C1-5

UNIVERSAL OSCILLOSCOPE

USSR

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SERVICE MANUAL

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1. PURPOSE

The C1-5 universal oscilloscope is designed for non-precision measurements of pulse and periodic waveforms and for lecture and demonstration purposes.

The instrument makes it possible to examine pulses of 0.1 to 3000-µs duration, measure pulse duration and amplitude and observe periodic waveforms and Lissajous figures.

2. STANDARD EQUIPMENT

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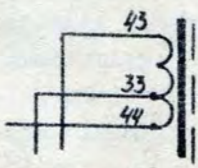
ELEMENTARY DIAGRAM			

3. BASIC SPECIFICATIONS

(a) Y-axis amplifier sensitivity at a frequency of 100 kHz is at least 25 mm peak-to-peak for every 0.3 V RMS with a wide band, and at least 25 mm for 0.1 V RMS with a narrow band.

(b) Y-axis amplifier frequency response is flat to within 3 dB in the range of 10 Hz to 10 MHz with a wide band, and 10 Hz to 500 kHz with a narrow band, at maximum gain and attenuation ratio of 1:1.

(c) Droop of a 2000-μs pulse does not exceed 15% of the pulse initial amplitude.

(d) Total pips on a 1-μs pulse does not exceed 1 mm at a display size of 20 mm, the rise time of the trigger pulse leading edge being 0.07 μs.

(e) Y-axis amplifier input impedance is not less than 0.5 megohm with 50-pF capacitor connected in parallel.

(f) X-axis amplifier sensitivity at a frequency of 100 kHz is at least 25 mm peak-to-peak for every 0.3 V RMS.

(g) X-axis amplifier frequency response is flat to within 3 dB in the range of 20 Hz to 500 kHz, at maximum synchronization gain.

(h) X-axis amplifier input impedance is not less than 80 kilohms.

(i) Two kinds of sweep are provided:

- driven sweep with nine fixed bands - 1, 2, 5, 10, 30, 100, 300, 1000 and 3000 μs (±20% at a sweep length of 50 mm);

- continuous sweep with nine continuously variable bands covering the total range of 20 Hz to 200 kHz.

(j) Driven sweep is initiated by signals of not over 0.35 V peak, continuous sweep is synchronized by signals of not over 0.12 V RMS.

(k) Calibration marks for pulse duration measurement are provided by pulse-duration calibrator at intervals of 0.05, 0.2, 1.0, 5, 20 and 100 μs, the error being within ±5%.

(l) The internal pulse amplitude calibrator providing direct offscale reading in RMS and peak values of voltage is accurate to ±10% of measured value over the scale section of 0.2 to 1.2 V RMS.

(m) Provision is made for directly applying the voltage under test to the CRT Y-plates and X-plates.

(n) Input impedance of the Y-plates and X-plates is not less than 3.6 megohms, with 30-pF capacitor connected in parallel.

(o) The input attenuator has attenuation ratios 1:1, 1:10 and 1:100, the accuracy being not more than ±5%.

(p) The standard service conditions for the instrument are as follows:

- ambient temperature of +20 ±5°C;

- relative air humidity of 65 ±15% as measured at +20 ±5°C;

- atmospheric pressure of 750 ±30 mm Hg (100,000 ±4000 N/sq.m);

- supply mains voltage of 127 V ±2% and 220 V ±2% 50 Hz, 115 V ±2% 400 Hz.

(q) The instrument is serviceable under the following conditions:

- ambient temperature from -30 to +40°C;

- supply mains voltage of 127 V $^{+5\%}_{-10\%}$, 220 V $^{+5\%}_{-10\%}$ 50 Hz, 115 V ±5% 400 Hz.

(r) Power consumption is not in excess of 180 VA.

(s) The instrument can operate continuously during 8 hours.

(t) Weight is not over 14 kg.

(u) Overall dimensions are 430 x 360 x 220 mm (without cover).

(v) The instrument mean trouble-free operation time (T_{mean}) is to be 600 hours minimum.

4. DESIGN

4.1. The instrument is mounted on an aluminium-alloy chassis fitted into a casing and screwed to it.

The chassis comprises a vertical panel carrying all the controls and two horizontal panels mounting valves and other components.

The upper horizontal panel carries the valves of the Y-axis amplifier and pulse-duration calibrator, electrolytic capacitors, resonant circuits of the pulse-duration calibrator, internal adjustment potentiometers, terminal strips and other parts and components. The CRT in magnetic shielding and the short-circuited Y-plates and X-plates connectors are also located on this panel.

The lower horizontal panel mounts the sweep generator and synchronizing amplifier valves, the power transformer with the mains change-over switch and fuse, filter chokes, electrolytic capacitors and other components.

The vertical face panel carries labelled controls (Fig. 2) and is protected by a removable cover.

4.2. The casing has louvres for ventilation purposes. A swing-out cover on the rear wall gives the access to the short-circuited plugs КП-1, КП-2, КП-3, КП-4 serving to connect the voltage under investigation right to the CRT deflecting plates, and to switch B7 used to select the Y-axis amplifier wide or narrow band.

The instrument is furnished with a telescopic viewing hood used to examine pulses at a poor brilliance of display.

5. CIRCUITRY

5.1. The instrument consists of the following components (see the functional block diagram in Fig. 1):

(a) input attenuator;
(b) Y-axis amplifier with a delay line;
(c) synchronizing and X-axis amplifier;
(d) sweep generator (continuous and driven sweeps);
(e) pulse duration calibrator;
(f) pulse amplitude calibrator;
(g) cathode-ray tube;
(h) power supply unit.

5.2. The signal under test is applied over a coaxial cable, and via the input attenuator it is fed to cathode follower Л1 (see Appendix 1) loaded into delay line ИЛ-1.

The delayed signal is amplified by valve Л2 and impressed onto the grid of valve Л3. Voltages derived from

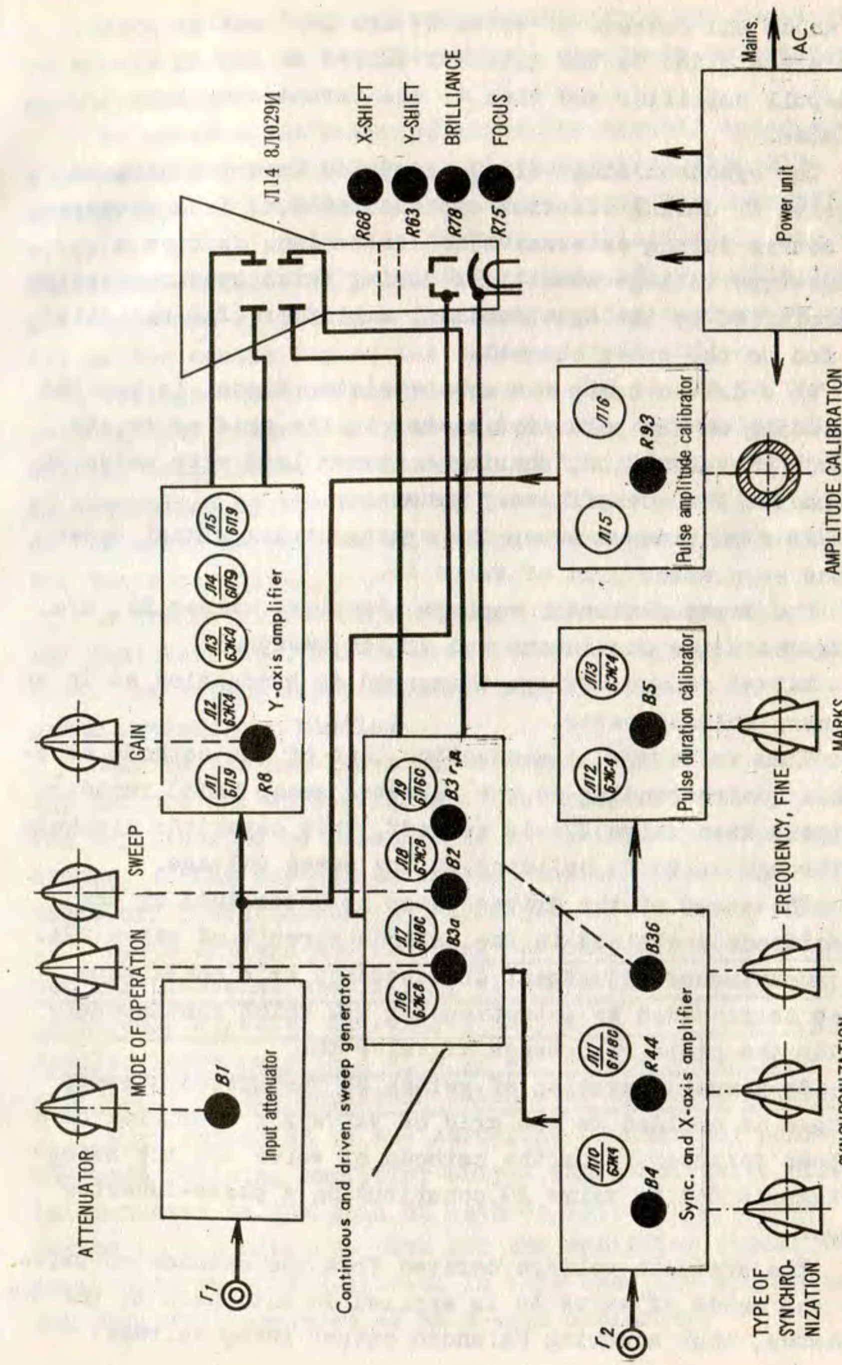


FIG. 1. C1-5 UNIVERSAL OSCILLOSCOPE. FUNCTIONAL BLOCK DIAGRAM

the anode and cathode of valve Л3 are 180° out of phase. They are applied to the grids of valves Л4 and Л5 of a push-pull amplifier and then to the cathode-ray tube Y-plates.

The synchronizing voltage supplied from the cathode of valve Л1 during internal synchronization, from an external source during external synchronization, or from a bridge-type voltage stabilizer during mains synchronization is amplified by the synchronizing amplifier (Л10 and Л11a) and fed to the sweep channel.

At a driven sweep the synchronizing signal is applied (depending on the polarity) either to the grid or to the cathode of valve Л11б, sharing a common load with valve Л6, to trigger the cut-off sweep generator.

At a continuous sweep the synchronizing signal comes to the suppressor grid of valve Л6.

The sweep generator employs identical valves Л6, Л7a, Л8 for both the continuous and driven sweeps.

Valves Л6 and Л7a are triggered in succession as in an ordinary multivibrator.

When valve Л7a is conducting, one of its cathode capacitors (corresponding to the selected sweep band) rapidly charges. When valve Л7a is cut off, this capacitor discharges through valve Л8 building up the sweep voltage.

The speed of the driven sweep is determined by the capacitance contained in the cathode circuit of valve Л7a.

Continuous adjustment of frequency at a continuous sweep is provided by potentiometer R32 which continuously varies the plate resistance of valve Л8.

By manual operation of switch B3 the sawtooth sweep voltage is applied to the grid of valve Л7б operating as a cathode follower. From the cathode of valve Л7б the sweep voltage is fed to valve Л9 constituting a phase-inverter stage.

The sawtooth voltage derived from the cathode of valve Л7б and anode of valve Л9 is applied in antiphase to the CRT X-plates, thus ensuring balanced output sweep voltage.

Part of the sweep voltage derived from the anode of valve Л7a is fed to the CRT control electrode to brighten up the sweep trace.

To measure the pulse duration the circuit incorporates a pulse-duration calibrator employing valves Л12, Л13. A negative pulse from the driven sweep generator cuts off valve Л12 which gives rise to free oscillations in one of the tuned circuits of valve Л12 cathode. The oscillations are sustained by positive feedback applied through valve Л13 to the centre tap of the tuned circuit coil.

Voltage from the anode of valve Л13 is fed to the CRT cathode thus periodically increasing and decreasing the display brilliance. The duration of the pulse under test is determined by the number of bright spots and blanking on the sweep as well as by the known resonant frequency of the tuned circuits.

A bridge circuit comprising filament lamps Л15, Л16 and resistors R90, R91 is used for measuring pulse amplitude. The bridge input receives supply voltage from the power transformer winding.

Due to the non-linearity of characteristics of lamps Л15 and Л16 the voltage across the bridge is fairly stable. The amplitude to be measured is determined by comparing the display of the voltage under test and of the known voltage taken off potentiometer R93 arranged in the bridge diagonal.

Lamps Л15 and Л16 are used not only for scale lighting but also serve as stabilizing elements in the pulse-amplitude calibrator circuit. Therefore, they must be replaced by similar lamps only (6.3 V, 0.22 A), with a subsequent adjustment of the amplitude calibrator by potentiometer R92.

With switch B3 in the AMPLIFIER (УСИЛИТЕЛЬ) position, the synchronizing amplifier output (anode of valve Л11a) is connected to the grid of cathode follower Л7б thus making up a conductive path for the amplifier signal to be applied to the CRT X-plates. In this case the synchronizing amplifier operates as an X-axis amplifier.

In addition, the signal can be applied directly to the Y-plates and X-plates, if they are disconnected from the Y-axis amplifier and the sweep generator by removing short-circuited plugs КП-1, КП-2, КП-3, and КП-4.

The supply unit comprises a power transformer, a HV and LV rectifiers and filters.

Y-Axis Amplifier with Input Attenuator

5.3. The Y-axis amplifier employs five valves Л1, Л2, Л3, Л4, Л5 (see Appendix 1).

Due to a high input impedance and a low input capacitance, the Y-axis amplifier presents but a small load to the circuit under measurement.

To protect the first amplifier valve against overloads, a resistance-capacitance attenuator having the attenuation ratios of 1:1, 1:10, 1:100 is connected at the input.

With switch B1 being in position 1:1, resistor R2 and parallel-connected capacitor C2 are shorted, so that the incoming signal passes via capacitor C1 to the grid of first amplifier valve Л1 without practically being attenuated (capacitance C1 is high).

R5 is a grid-leak resistance of valve Л1.

With the switch in position 1:10, resistor R2 and capacitor C2 are cut in the circuit, and resistor R3 and capacitor C3 are connected in parallel with resistor R5. Thus, an attenuator is formed, with one arm consisting of resistor R2 and capacitor C2, and the other, of resistor R3 and capacitor C3 in parallel with resistor R5.

