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PRECISION OF HOLE PROCESSING BY REAMER-BROACHING

To process holes in bushings, flanges, pulleys and other similar parts, various types of metal-cutting tools are used: drills, countersinks, reamers, broaches, and others. The use of a particular tool depends on the required accuracy, roughness and type of production.

Unfavorable cutting conditions cause an increase in the mechanical load on the blade section, where the chips separate from the main layer of material and its deformation, which is accompanied by significant heat release and low tool life.

This article proposes the processing of high-precision holes – a reamer-broaching, the design of which is confirmed by the patents of the Republic of Kazakhstan, and structurally combines the features of a reamer and a broach. This design provides favorable cutting conditions, which contributes to high machining accuracy and low surface roughness.

In cross-section, the profile of the helical teeth of the reamer-broaching can be of the following versions: standard profile of the reamer teeth, equal-wide tooth profile, like a broach with a helical equal-wide tooth, cutting-deforming.

The results of production testing of samples are given, the analysis shows that the accuracy of the diametrical dimensions of the holes after processing with a reamer-broaching increased by 1.2 quality compared to a machine standard reamer; the roughness decreased by 1, 2 classes.

Keywords: processing, hole, accuracy, quality, roughness, reamer, broach.

Introduction

One of the urgent problems of mechanical engineering is the processing of holes, which are subject to high requirements for the accuracy of size, shape and location.

Hole processing is carried out with metal-cutting tools: drills, countersinks, reamers, broaches, boring cutters, blocks and boring heads. Depending on the requirements for the accuracy of the holes, appropriate tools are used. Drilling and countersinking are preliminary operations, the rest are finishing operations.

When processing holes in body parts, bushings, flanges and similar machine parts, countersinking and unfolding operations are widely used. However, the countersink, the most common tool for processing holes after drilling, casting, forging, like any other tool with a short and therefore mechanically and thermally heavily loaded cutting part, has a limited cutting speed and relatively low durability. Wear is concentrated in the local area along a small length of the cutting part.

The unfolding is carried out with significantly lower cutting speeds, however, the cutting part also has a relatively short length and undergoes significant wear during operation. The reamer has small cutting edges in length that are constantly in operation, and the penetration of coolant into the cutting zone, where the material being cut at a high cutting temperature and a greater degree of deformation is in conditions of comprehensive hydrostatic compression, is difficult, which contributes to an increase in the intensity of wear. In addition, the rigidity of the spindle assembly of drilling machines is insufficient. With a large length of the processed hole, a longer length of the cutting tool, for this reason, the processing accuracy decreases and the roughness increases.

Materials and methods

Unwrapping and broaching are finishing operations. The disadvantage of unfolding is that the cutting work is focused on a relatively short cutting part and does not correct or poorly corrects the position and shape of the axis.

Unfavorable cutting conditions cause an increase in the mechanical load on the blade section, where the chips are separated from the main layer of the material and its deformation occurs, which is accompanied by significant heat generation, although less than during countersinking. Mechanical and thermal stresses lead to a relatively low resistance of cutting tools [1–10].

At the Department of Mechanical Engineering and Standardization, the analysis of methods and methods of processing cylindrical holes, parameters of the cut layer during cutting, geometry and designs of existing metal–cutting tools (reamers, broaches, combined tools) has been carried out, new metal-cutting tools have been developed to improve processing accuracy, surface quality of parts and productivity, patents of the Republic of Kazakhstan have been obtained [11–14].

Results and discussion

The advantages of broaching are used in the new design of the cutting tool: relatively low cutting speed, processing quality (size accuracy, roughness), reduction of abrasion.

Scanning-broaching allows to significantly reduce the breakdown of holes that occurs when processing with drills and countersinks, as well as to reduce the roughness of the treated surface and increase the durability of the tools themselves [4-5].

The sweep-broach is structurally constructed according to the following principle: in the axial section it has design features corresponding to the broach: the front shank, neck, front and rear guides, cutting and calibrating parts, and in the cross section the signs of the sweep: the shape and number of teeth, the geometry of the cutting part, and when working it rotates like a sweep (Figure 1).

