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STUDY AND THE CONTRIBUTION CONCERNING THE REALIZATION OF SEQUENCE INDICATORS OF PHASES

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***Abstract* – In this paper is approached the problem of verification the order interlinking of phases electrical three-phases network. After the exposure of this subject methods importance, and the current devices of verification are presented two new devices for the determination the order interlinking of phases electrical three-phases net. In the end of the paper are presented the conclusion results from the study.**

Keywords*: *indicator, interlinking of phases, three-phase system.

1. INTRODUCTION

The phase-sequence indicators are useful for the establishment interlinking of phases for three-phases power unit a set at normal of equipment apparatus and electric devices, who's operate is conditioned of the interlinking of network phases.
In the electrical actuation are known some cases which the electromotor of actuation presents a restrictive sense of rotation (of hydraulic pumps, fans, of mobile platforms used in construction). The actuation of outfit in an undesirable sense can conduct to change the outfit and driving motor. The analysis has a general characteristic and it refers to electromotor of direct current, induction motors, and synchronous motor.
In the first figure, is presented an outfit of four photos, the damage of power transformer induced of the inversion interlinking of phases for power unit from the driving system of drain switch.
These paper, proposes to study the phases-sequence indicator from the three-phases sources of power unit where are connected three-phases induction and synchronous motors. The sense of rotation to these motors is given by the sense of rotation to the motors rotary magnetic field, which is caused by the interlinking order of phases for power unit.
The phases sequence indicators are made in marry ways:

- through a induction three-phases motor;
- through the filter;
- through the stroboscopic effect.

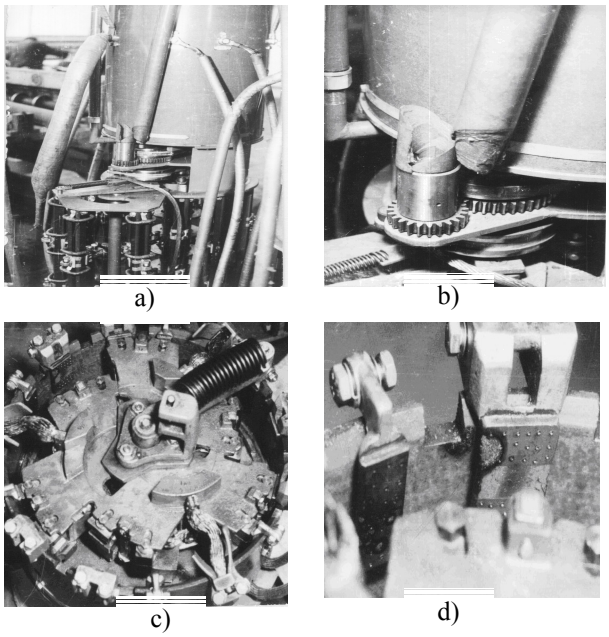


Fig.1. The damage of electrical transformer 40 MVA , 110/6KV [11]:

a) overview actuation rod's; b) the rod from actuation-detail; c) circuits breaker overview; d) circuit breaker contact-detail;

2. THE CURRENT STAGE FOR SOLUTIONS TO ACHIEVE THE PHASES-SEQUENCE INDICATOR

2.1 The current stage for apparatus made on the principle of induction three-phases motor

In the second figure is presented a phases-sequence indicator achieved with induction motor principle [1, 12]. The indicator operation is similar with the operation from the induction motor with the rotor in short circuit. The indicator is made from three disposed symmetrical electromagnets, Y-connected, and connected at verified three-phases sources clamp. Through the rotary magnetic field the ensemble of electromagnets react over a disk made from aluminum seated on bearing for friction reduction. The disc rotation sense gave the phases sequence.

