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ELECTRIC CIRCUIT TESTER **התקן לבדיקת מעגלי חשמל**

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ELECTRIC CIRCUIT TESTER

The present invention relates to the field of measurement means. The object of the invention is to provide means for checking of voltage presence and of integrity of electric circles in electric installations.

The device for checking electric circuits known in the art comprises two control probes, internal power supply, two pairs of light diodes connected anti-parallel and two resistors connected in series with the light diode pairs. Galvanic element or accumulator are used as a power supply [1].

The known device is disadvantageous in that a narrow range of checked voltages and low voltage developed by small-scale accumulators limits its field of application by preventing it from checking circuits with resistance over 3-4kΩ and in that the need in prolonged hours (10-12 hours) of accumulators charging even when the device is temporary not in use makes it inconvenient in use.

The closest art is an electric circuits control device constituted of main and auxiliary control probes having metal pins on the ends, internal power supply formed as an electrolyte condensers with low leakage current and capacity not less that several thousands of micro Farad, three light diodes, two Zener diodes, five diodes, four resistors [2].

This known device is disadvantageous in its limited functional abilities which don’t enable to identify phase and zero terminals of electric device, to locate breaks in current core of insulated wire, to uncover the buried wiring run etc. Moreover, the back-EMF of charged condenser (12-24V) prevents from indexing voltages below 24-48V,

while the absence of its charge level indicator forces increased charging time to provide reliable operation.

The object of this invention is to widen the functional capabilities of the tester and facilitate its operation.

Fig. 1 is a principal diagram of the “A combined voltage detector and electrical integrity checker by V. Gurevich”

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Fig. 2 is an example of tester body of Fig. 1. It also shows an example of fastening of probes A and B design in idle state formed with pin 41 and hole 42 as well as protrusion 43 and guiding units 44.

Fig. 3 is a view of auxiliary heads designated for voltage checking in range 500-1000V. In the tester embodiment comprising auxiliary heads D, the heads are made from dielectric material and have their own metal electrodes 37 and socket type contacts 38 used to provide for the head joint with the main probes electrodes. Resistors 39 and diode 40 are connected in series between electrodes 37 and contacts 38. The only difference between the heads of the main and auxiliary probes is in the diode connection direction.

Universal tester comprises main A and auxiliary B control probes connected by insulated wire C. The main probe body holds the electric circuit elements: resistors 1 to 14, diodes 15 to 17 and 46, Zener diode 18, light diodes 19 to 26, transistors 27 to 30, capacitors 31 to 32, multi-tone generator of audio frequency built around microcircuit 33 having piezoelectric audio emitter. 27 and 28 are bipolar transistors; 29 is a p-channel field-effect transistor with p-n junction; 30 is a Darlington transistor. The tester is provided with a telescopic antenna 34 and tactile electrode 35 located at the outer surface of main probe A. The tester has micro-button 36 whose pusher is located at the face side of main probe A. Big capacity of condenser 32 (2000-4000 microF) and low leakage currents, make it operable for 7-10 days after being charged only once. Condensers type LL-II or SL-7 made by “Taiwan Capacitor Ltd”; LE type made by “Samha Electric C.”;

EMRL type made by “Hitano Enterprise Corp.” or K50-29B type acceptance “5” made by radio elements plant in Riazan can be used. Light diodes 19-26 are mounted beneath the holes in the body of main probe A next to their respective designations. The table below shows examples of such designations:

Designation no. in the dwg.	Engraving of the main probe body	Description
1	2	3
25	-6V	1. Lower limit of checked voltages range 2. Negative voltage polarity at e main probe
19	380V	Higher limit of checked voltages range
24	Test/phase	1. Circuit 2. Phase determination in the ac circuit 3. Detection of charged conductors or equipment 4. Detection of broken current core in insulated wire 5. Finding the hidden wiring (antenna 34) 6. Indication of electric field of high voltage installations (antenna 34)
20	220V	
21	110V	checked
22	48V	voltage
23	24V	values
26	O	Indication of fully charged condenser 32

The tester operation is as follows:

As probes A and B touch the checked power source and probe's A potential is negative, there is current flow in the following circuit: probe B → wire C → resistor 6 → light diode 25 → diode 16 → diode 15 → resistor 1 → probe A electrode. Capacitor 32 which is by-passed by diode 16 and light diode 24 is not charged, whereas light diode 24 becomes illuminated indexing negative polarity on main probe A starting with 6 V. In order to determine the checked dc voltage value above 6 V, positions of probes A and B shall be interchanged. In this case probe A will have positive polarity and current will flow in the following circuit: resistor 1 → diode 17 → light diodes 19 to 23 with resistors 2-5 → condenser 32 → resistor 6 → wire C → probe B. After the condenser is completely charged and the voltage reaches the maximal value (about 16 V), Zener diode 16 is opened and light diode 26 becomes illuminated indicating the end of charging (about 15-20 sec). The Zener diode maintains the voltage on the condenser at a constant level of about 16 V during the probe charging from any 24 to 400 V power supply. The number of illuminated diodes 19 to 23 corresponds to the checked voltage value. In this way voltage check is concurrent with the tester recharge.

