EXPERIMENTAL SETUP FOR STUDYING THE CHARACTERISTICS OF A MEASURING TRANSDUCER WITH A SPATIALLY PERIODIC FIELD STRUCTURE

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In flaw detection and structural analysis, electromagnetic transducers (sensors) are widely used, operating on the phenomenon of eddy currents induced in metal products. In the theory of electromagnetic NDT methods, it is regular to distinguish the direct and inverse problems. The direct one lies in defining the field structure from a source with known parameters when a metal object with known characteristics is placed in its action radius. The inverse one is to determine the parameters of a metal object by studying the field response to the appearance of this object. To solve the inverse problem, it is proposed to use transducers (sensors) that implement multiparameter monitoring. Such transducers allow noncontact flaws detection in the samples under test (SUT). In addition, with their help, it is possible, by evaluating the electromagnetic parameters of the sample (magnetic permeability and conductivity [1]), to assess the SUT structural state [2]. Paper [3] contain developed by the authors mathematical apparatus, that allows obtaining equations for calculating the electrophysical parameters of the SUT by measuring the amplitudes and phases of spatial harmonics. In [4] authors got equations for calculating the parameters of these harmonics for a specific spatial model of mutual arrangement of SUT, excitating and measuring windings. For the validity of the formulas obtained, it is crucial to have a high accuracy of the positioning of all elements in accordance with the spatial model.

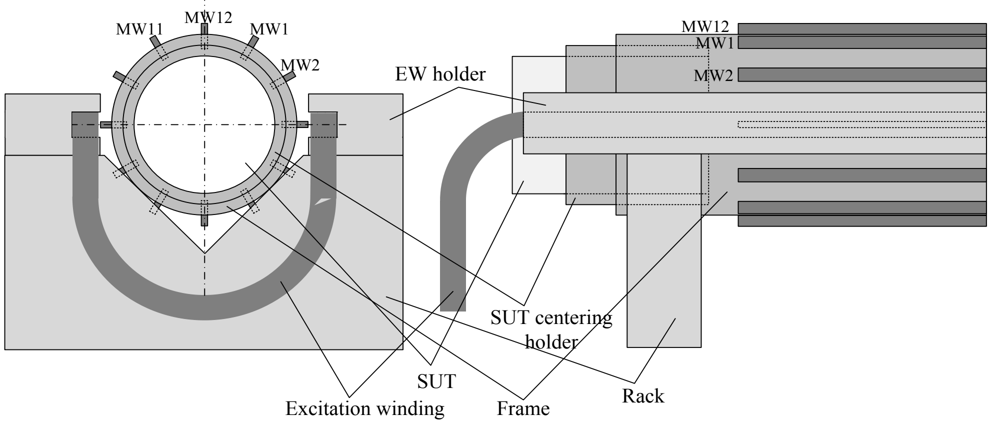

Figure 1 – Design of the experimental setup

The previous design of the [4] setup had a number of cons. The measuring windings (MW) were made by winding a thin wire and had significant geometric dimensions, moreover, the profiles of the windings were not strictly identical, which negatively affected the repeatability of the measurement results and the compliance of these results with theoretical calculations. The other drawback was low accuracy of specifying the angular coordinates of measuring windings placement, the relative positioning of the measuring windings and the excitating windings (EW) could not be changed. In addition, the magnetizing winding was made of a fairly thin wire on a very weak frame and had about 90 turns. The inductance of the winding was about 9 mH, the active resistance was about 12 ohms. As a result, the maximum magnetizing current was limited to about 800 mA, due to the heating of the winding and the limitation of the amplifier by the supply voltage.

When designing a new version of the setup we decided to divide it into a movable and a stationary part. The stationary part (see Fig.1) consists of a frame with a excitating winding mounted on it. The excitation winding is made of a copper wire of the ПЭВ-type with a diameter of 1 mm and has 36 turns. The resulting winding has a resistance of 1.38 ohms and an inductance of 856 μH. Besides that, the rigid structure of the frame makes it possible to accurately set the geometrical position of the excitation winding in the geometric model of the mutual placement of the SUT, measuring and magnetizing windings, which is quite important when comparing the results of mathematical modeling and experimental data. The movable part consists of a tubular frame with longitudinal slots in which the measuring windings are installed. To improve the accuracy of specifying the angular coordinate, the specified longitudinal slots were made on a milling machine with a dividing head. The measuring windings themselves, to minimize their dimensions, were made by manufacturing 4-layer FR4 PCB. This method of their manufacturing also made it possible to set the spatial arrangement and geometric parameters of these windings with sufficient accuracy. In the course of further work, the authors are going to experimentally evaluate the manufacturing quality of the setup by comparing the measurement results obtained using it with the results of theoretical calculations. In the future, it is planned to test the methods of structural analysis and flaw detection using this setup.

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