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ОБЗОР КОНСТРУКЦИЙ И ТЕХНОЛОГИЧЕСКИХ ВОЗМОЖНОСТЕЙ СОВРЕМЕННЫХ ОЧИСТНЫХ КОМБАЙНОВ

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Аннотация.
Запасы твердого топлива в Европе, расположенные на глубине не более 1200 м, эквивалентны глобальному потреблению Европой энергетического топлива более чем на 500 лет. Преимущество угля как основы энергетики состоит в том, что он залегает в земле в концентрированном виде. Если все количество мировых энергоресурсов приравнять к 100%, то на долю каменного угля приходится 70%, нефти – 18%, газа – 7%, гидроэнергетики – 5%.
Существующие технологии подземной добычи угля позволяют вынимать уголь, практически не нарушая поверхности земли и ее экологии. В будущем подземному способу добычи коксующегося угля не будет альтернативы.
В ближайшие 10-15 лет добыча угля будет производиться на пластах тонких, средней мощности и мощных, где комбайновый способ добычи станет превалирующим как по объему добычи, так и по качеству добываемого угля.
Подземный способ добычи угля в настоящее время ориентирован на использование очистных механизированных комплексов, в которых очистной комбайн – это машина, отделяющая механическим путем уголь от массива пласта, дробящая его до кусков транспортабельного размера и наваливающая уголь на забойный конвейер.
От совершенства конструкции очистного комбайна зависит эффективность и экономичность подземной выемки угля. В забое около 70 % энергии, расходуемой на добычу угля, связано с работой очистного комбайна.
В данной статье проанализированы основные конструкции очистных комбайнов со шнековыми исполнительными органами, их особенности, перспективы развития очистного оборудования для угольных шахт России. Рассмотрены практические примеры, подтверждающие оптимальность симметричной схемы расположения органов выемки по концам корпуса машины.

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очистной комбайн, шнековый исполнительный орган, симметричная схема расположения органов выемки, подземные горные работы, горные машины

DESIGN AND TECHNOLOGICAL CAPABILITIES OF MODERN CUTTER-LOADERS: OVERVIEW

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Abstract.
Solid fuel reserves in Europe, located at a depth of less than 1,200 m, are equivalent to Europe's global energy consumption for more than 500 years. The advantage of coal as the basis for energy is that it lies in the ground in a concentrated form. If all the world's energy resources are equal to 100%, coal accounts for 70%, oil for 18%, gas for 7% and hydropower for 5%.

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underground mining, mining machines

The existing technologies of underground coal mining make it possible to extract coal practically without disturbing the surface of the earth and its ecology. In the future, there will be no alternative to underground mining of coking coal.
In the next 10-15 years, coal mining will be carried out on thin, medium and thick seams, where the combine method of mining will become prevailing both in terms of the volume of mining and the quality of coal produced.
The underground method of coal mining is currently focused on the use of longwall set of equipment, in which a cutter-loader is a machine mechanically separating coal from the seam, crushing it to pieces of transportable size and pumping the coal onto a downhole conveyor.
The efficiency and cost-effectiveness of underground coal mining depend on the perfect design of the shearer. About 70% of the energy consumed for coal mining in the face is related to the work of the shearer.
The basic designs of cutter-loaders with auger executive bodies, their features, prospects of development of the clearing equipment for coal mines of Russia are analyzed in this article. The practical examples confirming optimality of the symmetric scheme of an arrangement of executive bodies on the ends of the machine frame are considered.

Introduction

In recent years, the economy of fuel and energy resources and coal in particular, has not improved in the European part of Russia, and its underground development has deteriorated. In underground mining, the cost of coal depends mainly on labor costs. Productivity growth could not compensate for the increase in material costs, wages and social costs, and European coal is becoming one of the most expensive energy sources [1].

World experience shows that underground mining of coal only up to 40-60% of reserves with the leaving of supporting pillars (i.e. losses are known to be planned) greatly simplifies underground coal mining, especially on seams with the thickness of 1.5 m and more, and makes it several times more economical and safe.

At the same time, labor productivity increases 2-4 times. At the same time, there is a need for fundamentally new solutions to open seams in order to drastically reduce the network of underground workings (in particular, the method of development by operating blocks has been proposed) and new technology and equipment for coal-face works.

Such measure will rapidly reduce the payback period for capital costs and operating costs of coal production [2].

Overview section

In the Soviet Union, and later in Russia, a significant number of works by well-known scientists are devoted to the problems of mining and tunneling equipment. In particular, the works [5-26] studied the arrangement of augers on cutter-loaders.

At present, there are a number of different schemes of cutter-loaders with auger executive bodies, which have found application both in the Russian Federation and abroad.

For example, the scheme of a single auger cutter-loader designed for the full thickness of the seam and located stationary and asymmetrically relative to the body of the combine is shown in Figures 1 and 2.

Control of seam thickness is carried out by means of interchangeable augers of various diameters, control of seam gypsometry – by lifting or lowering of the combine. This is a single-acting machine, however, is possible to ensure its shuttle operation by means of removable stripping devices. The main advantages of this scheme are its small overall dimensions in length, the ultimate simplicity of design, the ability to shuttle work. The disadvantages of the scheme are the lack of smooth regulation of the screw on the thickness of the seam and the inability to fully excavate longwall. Similar scheme have

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combines KSV-60 (Czech Republic), EW 60-G, EW 100-G, SE-IV (Germany), SL 250 (USA) and others, which received a limited area of distribution.

The schematic of a single auger mounted on a swing-arm handle is shown in Figures 3 and 4.

