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ANALYSIS AND DESIGN OF CUTTING INSERTS WITH MICROMETRIC BLADE ADJUSTMENT FOR BORING PRECISION HOLES

NNADI CHRISTIAN CHIMEZIE, NIKOLAY POPOK, ALIAKSEI SIDIKEVICH
Polotsk State University, Belarus

In an automotive and machine-tool industry are widely used body parts with surfaces obtained by boring. There is a problem processing such parts on CNC machines with the required accuracy at the lowest possible production costs. Machine-building enterprise "JSC" "Minsk Automobile Plant" is no exception. In the production of the beam of the front axle of the MAZ family of vehicles, it is necessary to obtain the maximum number of surfaces of the part for a single installation at the integrated CNC operation, (Figure 1).

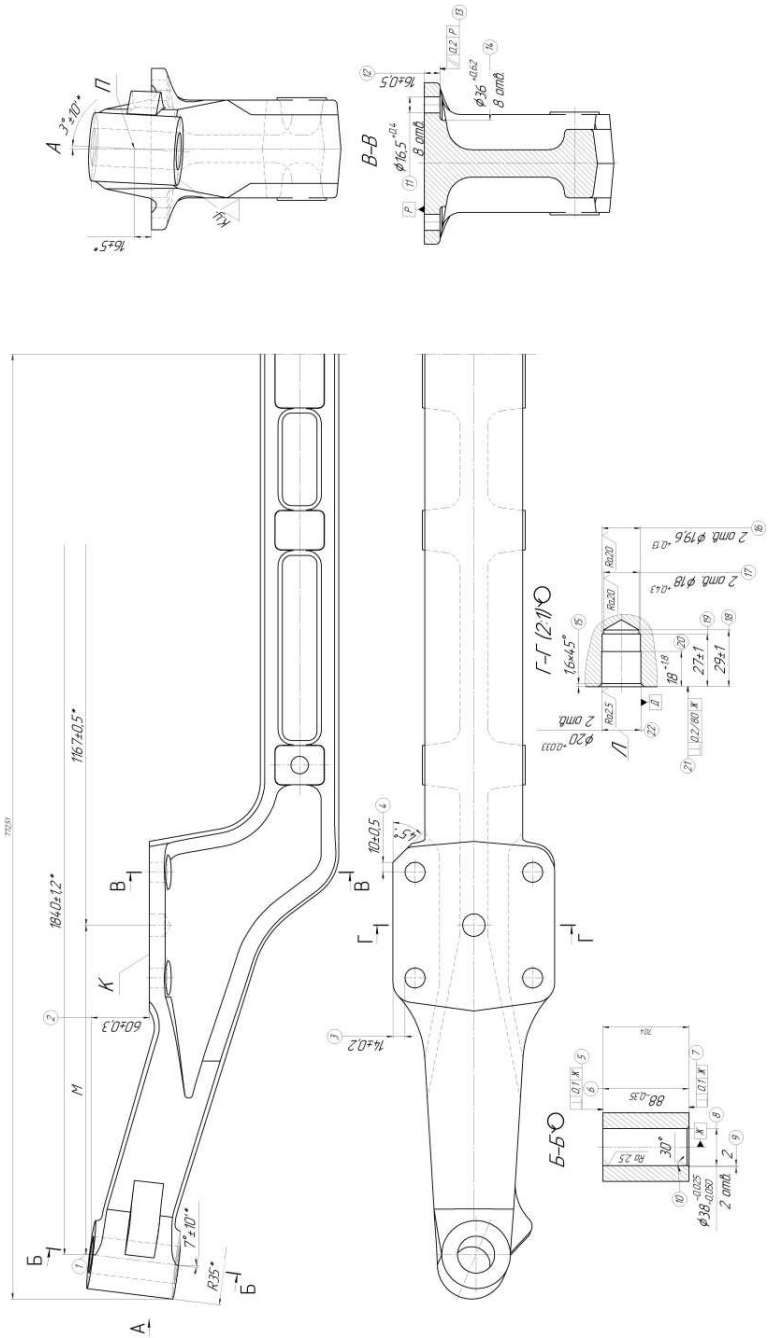


Figure 1. – Sketch map of the integrated CNC operation for processing front axle beams

When machining a hole $\varnothing 38^{-0,025}_{-0,050}$ an auxiliary tool-body, manufactured at the tool section of the enterprise (figure 2), and a tool insert with a micrometric blade setting, which is purchased abroad, is used.

