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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
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«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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APPLICATION OF THE COMBINED FINISHING AND HARDENING METHOD FOR COMPLEX QUALITY PARAMETERS OF THE PARTS SURFACE LAYER

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Abstract. The reliability and durability of products of modern machine-building production largely depend on the quality of their surface layer, and this dictates the need to apply such processing methods, which along with the improvement of the microgeometry of the part surface would change in the right direction the structure, physical and mechanical properties and the stress state of the surface layer. The research in this article is aimed at solving these problematic issues and is carried out within the framework of the AP19680395 project "Study of the stress-strain state of deposited parts and development of a method for reducing their deformations in the processes of surface plastic deformation", under grant funding from the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan. The conducted research has shown that one of the most efficient and environmentally friendly methods of machining parts by surface plastic deformation is the process of

smoothing. The combined technology of surface plastic deformation, combining rigid and elastic smoothing with the use of a combined tool with rigid and elastic indentor fastening is considered. It is established that this tool design comprehensively provides parameters of the quality of the surface layer of the working surfaces of critical parts due to different element radii. A system of automatic provision of the set interference, based on computer analysis of vibration signals and determining the ultra-precise adjustment of the combined tool is presented. It is shown that the tool makes it possible to comprehensively ensure the quality parameters of the surface layer of the parts. At the same time the process can be carried out at sufficiently productive modes. The use of a system for automatically ensuring the set interference during smoothing makes it possible to adjust the force parameters of the process with high accuracy. It has been established that as a result of hard-elastic smoothing a microstructure with a homogeneous dense hardened layer is formed in the surface layer, forming a regular surface roughness profile of a favorable blunted form, and providing increased wear resistance of the part surface layer and its correct geometric shape. Application of this technology makes it possible to form a layer-by-layer structure of the part surface layer with high-altitude roughness parameters in the nanometer range, thus ensuring high operational properties of the parts.

Keywords: Surface layer of the part, finishing-strengthening treatment, surface plastic deformation, hard and elastic smoothing, microstructure, surface roughness, indentor

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БӨЛШЕКТЕРДІҢ БЕТКІ ҚАБАТЫНЫҢ САПА ПАРАМЕТРЛЕРІН КЕШЕНДІ ҚАМТАМАСЫЗ ЕТУ ҮШІН АРАЛАС ӘРЛЕУ-ҚАТАЙТУ ӨҢДЕУ ӘДІСІН ҚОЛДАНУ

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Аннотация. Қазіргі заманғы машина жасау өнімдерінің сенімділігі мен беріктігі көбінесе олардың беткі қабатының сапасына байланысты және бұл бөлшектердің беткі микрогеометриясын жақсартумен қатар беткі қабаттың құрылымын, физикалық-механикалық қасиеттерін және кернеулі күйін дұрыс бағытта өзгертетін өңдеу әдістерін қолдану қажеттілігін тудырады. Осы мақаладағы зерттеу Қазақстан Республикасы Ғылым және жоғары білім министрлігінің Ғылым комитеті қаржыландыратын "Балқытылатын бөлшектердің кернеулі-деформацияланған жай-күйін зерттеу және олардың беттік пластикалық деформация процестеріндегі деформацияларын төмендету әдісін әзірлеу" AP19680395 жобасы шеңберінде проблемалық мәселелерді шешуге бағытталған. Жүргізілген зерттеулер бөлшектерді беттік пластикалық деформациямен өңдеудің ең тиімді және экологиялық таза әдістерінің бірі үтіктеу процесі екенін көрсетті. Индентордың қатты және серпімді бекітілуімен біріктірілген құралды қолдана отырып, қатты және серпімді үтіктеуді біріктіретін беттік пластикалық деформацияның біріктірілген технологиясы қарастырылады. Құралдың бұл дизайны элементтердің әртүрлі радиустары есебінен жауапты бөлшектердің жұмыс беттерінің беткі қабатының сапа параметрлерін жан-жақты қамтамасыз ететіні анықталды. Діріл сигналдарын компьютерлік талдауға негізделген және біріктірілген құралдың өте дәл баптауын анықтайтын берілген кернеуді автоматты түрде қамтамасыз ету жүйесі берілген. Құрал бөлшектердің беткі қабатының сапа параметрлерін жан-жақты қамтамасыз етуге мүмкіндік беретіні көрсетілген. Бұл жағдайда процесс жеткілікті өнімді режимдерде жүзеге асырылуы мүмкін. Үтіктеу кезінде берілген кернеуді автоматты түрде қамтамасыз ету жүйесін пайдалану процестің қуат параметрлерін жоғары дәлдікпен реттеуге мүмкіндік береді. Қатты серпімді үтіктеу нәтижесінде беткі қабатта біртекті тығыз қатайтылған қабаты бар микроқұрылым пайда болады, ол қолайлы доғал пішіннің беткі кедір-бұдырының тұрақты профилін қалыптастырады және бөліктің беткі қабатының тозуға төзімділігі мен оның дұрыс геометриялық пішінін қамтамасыз етеді. Бұл технологияны қолдану нанометрлік диапазондағы кедір-бұдырдың биіктік параметрлері бар бөліктің беткі қабатының қабатты құрылымын қалыптастыруға мүмкіндік береді, осылайша бөлшектердің жоғары өнімділік қасиеттерін қамтамасыз етеді.

