COMBINED TOOL WITH POSSIBILITIES FOR ONE-TIME MACHINING OF OPENING OF HYDRAULIC CYLINDERS

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Abstract: The present article is suggested new design of the cutting part of the combine tool for treatment the holes of hydraulic cylinders in which the cutting inserts of the movable two-blade block are axially displaced. As a result of this removed allowance of machining increases and provides high accuracy and productivity.

Keywords: skiving of hydraulic cylinders, movable two-blade block with axially displaced inserts.

1. INTRODUCTION

Operational reliability of hydraulic cylinders is determined by the tightness of their knee-joint compounds and its provision imposes typical quality requirements cylinder opening, which are particularly high for roughness of their working surfaces. Their nomenclature is characterized by great diversity of lengths and diameters of the opening, due to the demands of users.

A major manufacturer of hydraulic cylinders in Bulgaria is "Hydraulic elements and systems" – PLC, Yambol, where our developments of combined tools have industrial deployment and with them are experimented for production of new technical solutions.

From the analysis of the production programs of the company we found that the highest annual volume occupied cylinder opening with diameters 90 mm and 110 mm. Different lots cylinders differ in length and external design, but the technological process for obtaining opening is the same and is implemented in terms of batch production. Different lots cylinders differ in length and external design, but the technological process for obtaining holes is the same and is implemented in terms of batch production. [5]

2. EXPOSE

Existing tools for combined processing consist of cutting and deforming parts. The cutting part is crucial for the performance of the processing and the accuracy of the diametric dimensions. Accuracy is achieved by using movable two-blade block (MTB) for skiving with oppositely arranged inserts. It has very high stability (hardness) at pressure and productivity by cutting inserts with very small adjusting angles ($\kappa_r < 10^\circ$; $\kappa'_r < 1^\circ$) [1, 3], which allow feed speed to $f = 4 \text{ mm/rev}$. If the corresponding points of the main cutting edges lie in planes perpendicular to the axis of rotation there is a restriction about size of the received allowance of machining (0,5 - 0,7mm). This requires preliminary skiving of the workpiece which prolong technological process or the use of expensive pipes with higher precision of the openings.

The mentioned problem could be overcome to a large extent if the inserts of MTB become dislocated in the axial direction at a distance of in which the sections of the shear layers do not interfere [2, 3]. This allows for a double increase the addition and for a single treatment of the tubular workpiece (without preliminary skiving). Since in this case, the precision opportunities of MTB are limited (theoretical three times decreases the dissipation field of the workpiece). To be fully compensated this limitation the maximum stability of the block is replaced with regulated [4].

An important requirement to the tools for combined processing is their cutting part to have constantly guided (basing) along the treated surface. It is implemented by non-metallic guides, which together with the deforming part perform functions to reduce vibration, too.

Other requirement, which is essential for the applicability of tools is their going out (return) through processed opening to do not cause the appearance of traces or injuries mirrored appearance of the surface formed by the deforming part of the instrument.

2.1. Description of the developed construction of combined instrument

The construction of instrument for combined processing openings with a nominal diameter of 110mm, conforming to the conditions described above is shown in Figure 1. [5]

The cutting part includes a body **3**, cover **1**, centering pin **2**, screws **33**, non-metallic guides **35** and movable two-blade block **32** (its structure is described separately) housed in a channel of the body with square section. This part is joined to the supporting shaft **31** by key coupling and is rigidly secured thereto by means of front screws which are not visible in the figure. Non-metallic guides are firmly fixed in the four channels of the body **3**, which are centered in such a way that the diameter of the circle described around them is greater than the processed opening and its axis coincides with the axis of the tool.

Deforming part consists of deforming tapper rolls **5** housed in the separator sleeve **7**, bearing pins **6** and bearing tapered bushing **29**, mounted to the support shaft **31** by key coupling. Separator sleeve **7** is assembled by screws **9** to the hub **8** which is mounted on the shaft by means of radial **28** and axial **10** bearings.

The hub **8** is connected to the threaded sleeve **25** by a nut **26** which is rigidly fixed relative to the hub by means of screws **12**. The threaded sleeve **25** is assembled to the shaft **31** by key coupling with possibilities for free axial movement. It is realized through the adjustment nut **14**, assembled rotatably to the flange **17** through nut **16**. The flange **17** is joined to the shaft with a clearance, but it is fixed toward to shaft thanks to the three studs **18** passing freely through holes in the bottom of the coupling nut **20**. The studs press the flange **17** to the front face of the nut **20** under the action of spring **23**, support **21** and screws **19**. The rod **30** is connected to support **21** by a thread connection and lock nuts **22**. At its free end is mounted special screw **34**.

