

# New Type of Cutoff Tools and Hard-Alloy Multifaceted Unresharpenable Plates for Their Equipping

Nastasenko VA\*

Kherson State Maritime Academy, Kherson, Ukraine

## \*Corresponding author

NastasenkoVA, Kherson State Maritime Academy, Kherson, Ukraine, Uschakov st, 41 Post-Box 141, Post Index 73003; Tel: (+380552) 437-003 (or) +38 050-807-91-99; E-mail: Nastasrenko2004@ukr.net

Submitted: 10 Mar 2018; Accepted: 17 Mar 2018; Published: 31 Mar 2018

## Abstract

**Purpose:** This paper deals with the sphere of designing and manufacture cutting tools in designing with assembled parting-off cutters equipped with multifaceted unresharpenable plates (MUP).

**Methodology:** Lathe tools are the most popular among cutting tools and one of the ways of their improvement is to turn to assembled structures with mechanical fixing quickly replaceable multifaceted unresharpenable plates. In the sphere of developing assembled parting-off cutters the most effective technical solutions were found by foreign firms: Sandvik Coromant, Iscar, Horn, Taegu Tec, Mitsubishi and others. The analysis of these constructions show that 2 principles realized here: 1) side fixing of plate to the head of holder body 2) side installation with plate fixing by tacks or elastic clamps. In the first case multiage plates are used and in the second case one and two edge ones. The simplest variant – is to set standard MUP on lateral side and form. However, such variant is not acceptable as considerable radius of mating lateral faces MUP ( $r \geq 0,2$  mm). To eliminate radius  $r$  is possible by making flats  $m$  or ark grooves with radius  $r_b$  at the tap of MUP.

**Result:** The system of plates of new type is developed – lateral multifaceted unresharpenable plates (LMUP) created basing on standard hard alloy plates. Increase the depth of cutting of from 6,1 to 16,5 mm, relative expense of hart material alloy on one cutting plate edge in 1,1 – 2times superior in mass to the mass base plate.

**Originality:** New type of cutting plates was developed – lateral multifaceted unresharpened plates (LMUP), their differential feature is the availability of sharp cutting edges on side faces made by additional sharpening along the tops of their flats or arc grooves. These plates of decoding to the Russian Federation patent for the invention № 2366542.

**Practical value:** Suggested LMUP even in minimum trihedral execution are considerably superior to in size-mass characteristics to multiedge bas plates of leading world producers: Sandvik Coromant, Iscar, Horn, Taegutec, Mitsubishi and others which allows to recommend them for wide application.

**Keywords:** Multifaceted Unresharpenable Plates, Equipping Cutting Tools

## Introduction

The work relates to the sphere of cutting tools, in particular, to assembled cutting tools equipped with multifaceted unresharpenable plates (MUP) made of hard alloys. Tool materials from hard alloys are among the most progressive for equipping many types of cutting tools. The preferred variant of their manufacture and operation is in assembled design with mechanical mounting of MUP on a tool body of multiple uses, which eliminates the need for resharping

and in the presence of the sharpening section [1]. Most widely, these designs are used for straight turning tools, side-facing and copying tools, but for cutoff tools the creation of assembled designs is hampered by the need to minimize the cut width and the difficulties in mounting and fixing the plates, and therefore no ideal technical solutions have been found so far.

The solution of this problem is urgent and important, because the need for highly efficient, technologically advanced cutting tools is constantly growing, due to their wide expansion and application conditions. For example, in turning machining and bar-chucker

semi-automatic machines, there is still no alternative to cutoff tools. Eliminating the need for their resharpening through the use of MUP, confirms the high level of practical importance of the creation of such tools. The main purpose of the work performed is to analyze the known designs of cutoff tools and MUP for their equipping, the selection and development of their most preferred options.

