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MAGNETODYNAMIC TREATMENT OF INTERNAL CYLINDRICAL SURFACES OF PARTS MADE OF ALUMINUM MATERIALS

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The treatment of internal cylindrical surfaces of aluminum parts is difficult to perform due to material's low hardness and susceptibility to deformation. Traditional methods, including mechanical boring and electrochemical machining, are characterized by limited efficiency and high energy consumption, necessitating the development of innovative methods to enhance quality and reduce production costs.

The method is based on the use of magnetic fields generated by a magnetic system with permanent magnets, which act on ferromagnetic steel balls located in the tool's annular chamber.

Under the influence of centrifugal and magnetic forces, the deforming balls acquire kinetic energy and deliver directed impacts to the internal cylindrical surface of the workpiece. Local microdeformations caused by these impacts lead to plastic deformation of the surface layer, reducing roughness and increasing microhardness. The non-contact control of the balls prevents rapid tool wear and ensures high processing accuracy.

A key advantage of the method is the ability to adjust impact frequency parameters to optimize deformation distribution, minimize residual stresses, and achieve desired roughness characteristics.

Despite adjustable depth and frequency of magnetic field impact on the deforming balls via tool design, the method is limited to treatment of exclusively cylindrical internal surfaces, reducing its universality. Variability in the mechanical properties of aluminum alloys, which occurs due to differences in composition and alloying additives, requires an individualized approach to parameter selection to achieve stable surface hardening and roughness characteristics. Although material conductivity does not affect energy transfer to the balls, surface structure inhomogeneities may lead to uneven deformation. An additional challenge is ensuring stable ball movement under complex geometric conditions (surface waviness, high roughness), necessitating precise calibration of the magnetic system.

Implementing magnetodynamic rolling for internal cylindrical surfaces of aluminum parts will reduce treatment time by eliminating mechanical machining stages and improving surface quality. Energy consumption decreases due to magnetic fields minimizing energy losses compared to traditional methods requiring continuous mechanical or thermal action. Further experimental studies are required to optimize treatment parameters, evaluate the impact of treatment on material microstructure, and validate theoretically predicted hardening characteristics.