Figure 1. A single auger cutter-loader

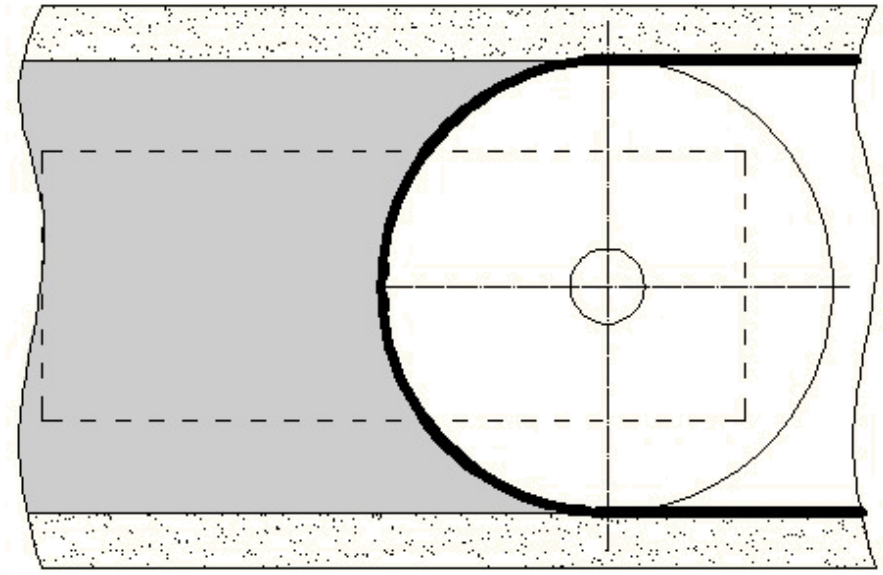

Figure 2. Scheme of coal seam extraction by single auger cutter-loader

These cutter-loaders have a two-way operation scheme. The auger removes the top pack of coal seam in the forward direction and the bottom pack in the reverse direction. Combines with this arrangement are simple in design. The main disadvantages of this constructive scheme are the impossibility of simultaneous coal extraction at the whole seam thickness and the need to have one niche at the end of longwall. These drawbacks affect productivity of all complex of the equipment. The similar scheme have combines KSV-33 (Czech Republic), KWB (Poland), EW 130-L (Germany) and others. Such machines have also received rather limited application.

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Figure 3. Cutter-loader equipped with a single auger mounted on a swing-arm handle

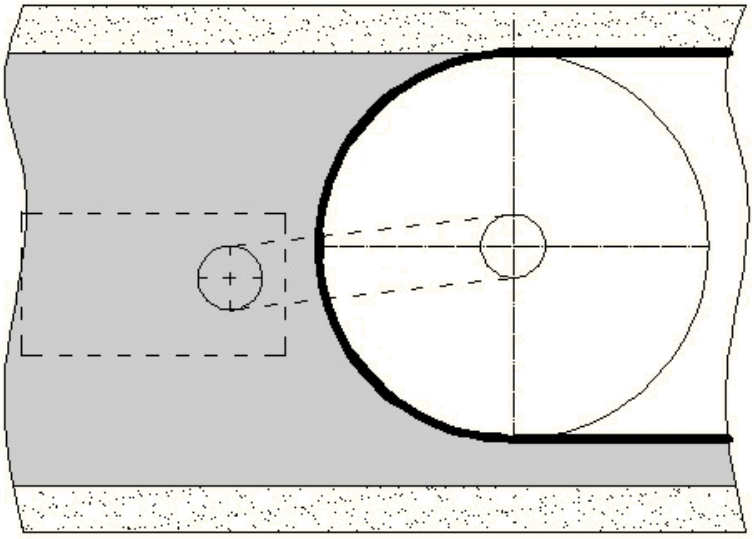

Figure 4. Scheme of coal seam extraction by cutter-loader equipped with a single auger mounted on a swing-arm handle

In combines with three augers (see Figures 5 and 6), the two lower augers are fixed on the body of the combine, and one – the upper auger – is placed on the oscillating handle. The three-screw shearers ensure that coal is excavated at full seam thickness. The main advantages of such a scheme are the possibility of self-cutting of the combine and, if necessary, to obtain a stepped shape of the cut, which increases the stability of the latter. Due to its disadvantage – difficulty of access to the area between the lower augers – this scheme has not been implemented (K58 type cutters).

Symmetrical scheme of the combine with four augers, arranged in pairs at the ends of the machine (see Fig. 7 and 8), provides coal extraction at the full thickness of the seam, as well as self-cutting of the combine (combines 4K52, K105, K120).

The disadvantages of such a scheme are: a complex design of the combine and difficult access to the area between the augers. As a rule, the machines are used on medium and thick seams.

The most common are combines with two screw actuators (see Fig. 9-16).

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The augers can be arranged asymmetrically or symmetrically with respect to the shearer body. In case of asymmetrical arrangement, one of the augers can be fixed permanently to the shearer body and the other to a swing (oscillating) arm that provides the seam thickness control, as shown in Figures 9 and 10 for 2K52M, EHW 100-G combines (Germany).

Both augers can be attached to the oscillating handles, as in the case of 1K101 (see Figures 11 and 12).

