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Increase in Accuracy of Processing by Edge Tool

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ABSTRACT: The article discusses the issues of improving the accuracy of machining with a edge tool during machining on metal-cutting machines, in particular, of increase turning accuracy in the way increase in tuning sharpness of cutters on the size. The purpose of improving the accuracy of setting the cutters on the size on lathes in the article proposes a scheme of precision adjustment of the cutters on the size with a micrometric adjustment, a design diagram and a method for determining the setting value for given settings of the setting diagram.

KEY WORDS: machine tool, blade tools, machining, machining accuracy, tuning accuracy, setting value, precision setting of cutters for size, setting of cutters for size with micrometric adjustment, setting scheme, design tuning scheme, settings for setting scheme.

I.INTRODUCTION

The quality of processing of details both on accuracy, and on quality of a surface will depend on a sort and features of the selected fair processing. Depending on requirements imposed to quality of surfaces of different details now as fair processing apply: expansion, drawing, grinding, thin turning and milling, etc. In developed traditions if at assessment of efficiency' spacing factor of which different ways of pre-processing was productivity and cost and also complexity of the equipment, then contrary to it for fair operations on the first place at their comparative assessment factor of quality of a surface acted. At the same time only methods the providing set qualities of a surface and accuracy of processing was compared on productivity and cost value of process taking into account complexity and the cost of the equipment. Now development of mechanical engineering demands from ways of fair processing providing the set quality of a surface and accuracy of processing with the simultaneous satisfaction of the requirement of productivity and cost value of process taking into account complexity and the cost of the equipment.

At the same time problems of fair processing consists not only permission of issues of receiving details of the correct form and the exact sizes within admissions, but also in permission of a problem of receiving a durable surface during the work of details in machines.

For this purpose the roughness should be minimum, these surfaces should be received under such physical conditions of cutting at which a surface layer life owes wear proof. For this purpose it is necessary to eliminate: adverse changes of a surface layer arising when roughing; reduction of deformation and the related temperature increase at fair processing, etc.

At fair processing by edge tools exist a number of problems of ensuring high accuracy of processing. To provide the high accuracy of edge processing, first of all, it is necessary to provide the minimum depth of the cut-off layer, and stability of process of cutting. As at the same time, owing to small sections of shaving and small values of contact of a cutter with a product of cutting's effort and heating of whole detail at minimum cutting depths, turns out very insignificant owing to what there are no significant changes in crystal structure and a peening of a surface layer of metal that provides high wear resistance of surfaces of thinly processed details. Small forces of cutting at the same time allow limited to very insignificant efforts at a clip of details. Owing to small values of efforts of deformation at installation and processing of details turns out also insignificant what provides the high accuracy and the correct micro geometry at thin turning. As a result of these factors it is possible to predict the accuracy of the sizes of the details processed above given conditions from confidence there correspond 7-6 quality class, and it is possible to maintain admissions about 5-8 microns, on diameter of 15-100 mm, values of ellipticity and conicity within 3 microns.

The edge tool when machining on metal-cutting machines refer processing to processing by cutters, mills, broaches, etc. Such cutting tools except for broaches, threading and development carry to the tool preliminary for landing and final for free surfaces of details of machines. Such application developed because a blade way of processing such as turning,

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milling, planning and some other ways of processing do not provide required accuracy or quality of a surface of the processed detail surface

II. LITERATURE SURVEY

In literature, characteristics of key parameters of different methods of processing are known [1]. The basic handbook data till some way of blade processing of details by the size lying within the sizes of 50-80 mm are given in tab. 1.

Table 1

Processing methods	Quality class		Economically accuracy, мм	Ultimate accuracy, мм
	Economically achievable	Practical achievable		
Turning:				0,03
Draft	12		0,4	
Fair	11		0,2	
exact	9	8	0,06	
Expansion				0.01
Preliminary	9		0,06	
final	7	6	0,03	
Drawing				0.01
Normal	8		0,05	
exact	7	6	0,03	

From tab. 1 it is visible that:

- ultimate economic accuracy when processing crude materials for processes of expansion and drawing lies within 7 quality class;
- limits of economically reached accuracy when turning are made by the 9 quality class that it is much less than the accuracy at expansion and drawing.

