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EXPERIMENTAL RESULTS AS REGARDS THE QUALITY OF THE SURFACES OBTAINED BY PRECISION CUTTING OF THE BARS

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Abstract: *Research conducted over several years led to design a new type of shearing device for cold cutting of bars, semi-closed, with elastic radial clamping of bar on both sides of the cutting plan, simple, compact, sealed and small dimensions. The originality of concept and construction was validated by patent. An experimental model was designed and made in very good condition. Experimental research relative to that was conducted entirely in laboratories of Economic Engineering and Production Systems Department at Transilvania University of Brasov, and covered several aspects. In this paper are presented results only on flatness and perpendicularity of parts cut with it.*

Key words: *cutting shear, cutting device, flatness, perpendicularity, invention.*

1. INTRODUCTION

The obtaining of work pieces under conditions of efficiency and quality is an important objective for production processes in machines manufacturing industry. Precision cutting represents the way to achieve these conditions. Every time possible, precision cold shear cutting is taken into consideration for large series and mass production.

Literature [4 and 7] presents a wide range of principle diagrams and cold shear cutting devices that are also utilized in practice. Alas, for precision cold shear cutting literature indicates only two diagrams as possible and applicable, both of closed type, one with radial and the other one with axial clamping of the bar.

Innovative theoretical and applicative research conducted at the Transilvania University of Brasov over several years [1] has been aimed at widening the range of the diagrams for the precision cold cutting of bars, and at the development of corresponding new constructive solutions of devices.

Research was focused on a working diagram – cold shear cutting, semi-closed, with elastic radial clamping of the work piece on both sides of the cutting plane and zero axial clearance – a diagram not described in literature.

Theoretical research has allowed the identification of a new family of cutting devices corresponding to the considered working scheme, a family based on ten variants of a lever mechanism. The family includes 55 devices, of which ten are homogenous [1]. One of these has already obtained a patent [2], and the others are to be protected similarly.

2. THE EXEPRIMENTAL DEVICE

In order to validate the theoretical concept referring to the correctness of construction and functionality of the designed new devices, a necessary stage was conducting applicative experimental research.

The device „**Ab │ Ab**", Fig. 1, the patented one, was selected for being designed and constructed as the experimental model.

The experimental model, Fig. 2, follows to a large extent the patented constructive solution. The model however is not endowed with stroke stoppers of the workpiece feed, while a significantly simplified solution was adopted for the stopping mechanisms of the slide withdrawals, thus facilitating the feed of the bars to be cut.

3. EXPERIMENTAL RESULTS

Experimental research was conducted in the laboratories of the Department of Economic Engineering and Manufacturing Systems of the Transilvania University of Brasov on a PAI 25 press.

Upon adequate adjustment of the machine, 5 mm calibrated bars were cut, made from aluminum, chrome, OL42 steel, OLC45 steel and 41CrNi12 stainless steel.

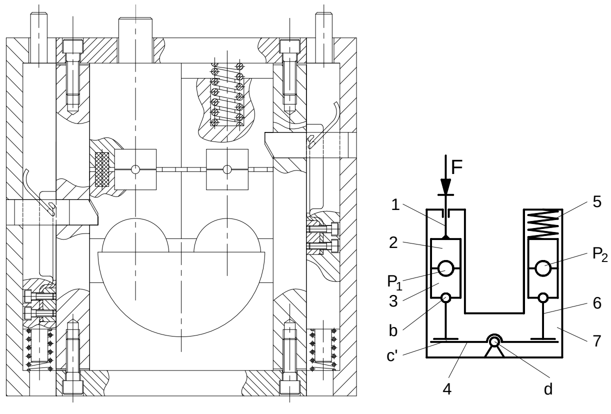

Fig. 1. Device "Ab │ Ab" and the principle diagram of the corresponding mechanism [1].