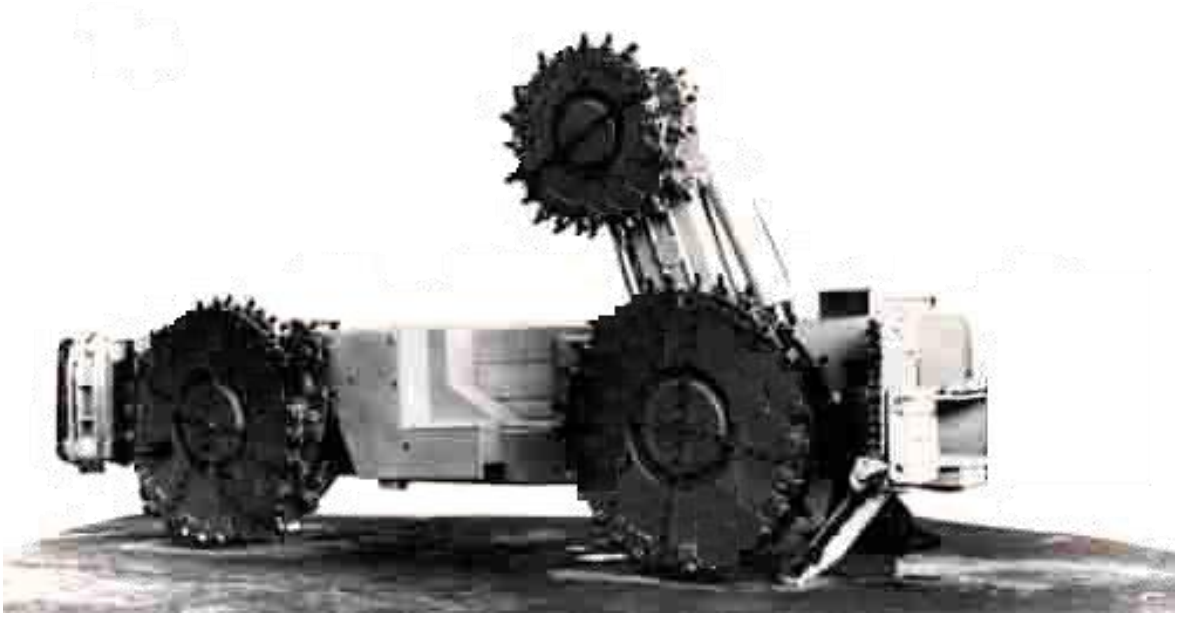

Figure 5. Cutter-loader equipped with three augers

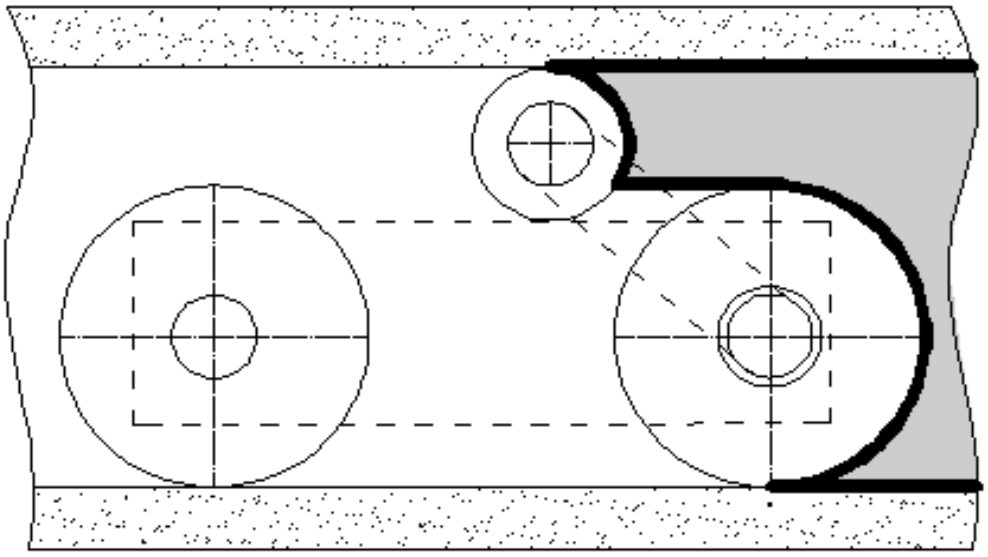

Figure 6. Scheme of coal seam extraction by cutter-loader equipped with three augers

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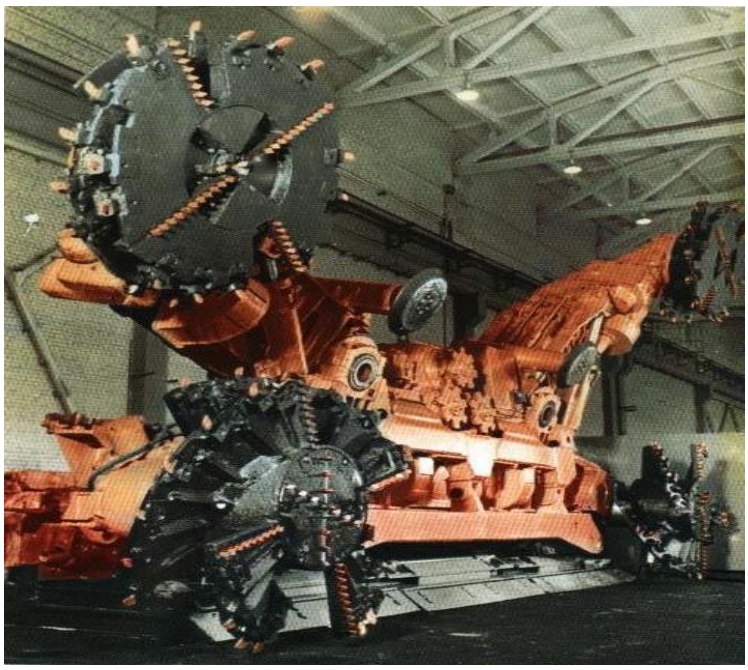

Figure 7. Cutter-loader equipped with four augers

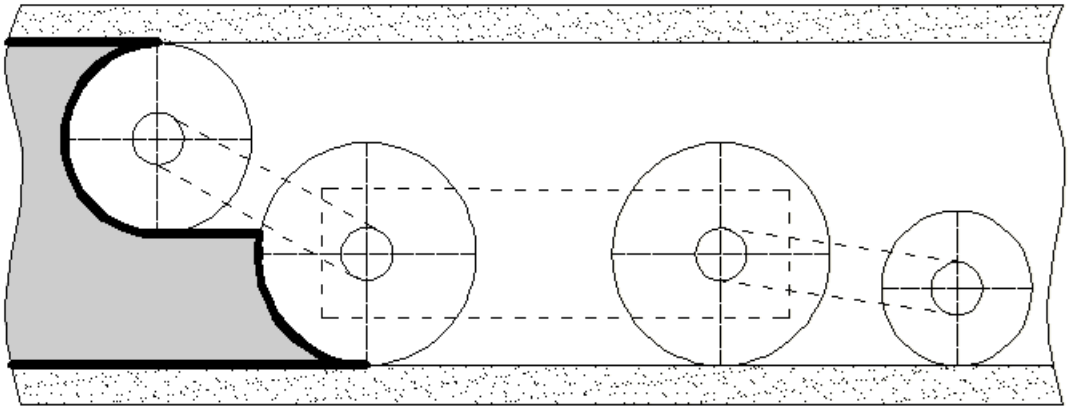

Figure 8. Scheme of coal seam extraction by cutter-loader equipped with four augers

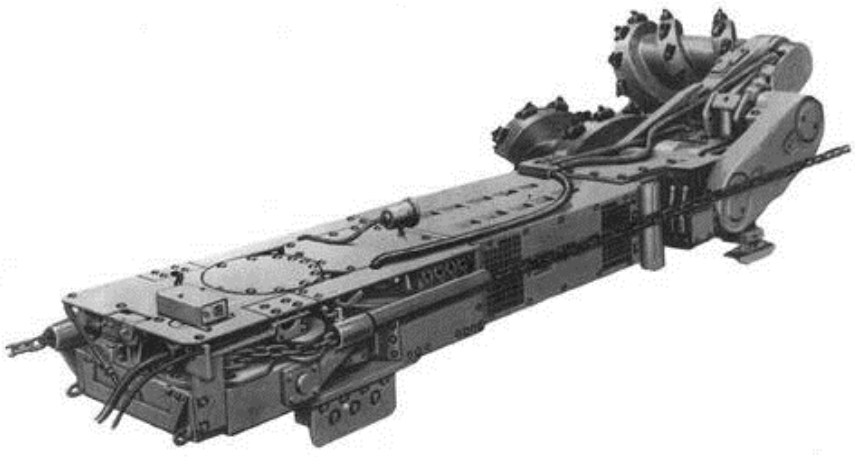

Figure 9. Cutter-loader equipped with two asymmetrically mounted augers

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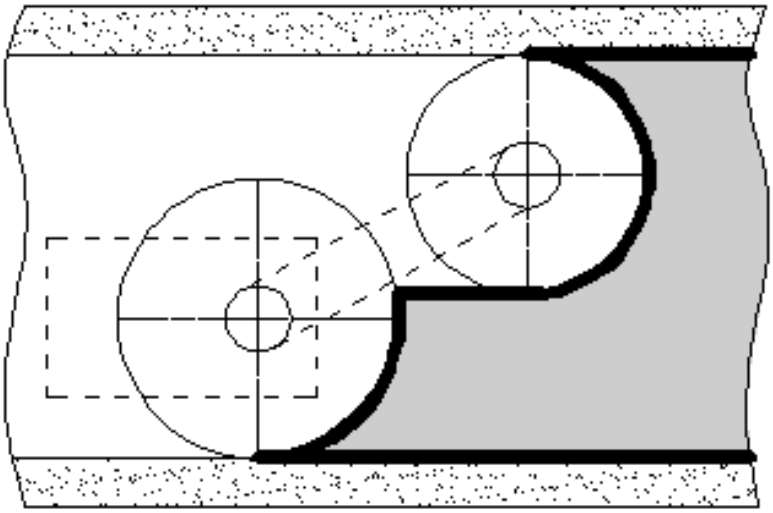

