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EFFICIENT CONTINUOUS HIGH-CURRENT TRANSDUCERS

Prof. A.M.Plakhtiev, Applicant G.A.Gaziev, Associate Professor Akbarova, Doctoral Student O.Ch.Donierov - «Tashkent Institute of Irrigation and Agricultural Mechanization Engineers» National Research University

Abstract

The paper presents the general principles of construction of continuous ferromagnetic transducers of large direct currents, the main requirements for them and the results of the development of one of the developed magnetomodulation continuous transducers of large direct currents with an extended controlled range and the issues of determining and studying its family of static characteristics.

Keywords: *continuous transducer, direct current, magnetic core, magnetomodulation transducer, static characteristic.*

Introduction. In practice, in land reclamation, irrigation, at many agricultural enterprises and farms in the water supply zone of agriculture, there is an urgent need to control large direct currents (BPT) with a size of tens to several thousand amperes and more with an error of 1-3%. The control of the TTO is usually carried out using shunts [1,2].

However, the presence of large power losses on the shunts, their high cost, undesirability or impossibility of breaking the circuit under the conditions of the technological process, as well as safety requirements, have led to the use of continuous converters and meters of large direct currents in circuits without breaking them, i.e. without destroying the integrity of the conductive bus [3]. However, the known continuous transducers have large dimensions and errors due to the influence of external factors, a narrow range of converted currents, and low sensitivity [4-19]. We have developed a number of energy-saving magnetomodulation continuous ferromagnetic converters of large direct currents, which are basically free from the above disadvantages [20].

Materials and analysis. Fig.1 shows the non-breaking magnetomodulation ferromagnetic transducer of large direct currents (BMPT) proposed by us. It is made on the basis of BMPT [21]. It contains a closed magnetic core consisting of ferromagnetic elements 1 and 2 with longitudinal and transverse gaps between them. Ferromagnetic elements 1 form a fixed ring. Each ferromagnetic element has two through holes through which the modulating windings 3 are wound. On each ferromagnetic element, a measuring winding 4 is wound between the through holes. All measuring windings are connected to each other in series and closed to the measuring device (not shown in Fig. 1), and the modulating windings are also connected in series and connected to a stable AC supply. Displacement of the moving ring by a fixed distance leads to a change in the longitudinal gaps between the ferromagnetic elements of the moving and fixed rings. This leads to a change in the total magnetic resistance in the path of the working magnetic flux and to a change in the sensitivity of the BMPT as a whole, which makes the device multi-limit.

The series connection of the modulating windings 3 in the presence of alternating current in them and the arrangement of the measuring windings 4 in the intervals between the through holes in ferromagnetic elements 1 and 2 made it possible to carry out longitudinal modulation of the magnetic resistance of a detachable closed magnetic core on the path of the working magnetic flux Fcreated by the controlled direct current, and to induce in the measuring windings 4 EMF, which depends on the converted direct current. The developed BMPT in the absence of alternating current in the modulating winding 3 can also control alternating current. When inspecting the BPT with a split magnetic core, the BMPT covers the bus 5. Due to the modulation amperates, the magnetic core is in a saturated state during each half-cycle of the supply voltage. At the same time, the permeability of

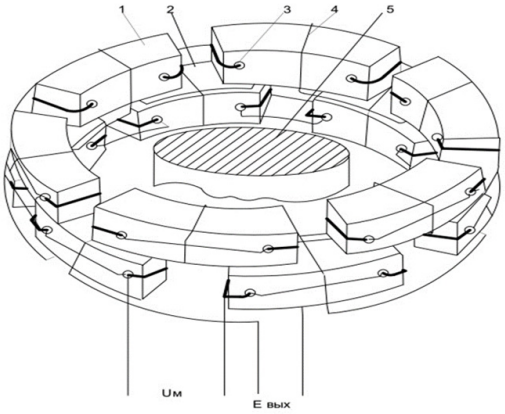


Figure 1. Continuous magnetomodulation ferromagnetic converter of large direct currents.

