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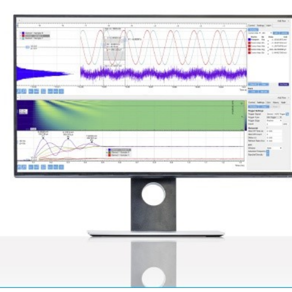

# Methods for Attaching Magneto Sensitive Elements to Build Protections

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**Abstract.**This article offers methods for attaching and configuring Magneto sensitive elements (ME) without using current transformers, used for building relay protection, for example, building filters of symmetrical components at any location of the phases of current pipelines.

## INTRODUCTION

In 2000-2005, the issue of replacing the relay protection of current transformers with any other sensors devoid of the disadvantages of current transformers was raised several times at the CIGRE session. Both the presence in them of a significant amount of steel and copper, insulation and weight, reaching 500 kg.

This problem of building relay protection without current transformers was then classified as a fundamentally unsolved problem in the electric power industry. It caused the activation of work to solve this problem. Only in Toraigyrov University, which has published more than a hundred works, the latter are given in the submitted work [1-8].

Here, miniature magneto sensitive elements (ME) are used for construction, which are installed near the phases of the protected electrical installation and are triggered (change the position of the contacts) when the magnetic flux is applied to the induction:

$$\overline{B}_{ac} = \overline{F}_{ac} / l = \mu_0 \overline{I}_{ac} W / 2\pi l \qquad (1)$$

Where $\overline{F}_{ac}$ – magneto-driving force of ME actuation; $\overline{I}_{ac}$ – minimum current in the phase of the electrical installation at which the ME is triggered; $W$ – number of coil turns; $l$ – the length of the coil; $\mu_0$ – magnetic permeability of air.

When determining $\overline{B}_{ac}$, a casing is installed on the ME so that its longitudinal axis coincides with the axis of the coil, that is, the $\overline{B}_{ac}$ vector must be directed along the axis. When the ME is located near the conductor of the electrical installation phase, it is affected by the magnetic field created by the current in this conductor. Since what is required to open the contacts depends only on the properties of the ME, and not on where it is installed, you can determine the current $\overline{I}_{ac}$ at which the ME will work from equality (1) according to the Biot-Savard-Laplace Law:

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$$\bar{I}_{ac} = 2\pi H_{ac} / \cos\alpha \tag{2}$$

Where $H_{ac}$ – the magnetic field strength at which the reed switch is triggered; $\alpha$ – angle between the longitudinal axis of the ME and the induction $\bar{B}_{ac}$.

This equality is used for the transition of magnetic fluxes to currents when selecting setpoints and parameters of developing protections.

Currently, the principles of construction and schemes of maximum current protection, differential, differential-phase protection, and some remote protection have been developed. And according to the developers [8-20], these protections mostly meet the requirements [21]. However, the issues of constructing methods for fixing protections and their measuring bodies in the vicinity of the phase current lines for many variants of electrical installations have not been resolved. In this paper, an attempt is made to solve the problem of constructing such structures for three-phase symmetric current lines.

## METHODS FOR ATTACHING MAGNETO SENSITIVE ELEMENTS

There are known devices [22-23] for installing ME with horizontal and symmetrical current lines. They have significant disadvantages – they do not have adjustment of the actuation current by moving the reed switch in a vertical plane, which limits the accuracy of regulation. Or the ME can't be rigidly fixed at a certain point. To solve this problem, we propose devices that allow you to install and configure ME to perform the functions of filters of symmetric components for building backup redundant relay protection. These devices can be used for any arrangement of the phases of the current lines. Examples of installing ME on a structure for performing filters of symmetrical components are presented.

Devices for relay protection of a line with symmetrical current lines of phases A, B and C are proposed. They are designed so that the reed switches are moved both in the vertical and horizontal planes relative to the current line. These designs allow you to change the angle between the horizontal plane and the longitudinal axis of the reed switches without removing the housing from each ME, which facilitates the installation and operation of the device.

The proposed devices are designed to solve the problem of constructing a relay protection line, for example, a zero-sequence current filter for protection against short circuits to earth, when the reed switch is used as a measuring and reacting organ.