The analysis of the different literary data and data provided in tab. 1 shows that the accuracy of methods of processing depends on the minimum depth of a possible dischargeable metal layer. At expansion and drawing it makes 0.03 mm. When turning such metal layer makes 0.06 mm. It is obvious that turning in serial and mass types of production by processing on the set-up equipment it is almost not possible to receive the accuracy of the diametrical sizes higher than 9th quality class.

In view of considerable percent of application of turning in mechanical engineering it is necessary to consider that the problem of improvement of quality and accuracy when turning is very relevant.

To quality of turning, including has an impact of a set of factors on accuracy. To this factor it is possible to carry: initial structure and a sort of the processed material; a status of a technological system, machine adaptation of the tool products, including existence of vibration and forced oscillations in the course of work; the cutting mode - the cutting speed, giving, cutting depth; geometry of the cutting tool; a status and material of the cutting edge; lubricant and cooling when cutting.

III. METHODOLOGY

All specified factors can be united in two main groups:

1. Geometrical factors belong the giving value, radius of a curve of top of the cutting edge, the auxiliary and main angles of cutting in the plan to them;

2. physical factors: material of a detail and the tool, speed and the angle of cutting, the deformation and fluctuations of the machine, the tool and a product refrigerant-greasing liquid, etc.

If the first group of factors influences mainly formation of roughness, then the second group of factors defines mainly stability of formation of shaving.

When processing by the edge tool of cylindrical surfaces the accuracy of the diametrical sizes depends both on processing methods, and on the used equipment, the tool and the scheme of cutting. Thus, one may say, that the accuracy of turning is influenced by a large amount of different technology factors, and for research of ways on increases in accuracy of processing, it is necessary to pay attention generally to the dominating factors.

If form accuracy, generally is defined by operation of the machine, then the accuracy of the sizes depends on setup, i.e. the error of installation of a cutter on the size does not influence change of a form of the processed detail, and

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influences only size variation. The error of installation of a cutter on the size belongs to accidental errors and as shows the conducted researches, submits to the law of normal distribution.

By us it was carried out experience for determination of the reached cutter setting accuracy on the size during the work on the thread-cutting machine. Installation of a cutter was made on a machine limb with the division price 0.01 mm. At the same time took place the following errors of installation of a cutter on the size: 1) inexact coincidence feed mark on a machine limb; 2) support's error of moving to results of an error of a screw pitch.

IV. EXPERIMENTAL RESULTS

The error caused by inexact coincidence feed mark a micrometer at installation, it was studied as an accidental error. By creation of distribution curve based on a large number of counting. Experience consisted that adaptation micrometer was established with the price of division of 0.001 mm repeatedly on the same division, and the actual position of a support or its movement (when studying an error of a movement) was fixed by the minimeter with the price of division of 0.001 m. The minimeter is installed strictly on a micrometer axis. Based on experience, the distribution curve for a mismatch error feed mark on a machine limb was constructed (fig. 1, a) and also an arithmetic average to the deflectionτ= +1.5 microns, average quadratic deviation σ=1.03мкм, to field distribution of curve disperse 6σ=6.5 are defined by micron (fig. 1, b). For a curve in fig. 1.b τ= +0.38 microns, σ=1.07 micron, the maximum error extent 6σ=6.55мкм.

It is possible to consider that the maximum error extent from mismatch feed mark on reading mechanisms in lathes, even at thin setup, is equal ~ 7 microns, In fig. 1, in the distribution curve of the error arising when moving a support of the lathe is shown. Two components enter this error: the error caused by mismatch feed mark and screw pitch errors on length of movement of 0.015 mm. For a curve of fig. 1, in τ=-0.13 micron, σ=1.14 micron. Total errors 6σ=6.8 micron.

