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IMPROVEMENT OF QUALITY OF INTERNAL CYLINDRICAL SURFACES

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Abstract:
The article represents research in order to determine the influence of main technological parameters of honing on the accuracy indicators of geometric shape of processed hole.

Keywords: Honing, Rigidity, Four-Bar Head, Shape Accuracy, Error, Bar Shape.

INTRODUCTION

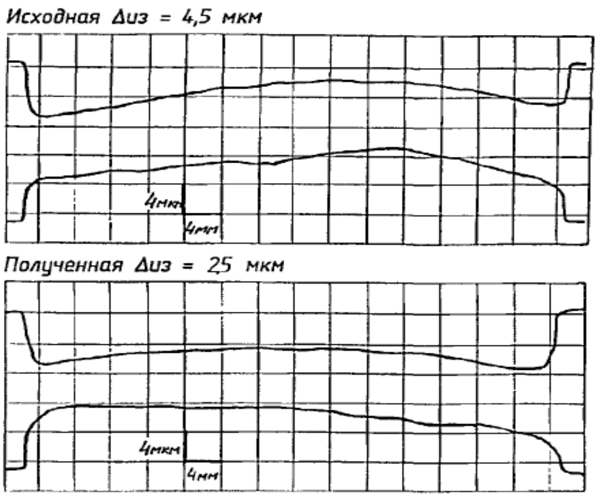
Large complex of studies was carried out in order to determine the influence of main technological parameters of honing on the accuracy indicators of geometric shape of processed hole. The influence of the ratio of the length of bars to the length of hole has been studied, as well as processing of the hole from both sides by the method of mutual straightening has been carried out.

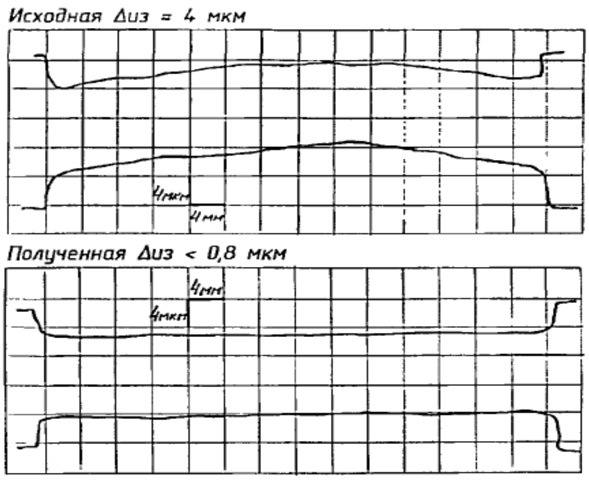
Intensity of correcting the bore axis curvature during honing of fuel equipment liners is greatly influenced by the flexural rigidity of the part and tool, the value of the expanding cone angle, the rigidity of the radial feed system, as well as the ratio of the length of the bars and the hole to be machined [1]. The cutting ability of the bars and the kinematics of the working movement are of great importance on the intensity of the axis curvature correction [2].

MAIN PART

When conducting experimental studies, in order to increase the rigidity of the four-bar head, a design option was used, in which two bars are movable in the radial direction and are located in the grooves at angle of 90 °. Opposite the movable bars, fixed bars are also soldered to the periphery of the body at an angle of 90 °. The cutting layer of all bars is made of rolled products.

Comparative experiments were carried out with the ratio of length of the bars to length of the processed hole L_{6p} / L_{OTH} = 0.5 and L_{6p}/L_{OTB}=0.83. The experiments were carried out on parts made of 12XH3A steel, with a hole length of L_{OTB} =60 mm, bars of length L_{6p} =30 mm and L_{6p} =50 mm. results of the experiment are shown in Fig. 1 and 2





Initial Obtained

Fig. 1. Correcting the curvature of the axis at L_{6p} /L_{OTH} = 0.5;T_{X0H}=1.5 min, P=0.8 MPa.

