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DEPARTMENT OF MINING ELECTROMECHANICS»

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EDUCATIONAL AND METHODICAL COMPLEX

BY SUBJECT

"SPECIAL CONSTRUCTIONS OF MINING MACHINERY AND EQUIPMENT»

(for students of the master's degree program:
5A312201-Mining machinery and equipment).

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The educational and methodical complex was developed in accordance with the standard program of the discipline "Special designs of mining machinery and equipment", approved by the order of the Ministry of Higher and secondary specialized education of the Republic of Uzbekistan No.___ of «__________».

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INTRODUCTION

Uzbekistan has built and operates mining enterprises with open and underground methods of extracting various minerals. These include a brown coal mine, "Angrensky" and management of underground coal mining JSC "Uzbekugol", quarry "Kalmakyr" AGMK, quarry "Muruntau" NMMC, which Occupies one of the leading positions not only in the CIS countries, but also in the world, etc.

The introduction of advanced mining technology is associated with the further improvement of transport in the mining industry, the improvement of transport in the mining industry, and the widespread use of flow-through transport systems.

This textbook is written in order to directly ensure the implementation of the Laws of the Republic of Uzbekistan "on education" and "on the national training program", in accordance with the State educational standard of the second stage of higher education - training of masters in the specialty 5A310705 -"Mining machinery and equipment" and the course program "Special designs of mining machinery and equipment".

Master's students of the specialty 5A310705 - "Mining machinery and equipment", during their bachelor's studies, study a number of specialization disciplines and there they become familiar with the designs of standard machines and equipment, the basics of their theory and calculation, the areas and conditions of application of these machines.

The course "Special constructions of mining machines and equipment" provides for the study of special, non-standard and new machines and equipment, improved components and equipment of standard multi-series machines and, therefore, there can be no standard textbook for this course, designed for students to use for many years.

Loss of a single economic space after the collapse of the Soviet Union, the inaccessibility of imported equipment due to its high cost made a state with a developed mining industry to rapidly develop their own design for the entire range of machinery and equipment in relation to its mining industry, and to manufacture these machines in the country by creating new or major upgrade of the existing production for the competitive mining equipment.

The desire of each state to develop its own production of mining machines has given rise to a wide variety of created mining equipment of the same functional purpose, not only in terms of design and layout solutions , but also in terms of technical, economic, operational and other parameters. Fundamentally new design solutions began to appear, for example, to createconditions for transportingrock mass from deep quarries, and much more

Therefore, the compilation of a complex on the course "Special constructions of mining machinery and equipment" is accompanied by a search, viewing and selection of materials from many different sources, mainly from specialized journals, collections of scientific papers, articles and reports, and other periodical literature, the INTERNET.

Attention is drawn to the manufacturability, prospects of new solutions, technical and economic indicators.

Navoi mining and metallurgical combine

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TRAINING MATERIAL

In the discipline

" SPECIAL CONSTRUCTIONS of MINING MACHINERY and EQUIPMENT»

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Reference summary

by discipline

"SPECIAL CONSTRUCTIONS OF MINING MACHINERY AND EQUIPMENT»

LECTURE NO. 1. MINING MACHINERY AND EQUIPMENT

Plan:

1. General information.
2. Conveyor beltsStomil Belkhatov.
3. Conveyor belts " RTI-KAUCHUK»

The purpose of the lecture *is to study mining machinery and equipment.*

Key words:: *rubber-cloth belts, conveyor belts, belts with steel cables, polyamide, polyester, Stomil Belkhatov, dvukhprokladochnaya tape, odnoprokladochnye tapes, rezinotrosovy tapes, transportation length.*

General information.

Belt conveyors are called continuous-action machines, the carrier and traction element of which is a flexible belt.

Belt conveyors are widely used in the industry. They are used to move bulk and individual cargo over short, medium and long distances in all areas of modern industrial and agricultural production; in mining; in metallurgy; in warehouses and ports; they are used as elements of loading and reloading devices, as well as as machines that perform technological functions.

The wide use of belt conveyors is due to a number of advantages:
- low weight;
- simple design;
- ability to transport cargo at high speeds (up to 6 ÷ 8 m / s);
- high productivity of belt conveyors (up to 30000 t / h);
- long transportation length (3 ÷ 4 km by one conveyor and more than 100 km in a multi-conveyor system).
– thanks to the flexibility of the belt, the conveyor belt can have complex routes with horizontal, inclined sections and with bends in the horizontal plane;
- ease of monitoring your work.

The length of 1 stave of the conveyor can reach up to 3-5 km, sometimes up to 14 km, the transportation range is more than 100 km, but more than 70% of conveyors have a limited length of up to 500 m.

The disadvantages of belt conveyors include:
- high cost of the belt (up to 50%) and the role of supports (up to 30% of the conveyor cost);

- a frictional method of transmitting traction that requires initial tension;
- increased belt tension under heavy workloads and long service life;
- difficulty of clearing sticky loads;
- difficult transportation of dusty, hot, heavy piece cargo;
- inability to use it for transportation of hot goods;
- a sharp drop in productivity when the lifting angle increases.

The maximum angle of inclination of the conveyor depends on the properties of the material being moved – mainly on the shape of the pieces, their size and humidity, etc.:

- for ordinary coal, ore and rock – up to 18^o;
– for small-sized cargo-up to 19-20^o, and in some cases (for example, for wet enrichment products) – up to 21-22^o;
- for large sorted cargo, the tilt angle is up to 16-17^o;
- for briquettes and individual loads, respectively, up to 10 ÷ 12^o.

If the tilt angles are greater than the specifiedones, the load rolls or slides down the belt.

When the conveyor is installed in an inclined position with the load being fed downwards, the maximum angle of inclination is reduced by 3 ÷ 5^o.

Classification of belt conveyors:

–*by application area*:
* General purpose conveyors (for bulk and individual loads)
• Special (for loading machines, mobile, portable)
* Underground

–*according to the shape of the route:*
• Simple ones (with one straight section, horizontal or inclined with up or down movement)
* Difficult (with a broken track)
* Curved (spatial)

–*by the slope angle of the track*
* Horizontal lines
• Gentle slopes
• Steep slopes (more than 22^0)
* Vertical lines

–*in the direction of cargo movement:*
* Lifting platforms
• Drains

–*according to the shape of the tape and the placement of cargo on it*
• with flat tape

• with grooved band
• with upper working side
• with lower working side
* with both working sides.

–by type of traction element

• with rubber band
• with rubber-cord tape
• with full-rolled steel strip
• with wire tape

Conveyor belts Stomil Belkhatov.

Stomil Belhatov A. O. is the largest in Poland and one of the leading European manufacturers of conveyor belts.

Stomil Belkhatov A. O. produces conveyor belts of two main types: rubber-woven and reinforced rubber-wire. The annual production capacity of the plant is about 140 km of rubber-cord belts, 100 km of rubber-cloth belts, 30 thousand tons of rubber mixes.

Rubber bands are made on the basis of polyamide (PA) and polyester-polyamide (EP) fabrics.

Polyamide, being a fully synthetic material, has a high tensile strength, low modulus of elasticity and the ability to significantly elongate. It is resistant to abrasion and bending, as well as to the effects of chemicals (excluding acids) and biological factors. The tapes produced on the basis of RA fabrics are characterized by good elasticity, the ability to absorb energy during impact and are characterized by a long service life. However, due to their relatively large elongation, they can only be used on small conveyors.

Polyester is also a fully synthetic material with high strength, but significantly less elongation than polyamide. It is resistant to abrasion, bending, exposure to chemicals, excluding alkalis, and biological factors. In belts, the core of which is made of polyamide-polyester fabrics, the warp threads are made of polyester, and the weft is made of polyamide. This combination is quite justified. Polyamide, which is characterized by a large elongation, increases the transverse elasticity of the tape, allowing you to get a deep tray. Polyester fiber has a higher modulus of elasticity than polyamide, so it is suitable for the base of belts designed for medium-length conveyors.

The plant produces RA-type rubber bands in the range of strength from 500 to 3500 kN / m and width from 500 to 2200 mm with the number of layers 2-6.

EP tapes are produced in the strength range from 500 to 3150 kN / m with the number of layers 2-6.

The allowed lengthening of RA-based tapes is up to 3.5 %. in Practice, it is lower and does not exceed 2.0%. In practice, the lengthening of EP tapes is 1.0-1.5%. [12].

Analysis of conveyor belts ' operation in mines and quarries has shown that their failure is usually caused by mechanical damage, rather than wear of the covers due to abrasion. At the same time, it was found that the durability of belts can be increased by increasing the strength for breakdowns and breaks.

In this regard,Stomil Belkhatov used protective gaskets in his belts, designed in such a way that they had low rigidity and high strength in the direction of the weft of the load-bearing gaskets. In this way, a good interaction of the gasket with the rubber of the cover is ensured. The protective pad located above the frame of the rubber-cloth tape gives the maximum effect when the rock pieces hit directly on the roller, and the protective pad located under the frame-when the material hits the tape between the rollers. Thus, it is best to use two protective gaskets. The energy absorption capacity of the tape is always greater when hitting a block between the rollers than directly into the roller. Therefore, if only one pad is used, it must be located above the tape frame.

The main characteristics of rubber-cloth conveyor belts are shown in the table.1.1.

Main characteristics of rubber-fabric conveyor belts

type of tape / number of fabric pads	tape strength, kN / m	standard thickness of plates, mm	frame thickness, mm	frame weight, kg / m^2	belt weight, kg / m^2
1	2	3	4	5	6
630/3	630	3+2	4.50	4.65	10.40
630/4	630	3+2	6.00	5.64	11.35
800/4	800	4+2	6.00	6.20	13.00
1000/4	1000	4+2	6.80	6.70	14.00
1000/5	1000	4+2	7.50	7.75	14.60
1250/4	1250	5+3	7.60	8.00	17.30
1400/4	1400	5+3	7.60	9.10	18.30
1600/4	1600	6+3	7.60	9.60	19.90
1600/5	1600	6+3	9.50	11.40	21.60
1800/4	1800	6+3	8.20	8.20	19.50
2000/4	2000	6+3	10.80	11.68	22.00
2000/5	2000	6+3	9.50	12.50	22.30
2500/5	2500	8+4	13.50	14.60	28.30
3150/5	3150	8+4	14.50	16.35	30.10
3500/5	3500	8+4	15.00	17.90	31.60

The use of conveyor belts with high-strength steel rope frames allows the material to be transported over long distances and with very high productivity.

The low working length of the rubber wire belt (about 0.2%) makes it possible to reduce the cost of transporting materials due to the possibility of designing and installing long conveyors on site.

Rubber-cord conveyor belts consist of protective rubber plates and a rubber side. The power frame of the belt is a series of parallel-laid galvanized metal cables, vulcanized in rubber.

The strength of the tape depends on the strength of the steel cables and the distance between them. These values are normalized.

The main advantages of belts with steel cables (compared to rubber-cloth belts):

- greater strength with smaller permissible drum diameters;
- lower elastic elongation (approximately 5 times)упругостное, allowing the installation of long conveyors with relatively short traction paths;
- lower constant elongation;
- possibility of obtaining a deep gutter (gutter angle 60-70 degrees);
- low maintenance and repair costs;
- high strength for short conveyors;
- relatively easy and cost-effective вouse of- becoming when the cables are not damaged;
- water entering the rod through damage to the lining can only spread along the cables, so that there is no delamination of the tape, characteristic of rubber-cloth tapes.

For the production of belts, steel cables made of galvanized high-carbon steel wire with a strength of up to 2200 MPa are used.

The plant produces belts with cable strengths from 800 to 5400 kN / m and widths from 800 to 2400 mm.

The main characteristics of rubber wire belts are given in table 1. 2.

Table 1.2

Main characteristics of rubber wire conveyor belts

Feed type	ST 1000	ARTICLE 1250	ST 1600	ST 2000	ST 2500
Minimum tensile strength of the tape, kN/m	1000	1250	1600	2000	2500
Diameter Cable diameter, mm	3,7-4,1	4,4-4,9	5,2-6,0	5,2-6,0	6,8-7,2
Nominal distance between cables, ±1.5 mm	12	14	15	12	15
Minimum thickness of rubber plates, mm	4	4	4	4	5
Recommended plate thicknesses, mm	5+5	5+5	8+8	8+8	8+8
Tape thickness, mm	13.7	14.4	21.2	21.2	22.8
Maximum belt width, mm	2400	2400	2400	2400	2400

Continuation of table 1.2

Feed type	ST 1000	ARTICLE 1250	ST 1600	ST 2000	ST 2500	Feed type
Minimum tensile strength of the tape, kN / m	3150	3500	4000	4500	5000	5400
Diameter Cable diameter, mm	7,6-8,1	8,2-8,6	8,8-8,9	9,6-9,7	10,6-10,9	11,2-11,3
Nominal cable spacing, ±1.5 mm	15	15	15	16	17	17
Minimum thickness of rubber plates, mm	5.5	6	6.5	7	7.5	8
Recommended plate thicknesses, mm	10+10	10+10	10+10	10+10	12+10	12+10
Tape thickness, mm	27,6	28,2	28,8	29,6	32,6	33,2
Maximum belt width, mm	2400	2400	2400	2400	2400	2400

Conveyor belts

"RTI-RUBBER»

The RTI - KAUCHUK plant (Moscow) is the largest manufacturer of rubber products in Russia. A significant part of the plant's output is occupied by conveyor belts.

The range of production includes multi-layer and one-two-layer conveyor rubber-fabric belts with external rubber linings, used for transporting bulk, lump and piece loads, as well as for transporting people through the mine workings of coal mines.

The appearance of high-strength polyester-polyamide fabrics with a breaking strength of 800-1600 N / mm (developed by JSC NIIT, Yaroslavl) allowed JSC RTI-KAUCHUK to produce belts with a smaller number of fabric gaskets while maintaining the strength indicators (or even exceeding them) of the tape itself. The use of high-strength fabrics in the production of conveyor belts showed not only the technological advantages of a low-layer design compared to a traditional multi-layer one, but also made it possible to reduce the weight and reduce the thickness of the belt with the same production characteristics. At the same time, the problem that is characteristic of малопрокладочнойlow-layer belts, related to the transverse rigidity of the tape, namely, its tray formation, was solved. New designs of single-and double-laying conveyor belts have been developed [19, 20].

The double-lining tape consists of two strong synthetic gaskets (polyamide or polyester-polyamide ныеyarns) with an additional thick intermediate layer of cushioning rubber with special characteristics. The traction frame is stable, has a lower relative elongation, has sufficient rigidity in the longitudinal and transverse directions, and resists shock loads well.

Currently, along with traditional conveyor beltsоднопрокладочные, single – layer belts with a strength of up to 1600 kN/m and double-layer belts with a strength of up to 3200 kN/m are produced. Operational tests of double-spacer belts have shown the superiority of new-design belts over traditional multi-spacer belts [16].

LECTURE№ 2. ADVANCED DOCKING TECHNIQUES CONVEYOR BELTS.

Plan:

1. Joining of rubber bands.

2. Joining of rubber-cord belts.

3. Joining the conveyor belt with mechanical joints.

The purpose of the lecture *is to study advanced methods of connecting conveyor belts.*

Key words:: *vulcanization presses, joining technology, hot vulcanization, joining method, double-laying belts, joining, rubber-cloth belts, rubber-wire belts, joint length, joint steps, vulcanization parameters, docking schemes.*

Connecting rubber bands.

The effective operation of conveyor transport systems is determined, in addition to the quality of the conveyor belt used, by the strength of its connection during the installation of conveyor complexes or during the repair of belts. At the same time, the strength of the joint depends on the joining technology and the materials used.

STOMIL BELCHATOV has developed a technology for joining rubber-cloth tapes, which ensures a strong connection of tape segments at the junction (Fig. 1. 1). Vulcanization presses with a minimum average joint pressure of 1.2 MPa should be used for joining the belt. As materials for carrying out the coupling (which may be put together with conveyor belts) use: rubber coating, rubber prosloika, solution to clean the mating surfaces of the joint (Tolman 80%, of chetyrehsot-len 10%, the extraction of gasoline 10%), and cotton cloth to separate the surfaces of the joint and the heating plates vulcanizer.

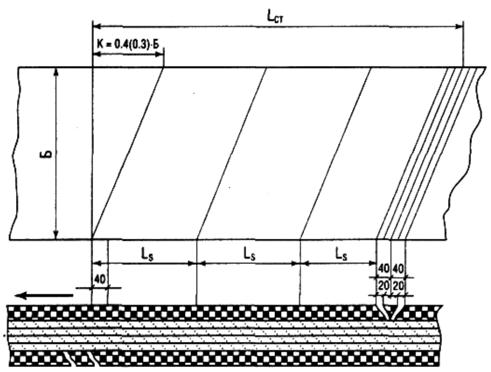


Fig. 1. 1. Scheme of joining of rubber bands

The joint length for rubber-cloth belts in hot and cold vulcanization methods can be determined by the formula:

$$L_{cm} = K + (Z - 1) \cdot L_s, \qquad (1.1)$$

where L_{St} is the length of the connection;

K – length of the bevel;

K = 0.4 (0.3) B (B is the width of the tape);

Z – number of gaskets;

Ls_s– длинаstep length.