### Materials and Results of the Research

Currently, the most effective technical solutions for assembled cutoff tools and unresharpenable hard-alloy plates of specific shape for their equipment have been created by foreign manufacturers: SANDVIK COROMANT, ISCAR, HORN, TAEGUTEC, MITSUBISHI, etc. [2-8].

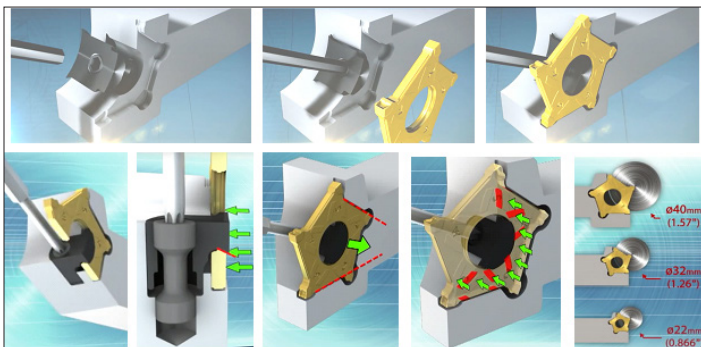
They have developed a number of basic designs, shown in Fig. 1, 2 and 3, in which 3 principles are implemented:

1. Lateral fastening of plates to the head of the tool holder body with a screw (Fig. 1.)
2. Lateral mounting and fastening of plates through their central hole (Fig. 2)
3. Lateral mounting with fastening of plates with clamps or elastic joints (Fig. 3).

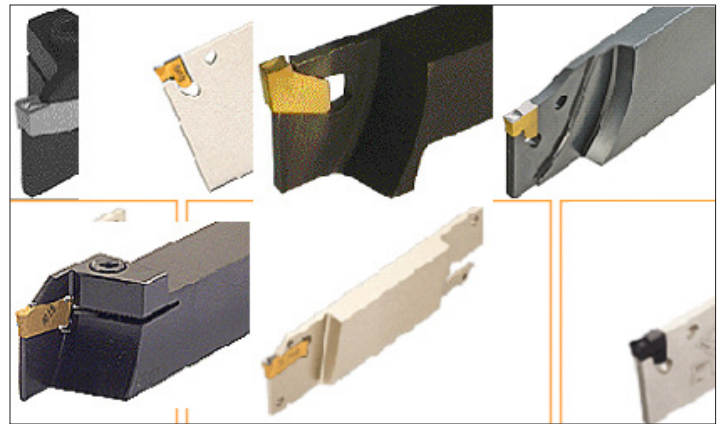
Herewith, in the first and second cases, multi-blade plates are used, and in the third case - simpler one- and two-blade ones.



**Figure 1:** Basic designs of assembled cutoff tools with mechanical lateral fastening of multifaceted unresharpenable plates manufactured by leading world companies



**Figure 2:** Basic designs of assembled cutoff tools with lateral mounting and mechanical fastening of PENTA IQ GRIP plates through their central hole



**Figure 3:** Basic designs of assembled cutoff tools with lateral mounting and mechanical fastening of one- and two-faceted unresharpenable plates manufactured by leading world companies.

The advantage of the cutoff tools of the 1st group (Fig. 1) is an increase in the number of cutting blades to 3 ... 5, which extends the possibility of remounting the plates as cutting blades become blunt.

### Disadvantages are as follows

1. Limitation of cutting by the radius of parts 6 ... 10 mm (Fig. 1), that is why such plates and cutters are effective only for cutting pipes and thin bars;
2. To completely replace worn plates, complete screw removal is necessary, which increases the processing time for this operation;
3. Big size of the plates and a decrease in the strength of their extension parts;
4. Considerable consumption of expensive tool material due to the need for a middle attachment section that increases the cost of MUP,
5. Complexity of the plate shape and the manufacture of the holder for their attachment.

