

上合组织国家的科学研究：协同和一体化  
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“Scientific research of the SCO  
countries: synergy and integration”

Part 2 - Participants' reports in English

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这些会议文结合了会议的材料 – 研究论文和科学工作者的论文报告。它考察了职业化人格的技术和社会学问题。一些文章涉及人格职业化研究问题的理论和方法论方法和原则。

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# CONTENTS

## ECONOMICS

- 社会人口特征对领导者形象的影响。 图像基础  
Impact of socio-demographic traits on leader's image. Image basis  
*Korshunova Natalia Evgenievna, Shataeva Olga Vladimirovna,  
Akimova Elena Nikolaevna*.....11

## JURISPRUDENCE

- 违反兽医法规，建立的控制植物病虫害的法规以及保护水生生物资源的法规：  
确定侵害主体的问题  
Violation of veterinary rules, rules established to control plant diseases and  
pests, as well as rules for the protection of aquatic biological resources: issues of  
determining the subject of encroachment  
*Golubev Stanislav Igorevich*.....16
- 违反《无线电规则》关于参与共享建筑的法规的要求，在《刑法》中引入吸引  
公民金钱的罪行的背景介绍  
Background introduction in the criminal code of the offense for attracting monetary  
funds of citizens in violation of the requirements of RF legislation on participation  
in shared construction  
*Terekhov Alexey Yurievich*.....23

## PEDAGOGICAL SCIENCES

- 媒体教学法的基本概念-网络人格  
The basic concept of media didactics - network personality  
*Monakhova Lira Yulevna, Riabokon Elena Aleksandrovna*.....31
- 多元艺术方法作为提高中国学生钢琴演奏水平的一种手段  
Poly-artistic approach as a means of improving the piano training of students of  
the People's Republic of China  
*Guan Cong, Krasovskaya Elena Pavlovna*.....38
- 为小学生教授“技术”科目的特点  
Features of teaching the subject "Technology" for primary school students  
*Ismailov Gafurzhan Mamatkulovich, Lomovskaya Sofia Anatolyevna,  
Nevinitsyna Victoria Sergeevna, Tursunbaev Nurulla Tursunbaevich*.....46

俄国教育管理中项目活动法的国家性质 The state-public nature of the project-activity approach in the management of Russian education <i>Budaeva Tatiana Tchagdurova</i> .....	52
比较分析在教师和音乐家的专业培训中电子教育资源的引入，以数字方式支持中俄两国的教育进程 Comparative analysis of the introduction of electronic educational resources in the professional training of a teacher-musician as a digital support for the educational process in China and Russia <i>Liu Qun, Osenneva Marina Stepanovna</i> .....	63
在“嘻哈”舞蹈的基础上发展5-7岁儿童的运动能力 Development of motor abilities in children 5-7 years old on the basis of the "Hip-Hop" dance <i>Snigur Marina Evgenievna, Streltsova Ekaterina Romanovna</i> .....	70

## PHILOSOPHICAL SCIENCES

书面体英语文本的语言风格特征（关于S. Achern的著作） Linguostylistic Features of English Texts of the Epistolary Genre (on the Material of the Work by S. Achern) <i>Bulaeva Natalya Evgenyevna, Straykova Ekaterina Eduardovna</i> .....	74
标题是文学作品中前景的要素（关于科幻小说的材料） Title as an element of foregrounding in a literary work (on the materials of science fiction) <i>Bulaeva Natalya Evgenyevna</i> .....	78
单位的情感语义及其从汉语到俄语的翻译 Emotive semantics of units and their translation from Chinese into Russian <i>Ma Jian</i> .....	83
将“人家”一词翻译成俄语的一些功能 Some features of the translation of the word "人家" into Russian <i>Bogdanova Nadezhda Andreevna, Solntseva Elena Georgievna</i> .....	90
俄国古典修辞学对话语质量的要求 Requirements for the qualities of speech in classical Russian rhetoric <i>Wen Suya</i> .....	95
二十世纪的俄罗斯商人：从人格特质到言语品质 Russian businessman in the XIX century: from personality traits to speech qualities <i>Yi Huihui</i> .....	102

## **PHILOSOPHICAL SCIENCES**

全球文化资本与教育系统中的知识经济学

Global cultural capital and the economics of knowledge in the system of education  
*Andreeva Svetlana Mikhailovna, Andreeva Anna Mikhailovna*.....108