The length of the joint steps depends on the strength of the fabric pad and is shown in table.1.3.

Table 1.3

Recommended length of joint steps for rubber bands

Strength of the fabric pad (kN / m)	Step length Ls (mm) for width	
	menee 1400 mm	bolee 1400 mm
do 150	150	200
ot 160 to 250	250	300
ot 250 to 315	350	400
ot 315 to 400	400	450
ot 500 to 630	450	500

The docking technology includes the following operations::

- marking of the bevel length and step length is performed;
- it is removed along the slope line of the 20 mm lining, the rubber lining is cut off obliquely. The length of the bevel should be 0.4 (0.3) B. this depends on the slope of the vulcanization press;
- in accordance with the planned steps, the gaskets are cut off;
- lubricate the surface of the gaskets with a solution and a rubber layer, and apply the interlayer rubber to the joint;
- vulcanization is carried out.

Recommended vulcanization parameters are shown in the table.1.4

Table 1.4

Vulcanization parameters

Rubber class	W, X, Y, A, AA, T1	K, R	TG	TZ
Temperature Vulcanization temperature	145±5^{0}C	145±5^{0}With	150±5^{0}C	160±5^{0}With
Толщина Tape thickness, mm	Time of curing, min			
1	**2**	**3**	**4**	**5**
10	25	30	50	45
14	30	30	50	50
16	30	35	50	50
18	30	35	50	50
20	35	40	50	55
22	35	40	50	55
24	40	40	55	55
26	40	45	55	55
28	40	45	55	60
30	45	50	55	60
32	45	50	60	60
34	45	50	60	60
36	50	55	60	60
38	50	55	60	60
40	55	60	65	65

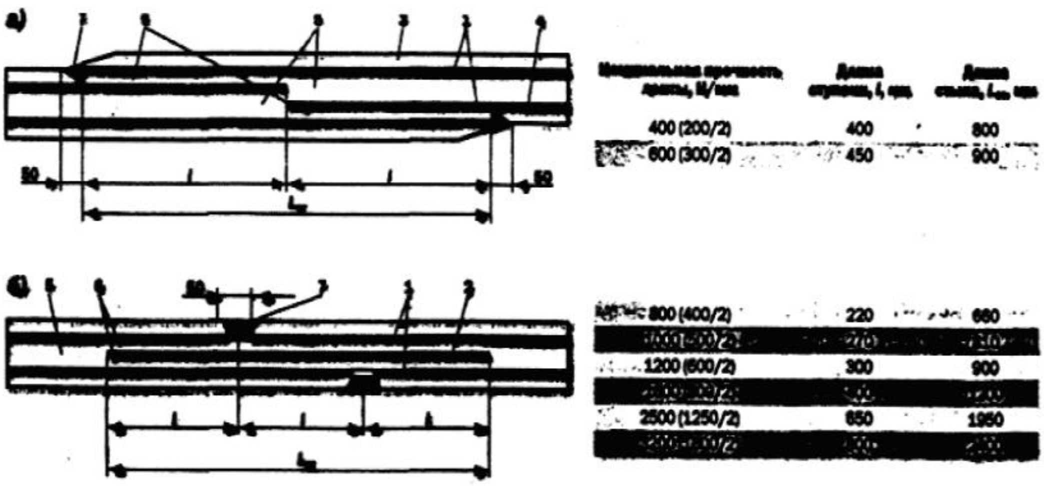
The conveyor belt after joining can be operated after cooling the joint site to ambient temperature, but not earlier than 2 hours after the end of vulcanization.

The complexity of joining two-layer tapes is significantly lower than that of multi-layer tapes [16].

RTI-KAUCHUK does not present any great difficulties – they are easily and quickly connected using mechanical connectors (all-in-one or split-joint), as well as by hot or cold vulcanization with the installation of an intermediate fabric (aramid) or rubber gasket.

In Fig.1.2 some options for connecting two-layer belts by hot or cold vulcanization are presented. The table also shows the length of a rectangular joint depending on the strength of the fabric pad.

Hot vulcanization is carried out by serial vulcanization presses, which provide a uniform pressure of about 0.8-1.0 MPa over the working surface of the joint and ± a vulcanization temperature of 145.5 ° C. The required vulcanization time of the tape is taken in accordance with the schedule shown in Fig. 1. 3.



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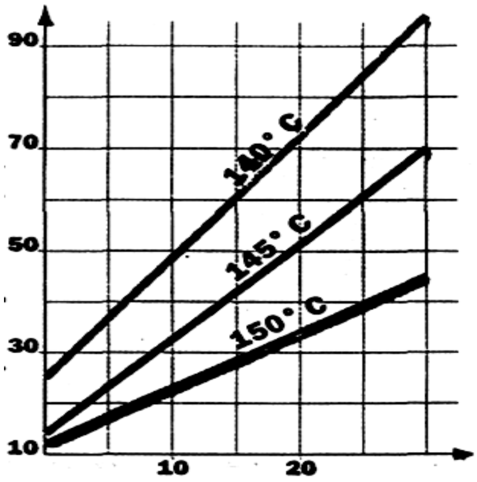
Vulcanization timeи, min



Tape thickness, mm

2.3. Dependence of the vulcanization time on the tape thickness

Connecting rubber wire belts

Technology of joining rubber-wire belts (St), developed byStomilBelchatow, provides a strong connection of tape segments at the junction. Moreover, for joining tapes of the following typeCTIt is recommended to use branded materials that can be supplied in conjunction with conveyor belts to achieve high efficiency.:

- plates (frame mix/lining mix) for production of working and non-working plates;
- interstitial strips (frame mix) for connecting cables;
- filling strips (frame mix) to fill in the interstitial space;
- closing strips (frame mix) for processing tape sides;
- rubber adhesive for joining elements of the tape frame;
- solution for cleaning the joined surfaces of joint elements (toluene 80%, tetrachloroethylene 10 %, extraction gasoline 10 %);
- cotton cloth for separating the joint surfaces and heating plates of the vulcanizer.

The developed technology of joining rubber-wire belts assumes their connection only by hot vulcanization.

Depending on the type of belt and its width, the connection of conveyor belts with steel cables can be one -, two -, three -, or four-stage.

The design of the joints is shown in Fig.1.4. and the docking parameters in table 1.5.

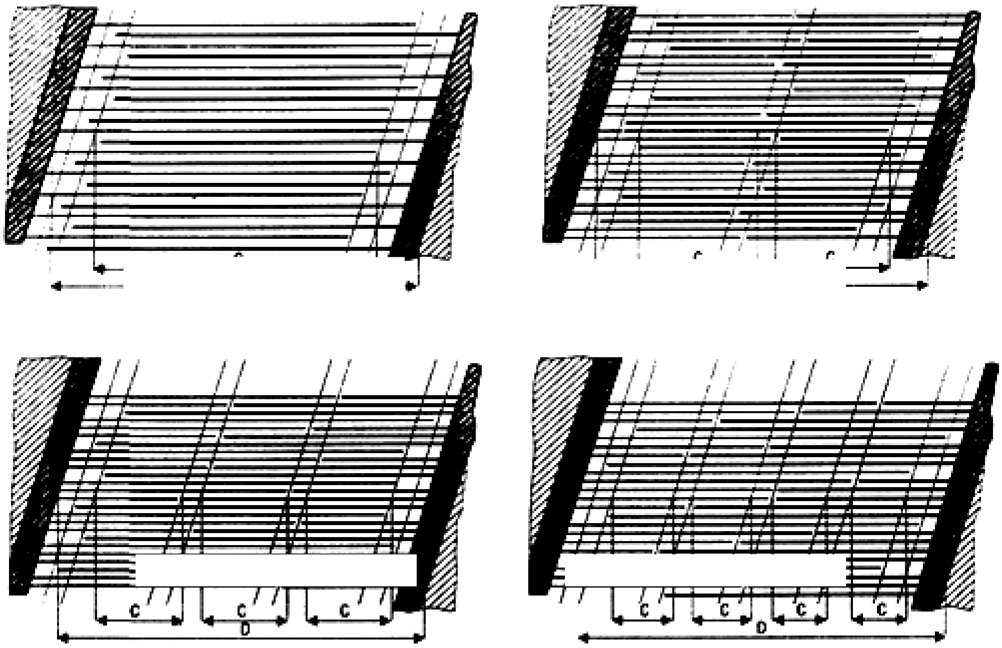


Fig. 2. 4. Connection of rubber bands with steel cables

The docking technology includes the following basic operations::

- setting up a vulcanization stand;
- marking the bevel length and step length;
- alignment of the connected ends of the belts and fixing them on the vulcanization table;
- performing operations for cutting working plates of rubber sides, frame rubber between metal cables, etc.;

- preparation of the contact surface with a sander and treatment with a solution for cleaning the surfaces to be joined;
- laying of non-working plates, covering their bevels with rubber glue and gluing the ends of tapes with a non-working plate;
- laying of steel cables according to the connection scheme;
- sticker of closing strips along the height of the cable surface and filling the free space between the cables with filling strips;
- application of the working plate on the cables and connection to the tape plates;
- ulcanization of thedocking point стыковки.

Table 1.5

Connection parameters

Feed type	ST 800	ST 1000	ARTICLE 1250	ST 1500	ST 1600	ST 2000	ST 2500
Number	of available items 1	1	1	1	1	2	2
Joint length (D), mm	600	600	650	750	700	1150	1350
Step length (S), mm	300	300	350	450	450	400	500

Continuation of table 1.5

Feed type	ARTICLE 3150	ST 3500	ST 4000	ST 4500	ST 5000	ST 5400
Number	of available items 2	3	3	3	4	4
Joint length (D), mm	1650	2350	2650	2800	4050	4450
Step length (S), mm	650	650	750	800	900	1000

Connecting a conveyor belt with mechanical joints.

The mechanical connection method is the fastest and most affordable, but not the most durable and long-lasting way to connect conveyor belts and conveyor belts.

Main advantages of mechanical connection of conveyor belts

- speed of the conveyor belt joining method;

- low financial costs compared to vulcanization;
- this method eliminates the need for a special room and bulky equipment (vulcanization presses);
- mechanical joining of conveyor belts can be performed at subzero temperatures and in rooms with high dust content;
- there is no need to use highly qualified personnel for vulcanization;
- for conveyors where prolonged downtime is unacceptable, mechanical coupling is preferred as a temporary measure (for high-load conveyors) or for permanent operation;
- for conveyors whose length changes frequently, a split mechanical connection is most preferable.

Main disadvantages of a mechanical joint

- low joint strength and service life compared to vulcanization;
- additional mechanical wear of rollers, drums and other working parts of the conveyor is observed;
- possibility of spillage at the junction of bulk cargo and materials;
- the possibility of sparking, which is dangerous in certain conditions;
- when transporting hot cargo, it is possible to burn the tape at the joint.

Mechanical connections of conveyor belts and conveyor belts can be all-in-one bolted or riveted and split hinge. The former include rivet and bolt connections in the form of plates. All-in-one bolted joints are used to repair longitudinal cuts of rubber-cloth conveyor belts. A typical representative of an all-in-one joint is flexco Bolt Solid Plate locks, as well as the domestic B3 analog. These mechanical joints are abrasive-resistant, designed for mechanical joining of rubber-cloth conveyor belts with a thickness of 6 to 30 mm with a load of up to 105kn/m.

Detachable mechanical connections of conveyor belts allow you to quickly and easily connect and disconnect belts without disassembling the conveyor, and thus reduce equipment downtime. The complexity of performing mechanical docking of conveyor belts is minimal. Typical detachable mechanical locks made by FLEXCO of the Alligator type, as well as domestic analogues B1 and B2, allow joining conveyor belts with a thickness of 4 to 19 mm with a tensile strength of 600 Kn/ m, minimum drum diameter of 100 mm, maximum recommended tension of 70 KN/m.

LECTURE NO. 3 CONVEYOR ROLLERSNEW IMPROVED ONES STRUCTURES.

Plan:

1. General information.

2. Designs of conveyor rollers of a new type.

3. Design of sibzms conveyor rollers.

4. Types of conveyor rollers.

The purpose of the lecture *is to study new and improved conveyor roller designs.*

Key words:: *analysis, reliability of components, service life of rollers, roller manufacturers, roller structures, bearing Assembly, structure, bearing Assembly, types of rollers, conveyor, rubber-metal seals, three-channel labyrinth.*

General information.

Reliability analysis of a variety of ultrasoniccrystals of belt conveyors for coal-governmental mines, iron ore mines, and other enterprises showed that conveyor rollers, along with lenthat have the least resources and demand the greatest amount of labor and funds to replace, repair and maintenance (30-40% or more of operating costs), but the total cost is about 25-30% of the cost of the conveyor.

The service life of conveyor rollers, for example, in the mines of JSC Vorkutaugol in loading units is from 0.5 to 1.0 years, and at the conveyor rate-from 0.7 to 2.5 years, averaging 1.7 years. The estimated service life of an average,over-loaded roller with a belt width of 1200 mm is assumed to be 35 thousand hours, which is several times longer than the actual one.

On some long conveyor lines, the numberof rollers reaches several tens of thousands. The rollers are updated from 2 to 5 times during the operation of the conveyor. The annual total demand for roliks, for example, for the mines of JSC Vorkutaugol is 150 thousand units, but it is still metby 30% due to the lackof necessary funds. Therefore, manufacturers are forced to increasethe roller installation step by 2-3 times, which, of course, affects the life of the belt and the energy intensity of the transport process.

The main manufacturers of conveyor rollers for the mining industry are Aleksandrovsky andKyshtym forwater. In recent years, due to the huge demand for rollers, thisproduct has been mastered and started to be produced by other enterprises that previously did not workin the mining industry, but have a good machine-building base and highlyqualified personnel.

Some of these companies are "Sibtenzopribora" (formerTopkinsky mechanical plant) and JSC " plant PIRS»

First roller designs "Sibtenzopribora" was characterized by simplicity, and was caused by the demand of consumers сниto lower the price. The simple design, low and affordable prices attracted consumers, despite the lowoperational life.

New and tough economic conditions put forward new requirements for the technical parameters of rollers, and questions about the service life of the roller began to arise more and more often. In order to increase the service life of the roller, technical solutions were made to protect the roller bearing Assembly. One of the main requirements for the operation of the roller is to ensure that the bearing is protected from external influences.

New designs do not use bearings with protective rubber-metal seals, which in themselves did not provide the necessary level of protection and at the same time increased the cost by 5-7%. New structures received an index IIof protection group II, which conventionally indicates the level of operating conditions - average (figure 1.5).

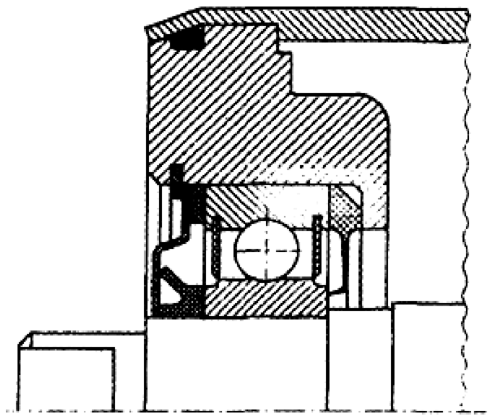


Figure 1.5. Bearing Assembly -II protection group

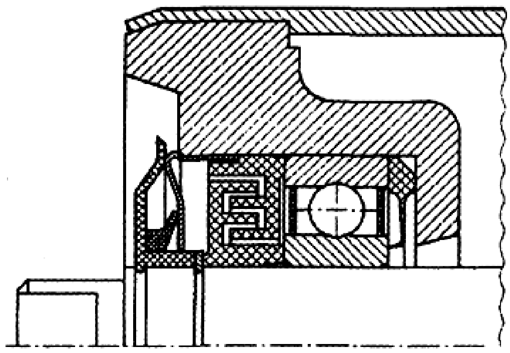


Figure 1.6. Bearing Assembly-IIIprotection group III

Analysis of the achievements of near and far foreign manufacturersallowed us to identify the most promising design of the bearing unit IIIof protection group III - for heavy conditions (figure 1.6).

The rollers manufactured by OJSC "Zavod PIRS" havethe following distinctive features::

- own originalsill Assembly;
- closed Autonomous internalvolume;
- specially designed labyrinthseal. The connectionof the roller shell and the

housing of the bearingAssembly can be either welded or rolled.