### Advantages of tools and plates of the 2<sup>nd</sup> group (Fig. 2)

1. Increase in the number of cutting blades to 5
2. Increase in the cutting radius to 20 mm,

### The disadvantages of the plates of this group

1. Inconvenience of remounting and fastening of the plates,
2. Complexity of plate shape for manufacture and operation;
3. Complex design of cutting tools.

### The advantages of tools and plates of the third group (Fig. 3)

1. Increase in the cutting radius to 30 ... 55 mm,
2. Relative simplicity of plate shape;
3. Relatively simple design of cutting tools.

### The disadvantages of the plates of this group

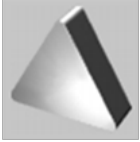


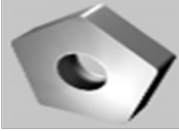
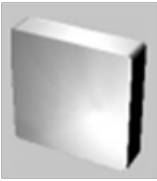



1. Relative inconvenience of remounting and fastening of small-sized plates,
2. Specific increase in the cost of sintering the plates in the recalculation on 1 cutting edge.

Thus, it is expedient to eliminate these drawbacks when improving the positive factors of cutoff tools and MUP.

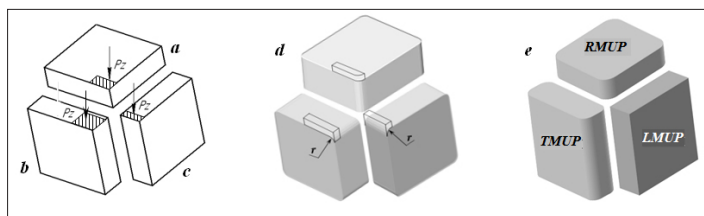
## Development of New Designs of Plates and Cutoff Tools

Standard plates used in turning tools have a simpler shape (Table 1). However, their use for cutoff tools is impossible, which requires their analysis and elimination of the identified disadvantages.

**Table 1: Basic MUP types used in assembled cutting tools and their main parameters**

MUP type	Plate parameters, sphere of application	MUP type	Plate parameters, sphere of application
	Plates of three-faceted shape – for straight turning tools, side-facing and boring tools		Diamond shaped plates with an angle of 55° and a hole – for copy turning tools
	Plates of irregular three-faceted shape with an angle of 80° and a hole for straight turning tools, side-facing, boring and free-cutting tools		Plates of five-faceted shape with a hole – for straight turning tools and face milling cutters
	Plates of square shape – for straight turning tools, side-facing and boring tools		Plates of six-faceted shape with a hole – for straight turning tools and face milling cutters
	Diamond shaped plates with an angle of 80° and a hole – for copy turning tools		Plates of round shape with a hole – for straight turning tools and face milling cutters

In the framework of the general scheme shown in Fig. 4 for mounting plates in the cutting tools covering all faces of the cube, a radial (Fig. 4.a), tangential (Fig. 4.b) and lateral mounting (Figure 4.c) is possible. However, the use of radial plates for tangential and lateral mounting is impossible, since a considerable radius  $r$  on the points (Fig. 4.d) worsens the conditions for cutting the root of the chips. Therefore, it is necessary to divide MUP into radial (RMUP), tangential (TMUP) and lateral (LMUP) (Figure 4.e), which cannot be interchangeable.



**Figure 4:** Interrelation of possible schemes for mounting cutting plates in the cutting tools along the three cube planes: a) radial, b) tangential, c) lateral, d) chip cutting options for radial MUP mounting on 3 cube planes, e) transformation of the structural and geometric parameters of the plates with radial (RMUP), tangential (TMUP) and lateral (LMUP) mounting.

