IMPROVING THE OPERATIONAL RELIABILITY AND DURABILITY OF ROTATIONAL PARTS BY ULTRASONIC TREATMENT.

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Among the most important tasks of modern mechanical engineering and other branches of the metalworking industry, solved in Russia and abroad, due to the high requirements for the properties of materials due to the increasing intensity of loading machines with a simultaneous tendency to reduce their weight, is to increase the operational reliability and durability of industrial products, increasing the efficiency of machinery and equipment.

The problem of durability can be solved not only by increasing the alloying elements in the material of the parts, but also by technological methods that provide a directed change in the physical, mechanical and other properties of the surface layer of the parts at the lowest material and energy costs.

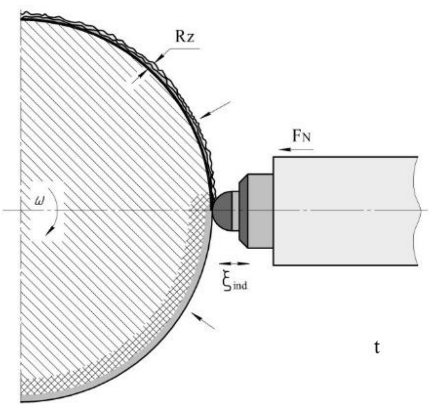
It is known that the destruction of parts during operation most often begins from the surface. The surface layers located at the phase boundary are actively affected by the external environment, being the most stressed. In this regard, there is a need to improve the physical and mechanical characteristics and geometry of the working surfaces of parts. The state of the working surface of a part affects its operational properties such as wear resistance, fatigue strength, corrosion resistance, etc. The lack of stability in the quality of engineering products adversely affects the solution of socio-economic and research problems. Technical problems, and hence the issues of developing fundamentally new technologies, intensifying work in the field of quality engineering, ensuring the release of products of the highest quality in a given production and the lowest labor costs.

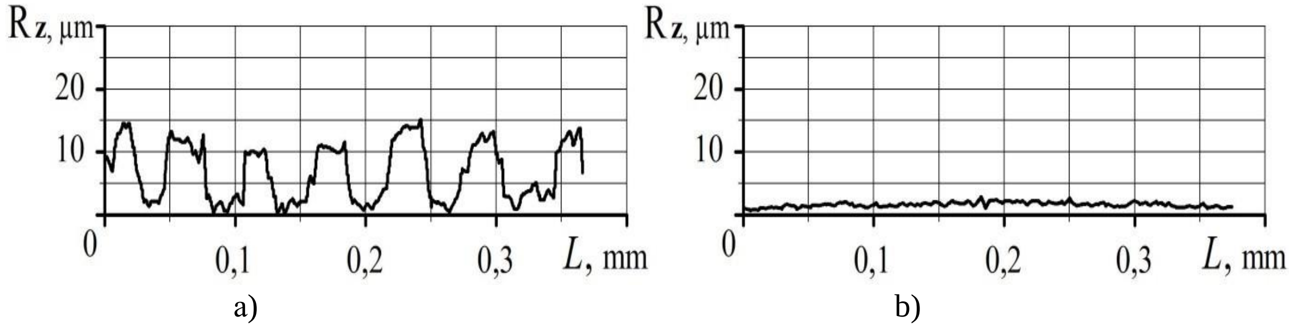
One of the most effective and economical types of hardening is surface plastic deformation (SPD), which makes it possible to more fully realize the potential properties of structural materials in real parts, especially in complex-shaped parts with stress concentrators.

The main disadvantage of this device is the limitation of the possibility, as it allows you to process cylindrical surfaces on lathes. For parts with different shapes, it is required to develop new ultrasonic schemes and bring them up.

Therefore, we believe that the development of a universal scheme for ultrasonic processing of typical parts on metal-cutting machines.

Rice. 1. Scheme of ultrasonic finishing: $\xi_{инд}$ – indenter oscillation amplitude; FN – static force; ω – angular velocity.





Rice. Fig. 2. Surface profilogram: a – after pretreatment; b – after ultrasonic treatment

Ultimately, ultrasonic technologies are becoming more widespread in mechanical engineering, the main features of which, which determine their technological prospects, are:

• high concentration of vibrational energy introduced into the contact zone of parts, which provides local effects at much lower energy consumption;

• low inertia of the process, which is the result of direct conversion of electrical energy into the energy of ultrasonic technological impact;

• the possibility of using oscillations excited in the process of ultrasonic oscillations, both for technological and diagnostic purposes.

The processes of repeated deformation and destruction of materials of the surface layers can be caused by various mechanisms operating at the microlevel, where the activation of one or another mechanism is determined by a combination of the magnitudes of external factors affecting the material. The most significant impact on the strength of materials during ultrasonic assembly is provided by stresses, frequency and amplitude of ultrasonic vibrations, temperature, and chemical activity of working media.

The introduction of ultrasonic vibrations of high intensity into the metal in the solid state causes an increase in the density of structural imperfections (dislocations, vacancies), which leads to a change in the physical and mechanical properties of the treated metal and affects the process of plastic deformation. At the boundary of the solid phase and the solid phase, ultrasonic vibrations lead to a change in the state of the surface layer, reduce the forces of boundary friction when moving one body to another. Analysis of the research results shows that, regardless of the composition and initial mechanical properties of metals under ultrasonic loading, the conditional yield strength decreases by 3.5-4 times, and the friction coefficient - by 2-4 times. Ultrasonic vibrations reduce the static yield strength similar to heating, however, to achieve the same effect, ultrasonic treatment requires much less energy than heating. This difference is explained by the fact that ultrasonic energy is absorbed in those places of the crystal lattice that are carriers of the plastic deformation mechanism (dislocations, grain boundaries, etc.), and is almost not absorbed in crystal-free zones of crystals.

The formation of complex oscillatory fields during ultrasonic treatment increases the efficiency of application and expands the possibilities of controlling ultrasonic treatment, as well as the displacement of the deforming element from the concentrator axis at different distances and at different angles relative to the axis of the workpiece, significantly expands the types of formed regular surface microreliefs.

The technical result of the proposed development is to increase the efficiency and expand the technological capabilities of ultrasonic finishing of the outer cylindrical surfaces of parts in order to improve their performance, improve the quality of the treated surface, and increase the reliability and durability of the parts. their work and shorten the break-in period. The simplicity of the design of this device allows you to use standard elements and apply it without additional costs for changing equipment and using universal lathes. The device can be placed on the support of the lathe, and the workpiece can be installed in the chuck or centers.

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