The ratings of the above resistors and capacitors are so selected that the signal applied to the grid of valve Л1 from the attenuator lower arm is ten times lower than the initial voltage.

Attenuation by 100 is performed in a similar manner, but in this case the lower arm of the attenuator is made up of R4, C4, R5.

The attenuation ratio remains constant over a wide frequency range. This is of importance when pulses are being examined, as unequal attenuation of harmonic components may cause distortion.

Attenuation at low frequencies depends on the resistance ratios of the resistors making up the attenuator.

At high frequencies attenuation is determined by the capacitance ratios of the capacitors connected in parallel with the resistors, with spurious capacitances taken into account.

Capacitance C2 is adjusted in tuning.

The attenuated signal is impressed onto the control grid of valve Л1 which acts as a cathode follower and ensures high impedance and low capacitance of the input.

Due to the low output impedance of the cathode follower, gain is controlled with a low-resistance potentiometer R8 whose resistance, together with R7, is equal to the wave impedance of delay line ИЛ-1 (about 400 Ohms).

The delay line is a long artificial line consisting of inductances and capacitances. It is meant to delay the signal being tested in the Y-axis amplifier channel by approximately 0.2 μs with respect to the horizontal sweep voltage.

The delay line passes all frequencies of the range and comprises a large number of sections.

Reflections from the line end are eliminated by loading the line with a resistance equal to the line wave impedance (R7, R8).

Potentiometer R8 feeds the signal to the grid of amplifying valve Л2 and further, via capacitors C8, to valve Л3.

Valve Л3 has load resistors in its anode and cathode circuits, the voltages derived from the anode and cathode are 180° out of phase.

Due to the shunting effect at high frequencies the capacitances of the valve electrodes and wiring capacitance lower the load impedance, reduce the gain and distort the pulse under investigation. To compensate for the shunting effect of spurious capacitances, use is made of a compensating coil connected in series with the load resistor in the anode circuit of valve Л3.

Signals from the anode and cathode of valve Л3 are impressed in antiphase via coupling capacitors C9, C12 onto the control grids of valves Л4 and Л5 of the push-pull stage. R23 and R24 are cathode resistors of the valves, and R16 and R25 are their grid-lead resistances.

The anode circuits of valves Л4 and Л5 contain load resistors R18 and R21 with compensating inductance coils.

Voltage is impressed onto the screen grids via common decoupling circuit R95, C5.

The signal taken off the anodes of valves Л4, Л5 between series-connected compensating coils is applied in antiphase via coupling capacitors C41 and C40 to the Y-plates of the cathode-ray tube.

In the Y-axis amplifier provision is made for switching over to a narrow band for the purpose of obtaining a higher gain. In this case the toggle switch connects load resistors R19 and R20 and compensating inductance coils L7 and L8 in series with the load resistors of valves Л4 and Л5. This is useful in investigation of signals of comparatively low frequencies having a small amplitude.

To avoid overload of input valve Л1, signals impressed onto its grid should not be over 1 V RMS. With the input attenuator switch in position "50 OHMS" (50 OM), resistor R1 (51 Ohms) shunts the instrument input to provide a low-resistance input. The Y-axis amplifier response is flat to within 3 dB at the range cut-off frequencies.

Synchronizing and X-Axis Amplifier

5.4. The amplifier is intended to amplify the synchronizing voltage for the sweep circuit, and to amplify the horizontal deflection voltage, when observing Lissajous figures.

In the first case function switch B3 is put in a position corresponding to the required type of sweep: CONTINUOUS (НЕПР.), DRIVEN (ЖД. ⎍), or DRIVEN (ЖД. ⊔).In the second case it is put in the AMPLIFIER (УСИЛИТЕЛЬ) position. In the first case the source of the signal is determined by the position of switch B4 TYPE OF SYNCHRONIZATION (РОД СИНХР.).

The synchronizing and X-axis amplifier employs valves Л10 and Л11a. The amplifier frequency response is flat to within 3 dB at the range cut-off frequencies.

The input voltage passes via capacitor C28 to variable resistor R44 controlling the amplitude of voltage impressed onto the grid of valve Л10. The valve cathode circuit includes self-bias resistor R45 and capacitor C29 for an additional correction of radio frequencies.

The anode circuit of valve Л10 contains load resistor R47 and compensating inductance coil L10. Supply for the anode comes via decoupling circuit R46, C59.

The screen grid is supplied through decoupling circuit R40, C27 of valve Л9.

The signal amplified by valve Л10 is impressed via coupling capacitor C31 onto the grid of valve Л11a which is the amplifier second stage. The first and second stages of the amplifier have identical circuits, the only difference being in that the correction of radio frequencies in valve Л11a is provided by capacitor C32 in the cathode only.

When the amplifier (valves Л10 and Л11a) is used as a synchronizing amplifier to initiate driven sweep, switch B3 connects its output to the grid or cathode of trigger triode Л11б having a common load with sweep generator valve Л6.

When the amplifier is used to synchronize continuous sweep, switch B3 connects its output to the suppressor grid of sweep generator valve Л6.

In a position when the amplifier amplifies the horizontal deflecting voltage, switch B3 connects its output to cathode follower Л7б and through it to phase inverter Л9.

Voltages derived from the cathode of valve Л7б and anode of valve Л9 are applied in antiphase to the X-plates of the cathode-ray tube.

Sweep Generator

5.5. If a sawtooth voltage varying in proportion with time is applied to the X-plates of the cathode-ray tube while the voltage under investigation is applied to the Y-plates, the resultant curve presented on the cathode-ray tube screen will show variation of the voltage under investigation with time.

If, then, the sawtooth voltage is synchronized by the signal under test so that a sawtooth constantly begins at the same point of the waveform under test, the resultant curve on the screen will be stable and convenient for observation.

The sawtooth voltage is generated in the instrument by the sweep generator built around valves Л6, Л7a, Л8.

Valves Л6 and Л7a constitute a modified multivibrator circuit. Coupling between them is capacitive (C13) and direct (from the anode of Л6 to the grid of Л7a).

Owing to the above couplings valves Л6 and Л7a operate in succession. At the time when valve Л7a is conducting and valve Л6 is cut off, the current flowing through valve Л7a charges one of the capacitors in its cathode. The cathode potential increases, i.e., the anode current and the voltage drop across anode load resistor R29 decrease.

Consequently, the anode potential rises with respect to the ground. Due to the charge of capacitor C13, the potential across the control grid of valve Л6 rises through grid-leak resistance R26, anode current starts flowing and the voltage drop across load resistor R27 (L9 is a compensating inductance coil) increases. The voltage at the anode and, consequently, at the grid of valve Л7a drops.

The anode current of valve Л7a decreases still more and its anode potential increases, thus causing a further

increase of the potential across the control grid of valve Л6 and increase of the anode current.

This process goes on in an avalanche-like manner until valve Л7a becomes cut off and valve Л6, fully conducting.

At the time when valve Л7a is cut off, the charged capacitor in its cathode discharges through valve Л8. The cathode potential decreases giving rise to a small current through valve Л7a. This current causes a drop of the voltage at the anode of valve Л7a and owing to the discharge of capacitor C13, the grid voltage of valve Л6 drops and its anode current decreases.

The lowering of the anode current through valve Л6 causes an increase of voltage at its anode and at the grid of valve Л7a, increasing still more the anode current through valve Л7a. In addition, the continuing discharge of the capacitor in valve Л7a cathode aids in raising the current through valve Л7a. This avalanche-like process goes on until valve Л7a is fully conducting and valve Л6 is cut off. The capacitor in the cathode of valve Л7a which by this time has fully discharged, now charges up again with the anode current through valve Л7a.

Due to the fact that the capacitor in the cathode of valve Л7a is charged with a heavy current through valve Л7a and discharged through a high anode resistance of valve Л8, the retrace (charge) lasts considerably shorter than the trace (discharge) which brings the sweep voltage curve closer to a sawtooth form.

Switch B3 connects the sawtooth voltage from the cathode of valve Л7a to cathode follower Л7б, from which it is impressed onto the grid of phase inverter Л9.

The sweep voltages taken from the cathode of valve Л7б and anode of valve Л9 are fed in antiphase to the X-plates of the CRT thus ensuring a balanced output of sweep voltage. The sweep frequency is changed in steps by switching over the band capacitors. The range of generated frequencies is from 20 Hz to 200 kHz.

Continuous adjustment of the sweep frequency within the given band is performed by means of potentiometer R32. Resistors R31 and R33 serve to limit the screen grid voltage.

The sweep linearity is improved by the employment of feedback resistor R30. The use of a feedback circuit consisting of resistors R42, R43, along with a proper selection of coupling elements, brings the remaining non-linearity to a minimum. The voltage to synchronize continuous sweep is applied to the suppressor grid of the sweep generator valve Л6. In case of a driven sweep triggering is provided by valve Л11б.

Synchronizing voltage causes valve Л6 to conduct more rapidly, and hence the sweep frequency becomes equal to, or multiple of the frequency of the signal under test. The display on the CRT screen becomes stationary making it possible to examine periodic waveforms in detail.

For examination of pulse waveforms, the sweep generator is switched over for driven sweep. The function switch is in the DRIVEN ⎍ or DRIVEN ⊔ position.

In these positions grid-leak resistance R26 of valve Л6 is connected, instead of the earth busbar, to the slide of potentiometer R73 which is used to set the required negative voltage to cut off valve Л6. The screen grid of valve Л8 is taken via resistor R102 to the positive side of the anode voltage.

Potentiometer R73 is adjusted to apply such a voltage to the control grid of valve Л6 at which the free oscillations stop, i.e., the sweep generator is blocked.

The signal under investigation or a signal synchronous with it acts on the grid or cathode of valve Л11б (depending on the trigger pulse polarity) in such a manner that a negative pulse is always present at the valve anode.

Since valve Л11б and valve Л6 have a common load (resistor R27 and inductance L9), a negative voltage drop develops across the anode of valve Л6, which disturbs the multivibrator equilibrium and causes the multivibrator to operate.

The generator will complete one cycle of oscillations irrespective of the duration of the trigger pulse. The process is the same as during continuous sweep.

On completion of one cycle the generator is blocked again and is made ready to receive the next trigger pulse. The sweep of this type is called a driven sweep. It provides the required sweep scale, while keeping the sweep synchronized with the signal under examination.

The grid circuit of valve Л11б contains leak resistance R51, and its cathode circuit has bias resistor R52. Switch B3 selectively connects capacitor C34 to shunt one of them.

Both in continuous and driven sweeps, the modulating electrode of the cathode-ray tube is fed with a positive brightening pulse from the anode of valve Л7a for the time of the beam trace. In this way the beam trace is brightened up and the retrace is dimmed out.

Cathode Follower and Phase Inverter

5.6. The voltages from the sweep generator output are applied to the cathode-ray tube X-plates via a cathode follower and a phase inverter.

The purpose of the cathode follower (valve Л7б) is to minimize the spurious wiring capacitance that adds itself to that of the sweep band capacitance, in order to ensure a relatively high repetition frequency of the continuous sweep and high speed of the driven sweep.

Sweep voltage from the load of the cathode follower is applied to one of the cathode-ray tube X-plates, and divided by resistors R36 and R37, it is passed to the phase inverter.

The transfer ratio of the cathode follower is a little less than unity. The sawtooth voltage removed from the cathode of valve Л7б is in the same phase as the sawtooth voltage applied from the sawtooth generator output to the cathode follower grid.

Due to a low output impedance of the cathode follower, the sawtooth voltage comes to the cathode-ray tube X-plates without considerable distortions in spite of a rather high spurious wiring capacitance.

The function of the phase inverter (valve Л9) is to furnish a balanced output to the cathode-ray tube X-plates. This is accomplished by inverting the phase of the incoming voltage.

The voltage to the input of valve Л9 is fed through a divider consisting of load resistors R36 and R37 of valve Л7б.

The transfer ratio of the phase inverter is close to unity, with frequency distortion at a minimum.

The cathode follower and the phase inverter complete the path to the cathode-ray tube X-plates for both the voltage from the sweep generator and the voltage supplied by the synchronizing amplifier for horizontal deflection of the beam.

With short-circuited plugs КП-3 and КП-4 disconnected, it is possible to inject voltage into the X sockets. In this case the voltage will be applied to both X-plates via capacitors C42 and C43.

Pulse Duration Calibrator

5.7. The pulse duration calibrator employs valves Л12 and Л13. The cathode circuit of valve Л12 includes one of the six tuned circuits as selected by switch B5 - L11 (20 MHz), L12, C22 (5 MHz), L13, C36 (1 MHz), L14, C37 (200 kHz), L15, C38 (50 kHz), and L16, C39 (10 kHz) which gives respective mark spacings 0.05; 0.2; 1; 5; 20 and 100 μs.

Valve Л12 is cut off by a negative pulse supplied from the sweep circuit through capacitor C35. This gives rise to free oscillations in the tuned circuit used. In order to sustain the oscillations for the complete cycle of the blanking pulse, the tuned circuit via valve Л13 and a coil

tap is fed with positive feedback which compensates for the attenuation.

The tuned circuits are shunted by resistors for equalizing the amplitude of the generated oscillations. The calibrator output is fed from the anode of valve Л13 to the CRT cathode to modulate the beam brilliance. The pulse image is presented on the CRT screen as a conglomeration of bright spots and dark spacings between them.

Voltage Calibrator

5.8. The signal voltage is measured by comparing the image of the incoming signal with that of the calibration voltage. To obtain calibration voltage independent of the mains voltage fluctuations, the equipment is provided with a voltage stabilizer consisting of a bridge whose arms include wire-wound resistors R90, R91 and lamps Л15, Л16 (6.3 V; 0.22 A).

The bridge receives voltage supply from a separate transformer winding. Stabilized voltage is taken off the diagonal incorporating potentiometer R93.

Voltage is stabilized by lamps Л15 and Л16 which present non-linear resistances so changing with the bridge input voltage fluctuations that the voltage across potentiometer R93 remains practically constant. The potentiometer enables fractions of stabilized voltage to be taken off. The calibration voltage is read off the scale of wire-wound potentiometer R93 conveniently graduated both in RMS and pulse-voltage values (the lower and upper scales, respectively). The pulse voltage is 2.82 times higher than the RMS voltage.