Figure 10. Scheme of coal seam extraction by cutter-loader equipped with two asymmetrically mounted augers

Figure 11. Cutter-loader equipped with two augers asymmetrically mounted on swing-arm handles

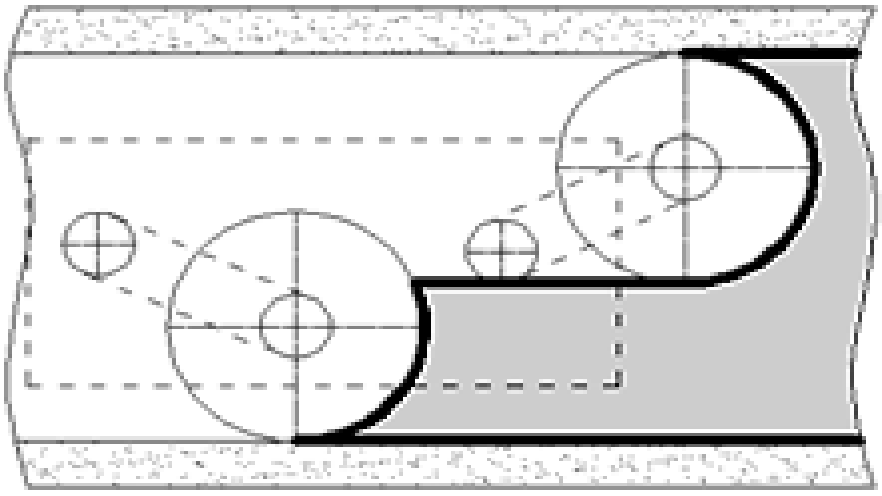

Figure 12. Scheme of coal seam extraction by cutter-loader equipped with two augers asymmetrically mounted on swing-arm handles

Such a scheme provides good coal mining at all seam thickness, shuttle operation scheme, good conditions for coal loading. However, a niche is required at one end of the longwall.

The asymmetrical scheme of the combine with two augers is shown in Figures 13 and 14.

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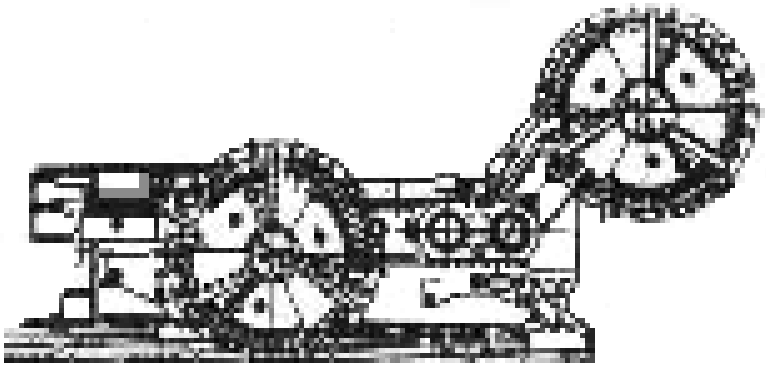

Figure 13. Cutter-loader equipped with two asymmetrically mounted augers

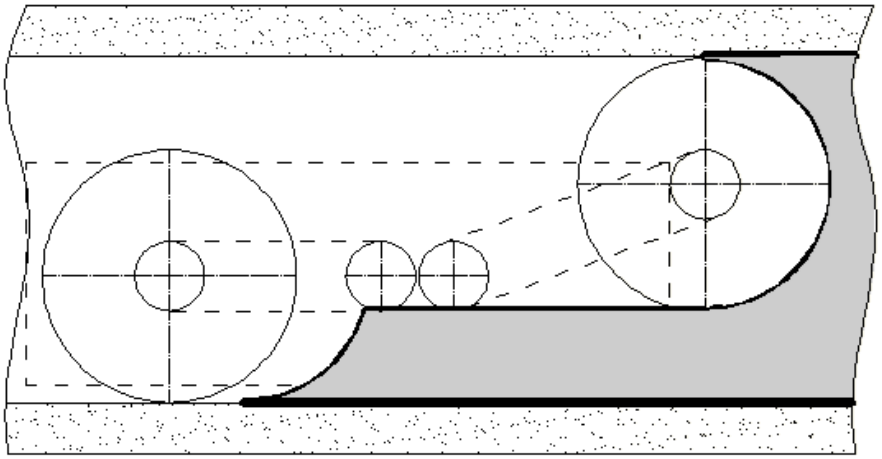

Figure 14. Scheme of coal seam extraction by cutter-loader equipped with two asymmetrically mounted augers

Both augers are mounted on swing-arm handles. The augers are brought closer together to provide a shorter, loose strip length in the self-cutting area and are offset to one end of the machine. In contrast to the scheme 10, the augers are facing in different directions. This arrangement of the machine requires a niche at one end of the longwall. KSH1KG, KSH3M and other cutter-loaders have such a scheme. This scheme has not been widely used.

Figures 15 and 16 show a cutter-loader with two augers arranged symmetrically relative to the body of the combine on swinging arms [3].

In this case the cutter-loader works according to the shuttle scheme and extracts coal to the whole seam thickness – shearers AT-1, K103, 1GSh68, K128P, KWB-6 (Poland), KSW-200 (Czech Republic), DTS-300 (France), AB16/200 (England), EDW-300L (Germany), etc.

Practice has confirmed optimum and perspective of the symmetric scheme of an arrangement of digging units on the ends of the machine body. Such a scheme of the combine has great opportunities for a high degree of unification of the functional units (assembly units) of the combine: electric motors, main gearboxes of the cutting part, rotary gearboxes, screw excavation bodies, feeders with wheel motions of rack and pinion type, control units, support and guiding mechanisms, mechanisms for lifting and lowering augers, creating on their basis a unified series of original designs of two-auger machines that cover the entire range (in terms of thickness) of the developed machines.

On the basis of coal shearers with two screws symmetrically located in relation to the body of the combine, which are most widespread in Russia and abroad, OMT OJSC ("Giprouglemash") has developed a number of such shearers.