Mounting method for three-phase symmetrical current lines with a voltage of 6-10 kV. For fixing and moving the ME, a device is proposed [24-25] that allows you to adjust the protection parameters near three-phase symmetrical current lines with a voltage of 6-10 kV. It (Fig. 1) contains a mounting bar 1, a clamp 2, which is attached to the support. The measuring body 3 is attached to the bar 1, which includes a phase-reversal circuit, adjustment resistors, and a reacting element. The first bar 4 with a scale and the second bar 5 with a scale are attached to the bar 1 with fixing clips 6 on one side, and on the other to the vertices of a regular triangle 7. In the process of use and practical use, to increase reliability, a plate with a protective cover 8 is used in General, and not for each ME, so that the seal can be installed on this device.

The position of the plate 9 with the protective cover 8 (Fig. 2a) with the ME can be changed along the length of the rod 4 with the scale 10 using bolts with wing nuts 11. Moving ME 12 (Fig. 2b) on the plate to the left or right relative to the current lines is carried out by moving the platform 13 along the threaded rod 14. A quantitative assessment of the change in the installation angle of the ME 12 is displayed by the calibration 15 applied on the plate 16. The platform 13 is attached using the mounting eye 17 to the plate 9 using clips. On platform 13, a scale 18 is installed for more accurate installation of the ME 12.