## **HISTORICAL SCIENCES**

COVID-19大流行对聚类过程的影响

Impact of the COVID-19 pandemic on the clustering process

*Senutkina Olga Nicolaevna, Luppov Maxim Andreevich*.....115

中国：从上海合作组织领导到世界领导

PRC: from the SCO leadership to the world leadership

*Syzdykova Zhibek Saparbekovna*.....119

## **POLITICAL SCIENCES**

阿联酋在海湾阿拉伯国家合作委员会与美利坚合众国合作框架内的经济合作

Economic cooperation of the UAE in the framework of the Cooperation Council of the Arab States of the Gulf with the United States of America

*Alnuaimi Humaid Saeed Hamad Saeedi*.....124

## **PSYCHOLOGICAL SCIENCES**

青少年内感和怨恨的性别差异

Gender differences of guilt conscience and resentment in adolescents

*Lebedeva Marina Vladimirovna, Verbina Galina Georgievna*.....132

## **PHARMACEUTICAL SCIENCES**

伏安法测定间苯二酚钠

Voltammetric determination of Metamizole sodium

*Zherebtsova Eugenia Yuryevna, Terentyeva Svetlana Vladimirovna,*

*Shinko Tatiana Gennadievna*.....138

## **TECHNICAL SCIENCES**

采矿和建筑业的研究与创新

Research and innovation for the mining and construction industries

*Ushakov Leonid Semenovich*.....143

缺乏深海北极油气田水下开发的替代方案

The lack of alternatives for underwater development of deep-sea Arctic oil and gas fields

*Huseynov Chingiz Saibovich*.....148

关于国防企业基地的信息资源 On information sources for base of defense enterprises <i>Akinshin Anatoly Anatolievich, Dybenko Alexey Nikolaevich, Polak Yuri Evgenievich</i> .....	154
针对个人营养的矫正目标饮食 Corrective targeted diets for personalized nutrition <i>Vasyukova Anna Timofeevna, Kononenko Marina Mikhailovna, Kulakov Vladimir Gennadievich</i> .....	159
钻铣夹头的形态合成 Morphological synthesis of drill-milling chucks <i>Gao Xingmin, Kuznetsov Yurii Nikolayevich</i> .....	164
当需要通过增加压力管道中的势能来防止反向水流和减轻水力冲击时，启动和停止抽水设备的工艺流程 Technological process of starting and stopping pumping equipment when it is necessary to prevent reverse water flow and dampen hydraulic shock by increasing the potential energy in the pressure pipeline <i>Shiryaev Vadim Nikolaevich, Urzhumova Yulia Sergeevna, Trushev Valery Valerievich, Tarasyants Sergey Andreevich</i> .....	170
能量饱和非均质复合材料结构形成的理论基础 Theoretical foundations of structure formation of energy-saturated heterogeneous composite material <i>Aleh K. Kryvanos, Aliaksandr Ph. Ilyushchanka, Yauheni Ya. Piatsiushyk</i> .....	176

## **AGRICULTURAL SCIENCES**

不同品牌干粮喂养对服务犬生长发育的影响的比较特征 Comparative characteristics of the effectiveness of feeding dry food of different brands on the growth and development of service dogs <i>Nikulin Yuri Petrovich, Tsoy Zoya Vladimirovna, Nikulina Olga Azgatovna</i> .....	183
滨海边疆区的喂食服务犬分析 Analysis of feeding service dogs in the Primorsky region <i>Tsoy Zoya Vladimirovna, Nikulin Yuri Petrovich, Nikulina Olga Azgatovna</i> .....	187
去势对公牛肉生产率的影响 Effect of castration on meat productivity of bulls <i>Nikulina Olga Azgatovna, Nikulin Yuri Petrovich, Tsoy Zoya Vladimirovna</i> .....	191
罗斯托夫州灌溉土地上甜菜栽培的资源节约技术特点 Peculiarities of resource-saving technology of table beet cultivation on the irrigated lands of Rostov Oblast <i>Mikheev Nikolay Vasilyevich</i> .....	195

钻铣夹头的形态综合  
**MORPHOLOGICAL SYNTHESIS OF DRILL-MILLING CHUCKS**

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摘要：使用了系统形态学的方法，提出了使用圆柱形刀柄的切削工具的工具卡盘（IZP）的新型解决方案，并提出了与已知工具相比较其设计的优于。并以形态矩阵的形式构建了IZP的形态模型。

关键字（中文）：工具夹盘、形态模型、钻头、刀具。

Drilling and milling chucks are a device for mounting and fixing on metal cutting and woodworking machines, as well as in drills of cutting tools with a cylindrical shank - drills, cutters, countersinks, etc[1,4-6].