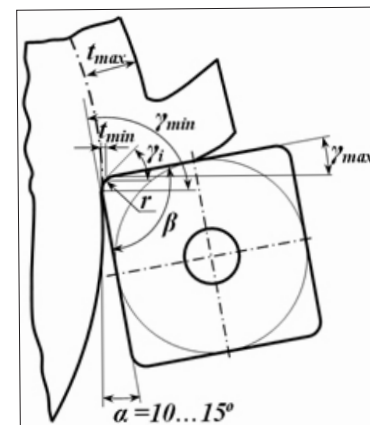
### Thus, the main tasks of the work performed are

1. Widening of the possibilities of application in cut-off tools of multiblade MUPs of the simplest forms;
2. Reduction of the complexity of manufacturing and

application of the simplest MUPs in cutoff tools;

3. Simplifying the design of cutoff tools for their application. At the same time, the cost of the proposed MUPs and the cutoff tools they are equipped with is reduced.

However, the analysis showed that it is not possible to use RMUPs in cutoff tools as the presence of a transitional radius  $r \geq 0.2$  mm at their points excludes the possibility of cutting with them when removing chips with a thickness of  $t_{min} \leq 0.5r$ , since the initial rake angle  $\gamma_{max} = -\alpha$  (where  $\alpha$  is the relief angle), in this section varies from  $\gamma_i = -(45^\circ + \alpha)$ , to  $\gamma_{min} = -(90^\circ + \alpha)$ , (Fig. 5):

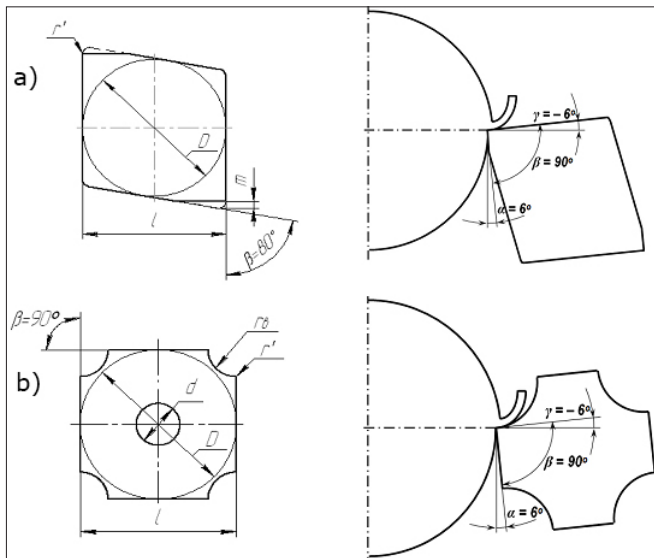


**Figure 5:** Transformation of the geometry of the cutting wedge on the radial point of the plate with its lateral mounting

The specific proportion of areas with rake angles unfavorable for cutting increases in the total length of the loaded edges with a decrease in the thickness of the cut layer from  $t_{max}$  to  $t_{min}$ . At  $\gamma_i < -45^\circ$  on the radius section  $r$  at the point, the cutting stops and the metal extrusion begins, the process of which is accompanied by considerable deformation of the cut layer, which leads to a substantial increase in the cutting forces and the power expended on the formation of the chip root. Thus, it is necessary to eliminate these drawbacks.

In the patent for the invention No. 2366542, of the Russian Federation, this problem has been solved by further sharpening the flats or radius grooves  $rb$  at the MUP tops after pressing them, which reduces the initial transition radial section from  $r \geq 0.2$  mm to the value of  $r \leq 0.01$  mm (Fig.6.a, b) and reduces MUP to a new type - lateral multifaceted unresharpenable plates (LMUP) in the framework of the mounting diagrams shown in Fig. 4 [9,10]. It should also be noted that in addition to reducing the width of the groove to be cut, the advantages of LMUP are: simplicity of shape, increase in the number of cutting edges and an increase in the thickness of the cross-section of the plate in the direction of cutting forces, which is a reserve for increasing productivity. The substantiation of the possibility of transition from typical MUP to LMUP by performing flats or arc grooves on the tops that provide the formation of cutting edges on the lateral sides of the plates, as well as their investigation, constitutes the scientific novelty of the work performed. The transformation of the original RMUP into the proposed LMUP of two varieties: of lateral mounting and lateral fastening, is shown in Fig. 7 on the example of the simplest three-faceted plates.

