil 1.12 μH (L2)	4822 156 20286	+	1	1	1	2
	Potentiometer 1000 Ohm (R2)	4822 100 10037	+	1	1	1	2
	Trimmer 35 pF (C2)	4822 125 60046	+	1	1	1	2
6	Pincer tip	M7 731 81	+	1	2	2	4
7	4 mm Banana tip	M7 343 31	+	1	2	2	4
8	Hook tip	M7 716 44	+	1	2	2	4
9	Bush		+	1	2	2	4

C. MEASURING PROBE PM 9332

This probe is delivered with plug-in unit PM 3333, where it will be used exclusively as a H.F. probe for the measuring ranges 20-50-100 mV/cm (see also the Directions for Use of the PM 3333).

The probe consists of: (Fig. 4).

1. Spring-loaded earthing pin
2. Earthing lead with alligator clip
3. Probe tip (red)
4. 60″ Coaxial cable
5. Bush converting the probe-tip into a BNC-plug.

Technical data

Deflection coefficient	20-50-100 mV/cm; + or — 3%
Frequency response	30 c/s — 50 Mc/s
Input impedance	100 kohm //5pF
Maximal voltage	400 V d.c.
Length of the cable	60 inches (1.5 metres)

Adjustment

- Plug the free end of the cable into the ”H.F. PROBE” terminal of plug-in unit PM 3333 and apply a square wave with a rise time of at most 25 nsec. to the probe tip. A suitable pulse-shaper can be made according circuit Fig. 5. It shapes the ”+Gate” output pulse.
- Adjust for a suitable trace height.
- Grasp the serrated end ”a” and loosen bush ”b” (See Fig. 4).
- Holding ”a” steady, turn ”3” until the square wave is displayed optimally.
- Lock ”3” in this position by tightening bush ”b”.

Replacing the cable

- Holding sleeve ”c” pull firmly to remove probe tip ”3”.
- Pull off earthing lead ”2”.
- Apply the new cable by operating in the reversed order.

