

ABSTRACT

Dissertation for scientific degree of Doctor of Philosophy (PhD) specialty
6D071800 - "Electrical Power"

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“Development of protection against ground faults on core balance current transformer and reed contact”

Keywords: Protection relay, single-phase ground faults, core balance current transformers, magnetic current transformers, reed contacts.

Relevance of the Study. In networks 3-35 kV with isolated neutral, single-phase ground faults make up a large portion of all faults in the network. A significant part of them comes to the single-phase faults of windings of electric machines and apparatus the body. Single-phase ground faults do not lead to significant currents. When these, the potential of faulty phase to the ground becomes zero, and the potential of fault-free phases increases up to the interphase. This and an electric arc in the winding of the machine can lead to a phase-to-phase fault in a very short period of time.

To protect the radial wires from the single-phase ground faults "ground protection" is traditionally used. Core balance current transformer is used as a filter, and special and quite expensive relays are used as measuring elements.

Reducing the cost of protection against single-phase ground faults can be due to combination of core balance current transformer and measuring body, such as a reed contact. That would significantly reduce the price of protection, and protection at the same time acquires new useful properties.

In this regard, development of an inexpensive and sensitive protection against single-phase faults in cable networks 6-10 kV is relevant.

The purpose of the Study is to develop an inexpensive and sensitive protection against single-phase ground faults in cable networks with isolated neutral.

The results of the Work. There were improved methods of modeling single-phase fault currents to the body of the electrical machine and emerging overvoltage, was developed the design of cable magnetic core balance current transformer, proposed a method of modeling its parameters and protection against single-phase ground faults, as well as the method of selecting its operating parameters, was developed a construction of ring core balance current transformer with a responsive element in the form of reed switch, proposed protection in this transformer with an element of increasing the sensitivity in the form of permanent magnet and additional windings, which are powered with direct or alternating current.

The Object of the Study is in the area of relay protection, dedicated to research and development of new, cheap and sensitive earth fault protections in cable networks with isolated neutral. This will establish such protection to everything, including low-duty lines, even where the general alarm system has been installed, without significant additional investment.

Scientific novelty. There were developed methods for modeling of single-phase fault currents to the body of the electrical machine and the emerging overvoltage. There was proposed a method of modeling parameters of the cable magnetic core balance current transformer, and the response level of protection against single-phase ground faults on its base. Also was offered a method of modeling parameters of core balance current transformer with a ferromagnetic core, in the air gap of which a reed contact is placed, as well as the response level of protection for this transformer, whose core is magnetized with a permanent magnet and an additional winding, which is powered by direct and alternating current.

The practical value. The developed mathematical models of a single-phase fault in the electrical machine and overvoltage, simply and with sufficient accuracy allow to model the currents in the windings of electrical machines with single-phase ground faults and values of

overvoltage. The proposed method of modeling the electromotive force of the cable magnetic core balance current transformer provides an opportunity to develop a new cable protection on the magnetic core balance current transformer. There was designed the relaying protection of cable with a new magnetic core balance transformer. On the basis of the proposed new method of relaying protection of cable against the single-phase ground fault to the core balance current transformer with a reed contact there was designed a new construction of the protection device. Developed a highly sensitive cable protection from a single-phase ground fault to the core balance current transformer with a reed contact and a permanent magnet, DC magnetic bias, as well as alternating current.

Information on publications. The main provisions of the Dissertation are published in 11 scientific works, including publications recommended by the Committee for control and certification in the field of education and science of MES of the Republic of Kazakhstan - 4, in publications with impact factor included in the information database of Thomson Reuters or Scopus companies – 3, in materials of international scientific and practical conferences - 4 and 3 of the patent of the Republic of Kazakhstan.

The structure and volume of the Dissertation. The dissertation consists of an introduction, three chapters, conclusion and applications. The work is set out on 86 pages of printed text, includes 56 figures and 1 table. List of used sources includes 58 references.