The housing of the bearing unit ismade of sheet steel, which means that it has a lower weight than the casthousing.The bearing Assembly consists of (Fig. 1. 7):

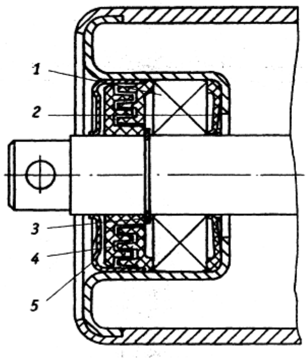


Fig. 1. 7. construction of the roller manufactured in JSC

"Piers factorv»

1-bearing according to GOST 8338-75 or at the customer's request according to GOST 7242-81;
2-rear sealing washer or single-channel labyrinth,which is placed behind the bearing;
3-locking ring according to GOST 13942-86;
4-an external three-channellaboratory made of a copolymerof polyethylene and-polypropylene, the temperature limitsof use of which are from -50 to +50°C.
5-protective cover.

The combination of the above features allowed us to create ahighly reliable roller design with a closed Autonomous internal volume, independent of environmental conditions and operating locations. The rollers produced by OJSC "Zavod PIRS" do not require maintenance,additional lubrication and repair duringи the entire service life, whichdistinguishes them from other manufacturers ' rollers.

The original design of thesill Assembly provides forthe labyrinth seal shield andthe bearing itself in case of such emergencies when the temperature of the outer surface of the roller rises to 200-250°C. In this case, the temperature inthe bearing unit does not exceed допустиthe permissible operating values of 140°C.

Since the design uses an originalbearing Assembly with a labyrinth sealthat ensures tightnessof the inner roller space, the service life of the rollers is 36 months or more.

Since 2000, the roller designhas been modernised: aprotective cover is placed on the outer labyrinth, which providesadditional reliable protection of the bearing Assembly from mechanical damage and abrasive ingress.

Design of conveyor rollers — SIBZMS.

A mandatory element of roller conveyors, which are very popular in modern production lines, are conveyor rollers. The quality of the rollers themselves largely determines the duration of operation and the functionality of the conveyor itself. The design of conveyor rollers consists of three main components: housing, spindle and bearing. Depending on the type of roller conveyor used, the technical characteristics of each of these elements are calculated.

On the body of the roller, which is actually its surface, the load for moving loads falls. The roller body is usually made of metals, most often steel, stainless steel or aluminum. Some conveyors use rollers with a plastic housing. The choice of structural characteristics and hull material should depend on the following qualities: resistance to abrasion and wear, load capacity, cargo dimensions, and other factors. Often, an additional coating in the form of rubber, PVC, or zinc is applied to the roller body. In some cases, an antistatic coating is applied to the surface of the rollers.

Basic dimensions of conveyor rollers: the size of the working surface of the roller, the body diameters (internal and external), the total length of the roller body and the mounting length of the spindle tip. The roller dimensions are selected according to the specific operating conditions in the roller conveyor.

Conveyor rollers are either used as standard or custom-made, depending on the type and specifics of production.

Roller supports are also a mandatory element in roller conveyors роликоопоры. Roller supports can be ordinary (linear) or special, depending on their functions. Ordinary roller bearings will serve to maintain the conveyor belt and give it the necessary shape. Special rollersupports perform several functions: adjust the position of the belt relative to the longitudinal axis; absorb the impact of the load on the belt at the loading points; clean the particles of stuck cargo; change the grooving of the belt in front of the drums.

Types of conveyor rollers

An important mandatory element of belt conveyors are rollers. The operability of the entire conveyor line depends on their characteristics and design features.

Design features

The roller structure consists of a steel tube closed on both sides by hubs with seals. Part length – from 100 to 1600 mm, diameter – from 54 to 159 mm. At the ends there are bearings that connect the axis. The outer side of the roller is coated with an anti-corrosion compound, or immediately made of galvanized metal. Plastics can be used in the manufacture of rollers. But they are not designed to move large loads.

Areas of application

Conveyor rollers are widely used in various industries of industrial production:

- Mining and coal mines;
- Oil and gas industry;
- Fuel supply at thermal power plants, processing plants, and metallurgical plants;
- In construction;
- On railway transport;
- In warehouses.

And this is not the whole list of applications of conveyor rollers. They allow you to reduce the level of industrial noise in the premises. They can be installed not only in working shops, but also in the open air, at low temperatures. They are used to move heavy and bulk cargo. Each such roller can withstand a load of more than 240 kg. Their advantage over loaders is that they are installed not only on large working areas, but also in conditions of their strict economy.

Advantages of using it

The use of rollers on horizontal belt conveyors provides certain advantages during the working process:

- Smoothness and uniformity of the conveyor belt movement in a given direction;
- Maintaining optimal belt tension;
- Increasing the operational life of the belt (reducing wear and tear);
- Ensuring the efficiency of the conveyor.

In addition to belt conveyors, rollers are used on roller conveyors, where they themselves act as a carrier plane.

Types of conveyor rollers

Depending on the purpose and scope of application, the rollers can be:

- Deflectordevices, their special feature is to prevent the conveyor belt from deviating from the specified trajectory of movement;
- Textoliths, used in the transportation of dangerous goods;
- Shake-off devices that clean the working belt from dirt. They are used for moving construction materials: sand, gravel, clay, etc.;
- Shock-absorbing, soften impacts, reduce the noise level during conveyor operation;
- Flat, with their help, loads move around their axis.

When choosing rollers for a conveyor, it is necessary to take into account their operating conditions and the characteristics of the goods being moved. This ensures a long and trouble-free life of the conveyor.

LECTURE №4. SPECIAL TYPES OF BELT DRIVES CONVEYORS AND THEIR THEORY.

Plan:

1. General information.
2. belt conveyor Drives and theory of their operation.
3. Special types of belt conveyors.

The purpose of the lecture: *to study the theories of special types of belt conveyor drives.*

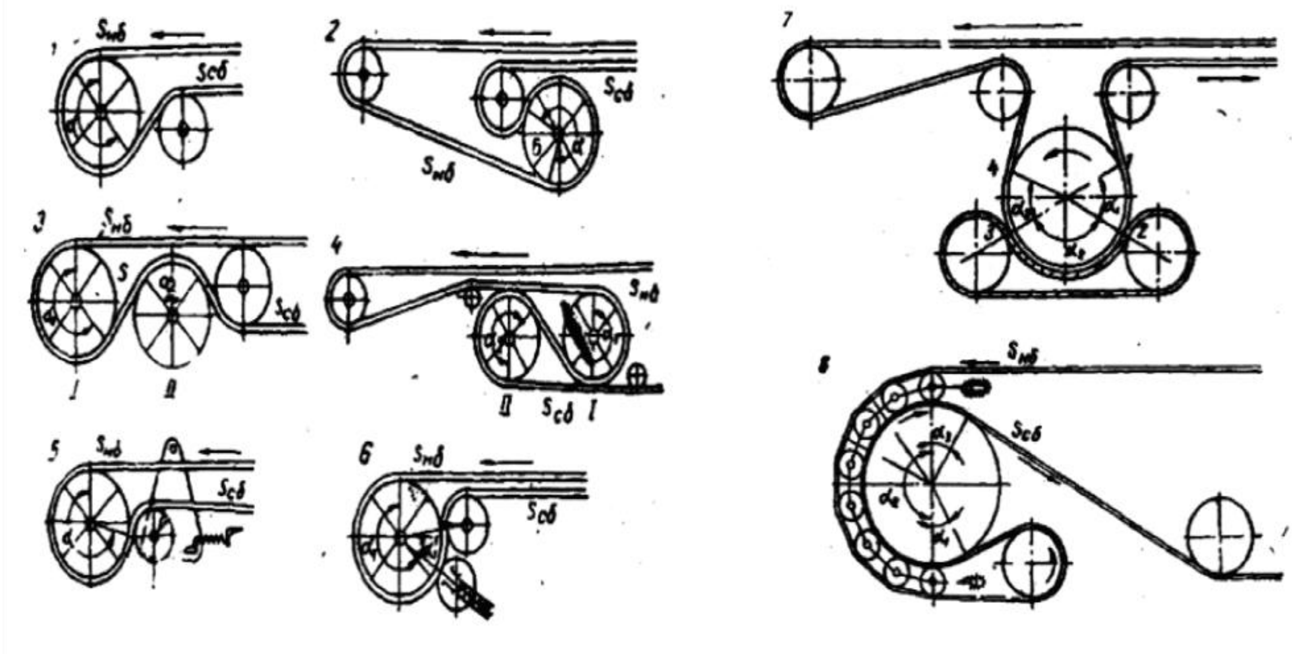
Keywords: *girth angle, drive diagram, pressure rollers, drive, Eulerian equation, friction theory, conveyor types, belt conveyors, steel ropes, single-drum drive, belt and chain conveyors.*

General information.

With an increase in the girth angle α при томand the same tension of the incoming or descending branch, the traction force W_0 may increase.

Girth angle on a single-drum drive according to scheme 1 (Fig.1.8) is 220-230°, and according to scheme 2 - from 270° to 290°. On a two-drum drive without a remote head according to scheme 3, the girth angle is equal to the sum $\alpha = \alpha_1 + \alpha_2$ and is about 350°, with a remote head according to scheme 4-about 480°.

To increase the pressure of the belt against the drive drum, and, consequently, to increase the friction force between them, use pressure rollers pressed by springs (schemes 5 and 6), or a short auxiliary pressure belt tensioned by a load or screws (scheme 7). A conveyor belt that transmits downforce through a battery of rollers (system drive) can serve as a clamping device.Eikhoff) - scheme 8. We present the theory of drives of these systems.



Pressure roller drive.In the drive according to scheme 5 in Fig.1.8 the force P pressing the roller against the drive drum is equal to the difference between the pressure of the springs and thepressing force of the belt tension. In this case, the pressure roller is simultaneously deflecting, and the force P acts at the point where the tape runs off the drum.

In the second case (scheme 6), the pressure roller is made separately from the deflector and creates a pressing force at the intermediate point of the girth arc.

To reduce the specific pressure on the belt at the point where the roller is pressed, it is always covered with a thick layer of particularly elastic technical rubber.

The pressure of the roller with a concentrated force P creates a frictional force between the belt and the drum $P\mu$. Therefore, for scheme 5, when the traction force is equal to the total friction force

$$S_{нб} = (S_{сб} + P\mu)\cdot \lambda^{\mu\alpha};(1.2)$$

$$W_0 = S_{нб} - S_{сб} = (S_{сб} + P\mu)\cdot\lambda^{\mu\alpha} - S_{сб} = S_{сб}(\lambda^{\mu\alpha} - 1) + P\mu\cdot\lambda^{\mu\alpha} \quad (1.3)$$

or:

$$W_0 = S_{нб} - S_{сб} = S_{нб} - \frac{S_{нб} - P\mu\cdot\lambda^{\mu\alpha}}{\lambda^{\mu\alpha}} = S_{нб} - \frac{S_{нб}}{\lambda^{\mu\alpha}} + P\mu =$$

$$= S_{нб}\left(1 - \frac{1}{\lambda^{\mu\alpha}}\right) + P\mu = S_{нб}\left(\frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}\right) + P\mu. \quad (1.4)$$

From equation (1.4) we find $S_{нб}$:

$$S_{нб} = \frac{W_0 - P\mu}{\frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}} = \frac{(W_0 - P\mu)\cdot\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1} =$$

$$= W_0 \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1} - P\mu \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1}. \qquad (1.5)$$

For comparison purposes, we present the corresponding parameters for a conventional belt conveyor drive:

$$W_0 = S_{нб} - S_{сб} = S_{сб}(\lambda^{\mu\alpha} - 1) = S_{нб} \cdot \frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}, \quad (1.6)$$

from where $S_{нб} = W_0 \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1}$. (1.7)

If we compare expressions (1.4) and (1.5) with expressions (1.6) and (1.7) for a conventional drive, it turns out that in the presence of a pressure roller with the same $S_{нб}$ the traction force W_0 is obtained by an amount $P\mu$ greater, and with the same traction force $S_{нб}$ by an amount $P\mu \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1}$ less, than in the absence of a pressure roller.

For the intermediate position of the pressure roller (scheme 6), the traction force is obtained from the expressions:

$$S_{нб} = (S_{сб}\,\lambda^{\mu\alpha'_1} + P\mu)\cdot\lambda^{\mu\alpha_1} = S_{сб}\lambda^{\mu\alpha} + P\mu\,\lambda^{\mu\alpha_1}; \quad (1.8)$$

$$W_0 = S_{нб} - S_{сб} = S_{сб}(\lambda^{\mu\alpha} - 1) + P\mu \cdot \lambda^{\mu\alpha_1} \quad (1.9)$$

or

$$W_0 = S_{нб} - S_{сб} = S_{нб} - \frac{S_{нб} - P\mu \cdot \lambda^{\mu\alpha_1}}{\lambda^{\mu\alpha}} =$$

$$= S_{нб} - \frac{S_{нб}}{\lambda^{\mu\alpha}} + \frac{P\mu \cdot \lambda^{\mu\alpha_1}}{\lambda^{\mu\alpha}} =$$

$$= S_{нб}\left(1 - \frac{1}{\lambda^{\mu\alpha}}\right) + \frac{P\mu}{\frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha_1}}} = S_{нб}\frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}} + \frac{P\mu}{\lambda^{\mu\alpha_1^э}}, \qquad (1.10)$$

that is, at the same $S_{нб}$ conditions, the P increase in the traction force W_0 turns out to be less than in the previous case, and moreover it decreases with increasing angle measured from the point of escape α'_1

Therefore, the closer the pressure roller is located to the point where the tape runs off, the higher the efficiency of its action. However, some advantage of this scheme over scheme 5 is that there is no pressing force on the pressure rollerof the springs.i.e., the lower the angle, the greater the pulling force can be.

Pressure belt drive. If on a drive with a pressure belt, as shown in diagram 7 (Fig.1.8), the angles of circumference of the drum by both belts are equal, then, assuming the tension of the pressure belt $S a$ is the same in all its sections, we have that the total tension force of both belts on the incoming branch is equal $S_{нб} + S a$, and on the escaping $S_{сб} + S a$ one .

The magnitude of these total forces determines the transmitted circumferential force, therefore, The Eulerian equation:

$$S_{нб} = S_{сб} \cdot \lambda^{\mu\alpha} \qquad (1.11)$$

gets the form in this case:

$$S_{нб} + S\alpha = (S_{сб} + S\alpha) \cdot \lambda^{\mu\alpha}, \qquad (1.12)$$

where from

$$S_{нб} = S_{сб}\, \lambda^{\mu\alpha} + S\alpha\left(\lambda^{\mu\alpha} - 1\right). \qquad (1.13)$$

$$W_0 = S_{нб} - S_{сб} = (S_{сб} + S\alpha) \cdot \left(\lambda^{\mu\alpha} - 1\right) =$$
$$= \left(S_{нб} + S\alpha\right) \cdot \frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}, \qquad (1.14)$$

from here

$$S_{нб} = \frac{W_0 - Sa\dfrac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}}{\lambda^{\mu\alpha} - 1} = W_0 \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1} - Sa\ . \qquad (1.15)$$

(i)

If we compare equations (1.14 and (1.15) with equations (1.6) and (1.7), it turns out that in the presence of a pressure tape W_0, the same $S_{нб}$ value is obtained by $S_a(\lambda^{\mu\alpha} - 1)/\lambda^{\mu\alpha}$ more, and $S_{нб}$ in the same W_0 case — by an amount S_a less than in the absence of a pressure tape. Due to some bulkiness, such drives are used only in stationary installations.

Expression (1.12) can be obtained on the basis of the General theory of friction of flexible bodies from the following.

We cut off an elementary angle at any point on the circumference arc $d\alpha$ (figure 1.9). When the drum rotates in the direction indicated by the arrow, a force acts on the corresponding segment of the conveyor belt on the right S and on the left $-S + dS$, and the increment of the conveyor belt tension dS is equal to the friction force of this belt against the drum on the arc of the angle $d\alpha$. A section of the pressure belt that is under constant tension is affected by a force Sa on the left and right.

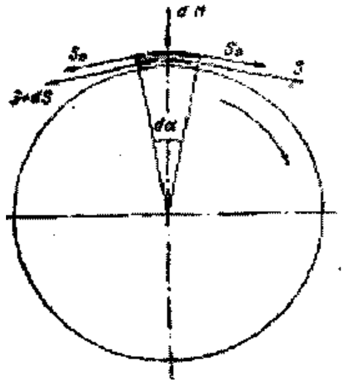


Fig. 1. 9 On the drive theory with
with a pressure band

Projecting onto the vertical all the forces acting on the segment of both tapes, neglecting the infinitesimal second order and assuming

$$Sin\frac{d\alpha}{2}=\frac{d\alpha}{2}$$

finding the pressing force

$$dN = (2S + dS + 2S_a)\cdot Sin\frac{d\alpha}{2} \cong$$

$$\cong (S + S\alpha)\cdot 2Sin\frac{d\alpha}{2} = (S + Sa)\cdot \quad (1.16)$$

from here $\mu dN = dS = (S + Sa)\cdot\mu\cdot d\alpha$ ***(1.17)***

or $\frac{dS}{S+S_a}=\mu\cdot d\alpha$ ***. (1.18)***

Integrating along the girth arc α ***for the case of full use of the traction force, we find***

$$\int_{S_{c\acute{o}}}^{S_{н\acute{o}}}\frac{dS}{S+S_a}=\int_0^a\mu\cdot d\,\alpha\,; \quad (1.19)$$

$$In\,(S_{н\acute{o}}+S_a)-In\cdot(S_{c\acute{o}}+S_a)=\mu\,\alpha\,; \quad (1.20)$$

$$\frac{S_{нб} + S_a}{S_{сб} + S_a} = \lambda^{\mu\alpha}. \qquad (1.21)$$

The $Sa = 0$ previous expression also applies the well-known Euler formula (1.11).