The problem of reliability of certain types of metal-cutting equipment cannot be fully solved if the question of the correct design and manufacture of chuck chucks is not raised, since it has been proven that characteristics such as accuracy, rigidity, vibration resistance, and others are largely determined by their properties.

Certain difficulties are caused by technological processes of manufacturing parts of tool chucks and, first of all, clamping elements. In many cases, this is clearly underestimated, which leads to a sharp decrease in the quality of machining.

One of the characteristic features of tool chucks is the wide range of sizes of tools to be clamped. The tool centering accuracy depends primarily on the design and manufacturing process of the clamping elements and is one of the main characteristics of tool chucks. Certain technological methods in the manufacture of clamping elements can achieve practically zero runout of the tool.

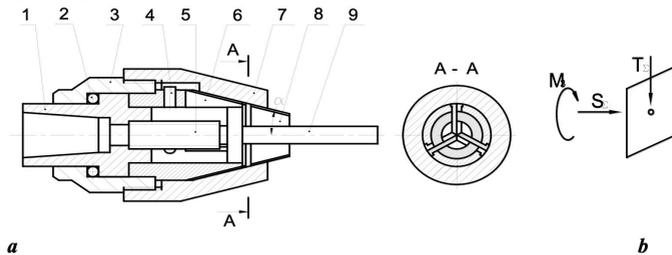
The clamping forces and torques transmitted by tool chucks vary over a very wide range. The automatic chuck is fast acting by simply turning the taper sleeve in a matter of seconds[3]. The stability of automatic chuck chucks fluctuates within extremely wide limits and depends on the design and correctness of technological processes in the manufacture of their parts.

Despite the well-established design forms of automatic drill chucks, the latter continue to be improved. You can outline several main directions in which work should go to improve these cartridges. [1-3].

First, structures must allow for tool clamping with wider tolerances. Secondly, new, high-strength materials must be used that can withstand large fluctuations in clamping forces. At the same time, this will reduce the size. Thirdly, it is necessary to look for new design solutions to increase the range of load changes and improve performance. Fourth, we must look for ways to self-regulate the strength of anchoring. At first, it is important to create a mechanism, adjusting which, the adjuster would be able to precisely set the desired value of the clamping force. Fifth, it is imperative to improve the manufacturing processes of automatic drill chuck parts. For the same clamping elements, different manufacturing and heat treatment processes are not justified at different plants. In practice, this leads to unnecessary waste of metal and excessive workload of tool shops.

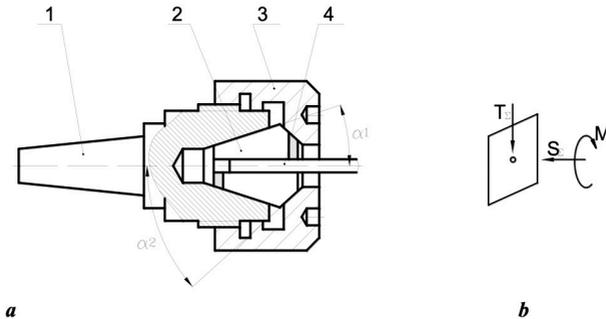
On the basis of patent research, it is proposed to search for new solutions using the system-morphological approach[1]. On the basis of patent research, it is proposed to search for new solutions using the system-morphological approach. The morphological model of the schemes of wide-range wedge drilling-milling chucks and new variants of their designs are given. It is known that for clamping cutting tools with a cylindrical shank, tool chucks with a wedge transmission-reinforcing link in the form of wedge cams and collets are widely used. Clamping chucks with a transfer-reinforcing link in the form of an eccentric have so far found greater application for clamping artificial and bar blanks.

Automatic clamping drill chucks (Fig. 1, a) allow clamping the tool in a wide range (wide-range), converting the  $M_3$  torque into the  $S_\Sigma$  axial force due to the screw pair, and then into the  $T_\Sigma$  radial force due to the wedge transmission-reinforcing link, that is the power flow from the drive to the clamping object looks like  $M_3 \rightarrow S_\Sigma \rightarrow T_\Sigma$  (Fig. 1, b).