In case of ac, namely at alternating voltage polarity, light diode 25 is illuminated too.

In the circuit ringing mode condenser 32 must be charged in advance. As the tester is connected to the circuit whose integrity is to be checked the current flow in the circuit is as follows: from "+" of condenser 32 → light diode 24 → closed (upon pressing) contact of micro-button 36 → diode 15 → resistor 1 → controlled circuit → probe B → wire C → resistor 6 → capacitor 32 "-". In this case diode 24 is illuminated if there are no breaks in the circuit light. This test mode is also useful for testing of relay and engine windings, semiconductor devices, condensers and other electric and radio elements. Steady illumination of light diode 24 is observed when the resistance in the external checked circuit does not exceed 100 kOhm.

Upon accidental pressing button 36 in voltage check mode or during condenser charging light diode 24 will be illuminated too via the internal source resistance. This is not accompanied by any tester's failures.

In order to determine the phase in ac circuit, electrode-sensor 35 is finger-touched. If following this probe A is connected to the phase wire (output) of electric installation, weak current will flow through resistor 13 (high resistance) and the human body to base-emitter junction of transistor 30 , which will open the resistor gate (amplification factor of this transistor shall be at least 50000). When triggered, the resistor generates discharge circuit of previously charged condenser 32 via light diode 24 and resistor 12. Transistor MPS-A14 made by “Motorolla” or BC6127, RN5306 made by other firms can be used as transistor 30.

To detect a charged insulated wire the end of telescopic antenna 34 protruding from probe A body is brought close to the outer insulation surface (without pulling out the antenna) and button 36 is pushed with a finger. In this way voltage is applied to transistors 27-29 from previously charged condenser 32. If the checked wire is charged, its electric field is applied via electrode 34 to field-effect transistor 29 gate thus cutting it off. Consequently the base potential of transistor 28 is changed causing its cutting off. This results in positive voltage at transistor 27 base which is triggered generating condenser 32 discharge circuit through light diode 24 and resistor 8.

Buffer stage of transistor 28 has a very important function. First, it provides for stable tester operation in the mentioned mode when transistor 29 gate is “separated” from the circuit potential, which becomes essential as the air humidity is increased. In the absence of this stage humidity increase to 85-90% causes spontaneous transistor 29 cut off; following this, transistor 27 is triggered and light diode 24 illuminated. An attempt to “connect” transistor 29 gate to the circuit potential even via high resistance (20-50mOhm) brings to a drastic decrease of the tester sensitivity to electric field making its inoperable. Buffer stage of transistor 28 enables to maintain high tester sensitivity and improves its operation reliability. Second, this stage enables output transistor 27 operation in trigger mode, thus providing high precision in location of current carrying core failure in an insulated conductor. A damaged carrying core in a charged conductor can be detected with 5-10 mm accuracy and indicated by extinguishing light diode 24 during antenna 34 edge advancement along this charged conductor.

Pulling out pin antenna 34 from the body will bring to a drastic increase of the tester sensitivity to electric field because of relatively big length of the antenna (200-250

mm). The tester operation in this mode is similar to procedure of detecting damaged current carrying cores in insulated conductor which consists of advancement of probe A with antenna mounted on it and pointing the wall along the estimated run of the internal wiring and specifying its position in accordance with turning the light in light diode 24 on and off. The tester sensitivity provides for detection of 220 V network wires located at a distance of 400-500 mm from the antenna. Tester operated in this mode can be used for remote controlled indication of dangerous voltage across current carrying parts of high voltage installations.

High resistance resistor 11 protects transistor 29 from damages in cases of accidental mains voltage applied across the antenna and protects the operator from the electric circuit potential during voltage check and unintentional touching the antenna.

To check voltages higher than 500V additional multi-functional heads D are mounted on the tester probes (Fig. 3). In the first place, the heads enable the operator to keep his hands away from the current-carrying parts charged with dangerous voltage. In addition, resistors 39 incorporated in the circuit limit the current through tester elements and protect them from overloading when high voltages are checked. Further, diodes 40 mounted in the heads are connected in series with diodes 15-17 and protect them from high voltage break down. Resistance of resistors 39 is selected so that using the heads causes the light diodes 19 and 20 illuminating threshold increase three-fold. In this case light diode corresponding to the voltage level of 220 V will illuminate at standard voltage of 660 V, and light diode corresponding to the voltage level of 380 V will illuminate at standard voltage of 1140V.