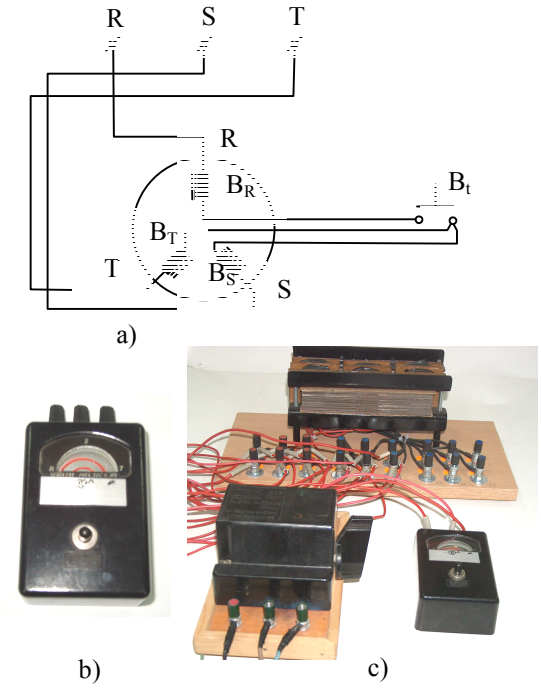


Fig.2 Phases-sequence indicator achieved with induction three-phase motor principle (ICEMENERG model) [1, 12]:

a)principle circuit diagram; b) indicator model ICEMENERG; c) experimental montage.

An other variant, realize with the same principle is presented in the third figure, that represent principle circuit diagram experimental model.

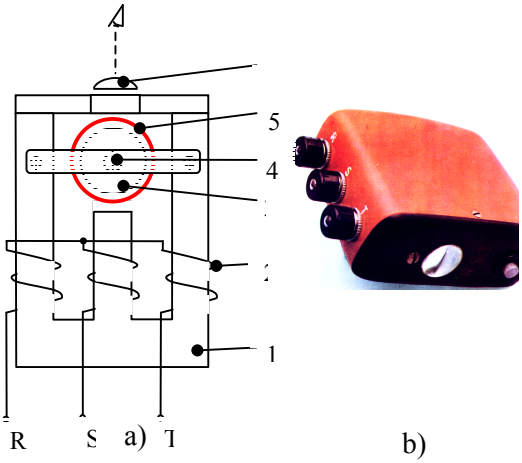


Fig.3 Phases-sequence indicator achieved with induction three-phase motor principle (URTAE Roman model) [6, 14]:

a) indicators principle diagram; b) homologate product; 1- wound core; 2- three-phases winding; 3- aluminum rotor; 4-rotor arbor; 5- colored band; 6) biconvex lens.

The apparatus is constituted from a opened magnetic core 1, in E form, where is set an ensemble of three concentrated coils 2, Y-connected and connected to the verified three-phases source. The ensemble described operate through the rotary magnetic field on a massive rotor 3 made from a non-magnetic conductor material (aluminum, copper, brass), and mounted on a arbor 4 that has like support two plates fixed on extreme columns of the core 1.

On the rotor surface is placed a colored band 5 followed by the onlooker through the slit clearance „f" and a biconvex lens 6. The displacement sense of spiral part saw through the slit and biconvex lens 6 show the sequence phases order.

The solution described presents the disadvantage that has mobile elements (that damage easily), makes the response more lower. They are package only special condition to not deteriorate the bearing where the disk leans, and they have a huge capacity. It doesn't observe if a phase from the voltage system saw in necessary to measure the power unit.

The solution from the third figure has advantage for deflate the gage and mass dimension.

2.2 The current stage for apparatus made on the principle of direct and inverse filtersequence

In figure 4 is presented a version made and tested of Mircea Diaconescu teacher from Electrotehnics College at Tehnic University Gheorghe Asachi, Iasi. The presented apparatus is constituted from light resistors four condensers and two glow-discharge tube.

The operation principle of this apparatus is based on the direct and inverse filter sequence.

In the case of the three binding post (R, S, T) are charged on a voltage system who's direct sequence ignites L_1 light. In this case light L_2 doesn't ignite. When the apparatus is charging with inverse voltage sequence L_2 light will ignite. In this case L_1 light doesn't ignite.

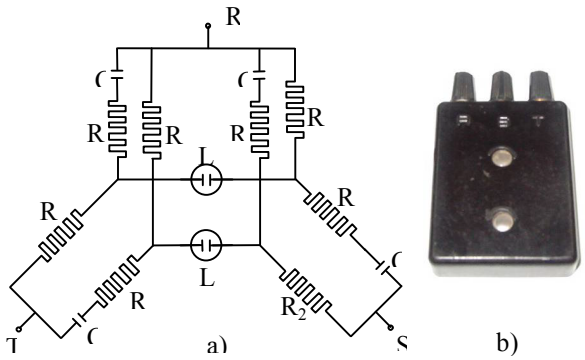


Fig.4 Phases sequence indicator based on filters principle with direct and inverse sequence (Mircea Diaconescu teacher is model): a) principle circuit diagram [1]; b) teacher Diaconescu indicator model

In indicators class based on direct and inverse sequence filter principle, enclose and the tester presented in figure 5.

