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DESIGN FEATURES OF INSTRUMENTS IN AUTOMATED PRODUCTION FACILITIES

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The article deals with designing cutting tools in automated production facilities and with their main features – interchangeability, versatility, high accuracy.

Introduction. Cutting tools of automated production facilities should provide minimum costs when using at a given stage of processing. Based on the features of the functioning of automated production facilities, there are following requirements for the tools:

1. High reliability;
2. High and stable cutting properties;
3. Satisfactory formation and removal of chips,
4. Quick change during replacement;
5. Interchangeability, ensured by adjustment to the size outside the machine;
6. Versatile application for typical machine surfaces of various parts on different CNC machines;
7. Increased accuracy of tools for CNC machines.

All these requirements fit into the three main features:

1. High performance;
2. Low power consumption of the cutting process;
3. Economical tool.

The ways of realizing the requirements 1–7 are basically the same as for tools in general are designed according to the same algorithm. However in the conditions of the automated equipment operation, the other ways of solving a number of problems are required.

Design. Creation of new designs of cutting tools and improvement of old ones, application of new tool materials (high-speed steel of increased wear resistance, fine-grained hard alloys, hard alloys, mineral-ceramics, superhard materials based on cubic boron nitride, etc.) and using scientifically grounded cutting modes are decisive factors in increasing the period of resistance of the cutting tool and labor productivity when processing parts from various materials. [1]

First of all, when choosing a cutting material, they tend to use a material of higher heat resistance and strength in order to increase the productivity and reliability of the tool. These requirements are not always compatible. Therefore, it is necessary to find an economically advantageous solution. In order to improve the versatility of tools, cutting materials in the form of multifaceted non-re-sharpened plates (MNP) are mechanically fastened to housings. As a result, such a tool can be quickly retrofitted with plates of another cutting material. [2]

The geometric parameters of tools with MNP are provided both by the parameters of the plate itself and by the inclined mounting of the plate in the tool body.

Tighter requirements for the reliability of the methods of chip formation led to the creation of MNP with shaped front surfaces, allowing chip breaking in a wide range of elements of the cutting regime (Figure 1).

Fig. 1. Non-standard plate produced by Sandvik Coromant

Optimizing the pitch of the teeth of the prefabricated tools is reduced to finding ways to fasten the plates, which, under all other conditions, will ensure the minimum step value. Overstepping the optimum border in the direction of minimizing the step fails.

In solving the remaining tasks of the algorithm for designing the working part of the tools of automated machine building, there are no principal features. There are not any of them in the design of the guiding parts. The difference is only in the fact that fewer tools have guiding parts, since CNC machines provide precise positioning of the tool. For the same reason, in many cases there is no need for a movable tool joint with the machine spindle.

The design of the connecting part differs mainly in that it is necessary to provide a quick-change attachment of tools in the case of manual replacement.

The tools of modular constructions differ from the standard connecting part, as the standard elements of the connecting part of general-purpose tools are of little use. They do not provide the required accuracy of positioning and rigidity, which, along with the requirements for rapid tool replacement and their manufacturability, made it necessary to look for new design solutions for connecting devices. Now there are a lot of them.

The interchangeability of tools is provided by the introduction of compensators in the form of micrometric screws into their design, which allows to adjust the required tool size in advance, outside the machine.

Versatility of tools is achieved due to the modularity of structures. This is one of the promising areas for the development of designs of boring cutting tools. [3] Any instrument of a specific purpose can be obtained by rapid assembly from standardized modules. In such an original way (modularity of structures), the contradiction between universality and specialization of the instrument is solved (Figure 2).

