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Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
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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.

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THE CONTROL PROBLEMS OF THE LARGE DIAMETER HOLES IN PROCESSING OF THE LARGE PARTS

Abstract. The development of the advanced industries of the Republic of Kazakhstan (RK, such as chemical, oil, geological exploration, etc., dictates the need to develop promising and resource-saving technologies for manufacturing parts and assemblies of the machines and technological equipment. The most problematic is to ensure control during their manufacture. This is especially seen when inspecting critical surfaces, in particular holes of the large parts. The study in this article aims to solve this problem. The analysis of the design and technological feasibility of the existing instrumentation was carried out. The results showed that their main disadvantages are low measurement accuracy, high cost and design complexity, the impossibility of controlling holes of large diameters, as well as their unstable position inside the controlled hole. Taking into account these shortcomings, a special inside gauge has been developed to control holes of the large diameters, which will allow measuring the deviation of the hole diameters from the nominal value in a wide range of sizes. The advantage of the developed inside gauge is the following: the ability to measure deviations in the diameters of large holes, the stable position of the inside gauge to control holes of large diameters, in holes during inspection, as well as ensuring measurement accuracy with a resolution corresponding to the resolution of the applied dial indicator. The patent of the RK No. 4125 has been received for the design of the inside gauge to control holes of large diameters.

Key words. Large-sized part, large diameter holes, hole control, measurement accuracy, indicator, inside gauge.

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ІРІ ГАБАРИТТІ БӨЛШЕКТЕРДІ ӨҢДЕУ КЕЗІНДЕ ҮЛКЕН ДИАМЕТРЛІ ТЕСІКТЕРДІ БАҚЫЛАУ МӘСЕЛЕЛЕРІ

Аннотация. Қазақстан Республикасының (ҚР) химия, мұнай, геологиялық барлау және т.б. сияқты алдыңғы қатарлы өнеркәсіп салаларын дамыту машиналар мен технологиялық жабдықтардың бөлшектері мен тораптарын дайындаудың перспективалы және ресурс үнемдейтін технологияларын әзірлеу қажеттігін талап етеді. Жоғарыда аталған салалардың үздіксіз жұмысы машиналар мен технологиялық жабдықтың сапасына тікелей байланысты. Жүргізілген зерттеулер машиналар мен технологиялық жабдықтарды әзірлеу және жөндеу кезінде ірі габаритті бөлшектерді өңдеу проблемасы бар екенін көрсетті. Ең өзекті проблема оларды әзірлеу кезінде бақылауды қамтамасыз ету. Бұл әсіресе негізгі беттерді, атап айтқанда ірі габаритті бөлшектердің тесіктерін бақылау кезінде сезіледі. Осы мақаладағы зерттеу осы мәселені шешуге бағытталған. Қолданыстағы бақылау-өлшеу құралдары мен аспаптарының конструкциясы мен технологиялық мүмкіндігіне талдау жасалды. Нәтижелер олардың негізгі кемшіліктері өлшеудің төмен дәлдігі, конструкцияның жоғары құны мен күрделілігі, үлкен диаметрлі тесіктерді бақылаудың мүмкін еместігі және бақыланатын тесік ішіндегі олардың тұрақсыз орналасуы екенін көрсетті. Осы кемшіліктерді ескере отырып, үлкен диаметрлі тесіктерді бақылауға арналған арнайы нутромер әзірленді, бұл тесіктердің диаметрлерінің өлшемдердің кең ауқымындағы номинал мәннен ауытқуын өлшеуге мүмкіндік береді. Әзірленген нутромердің артықшылығы мыналар болып табылады: үлкен өлшемді тесіктердің диаметрлерінің ауытқуларын өлшеу мүмкіндігі, үлкен диаметрлі тесіктерді бақылау үшін бақылауды жүзеге асыру кезінде тесіктерде нутромердің тұрақты орналасуы, сондай-ақ қолданылатын сағаттық типтегі индикатордың рұқсат ету қабілетіне сәйкес келетін ажыратымдылық қабілетімен өлшеу дәлдігін қамтамасыз ету. Үлкен диаметрлі тесіктерді бақылау үшін нутромердің конструкциясына ҚР №4125 патенті алынды.