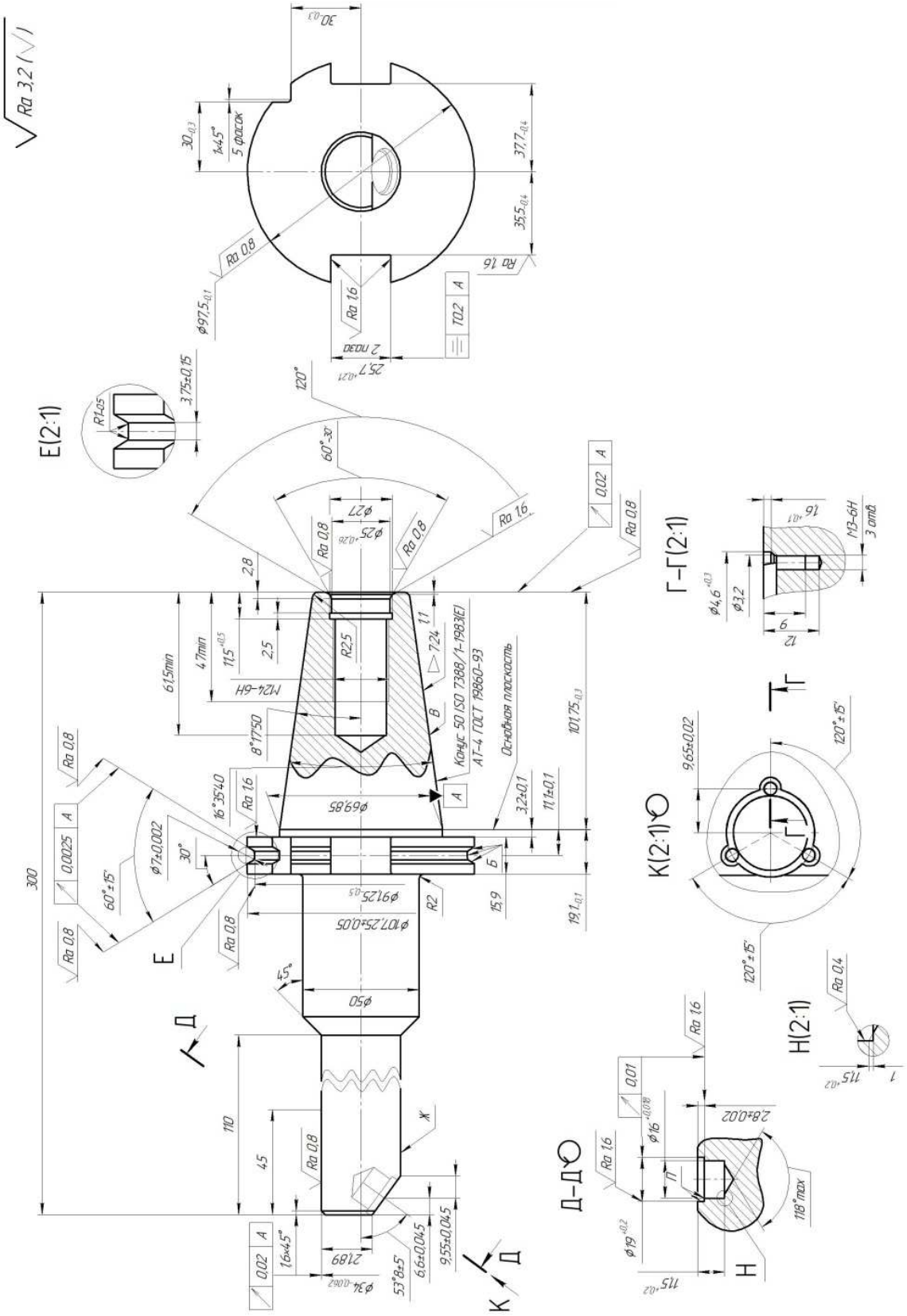


Figure 2. – Sketch auxiliary tool housing

The analysis shows that at domestic enterprises the production of tools with micrometric blade adjustment is not serially adjusted, and the use of foreign boring tools is expensive. In addition, the boring tools of various tool companies have different interchangeable elements, which makes it difficult and expensive to use them. Therefore, the creation of boring tools with micrometric adjustment of the blades, which would have interchangeable blocks and modules in a wide range of diameters of bore holes, ensured the manufacturability of the design and the required machining accuracy, and unified cutting inserts with micrometric blade settings for machining surfaces of parts on metal-cutting CNC machines is relevant. At the same time, special attention is paid to the structures of the mechanisms for moving and micrometric adjustment of the cutting blades in the tool inserts.