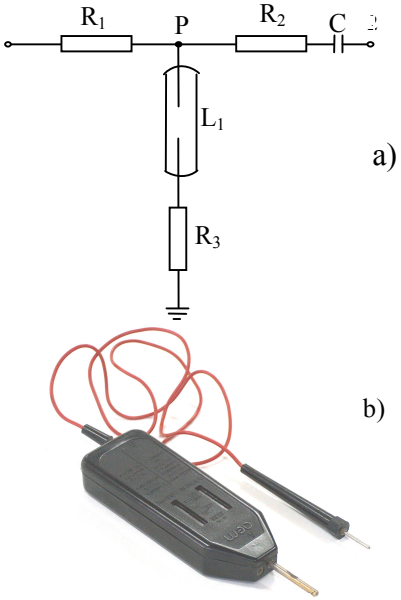


Fig.5 Phases-sequence indicator (AEM Timisoara model):

a) principle circuit diagram; b) overview.

The indicator represents the objectifies of a letters patent [9], being constituted from one resistor R_1 connected on a terminal 1, and a common point P, at a R_2 resistor, series arrangement with an condenser C connected to a terminal 2 and a discharge tube L_1, what is series arrangement with an resistance earthed R_3. The resistance R_1 value is approximately half from resistance R_2 value. The interlinking of phases checkout is made connecting the indicators terminal at two phases, and the ground terminal is touched with the hand; the lamp will light only in direct interlinking of phases case [9].

In figure 6 is presented another phases-sequence indicator on direct and inverse sequence filter principle. The indicator (fig.6a) is constituted from two resistive brackets and a capacitive bracket.Y-connected and connected to a three-phase source.

Depending on the resistive bracket interlinking of phases will be pass through an unequal current. Between the capacitive bracket capacity and the resistive bracket equivalent resistance settled this relation:

$$R = \frac{1}{\omega C}$$

and the currents ratio through the resistance bracket has a optimum value equal with 3,73.

For the case presented in [6] each resistive bracket is constituted from a lamp in series connection with a dropping resistor. The dropping resistor value are culled so that for direct sequence only L_A lamp light, and for inverse sequence only L_B lamp light. In waiting period when the contact breaker presented in fig 6a is opened both lamp light at a low intensity verifying circuit wholeness.

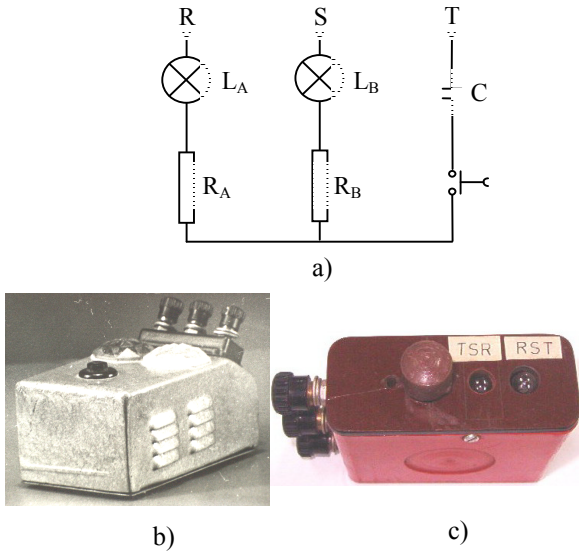


Fig.6 Phases-sequence indicator with lamps[6]

a) principle circuit diagram; b) lamps indicator of 15W [11]; c) lamp indicator of 2W [10].

2.3 The current stage for indicators based on stroboscopic effect .

The stroboscopic indicator represents the materialization of an patent idea [7, 8].

The apparatus is made from a high voltage indicator capacitive type, with glow-discharge tube, assembled with an optical disk element win synchronous motor. The glow-discharge tube luminescence is intercepted of a viewer through an obturator with slits, made in many way (slit cup, slit cylinder, disk with quaquaversal slits), assembled on a synchronous fractional motor arbor, preferably with 3000 rot/min. the motor fixed coil is bind of indicator cage, being rotate with a adjustable angle so that the glow-discharge tube luminescence became low.