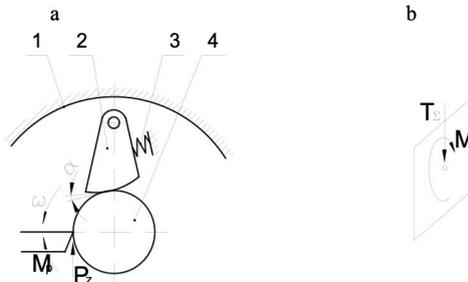
**Figure: 1. Wedge self-clamping drill chuck without a key (a) and the diagram of the power flow in it (b): 1 - case; 2 - balls; 3 - cylinder bushing; 4 - pin; 5 - screw with left-hand thread; 6 - separator; 7 - conical bushing; 8 - wedge cams; 9 - tool (drill)**

Tool chucks (Fig. 2, a) allow you to clamp a tool of the same size (high-range) and, similarly to wedge chucks (Fig. 1, a), convert a steep  $M_3$  moment into an axial force  $S_z$  due to the thread on the body and a thrust nut, and then into a radial force  $T_r$  due to conical surfaces on the collet, that is, a similar force flow (Fig. 2, b)  $M_3 \rightarrow S_z \rightarrow T_r$  is formed, but in the opposite direction.



**Fig. 2. Collet drill-milling chuck (a) and power flow diagram in it (b): 1 - case; 2 - double cone collet; 3 - persistent nut; 4 - tool**

Band chucks for piece workpieces (Fig. 3, a) are used in lathes and grinding machines, in which the previous clamp is protected by a spring, and the final self-jamming from the cutting forces (moments) due to jamming. The radial dimensions of the conventional eccentric chucks for workpieces do not allow them to be used as tool chucks.



**Fig. 3. Schemes of a self-clamping eccentric lathe chuck (a) and the power flow in it (b)**

Therefore, it is necessary to look for new technical solutions that combine the advantages of wedge and eccentric chucks, this is what this work is devoted to, as a result of research and development work, carried out at the Department of Machine Design using the system-morphological approach.

To do this, in the chuck-tool drive system, we select the main features:

- input (drive): 1- type of energy source; 2 - number of inputs; 3 - transmission-amplifying link I input; 4 - transmission-reinforcing link II input;
- cartridge 5 - Connecting part of the body; 6 - the location of the axis of the eccentric clamping element; 7 - the outer surface of the eccentric clamping element; 8 - the number of clamping elements;
- exit (fixing object): 9 - tool type; 10 -Loading.

We build a morphological model (the table is not given for confidential reasons) with various alternatives of its main features, according to which the total number of possible and not possible schemes of tool chucks:

$$N_{\text{BП}}=3 \cdot 3 \cdot 5 \cdot 5 \cdot 6 \cdot 3 \cdot 4 \cdot 2 \cdot 6 \cdot 4=777600$$

Let us represent the morphological model in the form of a morphological matrix in a collapsed and expanded form:

$$M_{\text{BП}}=M_{\text{BX}} \wedge M_{\text{CT}} \wedge M_{\text{BHX}}$$

$$i \text{ BП} = \begin{array}{c|cccc} \mathbf{1.1} & \mathbf{2.1} & \mathbf{3.1} & \mathbf{4.1} \\ \mathbf{1.2} & \mathbf{2.2} & \mathbf{3.2} & \mathbf{4.2} \\ \mathbf{1.3} & \mathbf{2.3} & \mathbf{3.3} & \mathbf{4.3} \\ & & \mathbf{3.4} & \\ & & \mathbf{3.5} & \end{array} \wedge \begin{array}{c|cccc} \mathbf{5.1} & \mathbf{6.1} & \mathbf{7.1} & \mathbf{8.1} \\ \mathbf{5.2} & \mathbf{6.2} & \mathbf{7.2} & \mathbf{8.2} \\ \mathbf{5.3} & \mathbf{6.3} & \mathbf{7.3} & \\ \mathbf{5.4} & & \mathbf{7.4} & \\ \mathbf{5.5} & & & \\ \mathbf{5.6} & & & \end{array} \wedge \begin{array}{c|cc} \mathbf{9.1} & \mathbf{10.1} \\ \mathbf{9.2} & \mathbf{10.2} \\ \mathbf{9.3} & \mathbf{10.3} \\ \mathbf{9.4} & \\ \mathbf{9.5} & \end{array}$$