Түйін сөздер: Бөлшектің беткі қабаты, әрлеу және қатайту, беттік пластикалық деформация, қатты және серпімді үтіктеу, микроқұрылым, беттің кедір-бұдыры, индентор

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ПРИМЕНЕНИЕ МЕТОДА КОМБИНИРОВАННОЙ ОТДЕЛОЧНО-УПРОЧНЯЮЩЕЙ ОБРАБОТКИ ДЛЯ КОМПЛЕКСНОГО ОБЕСПЕЧЕНИЯ ПАРАМЕТРОВ КАЧЕСТВА ПОВЕРХНОСТНОГО СЛОЯ ДЕТАЛЕЙ

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Аннотация. Надёжность и долговечность изделий современного машиностроительного производства в значительной степени зависят от качества их поверхностного слоя, и это диктует необходимость применять такие методы обработки, которые наряду с улучшением микрогеометрии поверхности детали изменяли бы в нужном направлении структуру, физико-механические свойства и напряженное состояние поверхностного слоя. Исследование в данной статье направлено к решению этих проблемных вопросов и проводится в рамках проекта AP19680395 «Исследование напряженно-деформированного состояния наплавляемых деталей и разработка метода снижения их деформаций в процессах поверхностного пластического деформирования», по грантовому финансированию Комитета науки Министерства науки и высшего образования Республики Казахстан. Проведенные исследования показали, что одним из наиболее эффективных и экологически чистых методов обработки деталей поверхностным пластическим деформированием является процесс выглаживания. Рассмотрена комбинированная технология поверхностного пластического деформирования, сочетающая жесткое и упругое выглаживание с использованием комбинированного инструмента с жестким и упругим закреплением индентора. Установлено, что данная конструкция инструмента комплексно обеспечивает параметры качества поверхностного слоя

рабочих поверхностей ответственных деталей за счет разных радиусов элементов. Приведена система автоматического обеспечения заданного натяга, основанная на компьютерном анализе вибросигналов и определяющая сверхточную настройку комбинированного инструмента. Показано, что инструмент позволяет комплексно обеспечивать параметры качества поверхностного слоя деталей. При этом процесс может осуществляться на достаточно производительных режимах. Использование системы автоматического обеспечения заданного натяга при выглаживании позволяет с высокой точностью настраивать силовые параметры процесса. Установлено, что в результате жестко-упругого выглаживания в поверхностном слое образуется микроструктура с однородным плотным упрочненным слоем, формирующая регулярный профиль шероховатости поверхности благоприятной притупленной формы, и обеспечивающая повышенную износостойкость поверхностного слоя детали и её правильную геометрическую форму. Применение данной технологии позволяет формировать послойную структуру поверхностного слоя детали с высотными параметрами шероховатости в нанометровом диапазоне, что тем самым обеспечивает высокие эксплуатационные свойства деталей.