The phase identification is made with point nearness of high voltage indicator to a bus bar system. The motor fixed coil is rotated until the light intensity intercepted of operator became the minimum. The graduated dial has displaced from the fractional synchronous motor until one of the figure marked on the support arrive straight the indicator point fixed on stroboscopic device. The operation is repeated and for the second bar system. The bas for what were obtained the same indication are considered identical

and can be paralleling. The operation is repeated and for the other bars. In this way the indicator with stroboscopic effect can be used for the phases identification for three-phases wiring, of high voltage that must be paralleling. Proceeding in a similar way the same indicator can be use for high voltage three-phases sequence source check.

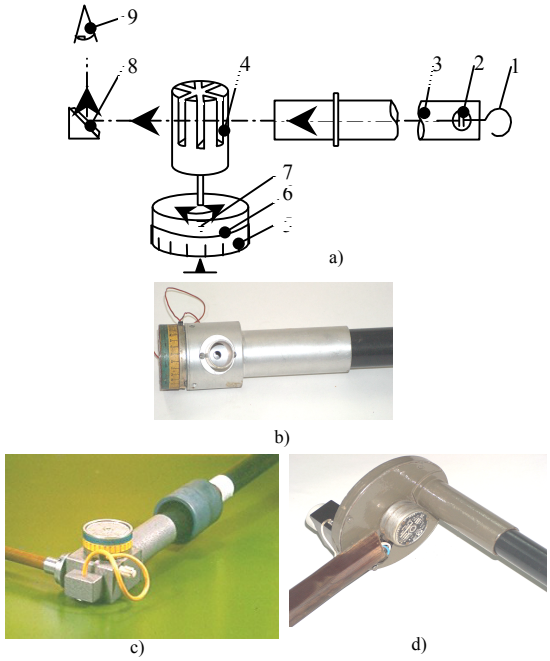


Fig 7 The indicator based on stroboscopic effect: a) principle diagram [8];

b) experimental model with cup leaf; c) experimental model whit slit cylinder; d) experimental model with disk slits quaquaversal; 1-crest; 2-glow- discharge tube; 3-hose insulating base; 4-obturator; 5-graded scale; 6-synchronous motor; 7-peak indicator; 8-mirror deflector; 9-detecter.

The utilize of voltage indicator presented anterior has been extended in a adapted manners for the realization of some precision and protection instruments.

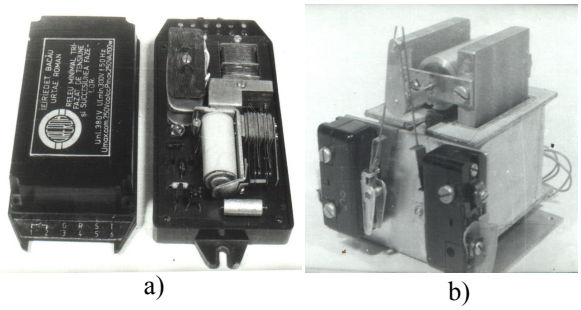


Fig.8 Protection system for the case of three-phases voltage feuding of untrue sequence:a)protective relay made on direct and inverse filter sequence base; b) protective relay made on induction motor solution;

3.CONTRIBUTION CONCERNING THE PHASES-SEQUENCE INDICATOR SENSIBILITY

One of the deficiency at current stage in phases-sequence indicator domain, represents the reduce sensibility the movable system deceleration is mat at high voltage of checked sources (the example presented in figure 2 where the movable system deceleration is made on 3×60 V; 50 Hz). The existence of movable elements made that the current indicators are vulnerable at power operated shock and swinging.

In figure 9 is presented a solution made by induction motor principle and show the phenomenon, that are manifesting at solid-liquid surface [2, 3, 4, 5]. The indicator is constituted from an outfit of three electromagnets who's geometry axis from in planar 120° angle having the winding Y-connected and that actuate through magnetic field rotary an a float rotor. The rotor is made from a paraffin disk and a ferromagnetic substance lamella is arranged in the interior of a globular bowl, clear, partial filler with water.