Түйін сөздер. Ірі габаритті бөлшек, үлкен диаметрлі тесіктер, тесіктерді бақылау, өлшеу дәлдігі, индикатор, нутромер.

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ПРОБЛЕМЫ КОНТРОЛЯ ОТВЕРСТИЙ БОЛЬШИХ ДИАМЕТРОВ ПРИ ОБРАБОТКЕ КРУПНОГАБАРИТНЫХ ДЕТАЛЕЙ

Аннотация. Развитие передовых отраслей промышленности Республики Казахстан (РК), такие как химическая, нефтяная, геологоразведочная и др. диктует необходимость разработки перспективных и ресурсосберегающих технологии изготовления деталей и узлов машин и технологического оборудования. Бесперебойная работа вышеуказанных отраслей напрямую зависит от качества изготовления машин и технологического оборудования. Проведенные исследования показали, что существует проблема обработки крупногабаритных деталей при изготовлении и ремонте машин и технологического оборудования. Самым проблемным является обеспечение контроля при их изготовлении. Особенно это ощущается при контроле ответственных поверхностей, в частности отверстий крупногабаритных деталей. Исследование в данной статье направлена к решению этой проблемы. Выполнен анализ конструкции и технологической возможности существующих контрольно-измерительных средств и приборов. Результаты показали, что основными недостатками их являются низкая точность измерения, высокая стоимость и сложность конструкции, невозможность контроля отверстий больших диаметров, а также их неустойчивое положение внутри контролируемого отверстия. С учетом этих недостатков разработан специальный нутромер для контроля отверстий больших диаметров, который позволит измерять отклонение диаметров отверстий от номинального значения в широком диапазоне размеров. Преимуществом разработанного нутромера является следующее: возможность измерения отклонений диаметров отверстий больших размеров, устойчивое положение нутромера для контроля отверстий больших диаметров, в отверстий при осуществлении контроля, а также обеспечение точности измерений с разрешающей способностью, соответствующей разрешающей способности применяемого индикатора часового типа. На конструкцию нутромера для контроля отверстий больших диаметров получен патент РК №4125.

Ключевые слова: крупногабаритный деталь, отверстия большого диаметра, контроль отверстий, точность измерения, индикатор, нутромер.

Introduction. Machines and technological equipment produced for the exploration, oil and gas, chemical and other industries are characterized by high metal consumption and high labor intensity of their manufacture. This is especially aggravated if their parts are large. For the manufacture of large-sized parts, either universal equipment and tooling are used, or processing complexes are created based on the use of unique equipment, large fixtures and conductors, and in some cases, original tools. When assembling such units and machines, the fitting method is widely used. Due to the specific features of the processing of heavy and large-sized parts and the small serial production of them, when developing the technology, it is impossible to mechanically introduce progressive methods and methods of processing, as well as the organization of work, which are widely used in large-scale and mass production of industries that are not related to heavy machine engineering.

Such details include the frame of submersible pumps. The bed of the NP8 submersible pump is its supporting part, on which the components and parts of the pump are mounted and to which especially high requirements are imposed in terms of its strength, rigidity and manufacturability (Anikin, 2018:138; Karelin, et al., 2010:446).

The bed in most cases is made of gray cast iron GCI15, GCI 18, GCI 21, GCI 32, and sometimes the beds are made welded from sheet steel (Morgunov, 2021:308, Korzh, 2010:184, Rakhimov, et al., 2021:9; Baydjanov, et al., 2019:8). Figure 1 shows the details of the submersible pump frame made of cast and welded construction.

a) b)

a - cast construction; b - welded construction; 1 - surfaces requiring high accuracy of location

Figure 1 - Construction of the submersible pump bed

Figure 2 shows a sketch of the submersible pump bed, indicating the surfaces, the location of which is highly demanding.