The scale zero is adjusted by means of trimming potentiometer R92.

The voltage calibrator scale is illuminated by lamps Л15 and Л16.

Vertical and Horizontal Adjustment Controls

5.9. The beam is set vertically by means of network R61, R62, R63, R64, R65 and horizontally, by means of network R66, R67, R68, R69, R70.

The operating principle of the vertical beam adjustment control is as follows.

A voltage of about +300 V is fed to resistors R61 and R64 from rectifier filter choke Дp1. The slide of potentiometer R63 is under the earth potential.

With resistances R61 and R64 equal, and the slide of potentiometer R63 in the middle position, equal potentials are applied to both plates 7 and 8, and the beam is located in the middle of the CRT screen.

As the slide of potentiometer R63 moves down, the potential across plate 8 decreases, and the potential across plate 7 increases by the same amount, which results in the beam deflection towards plate 7.

The signal under test applied to the Y-plates via capacitors C40 and C41 is superimposed on the constant potential of the plates and deflects the beam from its set position depending on the signal polarity and amplitude.

The beam horizontal adjustment control is effected in a similar manner.

Focus and Brilliance Controls

5.10. The focus control is used to focus the beam at various distances from the CRT first anode by varying the voltage applied to the anode.

The control is provided by potentiometer R75.

The position of the knob of brilliance control potentiometer R78 determines the bias applied to the CRT control electrode and consequently the current intensity in the beam. The potentiometer receives negative supply directly from the rectifier.

Resistors R77 and R79 decouple the CRT control electrode and cathode from the negative voltage rectifier making

it possible to apply to these electrodes intensity-modulated signals (calibration marks, brightening). Capacitor C47 is a blocking capacitor.

Potentiometer R71 is used to provide optimum focusing in replacement of the cathode-ray tube.

Power Supply Unit

5.11. The power supply unit comprises two rectifiers with filters fed from a common power transformer.

The positive voltage rectifier employing a diode bridge circuit (Д3) supplies all valves and some of the CRT electrodes.

At the output it has three separate filters with chokes Дp1, Дp2, Дp3 and electrolytic capacitors, and also, additional decoupling networks comprising resistors R40, R46, R95, R96 and R99.

The use of separate filtering and decoupling elements for the supply of units eliminates the interaction of units through the supply circuit.

Voltage at the output of the filters is about 300 V and it drops to about 150 V after the decoupling network.

The negative voltage selenium rectifier employing a voltage doubling circuit supplies the CRT electrodes and the negative grid-bias circuits.

As this rectifier draws small current, adequately good filtering is obtained by means of resistance R81 and comparatively low capacitance C48.

The negative voltage at the filter output is about 1000 V.

The negative voltage divider R72-R78 provides for voltages required for the supply of the CRT electrodes.

The power transformer primary incorporates the mains switch and fuse Пр1. The transformer primary can be connected either to 127-V and 220-V 50-Hz mains, or to 115-V 400-Hz mains by arrangement of switch B6.

The power consumed by the instrument from the mains does not exceed 180 VA.

Lamps Л15 and Л16 serve as pilot lamps.

6. GENERAL INSTRUCTIONS

6.1. For packing the instrument, wrap it in packing paper and put into a cardboard box.

Reinforce the cardboard box seams with a strip of packing paper or a special adhesive tape.

Place the box in the shipping case and fill the space between the box and the case sides, top and bottom, with shock-absorbing material (wooden shavings or other authorized materials).

6.2. On arrival at the place of destination the instrument should be taken out of the shipping case and cardboard packing box and wiped clean.

7. OPERATING INSTRUCTIONS

7.1. Safety precautions.

(a) Before putting the instrument in service, carefully study the Service Manual.

(b) Before connecting the instrument to the mains, make sure that it is reliably earthed through the special terminal on the face panel.

(c) Never operate the instrument when it is removed from its casing. High voltages are dangerous to life.

Layout of Controls

7.2. The vertical face panel (Fig. 2) accommodates all the controls provided with explanatory inscriptions.

(a) MAINS (СЕТЬ), to switch on and off the instrument.

(b) BRILLIANCE (ЯРКОСТЬ) and FOCUS (ФОКУС), to set the required brilliance and to focus the beam.

(c) X-SHIFT (СМЕЩЕНИЕ X) and Y-SHIFT (СМЕЩЕНИЕ Y), to control the beam vertical and horizontal displacements.

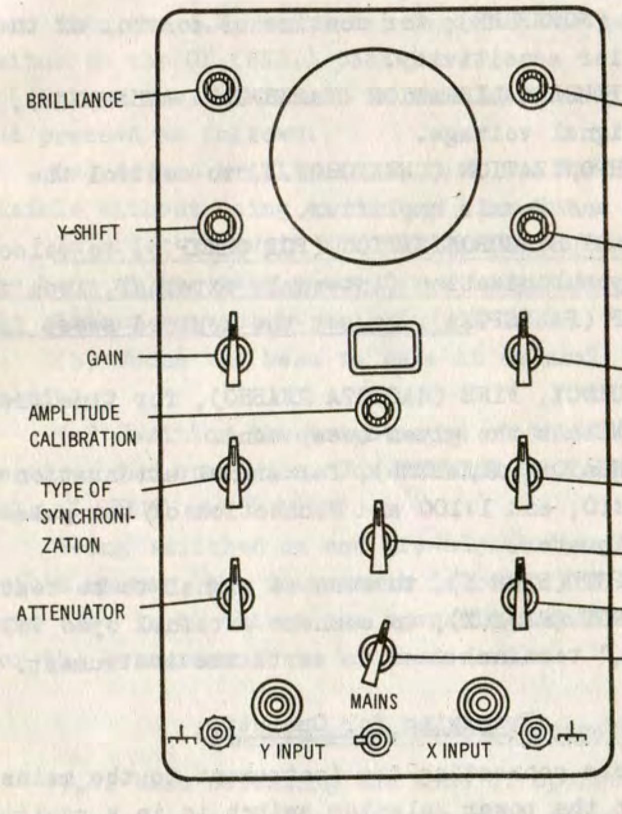


FIG. 2. CONTROLS LAYOUT

(d) MODE OF OPERATION (РОД РАБОТЫ)*, to select the required mode of operation.

(e) MARKS (МЕТКИ), to switch on the pulse duration calibrator.

(f) GAIN (УСИЛЕНИЕ), for continuous control of the Y-axis amplifier sensitivity.

(g) AMPLITUDE CALIBRATION (КАЛИБРОВКА АМПЛИТУДЫ), to measure the signal voltage.

(h) SYNCHRONIZATION (СИНХРОНИЗ.), to control the synchronizing and X-axis amplifier.

(i) TYPE OF SYNCHRONIZATION (РОД СИНХР.), to select the type of synchronization (internal, external, from mains).

(j) SWEEP (РАЗВЕРТКА), to set the desired sweep frequency.

(k) FREQUENCY, FINE (ЧАСТОТА ПЛАВНО), for fine frequency control within the given sweep band.

(l) ATTENUATOR (ДЕЛИТЕЛЬ), for signal attenuation at ratios 1:1, 1:10, and 1:100 and connection of the pulse-amplitude calibrator.

(m) Y-INPUT (ВХОД Y), to connect signal to be tested.

(n) X-INPUT (ВХОД X), to connect external sync voltage

(o) "⏚" terminal used to earth the instrument.

Preparing for Operation

7.3. Before connecting the instrument to the mains make sure that the power selector switch is in a position corresponding to the voltage required. If it is required to change over to another mains voltage, take off the power switch cap, draw out the plug, turn it as required, and insert it in place ensuring that the plug key is against the proper voltage index. Put the cap in place.

Note. The Manufacturer delivers the instrument as prepared for 220-V supply.

In order to avoid premature breakdown of the instrument, keep in mind the following:

* Abbreviated as OPRN in the equipment.

(a) Continuous operation should not exceed 8 hours.

(b) Permissible mains voltage fluctuation should not exceed 5%.

The instrument is switched on by plugging the power cord into the A.C. mains and throwing the power toggle switch to the ON (ВКЛ.) position.

Allow the instrument to warm up during 2 or 3 minutes and proceed as follows:

(a) Adjust brilliance so that the spot is clearly visible without being exceedingly bright.

In order to avoid the CRT screen burning, do not keep the beam at the same place for a long time and always use the minimum convenient brilliance.

(b) Focus the beam to make it as small and round as possible.

(c) Position the bright spot on the CRT screen as required for operation. For this purpose manipulate controls X-SHIFT and Y-SHIFT.

Being switched on and pre-adjusted in the above-described manner, the instrument is ready for operation. The next step is to select the operating conditions suitable for the measurements to be performed.

Selecting the Mode of Operation

7.4. When selecting the mode of operation determine the type of sweep, sweep frequency or sweep duration, type of synchronization and the attenuation ratio of the input attenuator. These factors depend on the kind and value of the voltage under test and the specific features of the circuit under test.

If some of these factors or all of them are not known, the most efficient mode of operation should be found by several checks. General considerations for the guidance in selecting the proper mode of operation are given below.

Type of Sweep

7.5. For investigation of pulses with a duration of up to 3000 μs driven sweep should be selected. Continuous sweep should be used for investigation of periodic waveforms or pulses with a duration of above 3000 μs.

The type of sweep is set with switch B3 placed on the front panel and labelled MODE OF OPERATION (РОД РАБОТЫ).

Sweep Frequency

7.6. The sweep frequency should be selected so as to display the whole pulse or waveform. X-axis presentation should occupy as much of the CRT screen as possible. The faster the sweep frequency, the larger the horizontal display.

If the duration of the pulse to be investigated is known, the sweep band selector can be set at the required speed duration beforehand. The sweep length for each band is indicated on the face panel.

When continuous sweep is employed, the sweep speed selector sets the frequency band only. Fine frequency adjustment is provided by the FREQUENCY, FINE (ЧАСТОТА ПЛАВНО) knob, while the display is observed on the CRT screen. The knob continuously varies the sweep natural frequency within the range of 20 Hz to 200 kHz when being turned all the way clockwise.

If the pulse duration is absolutely unknown, first set the band selector to one of the mid bands, and then select the most suitable band by further adjustment.

Synchronizing Voltage Source

7.7. In most cases it is convenient to synchronize the sweep by the signal under test. For this purpose set the TYPE OF SYNCHRONIZATION selector switch at the INTERNAL (ВНУТР.) position.

If the signal under test is unfit for synchronizing by virtue of its amplitude or waveform, connect an external sync voltage source (whose voltage is in synchronizm with the voltage under test) to the X-INPUT jack and set the selector to the EXTERNAL (ВНЕШН.) position.

To synchronize continuous sweep at a mains frequency (which may be necessary, for instance, in testing rectifier filtering), set the switch to the FROM MAINS (ОТ СЕТИ) position.

Input Attenuator

7.8. The maximum voltage that can be applied to the instrument input is 200 V peak. If the value of the voltage to be tested is known to be below 200 V but not known exactly, adjust the attenuator switch to 1:100 position and turn the GAIN (УСИЛЕНИЕ) switch so as to provide the display height of 20 - 25 mm.

If the display of this size cannot be obtained even with the gain switch turned fully clockwise, put the attenuator switch to the 1:10 position. If again the voltage value is not sufficient, set the attenuator switch to the 1:1 position and operate the instrument.

In the 1:1, 1:10, and 1:100 positions of the attenuator switch the input resistance is not less than 0.5 megohm.

The attenuator switch has one more position - 50 OHMS. In this position a 51-Ohm resistor shunts the input to provide a low-resistance input at the 1:1 attenuation.

Driven Sweep Synchronized by Signal under Test

7.9. The operating procedure is as follows.

(a) Put the MODE OF OPERATION selector switch to the DRIVEN ⊓ or DRIVEN ⊔ position.

(b) Make sure that the TYPE OF SYNCHRONIZATION selector is in the INTERNAL (ВНУТР.) position.

(c) If the duration of the pulse to be tested is approximately known, set the sweep band selector switch B2 to the required position.

(d) Set the input attenuator switch B1 to the position corresponding to the value of voltage under test as was indicated above.

(e) Apply the signal under test to the Y-INPUT jack and connect the chassis of the device under test to the earthing terminal.

When using the coaxial cables delivered together with the instrument, mind that the prong termination of the shorter conductor corresponds to the cable centre conductor, and the prong termination at the end of the longer cable, to the cable shielding.

With the signal under test applied, a display should appear on the CRT screen.

(f) If no display is obtained, turn the SYNCHRONIZATION knob in the clockwise direction until a steady image appears.

(g) If there is still no display, change the polarity of switch B3.

(h) If there is neither vertical deflection nor horizontal line on the CRT screen, the voltage under test or the synchronizing voltage, respectively, is too low.

(i) As soon as the pulse appears, adjust the SYNCHRONIZATION knob to contract the sync amplitude to the minimum sufficient level thus ensuring a steady display.

(j) Adjust the focusing and brilliance so as to ensure a clear and well-defined display.

Diminish the brilliance until the bright spot to the left of the pulse disappears. The telescopic viewing hood can be used to view the display at low brilliance. If the pulse duration is not to be measured, the calibration mark selector switch B5 should be put to the OFF (ВЫКЛ.) position.

(k) Select a sweep band at which the pulse display is the largest. If only a part of the pulse is displayed on the CRT screen, switch over to another sweep band possessing greater duration and proceed with this operation until the whole pulse is visible on the screen.

Such positions of switch B3, however, should be avoided when two pulses appear on the CRT screen due to a high repetition frequency. This disrupts the accuracy of driven sweep, contracts the sweep amplitude and worsens stability of the pulse duration calibrator.

The same effect is produced when the time spacing between pulses is shorter than the sweep cycle.

When selecting the sweep band, the pulse beginning should be shifted to the left portion of the CRT screen with the X-SHIFT knob, and the horizontal base line should be positioned at the middle of the CRT screen with the Y-SHIFT knob.

(l) If only the pulse shape, and not its amplitude, is to be determined, there is no need to set the image size exactly, and the prime consideration is to avoid overloading the amplifier. Therefore, keep the image size within 25 mm when checking pulses, and within 50 mm, when checking sine voltages with the gain control set at a maximum. The measuring procedure is described below.