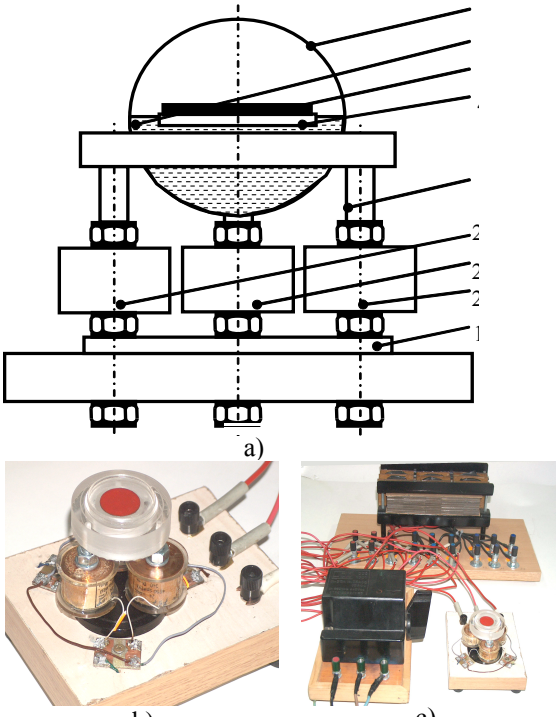


Fig.9 Phases-sequence indicator with float rotor [14]:

a) principle diagram; b) experimental model; c) experimental assemblage. 1- base wafer from ferromagnetic substance; 2a, 2b, 2c- focused windings Y-connected; 3- ferromagnetic vertical core; 4- globular bowl made from a transparent substance; 5- water that fill the container partial; 6- float rotor; 7- support for globular bowl filled with water.

The indicator increase sensibility results from the process that appear on the solid-liquid surface, the adherence and cohesion process [2, 3]. Because of the adherence power when a liquid came in contact with an solid, they surfaces are muting and cross under a determined angle.

The α angle between the solid surface and tangential plane to liquid surface is named marginal angle or sometimes contact angle [2, 3, 4, 5]. With this angle value the solid substances are: substances that soak and substances that don't soak. α value in sensible to impurities that can appear on contact surfaces α angle is influenced of the gaseous fluid where is the assemble.

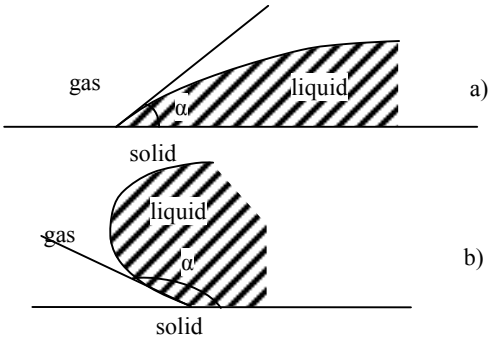


Fig.10 The angle contact between solid-liquid.

The force that actuate over the liquid in proportion to solid body surface has the alignment and sense obtained from the composition of adhesion and cohesive force (fig. 11 and 12).

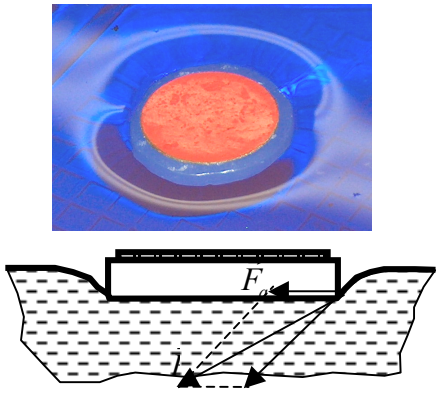


Fig.11 The adhesion and cohesive force for paraffin base

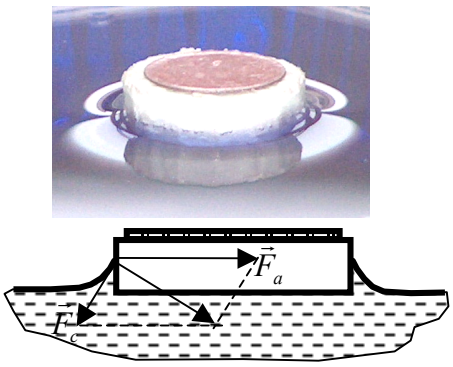


Fig. 12 The adhesion and cohesive force polystyrene base.