Assuming that the tension of the pressure belt S_α ***is the same in all its sections, we have:***

$$S_1 = S_{сб}\ ; \qquad (1.22)$$

$$S_2 = S_1 \cdot \lambda^{\mu\alpha_1}\ ; \qquad (1.23)$$

$$S_3 + S_\alpha = (S_2 + S_\alpha) \cdot \lambda^{\mu\alpha_2}; \qquad (1.24)$$

$$S_3 = S_2\lambda^{\mu\alpha_2} \cdot Sa(\lambda^{\mu\alpha_2} - 1); \qquad (1.25)$$

$$S_4 = S_3\lambda^{\mu\alpha_3} = S_1\lambda^{\mu\alpha} + Sa\,(\lambda^{\mu\alpha_2} - 1)\,\lambda^{\mu\alpha_3} = S_{нб}. \qquad (1.26)$$

For a single-drum drive with a pressure band, the tractive effort will be equal to:

$$W_0 = S_{нб} - S_{сб} = S_{сб} \cdot (\lambda^{\mu\alpha_1} - 1) + S_\alpha\left(\lambda^{\mu\alpha_2} - 1\right) \cdot \lambda^{\mu\alpha_2}. \qquad (1.27)$$

When $\alpha_2 = \alpha_3\ \alpha_1 = \alpha_3 = 0\ \ W_0 = (S_{сб} + S_\alpha)(\lambda^{\mu\alpha} - 1).$ ***(1.28)***

Drive with pressure conveyor belt. (scheme 8).

For a drive with a pressure conveyor belt traction force

$$W_0 = S_{нб} - S_{сб} = S_{сб}\left(\frac{\lambda^{\mu\alpha}}{1 + \lambda^{\mu\alpha_3} - \lambda^{\mu\alpha_1}} - 1\right), \qquad (1.29)$$

a relation

$$\frac{S_{нб}}{S_{сб}} = \frac{\lambda^{\mu\alpha}}{1 + \lambda^{\mu\alpha_3} - \lambda^{\mu\alpha_1}}\ . \qquad (1.30)$$

Special types of belt conveyors

Special types of belt conveyors include conveyors for large angles of inclination (steeply inclined conveyors), belt-rope and belt-chain conveyors, including conveyors with a curved longitudinal axis (with a folded belt) with a minimum bending radius in the horizontal plane-10 m.

a). Conveyors for large tilt angles

It is known that conventional belt conveyors with smooth rubberized tape can transport bulk cargo at angles of inclination up to 18^0 .

To increase the angle of the tape conveyor is used with corrugated sides of the soft rubber and with prevalentemente transverse ribs or tape prevalentemente paired membranes, merges in making ribbon chute forms on an inclined support rollers, allowing tilt angles of up to $20\text{-}30^0$; ribbon increased by latkovou due to the installation side support rollers with tilt angles up to $100^0\text{-}110^0$, allowing the angle of the conveyor to 25^0; conventional conveyor belts with additional clamping strip to hold bulk cargo – up to 35 - 40^0; system Flexowell – Pocketlift for steeply inclined and vertical transport of bulk cargo.

Due to the complexity of maintaining the reverse branch, the tapes of the first group (ribbed) are used in practice in limited quantities.

Конвейерная система The Flexowell-Pocketlift conveyor system (figure 1.10) is designed specifically for the steeply inclined and vertical transport of bulk cargo up to a height of 400 m with horizontal or inclined loading and unloading sections.

Two metal-waste belts, the left and right, whose installation width is comparable to the free cross-section width of Flexowellbelts, are connected by powerful triangular cross-sections. Both belts perform only a power function.
The transported material is fed into buckets bolted to reinforced steel crossbars. These crossbars also perform a guiding function, which gives the structure rigidity and eliminates the possibility of skewing.

The shape of the buckets allows you to do without articulated joints. The buckets transport material with a capacity of upto 1200^{m3}/ h (systems with a capacity of up$^{to\ 6000\ m3}$/ h are under development). The introduction of these systems opens up new opportunities in open - pit and underground mining, quarrying, and tunneling.

We will discuss steeply inclined conveyors with a pressure belt in more detail below (p 2.1.1).

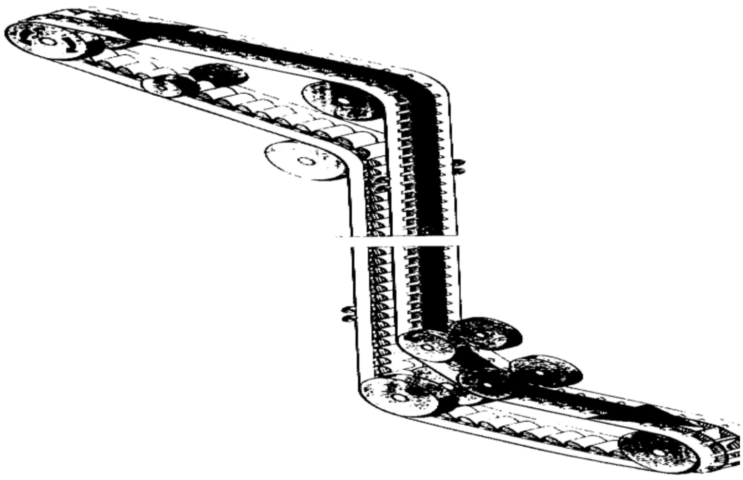


Figure 1.10. Conveyor system
Flexowell – Pocketlift

At the present stage, the mining industry is characterized by the construction of large mines and quarries with large cargo flows, for which it is advisable to use conveyors even at significant transportation distances. This increases the need for long conveyors with high-strength belts.

Special belt designs (such as those with a steel cable base) are very expensive; they also combine a relatively малопрочныйlow-strength rubber cover and a durable steel rope base. Therefore, along with the development of powerful belt conveyors based on high-strength belts, it became necessary to create belt conveyors with a division of functions between traction and load-bearing bodies in order to use relatively cheap and affordable traction bodies (ropes and chains) in combination with a light load - bearing surface-rubberized tape with a small number ofslots.

The advantages of steel ropes as traction elements (high strength, low weight, relatively low cost) constantly attract the attention of designers designing mountain transport vehicles.

Many designs of belt and rope conveyors have been proposed, which, according to the method of connecting the belt to the rope, separate: a) with a blind connection (clamps, couplings, sleeves); b) with controlled grippers that disconnect the rope from the tape when approaching the drive and tensioning stations and turn it on after the rope leaves them; C) with the tape lying freely on the ropes, driven by friction.

Each of these pipeline groups has certain characteristics. For example, in conveyors of the first group, the belt and ropes must have a common tensioning device, which makes their operation difficult with different belt and rope extensions; in addition, the attachment points form protrusions on the rope, which complicate the design of the leading pulleys. The proposed conveyors with controlled grippers have a complex design and have not received practical application.

The most numerous group consists of conveyors with a belt lying freely on the ropes and driven by the friction force of the rope. In Fig.1.11 two diagrams of belt and rope conveyors with a belt supported on one or more rope branches are shown. In conveyors of the first type (Fig. 1.11, a), the entire weight of the belt and cargo is transferred to the ropesa вконвейерах, and in conveyors of the second type (Fig. 1.11 , *b)* only part of the weight is transferred, so shoes with a wedge-shaped chute are attached to the belt to increase the friction force.

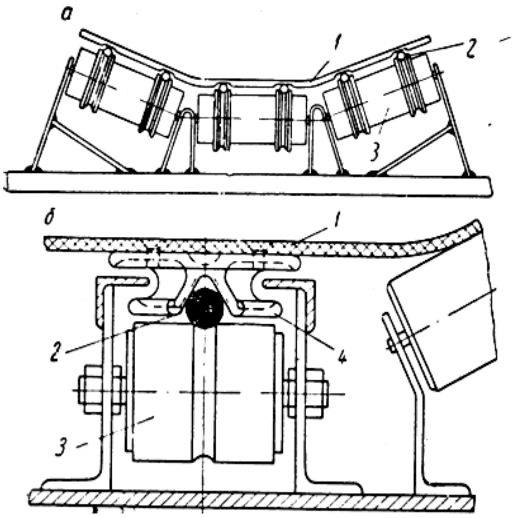


Figure 1.11. Diagrams of tape-rope конconnectors with ordinary rubberized tape:
a - multichannel; b-single-channel;1-tape; 2 -rope; 3-support roller; 4-Shoe.

Conveyors in which the ropes form two parallel contours closed in the vertical plane, and the tape of a special design with thickened edges, which have longitudinal grooves, rests on the ropes, are widely used in practice.

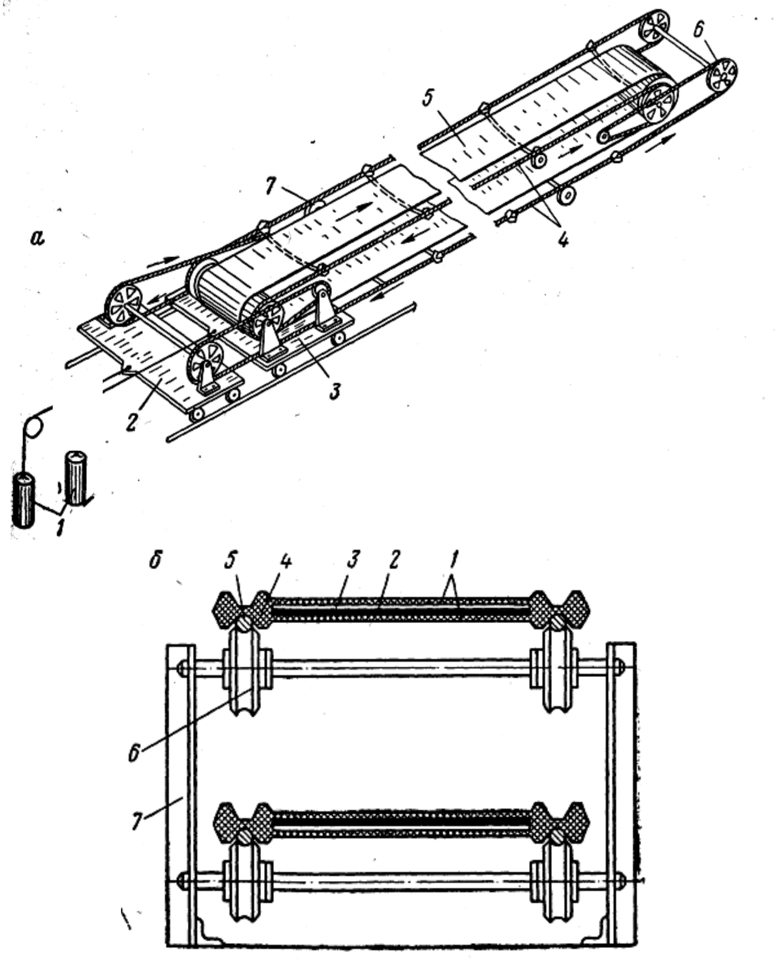


Fig. 1. 12. Belt and rope conveyor;

Such a conveyor (Fig. 1.12, a) consists of a belt 5, ropes 4, a drive device 6, tension trolleys 2, 3, tension loads 1 and supporting structures 7. the function of a load-carrying body is performed by a belt, a traction one-by a rope.

The tape has plates 1 (Fig.1. 12, b), fabric gaskets 2 and metal strips 3, which are embedded in the tape at a distance of about 0.5 m to create transverse rigidity. With thickened parts 4, the tape rests on ropes 5, supported by rollers 6, which are fixed on racks 7. the Ropes have a diameter of up to 35 mm.

A tensioning device that is separate for ropes and tape. Cargo or automatic tensioning stations are used as tension devices. The supporting structures are a series of racks 7 (Fig.1. 12, b) with supporting pulleys attached to them for the upper and lower branches of the rope.

Productivity up to 300-400 t / h; tilt angle (according to the condition of coupling of the tape with the rope) up to 12^0.

For more information about the use of rope and belt conveyors, see also p 2.2.

C).Belt and chain conveyors.

The scheme of a belt-chain conveyor is similar to that of a belt-rope conveyor, but instead of ropes, they have one or two chains as the traction organ. A positive feature of chains is the ability to use small-diameter sprockets, which allows you to have a compact drive, as well as more convenient attachment of connecting parts to the chain. In addition, the use of chains makes it easy to install intermediate drives.

The movement of the belt is transmitted either by friction (figure 1.13, a), or by mechanical (figure 1.13, b). chains are used both lamellar and round-link. The number of gaskets in the tape is determined by the requirements not of mechanical strength, but of rigidity in the longitudinal and transverse directions and is two or three. Drive stations are similar to plate conveyor stations. At the end stations, in addition to asterisks, drums are mounted that are freely wrapped around the tape. When the tape is rigidly attached to the chains, a single tensioning device is used for the chain and tape. When coupling the tape with the chain by friction (with a free-lying tape – 1.13, a), separate tensioners for the tape and chain are used.

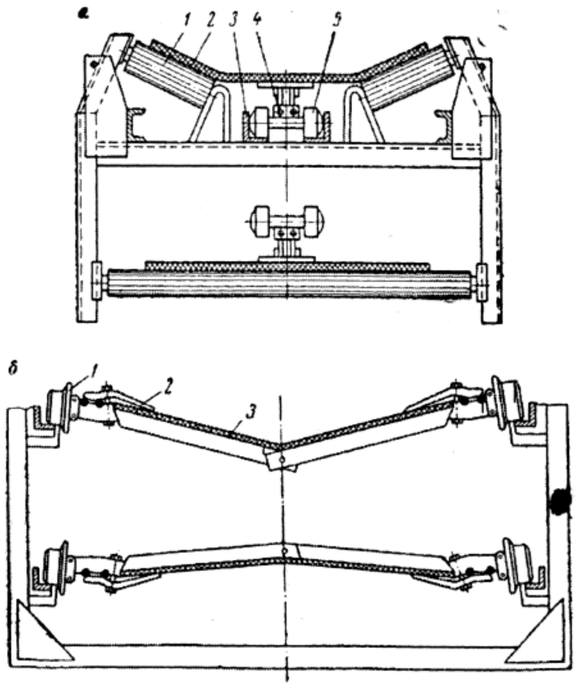


Figure 1. 13. Belt and chain conveyors:
a - cross-section of the conveyor with a free-lying belt;
1 - rollersupport ; 2-tape;
3 - guide; 4-chain;
5-way carrier trolley casters;
6-cross-section of the conveyor with rigid fastening of the belt to the chain;
1-chain with rollers; 2-clips; 3-tape.

In a conveyor with a free-lying belt on the working branch, the belt 2 partially rests on the side rollers 1, and the main part of the weight of the belt and cargo falls on disc plates mounted on the traction chain 4. The chain is made with running rollers 5 moving along guides 3. the Empty branch is supported by support rollers, and the chain rests on the belt. The traction force is transmitted by friction plates along the entire length of the belt. To increase the friction force, the plates are lined with rubber.

Capacity up to 200 - 500 t/h. The length of one installation is practically unlimited (due to the use of intermediate drives). The angle of inclination for conventional tapes is $10-18^0$, for special types of tapes (corrugated) up to $35-40^0$. When the corrugated belt is rigidly attached to the chain, the conveyor may bend in a horizontal plane.

LECTURE NO. 5. MACHINES AND EQUIPMENT FOR OPEN-SOURCE DEVELOPMENT.

Plan:

1. Steeply inclined conveyor CNC 270 for Navoi MMC.
2. Special constructions of transportfacilities for lifting cargofrom deep quarries.
3. Steeply Inclined conveyors with pressure plate with the feed.

The purpose of the lecture *is to teach students special structures of transportfacilities for liftingcargo from deep pits, to study machines and equipment for open-pit mining.*

Key words:: *belt, conveyor, design, pressure belt, cyclic-flow technologies, efficiency, efficiency of CNC, schematic diagram of CNC, transportation angle, lifting height, characteristics of CNC, steeply inclined conveyors.*

Steeply inclined conveyor CNC 270 for Navoi MMC.

