ABSTRACT

of thesis

"FABRICATED AND COMBINED STRUCTURE DEVELOPMENT OF CUTTER HEADS FOR HOLES FACE TURNING",

submitted in candidacy for the PhD degree

in 6D071200 – "Mechanical Engineering"

by

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Justification of the need for this scientific research work. According to the State Programs of Industrial and Innovative Development of the Republic of Kazakhstan for 2015–2019 and 2020–2025, the main barrier to ensuring high-quality economic growth is digitalization and technological re-equipment.

Technological modernization is necessary to create the basis for future high-performance enterprises or hi-tech start-ups, and to diversify existing production and increase competitiveness of the country.

Providing high-precision processing is impossible without the use of advanced high-performance equipment and tools that ensure the specified economic and technological indicators of the technological process in machine parts manufacturing.

Scientific research on the topic of the dissertation was carried out within the framework of the grant funding "Project and development and of assembled and combined tool head designs" as a part of "Zhas Ghalym" program for 2015–2016 (order № 6/1-07/625 dated 01.11.2013) and young scientists for 2021–2023 годы as a part of ИРН AP09058231 project " Research and design of resource- and energy-saving metal-cutting tools", funded by Science Committee of Ministry of Education and Science of the Republic of Kazakhstan

Relevance of the research topic

Improving the quality of machine parts is achieved by improving technological processes, namely, by the creation of new processing methods and designs of metal-cutting tools. Manufacturing costs for metal-cutting tools account for 22–30% of total manufacturing costs. Taking into account the importance of improving the technological processes of mechanical processing with the use of modern metal-cutting tools, the direction of theoretical and experimental research is relevant.

The development of new metal-cutting tools is carried out in the following directions: improvement of the geometry of the cutting surfaces of the tool to reduce the cutting force, development of new wear-resistant alloys and coatings, improvement of tools in order to expand the scope of their application.

Object of study

Combined cutter head for face turning.

Subject of study

Hole processing technology for combined cutter head.

Purpose of the study

Ensuring high precision for processing of holes with the development of new designs of fabricated and combined structure of cutter heads.

The main objectives of the thesis

1 Run a hole processing study analysis.

2 Develop new designs of combined cutter head in order to improve quality;

3 Drawing up mathematical and empirical dependencies describing the machining process and the nature of the influence of the design and geometric parameters of combined cutter heads on the accuracy of hole processing;

4 Develop a methodology for calculating the design and geometric parameters of the combined cutter head based on computer modeling.

Scientific novelty

The scientific novelty of the work is:

- designs of new metal-cutting tools have been developed: fabricated and combined cutter heads, by the creation of favorable conditions in the cutting process by balancing the moments arising during cutting that positively affect the accuracy and quality of hole processing;

- a diagram of the process of machining holes with a fabricated cutter head, which makes it possible to describe the cutting conditions; mechanism of action and distribution of cutting forces;

- the calculation of the assembled cutting head using the APM Multiphysics software, also their balancing was determined, and this leads to the equality of moments, uniform rotation during processing, a decrease in vibrations and vibrations, and, consequently, a decrease in error, an increase in processing accuracy and a decrease in the roughness of the hole surface.

Metrological support of the thesis

Experimental research on the topic of the dissertation was carried out in the laboratories of Satbayev University, the Faculty of Engineering of Toraighyrov University and on the basis of Pavlodar Pipe-Rolling Plant LLP.

Experimental studies were carried out on a 400V CNC drilling, milling, and boring machine. The hole processing accuracy was checked with a MarForm MMQ 200 measuring device and the surface roughness was checked with a MarSurf M 300 mobile device.

The practical value of the thesis

The practical significance lies in the development of original designs of fabricated and combined cutter heads for face turning with high accuracy of hole processing.

The developed design of a new metal-cutting tool, a combined cutter head with hard-alloy inserts, was tested in plant conditions. The use of it gives a smaller deviation in comparison with a standard tool in longitudinal and cross sections by 1.2 times, i.e. the accuracy and quality of the holes to be machined increase. In addition, the load on the hard-alloy plates is reduced by 1.2 times and their strength is increased by 1.1 times, which increases the tool life and its resource. The results of the dissertation work are introduced into the production of Pavlodar Pipe-Rolling Plant LLP, as well as the educational process of Toraighyrov University (formerly known as Pavlodar State University named after S. Toraighyrov) for the subject

"Design and production of metal-cutting tools" which is a part of "Mechanical Engineering" study program.

Provisions to be defended

1. Designs of fabricated cutter heads for face turning of holes, providing 7-9 quality accuracy with a surface roughness Ra of 2.5–3.2 microns

2. The results of experimental studies of the process of processing holes with a fabricated cutter head and the effect of cutting modes (rotational speed and feed) on the accuracy and quality of processing holes;

3. Substantiation of design and geometrical parameters of the assembled cutter head based on computer modeling on APM Multiphysics software;

4. Recommendations for the use of designs of assembled cutter heads for face turning of holes.

The personal contribution of the author is in setting the goal and objectives of the study; analysis of publications, scientific, technical and patent literature on the research of processing holes with metal-cutting tools, designing and developing the tool itself; participation in the development of designs for new metal-cutting tools; in the direct conduct of experimental research, processing and generalization of the results.

Approbation of work

The main provisions of the thesis were reported and discussed at a meeting of the scientific seminar of the Faculty of Engineering and scientific and methodological meetings of Satbayev University; at the international scientific-practical conference "Competitiveness of technical science and education" (Almaty, Satbayev University, 2016); international scientific conference of young scientists, students and schoolchildren "XVI Toraighyrov readings" (Pavlodar, PSU named after S. Toraighyrov, 2016); international scientific and practical conference "Innovative technologies in mechanical engineering" (Tomsk, Russia, 2018).

Publications

10 scientific papers have been published on the topic of the thesis, of which 3 in publications recommended by the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 1 patent for an invention of the Republic of Kazakhstan, 3 articles in publications included in the international Scopus database and 3 in digests of international conferences.

The structure and volume of the thesis

This thesis consists of 92 pages, contains 19 tables and 71 figures and includes the introduction, 4 chapters and conclusion, a list of references consisting of 116 titles and appendices.