Fig. 2. Correcting the curvature of the axis at L_{6p} /L_{OTH} = 0.83;T=0.5 min, P=0.8 MPa.

The results obtained indicate the advisability of honing precision holes in the details of the fuel equipment with a tool with a bar length $L_{бр}=(0,8 -1)\cdot L_{отв}$ providing a more intensive correction of the bent axis curvature.

The accuracy of the hole shape in the longitudinal section largely depends on the initial error of the geometric shape of tool and blank, ratio of the length of the bars ($l_{бр}$) and the length of processed hole ($L_{ОТВ}$), as well as on the setup parameters, including the position and length of the axial stroke (l_X) and the amount of overrun of the bars ($l_п$). The ability to vary the setup parameters is significantly limited when honing high-precision short holes commensurate with the length of the bars. Fig. 3 shows a diagram of the contacting of the stones when honing precise short holes in the test rings.

When honing short holes piece by piece, the value and range of axial travel (l_X) are very limited by the permissible values of the overrun of the stones ($l_п$). In practice, the amount of overrun of the bars is assigned equal to 1/3 of the length of the bar ($l_{бр}$). With a larger value of the overrun of the bars, the hole "collapses" at the ends. In our case, with a bar length of 30 mm, the recommended overrun value of the bars is l = 10 mm. With the length of the hole to be machined L = 25 mm (for rings with d = 35 mm), the maximum stroke length with the same overshoots of the bars will be 15 mm. From the condition of compliance with the contact of the entire surface of the bars with the hole being machined, the amount of stroke can be adjusted only in the aisles of 2 - 3 mm, and in the direction of decreasing the stroke. During raster honing of these rings, the stroke size was provided by the amplitude of axial vibrations.

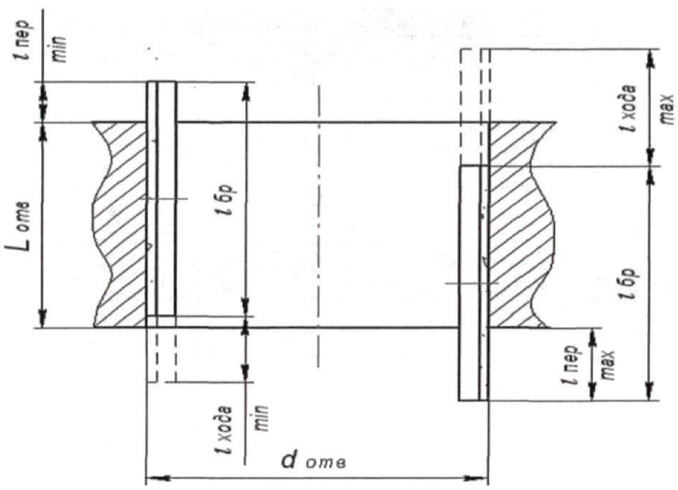


Fig. 3. Scheme of adjustment when honing the control ring

With a small value of the axial stroke, a local contact of the surface of the bars with the treated surface occurs, that is, the upper part of the bars contacts only the upper part of the hole, and the lower half of the bars with the lower part of the hole. As a result, uneven removal and wear of the bars occurs, and intensive copying of the initial error in the geometric shape of the tool by the hole and vice versa [3].

In this regard, the honing method with mutual straightening in the tool-part contact has been tested. The fundamental difference between this method is that the through hole is machined from two opposite sides by periodically flipping the blank (Fig. 4).