Since the 1980s, the Muruntau quarry of the Navoi mining and processing complex (Uzbekistan) has successfully used cyclic-flow technology for transporting minerals, which includes two lines of standard conveyors with a small angle of inclination (15°) located in the trench. The technical and economic indicators of the quarry improved when using the CPT: "the distance of transportation and the height of lifting the rock mass by road were significantly reduced" [1].

Corresponding member. A. O. Spivakovsky and Professor M. G. Potapov of the Academy of Sciences of the USSR proved that "the most economical mode of transport for deep quarries is conveyor transport". The use of CPT makes it possible to reduce the cost of transporting rock mass, since it is known that when the quarry is deepened for every 100 m, transport costs increase by 1.5 times when using cars, and conveyors – only by 5-6%.

At the end of 2009, Novokramatorsky machine-building plant CJSC (NKMZ CJSC) completed the production and shipment of a unique steeply inclined conveyor with a pressure belt (KNK-270) for the Navoi MMC.

The need to create a steeply inclined ascent at the Muruntau quarry arose due to the achievement of an exorbitant (unprofitable) lifting height for motor transport (more than 550 m) and plans to deepen the quarry to 1000 m. According to experts, the limit of transportation of minerals by road is several kilometers, while at the Muruntau quarry, the length of transportation exceeded this indicator several times. In addition, due to the constant increase in depth, further development of the quarry is limited due to the reduction in the size of its working area in the ore zone and the growth in the volume of mining and capital operations. To maintain at least the required performance, it is necessary to separate the sides, which is hardly possible, since the Northern and Western sides cannot be worked out, восточнома transshipment point is installed on the Eastern one, and a CPT complex is installed on the southern one.

Therefore, Navoi MMC decided to build a CCP with a steeply inclined conveyor lift in the North-Eastern part of the Muruntau quarry, which will free up its southern side. Steeply inclined lifting is planned to be carried out using a steeply inclined conveyor with a pressure belt (KNK-270), the lifting height of the mineral, which will be 270 m, with the subsequent possibility of installing another steeply inclined conveyor with a lifting height of 180 m (KNK-180). It should be noted that the quarry already operates a steeply inclined conveyor with a pressure belt with a lifting height of 30 m (KNK-30), manufactured by JSC Azovmash (Mariupol) and operated as a reloader on the southern side in the CPT complex. This conveyor has generally shown good performance and prospects for the use of conveyors of this type. Brief technical characteristics of KNK-270, transported rock mass and operating conditions:

technical performance

by weight . . . . 3500 t / h
by volume . . . . 2000 m3 / h
operational performance
daily allowance . . . . up to 53.5 thousand tons
annual fee . . . . 16 million tons
lifting height . . . . 270 m
angle of inclination of the steeply inclined part . . . . 37°
width of the tapes . . . . 2000 mm
tape speed. . . . . 3.15 m /s
installed capacity of the drives . .... 5040 (630D8) kW
input voltage 6000
In granulometric composition of transported rocks
. . . . 0-300 mm (60%)
. . . . 300-1200 mm (38.5%)
. . . . more than 1200 mm (1.5%)
size of chunks after crushing . ... not more than 300 mm
density in the rear sight . . . . 2.6 t / m3
bulk density . . . . .1.75 t / m3
compressive strength . . . . up to 250 MPa
maximum permissible wind speed . . . . 25 m /s
average annual precipitation. . . . . 129 mm

Special constructions of transportfacilities forlifting cargo from deep quarries.

In the case of cyclic-flow technology, one of the possible and promising directions for the development of conveyor transport at mining enterprises is the use линиях of steeply inclined conveyors (CNC) with a pressure belt in conveyor lines.

The efficiency and cost-effectiveness of CNC machines is currently proven by long-term experience in the operation of these conveyors when transporting various loads: coal, copperand iron ores, limestone, phosphates, clinker, and others, primarily atenterprises in the United States and other foreign countries. The prospectsfor the use of CNC in the CCP at mining enterprises of the CIS countries-are based on technical and economic indicators and technological design studies of many reputable teams of specialists. However, the prospects for the introduction and application of CNC in mining enterprises are also determined by the reliability and quality of technical solutions implementedin the development and production of CNC.

A schematic diagram of the CNC is shown in figure 2.1. the conveyor is Loaded through a standard device 5 on a slightly inclined or horizontal section of the load-bearing circuit. The load-carrying belt 1 transports the load to the transition section 6, where the load is pressed from above by the pressure belt 2. On crouton in the clone section 7, the load between the belts is additionally squeezed by-special clamping devicesвами *3*. At a given lifting height, the pressure belt is removed and the load is transferred to another device. In fact, a steeply inclined conveyor with a pressurebelt consists of two standard conveyorsforming two belt contours.воды *Priors 4* are available on both circuits and are installed at the discharge section *8*. Two standarddrives of two belt loops enable thecreation of high-power CNCmachines with high productivity.

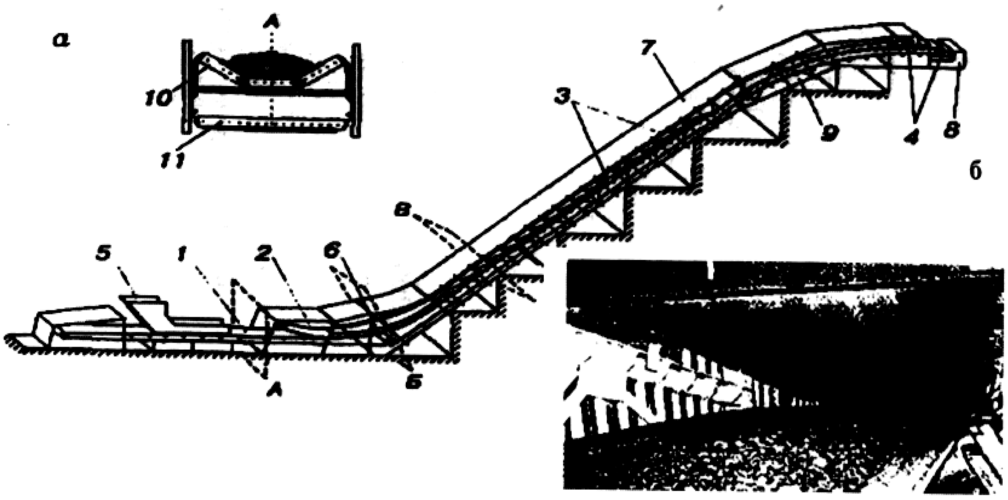
A large number of scientific and design works on the creation of CNC with a pressure band and attempts to implement it in metal are known. Let us mention some of them as examples.

The ukrnii project created a 2klk-2 conveyor with a pressure belt and pressurerolls with a capacity of 250 t/h. He successfully worked at mine No. 5 "Velikomostovskaya", transporting coal to the warehouse (on the surface). The permissible size of the pieces was 200 mm.

Steeply inclined conveyors with a pressure belt.

FirmКRupp has developed a steeplyinclined coal conveyorwith a capacity of 1200 t / h, with a belt width of 1000 mm and aspeed of 4 m/s. This type of conveyor with acapacity of 7000 t / h and a belt width of 2600 mm and a speed of 5 m/s wasinstalled at an angle of 36° on the receiving boom of a rotor-excavator of the same company.

However, until recently, the only successful one



ContinentalConveyor & EquipmentCompany was the manufacturer of the pressure plate with various configurations. (Winfield, Alabama, USA) was a manufacturer of CNC machines with pressure belts of various configurations. According to the firm, from 1984 to 2001 inclusive, there were morethan 100 conveyors have been prepared for liftingvarious loads.

The transport angle varies from 30° to 90°, with about 30% of the conveyors operating vertically.The speed of the belts is up to 5.3 m /s. the width of the tapes is up to 2134 mm. Conveyors have a wide range of productivity - from several tens to 4250 t/h. The company considers it possible to create a conveyor with a capacity of up to 15,000 t / h with a belt width of up to 3 m.

Table 2.1 shows the characteristicsof the most productive and powerful CNC machines with apress belt for quarries.

The conveyor, which was operated for a long time at the Majdanpek copper mine (SouthOssetia), had an actual average annual productivity of over5 million tons in 1993-1995 [26]. Based on the results of the CNC operation at the Majdanpek quarry, it was established that the fabric belts were used for 1.5 years before replacement (in 1995, the pressure belt was replaced after12233 hours of operation and 13.5 million tons of ore transportation), while the estimated timewas 6 months.

According to the company's specialists,as a result of the transition to a CCP within four years, it was possible to eliminate the need to increase the truck fleet by 3 times and reduce theдаря использованию конвейерной линии с КНК length of transportation by 3.5 km due to the use of a conveyor line with CNC, while ensuring continuity of cargo flow and improving safety. Annual savings averaged$ 12million. It should also be noted that these results were obtained in-the absence of experience in the operation of such conveyors inthe world and during the fine-tuning of the CNC during its operation. As experience gained, the reliabilityof the complex's equipment increased.

Table 2.1

Characteristics of CNC with pressure band

№ п/п	Place of operation	Commissioning year	Transported material	Density γ t / m^3	Capacity t / h
1	Majdanpek Mine (Yugoslavia)	1992	Copper ore	2.08	4000
2	Beth Energy (USA)	1991	Clean coal	0.8	726
3	Island Greek (USA)	1992	Waste coal	1.28	454
4	Gementos Veracruz (Mexico)	1992	Hot clinker	1.36	715
5	Montague Sys (USA)	1993	Coal	0.88	1950
6	Turris Coal Co (USA)	1993	Coal	0.88	1361
7	Perini (South Africa)	1993	Overburden	1.1-1.3	1266
8	Colver Pwr Plant (USA)	1994	Coal	1.12	260
9	Qualitech Steel (USA)	1998	Iron ore	2.2	180
10	Terra Nova (Mexico)	2000	Copper ore		2500

Continuation of table 2.1

№ п/п	Place of operation	Tran-sportation angle, degree	Lifting height, m	Length, m	Belt width, mm	Belt speed, m / s	Power of belt drives, kW: clamping / carrying / total
1	Majdanpek Mine (Yugoslavia)	35,5	93,5	173,7	2000	2,8	450/900/1350
2	Beth Energy (USA)	90	76,2	90,2	1372	2,8	112/112/224
3	Island Greek (USA)	up to 41	174,8	454,2	914	2,3	186/186/372
4	Gementos Veracruz (Mexico)	35	41,3	198,9	1219	1,7	56/112/168
5	Montague Sys (USA)	57	59,4	90,8	1829	3,7	186/298/484
6	Turris Coal Co (USA)	90	102,0	113,0	1524	4,6	298/298/596
7	Perini (South Africa)	90	70,1	83,8	1372	3,6	186/186/372
8	Colver Pwr Plant (USA)	up to 60	48,5	75,0	762	2,3	30/37,3/67,3
9	Qualitech Steel (USA)	68	67,6	91	914	1,2	37/37/74
10	Terra Nova (Mexico)	35	34	79	1524	2,66	255/255/510

CNC machines allow them to be positioned at angles fromthe sides of quarries and combine inclined sectionsof the conveyor track with flat ones without overloadingdevices. The angle of inclinationof the conveyor line can vary along the length of the route up to 90°C. All this makes it possible to transport the rock mass over the shortest distances, significantly reducing the length of conveyor lines incomparison with standard conveyors, and to minimize mining and capital workby avoiding laying special trenches and sinking shafts in quarries.

Depending on the profile of the quarry side or the technological need, the CNC canrely on mast supports with significant distances.

The lifting height of the load by one CNCis determined by the total strength of the two selected belts and reaches 150 m when using fabric belts, and 350 m when using rubber - cord belts. Toreduce the cost of belts, the cost of whichreaches 50-60 % of the total cost of the conveyor, when lifting cargo from deep quarries to a higher height, it is more profitable to usetwo or shorter conveyors (conveyor modules) equipped with cheaper fabric beltswith a lifting height of about 100 m instead of one long conveyor with rubber-wire belts. At the same time, due to the reduction of traction forces, less complex engineering structures will be requiredon the sides of the quarry (drive stations, etc.). the total length of the pressure andload-carrying conveyor belts becomes less than the length of the standard conveyor belt already at a lifting angle of more than 40° and the same lifting height.

LECTURE № 6 AUTOMOBILE CAREER LIFTS.

Plan:

1. General information.
2. Automobile career lifts.

The purpose of the lecture: *study of automobile career lifts.*

Key words:: *lifting system, traction calculation, calculation scheme, equilibrium condition, speed of movement, car, quarry lift, trolley wheel, rolling stock, dump truck.*

General information.

In recent years, the effortsof many specialist miners have focused on solving the most acuteproblem of open-pit mining, which is associatedwith the release of rock mass to the surface from deep pits. When the pit depth is 300 m or more, the use of motor vehicles becomes economically impractical and environmentally dangerous. The use of conveyorhoists on Board the quarry solves this problem in principle. However, the construction of such lifts requires large capital expenditures, andits construction (together with crushing and handlingunits) takes several years. In addition, such an important task as ensuring the normal functioning of the quarry during the transfer of the crushing andreloading unit of the lift to new horizons as the quarry deepens has not been practically solved.

It is necessary to look for alternative solutionsto this problem, in particular, with the useof car lifts or contactloaded dump cars. The relevanceof solving the problem of lifting loadeddump trucks on Board the quarry is also confirmedby a number of publications on this topic in recent years. According to one of the variants, the lift is made in the formof jamb trolleys moved along inclined rail tracks, one of which accommodates a rolling stock (or dump truck), and the other serves as a counterweight. A multi-rope lifting machine with friction pulleys is used as the drive. According to another version, loaded and empty cars - dump trucks are attached with the help of special couplings to an endless traction rope driven by a friction pulley and move along inclined paths.

Car career lifts.

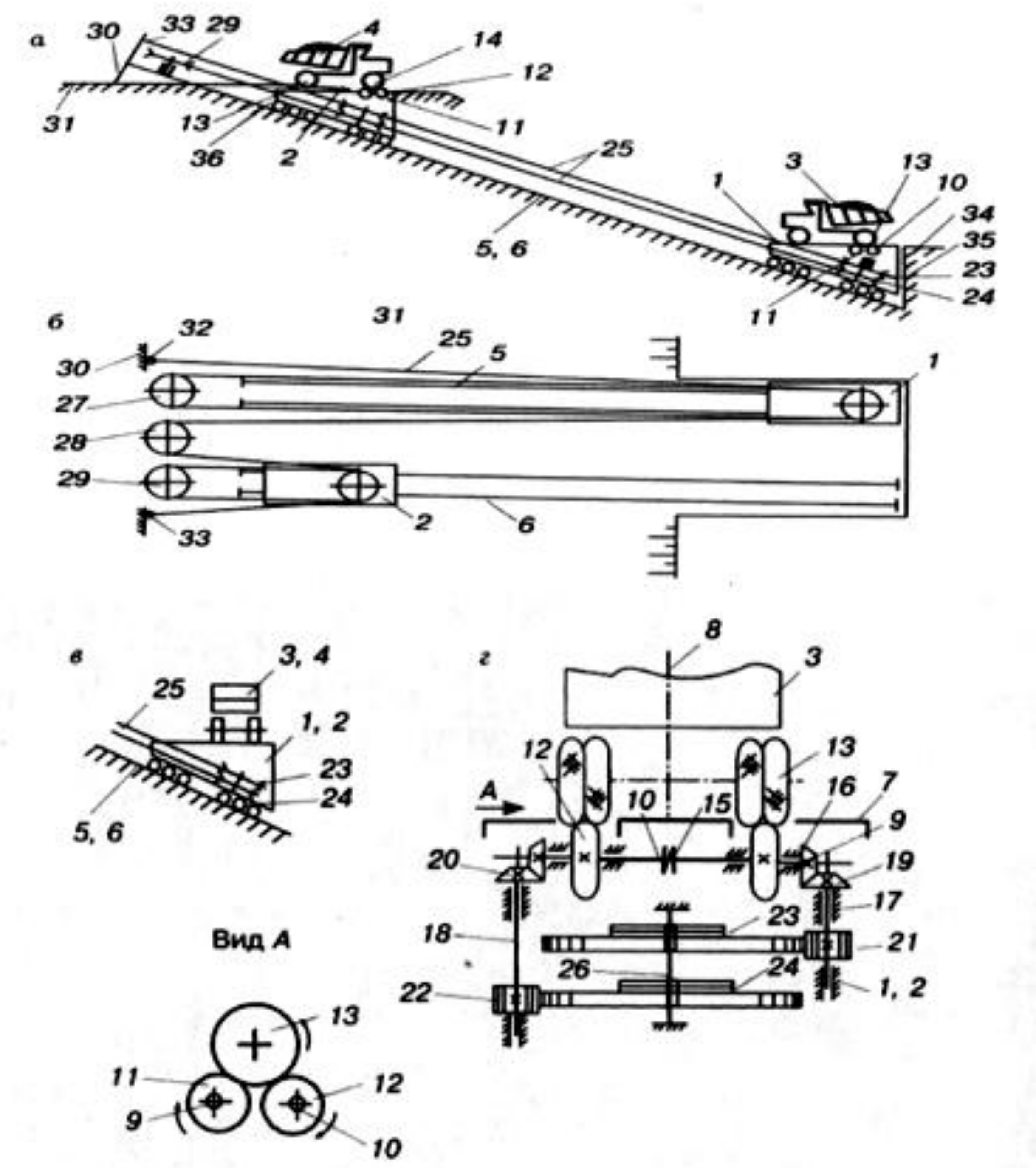
In order to simplify and reduce the cost of the lifting system, reduce material and energy consumption, provide the possibility of simultaneous liftingand lowering of dump trucks, and speed up the commissioning of the lifting system, we propose the third option, the essence of which isas follows.