Adjusting of the deforming part is implemented by axial movement of deforming rolls **5** toward the bearing tapered bushing **29**. For the purpose the locking screws **15** are loosened and in the rotation of the adjustment nut **14** the threaded bushing **25** drives hub with bearing that moves separator sleeve to taper sleeve **29**. On the front surface of the nut **20** has a graduated scale from which one division corresponds to the change of the diameter of the circle described about the rolls (working-adjusting dimension) with $0,005\text{ mm}$. In Figure 1 the position of rolls corresponds to the minimum adjusting dimension. Their adjusting dimension should be larger than the dimension of static adjusting of the block with $0,15 \div 0,25\text{ mm}$.

Figure.1. Tool for combine processing with regulated stability of MTB, self-established through translation
Basic parts: I - cutting; II - deforming; III - coupling

Smaller values are applied for smaller diameters. The coupling part of the tool contains a nut **20** to which is rigidly connected a supporting shaft **31** and by which the tool is established at the end of the boring bars being fastened by thread with a large pitch.

2.2. Description of the movable two-blade block

The construction of MTB is shown in Fig.2. It consists of two identical prismatic bodies **1**, assembled to each other through the corresponding sides using screws **3** and guide keys **4**. The method of assembly provides mobility of the bodies, relative each other. In the outer end of each of them is fixed mechanically inserts **2** with special shape and geometry. The inserts are based in rectangular channels and are fixed by screws **7**, thanks to elastic deformation of the bodies in the weakened sections, formed by holes **9** and **10** slots. The position of the inserts is determined by the supporting pins **8** and screws **13** so as to ensure the necessary axial displacement and the presence of minor cutting angle.

Figure 2. Two-blade block for skiving with regulated stability

The dimension of static adjustment is controlled using a micrometer and is adjusted by screws **5** and **6** as the distance between the tops of the cutting inserts. It can be made easier and more accurate with a device designed specifically for this purpose. Its use in axial displacement of the inserts is unavoidable.

The adjusting dimension is maintained constant by the action of springs **11** suspended so as they act for drawing closer the inserts against which counteracts stepped support **14** contacting the foreheads of adjusting screws **5** and **6**. After adjusting the dimension the last mentioned are tightened to each of the bodies by screws. The stepped support **14** acts as a wedge, which through its lowest rung provides a smaller adjusting dimension in order to pull out the instrument without scratches on the workpiece. This is accomplished by axial shifting of the wedge in the direction of feed at the end of the working toolpath. The working adjusting dimension of the block is recovered by returning the wedge to starting (working) position after the fast reverse toolpath.

The stepped support **14** performs another important function - providing regulated stability of the MTB. For the purpose the support constructed as dynamometer device, type tuning fork (figure 3) and is dimensioned so that it has the required elastic characteristic.

Actions by adjusting the dimension and changing the inserts is carried out when the block is located outside the cutting part of the tool.

Figure 3. Stepped support of the MTB with regulated elastic characteristic

2.3. Description of the operating cycle of the tool

In initial (adjusted) position the tool, which is established toward the boring bar, is located inside the specially crafted adjusted unit which acts as a back reversing center of universal lathe and more precisely in the opening of the guide sleeve which appears continuation of back center. The circular primary motion is transmitted to the workpiece from the front to the reverse centre and the feed movement is realized by longitudinal carriage. The processing of the surface finishes when deforming rolls leave the outgoing head of the workpiece.

During the stroke the cutting fluid is fed copious through the back center, the bulk of which passes through holes made on the hub 8 and taper sleeve 29 transporting chips to the front center. Through central clear opening of boring bars is actuated push rod that reaching the support 21 moves it in the direction of feed movement, shrinking tensioned spring 23 and by the studs 18 and flange 17 this movement is transmitted to the whole range of details relating to the separation bushing 7. At the same time and the same distance the rod 30 moves too. It enters with its front end between the two equal parts 1 (Figure 2) of the block and two-step support 5 is moved so that it stands on its lowest rung against the adjusting screws. In this situation, cutting and deforming parts of the instrument occupy sizes smaller than adjusting and the tool returns in a quick move to the starting position contacting with the treated surface with its non-metallic guides that protect it from sag. After the rapid move the push rod is retreated and the spring 23 restores the adjusting position of the both machining parts. In two-blade block this is carried out by returning the two-step support to the starting position by means of the rear end plane of the special screw 34 (Figure 1). The last mention passes with clearance through the opening of the two-step support, within which it the block has the necessary and sufficient freedom to self-establish freely during the work.

3. CONCLUSION

With the described design of the instrument is solved serious technical problem accompanying the combined processing of deep holes - pushing out the instrument of the processed opening at a quick move without the formation of unacceptable traces on its mirror surface.

Its important advantages are:

- the possibility of removing the two times greater allowance of machining in comparison with existing similar instruments;
- high accuracy of the diametral dimension of treated surfaces;
- high productivity of the processing.

The first two advantages are resulted respectively from the axial displacement of the cutting inserts and the regulated stability of the MTB. The third advantage is due to the opportunity to work with great feed which is created by the special geometry of the used inserts.

4. REFERENCES

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