Ключевые слова: Поверхностный слой детали, отделочно-упрочняющая обработка, поверхностное пластическое деформирование, жесткое и упругое выглаживание, микроструктура, шероховатость поверхности, индентор

Introduction

Modern details of tribocouplings should provide reliable working capacity of machines and mechanisms in the conditions of long-term operation, including in such extreme conditions as the raised loadings, speed of temperature, presence of abrasive and aggressive environments. There fore to materials of knots of a friction of a responsible purpose the raised requirements for wear resistance, antifrictional properties, ability to resist deformation at contact loadings, heat resistance, corrosion resistance are made. In the greatest measure the increase of operational properties should be provided by a surface layer of the materials used for manufacturing of modern details of tribocouplings (Abul'hanov et al., 2014; Antonjuk et al., 2014).

The reliability and durability of parts also largely depend on the quality of surface layers. This is explained by the fact that the surface layer of the metal turns out to be the most loaded and is a carrier of design, technological and operational stress concentrators, negatively affecting the fatigue strength of the part. To increase fatigue strength and wear resistance, it is necessary to apply such methods of machining, which along with the improvement of microgeometry of the part surface would change the structure, physical and mechanical properties and stress state of the surface layer in the necessary direction (Gubanov, 2013; Sherov et al., 2022; Idan Alaa Fadhil et al., 2017).

One of the effective methods to improve the operational properties of machine parts is the surface plastic deformation (SPD) finishing-strengthening treatment. Processing by this method ensures achieving minimum surface roughness and improving the physical and mechanical properties of the surface layer (Gubanov, 2009)

But in connection with the widespread introduction in production of dimensional

finishing and hardening processing by SPD method, the creation of methods of combined machining of surfaces by cutting and SPD, allowing to produce simultaneously machining by rolling and rolling itself or smoothing with the help of combined tools acquires special importance. These methods allow the formation of a nanostructured state and submicrorelief of the surface layer and provide a multiple increase in operational properties in the serial production of precision parts (Zubkov, 1992; Idan Alaa Fadhil, 2017)

Therefore, the issues of application, development and improvement of combined tools remain the most relevant in modern machine-building production, since such machining provides both a significant reduction in labor intensity due to the combination of operations, and high quality of the surface layer of machined parts. Smoothing, as it is known, is a method of part finishing-strengthening treatment by surface plastic deformation, which consists in deformation of machined surface by an indentor sliding along it. As a result of applied pressure, the surface layers are hardened and the surface microrelief favorable from the position of wear resistance is formed, in particular, the smoothed surface roughness profile (Kuznecov et al., 2012; Kuznecov et al., 2013; Kulikov et al., 2016; Kuznecov et al., 2010).

During smoothing, the height parameters of the roughness of the machined surface largely depend on the working feed of the tool, which reduces the productivity of the smoothing process. Thus, when machining with classical smoothers, compromise smoothing conditions are always sought in order to provide the specified values of surface layer microhardness, residual compressive stresses and high-altitude roughness parameters of the smoothed surface.

Materials and research methods

To this end, an innovative technological solution for applying the method of hard-elastic smoothing as a method of finishing-strengthening treatment of parts by surface plastic deformation with two tools (or a smoothing head) with rigid indenter fixing and elastic indenter fixing, which slide over the surface of the workpiece, while the indenter with elastic fixing passes over the tops of the surface roughness profile formed by the indenter with rigid indenter, is of certain practical interest. The double application of a trowel (troweling in two passes) with an elastically fastened indenter under certain conditions leads to nanostructured machining (Kuznecov et al., 2010; Kuznecov et al., 2011).

For rigid-elastic smoothing, the tool shown in Fig. 1 is effective.

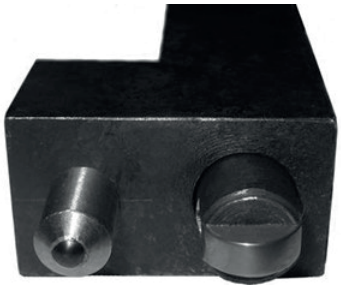


Fig. 1. Rigid-elastic leveler

The tool design includes an indentor and a working element in the form of a plate, two screws for fixing the indentor and plate, a holder, a spring, a sleeve in which the plate is fixed, a screw for adjusting the sleeve and a clamping screw. This provides a rigid kinematic connection between the indentor and the workpiece and an elastic kinematic connection between the plate and the workpiece.