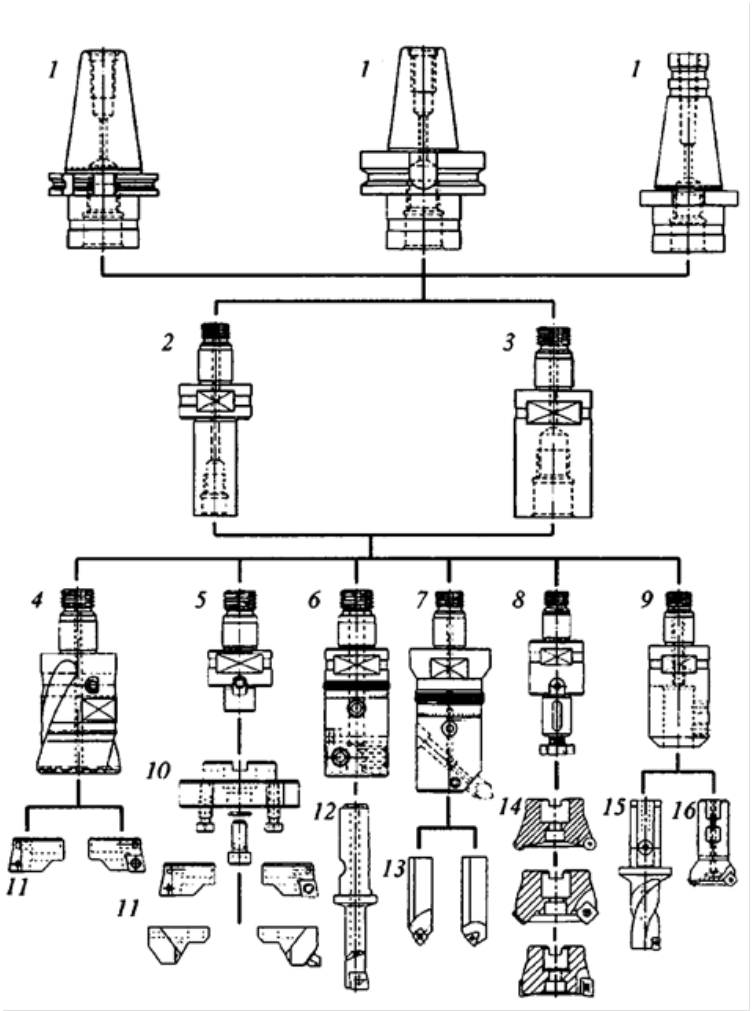

Fig. 2. Boring tool system based on cylindrical connection with axial puff

At the same time, specialized units make specialized units that results in low cost modules with high quality. The drawbacks of the assembly tools are their reduced stiffness compared to the solid tools. [4] However, this disadvantage also turns out to be a positive side: higher vibration resistance due to damping of the oscillations by the joints of the modules.

The high accuracy of the instrument depends on the accuracy of the manufacturing, as well as the choice of the optimal, in terms of accuracy, base surfaces, the methods of articulating the cutting tool with the auxiliary and with the machine tool. To maintain the accuracy of the positioning of the tool during operation, an important role is played also by the method of transferring the cutting forces from the machine to the tool.

The precision of the boring tools is provided by cutting inserts with micrometric extension of the insert, the so-called microboring. Analysis of their design and design features are described in [5-9].

REFERENCES

1. Прогрессивные режущие инструменты и режимы резания металлов : справочник / В.И. Баранчиков [и др.] ; под общ. ред. В.И. Баранчикова. —М. : Машиностроение, 1990. – 400 с. : ил.
2. Особенности проектирования инструментов автоматизированного машиностроения // Режущий инструмент [Электронный ресурс]. – Режим доступа: http:// http://rezh-instrument.ru/proektirovanie-rezhushchikh-instrumentov/osobennosti-proektirovaniya-instrumentov-avtomatizirovannogo-mashinostroeniya. – Дата доступа: 02.04.2018.
3. Попок, Н.Н. Анализ тенденций проектирования инструментальных систем / Н.Н. Попок // Вестник ПГУ. Сер 1. – 2012. – № 3. – Ч. 1. Термины и системы обозначений режущих пластин, державок и модулей. – С. 71–81.
4. Кожевников, Д.В. Режущий инструмент : учебник для вузов / Д.В. Кожевников, В.А. Гречишников, С.В. Кирсанов ; под ред. С.В. Кирсанова. – 3-е изд. – М. : Машиностроение, 2007. – 528 с. : ил.
5. Герасимов, А.А. Системы расточных инструментов с универсальными модулями / А.А. Герасимов, Н.Н. Попок, А.А. Цубанов // Технология-оборудование-инструмент-качество : материалы науч.-практ. конф., Минск, 8–11 апреля 2014 г. / редкол.: В.К. Шелег [и др.]. – Минск, 2014. – С. 33–35.
6. Gerasimov, A. Minimization of backlash in the threaded connections in boring cutting tools / A. Gerasimov, N. Popok // Европейский и национальный контексты в научных исследованиях : материалы 7-ой междунар. науч.-практ. конф., Новополоцк, 29–30 апреля 2015 г. : в 3 ч. / Полоц. гос. ун-т ; редкол.: Д.Н. Лазовский [и др.]. – Новополоцк, 2015. – Ч. 3. – С. 112–116.
7. Герасимов, А.А. Жесткость резьбовых соединений модульных расточных инструментов / А.А. Герасимов, А.В. Сидикевич, Н.Н. Попок // Перспективные направления развития технологии машиностроения и металлообработки : материалы междун. науч.-практ. конф., Минск, 7–8 апреля 2016 г. / редкол.: В.К. Шелег [и др.]. – Минск : Бизнесофсет, 2016. – С. 41–42.
8. Герасимов, А.А. Повышение точности резьбовых соединения модульных расточных инструментов. / А.А. Герасимов, А.В. Сидикевич, Н.Н. Попок // Металлообработка – 2015 : материалы 31-ой междун. науч.-практ. конф., Минск, 7–10 апреля 2015 г. / редкол.: В.К. Шелег [и др.]. – Минск : Бизнесофсет, 2016. – С. 62–63.
9. Герасимов, А.А. Жесткость резьбовых соединений модульных расточных инструментов / А.А. Герасимов, А.В. Сидикевич, Н.Н. Попок // Инновационные технолгии, автоматизация и мехатроника в машино- и приборостроении : материалы IV междун. науч.-практ. конф., Минск, 3–4 февраля 2016 г. / редкол.: В.К. Шелег [и др.]. – Минск : Бизнесофсет, 2016. – С. 115–116.