Figure 15. Cutter-loader equipped with two symmetrically mounted augers

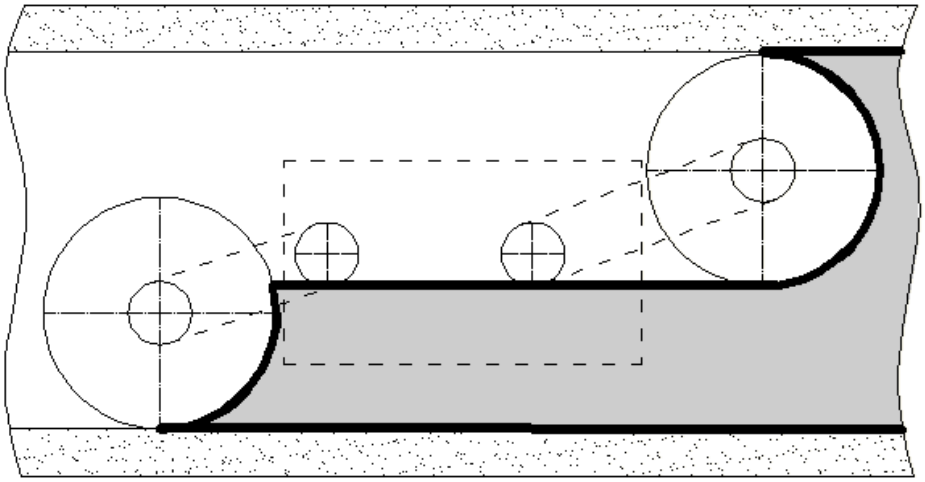

Figure 16. Scheme of coal seam extraction by cutter-loader equipped with two symmetrically mounted augers

Coal combine K500 of OJSC "OMT" design (see Fig. 17) is a machine made according to a prospective block-module scheme (see Fig. 18) with a transverse arrangement of all electric motors, excluding the use of bevel gears in the gearboxes of screw drive units and gearboxes of chainless feed mechanisms [4].

The machine is designed for mechanized coal mining in long stripping faces of flat and slightly inclined seams with the thickness of 1.6-3.5 m when working with a dip angle of up to 35° with coal cutting resistance up to 360 kN/m. For the first time in the domestic shearer are used: in rotary handles – rotating loading boards with hydromechanical control, hydro-controlled upper fencing boards, as well as high-pressure irrigation. Torsion shafts are installed in the auger drive unit, reducing low-frequency load fluctuations and simultaneously being safety elements.

The Nizhny Novgorod plant of OJSC NMZ produced the first prototype of the combine in 1996, which passed the full scope of bench tests at the Malakhovsky experimental plant, was accepted by the acceptance committee and sent for operational tests at the Zapadnaya mine of Production Association Intaugol. Tests were carried out in 1997 on the seam with the thickness of 1.6-1.7 m with an angle of occurrence up to 19° as a part of complex 3KM138I.

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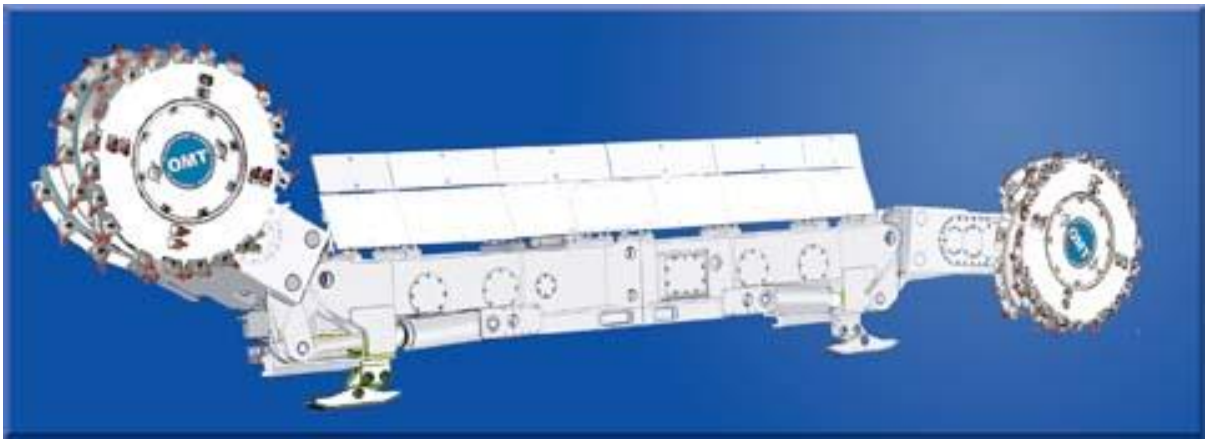

Figure 17. Cutter-loader K500 designed by OMT

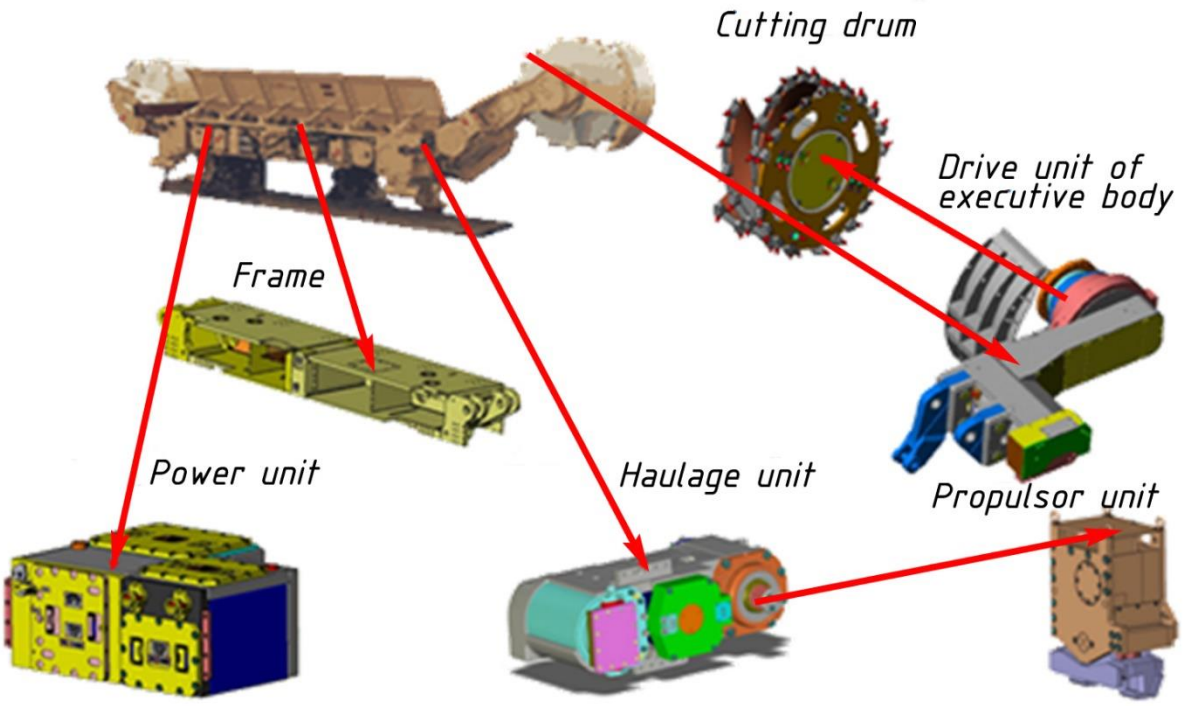

Figure 18. Block-module scheme of the cutter-loader (basic units and mechanisms)