At the moment when the modulation current passes through the zero value, the permeability of the magnetic core increases to the initial value. Thus, with the stability of the modulation amperates in the measuring winding, an EMF will be induced, which depends on the controlled current Ito the expression

$$e = w_к \omega S \sigma_1 в2\ H_{нm} \left[\frac{1}{ch^2(H_к - H_{нm}\sin\omega t)} - \frac{1}{ch^2(H_к + H_{|нm}\sin\omega t)}\right]\cos\omega t. \qquad (1)$$

Here, Нк is the quantity associated with the controlled current by the expression

$$H_к = \sigma_2 \frac{I_к}{\pi I_{ср}} \frac{(\sigma_в + 1)\left[\beta\sigma_в(1+\sigma_{вж})(1-ch\beta) - 4sh\beta\right]}{\beta K_\delta(1+\sigma_в+2\sigma_в\sigma_{вж})(1-ch\beta) - 2\left[\sigma_в(1+\sigma_{вж})-2\right]sh\beta};$$

Hпо - modulation value equal to $H_{ïî} = â_2 \frac{I_{ïm}\ w_ï}{à_ñð}$

where σ_1 and σ_2 are the approximation coefficients of the magnetization curve; I_{nm} is the electric current in the modulation circuit; a_{cp} is the average length of the excitation field strength line of the BMPT element; wп is the number of turns of the modulating winding of the BMPT.

Discussion. The resulting expression (1) is a periodic non-sinusoidal function, so moving on to the average value of the output EMF, let's write the expression for the output EMF in relative units as follows

$$E^{\partial} = \left[th\left(H_{ко} - H_{по}\right) + th\left(H_{ко} + H_{по}\right) - 2thH_{ко}\right] \quad (2)$$

Here $H_{ко} = в_2 H_к$ and $H_{по} = в_2 H_{пт}$ - are respectively dimensionless controlled quantity and modulation magnitude, where $в_1$ and $в_2$ approximation coefficients.

According to the expressionyu (2), a family of static characteristics of the BMPT at different modulation currents was obtained. It is shown in Fig. 2.

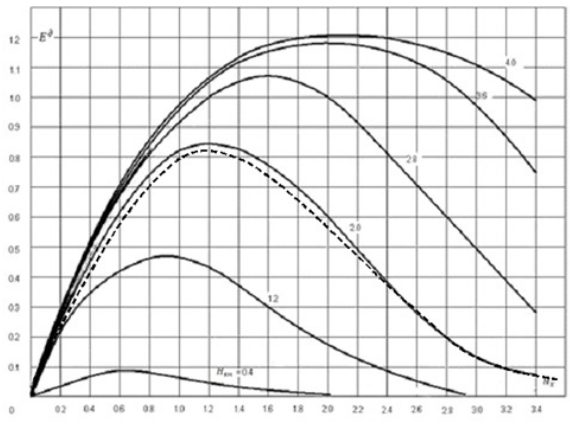


Figure. 2. BMPT Static Characteristics Family

From the analysis of the family of static characteristics of the BMPT, it follows that each value of the modulation value $H_{по}$ corresponds to a certain maximum value of the controlled value $H_{ко}$. Moreover, there is a displacement of the maxima $H_{по}$ their increasing value with an increase in $H_{по}$ inthe direction of increasing the controlled value of $H_{ко}$. The degree of discrepancy between the experimentally obtained results (dotted line) and the theoretically obtained results does not exceed 6%.

The possibility of uninterrupted conversion of direct and alternating currents in a wide controlled range, relatively high accuracy and sensitivity, the possibility of a fixed change in sensitivity, small weight and dimensions - all these are the advantages of the developed BMPT design..

Conclusion. Effective magnetomodulation continuous converters of large direct currents with an extended controlled range have been developed for various monitoring and control systems, which make it possible to control large both direct and alternating currents without breaking electrical circuits in a variety of existing monitoring and control systems in land reclamation, irrigation, at many agricultural enterprises and farms in the water supply zone of agriculture, at many enterprises, in the chemical industry, railway transport, metallurgy, renewable energy sources, industry with an error of 1.5%. They are distinguished by a wide range of converted direct currents, small dimensions and weight, increased accuracy and sensitivity, simple and manufacturable design with low material consumption and cost.

A family of static characteristics of a magnetomodulation break-free transducer at different modulation currents has been obtained and investigated.It is shown that there is a displacement of the maxima Нпо their increase in value with an increase in Нпо the direction of an increase in the controlled value of Нко. The degree of discrepancy between the experimentally obtained results and the theoretically obtained results does not exceed 6%.

Technical characteristics of the BMPT: range of converted direct and alternating currents – 0 – 10000 A; sensitivity – 0.2 mV/A; The reduced error is 1.5%; diameter of the inner window of the split magnetic core – 200 mm; weight – 0.8 kg.

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