Proposed LMUP, made under the patent of the Russian Federation No. 2366542 on the basis of the initial (Table 1) with a minimum length of the lateral sides of 16 mm and a maximum length of 30 mm, which exceeds all known versions of the plates for cutoff tools (Fig. 1, 2). They are able to replace ISCAR Pentacut plates with a reduction in overall dimensions and in complexity of manufacturing plates and cutting tools.

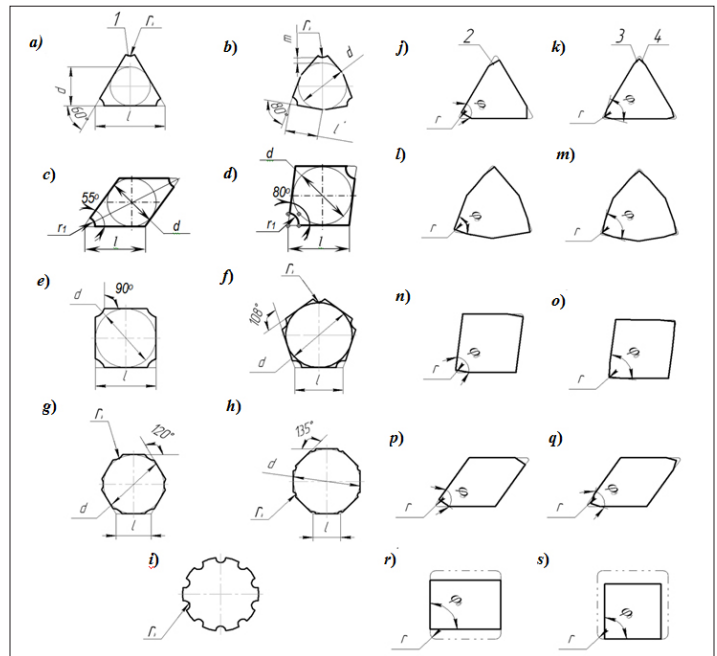


**Figure 6:** The simplest LMUP: a) with flattened surfaces  $m$ , b) with grooves  $rb$ , eliminating the transitional radius of mating the lateral sides, formed when they are pressed with RMUP



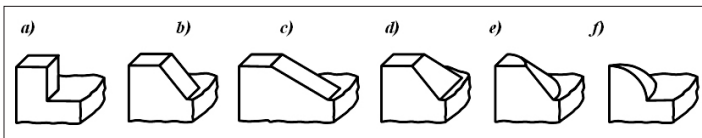
**Figure 7:** Transformation of the original RMUP to the proposed LMUP

The shapes of the other kinds of initial plates (Table 1), having grooves 1 or flats 2, or the double left 3 and right flats 4, removing the radius transition section  $r$  at the points of the sides are shown in Fig. 8 [11]. The creation of radius grooves at the points of LMUP doubles the number of cutting edges and the possibility of their remounting, adequately reducing their usage rate. At the same time, the number of versions of the proposed LMUP doubles due to the implementation of their central holes, which covers the field of 36 possible technical solutions in this area. It's plates: a) three-faceted, b) three-faceted with a profile angle of  $80^\circ$ , diamond-shaped with a profile angle of  $55^\circ$ , c) diamond-shaped with a profile angle of  $80^\circ$ , d) square, e) five-faceted, f) six-faceted, g) seven-faceted, h) round, i) tree-faceted with a flat, j) three-faceted with two flats, k) three-faceted with a profile angle of  $80^\circ$  and a flat, l) three-faceted with a profile angle of  $80^\circ$  and two flats, m) diamond-shaped with a profile angle of  $80^\circ$  and a flat, n) diamond-shaped with a profile angle of  $80^\circ$  and two flats, o) diamond-shaped with a profile angle of  $55^\circ$  and a flat, p) diamond-shaped with a profile angle of  $55^\circ$  and two flats, q) rectangular, r) square.