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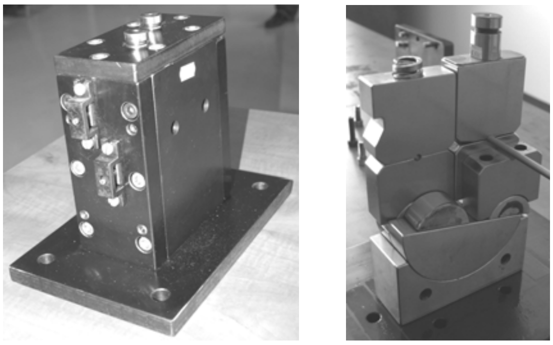


Fig. 2. Experimental model – general view (left) and partial view (right) on the assembly of the mechanism.

Also bars of diameters smaller than 5 mm were cut, made from OL00 steel – of 4.5 mm diameter, and from copper – of 4 mm diameter.

For all cutting operation included by the experimental research, the pre-clamping springs of the device were pre-strained in order to generate a force of approximately 5000 N. The utilized PAI 25 press has a working frequency of about 50 return strokes/minute. For the cutting operations carried out as part of the experimental research the total length of the press sliding block stroke was adjusted to 40 mm.

For the cutting of the 5 mm bars, the active (load) stroke of the machine is of 2.6 mm. Under these conditions the velocity at the start of the cutting is of $v = 52.6$ mm/s.

3.1. Results as regards the deviation from flatness of the surfaces obtained through cold precision cutting in the framework of the experimental researches

All pieces obtained through cutting with the experimental device were measured in order to determine the deviation from flatness of their frontal surfaces, those generated through cutting. To this purpose, a horizontal comparator 208.001 meter was used, of an accuracy of 0.002 mm. The measurements were achieved within the laboratories of the Economic Engineering and Production Systems Department, the place wherein all experimental researches were carried through.

The obtained values, grouped according to the material of the bars, are synthetically shown in Table 1.

The deviations from flatness of all surfaces obtained through cutting range between the general field 0.004÷0.082 mm, and the great majority within the field 0.016÷0.058 mm.

Table 1

Results as regards the deviation from flatness of the surfaces generated through cutting with the experimental device

Material of the bars	Field of values for the deviation from flatness [mm]	Medium value of the deviation from flatness [mm]
Copper	0.004 ÷ 0.022	0.011
Aluminum	0.008 ÷ 0.046	0.018
OL00	0.012 ÷ 0.054	0.025
OL42	0.024 ÷ 0.078	0.043
OLC45	0.016 ÷ 0.082	0.056
41CrNi12	0.008 ÷ 0.070	0.033
Chromium	0.014 ÷ 0.066	0.036

The specialized literature [3, 4, and 7] specifies that the precision cutting is that in which the deviation from flatness of the surfaces generated through cutting does not exceed the value of 0.1 mm.

To conclude, from the standpoint of the deviation from flatness of the surfaces obtained through cutting with the experimental device, all obtained pieces satisfy this criterion and consequently the claim that the designed, realized and experimentally tested device is one for high precision cutting.

3.2. Results as regards the inclination against the perpendicular plane on the axis of the work pieces obtained through cold precision cutting in the framework of the experimental researches

In order to measure the deviation from perpendicularity against the axis of the bar of the frontal surfaces of the work pieces obtained through cutting with the device in the stage of the experimental research, the obtained samples were professionally photographed, inserted in AutoCAD files, helping lines (parallel with the axis of the samples, perpendicular on this axis and parallel with the plane of the surface obtained following the cutting) were traced and the angle that characterizes the deviation from perpendicularity was measured, with sufficiently high accuracy.

Parts of the results obtained this way are synthetically presented in Table 2.

For all measured samples, the deviation from perpendicularity against the plane perpendicular on the axis of the bar of the surfaces obtained through cutting ranges within the field 0.01°÷2.8°. The cases with deviation from perpendicularity of more than 2° are rare, being the consequence either of the axial displacement of the cut part against the knives of the device, or of small volumes of material, resulted following the cutting and which adhered to the surface generated through cutting.

The majority of the deviations from perpendicularity range within the field 0.3°÷1.1°, small values – even beneath 0.3° – being more frequent than the great ones.