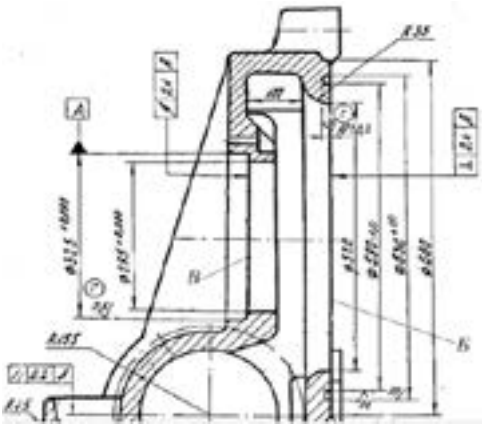


Figure 2 - Sketch of the submersible pump bed

It can be seen from the sketch that it is required to ensure the parallelism of the axes of the holes ∅325 mm, ∅295 mm and ∅255 mm, the perpendicularity of the side surface B to the axis of the holes ∅325 mm, the radial runout of the surface B relative to the surface A (Karsakova, et al., 2022:6).

Ensuring these requirements depends on the quality and accuracy of the machining of holes ∅325 mm, ∅295 mm and ∅255 mm, as well as surfaces B and C. The accuracy of measurement and control after machining plays an important role in this.

When processing these parts, there is often a need for original technical solutions. The main tasks in the processing of holes of large diameters of the heavy and large-sized parts are achieving the required geometry and accuracy, surface roughness and physical and mechanical properties of the surface layer (Sherov, et al., 2021 a:9; Dudak, et al., 2019 a:12, Dudak, et al., 2017 b:8). One of the ways to improve the efficiency of precision hole machining is to develop a set of measures that take into account the features of processing and control of large diameter holes.

Currently, in the Republic of Kazakhstan (RK), the manufacture and repair of large-sized parts (large valves, volutes, mills, etc.) are mainly carried out by heavy engineering plants, such as Almaty heavy engineering plant, Pavlodar heavy engineering plant, as well as large machine-building factories with appropriate technological equipment. The conducted studies have shown that one of the main problems arising in the manufacture of large-sized parts is to ensure the accuracy of control and measurement of holes of large diameters. Existing control and measuring tools, widely used in the conditions of machine-building plants of the Republic of Kazakhstan, such as calipers, inside gauges, plug gauges, etc., do not have the ability to control holes of the large diameters. And ordering expensive control and measuring equipment for these purposes does not justify the purchase costs and is unprofitable for the conditions of the machine-building plants of the Republic of Kazakhstan. The used control and measuring tools such as calipers, inside gauges (indicator, self-centering, micrometric), plug gauges, etc. have the following disadvantages: the inability to control holes of large diameters; unstable position inside the controlled hole during measurements; the impossibility

of determining the numerical values of the size of the controlled hole; insufficient measurement accuracy; inability to adjust to measure the different exact diameters (Sherov, et al., 2021 b:8; Kadyrov, et al., 2021:9, Issin, et al., 2018:6). In this regard, the study of the metrological security state for monitoring and measuring holes of the large diameters, as well as the development of the affordable control and measuring instruments with higher measurement accuracy, is an urgent task.

Research materials and methods. To solve this problem, the designs and technological capabilities of existing instrumentation were studied.

Known measuring tools for controlling the diameters of the holes caliper containing sponges for internal measurements, a movable frame, a rod, a vernier, a ruler (Ishlinsky, 1980:656). The disadvantage of the caliper tool is the low measurement accuracy, and caliper tools for inspecting large holes are not produced.

Known control means calibers-plugs containing cylindrical surfaces having dimensions equal to the smallest and largest limit size of the measured holes (Yakushev, et al., 1987:352). The disadvantage of the plug gauge is the impossibility of determining the numerical values of the size of the controlled hole, and gauges of large diameters are not manufactured.