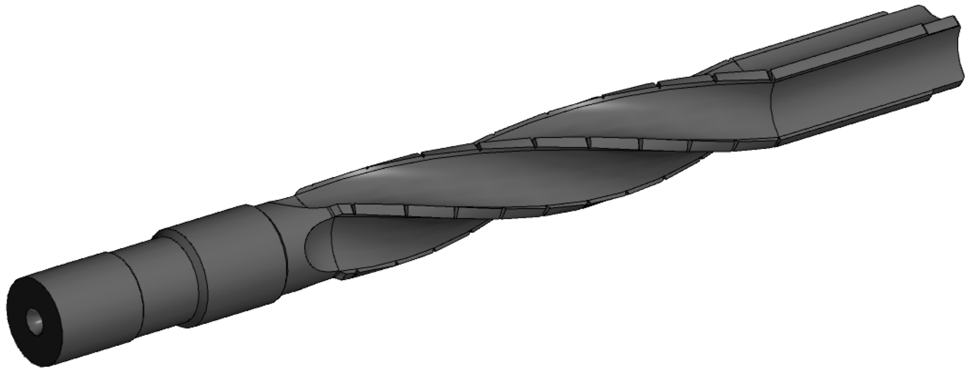

Figure 1 – 3D model of the sweep-broach

In cross-section, the profile of the helical teeth of the sweep-broach can be of the following versions: the standard profile of the teeth of the sweep, the equi-wide profile of the teeth, like a broach with a helical equi-wide tooth, cutting-deforming [13].

The use of an equidistant profile of teeth allows you to increase the durability of the sweep-broach, the number of overflows, and, consequently, to increase the service life due to overflowing along the back surface, unlike broaching with circular teeth, and recreate the state of the back surface after overflowing to the state of a new tool, which improves the quality of processing.

The use of a cutting-deforming profile allows for the cutting process and surface plastic deformation. The formation of the treated surface of the cylinder is carried out by the smoothing tape f, however, a sharp transition from a deformed to a non-deformable state can cause a deterioration in the quality of the treated surface. To eliminate this phenomenon, an angle of $\xi \leq 10°$ was introduced after the ribbon, providing a smooth transition from the deformed to the undeformed state of the treated surface to improve its quality.

The material of the cutting part of the sweep-broach can be both high-speed steel R6M5 and others, and soldered plates of a hard alloy.

The sweep-broach makes it possible to increase the efficiency of hole processing compared to stretching and unfolding by combining in one tool the signs of the sweep and broach: increasing durability, the total resource of the tool, the possibility of re-drawing the sweep-broach along the back surface and improving the quality of the surface to be processed, reducing the temperature and specific load on the cutting edges in the cutting zone; execution with cutting and deforming teeth provides an increase in the quality of processing.

The processing of the holes of machine parts with a sweep-broach is carried out on a lathe in the following ways: by fixing the sweep-broach in the chuck and on the lathe support with the left or right direction of the screw chip grooves [14].

The sweep-broach processing scheme when installing the workpiece on the lathe support is more acceptable, because the error from the clamping forces of the lathe chuck is excluded, which affects the shape of the hole being processed.

To exclude the influence of geometric errors of the machine (radial runout of the spindle, wear of the frame guides, etc.), a floating chuck has been developed, installed in the chuck of the machine, and a device for installing the workpiece in the tool holder on the caliper has also been developed.

Figure 2 shows the scheme of processing by a sweep-broach of a cylindrical hole on a screw-cutting machine, where 1 is a sweep–broach, 2 is the workpiece, 3 is the chuck of a screw-cutting machine, 4 is a device for installing the workpiece, 5 is a floating chuck, V is the direction of rotation of the sweep–broach, S – the feed direction of the workpiece.

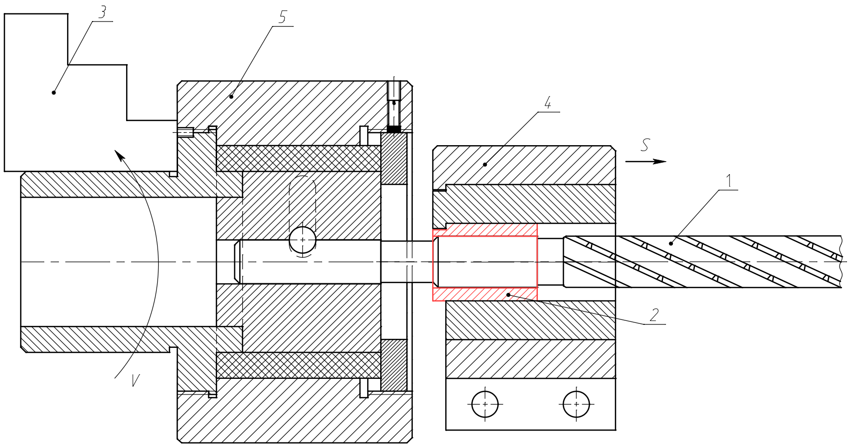

Figure 2 − The scheme of processing by a sweep-broach

When equipping mass production, a simpler special aggregate machine can be used for this operation.

Prototypes of the sweep-broach were manufactured at the machine-building enterprise of the city of Pavlodar «FormatMachCompany» LLP and tested in the educational and production workshops of the Faculty of Engineering at the Department of «Mechanical Engineering and Standardization» (Figure 3).