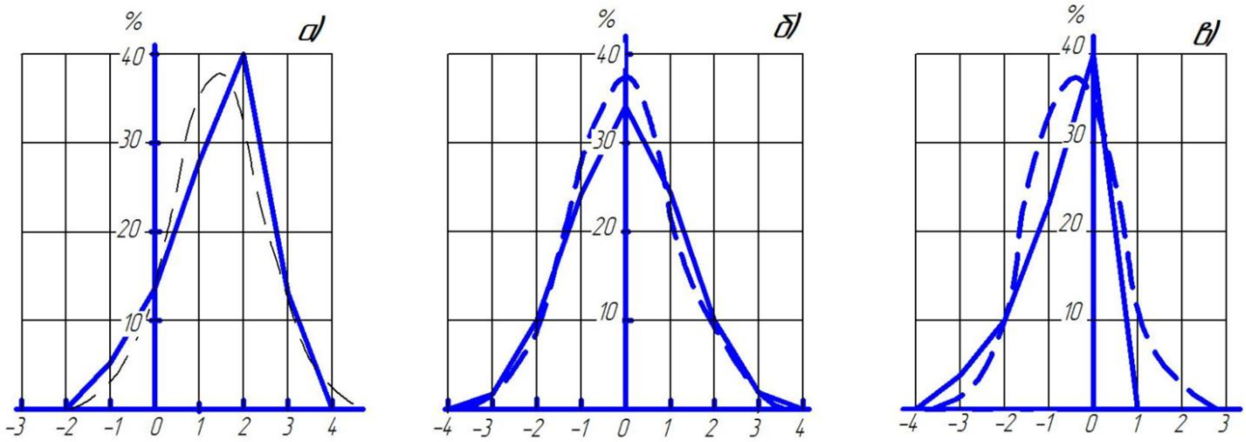

Fig. 1.

Error distribution curve: a) and b) mismatch feed mark on a limb on the machine; c) distribution curve of the errors arising when moving a support

Medium can be considered that the error at movement of a cutter on cutting depth value for the tested lathe lies in limits ~ 7 microns that will make the most vozhmozhny error on diameter ~ 14 microns.

As we see, the error of installation of the tool on shaving has essential value, and here application of means is of great importance for exact regulation of position of the tool. As, normal limbs on feed screws on the majority of machines do not provide adequate accuracy during the work after quality class of 7 and 8. Therefore supply of machines for implementation of exact processing with the devices allowing to reach the bigger setting accuracy of a cutter comes true fully. In such cases use of special tool blocks with micrometer adjustment is recommended. It is possible to tell from confidence that increase in tuning sharpness of cutters on the size on lathes is one of pacing factors of ensuring high accuracy of processing on such machines.

On the other hand, on which size it is necessary to conduct setup does not equal to the average size specified on the drawing. It should be defined, considering systematic variable inaccuracies, first of all heating of a system of

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machine-detail-tool and wear of the tool and therefore questions of setup are closely connected with questions of dimensional check in processing.

Besides, on the accuracy of processing of ferrous metals wear of a cutter on a back edge causing conicity of a detail or changes of diameter at serial processing of a series of details more affects. At fair processing on lathes, the wear of the tool is the reason of one of the most essential tolerances. In certain cases the general error is defined only by wear of the tool. It is explained by the fact that, process of fair processing is carried out by small values of giving. During the work as small giving the general way passed by a cutter is big that is natural, results in big wear of a cutter and consequently, to considerable conicity, or change of diameter of the processed detail. Knowledge of dependence of wear of the tool on the nature of process of cutting gives a chance to manage process of wear, reducing it to the minimum value.

For ensuring setting accuracy of a cutter on the size it is used any devices (devices with installation on minimeters, exact limbs, eccentric mandrels, etc.) which assignment as is well-known is increase in setting accuracy of a cutter.

Thus, the constructive scheme of setup for the size on lathes allows setting on the processed size within a scale of division of giving into cutting depth. This value is 0.1 mm or 0.05 mm. At such setup, it is impossible to receive details from high accuracy already at a stage of setup of the equipment. Therefore, by suppling of lathes of general purpose with the special devices for exact installation of a cutter on the size having potential of operational readjustment of provision of a cutter considering systematic variable inaccuracies. In the first wear of the cutting tool and heating of a system the machine-detail-tool, it is possible to increase the accuracy of edge processing considerably.