Considering that the literature [4, 5, and 6] specify as superior limit of the deviation from perpendicularity the value of 3° so that, from this standpoint, the cutting through shearing should be considered of accuracy, there ensues that for all the samples obtained with the experimental device and measured within the research, this criterion is fulfilled, therefore the device is for accurate cutting.

5. CONCLUSIONS

A novel principle and constructive concept has been developed for cold shearing devices of bars. The concept underlay the design of a family of devices.

For one of the devices, a patent specification was required and obtained [2]. Corresponding to this device of the family, an experimental model device was designed, constructed and tested.

All pieces obtained through cutting with the experimental device were measured so as to determine the deviation from flatness of their frontal surfaces, those generated through shearing. To this purpose, a horizontal comparator meter was used, of the precision of 0.002 mm.

Table 2

Results as regards the deviation from perpendicularity against the perpendicular plane on the axis of the bar of the surfaces generated through cutting of several pieces obtained through shearing with the experimental device

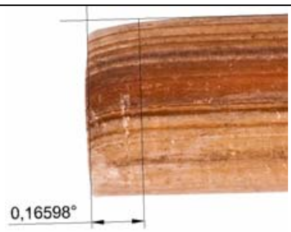
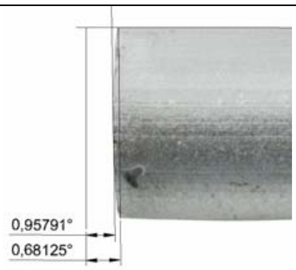
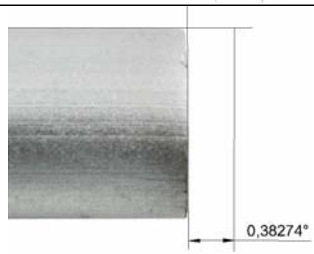
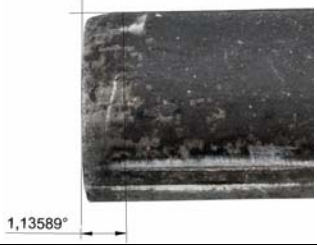
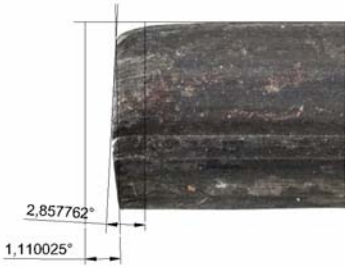
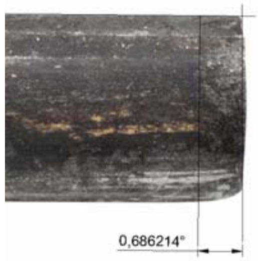
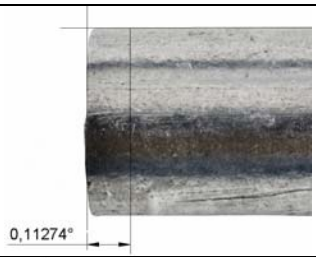
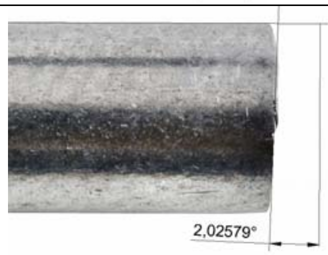
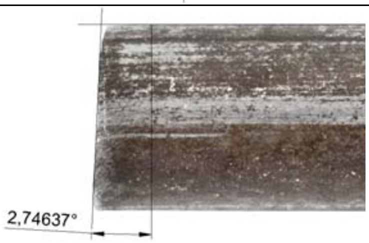
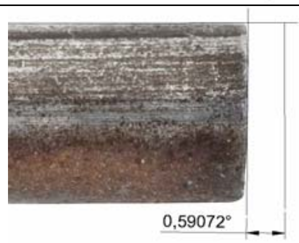
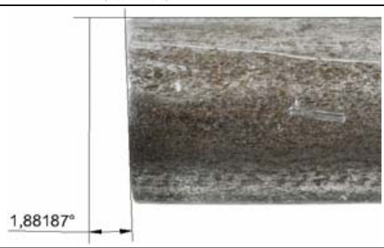
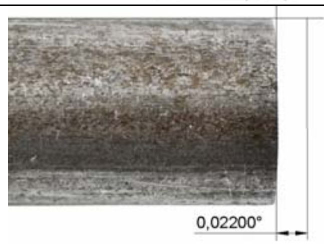
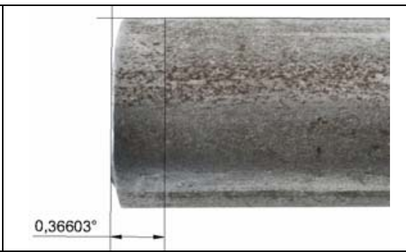
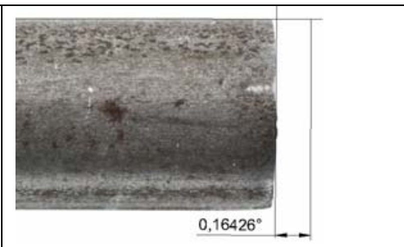
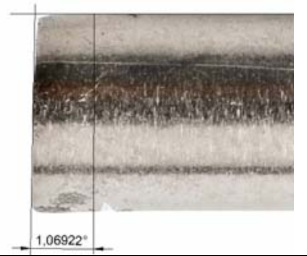
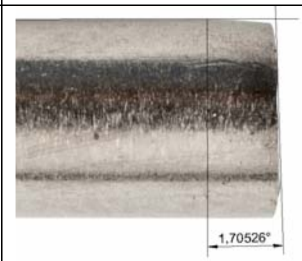
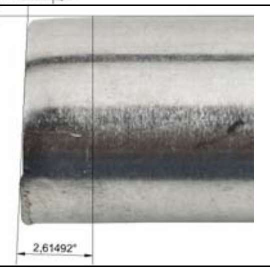
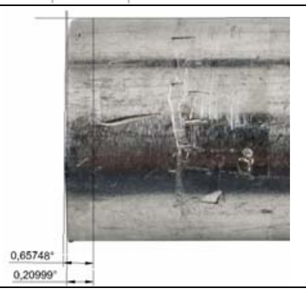
No.	Material of the sample	Sample		α_{min} α_{max}
1	Copper			0.01087° 0.16598°
2	Aluminum			0.38274° 0.95791°
3	OL00			0.51117° 1.13589°
4	OL00			0.686214° 2.857762°
5	OL42			0.11274° 2.02579°
6	OLC45			0.59072° 2.74637°
7	OLC45			0.02200° 1.88187°