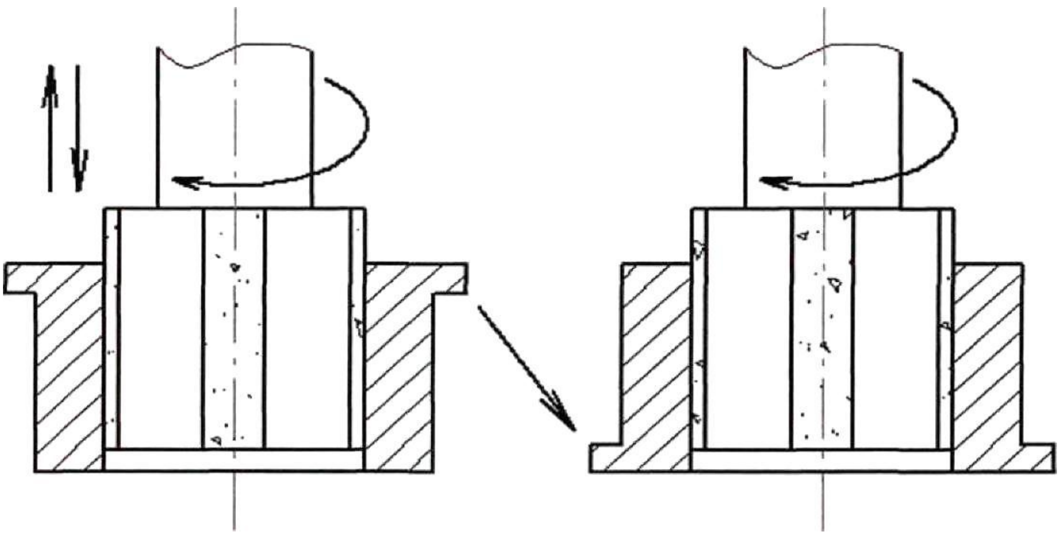


Fig. 4. Scheme of honing by the mutual straightening method

In this case, the honing cycle ($T_{хон}$) is divided into at least two or more sub-cycles *($T_{хон}=T_1+T_2+...T_n$),* in each of which processing from different sides. This method ensures uniform contact of the working surface of the bars with all sections of the hole being machined. Due to the effect of mutual straightening, the correction of the initial error in the shape of the hole is intensified and the accuracy of the shape of the working part of the tool is automatically increased, which allows reducing the requirements for the accuracy of its manufacture. In addition, when honing a hole from both sides, the influence of adjustment errors, for example, unequal overshoot of the stones on the accuracy of the geometric shape of the machined hole, is eliminated. This method is especially effective when honing when the length of the holes is commensurate with the length of the stones.

This method has been tested for honing holes with d = 18 mm. Two rings installed by a "package" with a "hard" hone carried out the processing at once. As a result, it became possible to increase the length of the axial stroke to 22-24 mm, which corresponds to the amplitude of axial vibrations B = 11-12 mm. When honing with a "hard" hone, the number of parts in a "package" is limited by their total weight. With a large total mass, it is necessary to use a honing scheme with a hinged head and a rigid fastening of the "pack" of rings. The advantage of honing rings with a "batch" is the increase in productivity due to the simultaneous processing of several parts, improvement of the mutual direction in the tool-part contact, which has a positive effect on the shape accuracy, as well as the uniformity of the machined parts. The disadvantages include an increase in the allowance due to the initial different dimensions and errors in the shape of the parts.

Comparative experiments have been carried out that have shown high efficiency of honing with mutual straightening even with a single overturn of blank, or "package" of parts. The experiments have been carried out under the same processing conditions. The initial error of the geometrical shape of the hone (cone-shaped) was no more than 10-15 microns.

When honing, the hole on one side is a partial copy of the tool shape error. The results are shown in Fig. 5 a, 5 b. The deviation of the shape (taper) of the machined hole is 1.5 - 1.8 microns.

When honing by the mutual dressing method, the main stock is removed during the first sub-cycle (T_1). After the turnover of blank, or "package" of parts, that is, in the second sub-cycle, the honing time (T_2) is assigned depending on the error $\Delta Дп$ of the shape of the hole after the first sub-cycle and the metal removal rate Q micron/min. In the first approximation, the time T_2 can be determined from the expression $T_2=2\Delta пр/Q$ (min).

Results of the experimental verification are presented in the profilograms in Fig. 6. With the same tool shape error (10-15 micron) and single flip of the rings, the deviation shape of processed hole did not exceed 1 micron.