To reduce the number of options for solving the problem of synthesizing tool chucks with an odd number of clamping elements, weed the matrix for a milling machine using a manual clamping at the initial setting for a given machining program with a limited number of connecting part and options for the location of the clamping element axis. Then we get the truncated matrix.

$$i \text{ BП} = \begin{array}{c|cccc} \mathbf{1.1} & \mathbf{2.1} & \mathbf{3.1} & \mathbf{4.1} \\ & \mathbf{2.2} & \mathbf{3.2} & \mathbf{4.2} \\ & \mathbf{2.3} & \mathbf{3.3} & \mathbf{4.3} \\ & & \mathbf{3.4} & \\ & & \mathbf{3.5} & \end{array} \wedge \begin{array}{c|cccc} \mathbf{5.1} & \mathbf{6.1} & \mathbf{7.1} & \mathbf{8.1} \\ \mathbf{5.2} & & \mathbf{7.2} & \\ \mathbf{5.5} & & \mathbf{7.3} & \\ & & \mathbf{7.4} & \end{array} \wedge \begin{array}{c|cc} \mathbf{9.6} & \mathbf{10.3} \end{array}$$

In this case, the total number of IPU circuits will significantly decrease and amount to:

$$N'_{\text{BП}}=1 \cdot 3 \cdot 5 \cdot 4 \cdot 3 \cdot 1 \cdot 4 \cdot 1 \cdot 1 \cdot 1=720.$$

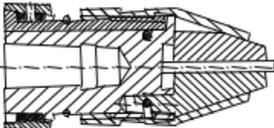
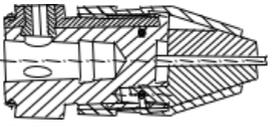
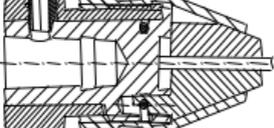
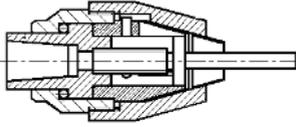
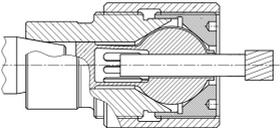
Let us illustrate the formation of tool chucks with two manual clamping inputs (Fig. 5), where in all subsequent combinations (variants  $X_2 - X_4$ ), starting with variant  $X_1$ , new solutions are emphasized.

Tape drilling and milling chucks, developed by ZMOK LLC, are designed for fast and reliable clamping of tools with a cylindrical shank (drills, countersinks,

reamers, cutters, etc.) of right and left rotation in a given range.

With the help of these chucks, it is possible to mill many grooves, drill and cut an unlimited number of holes, unscrew and tighten an unlimited number of screws and nuts, provide various sets of locksmith, machine and assembly tools (manual, electrical, mechanical).

Chucks are efficient and convenient to use in surgical operations - for opening holes in bones, where light weight and dimensions are required, as well as reliable fixation of a drill or other instrument with the possibility of quick changeover to a different clamping diameter. Personality convenience is created by these designs of cartridges when working with a pneumatic or power tool with a fast set of revolutions - there is no self-loosening from inertial forces at the time of starting the cartridge. Additional advantages are low weight and diametrical dimensions, convenience of processing hard-to-reach places.

No	Type of ISP	Constructive scheme	Morphological formula
X <sub>1</sub>	Without key and two entrances		$ 1.2-2.2-3.1-4.1  \wedge$ $\wedge 5.1-6.1-7.1-8.1  \wedge$ $\wedge 9.6-10.3 $
X <sub>2</sub>	With a key and several cylindrical eccentrics on the entrance 2		$ 1.3-2.3-3.1-4.2  \wedge$ $\wedge 5.1-6.1-7.1-8.1  \wedge$ $\wedge 9.6-10.3 $
X <sub>3</sub>	With key, shirt and one cylindrical eccentric at the entrance 2		$ 1.3-2.2-3.1-4.2  \wedge$ $\wedge 5.1-6.1-7.1-8.1  \wedge$ $\wedge 9.6-10.3 $
X <sub>4</sub>	Wedge self-clamping		$ 1.2-2.1-3.3-4.5  \wedge$ $\wedge 5.1-6.2-7.2-8.1  \wedge$ $\wedge 9.6-10.3 $
X <sub>5</sub>	Collet wide-range spherical		$ 1.2-2.1-3.3-4.5  \wedge  5.1-6.2-7.2-8.1  \wedge  9.6-10.4 $

**Fig.4. Variants of synthesized tool clamping chucks according to the morphological model**

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