V. E. Shcherbinin. *Magnetic, magnetoelastic, and magnetoacoustic nondestructive quality-control methods.* In our day, we have seen nondestructive quality control, which was originally a sorting procedure, grow into a tool for active intervention in the production process. In the broad sense of the phrase, nondestructive quality control methods may be understood as means of evaluating the functional serviceability of products, with the result determined by the set of physical, chemical, and structural properties that assure performance of the product under a given set of conditions; this evaluation should be used at all stages in production and should influence the production process.

In nondestructive testing, the object of control is subjected to a physical field, and the condition of the object is judged from its response. Quality-control methods in which constant magnetic fields are used are called magnetic methods. They can be used in solving three classes of technical problems: determination of the mechanical properties of ferromagnetic products, measurement of geometric parameters, and detection of breaks in continuity.

Mechanical-property testing is based on the correlation between the mechanical properties required of the product and its magnetic characteristics. Quite often, it is sufficient to use only one magnetic characteristic, for example, coercive force, to establish product quality. For example, the coercimeter designed by M. N. Mikheev is widely used in quality control of the heat treatment of steels.[1] In other cases, e.g., quality control of certain alloy steels, two characteristics are used or the entire hysteresis loop is studied.

In a magnetoelastic method that we have proposed for the same applications, the product is magnetized and then loaded in its elastic range, and mechanical properties such as hardness are judged from the change ΔB. This makes it possible to set up quality-control procedures for products made from such steels as 40Kh and other high-carbon alloy steels after medium- and high-temperature tempering. Automatic flaw detectors that embody this principle are now being used successfully in industry.[2]

Elastic vibrations in the acoustic-resonance range can be set up in a product by applying alternating loads. In the range of magnetizing fields where the basic processes are those of rotation of the spontaneous-magnetization vectors, the emf from the magnetoelastic effect has the same hardness dependence for all steels with no exceptions.

Use of electromagnetoacoustic (EMA) conversions opens up interesting possibilities. The coefficient of EMA conversion is not sufficient to permit use of EMA instead of the usual contact transducers (for example, piezoelements) to set up elastic vibrations in the products. However, a resonant condition can be used for many articles. For example, we have achieved quality-control of products in the form of disks, which were placed in a polarizing field with automatic recording of the deviations from the resonant frequency. It is possible to check over 1000 pieces per minute and, no less importantly, to reject any defective pieces, no matter where the defects occur (on the surface of the metal or in its interior). Another promising trend in EMA conversion is prediction of stressed states in ferromagnetics, since the EMA signal depends quite strongly on magnetostriction under certain conditions.[3]

[1] M. N. Mikheev and G. V. Bida, in: Élektromagnitnye metody izmereniĭ i nerazrushayushchego kontrolya (Electromagnetic Measurement and Nondestructive Quality Control Techniques). USSR Academy of Sciences Ural Scientific Center, Sverdlovsk, 1982, p. 27.

[2] L. S. Pravdin, G. I. Deordiev, and A. S. Zel'skiĭ, *ibid.* pp. 88–94.

[3] V. A. Komarov, R. S. Il'yasov, N. I. Shakshin *et al.*, *ibid.* pp. 103–107.