The lifting system (Fig.2.2*)* consists of tworacks on wheel travel 1,2 with the possibilityof placing on them, respectively, loaded 3 and empty *4* dump trucks. At the same time, dump trucks can be placed both in the longitudinal and transverse directions relative to the trolleys. Trolleys are installed on inclined rail tracks5, 6 at an angle β to the horizon.

In the slots of the horizontally oriented flooring 7 of each trolley are placed on two parallel axes 9, *10,* perpendicular to the longitudinal axis *8* of the dump truck, and with a gap to each other wheels with elastic coatings *11, 12* with the possibility of supporting on them the drive 13 or non-*drive 14* wheels of the dump truck3 or *4.* Axis 9, *10* made the cut *15,* mounted in bearings 16 bogie frames *1, 2* and cinematically, through the shafts *17* and 18 with a conical pairs *on 19, 20* and cylindrical gear pairs *21, 22,* associated with Privolnymi blocks *23, 24,* 25 envelope of a rope and usoriginal equipment with the possibility of rotation of od-Noah fixed axis *26.* In this case, the shaft *17* кинеkinematically connects the axis 9 with the odd driveblocks 23, and the shaft *18*-the axis 10 with the even drive blocks 24; the shafts themselves are located on opposite sides from the axes 9 and *10* with theaxes 11 and 12. The rope 25 is closed on the reverse blocks 27, *28,* 29, mounted on the frame 30,secured on Board 31 of the quarry. The freeends 32 and 33 of the rope 25 are also closed there.

Thus, both trolleys aremechanically connected to each other throughthe Central block 28 placed on Board the quarry by a system of double polispasts. The multiplicity of polispasts is selected depending on the load-liftingcapacity of the dump trucks being moved. As the results of the research have shown, the optimal lifting system is with four-fold polispasts. In this case, the drive blocks *23, 24* can besingle - and multi-lobed (for example, two-lobed); *34* — the horizon of the quarry from whichheavy dump trucks are lifted; 35, 36 - stops for trolleys in the lower and upper positions.

The system of lifting and lowering dump trucksoperates as follows. On thecart 1, located in the lowest position, a loaded dump truck enters in such a way that after stopping its driving wheels 13 are on the wheels 11 and *12*ofthe cart 1.



The system for lifting dump trucks aboard the quarry and lowering them into the quarry:
a - side view, with the longitudinal placement of the dump truck on the trolley;
b-plan; в-variant of the transverse placement of the dump truck on the trolley;
g-kinematic diagram of the drive of rope blocks

After that, on the cart 2, located in the highest position in this position, an emptydump truck enters. Its front (non-driving) wheels *14* can also be placed on the wheels 11, 12 of the cart 2. Then the driver of the dump truck 3 turns on the driving wheels.

Upon rotation of the drive wheels 13 torque from them transferred to the wheels 11, 12, axis 9, *10*, bevel gear 19, 20, shafts 17, 18, spur gear pairs 21, 22, which are rigidly connected to the blocks 23 and *24*, so the picglaciers will start to rotate in opposite directions, interacting with correspond to themain branches of the rope 25.

The rotation of the blocks 23 and *24* and their interaction with rope 25 lower trolley 1 GRUgenim truck will begin holdto deal up the track 5, and the top 2 with an empty truck the truck is to go down the track 6, while both taleskey is not reached their extremeprovisions: cart 1 — stop 36 on Board 31, a career, and cart 2 — stop 35 on the appropriate Goriumbrella *34* career.

Next, the cycle repeats, but theloaded dump truckis lifted on trolley 2, and the descent along the road is carriedout on trolley 1. In thiscase, when the empty dump truck is lowered, when its front wheels 14 rest on the wheels 11, 12 of the cart 1 or 2 from the rotating blocks 23, *24,* the non-driving wheels *14* of the dump *truck 4* also rotate. Signals to driversof heavy and empty dump truckscan be sent from traffic lights installed at the top and bottom withtheir duplication, for example, sirens.

Thus, the liftingof dump trucks on Boardthe quarry is carried out without the use of a speciallifting machine throughthe operation of the traction engines of the self-lifted dump trucks. At the same time, the dump trucks lowered into the quarry together with the trolley perform the functionof a counterweight.

The lifting system with two dumptrucks placed simultaneously on each trolley is performed in the same way as described for lifting single vehicles.

The traction calculation of the lifting system has its own peculiarities (Fig. 2. 3). First, the rope tension in the incoming branch of the descending trolley is determinedтележки

$$S_1^{'} = W_1 \eta_{б}^{\,i_n - 1} (1 - \eta_{б}) \cdot (1 - \eta_{б}^{i_n})^{-1}, \qquad (2.1)$$

where W_1 is the resistance to movement of a truck with empty dump trucks, kN;

$\eta_{б}$ — Efficiency ofdeflecting units;

i_n - multiplicity ofthe multi-track suspension of the trolley.

The tension of the rope branches of a lifting truck (with a loaded dump truck) can befound from the equilibrium equation of the system

$$W_2 = S_1\left(1+\lambda^{\mu\alpha_1}\right) + \left(S_1\eta_б\lambda^{\mu\alpha_1} - W_K^{'}\eta_б - W_K\right)\cdot\left(1+\lambda^{\mu\alpha_2}\right), \qquad (2.2)$$

where W_2-Cresistance to the movement of a loaded dump truck, kN;

S_1 -rope tension in the running branch of the rising trolley; kN;

μ - coefficient of adhesion of the rope to the drive pulley;

α_1, α_2 - effective rope girth angles of the first and second drive pulleys corresponding to the relative sliding angles, radians;

$W_k^{'}, W_k$ - resistance to the movement of the rope branch down and up, respectively, when the trolley is in the lower position, kN.

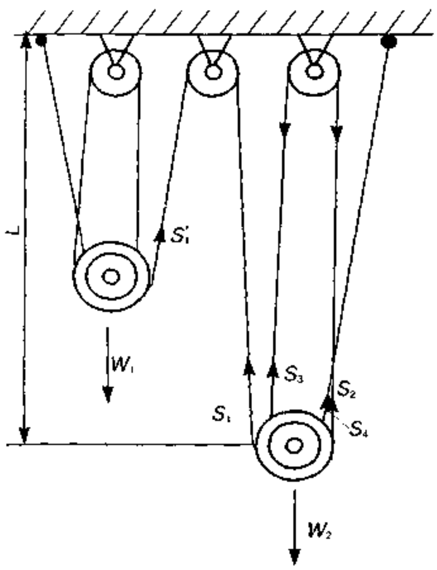


Fig. 2. 3. Design scheme of the lifting system

The equilibrium condition (2.2) should be considered for various combinations of parameters α_1 and α_2, given by the value α_1 and defining the corresponding value α_2.

The rope tension in the first S_1, second S_2,third S_3 and fourth S_4 branches ofthe lifting trolleysupport system will be equal to

$$S_1 = S_1^{'}\eta_б - W_k; \qquad S_2 = S_1\cdot\lambda^{\mu\alpha_1}$$

$$S_3 = \left(S_2 - W_k^{'}\right)\eta_б - W_k; \; S_4 = S_3\cdot\lambda^{\mu\alpha_2}. \qquad (2.3)$$

Traction forces on the first and second pulleys:

$$W_{n(\alpha_1)} = S_2 - S_1 + \omega'_{ш}(S_2 + S_1);$$

$$W_{n(\alpha_2)} = S_4 - S_3 + \omega''_{ш}(S_4 + S_3), \qquad (2.4)$$

where $\omega'_{ш}$, $\omega''_{ш}$ are the rotation resistance coefficientsof the first and second pulleys.

The results of calculations using formulas (2.2), (2.3), and (2.4) can be conveniently summarized in a table of parameter values $S_1, S_2, S_3, S_4, W_{n(\alpha_1)}, W_{n(\alpha_2)}$ when different α_1 values (π, 1,5π, 2π,...).

Due to the redistribution of tension in the wings of the multi-blade suspension of the trolley, an option with any combination of the girth anglesof the first and second pulleys is possible.

According to the maximum rope tension forthe selected version, the type and diameter of the rope are selected, and according to it — the diameters of pulleys and blocks in accordance with the specified or acceptedmode of operation of the lifting unit.

The bogie travel speeds andtheir corresponding gear ratios in the friction pulley drive system are determined fromthe power balance in the lifting system

$$2n_c N_{ДВ} \eta_{пм} = V_{Т} (3W_{n(\alpha_1)} + W_{n(\alpha_2)}) \qquad (2.5)$$

where n_c is the number of simultaneously raised (lowered) dump trucks;

$N_{ДВ}$ - power of one dump truck engine, kW;

$\eta_{пм}$ - Efficiency of the transfer mechanism of the trolley drive;

$V_{Т}$ - speed of the trolley, m/s.

The found value $V_{Т}$ is used to select the mode of operation of dump truck engines (wheel circumferential speed).

Calculations show that, for example, when yousaute lift 450 m and the angle of inclination of lift 40° with simultaneous ascent (descent) of the two saof Masalov BelAZ-7512 capacity 120t the velocity of the cart can be estimated to be equal to 0.55 m/s, which provides the carrying capacity of the lift (length L = 660 m) is not less than 600 to 700 t/h, or about 4.1 million tons/year during the duration of the day 19 hours and 340 working days in a year.

With a capacity of over 4.0 milliontons per year, it is possible to equip two parallel lifts, which in most cases will still be cheaper than the option with a lifting machine.

According to reputable experts, the creation of car lifts is, in principle, possible. Such a technical solution will reduce the fleet of dump trucks, reduce transport costs and improve the economic efficiency of operating deep pits.

But for the final decision-making, it is necessary to study in more detail not the mechanical part of the project, but rather the issues of stability of the reinforced concrete bed of the car lift, the impact of seismic impacts during blasting operations, underground water, temperature fluctuations and other factors on its condition.

LECTURE №7. QUARRY CONTAINER LIFT.

Plan:

1. General information.
2. Using the forces of gravity to transport cargo from mountain quarries.
3. long-distance Conveyors.

The purpose of the lecture *is to study quarry container lifts.*

Key words:: *transportation costs, car lifts, lift layout, combined system, technological transport, lift characteristics, gravity usage, quarry geometry, cargo transportation, ropeway system, cable cars, belt conveyors.*

General information.

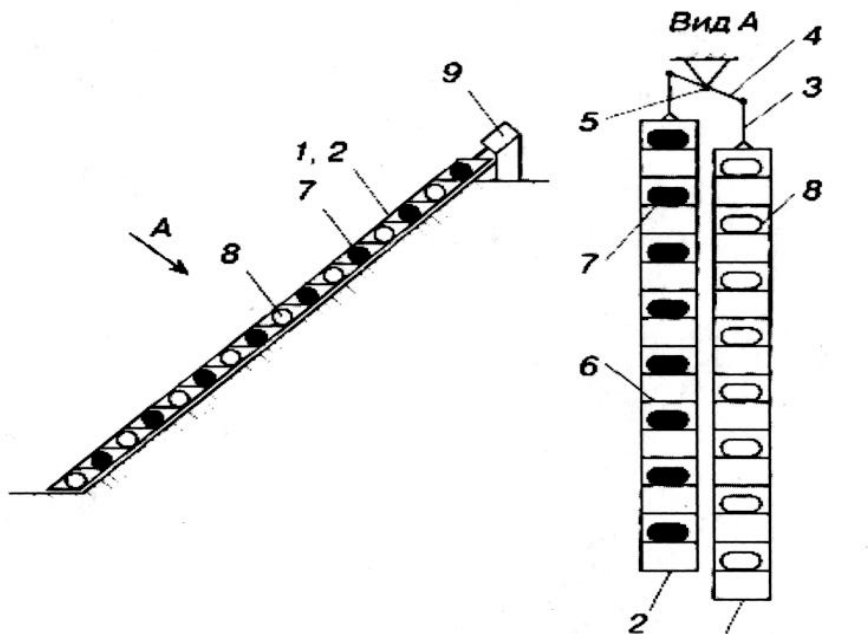
With modern systems and technical meansof technological transport andcurrently achieved quarry depths, transport costs account for 60-65 % of the total cost of ore extraction. Calculations showthat with further deepening of quarries, transport costs will be 3-4 times higher than the amount for other items ofwaste and their share will reach 75-80 %. At thesame time, the main share of transport costs falls on the liftingcycle. Useful work on lifting the rock mass from the quarry is directly proportional to its depth, but the faster growth rate of transport costsis due to the peculiarities of transport used in the lifting cycle. In fact, depending on the mode of transport, the length of transport communicationswith the same pit depth can differ by more than 15 times. Hence the difference incapital, operating and other costs. Understanding therising cost trend can be achieved byusing more economical modes of transport. However, a radical change in the situation is possible only through non-traditional transport technologies and technical means.

In recent years, a numberof developers have proposed schemes for car lifts. [6, 13, 30]. They reducethe length of transport links,exclude overloading, sorting or crushing of material in the quarry, and consequently reduce thecost of transporting rock mass. However, these systems havea significant drawback: their productivity decreases as the pit depth increases, and therefore,the reason for the outstripping growth of transport costs remains.

A fundamentally new container lift was proposed at the NIIKMA Institute [24]. It is designed for the delivery of loaded containers (dumptrucks, dump cars or their removable bodies) from the quarry and at the sametime launching empty ones into the quarry. The kinematicscheme of the lift is designed in such a way that it contains not one, but several loaded andadjacent containers, which allows you to maintain a steady state of operation.increase the technical productivity of the lift when the pit is being deepened and thus eliminate one of the main reasons for the outstripping growth of transportcosts.

Figure 2.4 shows a schematic diagram of the specified lift. Two kinematically connected parallel and adjacent to each other frames 1 and 2are mounted on the side of the quarry or in an undergroundexcavation and are connected to each other, for example, throughrods 3 connected to a double-arm lever *4.* The leveris sharpened by means of a hinge 5 to the base. Frames *1* and *2* are divided into compartments by partitions 6. in the compartments on partitions 6, loaded 7 and empty *8* containers are placed. Each compartment has a mechanism formoving containers into the compartments of the adjacent frame.The Elevator *4* is equipped with a drive 9. When used as containersof dump truck bodies or dump cars, the Elevator is equipped with devices for removing them and installing them on the vehicle base. To ensure the rhythmic operation of the lift, its loading and unloading parts can be equippedwith container storage devices.

2..5 shows the technological scheme of the Elevatoroperation. In the initial position (see Fig. 2.5, a*)* inthe lower compartment



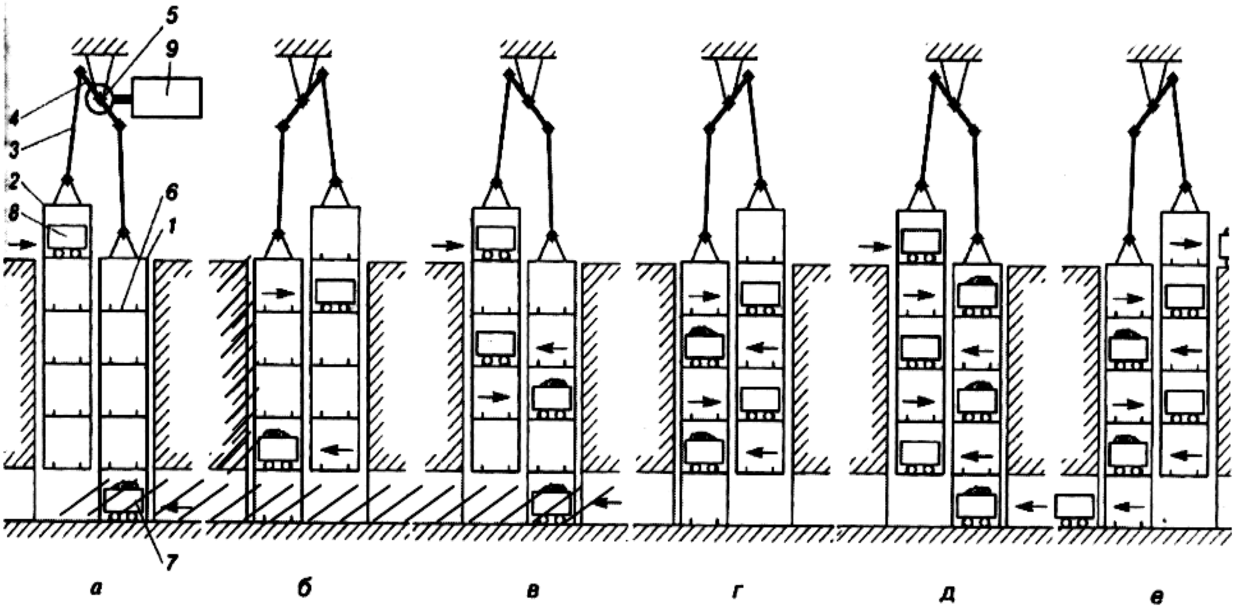


Рис. 2. 5. Принципиальная технологическая схема работы контейнерного подъемника

frame 1 receives a loaded container 7, and in the upper compartment of frame *2* — an empty container *8.* Drive 9 moves the lift to the position shown in figure 2.5,δ, and stops to exchangecontainers between the frames / and*2.* In thiscase, the heavy container *7* is moved to the second lower compartment of the frame *2,* and the empty container *8 is* moved to the second upper compartment of the frame. After that, frames *1* and *2* перевоаre moved to the starting position (see figure 2.5 C), and-the Elevator stops again to exchange containers between the frames, load the next loadedcontainer into frame *1* and empty container into frame 2*2.* Next, thelift is transferred sequentially to the positions. 2.5 d, *d,* and d are shown in figures 2.5, and during stops, regular container exchanges are performed betweenframes. After moving the mechanism to the position shown in Fig. 2,5, *e,* осуществляется выгрузка из the loaded container on the surface and thenext container in the quarry are unloaded from the compartment. This position (see figure 2.5 e) fixes the output of the lift to the nominaloperating mode.