As a result of the tests carried out, the advantages of the shearer's design scheme with transverse arrangement of electric motors, which provides access to the equipment from the side of worked-out space, as well as a number of basic technical solutions, were fully confirmed.

After the tests, the drawings were corrected by Giprouglemash. In addition to hardening parts of a number of units on the modernized shearer was installed a new control equipment – KUUK500, created by Tula Machine Building Plant under the leadership of G.D. Misailov, head of the department of Giprouglemash. The modernized shearer was purchased in 2000 by Vorgashorskaya mine and passed industrial tests. After that the cutter-loader was left at the mine for further operation. The Acceptance Committee recommended the K500 cutter-loader, KUUK500 control system and all electrical products for industrial production.

Subsequent shearers of this series, manufactured to the order of the mines by Nizhny Novgorod Machine Building Plant, are operated in the Pechora coal basin and are constantly improved by Giprouglemash and the plant.

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OMT OJSC together with Yurginsky Mashzavod LLC developed a working design of the K500 combine. Later on, Yurginsky plant decided to deal with the combine on its own and the first prototype of the combine of its production K500Yu (see Fig. 19) was sent in 1997 to the mine "Zyryanovskaya" in Novokuznetsk.

In recent years, the Russian coal mechanical engineering industry has undergone significant changes as a result of which the volume and range of produced extracting equipment has changed. The production of machines is becoming individual, taking into account specific mining-geological and mining-technical conditions of operation. At modern highly productive coal enterprises the tendency to concentrate mining operations, decrease the number of mining faces up to the system "mine - seam" or "mine-longwall" appeared. Implementation of this idea is impossible without increase of productivity of coal-mining complexes and, consequently, of separate machines, including coal-mining shearers.

Figure 19. Cutter-loader K500Yu designed by Yurga machine-building plant

The study of operators' requirements at the advanced enterprises has shown the need to create a domestic combine, first of all, for medium and thick seams, providing a stable load at the level of 10 thousand tons per day and able to compete in terms of technical level, reliability and price with combines of leading foreign companies.

On the basis of the above, OMT OJSC made a decision in 2003 to create a new model of a combine for development of seams having thickness 2.2-4.3 meters, named K600.

When developing the K600 combine (see Fig. 20), the experience of creating the K500 block-modular combine was used, which is in production at Nizhny Novgorod and Yurga machine-building plants. Giprouglemash also used the experience of foreign companies: JOY, Eickhoff and others.

Today the supplier of the K600 cutter-loader is OMT OJSC. All components and parts are delivered to Kiselevsk, where the shearer is assembled at OMT's mining equipment plant, and bench tests of the units and the machine as a whole are performed. The first sample of the K600 cutter-loader was manufactured in 2005.

The next modification of the K600 shearer is the K700 cutter-loader (see Fig. 21). Cutter-loaders type K700/1140 OMT are designed for extracting coal seams with a thickness of 1.8–4.2 m with an angle of slope of up to 35° on the stretch and up to 10° on the rise and fall, with coal cutting resistance up to 420 kN / m, dangerous for dust and gas. The cutter-loaders are equipped with electric drive feed mechanisms based on electromagnetic brakes. Gearboxes of cutting and feed are protected from dynamic loads.

Figure 20. Cutter-loader K600 designed by OMT

Combines have a block design of the main components, local and remote control via radio channel, control equipment that provides:

- supply voltage control and correct phase sequence;
- diagnostics of mechanisms and operating modes of the combine;
- chronological information (by code request) about operating modes;
- fixing of emergency modes in the "Black Box" unit.

Figure 21. Cutter-loader K700/1140 designed by OMT

In January 2012 in the Kiselevsk branch of OJSC "United Machine-Building Technologies" the presentation of a new cutter-loader K800/3300 (see Fig. 22), designed, constructed and manufactured at this plant, took place. The uniqueness of the K800/3300 cutter-loader is in the fact that the voltage of 3300 V is applied here, which allows to increase the reliability of the switching electrical equipment operation due to the current loads reduction. This sample was delivered for further use at the mine in Rostov region.

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Figure 22. Cutter-loader K800/3300 designed by OMT

Improvement of mining equipment and creation of necessary production facilities for the coal industry of the Russian Federation will allow ensuring technical progress in the field of equipment and technology of underground mining of coal deposits, as well as reducing the technological impact of mining on the environment.

Conclusions

The analysis of the current state of constructions and prospects of development of cutter-loaders showed that:

- the high level of unification, the possibility of assembly and repair by the aggregate-unit method are provided by frame structures of machines at their symmetry;
- optimal in terms of layout are twin-auger cutter-loaders with the arrangement of augers with individual electric drive at the ends of the body and electric chainless feed system with frequency controlled speed;
- in order to securely hold the cutter-loaders in flat and inclined seams during forced stoppages or emergency power outages, the engine blocks must be equipped with normally closed brakes;
- optimally designed twin-auger cutter-loaders virtually have no power limitations of up to 1000 kW/t;
- in the long term, it is advisable to increase their energy efficiency, taking into account the reserve of 15 to 30% of their drive power.

Список источников

1. Морозов В.И.. Чуденков В.И., Сурина Н.В. Очистные комбайны: Справочник // Под общей ред. В.И. Морозова. – М.: Издательство МГГУ, 2006. – 650 с.
2. Топчиев А.В., Ведерников В.И., Коленцев М.Т. Горные машины и комплексы. М., «Недра», 1971, 560 с.
3. Хорин, В.Н. Развитие техники для подземной добычи угля, калийных и марганцевых руд (работы института «Гипроуглемаш» за 1935-1985 гг.). // Под общ. ред. В.Н. Хорина и С.Х. Клорикьяна – М.: Недра. – 1985. – 360 с.
4. Старичнев, В.В. Угледобывающая техника института «Гипроуглемаш» и ее создатели / В.В. Старичнев, В.З. Шабловский // М.: «Дизайн-бюро «Альянс-А». – 2005. – 128 с.
5. Ржевский, В.В. Проблемы горной промышленности и комплекса горных наук. – М., Изд–во МГИ, 1991. – 242 с.
6. Солод, В.И. Проектирование и конструирование горных машин и комплексов. Учебник для вузов / В.И. Солод, В.Н. Гетопанов, В.М. Рачек // М.: Недра. – 1982. – 350 с.
7. Подэрни, Р.Ю. Угольная промышленность в США // М.: Недра. – 1968. – 187 с.
8. Братченко, Б.Ф. Угольная промышленность США / Б.Ф. Братченко, В.Н. Хорин // М.: Недра. – 1971. – 312 с.