In the present article the scheme of increase in tuning sharpness of cutters on the size on lathes is considered. In fig. 2 the scheme of precision setup of cutters for the size is given in lathes.

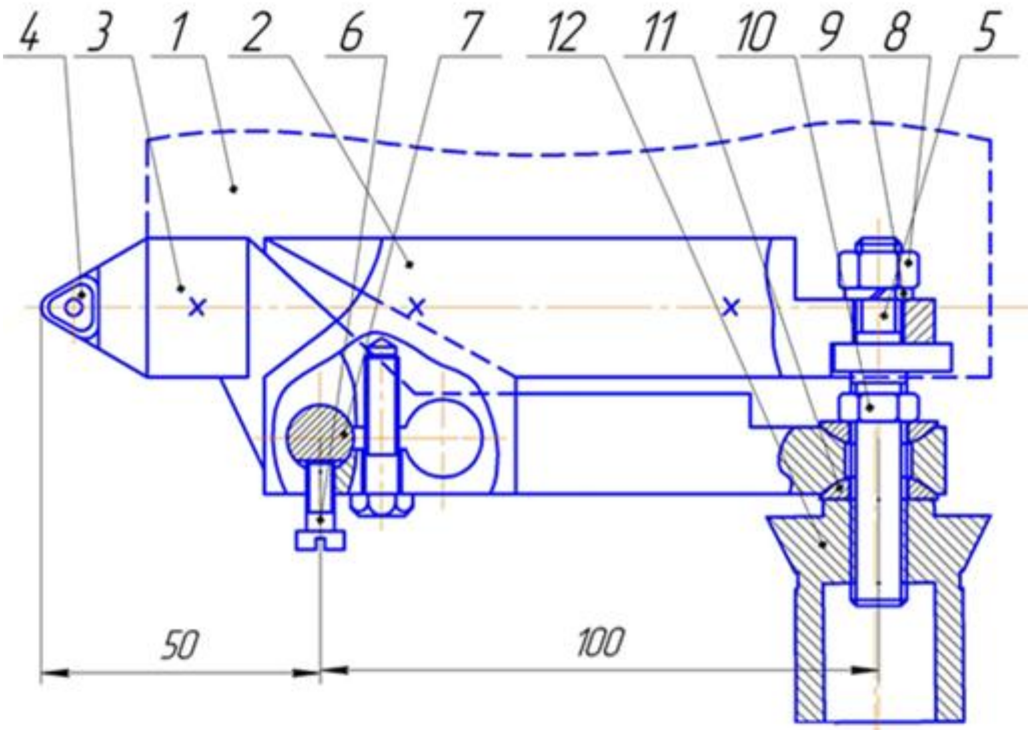

Fig. 2. The scheme of precision setup of cutters for the size on lathes:

1 tool block, 2 – the case of a cutter, 3 – a cutter, 4 – a hard-alloy plate, 5 – a pin, 6 – the screw, 7 – an axis, 8 – a nut, 9 – a spring washer, 10 – a nut, 11 – a spherical washer, 12 – an adjusting nut

Building 2, the device of precision setup of a cutter for the size is mounted on lathe tool block 1, and fixed by bolts of fixing of a cutter in the tool block. In a cutter installation site in the case, it is made two openings with different diameters and connecting among themselves a groove.