Continuous Sweep Synchronized by Signal under Test

7.10. Operations to be performed do not differ from those outlined for driven sweep, but:

(a) Set the MODE OF OPERATION switch to CONTINUOUS.

(b) Select a sweep band and use the FREQUENCY, FINE knob to obtain a steady display, manipulate the SYNCHRONIZATION knob (with the sync amplitude at a minimum) to cancel out undesirable slips of the display, i.e., to make it reliably fixed.

A too high synchronizing voltage will distort the sawtooth sweep resulting in sweep non-linearity and in sharp contraction of its amplitude.

IMPORTANT! In continuous sweep be sure to set the MARKS switch to OFF.

Sweep Synchronized by External Source

7.11. To obtain external sweep synchronization, connect the external sync signal source to the X-INPUT jack and set the TYPE OF SYNCHRONIZATION switch to the EXTERNAL position. Further procedure is the same as was described for the sweep synchronization by the signal under test. At external synchronization, like at internal synchronization, both continuous and driven sweeps can be used.

In externally synchronized driven sweep, the position of the MODE OF OPERATION switch should correspond to the sync pulse polarity irrespective of the polarity of the signal under test.

Sweep Synchronized from Mains

7.12. Only continuous sweep can be synchronized from mains. Set the synchronization switch to the FROM MAINS position and adjust the synchronization amplitude with the SYNCHRONIZATION knob.

Mains synchronization is used primarily for investigation of rectifier ripples, mains-frequency hums and other waveforms whose frequency is equal to, or multiple of the mains frequency. The adopted procedure is the same as that described for continuous sweep synchronized by a signal under test.

Sweep from External Source

7.13. If another than the internally sawtooth voltage supplied from internal sweep generator is required for the horizontal deflection of the beam, set the MODE OF OPERATION switch to the AMPLIFIER position, and the SYNCHRONIZATION switch to the EXTERNAL position, and apply sweep voltage to the X-INPUT. The SYNCHRONIZATION switch can be used to adjust the voltage amplitude. Apply the signal to be tested to the Y-axis amplifier input. Thus, if the sweep frequency is known the figures displayed on the screen will

help you to determine the frequency of voltage under test (Lissajous figures).

Determining Pulse Duration

7.14. The same procedures are adopted as in the case of driven sweep operation. Pulse duration calibration can be used in both at internal and external synchronizations.

To determine the pulse duration, set the MARKS switch to an operating position and see that calibration marks appear on the pulse display in the form of bright spots and dark gaps.

Adjust the MARKS switch so as to obtain the maximum number of calibration marks convenient for reading.

Adjust focus and brilliance so as to make the display with the superimposed marks clear. For mark definition it is sometimes useful to adjust the synchronization using the SYNCHRONIZATION knob. To simplify the reading procedure, draw out the viewing hood of the CRT.

If the range is wrongly selected, marks may merge into a solid line, or on the contrary, be spaced too wide apart to afford an accurate measuring.

By trying different positions of the MARKS switch it is possible to find the necessary range for measuring the steepness of pulse edges.

If the pulse edges are very steep, calibration marks will be distinctly visible on the slope whereas on the flat top they will merge.

Knowing the number of calibration marks within a pulse or within its edges and the mark value, it is possible to determine the pulse duration and the edge steepness.

It is also possible to determine in the same way the duration of the oscilloscope sweep or of any portion of a pulse (trailing edge, etc.). Remember that the mark comprises a bright spot and a dark gap.

A bright spot or a dark gap alone is half the mark value. If a precise reading is required, even smaller fractions of a mark should be taken into account.

The mark value is determined by the selected range. The MARKS selector affords 0.05, 0.2, 1, 5, 20, and 100-μs marks.

More accurate results of pulse duration measurement can be obtained when small marks are used, and the sweep band is so selected that the pulse occupies the most of the effective area of the CRT screen.

Determining Pulse Amplitude

7.15. To calibrate the pulse under test in amplitude, do the following.

(a) Apply the pulse under test to the Y-axis amplifier input.

(b) Use the input attenuator and GAIN knob to set a display of desired size, but not larger than 25 mm.

(c) Read the pulse size off the graticule applied to the CRT screen.

(d) Notice the position of the input attenuator knob. Leave the GAIN knob in the same position till the measurement is over.

(e) Set the input attenuator to the CALIBRATION position.

(f) Use the AMPLITUDE CALIBRATION knob to adjust the calibration voltage so that its display is equal to that of the pulse under test, or if the calibration voltage is insufficient for this purpose, set any size of the calibration voltage display that is convenient for reading.

It is desired, for more accurate measurement, that the calibration voltage display differs from the pulse display by not more than 1.5 - 2 times.

(g) Having fixed the display of the calibration voltage, read the obtained value against the index line of the AMPLITUDE CALIBRATION (КАЛИБРОВКА АМПЛИТУДЫ) potentiometer scale. Reading should be taken just against the index line to ensure greater accuracy. Use the PULSE (ИМП.) scale for pulse measurements, and the RMS (ЭФФ) scale for sine voltage measurements.

(h) With the calibration voltage known, it is possible to determine the amplitude of the pulse under test referring to the ratio between the display of the pulse under test and that of the calibration pulse with due allowance for the input attenuation.

The amplitude of the pulse under test equals:

$$V = \frac{a}{b} \times V_c \times K \text{ (volts)},$$

where a = the display in mm;

b = calibration voltage display in mm;

V_c = calibration voltage amplitude in volts, corresponding to display b;

K = input attenuation ratio used for measuring the signal under test.

In case the calibration voltage display is set equal to that of the pulse under test, the amplitude of the pulse under test is determined by multiplying the calibration scale reading by the attenuation ratio.

If the calibration voltage display at driven sweep is unsteady, simultaneously set the MODE OF OPERATION switch to the CONTINUOUS or GAIN position and the input attenuator, to the calibration position.

Sine voltage measurements are taken likewise.

In this case mind to use continuous sweep and take the readings off the RMS scale.

The sine-wave voltage display may be as high as 50 mm.

Direct Application of Voltage to CRT Deflecting Electrodes

7.16. When it is necessary to test pulses and frequencies extending beyond the frequency response of the amplifiers they should be applied directly to the deflecting electrodes of the CRT so as to prevent possible phase and frequency distortions. In this case external synchronization should be used. It should be borne in mind that, with the signal applied directly to the CRT electrodes, there is no pulse delay, so that the pulse leading edge may be not visible. Decoupling capacitors are provided at the input of the CRT plates.

For direct connection use is made of a jack panel. To gain access to this panel, open the cover plate arranged on the rear panel of the casing, remove the short-circuited plugs from the jacks and apply the voltage under test to the jacks labelled PLATES (ПЛАСТИНЫ).

The maximum voltage that can be applied directly to the CRT plates depends on the operating voltage of the decoupling capacitors and is equal to 200 V peak.

Decoupling capacitors are provided only for the upper jacks of the CRT deflecting plates. The lower jacks (Y-axis amplifier and sweep circuit outputs) have no such capacitors and therefore must never be earthed or shorted out, otherwise the instrument will fail.

The same jack panel carries the tumbler for selecting the Y-axis amplifier bandwidth. Setting to a narrow bandwidth decreases the bandwidth from 10 MHz down to 500 kHz, but raises considerably the amplification ratio of the Y-axis amplifier.

8. PREVENTIVE MAINTENANCE

8.1. The object of preventive maintenance is to ensure normal operation of the instrument.

Once every six months, and also after prolonged storage (above twelve months) carry out the following preventive maintenance operations.

8.2. (a) External inspection:

- check the controls for fastening and smooth action;
- check the painted, varnished and plated surfaces for condition.

8.3. (b) Test the electrical parameters for compliance with the Certificate data.

An internal inspection should be carried out once every two years in addition to the above operations:

- check the fastening of the components on the chassis, and contact joints for reliability, and see that the nuts are properly locked;
- clean the instrument from dust, dirt, corrosion spots;
- check the valves for condition.

In checking the instrument, refer to the technical requirements set forth in the BASIC SPECIFICATIONS section.

9. INSTRUCTIONS FOR REPAIRS

The most frequent cause of a faulty operation of the instrument is the failure of valves or the cathode-ray tubes. Therefore, they are the first to be inspected in case of a fault.

If the valves and the cathode-ray tube are found in good order, proceed to inspecting the switches for loose connections and further to locating the faulty component in the defective unit. During trouble-shooting refer to the elementary diagram and List of Components, and when replacing adjustable components, pay attention to the ratings indicated by the Manufacturer.

Use a valve voltmeter, type ВК7-9 or a similar one, for fault location.

After elimination of the fault, check and adjust the electrical parameters of the instrument. The following adjustment components should be used:

(a) trimming capacitor C2 is used to adjust the attenuation of a 10-μs pulse with the attenuator set in positions 1:10 and 1:100;

(b) potentiometer R73 is used to stop the free-running oscillations of the sweep generator throughout all the bands when adjusted for driven sweep operation;

(c) potentiometer R92 is used to set the minimum error at the end of the amplitude calibrator scale.

(d) cores of coills L11 to L17 of the pulse duration calibrator are used to set the tank frequency when checking calibration marks against a crystal-controlled pulse duration calibrator.

(e) potentiometer R71 is used to obtain the optimum focusing of displays after replacement of the cathode-ray tube.

<u>Troubles and Remedies</u>

Trouble	Cause	Remedy
With instrument connected to mains, amplitude calibrator scale is not illuminated	Blown-out fuse	Replace fuse
	Broken supply cord	Eliminate trouble
	No contact in power switch	Replace switch
	No contact in lamps Л15 and Л16	Screw in lamps to obtain contact
	Lamps Л15 and Л16 burnt out	Replace lamps
One illuminating lamp of amplitude calibrator scale burns, amplitude measuring error is large	Lamp Л15 or Л16 out of contact	Screw in the lamp
	Lamp Л15 or Л16 burnt out	Replace faulty lamp
	Discontinuity in wire-wound resistor R90 or R91	Eliminate discontinuity or replace resistor
No beam on CRT screen	Faulty cathode-ray tube Л1^	Replace cathode-ray tube
	Poor contact of CRT socket	Ensure good contact
	CRT loosely seats in socket	Ensure that CRT base thrusts against socket
Low or no vertical amplification	One of Y-axis amplifier valves	Replace faulty valve

Trouble	Cause	Remedy
	Л1, Л2, Л3, Л4, Л5 faulty	
	No contact in input attenuator switch	Eliminate fault
	No contact in plugs КП-1, КП-2 on rear panel	Ensure contact
No horizontal amplification in AMPLIFIER mode of operation	TYPE OF SYNCHRONIZATION switch is not in position EXTERNAL	Put switch in the EXTERNAL position
	Faulty valves Л7, Л9, Л10, Л11	Replace faulty valve
	No contact in function switch B3	Repair switch
	No contact in plugs КП-3, КП-4 on rear panel	Ensure contact
Short square pulses up to 1.0 μs badly distorted	Switch B7 BAND (ПОЛОСА) on rear panel not in "10 MHz" position	Set switch at "10 MHz"
	Break of capacitor in input attenuator switch B1	Restore continuity
Long square pulses of 1000 μs and above are badly distorted, top droops heavily	Break of resistor in input attenuator switch B1	Replace resistor
	Faulty input capacitor or decoupling capacitors C1, C6, C8, C9, C12, C40, C41	Replace faulty capacitor

Trouble	Cause	Remedy
	(capacitance very low)	
Sweep trace too short	Faulty valve Л9	Replace valve
	No contact in plugs КП-3, КП-4 on rear panel	Ensure contact
At driven sweep, length of sweep trace depends on pulse duration; at continuous sweep, there is no sweep trace	Faulty valve Л6	Replace valve
	Faulty capacitor C13	Replace capacitor
	No contact in function switch B3	Ensure contact
Neither continuous nor driven sweep can be obtained	Faulty valves Л6, Л7, Л8	Replace faulty valve
	No contact in function switch B3	Ensure contact
	No contact in plugs КП-3, КП-4 on rear panel	Ensure contact
At driven sweep, pulse leading and trailing edges are blurred at sweep bands below 10 µs	Low insulation resistance between cathode and heater of valve Л7	Replace valve Л7
At driven sweep, steady display cannot be obtained, more than one pulse is displayed on the CRT screen	Repetition rate of pulses under test is too high	Reduce pulse repetition rate or select shorter sweep band
At continuous sweep, sweep trace becomes shorter,	Faulty capacitor C23, C42 or C43	Replace capacitor

Trouble	Cause	Remedy
if lower sweep repetition frequency band is selected	Poor contact of plugs КП-3, КП-4 on rear panel	Ensure good contact
Instrument operates, but power consumption is too high, power transformer excessively heated	Diode Д3 of rectifier bridge faulty	Replace faulty diode
	Short-circuited turns in power transformer	Replace power transformer
Power consumption from mains extremely high, instrument does not operate, fuses blow each time if replaced	Short circuit in heater circuits	Check and eliminate fault
	Anode circuits shorted to chassis	Check and eliminate fault
	Filter chokes shorted to chassis	Replace faulty choke
	One of electrolytic capacitors punctured	Replace faulty capacitor
Pulse duration calibrator fails to operate at one of calibration bands	Break of coil of corresponding calibration mark band	Restore continuity or replace coil
	No contact in selector B5	Ensure contact
No marks from pulse duration calibrator	Faulty valve Л12 or Л13	Replace valve
	No contact in selector B5	Ensure contact
	Punctured capacitor C35	Replace capacitor
At one of bands marks differ con-	Changed capacitance or wire	Replace capacitor

Trouble	Cause	Remedy
siderably from the band rating	break of tuned circuit capacitor	
Marks differ considerably in brilliance at the beginning and at the end of sweep trace at one of calibration mark bands	Broken shunt resistor of the respective grid oscillatory circuit	Solder up or replace resistor
Beam intensity fails to be adjusted on the CRT screen	Punctured capacitor C47	Replace capacitor
	Break in attenuator R72-R78	Locate and eliminate trouble
	Faulty CRT Л14	Replace CRT
	No contact between CRT and socket	Ensure contact
	Faulty potentiometer R78	Replace potentiometer
Beam fails to be focused with the FOCUS control knob	Break in attenuator R72-R78	Locate and eliminate break
	No contact in CRT socket	Ensure contact
	Faulty potentiometer R75	Replace potentiometer
	Low insulation resistance between plates of capacitor C45 or C46	Replace faulty capacitor
Beam fails to be shifted on the CRT screen by control knobs	No anode supply voltage (shorted anode circuit)	Check rectifier bridge, eliminate short circuit

Trouble	Cause	Remedy
	Beam shift potentiometer R63 or R68 out of order	Replace faulty potentiometer
	Punctured capacitors C40-C43	Replace faulty capacitor
	Break in supply circuit of beam shift potentiometers	Locate and eliminate break

10. INSTRUCTIONS FOR CHECKING

10.1. The following instruments are required for checking the universal oscilloscope:

(a) Г4-1А standard signal generator;

(b) low-frequency generator (20 Hz - 100 kHz);

(c) long-pulse generator (2000-μs duration, flat top droop not in excess of 5%);

(d) Г5-1А square-pulse generator with standard attenuator, or Г5-8 small-size pulse generator;

(e) sine voltage source producing calibrated voltages at a frequency of 50 Hz, setting error not exceeding 1%;

(f) A.C. voltmeter and ammeter;

(g) crystal-controlled pulse duration calibrator.