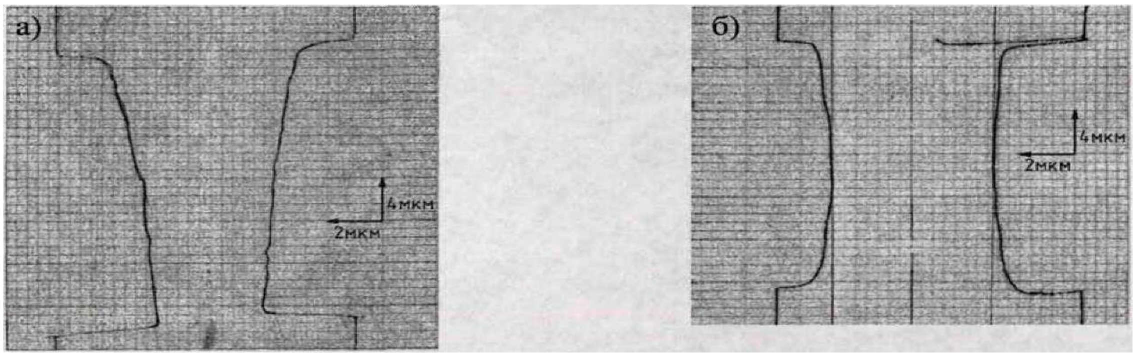
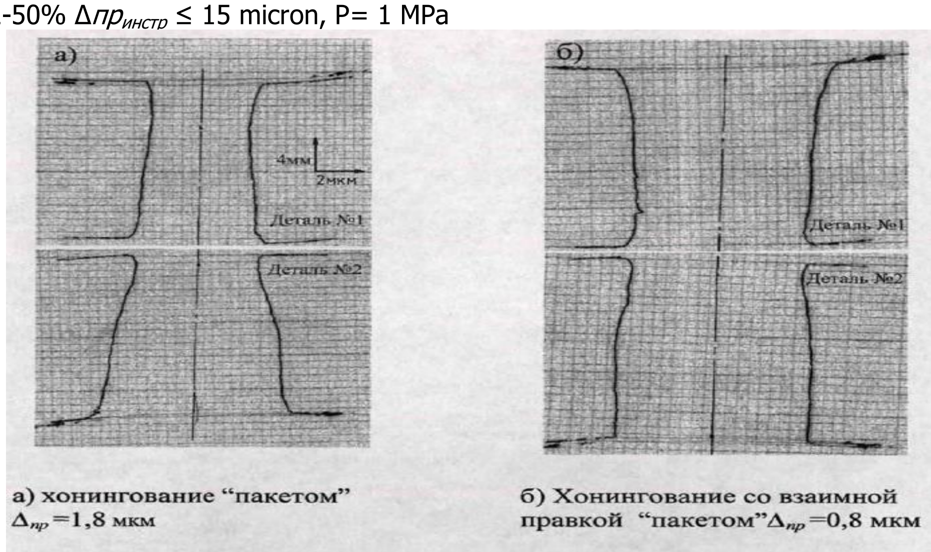


Fig. 5. Results of the experiment.

Bars KM40/28-M5-22-50% $\Delta пр_{инстр}$ ≤ 15 micron, P= 1 MPa



a) honing by package *b) honing by package with mutual setting*

Fig. 6. Results of the experiment. Bars KM40/28-M5-22-50% l_X=22 mm, P=1 MPa

CONCLUSIONS

In almost all experiments, profilograms and round diagrams were recorded after dimensional honing with hard bars and after final honing with elastic bars. The results of measurements show that after finishing honing the geometric shape of the hole does not change, that is, the bars on rubber-containing bonds carry out metal removal only in the aisles of the roughness obtained after dimensional honing. It should also be noted that almost all experiments were carried out during honing by the method of mutual straightening.

Such a variety of initial errors in the geometric shape of the holes, both in size and in appearance, suggests that it is advisable to replace the preliminary grinding operation with a more efficient preliminary honing operation. Moreover, preliminary honing can be carried out using the same equipment and the same tool only by replacing the honing bars.

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