The development and use of cutting inserts with micrometric adjustment of the blade for surface treatment of parts on CNC machine tools will provide the following advantages compared to the analogues currently used [1].

1. Reduce the range of cutting tools;
2. Design and manufacture easily customizable cutting tools that will provide rational cutting and cutting allowance schemes in each particular case of processing.
3. Rigid design of the cutting inserts with micrometric adjustment of the blade will increase the resistance of the cutting plates by 1.5 times and the quality of processing up to 20%.
4. The process of equipment changeover is simplified, less qualification of service engineers is required.
5. The cost of new cutting inserts with micrometric blade adjustment for domestic consumers will decrease in comparison with foreign analogues.

The tool insert can be attributed to the classification of the cutting tool to the assembled tools. The composition of the insert may contain:

1. Cutting blade;
2. The installation mechanism of the cutting blade;
3. Cutting blade adjustment mechanism;
4. Housing
5. The installation mechanism of the housing in the base boring mandrel
6. Other mechanisms

In the assembly cutting tool as a cutting blade can be used [1,2,3]:

replaceable polyhedral plates (RPP);

replaceable sharpened plates (RSP);

interchangeable composite inserts with superhard tool materials consisting of a holder and a cutting blade fixed by soldering or gluing.

The tool insert can be installed in a basic boring mandrel - with a radial scheme (figure 3,a); at the angle of 53°8′(figure 3,b).

Based on the analysis of the use of various RPP as a cutting blade, it should be noted that the plates with the original marking according to GOST 19042 are most often used, these are triangular plates with a back angle of TPUN. TEGN, TPMR plates are also available. In the design under development, plates TPUN-110304 and TPMR-110308 can be offered. Plate TPUN-110304 has a back angle of 11 °, but does not have chip breakers. Plate TPMR-110308 has a back angle of 11 ° and chip breaker grooves.

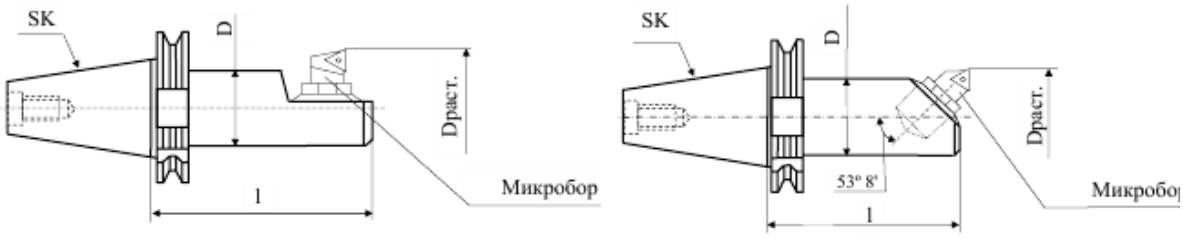


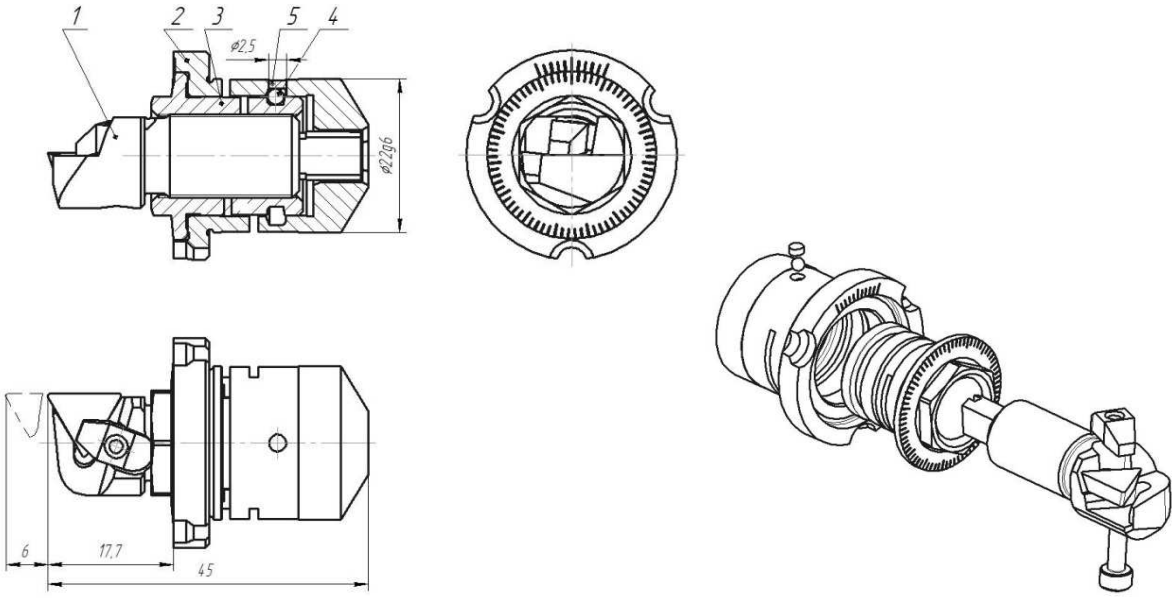
Figure 3. – Installation diagrams of the cutting inserts in the base boring bar: a - radial; b-angled