All instruments used for checking should have certificates, with their last check date indicated.

Checking should be carried out regularly, at least once every three months.

Checking Procedure

10.2. The Y- and X-axis amplifier sensitivity is checked in the absence of sweep, by applying the test signal to the Y- or X-axis amplifier input. The test signal is a 100-kHz, sinusoidal voltage of 0.3 V RMS for the Y-axis amplifier wide band and the X-axis amplifier, and 0.1 V RMS for the Y-axis amplifier narrow band. The test result is satisfactory, if the display size is not less than 25 mm. If the display size is smaller, check the Y-axis amplifier valves and circuit for good repair.

10.3. The nonuniformity of frequency response of the Y- or X-axis amplifier is checked at a constant input voltage providing the sweep trace length of 30 mm at a frequency of 100 kHz.

With the input attenuator in position 1:1, the frequency response is taken over the following points: 10 Hz, 20 Hz, 400 Hz, 100 kHz, 1 MHz, 5MHz, 6 MHz, 9 MHz - for the Y-axis amplifier wide band, 10 Hz, 20 Hz, 400 Hz, 100 kHz, 500 kHz - for the Y-axis amplifier narrow band, and 20 Hz, 400 Hz, 10 kHz, 100 kHz, 400 kHz, 500 kHz - for the X-axis amplifier.

The nonuniformity of frequency response is calculated as 20 logarithms of the maximum-to-minimum sweep trace length ratio in mm. The test result is satisfactory if the frequency response is flat to 3 dB. If it is worse, check all the stages of the amplifier and, if found in good order, adjust resistances R17 and R22.

10.4. The droop of a 2000-μs pulse top is measured as the difference between the peaks of the pulse leading and trailing edges. The test result is satisfactory, if the difference does not exceed 15% of the pulse amplitude at the beginning, excluding the pulse droop produced by the pulse generator itself. If the pulse droop exceeds the indicated value, adjust capacitance C7.

10.5. The total pip is checked on pulses of 1-μs duration.

At maximum amplification set the pulse display size of 20 mm. If the pips do not exceed 1 mm, the test result is satisfactory. If the test procedures described in

steps 10.3 and 10.4 have given satisfactory results, the pips will be within 1 mm.

10.6. The input impedance of Y- and X-axis amplifiers and deflection plates is checked with the BK7-9 voltohmmeter, at a point after the input capacitors and with the instrument switched off. The input capacitance is checked with any capacitance meter having a measurement error of not more than ±5%. If the input circuit is in good order, the input parameters will comply with the specified data.

10.7. Duration of sweep fixed bands is checked against the internal calibration marks at external triggering. The result is satisfactory, if the sweep speed related to the length of 50 mm meets the specified data, with the ±20-per cent allowance.

10.8. Repetition frequency of continuous sweep should cover the total range of 20 Hz to 200 kHz. The sweep frequency is measured by means of the Г3-4A and Г4-1A signal generators.

Apply voltage at different frequencies to the Y-axis amplifier input. Select such a voltage frequency for each band, that provides a display of one period on the CRT screen. The measurements are made with the FREQUENCY, FINE knob in both extreme positions. Allocation of frequencies over a band is not specified in case of their mutual overlapping. All bands are checked at the minimum synchronizing voltage level. A band may be narrowed by 4 Hz from the lower end and by 40 kHz, from the upper end.

The test result is satisfactory, if all above requirements are met. If not, adjust the band of sweep generator capacitors C10, C15 - C21, C26.

10.9. Driven sweep minimum trigger voltage is measured at the maximum gain of the Y-axis amplifier for the wide band, with the input attenuator set at 1:1, maximum gain synchronizing amplifier and pulse duration calibrator switched on. Triggering is performed by a 0.5-μs pulse from the pulse generator. Gradually increasing the pulse amplitude obtain a steady display and measure the triggering voltage by the pulse generator voltmeter. If a higher than specified voltage is required to initiate the driven sweep and synchronize continuous sweep, check the synchronizing amplifier (Л10, Л11а,б). The test result is satisfactory, if dependable triggering and synchronization are obtained in the above-specified conditions.

10.10. The maximum error of the pulse duration calibrator is checked by counting on the CRT screen the number of marks spaced between the calibration marks provided by the crystal-controlled calibrator. The result is satisfactory, if the error does not exceed ±0.5 the mark for 10 marks which corresponds to an error of ±5 per cent. The error is reduced by adjustment of the position of a given coil core (coils L11-L16).

10.11. The maximum error of the pulse amplitude calibrator is checked by comparing on the CRT screen the lines produced by the amplitude calibrator and the calibration sine voltage source.

Measurements should be taken at three points of the internal calibrator scale at 220 V. The result is satisfactory, if the amplitude calibrator error does not exceed ±10 per cent with the input attenuator set to 1:1. Error at 1 V can be reduced with potentiometer R92, and at 0.2 V, by scale displacement relative to the measuring potentiometer.

10.12. The maximum error of the input attenuator is checked by comparison with a standard attenuator. The test pulse is of 10 μs. The result is satisfactory, if the attenuation is accurate to ±5 per cent. The 10-μs pulse shape can be improved by adjusting capacitors C2-C4 (according to the division band).

10.13. The power consumption from 220-V, 50-Hz mains is checked by means of a voltmeter and an ammeter. The result is satisfactory, if power consumption does not exceed 180 VA. Any increase above this figure indicates that the instrument supply circuits are out of order.

Check the power transformer, diodes, filter electrolytic capacitors and the other circuit components.

11. STORAGE

11.1. The instrument should be stored under the following conditions:

- ambient temperature from +10 to +35°C;
- relative humidity up to 80% as measured at +20 ±5°C.

11.2. The storage room should be free from dust, vapours, acids, alkalis and corrosive gases.

11.3. The instrument delivered for storage for less than 6 months since the date of arrival may be stored packed.

11.4. The instrument intended for prolonged storage (over 6 months) may be stored either removed from the shipping packing or in it under the above-specified conditions, unless the delivery terms specify other conditions.

11.5. The instrument intended for prolonged storage should be hermetically packed. For this purpose place the cardboard box containing the instrument into a bag made from a plastic film.

APPENDICES

Appendix 1

LIST OF COMPONENTS
(to elementary diagram)

Desig-nation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R1	ГОСТ 6562-67	Resistor ВС-0,25-I-51 Ом±5%	51 Ohms	1	
R2	ГОСТ 7113-66	Resistor МЛТ-0,5-2,2 МОм±5%	2.2 MOhms	1	Adjustable with 1% allowance
R3	ГОСТ 7113-66	Resistor МЛТ-0,5-270 кОм±5%	270 kOhms	1	
R4	ГОСТ 7113-66	Resistor МЛТ-0,5-22 кОм±5%	22 kOhms	1	
R5	ГОСТ 7113-66	Resistor МЛТ-0,5-2,2 МОм±10%	2.2 MOhms	1	
R6	ГОСТ 6562-67	Resistor ВС-0,25-1-56 Ом±10%	56 Ohms	1	
R7*	ГОСТ 7113-66	Resistor МЛТ-0,5-2,4 кОм±10%	2,4 kOhms	1	Adjusted in tuning
R8	ГОСТ 5574-65	Resistor ПСП-I-1-А-470 Ом ±20% ОС-3-20	470 Ohms	1	
R9	ГОСТ 7113-66	Resistor МЛТ-0,5-1 МОм±10%	1 MOhm	1	
R10	ГОСТ 7113-66	Resistor МЛТ-0,5-150 Ом±10%	150 Ohms	1	
R11	ГОСТ 7113-66	Resistor МЛТ-0,5-2 кОм±5%	2 kOhms	1	
R12	ГОСТ 7113-66	Resistor МЛТ-0,5-560 кОм±10%	560 kOhms	1	
R13	ГОСТ 7113-66	Resistor МЛТ-0,5-820 Ом±10%	820 Ohms	1	
R14	ГОСТ 7113-66	Resistor МЛТ-0,5-220 Ом±10%	220 Ohms	1	
R15	ГОСТ 7113-66	Resistor МЛТ-0,5-470 Ом±10%	470 Ohms	1	
R16	ГОСТ 7113-66	Resistor МЛТ-0,5-240 кОм±5%	240 kOhms	1	
R17*	ГОСТ 7113-66	Resistor МЛТ-0,5-4,3 кОм±5%	4.3 kOhms	1	Adjusted in tuning

Desig-nation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R18	ГОСТ 7113-66	Resistor МЛТ-2-3 кОм±10%	1.5 kOhms	2	2 pcs connected in parallel
R19	ГОСТ 6513-66	Resistor ПЭВ-10-4,3 кОм 5%	4.3 kOhms	1	3,9
R20	ГОСТ 6513-66	Resistor ПЭВ-10-4,3 кОм 5%	4.3 kOhms	1	
R21	ГОСТ 7113-66	Resistor МЛТ-2-3 кОм±10%	1.5 kOhms	2	2 pcs connected in parallel
R22*	ГОСТ 7113-66	Resistor МЛТ-0,5-4,3 кОм±5%	4.3 kOhms	1	Adjusted in tuning
R23	ГОСТ 7113-66	Resistor МЛТ-0,5-100±10%	100 Ohms	1	
R24	ГОСТ 6562-67	Resistor ВС-0,25-1-68 Ом±10%	68 Ohms	1	
R25	ГОСТ 7113-66	Resistor МЛТ-0,5-240 кОм±5%	240 kOhms	1	
R26	ГОСТ 7113-66	Resistor МЛТ-0,5-510 кОм±5%	510 kOhms	1	
R27	ГОСТ 7113-66	Resistor МЛТ-2-47 кОм±10%	23.5 kOhms 15+8,2 kΩ	2	2 pcs connected in parallel
R28*	ГОСТ 7113-66	Resistor МЛТ-1-18 кОм±10%	18 kOhms	1	Adjusted in tuning
R29	ГОСТ 7113-66	Resistor МЛТ-0,5-1,2 кОм±10%	1.2 kOhms	1	
R30*	ГОСТ 7113-66	Resistor МЛТ-0,5-220 Ом±10%	220 Ohms	1	Adjusted in tuning
R31*	ГОСТ 7113-66	Resistor МЛТ-0,5-56 кОм±10%	56 kOhms	1	Adjusted in tuning

Desig-nation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R32	ГОСТ 5574-65	Resistor IIСП-I-1-А-470 кОм ±30% ОС-3-20	470 kOhms	1	
R33*	ГОСТ 7113-66	Resistor МЛТ-0,5-100 кОм±10%	100 kOhms	1	Adjusted in tuning
R34	ГОСТ 7113-66	Resistor МЛТ-0,5-5,1 МОм±10%	5.1 MOhms	1	
R36	ГОСТ 7113-66	Resistor МЛТ-2-47 кОм±10%	23.5 kOhms	2	2 pcs connected in parallel
R37*	ГОСТ 7113-66	Resistor МЛТ-0,5-1 кОм±10%	1 kOhm	1	Adjusted in tuning
R38	ГОСТ 7113-66	Resistor МЛТ-0,5-150 Ом±5%	150 Ohms	1	
R39	ГОСТ 6513-66	Resistor ПЭВ-10-10 кОм 10%	10 kOhms	1	
R40	ГОСТ 7113-66	Resistor МЛТ-2-27 кОм±10%	27 kOhms	1	
R41	ГОСТ 7113-66	Resistor МЛТ-0,5-1 МОм±10%	1 MOhm	1	
R42*	ГОСТ 7113-66	Resistor МЛТ-0,5-330 кОм±10%	330 kOhms	1	Adjusted in tuning
R43*	ГОСТ 7113-66	Resistor МЛТ-0,5-2 кОм±5%	2 kOhms	1	Same
R44	ГОСТ 5574-65	Resistor IIСП-I-1-А-100 кОм ±20% ОС-3-20	100 kOhms	1	
R45	ГОСТ 7113-66	Resistor МЛТ-0,5-150 Ом±10%	150 Ohms	1	
R46	ГОСТ 7113-66	Resistor МЛТ-0,5-1 кОм±10%	1 kOhm	1	
R47	ГОСТ 7113-66	Resistor МЛТ-1-5,6 кОм±10%	5.6 kOhms	1	