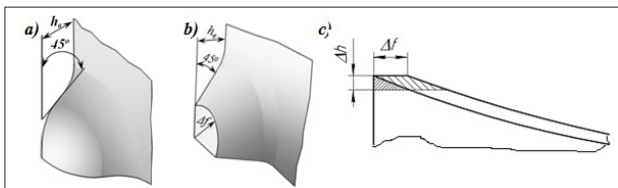
**Figure 8:** Shape of standard LMUP with arc grooves  $r_1$  of radius  $r_1$  or with flats 2, 3, 4, removing radial transition sections  $r$  at the lateral cutting edges at the points

To exclude grinding in the cut of the sides of LMUP of cutoff tools, the patent No. 2366542, suggests various versions of lateral protrusions at the points obtained during pressing (Fig.9): a) cubic; b) cubic with bevel; c) cubic with an elongated bevel; d) pyramidal; e) conical, cut at the top and sides; f) spherical, cut on the sides [9].



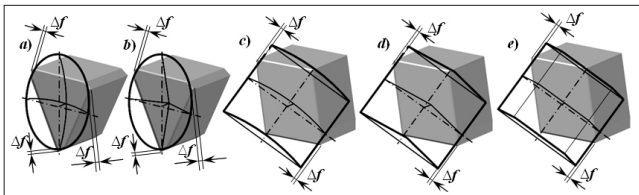
**Figure 9:** Designs of the protrusions at the points on the sides of LMUP

Taking into account the technology of plate manufacture and operating conditions of molds, it is preferable to produce spherical projections with transitional radius sections at the foot (Fig. 10.a). Depending on the LMUP thickness, the height of the projections is  $h_b = 0.4 \dots 0.8$  mm, and to ensure the projection strength – its angle should be  $\geq 45^\circ$ . To reduce the heat concentration at the projection top and its wear, the spherical part can be cut (Fig. 10.b), with the formation of an arc pad of radius  $\Delta f$ , which is close in size to the height of the projection  $h_b$ . In this case, the amount of material rubbed at the tops increases within the same value of linear wears  $\Delta h$  (Fig. 10c).



**Figure 10:** Preferred forms of projections at the tops on the lateral sides of LMUP

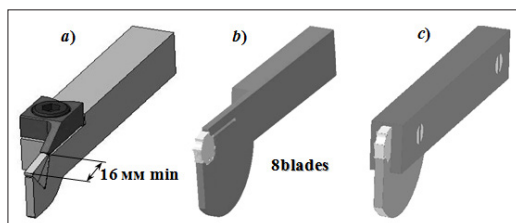
In patent №2366542, there are also possible versions of different types of grooves on the sides of LMUP obtained during pressing in mass production or as a result of additional sharpening in individual production (Fig. 11): *a*) concave spherical; *b*) conical; *c*) cylindrical; *d*) angular, *e*) trapezoidal. In addition, it is also advantageous for the tops to preserve residual areas of  $\Delta f$  [9].



**Figure 11:** Designs of the grooves protrusions at the points on the sides of LMUP

Thus, the offered LMUP designs provide all the required cutting conditions for cutoff tools and exceed the capabilities of that known [12].

The fastening of the proposed plates in the holder of cutoff tool body is shown in Fig. 12 and can be made by *a*) stitching, *b*) elastic clamping, *c*) U-shaped body.



**Figure 12:** Suggested designs of cutoff tools with LMUP and comparison of their parameters

The manufacturing of the proposed LMUP by additional sharpening allows obtaining experimental samples for testing. The tests carried out make it possible to recommend the proposed cutoff tools and LMUP for wide implementation.

