Nonlinearity of ferrite core probes and initial phases characteristics of signals harmonics

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The design of most typical eddy current probes involves the presence of a ferrite core. One of the important problems with the use of such probes is the nonlinearity of the ferrite characteristics due to the hysteresis of the magnetic materials, which leads to formation of harmonic components and, accordingly, to nonlinear distortions in the coils of the probes. Unlike the generally accepted in non-destructive testing concept of combating such non-linearity, we present a new approach based solely on its use, excluding a linear component. For this purpose, we have created a system called Structuroscope EG, which in addition to measuring the amplitudes of the response signals harmonic components determines the value of their initial phases. This paper presents the results of the experimental studies of signals harmonic component phase characteristics obtained on the probes measuring coils with ferrite cores depending on parameters of the excitation signal, characteristics of the ferrite core, and material of the tested object. First, there are shown the regularities of changing in the response signals harmonic components phase characteristics under excitation of a probe core of a various geometry without a sample with a sinusoidal and a pulsed signal with a stepwise increase in their amplitude fed to excitation coils with different inductivity. Also there is demonstrated the influence of parameters of the measuring coil on the results of experiments. After that there are presented experiments with the probes and the tested samples made of paramagnetic and ferromagnetic materials, that is materials of a positive magnetic susceptibility. It is established that changes in response signals harmonic components initial phases values have certain features depending on the position of a measuring coil on the probe, geometric parameters of the samples, inhomogeneity of the samples structure caused by plastic deformation and pulsating loading of different levels, defects, thermal processing types, the composition of a suspension solution and the method of its preparation. The results of the researches demonstrate that the phase characteristics of the harmonic components of the response signals formed by the nonlinearity of ferrite cores of eddy current probes have a high sensitivity to the structural factors of the objects under control and for their determination the theory of magnetic chains can be applied.