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R48	ГОСТ 7113-66	Resistor МЛТ-0,5-1 МОм±10%	1 MOhm	1	
R49	ГОСТ 7113-66	Resistor МЛТ-2-12 кОм±10%	12 kOhms	1	
R50	ГОСТ 7113-66	Resistor МЛТ-0,5-820 Ом±10%	820 Ohms	1	
R51	ГОСТ 7113-66	Resistor МЛТ-0,5-47 кОм±10%	47 kOhms	1	
R52	ГОСТ 7113-66	Resistor МЛТ-0,5-47 кОм±10%	47 kOhms	1	
R53	ГОСТ 7113-66	Resistor МЛТ-0,5-560 кОм±10%	~~560~~ kOhms	1	510k
R54	ГОСТ 7113-66	Resistor МЛТ-0,5-56 кОм±5%	56 kOhms	1	
R55	ГОСТ 6562-67	Resistor ВС-0,25-1-68 Ом±10%	68 Ohms	1	
R56*	ГОСТ 7113-66	Resistor МЛТ-0,5-820 Ом±10%	820 Ohms	1	Adjusted in tuning or removed
R57*	ГОСТ 7113-66	Resistor МЛТ-0,5-820 Ом±10%	820 Ohms	1	Same
R58*	ГОСТ 7113-66	Resistor МЛТ-0,5-1,5 кОм±10%	1.5 kOhms	1	Same
R59*	ГОСТ 7113-66	Resistor МЛТ-0,5-2,4 кОм±5%	2.4 kOhms	1	Same
R60	ГОСТ 7113-66	Resistor МЛТ-1-820 Ом±10%	820 Ohms	1	
R61	ГОСТ 7113-66	Resistor МЛТ-0,5-390 кОм±10%	390 kOhms	1	
R62	ГОСТ 7113-66	Resistor МЛТ-0,5-4,7 МОм±10%	4.7 MOhms	1	
R63	ГОСТ 5574-65	Resistor IIСП-I-I-А-470 кОм ±30% ОС-3-20	470 kOhms	1	
R64	ГОСТ 7113-66	Resistor МЛТ-0,5-390 кОм±10%	390 kOhms	1	
R65	ГОСТ 7113-66	Resistor МЛТ-0,5-4,7 МОм±10%	4.7 MOhms	1	

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R66	ГОСТ 7113-66	Resistor МЛТ-0,5-4,7 МОм±10%	4.7 MOhms	1	
R67	ГОСТ 7113-66	Resistor МЛТ-0,5-390 кОм±10%	390 kOhms	1	
R68	ГОСТ 5574-65	Resistor IIСП-I-1-А-470 кОм ±30% ОС-3-20	470 kOhms	1	
R69	ГОСТ 7113-66	Resistor МЛТ-0,5-390 кОм±10%	390 kOhms	1	
R70	ГОСТ 7113-66	Resistor МЛТ-0,5-4,7 МОм±10%	4.7 MOhms	1	
R71	ГОСТ 5574-65	Resistor IIСП-II-1-А-470 кОм± 30%	470 kOhms	1	
R72*	ГОСТ 7113-66	Resistor МЛТ-0,5-8,2 кОм±10%	8.2 kOhms	1	Adjusted in tuning
R73	ГОСТ 5574-65	Resistor IIСП-II-1-А-22 кОм±20%	22 kOhms	1	
R74	ГОСТ 7113-66	Resistor МЛТ-2-390 кОм±10%	390 kOhms	1	
R75	ГОСТ 5574-65	Resistor IIСП-I-1-А-220кОм ±20% ОС-3-20	220 kOhms	1	
R76	ГОСТ 7113-66	Resistor МЛТ-0,5-150 кОм±10%	150 kOhms	1	
R77	ГОСТ 7113-66	Resistor МЛТ-0,5-1 МОм±10%	1 MOhm	1	
R78	ГОСТ 5574-65	Resistor IIСП-I-1-А-100 кОм ±20% ОС-3-20	100 kOhms	1	
R79	ГОСТ 7113-66	Resistor МЛТ-0,5-560 кОм±10%	560 kOhms	1	
R80*	ГОСТ 7113-66	Resistor МЛТ-0,5-68 кОм±10%	68 kOhms	1	
R81*	ГОСТ 7113-66	Resistor МЛТ-0,5-330 кОм±10%	330 kOhms	1	Adjusted in tuning

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R90	Тв5.173.014	Wire-wound resistor, 47 Ohms	47 Ohms	1	To be wound on former of BC resistor (0.5 - 10 kOhms and higher)
R91	Тв5.173.014	Wire-wound resistor, 47 Ohms	47 Ohms	1	
R92	ГОСТ 5574-65	Resistor IIСП-II-1-А-22 кОм±20%	22 kOhms	1	
R93	ОЖО.468.502.ТУ	Potentiometer ПП3-12-4,7 кОм 10%	4.7 kOhms	1	
R94*	ГОСТ 7113-66	Resistor МЛТ-0,5-2,7 кОм±10%	2.7 kOhms	1	To be adjusted in tuning or removed
R95	ГОСТ 6513-66	Resistor ПЭВ-10-4,3 кОм 10%	4.3 kOhms	1	
R96	ГОСТ 6513-66	Resistor ПЭВ-10-4,7 кОм 10%	4.7 kOhms	1	
R97*	ГОСТ 7113-66	Resistor МЛТ-0,5-1 кОм±10%	1.0 kOhm	1	To be adjusted in tuning or removed
R98	ГОСТ 7113-66	Resistor МЛТ-0,5-750 кОм±5%	750 kOhms	1	
R99	ГОСТ 7113-66	Resistor МЛТ-2-22 кОм±10%	11 kOhms 10 +4K	1	2 pcs, connected in parallel
R100	ГОСТ 7113-66	Resistor МЛТ-0,5-180 кОм±10%	180 kOhms	1	
R101	ГОСТ 7113-66	Resistor МЛТ-0,5-33 кОм±10%	33 kOhms	1	

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
R102	ГОСТ 7113-66	Resistor МЛТ-0,5-5,6±10%	5.6 kOhms	1	
C1	ГОСТ 9687-61	Capacitor БМТ-2-400-0,1±10%	0.1 μF	1	
C2	ОЖО.460.010 ТУ	Capacitor КПК-МН-6/25	6-25 μF	1	
C3*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-220±5%	220 pF	1	Adjusted with 1% tolerance
C4*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-2400±5%	1000/120 1500		
	ГОСТ 11155-65	Capacitor КСО-1-250-Б-220±5%	2620 pF	1	
C5	ОЖО.464.079 ТУ	Capacitor К50-12-450-20	20 μF	1	
C6	ГОСТ 9687-61	Capacitor БМТ-2-400-0,1±10%	0.1 μF	1	
C7*	ГОСТ 11155-65	Capacitor КСО-1-250-Б-240±10%	240 pF 220/10 10	1	Adjusted in tuning
C8	ГОСТ 9687-61	Capacitor БМТ-2-400-0,1±10%	0.1 μF	1	
C9	ГОСТ 9687-61	Capacitor БМТ-2-400-0,22±10%	0.22 μF	1	
C10	ГОСТ 9687-61	Capacitor БМТ-2-400-0,22±5%	0.44 μF	1	Connected in parallel
	ГОСТ 9687-61	Capacitor БМТ-2-400-0,22±5%		1	
C12	УБО.462.014 ТУ	Capacitor МБМ-160-0,25-II	0.25 μF	1	
C13	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 μF	1	
C15*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-220±5%	220 pF	1	Adjusted in tuning
C16*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-680±5%	680 pF	1	Same

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
C17*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-1000±5%	1430 pF	1	Connected in parallel, and adjusted in tuning
	ГОСТ 11155-65	Capacitor КСО-2-500-Б-430±5%		1	
C18*	ГОСТ 11155-65	Capacitor КСО-5-500-Б-4300±5%	4300 pF	1	Adjusted in tuning
C19*	ГОСТ 11155-65	Capacitor КСО-5-500-Б-4700±5%	14700 pF	1	Connected in parallel, and adjusted in tuning
	ГОСТ 9687-61	Capacitor БМТ-2-400-0,01±5%		1	
C20	ГОСТ 9687-61	Capacitor БМТ-2-400-0,033±5%	43000 pF	1	Same
	ГОСТ 9687-61	Capacitor БМТ-2-400-0,01±5%		1	
C21*	ГОСТ 9687-61	Capacitor БМТ-2-400-0,15±5%	154700 pF	1	Connected in parallel, and adjusted in tuning
	ГОСТ 11155-65	Capacitor КСО-5-500-Б-4700±5%		1	
C22*	ГОСТ 7159-69	Capacitor КТ-2-М47-39 пФ±10%-3	39 pF	1	Adjusted in tuning
C23	ГОСТ 9687-61	Capacitor БМТ-2-400-0,1±10%	0.1 µF	1	
C26*	ГОСТ 7159-69	Capacitor КТ-2-М47-62 пФ±5%-3	62 pF	1	Adjusted in tuning

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
C27	ОЖО.464.079ТУ	Capacitor К50-12-450-20	20 µF	1	
C28	УБО.462.014ТУ	Capacitor МБМ-160-0,5-II	0.5 µF	1	
C29*	ГОСТ 11155-65	Capacitor КСО-5-500-Б-3000±5%	3000 pF	1	Adjusted in tuning
C31	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 µF	1	
C32*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-750±5%	~~750 pF~~	1	Adjusted in tuning
C33	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 µF	1	
C34	ГОСТ 11155-65	Capacitor КСО-5-500-Б-5600±10%	5600 pF	1	
C35	ГОСТ 11155-65	Capacitor КСО-5-500-Б-6800±10%	6800 pF	1	
C36*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-680±5%	680 pF	1	Adjusted in tuning
C37*	ГОСТ 11155-65	Capacitor КСО-2-500-Б-1200±5%	1200 pF	1	Same
C38*	ГОСТ 11155-65	Capacitor КСО-5-500-Б-3900±10%	3900 pF	1	Same
C39*	ГОСТ 11155-65	Capacitor КСО-5-500-Б-5600±10%	5600 pF	1	Same
C40	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 µF	1	
C41	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 µF	1	
C42	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 µF	1	
C43	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 µF	1	
C45	ОЖО.462.104ТУ	Capacitor МБМ-1500-0,05 ±10%	0.05 µF	1	
C46	ГОСТ 11155-65	Capacitor СГМ-3-1600-Б-510±10%	510 pF	1	

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
C47	ГОСТ 9687-61	Capacitor БМТ-2-400-0,047±10%	0.047 μF	1	
C48	ГОСТ 7112-54	Capacitor МБГП-1-1500-А-0,5-II	0.5 μF	1	
C49	ГОСТ 7112-54	Capacitor МБГП-2-1000-А-1-II	1 μF	1	
C50	ГОСТ 7112-54	Capacitor МБГП-2-1000-А-1-II	1 μF	1	
C52	ОЖО.464.079ТУ	Capacitor К50-12-450-50	50 μF	1	
C53	ОЖО.464.079ТУ	Capacitor К50-12-450-20	20 μF	1	
C56	ОЖО.464.079ТУ	Capacitor К50-12-450-20	20 μF	1	
C57	ОЖО.462.022ТУ	Capacitor МБГП-2-400-0,25-II	0.25 μF	1	
C58	ОЖО.464.042ТУ	Capacitor К50-3-450-20	20 μF	1	
C59	ОЖО.464.042ТУ	Capacitor К50-3-450-20	20 μF	1	
C60	ОЖО.464.042ТУ	Capacitor К50-3-450-20	20 μF	1	
C61	ГОСТ 11155-65	Capacitor КСО-2-500-Б-1000±10%	1000 pF	1	
C62	ГОСТ 9687-61	Capacitor БМТ-2-400-0,015±10%	0.015 μF	1	
C63*	ГОСТ 11155-65	Capacitor КСО-5-500-Б-5100±5%	5100 pF	1	Adjusted in tuning
Л1	ЧТУ-01-400-52	Valve 6П9		1	
Л2	ЧТУ-01-401-56	Valve 6Ж4		1	
Л3	ЧТУ-01-401-56	Valve 6Ж4		1	
Л4	ЧТУ-01-400-52	Valve 6П9		1	
Л5	ЧТУ-01-400-52	Valve 6П9		1	
Л6	СТ3.300.011ТУ	Valve 6Ж8		1	

Designation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
Л7	СА3.301.000ТУ	Valve 6Н8С		1	
Л8	СТ3.300.011ТУ	Valve 6Ж8		1	
Л9	ЧТУ.01.411.54	Valve 6П6С		1	
Л10	ЧТУ.01.401.56	Valve 6Ж4		1	
Л11	СА3.301.000ТУ	Valve 6Н8С		1	
Л12	ЧТУ.01.401.56	Valve 6Ж4		1	
Л13	ЧТУ.01.401.56	Valve 6Ж4		1	
Л14	СУ3.350.024ТУ	Cathode-ray tube	8ЛО29И	1	
Л15	ГОСТ 2204-69	Lamp МН6,3-0,22	6.3 V, 0.22 A	1	
Л16	ГОСТ 2204-69	Lamp МН6,3-0,22	6.3 V, 0.22 A	1	
ИЛ-1	ВФ5.064.007	Delay line		1	Contains 26 capacitors КТ-2а-М47--20 pF±5%-3, adjusted with 1 pF tolerance
L1	ВФ5.775.013	Inductance coil	20 μH	1	
L2	ВФ5.775.012	Inductance coil	10 μH	1	
L3	ВФ5.775.014	Inductance coil	25 μH	1	

Desig-nation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
L4	ВФ5.775.014	Inductance coil	25 μH	1	
L5	ВФ5.775.015	Inductance coil	22 μH	1	
L6	ВФ5.775.015	Inductance coil	22 μH	1	
L7	ВФ5.775.016	Inductance coil	450 μH	1	
L8	ВФ5.775.016	Inductance coil	450 μH	1	
L9	ВФ5.775.024	Inductance coil	3100 μH	1	
L10	ВФ5.775.016	Inductance coil	450 μH	1	
L11	ВФ5.775.017	Inductance coil	1.1 μH	1	Core СЦР-7, 4-5 turns, wire ПЭЛ. 0.51,
L12	ВФ5.775.018	Inductance coil	7.1 μH	1	Core СЦР-7
L13	ВФ5.775.019	Inductance coil	26 μH	1	Same
L14	ВФ5.775.020	Inductance coil	420 μH	1	Same
L15	ВФ5.775.021	Inductance coil	2000 μH	1	Same
L16	ВФ5.775.022	Inductance coil	21000 μH	1	Core СЦР-7 10 turns, wire ПЭЛ 0.51
L17	ВФ5.775.023	Inductance coil		1	
D1	УФО.321.035ТУ	Rectifier 7ГЕ24Ф		1	Grouped with spread of back resistance of not more than 5%
D2	УФО.321.035ТУ	Rectifier 7ГЕ24Ф		1	
D3	УФО.336.006ТУ	Rectifier КЦ402Ж		1	