The installation mechanism of the cutting blade (plate) in the holder includes an exact groove closed on both sides, which ensures that the plate is precisely oriented in space relative to the axis of the base mandrel. This is achieved by having a contact at three points on the plate and a groove of the plate mounting mechanism.

The tool insert must have minimal dimensions, which leads to the complexity of the structures of its individual elements. It is proposed to combine the mechanism for the installation of the RPP and the screw entering the mechanism for adjusting the cutting blade. The screw has an exact chassis thread, made in 4 degrees of accuracy with a tolerance field g. This accuracy is due to the accuracy of the movement of the plate when adjusting the cutting insert itself on the size.

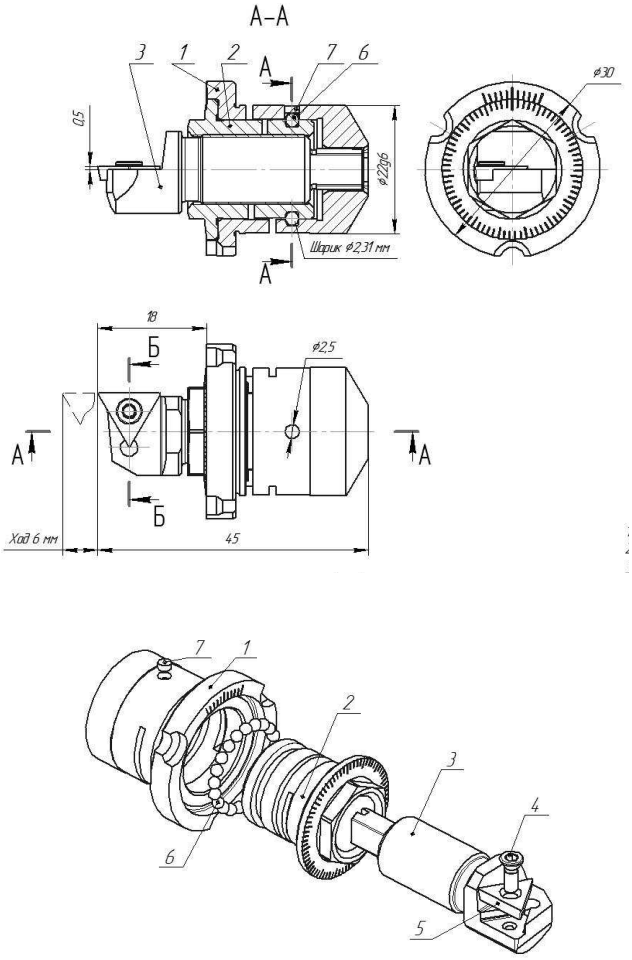
It is also proposed to combine two functions - movement and installation in one detail: the reciprocal internal threaded surface of the plate movement adjustment mechanism, a dial with a vernier and the presence of a surface serving as the main design base in the body (cup) of the tool insert. Structurally, this detail has many complex surfaces and is the most non-technological. Leading manufacturers of tool inserts go to this consciously, having high-tech equipment. The main problem of the interaction of the threaded sleeve and the threaded insert is the need to sample the gaps in the thread, due to possible inaccuracies in the manufacture. This opportunity should be laid constructively. For this purpose, a preload of the threaded connection is realized, considering various materials in a screw-nut friction pair, and the stiffness of the split nut. The variability of ensuring the accuracy of such a compound is very large and can only be determined by experimental methods and additional calculations.

The installation mechanism of the cutter insert in the base boring mandrel is combined with the preload mechanism of the threaded pair in the "cup" part. The installation mechanism in the base mandrel includes the presence of a cylindrical surface, as the most technologically advanced in manufacturing, and three radius slots for fastening on the base mandrel with screws. The preload mechanism contains a split bushing with a counter internal groove in which hardened balls of a certain size are installed when the bushing is compressed in a glass. Balls rolling in the grooves of the sleeve and the glass transfer elastic force from the glass to the sleeve. This leads to the displacement of the sleeve so that the gap in the thread between the threaded insert and the sleeve disappears. The second positive point in the use of hardened balls is the transition of sliding friction to rolling friction and the emergence of a rolling bearing, which makes it possible to reduce the friction that occurs with considerable preload forces to eliminate the gap in the thread. In Polotsk State University at the department "Technology and equipment for machine-building production" designs of tool inserts for radial installation and installation at an angle were developed. The variability of the designs also included various methods of fastening the plate: with a clamp on top for plates without a hole (Figure 4), a screw for plates with a hole (Figure 5).