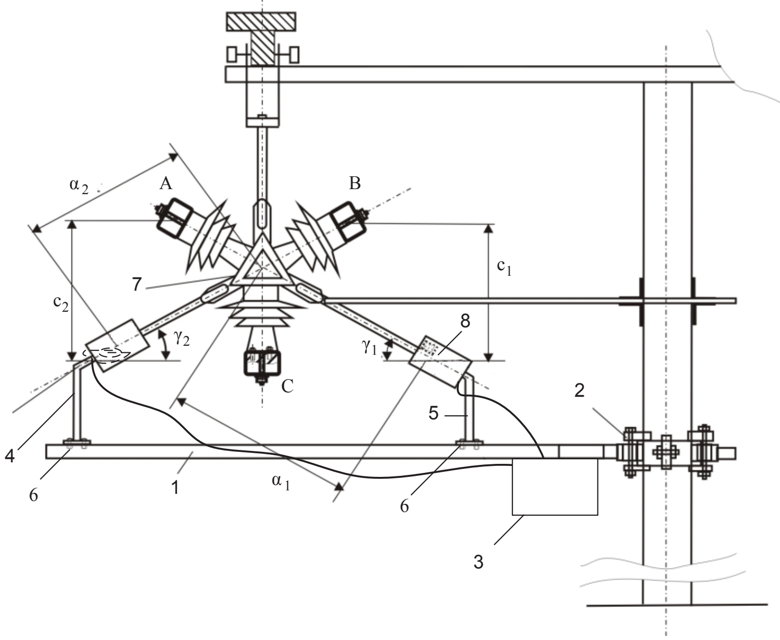


**FIGURE 1.** Device designed for three-phase symmetrical current lines with a voltage of 6-10 kV

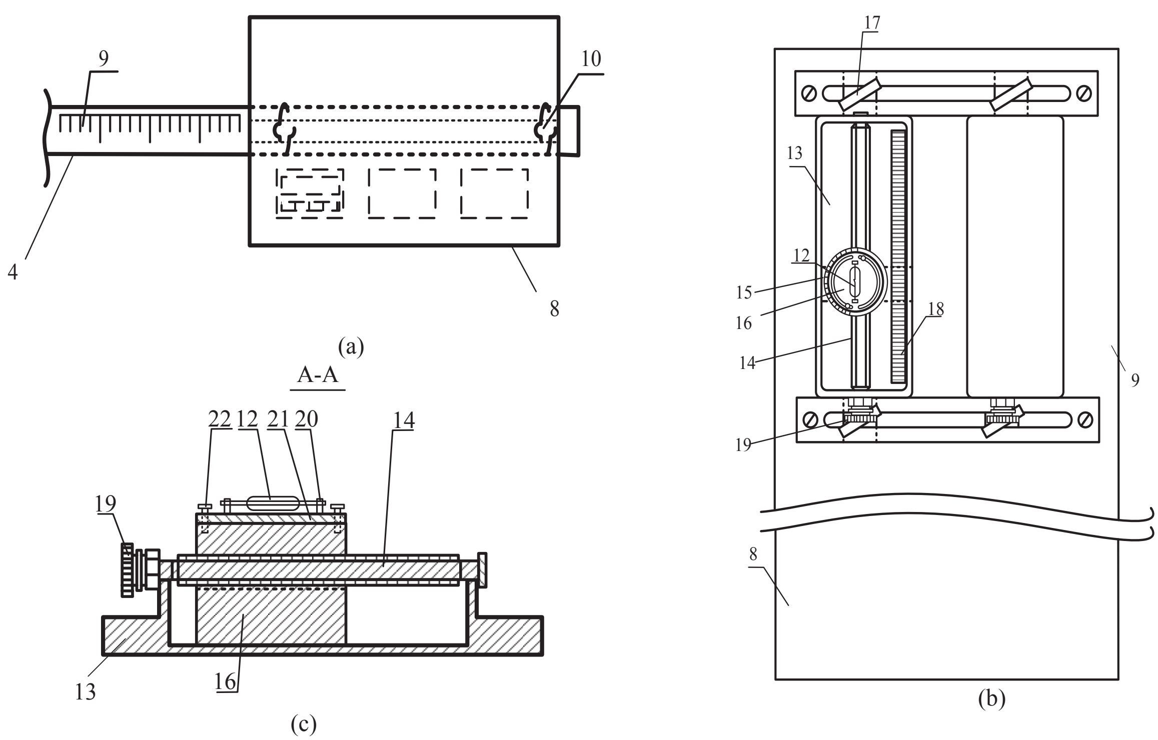


**FIGURE 2**. The device regulating the position of ME: a – Plate;b – Platform with the ME; c – Platform with ME in the section A-A

Changing the distance between the current line and the ME in the vertical plane is achieved by changing the position of the platform 13, fixing the fixing eye 17 with clips. The angle between the horizontal plane and the longitudinal axis of the ME (Fig. 2c) is regulated by the handle 19, which acts on the threaded plate 16 and the threaded rod 14. The position of the MC on the other planes is adjusted similarly.

Magneto sensitive elements 12 is attached (Fig. 2c) by means of a reed switch attachment 20 to the plate 21 fixed with screws 22.

These groups may include ME 12 with a cylinder length of up to 5 cm, such as the KEM-1, MKA and MKS types. The entire installation is made of non-magnetic material, such as duralumin. The clamp 2, the mounting eye 17 and the bolts 22 are made of non-magnetic material, such as stainless steel. The support is standard reinforced concrete.

Example of installing an ME for performing the functions of a reverse sequence current filter (SCF).To do this, it is necessary that the coordinates of one of the ME on the plate 16, located between the current lines of phases B and C (Fig. 1), are: $a_1 = 2\sqrt{3}/3$, $\gamma_1 = 30^0$, $c_1 = 1$, where $a_1$ – the distance from the center O to this plate, $\gamma_1$ – the angle between the longitudinal axis ME and the horizontal plane, $c_1$ – the distance from the current lines of the phases B to this plate. The coordinates of one of the MC on the second plate, located between the current lines of phases A and C, were: $\alpha_2$=2 $\sqrt{3}$ /3, $\gamma_2 = -30^0$, $c_2 = 1$. Let the distance between the phases of the EI is equal to one meter, and the nearest phase neighbor line – 12 meters [11-14], the distance from the center On to the plate 16 with ME along the longitudinal axis of the rod 4 is $a_1$ ($a_2$) m, is governed by the position of each of the ME 12 in the fixing lug 17 and the locking screw 22, and then turns the handle 19 of the rod 14 is threaded. Platform 13 is attached so that the reed switch is at $c_1$ ($c_2$) meters from the current lines of (Fig. 1) phases B and C (phases A and C). The angle between the longitudinal axis of one of the ME and the horizontal plane $\gamma_1$ ($\gamma_2$) is adjusted using the handle 19.

From the above, it follows that in this device, the ME can move in the vertical and horizontal planes relative to the current wire.

Mounting method for three-phase symmetrical current lines with a voltage of 6-35 kV. Method [26-27] to install ME on an electrical installation with voltage 6...35kV in contrast to designs on 6...10kV contains rod 23 with holes 24 and with a scale (Fig. 3a). ME 12 (Fig. 2) and the mounting bolts 25, the plate 9 with the casing 8 with the mechanism changing the position of ME, a similar casing design for 6-10 kV.