The NIIKMA Institute has made models of such a lift of three types: one vertical and two inclined. Preliminarykinetic and technological studies were performed. Calculations have shown that when installing-
when the lift is installed at a 45° angle in a 300 m deep quarry and when used as dumpcar containers with a liftingcapacity of 180 tons its annual capacity will be 14 million tons The power of the Elevator drive will not exceed 5 MW. The lift's performance will improve if you use upgraded dump trucks or dump cars with easy-to-remove bodies. The creation of such vehicles will require additionalcosts, but at the same time, removable bodies willsignificantly reduce the turnover cycle of transport, andconsequently, the fleet of rolling stock and the cost of

transportation. Individual body rollover systems are not required for vehicles with-removable bodies.It is enough to equip the surface complex of the Elevator with mechanisms for unloading coal, for example, a receiving hopper for coarse crushing. It should also be equippedwith facilities for removing loaded and emptycargo tanks, similar to those used on the lift itself. Excluding the body folding mechanism willincrease the reliability and stability of vehicles and increase their loadcapacity.

The main advantages of this combinedtechnological transport system are:

- the ability to work at an angle of inclination up to 90°, which significantly reduces the length of lifting the rock mass;
- the lifting of loaded containers and the return of empty containers take place simultaneously;
- the duration of the container turnover cycle is practically independent of the quarry depth;
- energy consumption for moving containers and elements of the lift itself is minimized due to the staticbalance and equal strength along the length of the mechanical system of the lift;
- the lift provides the ability to load and unload containers from any horizon of the quarry;
- the tare ratio of the proposed system, the rolling stock fleet, its maneuvering areas, and the material unloading time may beshorter than for traditional transport systems and types;
- it becomes possible to simplify the design of rolling stock and improve its technicalcharacteristics.

According to the developers, this transportation system will increase the economic efficiency of open pit transport in deep pits.

Using the forces of gravity to transport cargo from upland quarries

Significantshifts of overburden andvalley horizons inmountain quarries above-valleys, especiallyof the hill type, allow the use of devices operating on the basis of gravitational forces to move the rock mass: ore slides,pulsed devices for lowering loadeddump trucks, as well as special dumptrucks that use the energy of rotating masses.

The use of gravity is a technical necessity for improving vehiclesin order to reduce the specific fuelconsumption and environmentalpollution of the environment in deep and uplandquarries. At the same time, due to the reduction of transport berms, the volume of overburden extraction decreases.

Table 2.2

Parameters of quarries (sections) that use road transport

№	Careers (cross-sections)	Dimensions, m					
		Length		Width		Depth	
		From	to	from	to	from	to
1	Ferrous metallurgy	2100	6300	1000	2200	150	3500
2	non Ferrous metallurgy	400	3100	310	1500	70	800
3	Coal mines	900	15000	500	3500	100	230

The geometry of quarries (table 2.2) with a depth and height (upland quarries) of several hundred metersallows you to use gravity to transportrock mass or transport vessels without energy costs (or at their minimum cost) over significant distances.

One of the possible schemes is shown below (Fig.2.6) transportation of cargo in a quarryusing gravity forces. In the cargo transportation scheme, which includes tracks with trolleysmoving along them, connected to each other by a flexible traction element,the track corresponds to the profileof the quarry side (see figure).-дой площадке уступа оборудоThe tracks on each platform of the ledge are equipped with two vertical walls with rails located on both sides of the platform, and the trolley has additional wheels that interact with the rails of the vertical walls.женными по обе стороны от тележки, а тележка имеет дополнительные колеса, взаимодействующие с рельсами вертиFor tension of the traction body, the rails installed on the platform of the ledge and the rails parallel to them on the vertical wall have a slope towards the developed space, the value of which is greater than the value of the coefficient of resistance to movementof the track along the rails. In addition, flat sections of rails have a slope towards the developed space, determined by the formula

$i>>k = P/G$

where k is the coefficient of resistance to movement

trolleys on rails;

P is the drag forceof the trolley movement

on a horizontal path;

G is the weightof the cart.

This slope corresponds to the angle α . Meetingthe conditions i>k provides thenecessary rope tension.

The device for cargo transportation worksas follows. Dumptrucks are mounted on trolleys at the same time: for example, an empty dump truck is placed on the lower trolley, and a loaded dump truck is placed on the upper one. Then, when the drive drum rotates, the lower trolleymoves along the platform of the ledge by the traction organ, the upper one - towards the developed space underthe action of its own weight. At the same time, the lower wheels of the trolley roll along the lower rails,

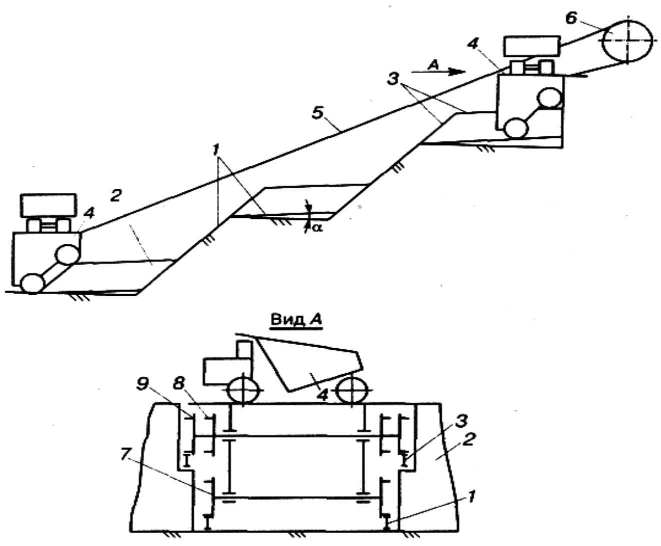


Fig. 2. 6. Diagram of the device for cargo transportation:

1, 3 - lower and lateral rail tracks, respectively;

2 — vertical wall; 4-trolleys;

5-flexible (traction) body; 6-drive drum;

7, 8, 9 - lower, upper and additional wheels, respectively.

andadditional ones-along the side rails, which ensures the horizontal position of the trolley platform. Then the carts move along the slopes of the ledge: the lower one - up, and the upper one-down.In this case, the drive unit operates in the generator-mode and recovers energy to the grid.

When the trolley is moved along the slope ata distance equal to the distance between the axles of the lowerand upper wheels, the additional wheelsmove out of contact with the side rails, and thetrolley moves along the lower rails.

This solution allows you to eminimum to reduce costs on the track, to exclude mining-related wypracowanie side of the pit under the track for ways to ensure the descent of dump trucks in a quarry on the shortest path, to reduce operating costs for maintenance of the trucks, reducingat capturing Stripping volume due to the reductionof the width of the carriageway of roads, tookchit capacity of dump trucks and tonecnon account to reduce the cost of transportation by about 10-15 %.

This scheme is also applicable in principle for the case of lifting the load up, then the empty dump truck will go down under its own weight.

Long-distance conveyors

In the Guinness book of records, among other achievements of human civilization, the largest engineering structures are also listed, including three large transport systems. The first and second places in this list are occupied by the longest single-span (single-axle) rope and belt conveyors with a length of 30 km and 20 km, respectively, which have been operated since 1984 on the territory ofWorsleyAluminaPtyLtd(Western Australia). The third position in this listbelongs to the world's longest bending conveyor with a length of 18 km, which has been in operation since 1987 atan enterprise developing a potash ore Deposit in the Dead sea area (Sodom, Israel).

The world leader in the production of long-distance conveyors is the "bulk materials Transportation" division ofMETSOMINERALS(England).

Until the middle of the 20th century, any conveyor with a length of more than 1 km was considered the highest technical achievement, and in 1953 the rope-belt conveyor "established" a record value for the length of a single span- more than 10 km. The 14.6 km long rope and belt conveyor, which was put into operation in 1971 in Uniontown, Kentucky, USA, was one of the longest systems.

This achievement remainedthe highest until 1984, whenthe " WorsleyAlumina "conveyors were put intoWorsleyAluminaoperation.

The characteristics of some of the world's longest rope-and-belt conveyor systemsare presented in table 2.3.

WorsleyAlumina'sconveyors, which were put into operation more than 20 years ago, still remain unsurpassed in their parameters.Despite the intensive development of systems andtechnological innovations in the productionof traditional conveyors (when the traction force is transmittedto the load-bearing belt), the longestsingle-axle design is still a system with a length of about 16 km, i.e. almost half less than the longest rope-belt conveyor.

However, single-span structures are only part of a complex consisting of several conveyors combined together and forming a very long system for transporting bulk materials.

A large distance of transportationof bulk materials can be considered a distance from 10 km up to 100 km. The maximum distance, i.e. the limit for a particular typeof material, is determined on the basisof comparative economic calculations of alternativevariants of means of transportation. In this range of Rastofor the delivery of bulk materials, alternative options are: road freight transport; pipeline transport; railway transport; suspended aerial cableways.

There are numerous criteria used when choosing the optimal transportation option from among several alternatives. In most cases, the choice of transport system is based on the following factors::

• cost of the system itself;

• cost of installation of the system;

* cost of operating the system.

Table 2.3

Key Specifications of Some of the World's Largest Belt Conveyors

Location	Year of introduction	Length, m	Productivity, t / hour	Material	Speed, m / s	Installed power, kW	Distinctive features
1	2	3	4	5	6	7	8
Scotland	1951	720	130	Raw coal	1,14	75	First serial belt conveyor
England	1961	4207	870	Raw coal	2,29	750	Underground
USA	1971	14598	1360	Crushed coal	4,19	1865	Surface
USA	1978	9913	2000	Copper ore	4,19	1865	Surface
England	1981	9200	2700	Raw coal	7,50	8750	Inclined conveyor designed for 14200 m
Zambia	1981	11385	850	Copper ore	3,50	1200	Large horizontal bend
Australia	1981	10400	2500	Coal	4,00	2500	Surface
Australia	1983	30441	2300	Bauxite	6,00	8000	The longest conveyor belt in the world
Australia	1983	20712	2300	Bauxite	6,00	5200	The second longest conveyor in the world
Jamaica	1984	14192	1428	Bauxite	4,00	1865	Surface
India	1985	14550	1800	Bauxite	4,70	2000	Surface
Israel	1987	18113	800	Potash	4,60	4000	The world's longest bending conveyor
Canada	1997	6000	2200	Raw coal	6,00	6000	Steeply inclined

Jamaica	1991	7866	1000	Bauxite	3,25	750	Surface descending with turns
Venezue la	1992	4232	1600	Bauxite	4,00	2500	Large regenerative conveyor
USA	1992	6415	700	Crushed coal	3,25	1350	Very difficult terrain
USA	1992	10745	1360	Raw coal	4,19	1865	Moving conveyor Anamax
Philippin es	1996	5775	1000	Limestone	3,50	600	Bend with a radius of 400 m
Canada	1997	10390	1070	Raw coal	4,80	1365	Descending with bends with a radius of 430 m

The first two factors combine the total amount of investment, and the third - the cost of operation and maintenance. The sum of all costs, including depreciation during the operation of the facility, gives the full ortotal cost. As practice shows, for the transportation of bulk materials over longdistances, rope-belt conveyors have the lowest total cost, in most cases.

All alternative transport options are characterized by a set of advantages and disadvantages (tab.2.4). Automotive - mobile and versatile, suitable for short transportation distances and service life. However, it requires high operating costs. Pipelines can be used for transportationover quite long distances. This type of transport is considered relatively safe for the environment, but requires high capital expenditures with extremely low operational efficiency due to highoperating costs and high energy consumption. Long-distance transportation can be carried out by rail. But it is also characterizedby high capital expenditures and very limited-opportunities to overcome gradients and ascents, whichultimately leads to high operating costsfor transportation.Long-distance and sharply rough terrain transportation can be carried out on suspended aerial-rope boards, but its transport vessels have a small capacity and load-lifting capacity. Conveyor transport, in turn, is characterized by the lowest operating costs, but requires significantly large initial capitalexpenditures.

Table 2.4

Advantages and Disadvantages of Various Bulk Transportation Systems

System type	Benefits	Disadvantages
1	2	3
Automobile transport	1. Mobility and versatility; 2. Applicability for short routes; 3. Low annual tonnage; 4. Suitability for high-speed quarries; 5. Ease of relocation	1. High production costs; 2. High labor costs; 3. High maintenance costs of the road network; 4. Loss of capital cost advantage over long distances; 5. Dependence on fluctuations in fuel prices
Pipeline transport	1. Possibility of transportation over long distances; 2. Environmentally friendly	1. High capital costs; 2. Very high energy consumption; 3. Dehydration of the material; 4. The need to return water
Railway transport	1. Unlimited transportation distance; 2. Versatility of application	1. High capital costs; 2. High production costs; 3. Severe incline restrictions (route selection)
Suspended cable cars	1. Possibility of transportation over long distances; 2. Possibility of steep climbs; 3. A small amount of preparatory earthworks and work on the erection of load-bearing structures	1. Limitation on transportation capacity (<1000 t / h); 2. Large costs for the organization of loading and unloading units; 3. High labor costs; 4. Limitations on the bends of the transportation path
Traditional belt conveyors	1. Possibility of transportation over long distances; 2. High performance of transportation (over 5000 t / h); 3. Wide network of manufacturers support; 4. Low manufacturing costs; 5. Simplicity of extension	1. High capital costs; 2. Limited strength of the tape; 3. Several drives; 4. Risk of rupture of the tape; 5. High power consumption;

		6. Lack of flexibility for making turns and re-routing; 7. The complete set of the conveyor is "recruited" from various suppliers
Rope belt conveyors	1. The lowest total cost; 2. Reliable bends with a radius of up to 400 m; 3. The smallest installed capacity; 4. Slopes up to 18 degrees; 5. Small amount of preparatory earthworks and work on the erection of load-bearing structures; 6. Flexibility in routing; 7. Reversibility depending on the location of the tensioning station; 8. Possibility of loading on the return route; 9. Ease of extension; 10. Minimum of transfer points; 11. Environmentally friendly; 12. Availability of regional support of Svedala in 55 countries	1. One source; 2. High capital costs; 3. Difficult to move and not growing fast enough; 4. Differing learning curve, need for learning

The ability of a rope and belt conveyor to cover long distances with a single span and, in most cases, with a single drive is determinedby a unique structural design: the traction force for movingthe belt is applied to the steel ropes, and not to the belt as in traditional conveyors.

The cost погрузочно - разгрузочныхof rope conveyor loading and unloading stations is usually higher than for conventional conveyors, due to the need to separate the belt and rope at these points and providea separate tensioning system for each element. Thisis essential for short transport lengths and simple arrangements, where rope-and-beltconveyors may be less efficient thantraditional belt conveyors. However, as the lengthand complexity of the track layout increases, where a steel cable is required, the cost of loading andunloading stations becomes an insignificant part of the total cost of the conveyor. For a rope conveyor, the specific price of the belt is the same and constant both for a length of 1 km and 20 km.

When transporting over long, and even more so over very long, distances, the rope-belt conveyor usually requires the lowest capitalcosts.