In the first case (figure 11) the rotor „slid" on water surface that conduct at electromagnetic fields decrease which start the rotor. The fact described is possible at a lower voltage (3×9 V; 50 Hz) than classical indicator case.

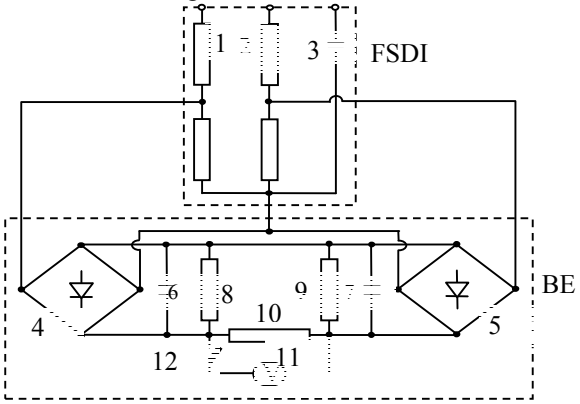
In the second case (figure 12), because bigger adhesion force, the rotor stay captive on water surface that involves bigger electromagnetic fields for his inaction give out. The explanation why the rotor deceleration is made at a bigger voltage (3×5o V; 50 Hz), than classical indicators.

In figure 13b) is presented another solution made and experienced of authors and that is made on direct and inverse filter sequence principle.

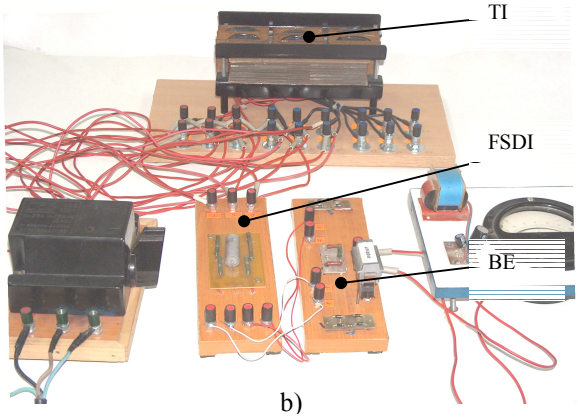
The indicator (fig. 13 a) is constituted from a direct and inverse DISF that on the outlet supplies two voltage U_{RST} and U_{TSR} unequal in normal way.

The sense of inequality is depends on phases sequence order and is controlled with help of a apparatus of electrical balance type that supplies on the outlet a direct current signal. The signal polar mapping depend of phases sequence order an it is approached with a magnetoelectric instrument preferably, with o on tuning dial middle.

The polar mapping control can be made throw the indicator needle of galvanometer. If the galvanometer sensibility is 1×10^{-6} A/div, the indicator described can control a three-phases sequence phases system with circuit voltage of volt fraction order.



a)



b)

Fig. 13 Phases-sequence indicator made on direct and inverse filter sequence principle[16]:

a) principle circuit diagram; b) experimental montage; DISF- direct and inverse filter sequence; EB-electrical balance; ET- experienced transformer; 1,2- resistive bracket in potentiometer circuit; 3- capacitive bracket; 4 and 5- rectifier bridges; 6 and 7- filter capacitors; 8,9 and 10- resistors; 11- meter.

4. CONCLUSIONS

The phases sequence indicators that constitutes the current technical stage are made after the principle:
induction motor principle;
direct and inverse filter sequence principle;
the stroboscopic effect principle.
In all those cases the common deficiency approached after a long period of analyze consists in reduced sensibility. The mentioned indicators can be used only when the three-phases controlled source have circuit voltage of volt decimal order. In indicator case made on induction motor principle intervene another disadvantage connection with vulnerability at mechanically impulse and vibration.
The authors contribution have like object the indicators sensibility increase so to can be use for three-phases controlled source with voltage of volt order.
One of the contributions is made on induction motor principle and on adhesion and cohesive force manifested on liquid-solid interface. At this indicators the motive crew deceleration was possible in a voltage three-phase system of 3×9 V; 50 Hz.
The second contribution has like object the realization of a indicator on direct and inverse filter sequence principle. The determined sequence depends of electric signal polarity delivered on the outlet, and the indicator sensibility depends of polarity indicator sensibility. The galvanometer, with sensibility 1×10^{-6} A/div indicator needle, appropriation make the premise of three-phases source with circuit voltage of volt fraction order.

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