Desig-nation	St. Stnd. (ГОСТ), Specif., Dwg. No.	Name and type	Rating	Qnty	Note
Др1	Тв5.750.000	Choke	8 H	1	
Др2	Тв5.750.000	Choke	8 H	1	
Др3	Тв5.750.000	Choke	8 H	1	
Тр1	ВФ4.704.007	Transformer		1	
Пр1	НИО.481.017	Fuse ПМ1	1 A	1	Spare ПМ2; 2 A, 1 fuse
В1	ВФ3.600.023	Wafer switch	5П4Н	1	
В2	ВФ3.600.020	Wafer switch	9П1Н	1	
В3	ВФ3.600.024	Wafer switch	4П6Н	1	
В4	НВФ3.600.009	Wafer switch	3П1Н	1	
В5	ВФ3.600.021	Wafer switch	7П2Н	1	
В6	ПГ6.673.001	Switch block		1	
В7	ВРО.360.007ТУ1	Toggle switch Т3		1	
В8	ВРО.360.007ТУ1	Toggle switch Т1		1	
Г1	Тв6.604.005	Receptacle		1	
Г2	Тв6.604.005	Receptacle		1	
К1	НВФ4.830.003Сп	Terminal		1	
К2	НВФ4.830.003Сп	Terminal		1	
Ш1	Д6.633.003	Plug connector		1	

ARRANGEMENT OF MAIN PARTS AND ASSEMBLIES

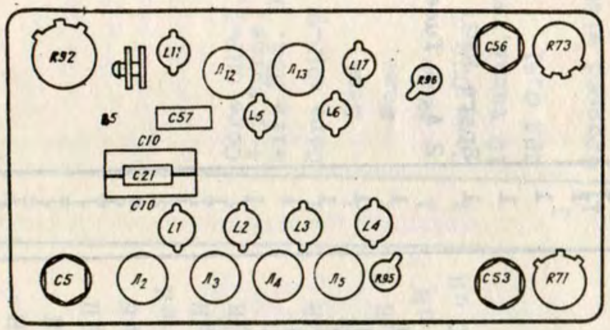


FIG. 2. UPPER CHASSIS (BOTTOM VIEW)

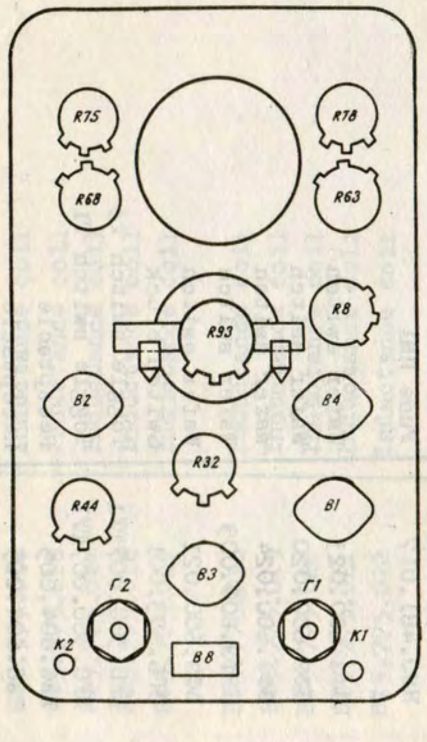


FIG. 3. FRONT PANEL

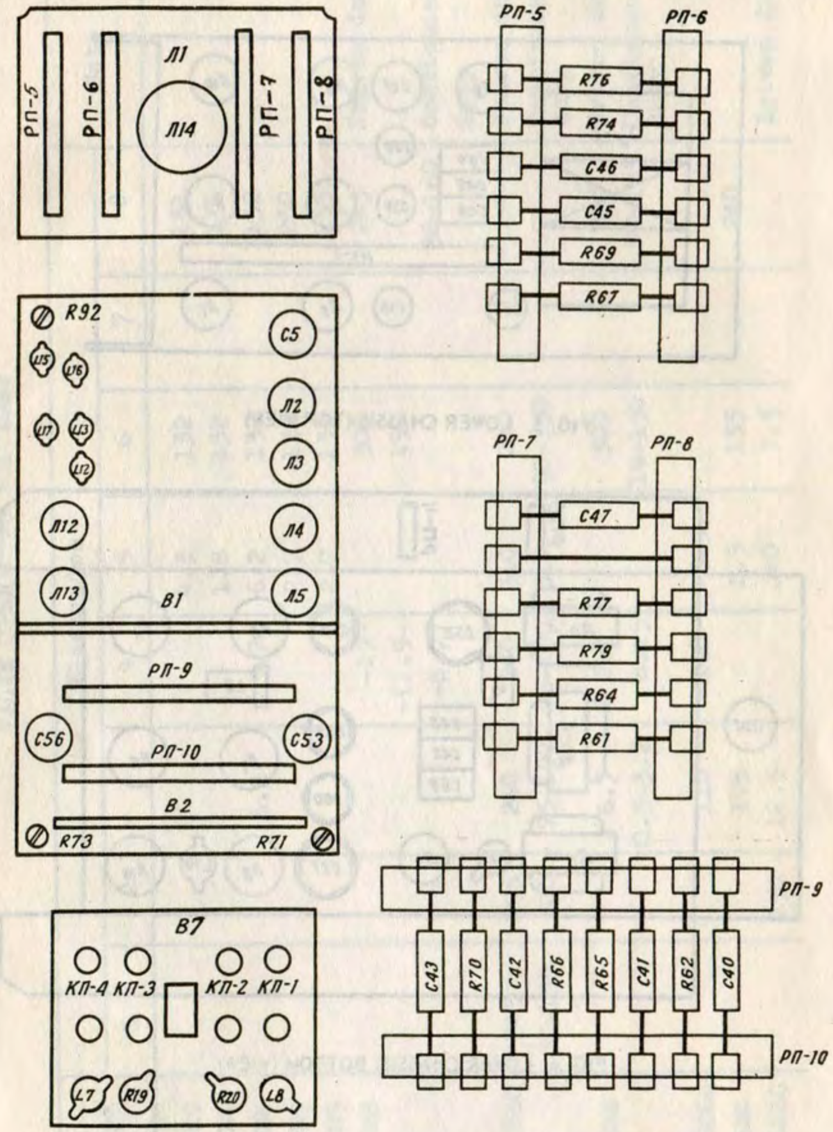


FIG. 4. UPPER CHASSIS. TOP VIEW

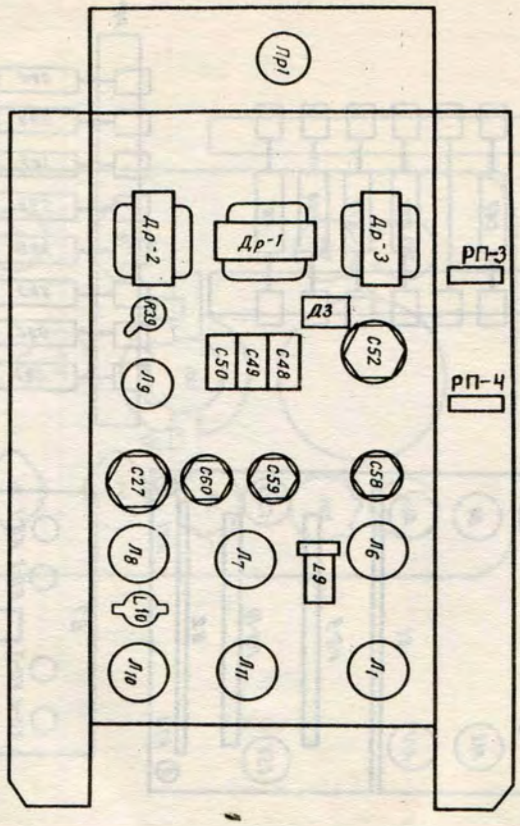


FIG. 6. LOWER CHASSIS. BOTTOM (VIEW)

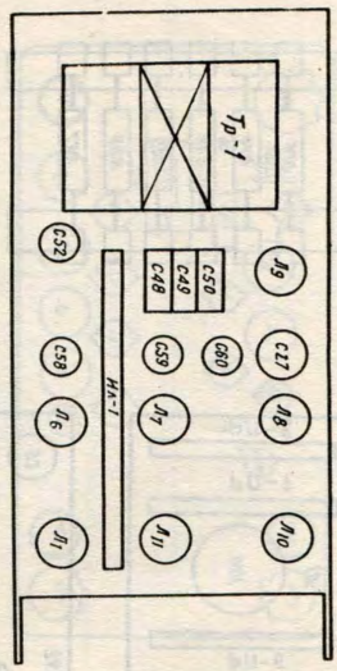


FIG. 5. LOWER CHASSIS (TOP VIEW)

Appendix 3

VALVE OPERATING VOLTAGES

Valve No.	Type	Electrodes								Note
		1	2	3	4	5	6	7	8	
Л1	6П9					4.3	132		132	
Л2	6Ж4					1.8	132		116	
Л3	6Ж4			6.2	3.7	6.2	132		132	
Л4	6П9					2.7	132		260	
Л5	6П9					2.7	132		255	
Л6	6Ж8				-17		300		245	Driven duty
					-(1.9-8.7)		190		38-160	Continuous duty
Л7	6Н8С	245	295	240	240	310	240			Driven duty
		33-155	300	75-190	75-190	310	90-150			Continuous duty
Л8	6Ж8			6.7	0.6		300		245	Driven duty
				0.5-3.2	0.45		19-150		80-185	Continuous duty
Л9	6П6С			110	160	-9.5				
Л10	6Ж4			1.5		1.5	155		240	
Л11	6Н8С		250	12.5		240	7.5			Driven duty

Valve No.	Type	Electrodes 1	2	3	4	5	6	7	8	Note
Л11	6Н8С		38-165	2.75--9.45						Continuous duty
Л12	6Ж4					0.14	275		190	
Л13	6Ж4						180		180	

Valve No.	Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Л14	8Л029И	-(920--950)	-(770--840)	-(850--890)		-(420--660)		88	90	120	100	95			-(890--920)

Bridge output is +350 V.

HV rectifier output is -1250 V.

HV filter output is -950 V.

Note. Voltages have been measured with all the controls turned fully counterclockwise except for the FREQUENCY, FINE control which has been put in both extreme positions (calibration switch in position 0.05, wide amplifier band). The beam has been in the centre of the CRT screen. Measurements have been taken with the BK7-9 voltohmmeter.
Heater voltage of all valves is ~ 6.3 V.
The actual voltages may deviate from the above data by ±20%.

RESISTANCE CHART

Valve No.	Valve type	Electrodes 1	2	3	4	5	6	7	8
Л1	6П9	0	28 kOhms	0	560 kOhms	380	55 kOhms	30 kOhms	52 kOhms
Л2	6Ж4	0	28 kOhms	0	1 MOhm	150	50 kOhms	46 kOhms	46 kOhms
Л3	6Ж4	0	28 kOhms	700	550 kOhms	705	48 kOhms	30 kOhms	43 kOhms
Л4	6П9	32	30 kOhms	0	280 kOhms	32 kOhms	50 kOhms	30 kOhms	43 kOhms
Л5	6П9	32	27.5 kOhms	0	250 kOhms	32	45 kOhms	30 kOhms	43 kOhms
Л6	6Ж8	0	29 kOhms	67 kOhms	500 kOhms	0	62 kOhms	29 kOhms	65 kOhms
Л7	6Н8С	65 kOhms	40 kOhms	∞	∞	45 kOhms	24 kOhms	∞	∞
Л8	6Ж8	0	30 kOhms	230	2 kOhms	220	85 kOhms	29 kOhms	∞
Л9	6П6С	28 kOhms	28 kOhms	50 kOhms	72 kOhms	1 MOhm	∞	28 kOhms	0
Л10	6Ж4	0	30 kOhms	145	37 kOhms	145	71 kOhms	30 kOhms	500 kOhms
Л11	6Н8С	45 kOhms	63 kOhms	45 kOhms	1 MOhm	55 kOhms	750	27.5 kOhms	27.5 kOhms
Л12	6Ж4	0	28 kOhms	0	550 kOhms	∞	98 kOhms	30 kOhms	47 kOhms
Л13	6Ж4	0	28 kOhms	0	∞	∞	45 kOhms	28 kOhms	48 kOhms

Valve No.	Valve type	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Л14	8Л029И	800 kOhms	2 MOhms	1.35 MOhms	∞	400 kOhms	∞	5 MOhms	4.8 MOhms	110 kOhms	4.8 MOhms	4.8 MOhms	∞	∞	800 kOhms

Note. Voltages have been measured with controls turned fully counterclockwise (calibration switch in position 0.05, wide amplifier band). Measurements have been taken with the BK7-9 voltohmmeter.
Resistances are measured relative to earth.
The actual resistance may deviate from the above data by ±20%.

Appendix 5

TRANSFORMER WINDING DATA

Description	Winding No.									
	1	1a	Screen	II	III	IV	V	Screen	VI	VII
Wire grade	ПЭВ-1	ПЭВ-1	MI-M	ПЭВ-1	ПЭВ-1	ПЭВ-1	ПЭВ-1	MI-M	ПЭВ-1	ПЭВ-1
Dia, bare, mm	0.8	0.59	0.06	0.59	1.56	0.59	0.59	0.06	0.35	0.1
Number of turns	412	312	1.2	55	23	23	23	1.2	990	1770
Number of layers	12	11	Open turn	1	1	1	1	Open turn	8	5
Turns per layer	58	78	–	55	23	23	23	–	128	380
Layer width, mm	54	54	52	27	41	16	16	52	54	50
Tap from turns	360	–	–	18	–	–	–	–	–	–
Type of winding	Layer-by-layer									
Direction of winding	In one direction									

Description	Winding No.									
	1	1a	Screen	II	III	IV	V	Screen	VI	VII
Insulation between layers	K-120x1	K-120x1	K-120x1 ПО,07x1	-	-	-	-	K-120x1 ПО,07x1	K-0,80x1	KOH11x1
Insulation above winding	K-120x1 ПО,07x1	K-120x1 ПО,07x1	K-120x1 ПО,07x1	K-120x2	K-120x1 ПО,07x2	K-120x1 ПО,07x2	K-120x1 ПО,07x2	K-0,80x1 ПО,07x2	K-0,80x1 ПО,07x2	K-120x2 ПО,07x2
Lead wire	Winding wire		ПМВГ 0.35 sq.mm		Winding wire			ПМВГ	0.35 sq.mm	
Number of leads	3	1	1	2	2	2	2	1	2	2
Lead insulation	PVC tube Ø1-Ø2			—	Linox. tube Ø2		PVC tube Ø1-Ø2			
Voltage, V	115, 12	93	-	9.1	6.35	6.47	6.45	-	276	499
Lead Nos	21-22-23	23-24	15	43-33-44	31-32	41-42	12-13	16	35-36	45-46
	220 V				6,3 V		5-6 A			

Note. The first figure in the lead No. denotes the No. of terminal strip, and the second, the No. of lug.

