Different Features of Ball Knurling Tools

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ABSTRACT
The article describes the features of ball rolling tools in the formation of protection factors from external influences.

Keywords: Indicator, Operation, Quality, Performance, Strength, Rigidity, Resistance, Residual Deformation, Contact, Mechanism, Method, Processing.

Introduction

One of the most important indicators that determine the demand for an operated object is the quality and indicators of the surface. Ensuring the required quality is possible when meeting the operational requirements for machine parts. The operability and reliability of the part are ensured by fulfilling the following basic requirements: strength, rigidity and resistance to various influences (wear, vibration, temperature, etc.).

Fulfillment of strength requirements under static, alternating and dynamic loading should exclude the possibility of destruction [1], as well as the occurrence of unacceptable residual deformations.

The rigidity requirements for a part or contact surface are reduced to limiting the deformations arising under the action of loads that disrupt the performance of the product, to the inaccessibility of the loss of overall stability for parts subjected to compression, and local stability for thin elements [2,3]. The wear resistance of the part, which significantly affects the durability of the mechanism, must be ensured. It is enough that for each part not all of the requirements listed above are met, but only those that are associated with its operation.

Parts experiencing maximum stresses on the surface (bending, contact stresses) are subjected to surface hardening to increase fatigue resistance. There are the following methods of surface hardening: mechanical, thermal, chemical-thermal, laser hardening, ion implantation, etc. Of these methods, mechanical is the one that has the best environmental, operational and economic indicators

Fig.1. Surface after honing

Fig. 2. Surface after knurling with a ball deforming tool head

Machining designated for the formation of machine parts based on chip removal using a cutting tool installed on metalworking technological equipment cannot provide the above listed operational requirements without chemical-thermal exposure. Since, for parts obtained after processing with chip removal [4,5], in more cases they are subjected to additional processing, for example, chemist - thermal, thermal, etc. Which require additional costs for preparation for the chemist - thermal, thermal, etc. production facilities.

Machining using a rolling ball deforming tool head is accompanied by the formation of a "new" surface with a significantly lower height of micro-ridges - roughness, compared to the original roughness, "destroyed" by the so-called submicro - roughness. The surface of the rolled parts becomes smooth. This, for comparison, the treated surfaces with a honing and ball tool head are shown in Fig. 1 and 2. The materials taken for the experiment were steel 40X (rolled). As can be seen from the figures, the surface obtained by honing is relatively rough, and the knurled surface is smooth. The roughness of the latter is approximately R a = 0.4...0.025 µm, and after honing - R a = 0.4...0.2 µm [9,11]. Conditions and processing modes are the same. To carry out the process, a ball knurler (tool) can be installed on a tool carrier in any type in groups of technological equipment and even on multi-operational ones with an automatic tool changer.

At the same time, labor productivity increases by 5-10 times or more compared to traditional honing operations.

Under smoothing modes of surface plastic deformation (SPD), the surface roughness depends on a number of factors:
- rolling forces;
- submissions;
- diameter of the deforming ball;
- the number of passes of the tool head;
- initial roughness;
- physical and mechanical properties of the processed material;
- other.

Rolling force, feed rate, deforming ball diameter, number of tool head passes; initial roughness is selected depending on the physical and mechanical properties of the material being processed and other factors [5].

Ball knurling tools have a number of advantages compared to roller tools - simple design, small dimensions, the ability to use standard balls produced by ball bearing industries. They do not require an exact setting relative to the workpiece surface, as the balls are self-aligning. The balls have a point contact with the treated surface, which ensures the creation of high specific pressures at low forces during the deformation of the surface layer of the part. The process occurs during the rolling of two bodies, i.e. detail and ball. All these qualities determine the scope of the ball tool: dimensional finishing and hardening of thin-walled parts, low-rigid parts with a large ratio of length and diameter. Ball tools are most cost effective when used in single and small batch production, series and large batch production as well as mass production. In the last ball deforming tool recommended itself as a substitute for abrasive tools. Compared with an abrasive tool, the productivity of a tool with ball deforming elements in terms of the main technological time is much lower, but in terms of piece technological time it almost does not recede [7]. The durability compared to bladed tools is very high. Their only drawback is that it is not possible to regrind and restore. This is their main drawback.

A rigid single ball tool used on lathes and rotary machines is shown in fig. 3. In body 5 on axes 6 and 7, two ball bearings 4 and 8 are installed, which support ball 7, which is held in the tool body from falling out by separator 2. The separator is attached to the body with screws 3.

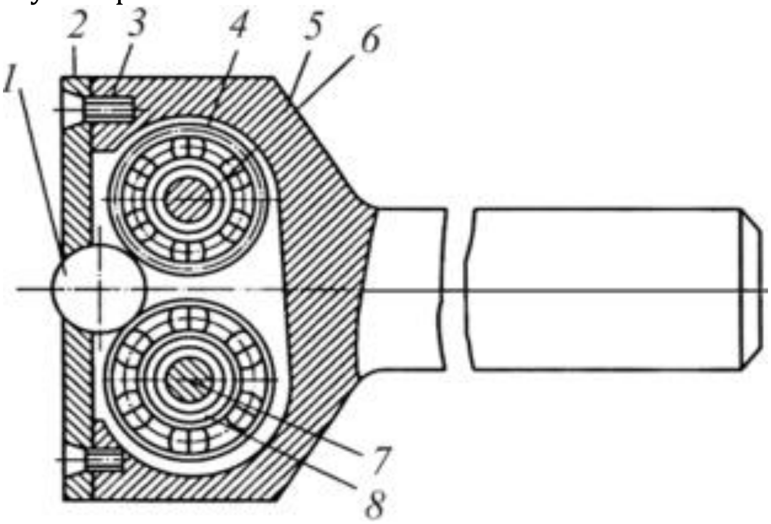

Fig. 3. Scheme of a rigid single-ball knurler.