Table 2, Continuation

8	OLC45			0.16426° 0.36603°
9	41CrNi12			1.06922° 1.70526°
10	Chromium			0.05993° 2.61492°
11	Chromium			0.20999° 1.34962°

The deviations from flatness of all surfaces obtained through shearing range within the general field 0.004÷0.082 mm, and the great majority in the field 0.016÷0.058 mm. There is accurate cutting the one in which the deviation from flatness of the surfaces generated through cutting does not exceed the value of 0.1 mm. All pieces obtained meet this criterion and consequently the claim that the designed, realized and experimentally tested device is one for accurate cutting proves justified.

For all measured samples, the deviation from perpendicularity of the surfaces obtained through cutting against the axis of the bar fits within the range 0.01°÷2.8°. The cases with deviation from perpendicularity of more than 2° are rare. The majority of the deviations from perpendicularity range within the field 0.3°÷1.1°, small values – even beneath 0.3° – being more frequent than the high ones. As the cutting is deemed of accuracy if the deviation from perpendicularity has a maximal value of 3°, there ensues that for all samples obtained with the experimental device and measured within the research, this criterion is met, therefore from this standpoint the device is for precision shearing, too.

The experimental device was donated by the authors to Transilvania University of Brasov.

The authors take the necessary steps for patenting other homogeneous devices of the family.

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