During hard-elastic smoothing of metal surface the surface roughness parameter Ra=0,02-0,1 mkm; depth of hardened layer up to 0,2 mm; residual compression stresses of the first type more than 200 MPa; microhardness of surface layer more than 4000 MPa (when finishing indenter with elastic fastening to Ra=0,01 mkm; data are average, concrete values depend on machined material) are provided. A regular surface roughness profile of a favorable blunted shape is formed, an upper dense homogeneous hardened layer on a substrate of inhomogeneous hardened layer, the surface acquires a characteristic mirror shine.

Hard-elastic smoothing is realized by the next step after fine turning. First, the surface is smoothed with a rigidly clamped indenter tool (rigid smoothing; on universal machines or CNC machines, CNC machines are preferable). This eliminates the waviness that can occur after turning. To set the interference precisely, CNC machines use a probe that sends a binary signal to the automation controller. The probe is fixed or integrated into the tool. This determines the point at which the indentor touches the workpiece (coordinate), i.e. the "zero interference". An indentor with a radius of up to 3 mm is used. The surface layer of the part is hardened and a preliminary roughness is formed. Then the surface of the part is smoothed with an elastic indenter tool (elastic smoothening), such as the Cogsdill DB-3 Diamond Burnishing Tool, the main requirement being that the smoothening tooling provides the required accuracy of machining. The indentor contact force is set off-machine. Then, a calibration chart (indenter insertion value - tapping force) is used to set the coordinate for the burr in the control program. The burr runs along the pre-roughing profile, reducing the pre-roughing roughness parameter Ra as much as possible and finally forming the microstructure of the part's surface layer. An indentor with a radius of more than 3 mm is used (with a larger radius the roughness parameter of the smoothed surface Ra is smaller). It is reasonable to use single hard and elastic scrapers on a two-slide CNC machine with an inclined turret (or on HYPER QUADREX 250 MSY "Mazak" and similar equipment). In this case the elastic smoothing tool must be offset relative to the rigid smoothing tool by a multiple of half the longitudinal feed (odd numbers), with equal feeds of smoothing tools, for maximum smoothing of roughness (Korohodkina, 2019; Kochetkov et al., 2013; Maksimov et al., 2006).

As a result of the fact that the indentor and the plate are located at a distance from each other in the direction of the axis of the machine centers, there is a reduction of up to 4 times the height parameters of the roughness of the surface formed by the indentor, as the plate runs along the protrusion of the roughness profile of the surface formed by the indenter (which is provided by the selection of the working feed). During the machining of the part-body of rotation at the working feed, at first, the maximum microhardness of the part surface layer and residual compressive stresses, as well as the primary

roughness are formed by hard indentor smoothing, and then the elastic smoothing with a plate finally forms the surface roughness of the part in the nanometer range and the layer-by-layer microstructure of the surface layer.

Results

This tool design makes it possible to comprehensively ensure the quality parameters of the surface layer of the working surfaces of critical parts due to the different radii of the elements: the indentor should be taken with a smaller radius than the plate (Mamaev, 1998; Markus et al., 1991; Putjatina et al., 2011; Smeljanskij, 2002).

The practice of using a rigid-elastic smoothing tool has shown that a dense homogeneous hardening layer is formed on the surface of the part, which then passes into a non-uniform hardened layer, which ensures high operational properties of the parts.

Hard-elastic tumbling produces a microstructure in the surface layer (Fig. 2) with a homogeneous dense hardened layer (formed by elastically clamped tumbling; since plastic deformation of the material after tumbling with a rigid-elastically clamped indenter will cause a change in the size of the part, a machine setting to determine the "0" surface for an elastically clamped indenter is mandatory; the subtlety is that the pressing force should be exactly that required to form a homogeneous hardened layer so that the indentor with elastic fixing smoothed the tops of the preliminary roughness, but not "plowed" it completely, that is, if we exceed the required force, we will form "new" roughness, and if the force is less, we will not form a multilayer microstructure; in the first approximation, when smoothing a specific material, we should be guided by the upper value of force for the smoothing mode of smoothing), which passes into the hardened heterogeneous layer (formed by hard-fastened smoothing); the surface roughness parameter Ra < 0.1 mkm is achieved.