9. Филимонов, Н.А. Выемочные и проходческие горные машины // М.: Госуглетехиздат. – 1959. – 428 с.
10. Маметьев, Л.Е. Распределение напряжений между деталями узлов крепления дисковых инструментов при разрушении проходческих забоев / Л.Е. Маметьев, А.А. Хорешок, А.М. Цехин, А.Ю. Борисов // Физико-технические проблемы разработки полезных ископаемых. – 2015. – №6. – С. 93-100.
11. Миничев, В.И. Угледобывающие комбайны. Конструирование и расчет // М.: Машиностроение. – 1976. – 248 с.
12. Топчиев, А.В. Горные машины – справочник / А.В. Топчиев, В.И. Ведерников // М.: ГНТИ литературы по горному делу. – 1960. – 384 с.
13. Солод, В.И. Горные машины и автоматизированные комплексы / В.И. Солод, В.И. Зайков, К.М. Первов // М.: Недра. – 1981. – 504 с.
14. Позин, Е.З. Разрушение углей выемочными машинами / Е.З. Позин, В.З. Меламед, В.В. Тон // М.: Недра. – 1984. – 287 с.
15. Малеев, Г.В. Проектирование и конструирование горных машин и комплексов / Г.В. Малеев, В.Г. Гуляев, П.А. Бойко // М.: Недра. – 1988. – 268 с.
16. Козлов, С.В. Основные проблемы технического переоснащения угольных шахт России. – М.: МГГУ. – 1998. – 68 с.
17. Хорешок, А.А. Горные машины и оборудование подземных горных работ. режущий инструмент горных машин: учебное пособие / А.А. Хорешок, Л.Е. Маметьев, А.М. Цехин, А.Ю. Борисов // Кемерово: КузГТУ. – 2012. – 288 с.
18. Линник, В.Ю. Повышение эффективности функционирования шнековых исполнительных органов очистных комбайнов в различных условиях применения. Автореф. дис. … канд. техн. наук. – М., МГГУ. – 2004. – 20 с.
19. Линник, Ю.Н. Концепция развития очистного, проходческого, конвейерного и бурового оборудования на период до 2020 г. / Ю.Н. Линник, И.С. Крашкин, В.Г. Мерзляков [и др.] // Горное оборудование и электромеханика. – 2006. – №3. – С. 2-6.
20. Павленко, С.В. Комбайн КДК500 в забоях ООО «Шахтоуправление «Садкинское» / С.В. Павленко, А.О. Иванков, В.В. Косарев // Уголь. – 2008. – №6. – С. 26-30.
21. Khoreshok A.A. Stress-deformed state knots fastening of a disk tool on the crowns of roadheaders / A.A. Khoreshok, L.E. Mametyev, A.U. Borisov, A.V. Vorobiev // Chinese Coal in the XXI Century: Mining, Green and Safety. Taishan Academic Forum – Project on Mine Disaster Prevention and Control. – 2014. – Pp. 177-183.
22. Клементьева, И.Н. Современное состояние и перспективы развития конструкций карьерных комбайнов для безвзрывной послойной выемки прочных пород / И.Н. Клементьева, Д.А. Кузиев // Горный информационно-аналитический бюллетень (научно-технический журнал). – 2019. – №2. – С. 123-128.
23. Локшинский, С.Г. Обзорная информация. Направления разработки и внедрения электрических систем подачи очистных комбайнов / С.Г. Локшинский, Ю.И. Гордиенко, В.В. Исачкин [и др.] // М.: ЦНИЭИуголь. – 1991. – 46 с.
24. Кантович, Л.И. Влияние конструктивных, технологических и виброреологических параметров на производительность карьерного комбайна со шнекофрезерным рабочим органом / Л.И. Кантович, А.А. Грабский // Горное оборудование и электромеханика. – 2009. – №1. – С. 5-11.
25. Красников, Ю.Д. Оптимизация привода выемочных и проходческих машин. / Ю.Д. Красников, З.Я. Хургин, В.М. Нечаевский, С.В. Солод [и др.] Под ред. чл.-кор. АН СССР А.В. Докукина // М.: Недра. – 1983. – 264 с.
26. Подэрни, Р.Ю. Исследование нагрузок на исполнительных органах и динамических характеристик карьерного оборудования с целью повышения эффективности рабочего процесса. Дис. ... докт. техн. наук // М..: МГИ. – 1972. – 251 с.

References

1. Morozov V.I.. Chudenkov V.I., Surina N.V. Ochistnye kombayny: Spravochnik [Cutter-loaders: Handbook] // Pod obshchey red. V.I. Morozova. – M.: Izdatel'stvo MGGU, 2006. – 650 s.
2. Topchiev A.V., Vedernikov V.I., Kolentsev M.T. Gornye mashiny i kompleksy [Mining machines and complexes] / M., «Nedra», 1971, 560 s.
3. Khorin, V.N. Razvitie tekhniki dlya podzemnoy dobychi uglya, kaliynykh i margantsevykh rud (raboty instituta «Giprouglemash» za 1935-1985 gg.). [Development of technics for underground mining of coal, potassium and manganese ores] // Pod obshch. red. V.N. Khorina i S.Kh. Klorik'yana – M.: Nedra. – 1985. – 360 s.

4. Starichnev, V.V. Ugledobyvayushchaya tekhnika instituta «Giprouglemash» i ee sozdateli [Coal mining equipment of Giprouglemash institute and its creators] / V.V. Starichnev, V.Z. Shablovskiy // M.: «Dizayn-byuro «Al'yans-A». – 2005. – 128 s.

5. Rzhevskiy, V.V. Problemy gornoy promyshlennosti i kompleksa gornykh nauk [Problems of mining industry and complex of mining sciences] / M., Izd–vo MGI, 1991. – 242 s.

6. Solod, V.I. Proektirovanie i konstruirovanie gornykh mashin i kompleksov. Uchebnik dlya vuzov [Design and construction of mining machines and complexes] / V.I. Solod, V.N. Getopanov, V.M. Rachek // M.: Nedra. – 1982. – 350 s.