To check the operability and correct adjustment of protection relay from earthing in the checked electric network, button 45 is pressed and the tester probes brought in touch with the “grounded” wire thus imitating damaged phase insulation of the electric installation. In this case current through the tester is increased to 25...30 mA resulting in internal resistance decrease at by-passing resistor 1. The earthing protection of domestic electric networks is normally matched to such currents. If the protection relay is operable and appropriately adjusted it is immediately engaged cutting off the mains.

Accidental pressing the button, for example in voltage check mode does not cause any damages to tester elements, since a sleigh current increase does not go beyond the allowed values.

Hence, the tester is more advantageous in that it has a wider functional range comparing to the prototype and is much more convenient in use.

Experimental samples of the tester have been built and tried.

1. US patent no. 4366434, GOIR31/02, 1982
2. Russian Federation Patent no. 1773185, GOIR31/02, 1993.

What is claimed is:

1. Proposed combined voltage detector and electrical integrity checker by V. Gurevich comprising main and auxiliary control probes having metal pins on its faces, internal power supply constituted from an electrolytic condenser with low leakage current and minimal capacity of thousands of micro-Farad, three light diodes, Zener diode, two diodes, four resistors featuring at least five light diodes, 10 resistors, four transistors and a telescopic antenna, miniature button with engaged contact and tactile metal electrode-sensor connected to the internal circuit elements and extending to the outer surface of the main control probe, whereas

the 1st resistor, 1st diode, first five light diodes, four of which are shunted by the 2nd, the 3rd, the 4th and the 5th resistors respectively, as well as Zener diode, the 6th light diode and the 6th resistor form a serial circuit connected to the check probes circuit in parallel to the section of this circuit comprising Zener diode and the 6th light diode, the mentioned electrolyte condenser is connected, between the positive and the negative outputs of which the 7th light diode, the 1st transistor with its “collector-emitter” junction and the 7th resistor, are connected in series, while the “base” of this transistor is connected to the negative output of condenser via the 8th resistor, as well as with mentioned tactile electrode-sensor through the 9th resistor, furthermore, between the cathode of the 7th light diode and the negative output of the condenser four parallel circuits are connected via the mentioned miniature button contacts: the first one comprising the 10th resistor, the “source-drain” junction of the 2nd transistor which is a field-effect transistor, whose “gate” is connected to the mentioned telescopic antenna via the 11th resistor and the 12th resistor connected in series; the second circuit comprising the 13th resistor, “emitter-collector” junction of the 3rd transistor, whose “base” is connected to the “drain” of the 2nd transistor and the 14th resistor connected in series; the third one comprising the “emitter-collector” junction of the 4th transistor and mentioned 14th resistor, whose “base” is connected with the 3rd transistor; the fourth one comprising the 2nd diode, connected in series with the 8th light diode, operated in the reverse direction; besides, the common the connection point of one of the contacts of mentioned button, the 10th resistor, the 13th resistor and the collector of the 4th resistor

are joined with the common connection point of the 1st resistor with the anode of the 1st diode via the 3rd diode, directly connected between these points.

2. A combined voltage detector and electrical integrity checker by V. Gurevich according to claim 1, further featuring an audio indicator of dangerous voltage level comprising a audio generator built around a microcircuit with piezo-ceramic emitter at the output and connected via diode in parallel to a group of light diodes connected in series shunted by an additional condenser selected in accordance with the allowed level of dangerous voltage that must match the nominal generator voltage, whose current shall not exceed the current through these light diodes.

3. Universal tester according to claim 1, further featuring two heads, each being formed as a cone made from a dielectric material with an internal cavity coupled with the outer surface of the main and auxiliary probes, each having its own metal face pin and a socket coupled with metal pins of the main and auxiliary probes, diode and resistor connected in series are connected between these contacts and pins of each of the auxiliary heads, while in the main probe head the anode of diode is connected to a metal head pin, and in the auxiliary probe head - its cathode.

4. Universal tester according to claim 1, further featuring in addition a second miniature button with shorting contact connected in parallel with the 1st mentioned resistor, and the resistance of the 6th resistor is selected in such a way as to match the current in the check probes circuit with engaged contacts of this button to the engagement current of the relay protecting from grounding in the checked electric network.

Inventor V. Gurevich