A device for measuring the diameter of holes is known, comprising a housing, a gauge installed in the housing, a measuring pin, a hard stop and a transmission element between the measuring pin and the gauge (Kutaya, et al., 1994:610). The disadvantage of this device is the narrowness of the technological capabilities and the measurement of the diameters of the large holes is impossible.

Known caliper containing a full body, mounted on the body of the indicator with a measuring tip, a pusher (Shpytev, 1995:6). A disadvantage of the known inside gauge is the inability to adjust to measure different exact diameters, which requires the manufacture or purchase of a set of expensive rings for different measured diameters.

Known caliper indicator, containing a housing, a replaceable insert, a rod with a conical needle, measuring elements installed in the holes of the replaceable insert and made in the form of pins, the replaceable insert is made with the dimensions of the through gauge in diameter (Glyantsev, 1987:5). The disadvantage of this indicator inside gauge is the complexity of the design and the narrowness of technological capabilities, since the measurement and control of holes of large diameters is impossible.

Known caliper self-centering, containing a housing, indicator, bearing arms, indicator head, measuring tip (Rabinovich, 2014:6). The disadvantage of this inside gauge is the difficulty in operation, insufficient measurement accuracy and the narrowness of technological capabilities, since it is impossible to measure and control the holes of the large diameters.

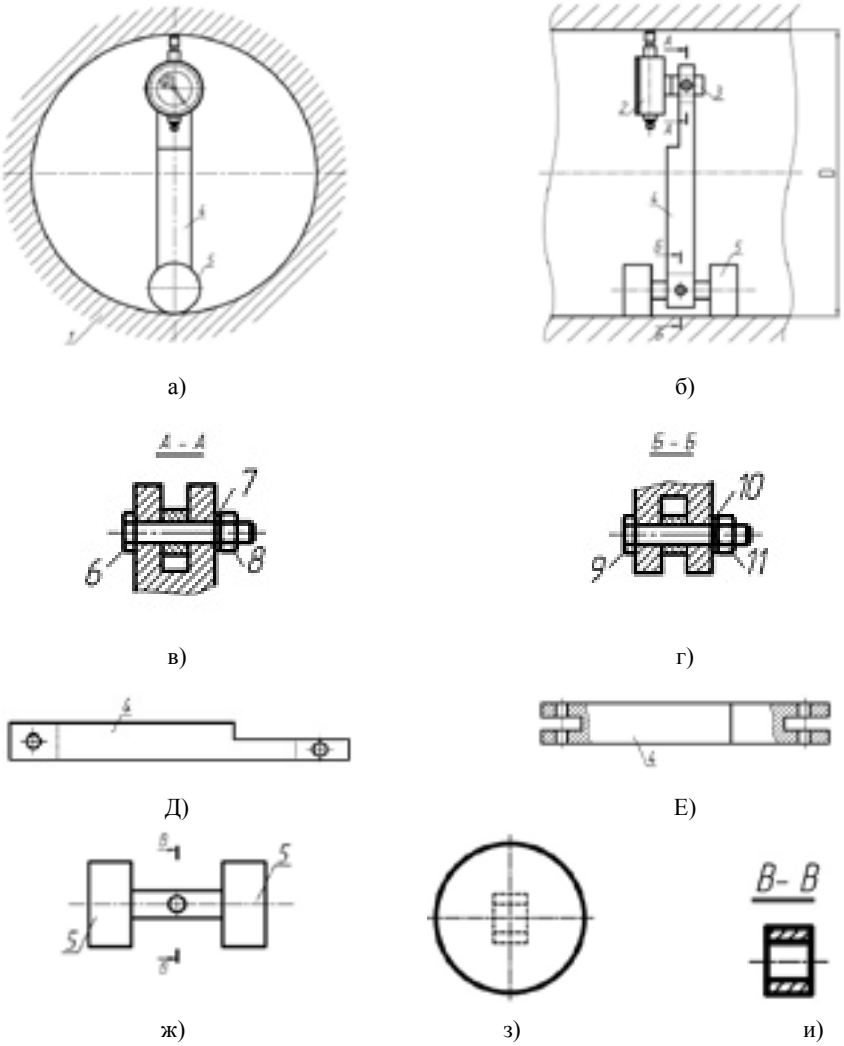
Known caliper for measuring holes, containing a housing mounted in the meter body, two measuring pins, a transmission mechanism between the measuring pins and the meter and the element of preliminary centering of the caliper in the holes (Grigoriev, et al., 1999:230). The disadvantage of this inside gauge is the increased complexity of the design of the measuring link due to the presence of two measuring tips, which reduces the measurement accuracy.