The disadvantage of a rigid single-ball knurler can be attributed to shear deformation of the surface layer in the direction of movement of the knurling tool.

Multi-ball is used to arrange the action of one-sided rolling force on the workpiece surface, to increase processing productivity and increase the degree of hardening in one pass of the tool (Fig. 4).

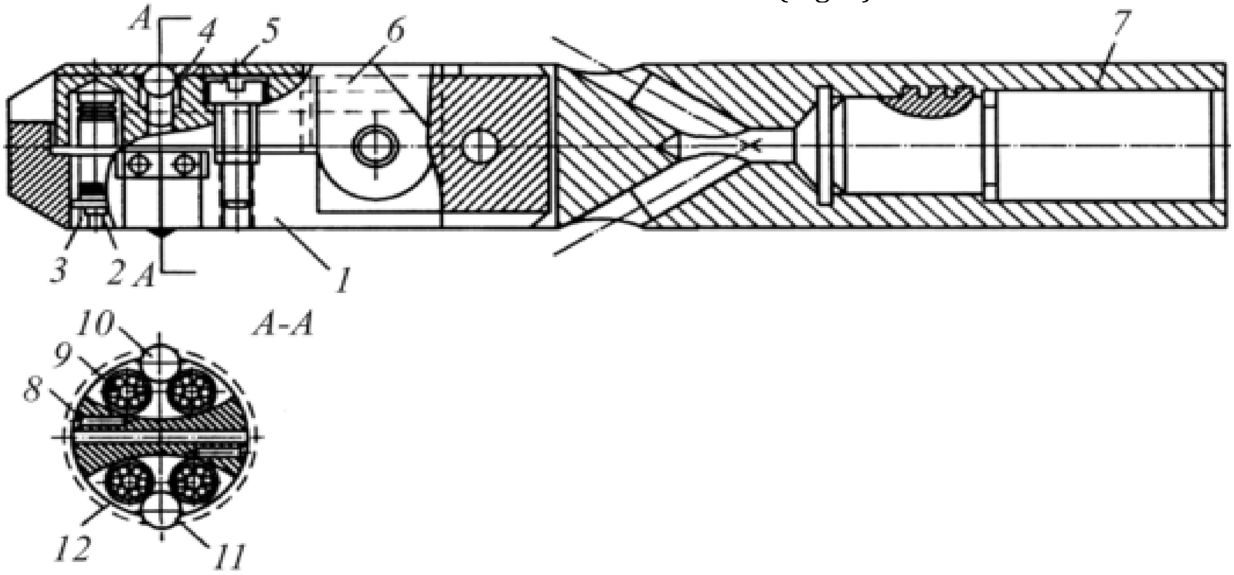

Fig. 4. . Schematic diagram of a two-ball elastic rolling for holes: Deforming balls 10 to 11 rest on ball bearings 9 and 12, the axes of which are installed in levers 1 and 6. The levers can rotate around a common axis under the action of a spring 2.

Using this design of the tool, it is possible to provide more uniform plastic deformation in two directions of the coordinate axes (X, Y) for unequally rigid parts, the force of which is regulated by screw 3. The stroke of the levers is limited by screw 5. The levers are installed in mandrel 7, with which the tool is fixed in the socket revolver machine. Separators 4 serve to hold the balls in the holes of the levers and are attached to the levers with screws 8.

This disadvantage of a rigid single-ball knurler can be eliminated by the spring 2 in Fig. 4.

20Kh2N4A and 18KhGT steel with their subsequent carburizing and heat treatment are recommended as the material of the knurling ball, experiencing large dynamic and alternating loads. For accelerated nitrogenation of surfaces of parts operating in an active medium, steel 95X18 is used, containing 0.95% C and 18% Cr. Ball knurlers according to GOST 801 - 78, steel is marked: SHKH15, SHKH4, SHKH15SG, SHKH20SG.

The designation of the grade of materials for samples and tools is taken from the classifier of the Russian Federation.

It should be noted that the number of passes of the tool head more than three times leads to a deterioration in the quality indicators of the surface layer of machine parts.

The method is the most efficient process in the dimensionless finishing of metal products.

The essence of the method lies in the fact that the deforming element (ball or roller) of the tool is pressed onto the surface under a certain pressure and rolls along the generatrix or guide lines.

As a result, the following is achieved:

- the roughness of the surface layer, left by the legacy of previous processing, is smoothed out;

- dislocation of atomic grains into the structural structure;

- improving the microhardness of the surface layer.

Two goals are set:

- obtaining the required surface roughness in the aisles up to 0.4 - 0.025 microns;

- achievement of microhardness of the surface layer obtained by the thermal method.

Sources

1. The results were obtained in the technopark of the department "Mechanical engineering" FerPI. 2

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