## Conclusion

1. A classification of multifaceted unresharpenable plates MUP with division into radial RMUP, tangential TMUP and lateral LMUP is proposed and their distinctive constructive and geometric parameters are described.
2. A distinctive feature of LMUP is the presence of sharp cutting edges on the sides, which are obtained by their additional sharpening at the profile tops, in the form of longitudinal flats or arc grooves, which allows them to be classified as a separate type of quick-changeable cutting plates.
3. The proposed LMUP with flats, even in the minimal tree-faceted version with a profile side length of 16 mm, significantly exceed in size and mass characteristics the well-known multi-edged unresharpenable plates of the world's leading manufacturers: SANDVIK COROMANT, ISCAR, HORN, TAEGUTEC, MITSUBISHI, etc., which allows recommending them to wide implementation.
4. The proposed LMUP with arc grooves on the tops doubling the number of cutting edges (up to 6 in three-faceted and up to 8 in square ones) exceed in their number the known 3, 4 and 5-faceted plates of all the world's leading manufacturers: SANDVIK COROMANT, ISCAR, HORN, TAEGUTEC, MITSUBISHI, etc., which allows them to be recommended for wide implementation.

## References

1. Ivanov Yu I, Zakonov OC (2007) Ocenka Ehfektivnosti Instrumentov so Smennimi mnogogrannimi plastinami “Stanki i instrument” 6: 07-12.
2. Smenniye plastinih i instrument: [catalog] (2000) Sandvik Coromant 172.
3. Produktiya Concern Sandvik Coromant: [catalog] (2015) Shveden: Sandvik Coromant 126.
4. Katalog firmih Iscar / Otrezka [Elektronniy resurs] (2010) 29 p, rezhim dostupa: <http://www.iscar.com/eCatalog/Products.aspx?mapp=TG&app=51>.
5. Katalog firmih Horn / Otrezka [Elektronniy resurs] (2015) 40 p rezhim dostupa: [https://www.phorn.de/fileadmin/user\\_upload/media/PDF/Catalogues/DE-EN/2014-2015/Chapters/Drehen-F\\_224.pdf](https://www.phorn.de/fileadmin/user_upload/media/PDF/Catalogues/DE-EN/2014-2015/Chapters/Drehen-F_224.pdf).
6. Metalworking Cutting Tools Shop version: [katalog] (2008) TaeguTec 188.
7. Tokarniy instrument (2007) vrathayuthiysya instrument, instrumentalniye sistemih [obthiy katalog] Mitsubishi 206. [www.iscar.penta-iq-grip](http://www.iscar.penta-iq-grip)
8. Patent Rossiyskoy Federacii na izobrenie No 2366542 MPK V27V 27/16 Sborniy otreznoy rezec i rezhuthie plastinih k nemu. Zayavka No 2007111687 ot 29.03.2007. Avt. izobr. Nastasenko V.A., Babiy M.V. //Opublikovano 10.09.09. BI No 25.
10. Nastasenko VA, Babiy MV (2009) Noviye vidih otreznikh i kanavochnikh rezcov s mnogogrannimi tverdospлавnimi neperetachivaemimi plastinami “Progressivniye tekhnologii i sistemi mashinobuduvannya: mizhnarodniy zb. nauchivkh pracj”, Donecjk, DonNTU 38: 150-157.
11. Nastasenko VA, Babiy MV, Blah IV, Virich VV (2011)

---

Noviye vidih rezhuthikh instrumentov s bokovoyj ustanovkoyj rezhuthikh plastin "Progresivni tekhnologii i sistemi mashinobuduvannya : mizhnarodniyj zb. naukovikh pracj", Donecjk, DonNTU 41: 186-194.

12. Babiyy M V (2010) Evolyuciya kanavkovikh ta vidriznikh rizeiv i perspektivi ikh rozvitku "Visnik Khmeljnicjkogo nacionaljnogo universitetu" 5: 120-126.

**Copyright:** ©2018 Nastasenko VA. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.