Fig. 7

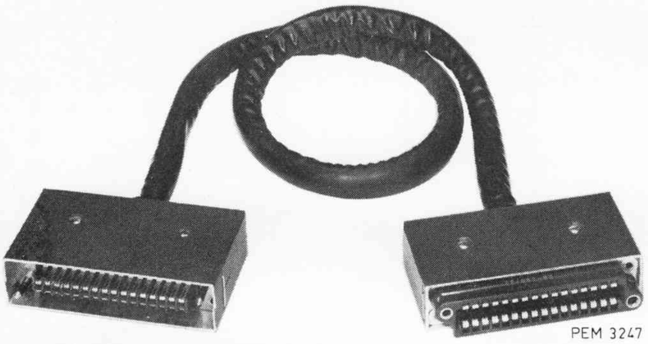


Fig. 8

Fig. 9

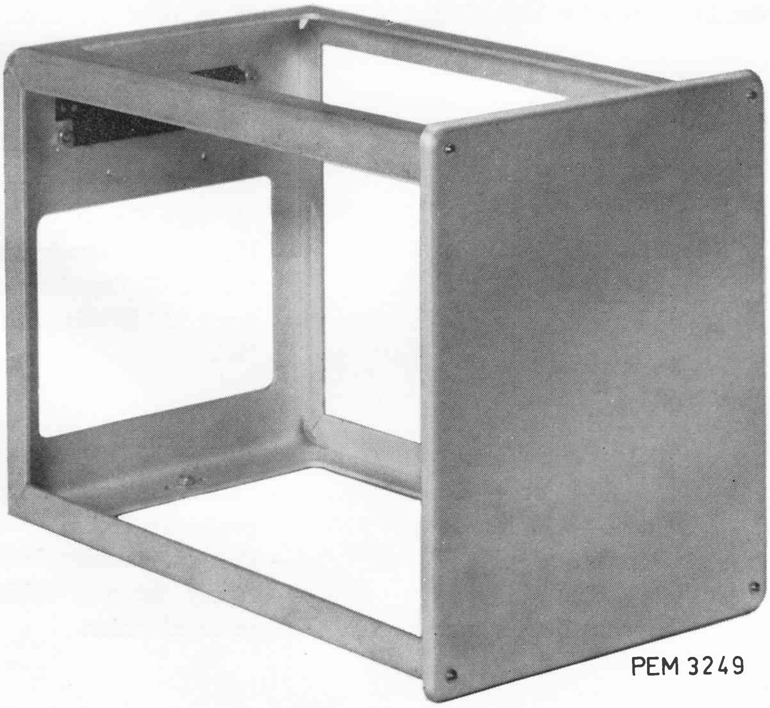


Fig. 10

PARTS LIST OF MEASURING PROBE PM 9332

Pos.	*Description*	*Codenumber*	*S*	*Necessary for* 1	2	5	10 *App.*
2	Earthing lead with alligator clip	4822 321 20096	+	1	2	2	4
1	Earthing pin	4822 265 20029	+	1	1	1	2
3	From measuring probe:						
	Contact spring (inner)	4822 492 20011	+	1	1	1	2
	Rotor (complete)	4822 159 00595	+	1	1	1	2
	Bush	M7 698 27	+	1	1	1	2
4	Cable (complete)	4822 321 20086	+	1	2	2	4
	Insulating sleeve for same	4822 325 50038	+	1	2	2	4
5	Bush		+	1	2	2	4

D. VIEWING HOOD M7 136 98

Entirely moulded-rubber eye-piece, which fits directly on the bezel in front of the cathode-ray tube. Fig. 6.

E. CABLE (50 OHM) COAXIAL M7 504 68

One end is provided with a BNC-connector, the other end is provided with two 4 mm banana-plugs. Fig. 7.

F. FILTER MAT. 4822 159 00459

Spun glass air filter $9^3/_4$ x $8^3/_{16}$ inches (25 x 21 cm) PM 3330 Fig. 7.

G. SERVICING ADAPTOR 4822 159 00558

This plug-in Extension with flexible cord allows any plug-in pre-amplifier to be operated entirely out of its housing e.g. during fault-tracing. Fig. 8.

H. SERVICING ADAPTOR 4822 159 00559

Plug-in extension, which allows any plug-in pre-amplifier to be operated partially out of its housing e.g. during adjustment. Fig. 9.

J. BLANK PLUG-IN SKELETON PM 3360, Fig. 10.

If some circuit is built into this unit the present power supplies can be loaded according the following table (irrespective the type of Y-Unit in use).

Supply volts	*Max. load mA*	*Terminal number*
— 150	65	30
— 70	75	29
— 24	320	28
— 12	15	14
— 6.3	1190	13
+ 12	60	3
+ 24	550	9
+ 70	10	23
+ 130	40	7
+ 200	5	21
+ 330	10	5
+ 400	5	4
6.3~	1.5 A	{ 2 3 (+ 12 V)
6.3~	0.5 A	{ 19 29 (— 70 V)
6.3~	1 A	{ 25 23 (+ 70 V)

K. PLUG-IN TEST UNIT PM 3361, (4822 395 30016) Fig. 11

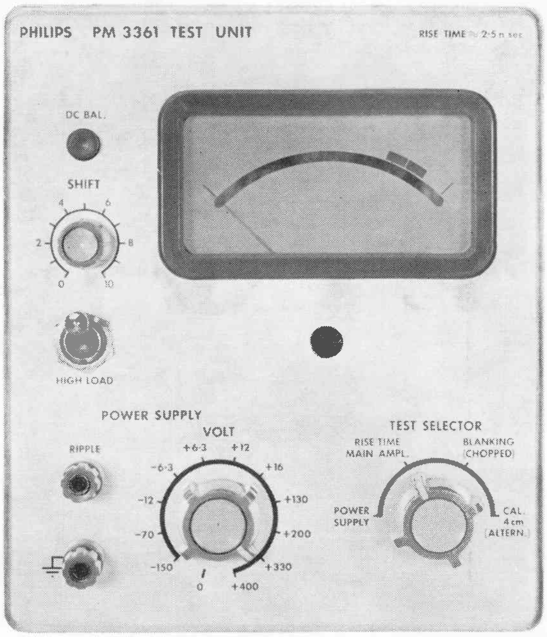
Test-unit PM 3361 is designed for servicing activities on the basic oscilloscope PM 3330. With this test-unit it is possible:

- to read off on a voltmeter the deviation of the power supplies in per cents of their rated values.
- The same at full load.
- To apply a fast rising square wave (2.5 nsec.) for the adjustment of the Y-amplifier.
- to check the correct "chopped" operation when a multitrace unit will be used.
- to check the Y-deflection sensitivity and the correct "alternate" operation.

For further details see the "Instructions for Use" delivered with the unit.

L. MOBILE OSCILLOSCOPE TABLE PM 9319.

The tilt of the table top is adjustable to 3 positions to achieve convenience in observing the CRT display. A drawer provides storing space for probes, cables, manuals etc. An open shelf at the bottom can take plug-in units which are not in use. Fig. 12 a + b.



PEM 3243

Fig. 11

Fig. 12a

Fig. 12b