THE MODERN PRINCIPLE OF DESIGN OF ELECTROMAGNETIC TRANSDUCERS OF THE PRIMARY CURRENT TO SECONDARY VOLTAGE

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Abstract
In the given article described principle of design of electromagnetic transducers of values and phases of primary current of power net to secondary voltage on the bases of new construction of magnetic transformers circuits. Classical electromagnetic current transducers – transformers (EMCT), which using in electrical nets of power supply systems, constructed on the bases a closely magnetic conversion systems - circuits, have a low accuracy during conversion, operational limitation, when the are installed in one, three and multi - phases electric nets. In the given materials analyzed of the constructions of magnetic part of electromagnetic transducers of primary current to secondary voltage which used in electrical nets of power supply systems, methods of improving their principles of design and developing of characteristics.

Keywords: power supply, one, three and multi - phases electrical nets, the secondary voltage, electromagnetic conversion, measure windings, conductor.

Introduction

The monitoring and control of processes of production, transmission, distribution and consumption of electric energy is very importance's performance means of transformation of current which leads to significant economic losses. Developing an integrated approach, providing high accuracy and efficiency of the combined control sources of electricity, increase operational capabilities, simplifying the design, reducing weight and size indicators, improving manufacturing techniques, ensuring endless measuring processes, a current conversion through the use of modern transducers are ongoing challenges electricity consumption management [1,2].

Main Part

The objective of this work is developed with enhanced reliability and improved operational capabilities of electromagnet current transducers (EMCT). The problem is solved that in EMCT to voltage (EMCVT) the magnetic circuit is performed with one, three and multi - phases recesses located along the axis, which two outer recesses in one direction of the axis, and the medium - on the other side of axis. The air gap, which there are located U - bracket of magnetic material, which are located inside the insulating plate with measure windings [3]. Limitations uses of EMCVT are: low accuracy during transformation of primary quantities to the secondary on the bases of saturation effect a closed magnetic system, complexity of their installation in different areas of electric nets and no nominated weight and size of construction devices and elements, impossibility of simultaneous control of magnitude and the currents of electrical nets.The aim of this research is improve of metrological characteristics of construction and parameters of transducers of primary one, three and multi - phases currents of electrical nets and expand the functionality of the design, when conversion of electric quantities to magnetic field.

In Fig.1a, b shown constrictions of developing EMCVT with improved metrological and operational characteristics [4]. In fig. 1 shown EMCTV which contain a magnetic core 1, with one, three and multi - phases grooves along the axis, from them two outer recesses in one direction of the axis, and the medium on the other side of the axis, here air gap located the primary winding, the conductors A, B and C - phase of electrical net and U - brackets 2, 3 and 4 of magnetic material, which are measure windings 5, 6 and 7 on the insulating plates 8, 9 and 10. EMCVT, shown in fig.1 works as follows: when the current flows in A, B and C in primary windings of electrical net, in the magnetic core 1 appear a magnetic fluxes F_1, F_2 and F_3, which in the gap between the ends of the cross turns flat measure windings 2, 3 and 4 where in:

$$F_1 = (I_A \cdot W_A) / R_{\mu 1}, \tag{1}$$

$$F_2 = (I_B \cdot W_B) / R_{\mu 2}, \tag{2}$$

$$F_3 = (I_C \cdot W_C) / R_{\mu 3}, \tag{3}$$

where: I_A, I_B and I_C - the primary currents flowing through the primary winding of the conductors A, B and C -phase of electrical net; W_A, W_B, W_C – number of turns of the primary winding of the conductors A, B and C - phase electrical net (here $W_A = W_B = W_C = 1$ - i.e., each primary winding is made in the form of one loop and located in the recess of the magnetic cores); $R\mu_1 = R\mu_2 = R\mu_3$ – accordingly, the total magnetic resistance of sectors of the magnetic core and air gap of paths of magnetic fluxes F_1, F_2 and F_3. In the developed of processes of design of EMCTV, in magnetic resistance separated portions of circuit transformation $R\mu$ depends on the geometric dimensions of the magnetic core, a U – shaped bracket, air gap and allow us to determine the range of the converted value of the primary currents I_A, I_B and I_C .

$$R_\mu = \rho l / S \tag{4}$$

where: ρ – specific resistance of the magnetic sections of the magnetic core, l – the value of air gap magnetic circuit, i.e. the length of the air (non-magnetic) areas in the path of the magnetic flux F, S - cross section areas in the path of the magnetic flux.