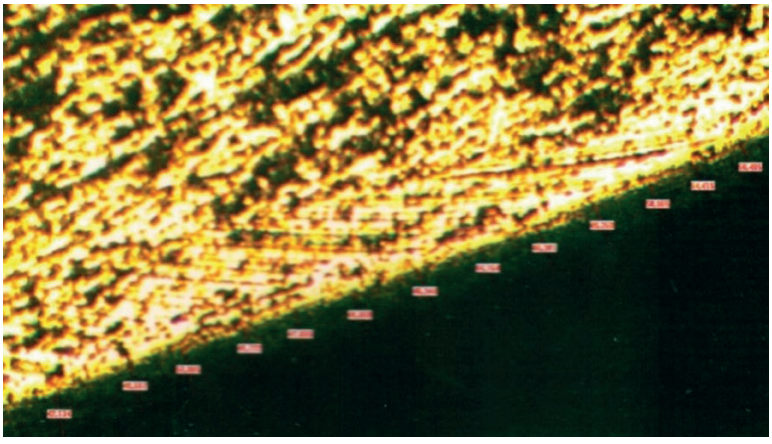


Fig. 2. Microstructure of D16T alloy after hard-elastic smoothing

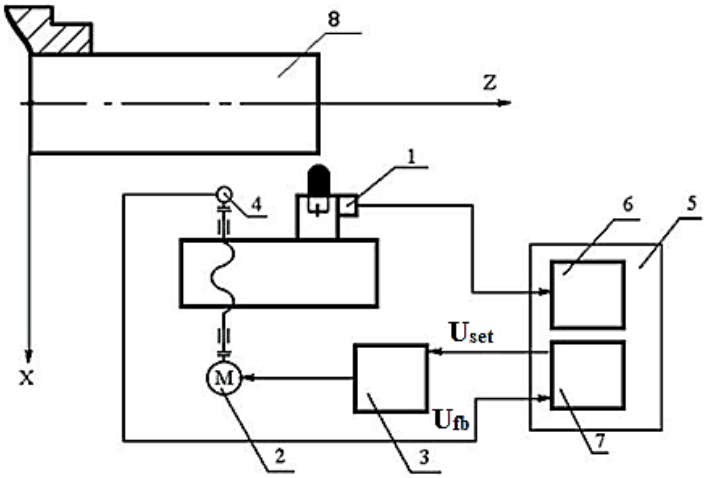
This ensures increased wear resistance of the surface layer of the part and its correct geometric shape. It should be noted that during smoothing with a classical indentor in the form of a plate, the working surface of which is profiled by a radius in width, it is

impossible to completely smooth the stepped surfaces of parts — bodies of rotation, because the spherical indentor will press against the end of the step, adjacent to the surface being smoothed, and the section whose length will be equal to the distance between the indentor and the plate remains unsmoothed.

Discussion

In order to realize the possibility of full smoothing of stepped surfaces of parts - bodies of rotation, it is proposed to use an indenter in the form of a plate, the working surface of which is additionally profiled with a radius along the thickness of the plate.

Since the tension during smoothing is only tens of micrometers, the accuracy in its setting will largely determine the quality of the surface layer of the part obtained after smoothing. Therefore, setting the tool to "zero" interference (the reference point for the set interference value) is of fundamental importance, which can be realized on CNC lathes in the following way (Fig. 3).



1 - electric contact sensor of the tool touching the workpiece; 2 - executive electric motor of the feed drive; 3 - thyristor converter; 4 - feedback sensor of the feed drive position; 5 - CNC device; 6 - controller of electroautomatics; 7 - controller of electric drives; 8 – workpiece

