Electromagnetic circuit model of the eddy current defectoscope

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Abstract **The model of the device for nondestructive control using eddy currents' method in a electromagnetic circuit described by a system of differential finite equations.**

Keywords **eddy current, nondestructive control, magnetic flux, excitation coil, sensing coil.**

I. INTRODUCTION

The eddy current defectoscope is a nondestructive control device consisting of one or more inductive coils which are designed for excitation the eddy currents in the control object. It converts the electromagnetic field, which depends on the parameters of the object, into the information signal of defectoscope. Known models of devices for nondestructive control using eddy currents' method are based on Maxwell's equations for monoharmonic processes in terms of the magnetic vector potential. These models are complicated for engineering calculations of these devices.

II. Digest

This paper deals with magnetic circular model of the eddy current defectoscope with ferromagnetic core Figure 1. The domains with defectoscope, the object of control and the environment around is divided into elementary volumes in the form of various-sized cylinders Figure 2. These cylinders represent reluctance R_{mv}, R_{mh} of domain with its vertical and horizontal components of the magnetic flux.

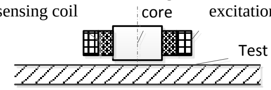

Fig. 1. The eddy current nondestructive testing

The studied objects can be made of ferromagnetic and non ferromagnetic conductive materials, i.e. the electromagnetic circuit is nonlinear Figure 3. Defects in these objects are approximated by the resistance change of the respective domain of broken area.

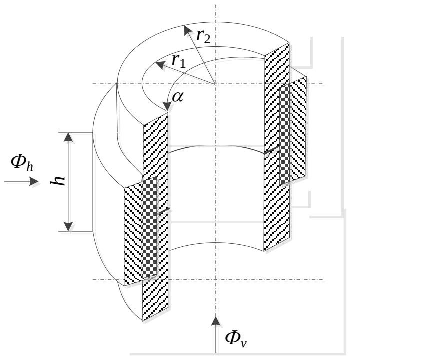

Fig. 2. The elementary volume and its parameters

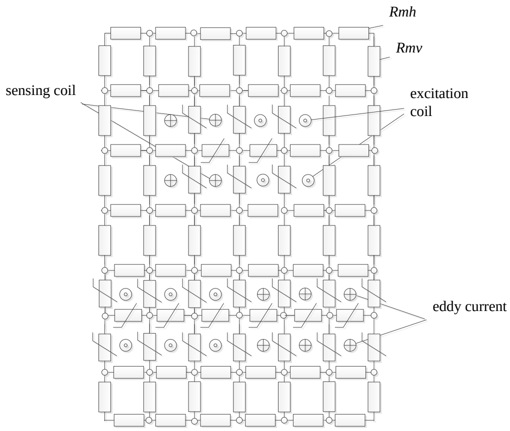

Fig. 3. Magnetic circuit diagram

The mathematical model of defectoscope is formed in the co-ordinates of loop magnetic fluxes and currents of branches as a system of differential finite equations:

$$\mathbf{\Gamma}_m \vec{U}_m(\Phi) - \mathbf{W}_t \vec{i} = 0; \qquad (1)$$

$$\mathbf{W} d\vec{\Phi}_\kappa / dt + \mathbf{R}\vec{i} - \vec{u} = 0; \qquad (2)$$

where: $\mathbf{\Gamma}_m$ – $(q \times s) \times p_m$-dimensional second incidence matrix of the magnetic circuit (here $q \times s$ - scheme size grid of the magnetic circuit; p_m - graph number edge of the magnetic circuit); $\bar{U}_m(\Phi) - p_m$-dimensional column vector the magnetic tensions of branches; $\bar{\Phi}_\kappa$ – column vector of loop magnetic fluxes; $\mathbf{W}$ – $n \times (q \times s)$ dimensional matrix turns the elementary loops of a magnetic circuit; $\vec{i} = (i_1, i_2, .. i_n)_t$ – column vector solenoid current and eddy currents; $\vec{u} = (u_1, 0, ... 0)_t$ – column vector the tensions of solenoid and equivalent winding; $\mathbf{R} = \mathrm{diag}(R_1, R_2, \ldots R_n)$ – resistance diagonal matrix.

III. CONCLUSION

The proposed model allows to optimize defectoscope's parameters (construction, form tension of the excitation coil) for defects sensitivity enhancement.

IV. REFERENCES

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