<table>
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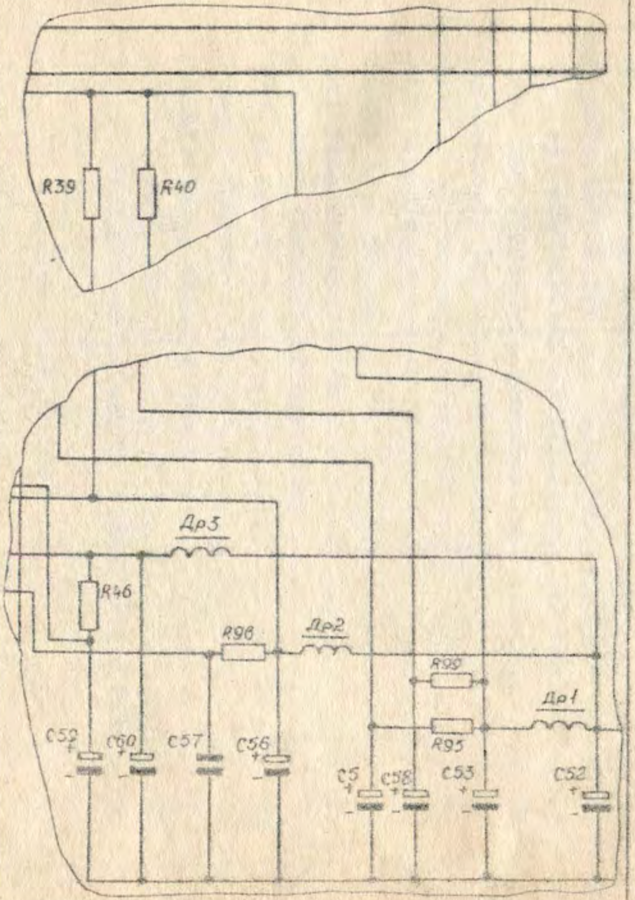
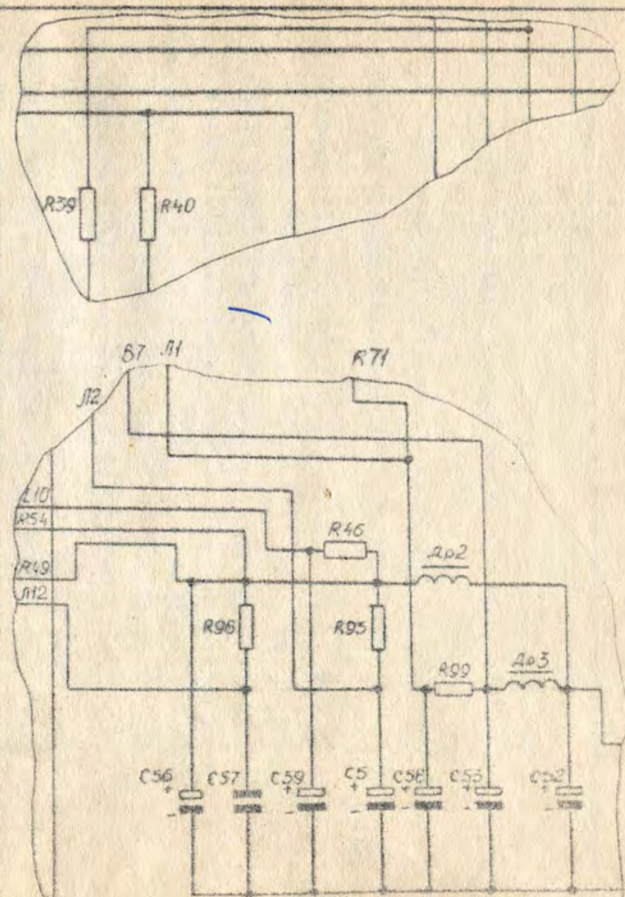
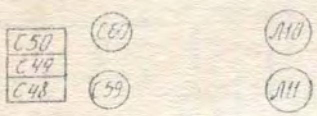
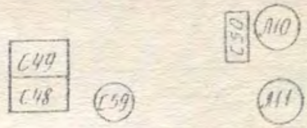
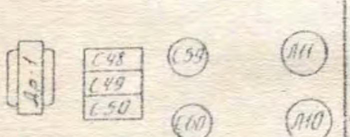
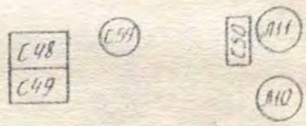
<tr><td>ELEMENTARY DIAGRAM</td><td></td><td>
</td><td>
</td></tr>
</table>

Page	Line	Printed	Should read
21	12 above	At the output it has three separate filters with chokes Dp1, Dp2, Dp3 ...	At the output it has two separate filters with chokes Dp2, Dp3 ...
58	C53, C56	|K50-12-450-20| 20 μF |	|K50-12-450-50| 50 μF |
	C58, C59	|OЖO.464.042 TY|K50-3-450-20|	|OЖO.464.079 TY|K50-12-450-20|
	C60	|OЖO.464.042 TY|K50-3-450-20|	
61	Dp1	|T85.750.C??|Choke|8 H| 1 |	
64	FIG.5.		
	FIG.6.		
70	5 below	|-|9.1|6.35|6.47|6.54|-| |276|499|	|-|15,2|6,3|6,3|6,3|-| |253|515|
60	D1 D2	1 1 } Grouped with spread of back resistance of not more than 5%	2 2 } Both in succession

CONTENTS

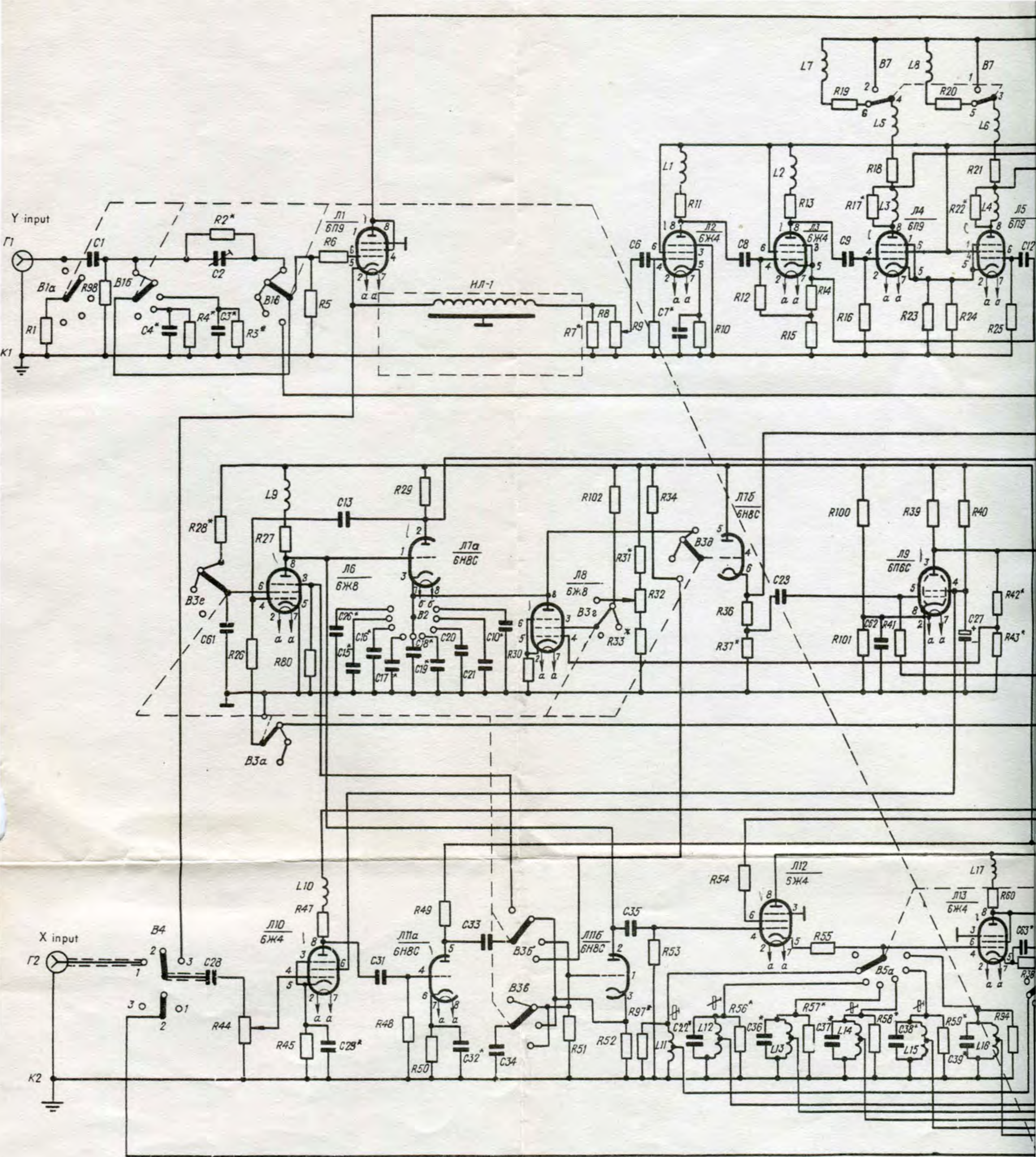
Addition 1 list

ОТК 132

Осциллограф универсальный С1-5
Техническое описание и инструкция
по эксплуатации

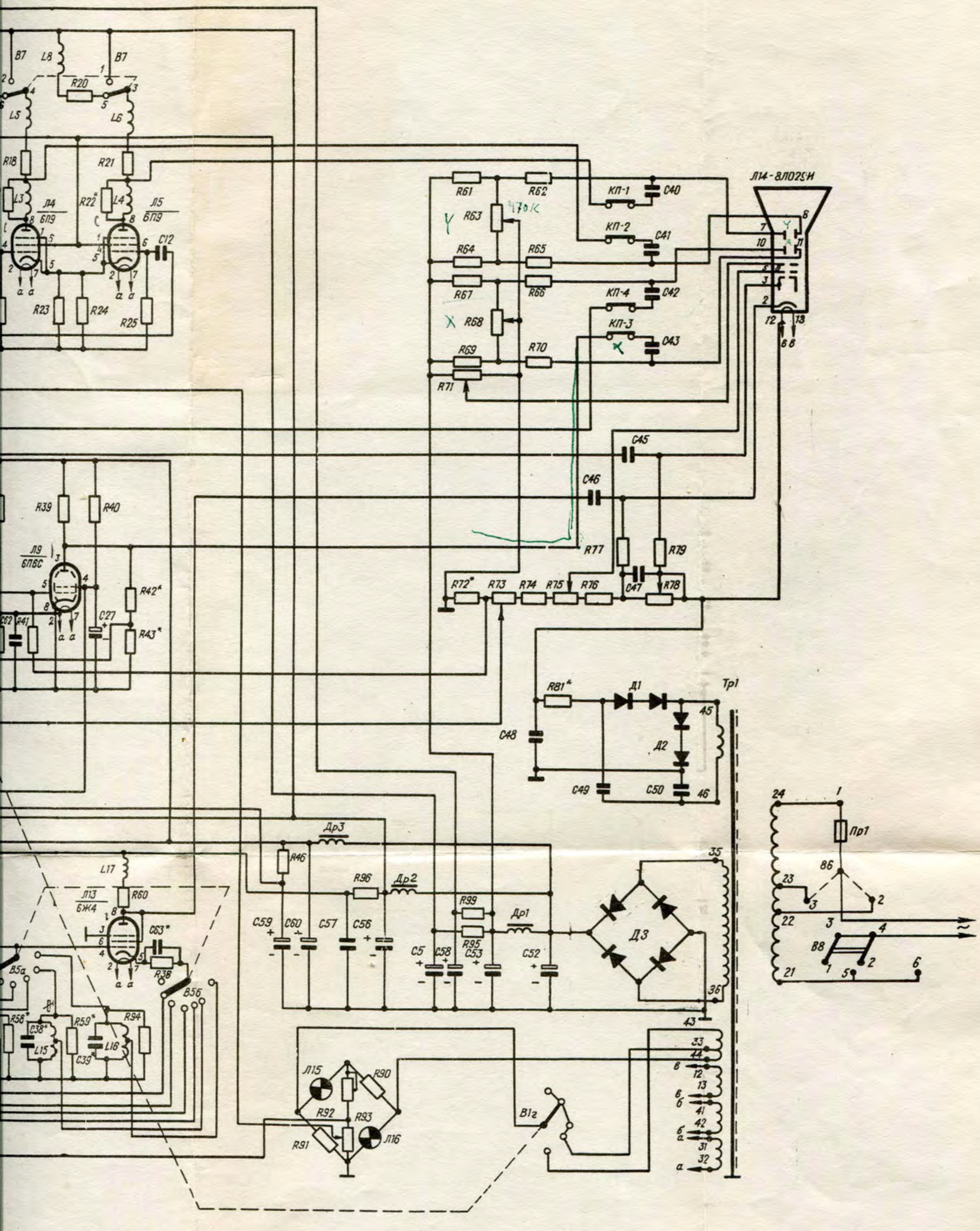
(на английском языке)

8/42783-П4



*Subject to adjustment

FIG. 1. C1–5 UNIVERSAL OSCILLOSCOPE. ELEMENTAR



OSCILLOSCOPE. ELEMENTARY DIAGRAM