4. Formation of coatings of different thicknesses allows to change their properties in a wide range.

5. The established regularities of phase composition formation make it possible to obtain coatings with specified characteristics.

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ELECTROMAGNETIC-ACOUSTIC CONVERTER WITH COMBINED MAGNETIZATION

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Abstract. This paper presents an innovative approach to improving the performance of electromagnetic-acoustic transducers (EMATs) for nondestructive testing (NDT) of ferromagnetic metal products. A novel design utilizing both a permanent magnet with reduced field intensity and an additional pulsed magnetization mechanism is proposed. This configuration significantly enhances inspection sensitivity, reduces the attraction force between the converter and the test object, and enables higher probing frequencies without overheating issues. Experimental results demonstrate the effectiveness of the proposed system, offering up to a 40% increase in signal amplitude.

Keywords: electromagnetic-acoustic converter, ferromagnetic product, nondestructive testing, ultrasonic pulses, combined magnetization, signal sensitivity, pulse timing.

Introduction. In the modern era of industrial production and safety control, the demand for non-contact, high-precision diagnostics of metal components continues to grow. Ferromagnetic materials, widely used in pipelines, mechanical parts, and structural elements, require reliable methods of inspection that do not damage the surface and provide clear results under various operating conditions. Traditional ultrasonic methods often require thorough surface cleaning, use of couplants, and are limited in terms of speed and automation potential. The use of electromagnetic-acoustic (EMA) methods offers a promising alternative, especially in portable applications and complex environments. Enhancing the sensitivity and usability of EMA systems is therefore of paramount importance.

The *subject* of this research is the process of electromagnetic-acoustic excitation and detection of ultrasonic waves in ferromagnetic materials, using a specially designed converter that combines different types of magnetization. The study focuses on how varying the characteristics of the magnetic field impacts signal generation and reception, and ultimately the quality and reliability of flaw detection in metals.

The *object* of the research is a ferromagnetic metal product, particularly in the form of steel components used in industrial applications. The research explores how such materials interact with combined magnetic fields during EMA-based ultrasonic testing and how the efficiency of signal propagation and echo response can be improved.

The *main goal* of this research is to develop and experimentally validate an electromagnetic-acoustic transducer (EMAT) system that utilizes both permanent and pulsed magnetization for increased sensitivity and practical applicability in nondestructive testing. The tasks include: designing a combined magnetization unit, creating a functional experimental prototype, conducting comparative measurements under different magnetic field configurations, analyzing signal quality and amplitude, and formulating recommendations for improving portable NDT tools using this hybrid approach.

The *novelty* of this research lies in the proposed integration of a low-induction permanent magnet with a synchronized pulsed magnetic field source, forming a compact and efficient EMAT design. This approach not only increases signal sensitivity by up to 40%, but also reduces magnetic attraction between the device and the metal surface, which is a common operational issue in portable testing. Furthermore, the system enables high-frequency probing without significant thermal buildup, addressing a critical limitation of conventional pulsed-magnet systems.

Presentation of the main research material

A prototype of a hybrid EMAT was developed, incorporating a small permanent magnet made from NeFeB material and a low-inductance pulsed coil. The system is controlled by a synchronized electronic block that ensures precise pulse timing. Experimental testing was conducted using a steel sample (grade St.45) with a thickness of 39 mm. The setup allowed for a delay of more than 50 μs between the magnetizing pulse and the high-frequency current impulse, optimizing the interaction of magnetic and eddy currents in the sample. This combination produced a significantly stronger ultrasonic signal, with echo amplitudes increasing by up to 40%. Additionally, the reduced magnetic attraction facilitated smoother movement of the EMAT across the test surface, improving usability in manual scanning applications.

*Conclusion*s. The study confirms that combining permanent and pulsed magnetic fields in EMATs enhances ultrasonic signal generation, thus improving the sensitivity and effectiveness of nondestructive testing in ferromagnetic materials. This configuration allows for higher-frequency probing without the risk of coil overheating and minimizes magnetic adhesion. The approach contributes to more efficient inspection processes and better adaptability for portable NDT systems.

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CALCULATION OF THE PROTECTIVE PROPERTIES AGAINST IONIZING RADIATION OF REFRACTORY CEMENTS BASED ON ALKALINE COMPOUNDS

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