Known caliper for monitoring holes of small diameters containing a dial indicator (Ishlinsky, 1980:656). The disadvantage of the inside gauge is the impossibility of the controlling holes of the large diameters and its unstable position inside the controlled hole.

Results. The results of the conducted studies show the need to solve the following problems: providing the possibility of measuring deviations in the diameters of the large holes; ensuring a stable position of the inside gauge to control holes of the large diameters, in holes during control; ensuring the accuracy of measurements with a resolution corresponding to the resolution of the dial indicator used.

The authors have developed a special inside gauge to control holes of the large diameters (Donenbaev, et al., 2019:8).

The proposed inside gauge for testing holes of large diameters is shown in Figure 3.



а) б) в) г) Д) Е) ж) з) и)

a - position diagram of the internal caliper for testing holes of the large diameters, in the holes of the controlled part, front view; b - position diagram of the internal caliper for testing holes of large diameters, in the holes of the controlled part, side view; c - section A-A; d - section B-B; d - stand, side view; e - stand, top view; g - support, front view; h - support, side view; and - section B-B.

Figure 3 - Internal caliper to control holes of large diameters.

Discussion. A bore gauge for testing holes of large diameters (see Fig. 3) inserted into a hole with a diameter D of the controlled part 1 consists of a dial indicator 2, fixed with an eyelet 3 and a bolted connection 6,7,8 at one end of the rack 4, at the other end rack 4 fixed support 5 by means of a bolted connection 9,10,11.

The assembly of the internal caliper for testing holes of large diameters (see Fig. 3) is carried out as follows. A support 5 is installed at one end of the rack 4, a bolt 9, a washer 10 is inserted and fixed with a nut 11. At the other end of the rack 4, a dial indicator 2 is installed with the help of an eye ring 3, a bolt 6, a washer 7 is inserted and fixed with a nut 8.

Working with a bore gauge to control holes of large diameters is carried out as follows.

A bore gauge for testing holes of large diameters is adjusted to control a hole with a diameter D with a nominal value. The setting of the inside gauge for the indication is carried out according to the indications of the dial indicator 2 by moving it with the help of the lug 3 on the stand 4.

Determination of the deviation of the actual size of the hole is carried out by installing an inside gauge to control holes of large diameters in the hole and placing the indicator support 5 and dial indicator 2 in contact with the surface of the hole of diameter D.

By a slight turn of the inside gauge to control holes of large diameters, in the end plane to the hole of diameter D, the extreme position of the indicator needle is determined, corresponding to the value of Id. The deviation of the controlled value of the diameter D from its nominal value is calculated by the formula

$$\Delta_o = И_a - И_n$$

where Δ_o is the deviation of the hole diameter from its nominal value;

$И_a$ - indication of the dial indicator when measuring the deviation of the actual value from its nominal value;

$И_n$ - indication of the dial gauge when checking the hole at the nominal value of the diameter.

Conclusions. The use of a bore gauge to control holes of large diameters will allow measuring the deviation of hole diameters from the nominal value in a wide range of sizes.

The advantage of the developed design of the inside gauge is the following:

1. Possibility of measurement of deviations of diameters of openings of the big sizes.

2. Steady position of the gauge to control holes of the large diameters, in the holes during the control.

3. Ensuring the accuracy of measurements with a resolution corresponding to the resolution of the dial indicator used.

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