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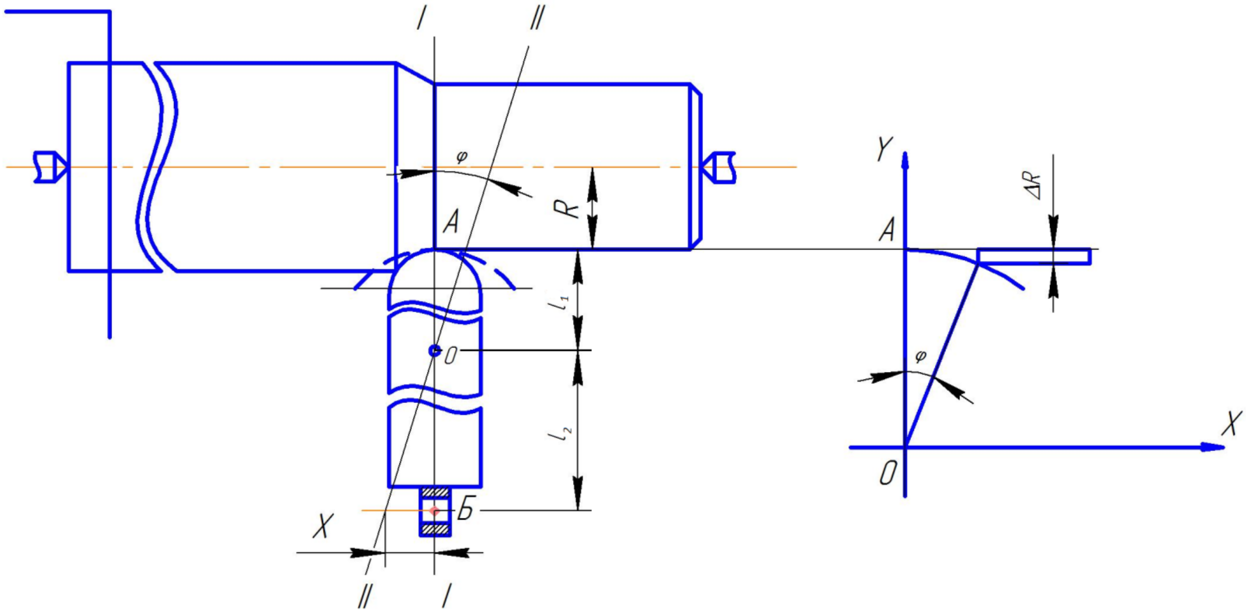
The cutter 3 with a hard-alloy plate 4 has special construction, which in the horizontal plane has same openings that in the case on which means by means of axis 7 is established in the case. Axis 7 is fixed in the case by the screw. The landing opening of the case and axis 7 is made in biaxial option [2] that at corresponding tightening of screw 6 provides exact landing with axis 7 in building 2 opening. The cutter 3 at the same time can turns concerning axis 7 that in turn allows to change at the expense of angular a shoulder of a cutter of the provision of the cutting edge of a plate of rather vertical plane. For this purpose, in the vertical plane of a tail part of a cutter and corresponding the place of the case it is made openings, which are connected among themselves to the help of a pin 5, nuts 8 and 10, a washer spring 9, spherical washers 11 and an adjusting nut 12. 12 allows to turn rotations of an adjusting nut a cutter concerning axis 7 that in turn allows exact precision settings of the cutting cutter edge for the size in the horizontal plane.

On rice 3. the scheme of definition change of depth of cutting of Δt at turn of a cutter concerning axis O is shown.



Rice 3. The scheme of definition change of depth of cutting of Δt at turn of a cutter concerning axis O.

$$\Delta t = (l_1 - l_1 cos\varphi) * \frac{l_1}{l_2} , \qquad (1)$$

Where

$$tg\varphi = \frac{X}{ОБ'} \qquad (2)$$

For the construction given on fig. 1 we will define change of depth cutting of Δt when moving the end of a cutter of value X (fig. 2).

From the equation (1) we will receive that,

$$l_1 = \frac{\Delta t}{1 - cos\varphi} \qquad (3)$$

If to consider that $ОБ = l_2 \, ul_2 = 2l_1$, then we can write the equation (2) in a look

$$tg\varphi = \frac{X}{2l_1} \qquad (4)$$

Having solved jointly the equation (3) and (4) for Δt we will receive the following expressions

$$\Delta t = \frac{X(1 - cos\varphi)}{2\,tg\varphi} \qquad (5)$$

If to consider that on construction of l2 = 100 mm that, then moving of the end of a cutter to X =0.1 mm can give change of depth cutting equal on values Δt≈0.2 to micron.

On the basis of the results stated above it is possible to draw the following conclusions:

Researches the geometry of cutting of edge processing shows a possibility of removal of shaving ranging from 5 up to 10 microns.

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V.CONCLUSION AND FUTURE WORK

For implementation in conditions of production of this solution, it is necessary to provide fluctuation of elastic deformations of nodes of a technological system in commensurable limits with deviations provided with cutting geometry.

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