7. Poderni, R.Yu. Ugol'naya promyshlennost' v SShA [Coal industry in USA] // M.: Nedra. – 1968. – 187 s.

8. Bratchenko, B.F. Ugol'naya promyshlennost' SShA [USA coal industry] / B.F. Bratchenko, V.N. Khorin // M.: Nedra. – 1971. – 312 s.

9. Filimonov, N.A. Vyemochnye i prokhodcheskie gornye mashiny [Extraction and workings mining machines] // M.: Gosugletekhizdat. – 1959. – 428 s.

10. Mamet'ev, L.E. Raspredelenie napryazheniy mezhdu detalyami uzlov krepleniya diskovykh instrumentov pri razrushenii prokhodcheskikh zaboev [Stress distribution in attachments of disc cutters in heading drivage] / L.E. Mamet'ev, A.A. Khoreshok, A.M. Tsekhin, A.Yu. Borisov // Fiziko-tekhnicheskie problemy razrabotki poleznykh iskopaemykh. – 2015. – №6. – S. 93-100.

11. Minichev, V.I. Ugledobyvayushchie kombayny. Konstruirovanie i raschet [Coal mining combines. Engineering design and calculation] // M.: Mashinostroenie. – 1976. – 248 s.

12. Topchiev, A.V. Gornye mashiny – spravochnik [Mining machines – Handbook] / A.V. Topchiev, V.I. Vedernikov // M.: GNTI literatury po gornomu delu. – 1960. – 384 s.

13. Solod, V.I. Gornye mashiny i avtomatizirovannye kompleksy [Mining machines and automatic complexes] / V.I. Solod, V.I. Zaykov, K.M. Pervov // M.: Nedra. – 1981. – 504 s.

14. Pozin, E.Z. Razrushenie ugley vyemochnymi mashinami [Coal breaking by extraction machines] / E.Z. Pozin, V.Z. Melamed, V.V. Ton // M.: Nedra. – 1984. – 287 s.

15. Maleev, G.V. Proektirovanie i konstruirovanie gornykh mashin i kompleksov [Design and construction of mining machines and complexes] / G.V. Maleev, V.G. Gulyaev, P.A. Boyko // M.: Nedra. – 1988. – 268 s.

16. Kozlov, S.V. Osnovnye problemy tekhnicheskogo pereosnashcheniya ugol'nykh shakht Rossii [Main problems of technical re-equipment of coal mines in Russia] / M.: MGGU. – 1998. – 68 s.

17. Khoreshok, A.A. Gornye mashiny i oborudovanie podzemnykh gornykh rabot. Rezhushchiy instrument gornykh mashin: uchebnoe posobie [Mining machines and equipment of underground mining. Cutting tools of mining machines. Textbook] / A.A. Khoreshok, L.E. Mamet'ev, A.M. Tsekhin, A.Yu. Borisov // Kemerovo: KuzGTU. – 2012. – 288 s.

18. Linnik, V.Yu. Povyshenie effektivnosti funktsionirovaniya shnekovykh ispolnitel'nykh organov ochistnykh kombaynov v razlichnykh usloviyakh primeneniya. Avtoref. dis. … kand. tekhn. nauk [Increase of efficiency of functioning of the auger executive bodies of the shearers in various application conditions. Abstract of thesis of Candidate of Technical Sciences]. – M., MGGU. – 2004. – 20 s.

19. Linnik, Yu.N. Kontseptsiya razvitiya ochistnogo, prokhodcheskogo, konveyernogo i burovogo oborudovaniya na period do 2020 g. [Development concept for cleaning, tunneling, conveyor and drilling equipment for the period up to 2020] / Yu.N. Linnik, I.S. Krashkin, V.G. Merzlyakov [i dr.] // Gornoe oborudovanie i elektromekhanika. – 2006. – №3. – S. 2-6.

20. Pavlenko, S.V. Kombayn KDK500 v zaboyakh OOO «Shakhtoupravlenie «Sadkinskoe» [Combine KDK500 in the faces of Sadkinskoye Mine Management Ltd.] / S.V. Pavlenko, A.O. Ivankov, V.V. Kosarev // Ugol'. – 2008. – №6. – S. 26-30.

21. Khoreshok A.A. Stress-deformed state knots fastening of a disk tool on the crowns of roadheaders / A.A. Khoreshok, L.E. Mametyev, A.U. Borisov, A.V. Vorobiev // Chinese Coal in the XXI Century: Mining, Green and Safety. Taishan Academic Forum – Project on Mine Disaster Prevention and Control. – 2014. – Pp. 177-183.

22. Klement'eva, I.N. Sovremennoe sostoyanie i perspektivy razvitiya konstruktsiy kar'ernykh kombaynov dlya bezvzryvnoy posloynoy vyemki prochnykh porod [Current state and prospects of development of quarry combine designs for blast-free layer-by-layer excavation of solid rocks] / I.N. Klement'eva, D.A. Kuziev // Gornyy informatsionno-analiticheskiy byulleten' (nauchno-tekhnicheskiy zhurnal). – 2019. – №2. – S. 123-128.

23. Lokshinskiy, S.G. Obzornaya informatsiya. Napravleniya razrabotki i vnedreniya elektricheskikh sistem podachi ochistnykh kombaynov [Overview information. Areas of development and implementation of electric feed systems for shearer loaders] / S.G. Lokshinskiy, Yu.I. Gordienko, V.V. Isachkin [i dr.] // M.: TsNIEIugol'. – 1991. – 46 s.

24. Kantovich, L.I. Vliyanie konstruktivnykh, tekhnologicheskikh i vibroreologicheskikh parametrov na proizvoditel'nost' kar'ernogo kombayna so shnekofrezernym rabochim organum [Influence of structural,

technological and vibro rheological parameters on the productivity of a quarry combine with a screw cutter working body] / L.I. Kantovich, A.A. Grabskiy // Gornoe oborudovanie i elektromekhanika. – 2009. – №1. – S. 5-11.

25. Krasnikov, Yu.D. Optimizatsiya privoda vyemochnykh i prokhodcheskikh mashin [Optimization of the drive of extraction and tunneling machines] / Yu.D. Krasnikov, Z.Ya. Khurgin, V.M. Nechaevskiy, S.V. Solod [i dr.] Pod red. chl.-kor. AN SSSR A.V. Dokukina // M.: Nedra. – 1983. – 264 s.

26. Poderni, R.Yu. Issledovanie nagruzok na ispolnitel'nykh organakh i dinamicheskikh kharakteristik kar'ernogo oborudovaniya s tsel'yu povysheniya effektivnosti rabochego protsessa. Dis. ... dokt. tekhn. nauk [Research of loads on executive bodies and dynamic characteristics of quarry equipment in order to improve the efficiency of the working process. Thesis of Doctor of Technical Sciences] // M..: MGI. – 1972. – 251 s.

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