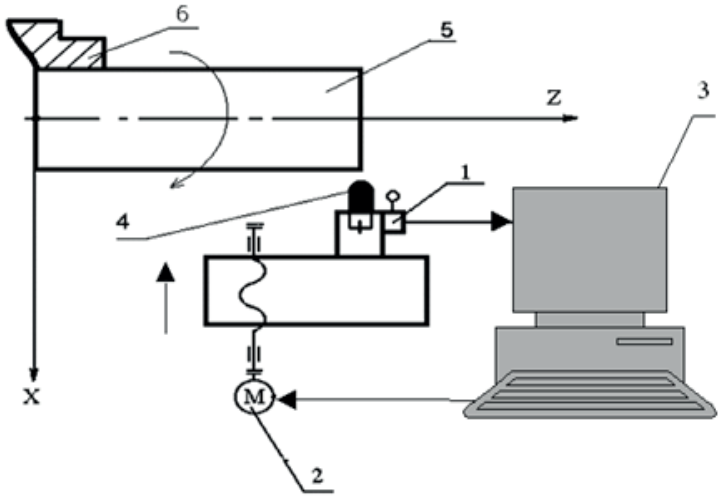
Fig.3. System of automatic ensuring the set interference:

The system of automatic ensuring of the set interference functions in the following way: the control program sets the hammerless approach of the tool at the rapid traverse speed to the machined workpiece 8 to the point, which is away from the workpiece surface according to coordinate X by the value Δ = 0.2-0.1 mm. Then, the control program sets the movement along X, with minimum feed, by the value Δ_{back}, which is guaranteed to be higher than Δ. The controller of electric drives 7 forms a corresponding setpoint signal U_{back} to the thyristor converter 3 by coordinate X. The electric motor of the feed drive 2 begins to work with the set displacement. In this case there is a comparison of the set movement and its actual value, received by the feedback channel from the feedback transducer 4 (U_{os}). At the same time, the state of the electric contact

touch sensor 1 is checked. For this purpose, the sensor is polled or the operation of this system is organized by interruption, which achieves high accuracy of the system.

At the moment when the tool touches the workpiece, a discrete signal from the electric contact sensor 1 goes to the automation controller 6, which stops the interpolation procedure, generates $U_{back} = 0$ and, consequently, stops the electric motor of the feed drive and generates the sign "End of frame processing". Then, the value of the set tension is set and the process of smoothing begins in the working modes.

Practice shows that sometimes it is advisable to replace the CNC system with a personal computer while keeping the electrical part of the drives unchanged. The system of automatic ensuring the set interference, based on the computer analysis of vibration signals arising when the tool touches the surface of the workpiece, is shown in Fig. 4. The computer communicates with the metalworking equipment through special interface devices, and a separate service program is developed for all drives.



1 - vibration sensor; 2 - executive electric motor of the feed drive; 3 - computer; 4 - smoothing machine; 5 - workpiece; 6 - chuck.

Fig. 4. System of automatic ensuring the set tension:

For PC controlled machines when setting the tool to "zero" tension it is possible to do without introducing additional devices for tool touch control. For this purpose, the service (control) program sets the "hammerless" approach of the tool at the rapid traverse speed to the workpiece at the point that is Δ=0.2-0.1 mm from the surface of the workpiece by coordinate X.

Next you set the X movement to the minimum feed rate, by a value Δ_{back} that is guaranteed to be greater than Δ. As soon as touching occurs (correspondingly the vibration signal appears) the program sends a coordinate fixation message to the X service program of the machine tool. Once the tool is set to "zero" tension the set point value is set. This method is easy to implement in practice and improves setting accuracy.

In the program, which analyzes the vibration signal, it is possible to change the sensitivity to vibration, at which the message about reaching the "zero" tension will be sent. The purpose of this is to allow the tension to be adjusted depending on the geometry and material of the smoothing part (which have a significant effect on the vibration level), so that even with a high level of damping (a measure of vibration energy absorption) the threshold for vibration sensitivity can be increased and high tuning accuracy can be maintained. If you know at what frequency there will be a change in amplitude when the tool indentor touches the surface of the workpiece, in this case the program provides for the possibility of tracking the occurring vibrations exactly at this (specified) frequency.

Conclusions

The review of researches in the field of surface plastic deformation of parts has defined the process of smoothing as an effective and environmentally friendly method of processing. Combined technology of surface plastic deformation including processes of rigid and elastic smoothing by combined tools provides obtaining high quality parameters of surface layer of working surfaces of critical parts due to different radii of elements.

As a result of using this method the formation of a layer-by-layer structure of the surface layer of the part with height parameters of roughness in the nanometer range to ensure high performance properties of parts and comprehensively provide quality parameters of the surface layer of the working surfaces of parts, including through more accurate tool setting and significantly increases the productivity of machining in general.

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