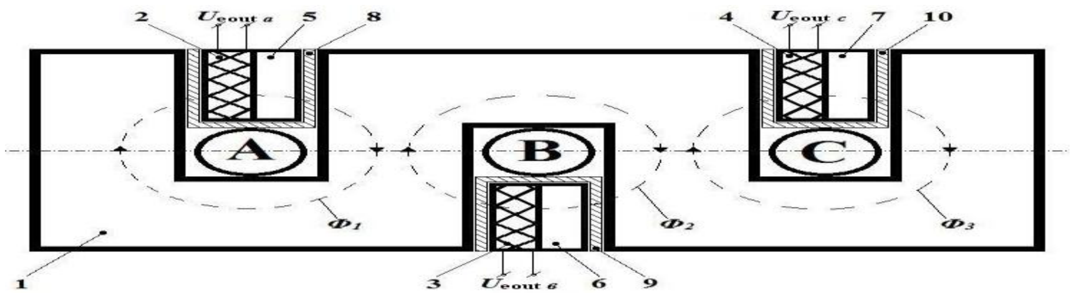

Fig.1. The constructions of EMCVT

The voltage at the output of each measuring coil $Ueout_1$, $Ueout_2$ and $Ueout_3$ determined according to interference of the magnetic fluxes F_1, F_2 and F_3 in magnetic core (Fig.1) and δ:

$$U_{eouta} = 4{,}44 f \cdot W_1 F_1, \quad (5)$$

$$U_{eoutв} = 4{,}44 f \cdot W_2 F_2, \quad (6)$$

$$U_{eoutc} = 4{,}44 f \cdot W_3 F_3, \quad (7)$$

where: $W_1 = W_2 = W_3$ is the number of turns of a flat measure windings (measure winding is carried out with the same number as W), f – frequency of the supply mains.

The magnetic fluxes F_1, F_2 and F_3 created by the primary currents I_A, I_B and I_C of one, three and multi - phase conductors of an electric network and having the ability to change their values depending on the magnitude of air gap δ allow signal of currents in output voltage.

In Fig.1,b shoved a perspective view of the structure EMCVT power systems. Power system devices includes a magnetic circuit 1, triangular, in shape with a U –notches at the tops, inside which the clamps 2, 3 and 4 of magnetic material, and the recess is designed similarly and rotated between a 120^0, and within each recess is a source of magnetic flux, the primary winding is A, b and C of the primary conductor one, three and multi – phases electrical net and measuring coil 5, 6 and 7 on insulating plates 8, 9 and 10 [5]. When current flows in A, B and C - in the primary windings of the one, three and multi - phases conductors of the electrical network, in the magnetic core 1 of the electromagnetic transducer one, three and multi - phases current appears uniform symmetrical magnetic fluxes F_1, F_2 and F_3, which are between the ends of the crossed coils, the measuring coils 5, 6 and 7, where:

$$F_1 = (I_A \cdot W_A) / R_{\mu 1}, \quad (8)$$

$$F_2 = (I_B \cdot W_B) / R_{\mu 2}, \quad (9)$$

$$F_3 = (I_C \cdot W_C) / R_{\mu 3}, \quad (10)$$

where: I_A, I_B, I_C - the primary currents, A, B and C – phase of electrical nets; W_A, W_B, W_C – number of turns of primary winding; $R_{\mu 1} = R_{\mu 2} = R_{\mu 3}$– the total magnetic resistance of sectors of the magnetic core and the air gap in the path of the magnetic fluxes Φ_1, Φ_2 and Φ_3. In power system with magnetic resistance portions of circuit transformation R_μ depends on the geometry of the magnetic circuit, notches, shaped bracket, the air gap and allow us to determine the range of the converted value of the primary currents I_A, I_B, I_C .

$$R_\mu = \rho l / S \quad (11)$$

where: ρ – specific resistance of the magnetic sections of the magnetic core, δ – the value of air gap of magnetic circuit. S - cross section of areas in the path of magnetic flux.

The voltage at the output from each of the measure coil U_{eout1}, U_{eout2} and U_{eout3} EMCVT of power system of telecommunications devices are based on interference of the magnetic fluxes F_1, F_2 and F_3 in the magnetic core (Fig.1) and the magnitude of air gap δ:

$$U_{эвыха} = 4{,}44 f \cdot W_1 F_1, \quad (12)$$

$$U_{эвыхв} = 4{,}44 f \cdot W_2 F_2, \quad (13)$$

$$U_{эвыхс} = 4{,}44 f \cdot W_3 F_3, \quad (14)$$

where: $W_1 = W_2 = W_3$ is the number of turns of the measuring coils, f – frequency.

The symmetrical magnetic fluxes F_1, F_2 and F_3, created by the primary currents I_A, I_B and I_C of the one, three and multi - phases conductors of the electrical net in dependence on the geometrical sizes of staples of magnetic material, number of turns of the measuring coils and air gaps δ, allow to obtain a signal with high accuracy on the multi - phase currents of electrical net of power supply system in the form of output voltage.

Conclusion

Due to implementation of the magnetic core with cut-outs located along the axis, of which the two outer recesses in one direction of the axis, and the medium on the other side of the axis, the air gap, in which there are P - brackets of magnetic material, which are located inside the insulating plate with flat measuring windings, allows to efficiently convert the signal and a magnitude and phase of the multi-phase currents of the electrical network, changing the limit of large range according to the electrical load allows to effectively capture the measurement coil and to convert the signal as magnitude and phase, varying in the limit of large range according to the electrical load and the cross section of the conductor.

There is possibility of accurately transform primary currents in a large range of variation due to the use of U - shaped brackets for fixed installation of measuring coils, improving the shape of the magnetic conversion circuit, a spatial symmetric with the air gaps, allowing the creation of the magnetic system of magnetic symmetrical flow and simplify the design EMCVT.

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