It is designed so that the movement of the ME is carried out in the vertical and horizontal planes relative to the phases of symmetrical current lines 6-35 kV. Non-magnetic materials are used in the construction.

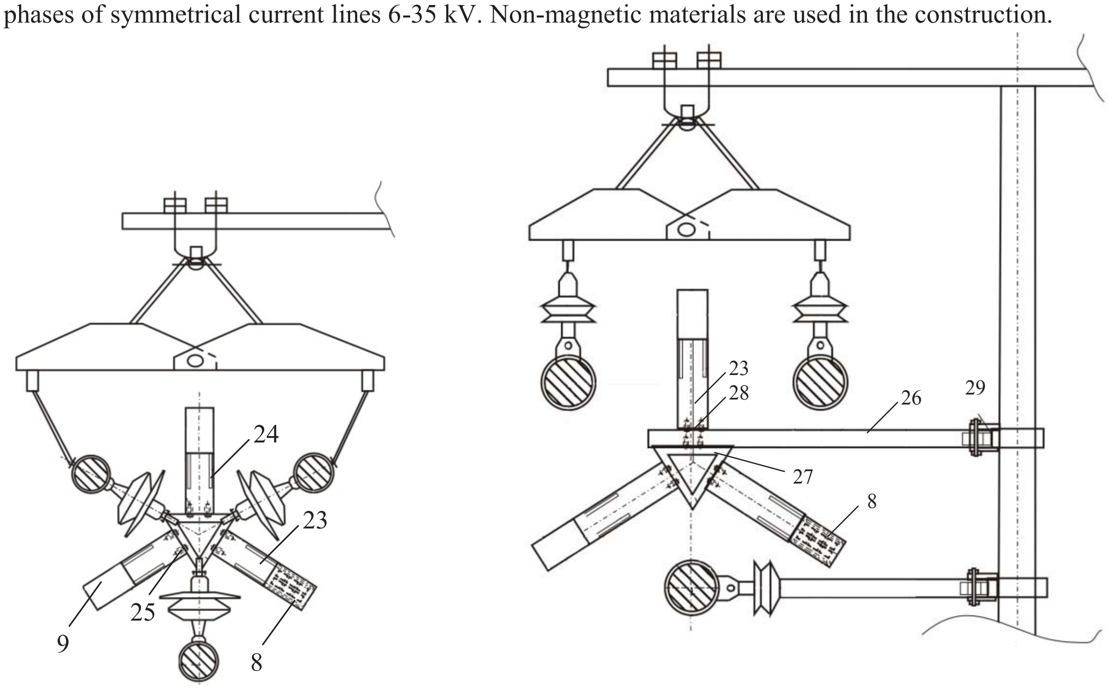


**FIGURE 3.** Mounting method for three-phase symmetrical current lines: a – with a voltage of 6-35 kV; b – with a voltage of 35-110 kV

The location of the ME for performing the functions of the combined filter is selected in the same way as for the device for setting and regulating the parameters of the ME, designed for three-phase symmetrical current lines with a voltage of 6-10 kV, only the mounting method changes. The proposed design expands the scope of ME use for electrical installations with a voltage of 6-35 kV.

Mounting method for three-phase symmetrical current lines with a voltage of 35-110 kV [28-29]. Unlike the first method of attachment, this one contains (Fig. 3b) a plate 26, which is attached to the sides of a regular triangle 27 and to the rod 23 fixing bolts 28.

Installation and configuration of the method is similar to the method described above. The position of the plate 26 is changed along the rod 23 by means of a clamp 29.

This method of fixing the ME expands the scope of use by using three-phase symmetrical current lines with a voltage of 35-110 kV for relay protection.

## CONCLUSION

Designed methods of attachment MK at fixed points provide the opportunity to adjust the parameters built with their help, by moving in the vertical and horizontal planes relative to the conductor and the electrical angle change between horizontal or vertical planes and the longitudinal axis ME.

The proposed devices are designed so that the movement of the ME is carried out in a vertical plane relative to the current wire, the angle between it and the longitudinal axis of the MEcan be changed. This facilitates the operation of the device and protects the contact connections and wires from the adverse effects of the external environment.

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