Figure 3 – Prototypes of the sweep-broach

Production tests were carried out at «The Plant of Non–Standardized Equipment» LLP by comparing the results of hole processing with a machine standard sweep and – sweep-broach.

Conclusions

The results of production tests of samples processed with metal–cutting tools – machine standard sweep and sweep-broach are respectively as follows:

1) the accuracy of the diametrical dimensions of the holes according to 7–8 quality, the roughness of the surface of the holes corresponds to grades 9 and 10.

2) the accuracy of the diametrical dimensions of the holes according to the 6–7 accuracy quality, the roughness of the surface of the holes corresponds to the 10 and 11 roughness classes.

The analysis of the results shows that the accuracy of the diametrical dimensions of the holes after processing by the sweep-broach increased by 1–2 quality compared to the machine standard sweep; the roughness decreased by 1–2 classes.

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ТЕСІКТЕРДІ ҰҢҒЫЛАҒЫШ-ТАРТАЖОНҒЫШПЕН ӨҢДЕУ ДӘЛДІГІ

Төлкелердегі, ернемектердегі, тегерлердегі және басқа да ұқсас бөлшектердегі тесіктерді өңдеу үшін металл кесетін құралдардың әрқандай түрлері қолданылады: бұргылар, үңгілер, с ұңгылагыштар, тартажонгыштар және басқалар. Осы немесе басқа құралды қолдану қажетті дәлдікке, кедір-бұдырлыққа және өндіріс түріне байланысты.

Кесудің қолайсыз жагдайлары кескіш құралдың жүзінің учаскесінде механикалық жүктеменің жогарылауына әкеледі, онда материалдың негізгі қабатынан бөлініп, оның деформациясы пайда болады, бұл айтарлықтай жылу шыгарумен және құралдың төмен тұрақтылыгымен бірге жүреді.

Бұл мақалада жогары дәлдіктегі тесіктерді өңдеу ұсынылады – ұңгылагыш-тартажонгыш, оның дизайны ҚР патенттерімен расталган және ұңгылау мен тартажонудың белгілерін конструктивті түрде біріктіреді. Бұл конструкция кесудің қолайлы жагдайларын қамтамасыз етеді, бұл өңдеудің жогары дәлдігіне және бетінің кедір-бұдырлыгына ықпал етеді.

Көлденең қимада ұңгылагыш-тартажонгыш бұрандалы тістерінің профилі келесі жасауында болуы мүмкін: ұңгылагыш тістерінің стандартты профилі, бұрандалы тең тісті тартажонгыш сияқты тістердің эквивалентті профилі, кесу-деформациялау.

Үлгілерді өндірістік сынау нәтижелері келтірілген, талдау көрсеткендей, саңылаулардың диаметрлік өлшемдерінің дәлдігі ұңгылагыш-тартажонгышпен өңдеуден кейін машиналық стандартты ұңгылагышпен салыстырганда 1, 2 квалитетке өсті; кедір-бұдырлық 1, 2 сыныпқа азайды.

Кілтті сөздер: өңдеу, тесік, дәлдік, квалитет, кедір-бұдыр, ұңгылагыш, тартажоңгыш.

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ТОЧНОСТЬ ОБРАБОТКИ ОТВЕРСТИЙ РАЗВЁРТКОЙ-ПРОТЯЖКОЙ

Для обработки отверстий во втулках, фланцах, шкивах и других подобных деталях применяются различные типы металлорежущих инструментов: свёрла, зенкеры, развёртки, протяжки и другие. Применение того или иного инструмента зависит от требуемой точности, шероховатости итипа производства.

Неблагоприятные условия резания вызывают повышение механической нагрузки на участке лезвия, на котором происходит отделение стружки от основного слоя материала и его деформации, что сопровождается значительным тепловыделением и низкой стойкости инструмента.

В данной статье предлагается обработка высокоточных отверстий – развёрткой-протяжкой, конструкция которой подтверждена патентами РК, и конструктивно сочетает в себе признаки развёртки и протяжки. Данная конструкция обеспечивает благоприятные условия резания, что способствует высокой точности обработки и низкой шероховатости поверхности.

В поперечном сечении профиль винтовых зубьев развёртки-протяжки может быть следующих исполнений: стандартный профиль зубьев развёртки, равноширокий профиль зубьев, как у протяжки с винтовым равношироким зубом, режуще-деформирующий.

Приведены результаты производственных испытаний образцов, анализ показывает, что точность диаметральных размеров отверстий после обработки развёрткой-протяжкой увеличилась на 1, 2 квалитета по сравнению с машинной стандартной развёрткой; шероховатость уменьшилась на 1, 2 класса.

Ключевые слова: обработка, отверстие, точность, квалитет, шероховатость, развёртка, протяжка.

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