1 – assembly "threaded insert"; *2* – cup; *3* – bushing; *4* – ball; *5* – lead, used as cork from balls falling out
Figure 4. – Sketch of the insert with the fastening of the plate with the clamp on top

The "threaded insert" assembly (Figure 6) contains four elements - holder 1, tack 2, screw 3, plate, cutting 4.



1 – cup; *2* – sleeve; *3* – holder; *4* – screw special; *5* – plate hard alloy;
6 – ball; *7* – lead, used as cork from balls falling out
Figure 5. – Sketch of the insert with screw fastening of the plate

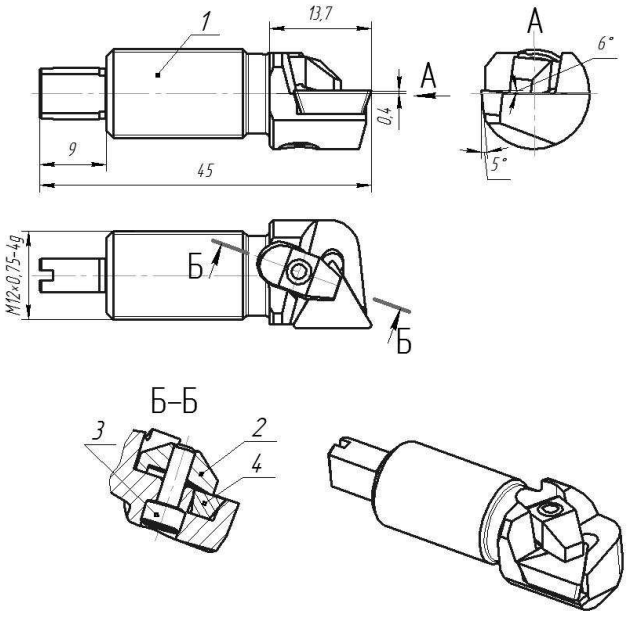


Figure 6. – Sketch of the threaded insert

The most complex part is the threaded insert holder. To improve the accuracy of manufacturing the groove for the plate and tacking, it is necessary to use a milling cutter made of hard alloy after quenching the entire threaded insert. Before processing, it is necessary to grind the outer diameter under the thread, and to grind the thread with special single-thread circles from elbor.

The "bushing" part 2 contains a non-technological element — an internal threaded surface, which involves the use of special master taps and final grinding of the coils to obtain the desired roughness.

Details "sleeve" 2 and "glass" 1 contain radial grooves. They are low-tech due to the size of their length and width. However, they are necessary from the point of view of obtaining a "spring" for preload when sampling a gap in a threaded connection.

The company Sandvik Coromant (Sweden) separately, on request, delivers a special tool for pre-loading the thread of the tool insert and replacing the thread insert in case of damage by the insert plate of the thread insert.

The analysis carried out and the developed designs of the cutter inserts with micrometric adjustment of the blade for boring precise holes allow to modernize the existing technological process, which will ensure a reduction in the price of the prefabricated cutting tool used and, accordingly, a decrease in the price of the product. The use of standardized inserts with micrometric blade settings with standardized elements of the installation will reduce the range of cutting tools in the enterprise as a whole, followed by import substitution of an expensive assembly cutting tool.

REFERENCES

1. Metal-cutting tools Reference Designer / Feldshtein, E.E., Kornievich, MA – New Knowledge, 2009.
2. Popok N.N. Analysis of trends in the design of instrumental systems. – Part 1. Terms and systems for the designation of cutting plates, holders and modules / N.N. Popok // Bulletin of the PSU. Series B. – 2012. – № 3. – P. 71–81.
3. Analysis of trends in the design of instrumental systems. – Part 2. Fastening mechanisms of modules / N.N. Popok // Bulletin of the PSU. Series B. – 2012. – № 11. – P. 11–19.
4. Analysis of trends in the design of instrumental systems. – Part 3. Instrumental systems for multi-purpose processing / N.N. Popok // Bulletin of the PSU. Series B. – 2012.– № 3. – P. 19–37.