The elimination of intermediate overload points, which are unavoidable in standard pipelines, has a significant impact not only on the reliability of the system, but also on the cost of operation and maintenance. In Fig.2.7 and 2.8 present graphs of the impact of the numberof spans on the system performance as a whole and on the degree of technical readiness (reliability) of the system. It is assumed that each individual conveyor in the transportation process chain hasa 95% availability factor, and when they work in the same system, the impact becomes significant.

Figure 2.9 shows a graph of the relative dependence of the drive power on the length of the conveyor belt for different types of conveyors.

Figure2.7 Dependence of the design technical performance of the conveyor system on the number of individual stages (included in the conveyor system)

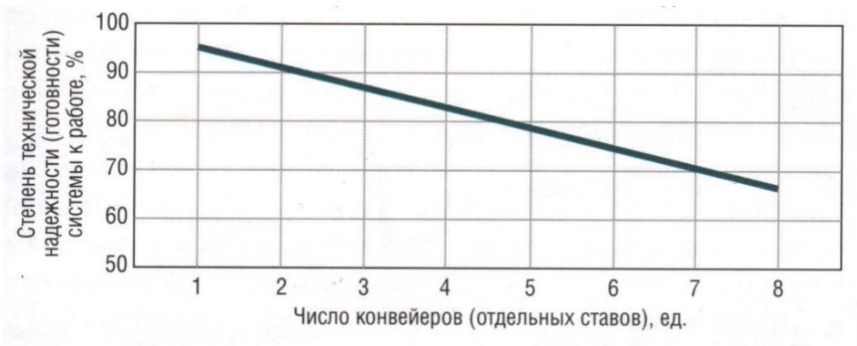


Figure 2.8. Dependence of the degree of technical readiness for operation of the conveyor system on the number of

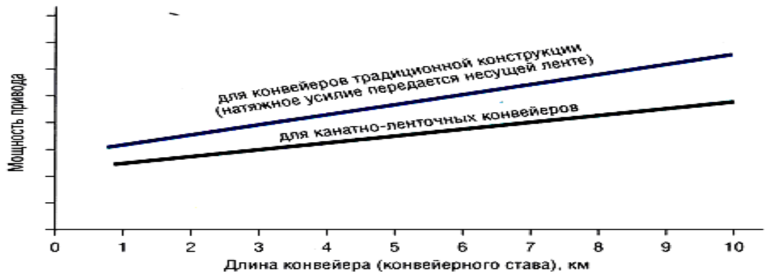


Figure 2.9. Dependence of the conveyor belt drive power

the system depends on its length

LECTURE №8 KRUPP ROTARY EXCAVATORS KRUPP.

Plan:

1. General information.
2. Rotary excavators advantages and disadvantages.
3. design parameters of excavators.

The purpose of the lecture *is to study Krupp rotary excavators KRUPP.*
Key words:: *advantages, rotary excavators, parameters of excavators, characteristics of excavators, sizes of excavators, S 100-S 630, applications of excavators, design parameters, geometric parameters, bucket shapes.*

General information.

Firm Kruppfdrdertechnik (Germany) is a world leader in the production of rotary excavators. It has been producing its products for more than 70 years. Compact rotary excavators of this company allow you to develop rocks with a compressive strength of 10 MP*a*, and in some cases-up to 20 MPa.

Thanks to the original design of the all-metal impeller and a shortened handle that accepts increased digging forces, buckets are loaded with a high degree of filling.

Rotary excavators advantages and disadvantages.

Main advantages of using rotary excavators:

* no drilling and blasting operations;
* the lumpiness of the excavated material is optimal for transportationby conveyor belts;
* use of conveyors as the most economical mode of transport;
* no cost of crushing rocks.

Currently by the company KRUPP compact rotary excavators are manufactured in a standard design, which makes it possible toprovide sufficient ease of maintenanceand, if necessary,repair by using standardelements of mass-produced machines in their design. For heavy - duty applications in quarries or large constructionках применение указанных станsites, the use of these standard components allows for quick repairs or maintenance.

KRUPP produces a wide range of compact rotary excavators from S 100 to S 1600 manufacturerностьюfrom 450 to 6600 m3/h.

Four types of KRU PP rotary excavators are discussed below. The schemeof the excavator face and the main technological parameters of its operation are shown in Fig. 2.10. the valuesof technological parameters for the considered sizes ofrotary-excavators of the company KRURRS are given in table.2.5.

Table 2.5

Values of technological parameters of excavators companies KRUPP

№	Sizes	S 100	S 250	S 400	S 630
1	Face height, A (m)	6	9	11	15
2	approach Width, B(m)	8	12	15	20
3	Chip depth, S (m)	2,0	3,5	4,0	4,5
4	Face slope angle, α_1 (^{0})	60	60	60	60
5	Slope angle of the formed ledge, α_2 (°)	66	64	62	60

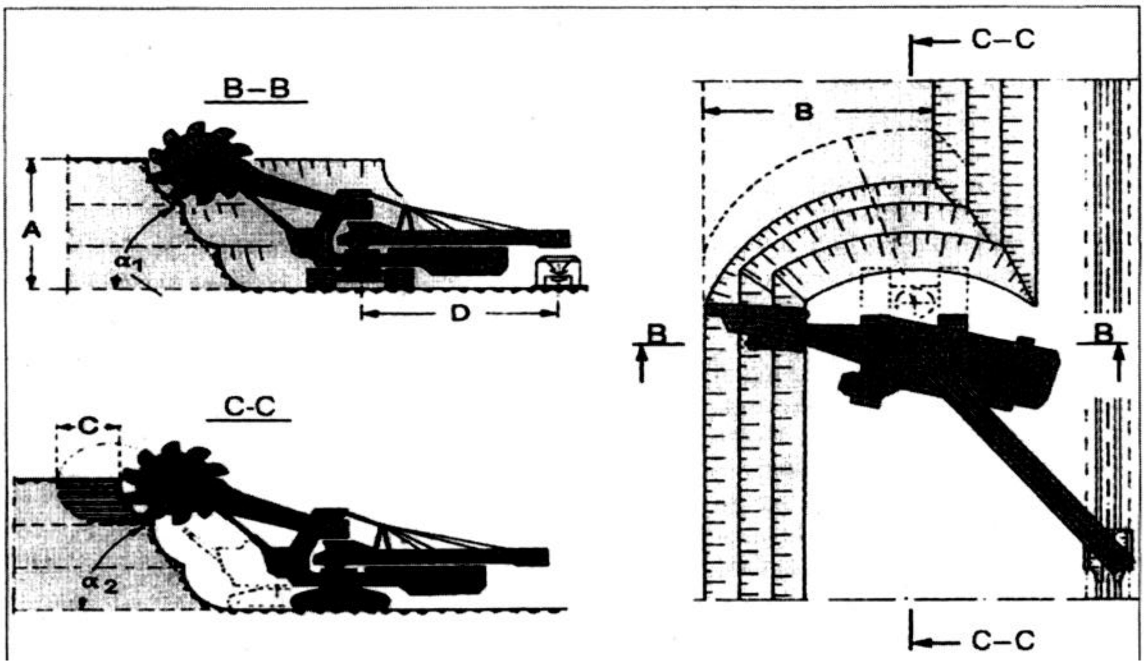
Table 2.6 showsthe technical characteristics of excavators manufactured by KRUPPsizes from S 100 to S 630.

Table 2.6

Technical characteristics OF Krupp rotary excavators

№	Indicators	S 100	S 250	S 400	S 630
1	Bucket capacity, l	100	250	400	630
2	belt Width, m	0.80	1.00	1.20	1.40
3	Theoretical capacity,^{m3}/ h	500	1250	2000	3000
4	Effective capacity, м^{m3}/ h	200	550	900	1400
5	Working weight of the excavator, t	55	140	200	400
6	Installed electric power, kW	190	350	550	980

7	Alternatively: installed power of diesel engine, kW	230	410	640	11Z0



Characteristic designfeaturesof excavators manufactured by K RURURRS are: the-presence of an automatic centralizedlubrication system; hydraulic driveof undercarriage bodies, rotary and lifting ycdevices; power supply bothdirectly from the electric grid and from a diesel engine. In the case of electric power supply, electric motors are used to drive both belt conveyors and the rotor, while in the case of powersupply from a diesel engine, all elements are driven hydraulically.

The s 100 excavator is the smallest rotary excavator of KRU companyPP weighing 55 tons (Fig.2. 11)..It can be easily disassembled andported to a low-frame trailer. Therefore, it is particularly suitablefor use on constructionsites with a limited period of operation. S 100 can also be used in quarries, for example, for chalk extraction. At the same time, effectivefine-grained crushing of the chipped material is ensured.

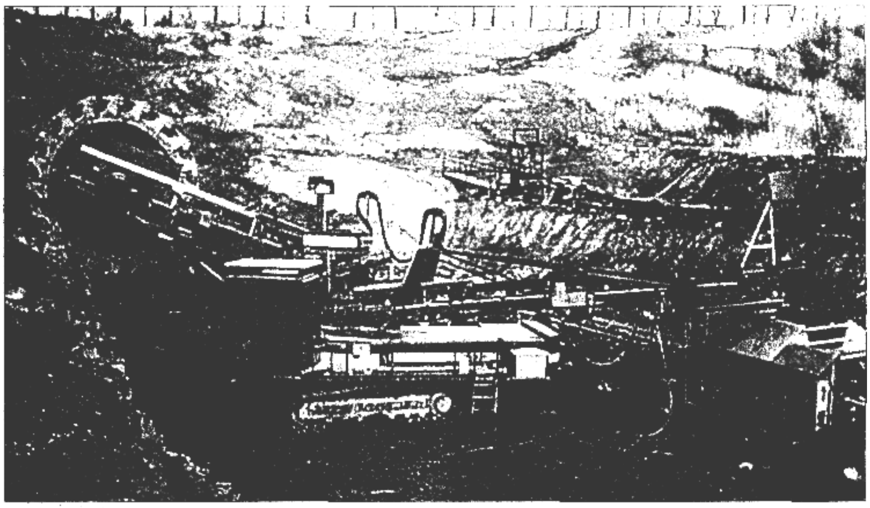


Fig.2. 11. Rotary excavator S 100 at working in a clay quarry

The complete support trolley, rotary gearbox and final stages of the impeller drive are well-proven serial structural components.

The s 250 excavator has a workingweight of about 140 tons. This mechanism is designed tobe transported to the place of use on a low-bed trailer in the formof several Assembly units with on-site Assembly. In Fig.2.12 shows the s 250 excavator impeller

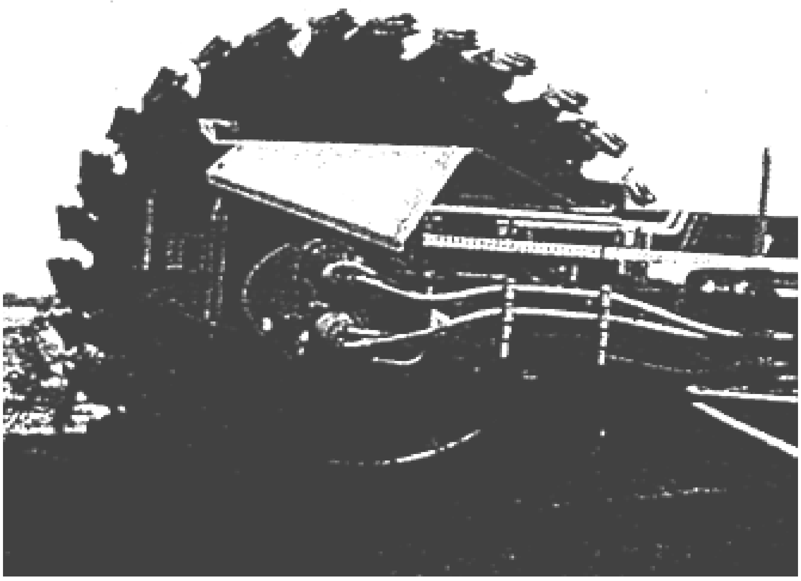


Figure 2.12 excavator Impeller S 250

The s 400 excavator has a workingweight of about 200 tons. Underfavorable traffic conditions, i.e. with a roadway widthof 5-6 m, it can be transported toits destination.

it can be used on a low-bed trailer in the formof several mounting units and relatively quickly assembled and dismantled.

The s 630 is the largest of the standardcompact rotary excavators. Its working weight is about 400 tons. Due to the wide aggregability of the mechanism, its installation takes relatively little time.

The counterweight consoleных экскаваторов of the s 250, S 400 and S 630 rotary excavators is designed in such a way that гидросистемы и централиа separate enclosed space is provided for both the hydraulic system and the centralized lubrication system, as well as for the electrical equipment andcontrol system.

The excavators are additionally equipped with equipment that provides coordination of drive motors and electricalequipment, computer control, preliminaryselection of the depth of the approach, remotecontrol, electric heating, laser control forleveling the surface, video monitoringof ore reloading, chute heating, special cleaning of the conveyor belt. In addition, the excavator can be equipped with belt scales, an air conditioner, a radiotelephoneburnout device, a bulldozer knife for rolling out the berm at the track level, analyzers with continuous operation.

Design scheme of rotary excavators of the company KRUPP series S 100-S 630 and their main parameters are shown in figure 2.13.

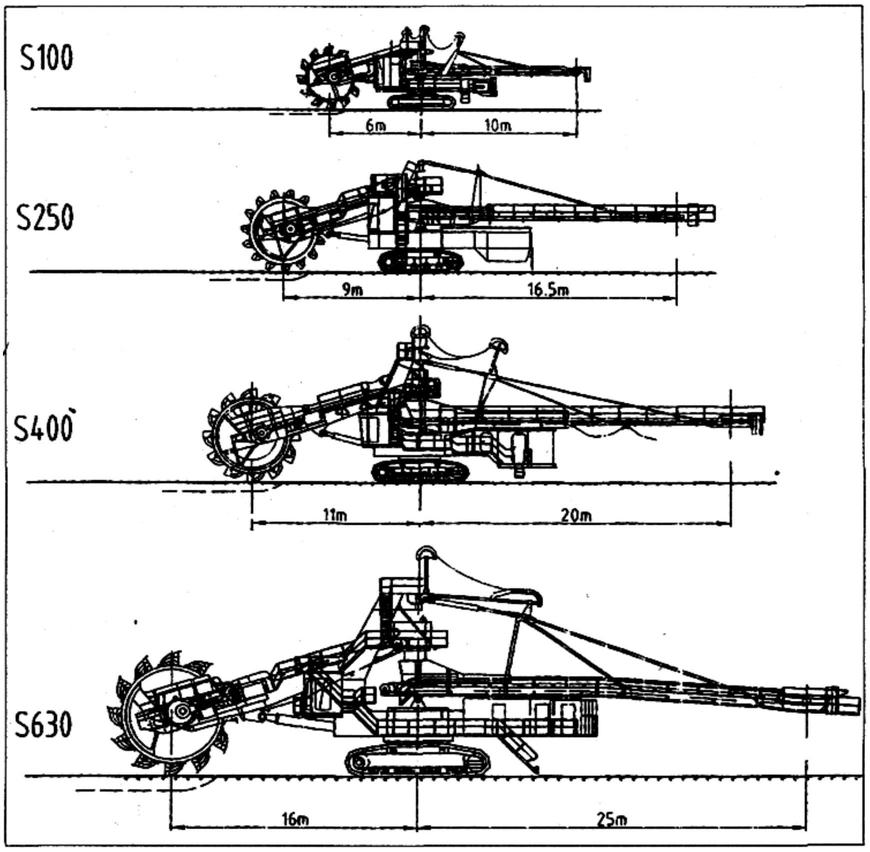


Figure 2.13. Design diagram and main parameters
excavators S 100-S 630

The possibilities of using the s 250, S 400 and S 630 excavators on large constructionsites and in quarriesare very diverse. All parts of the running and turning mechanisms ofторов the s 250 and S 400 excavators arestandard with some minormodifications. For the excavtor S 630, most ofthe mechanical components are also taken from the designof mass-produced construction machines. The main advantages of the company's standardcompact rotary extractorsinclude: KRUPP should be attributed to the economy of continuous excavation of large masses and shallow excavation of connected and solid soils.

Design parameters of excavators.

The main design parameters of a rotary excavator that affect the efficiency of the excavation process are the geometric parametersof the machine and running equipment, as well as the kinematic parametersof the drives and the shape of the teeth and buckets.

The geometrical parametersof the excavator and runningequipment significantly affect the size of the miningblock and the efficiency of the rotary excavator in the block, while the geometrical parameters and shape of the buckets and teeth significantly affect the cutting force and energy consumption for the digging process.

The main geometrical parameters of the excavator include the diameter and width of the impeller, and the asymmetry buckets, the coordinates of the point of suspension and the boom and mounting angles and offset working koleCA on the arrow (Fig. 2.14). For improvement of unloading of ladles and to prevent contact konstruktion of the arrow with the slope of the breed in the block, the impeller rotary excavatorRA may be offset relative to the axis of the boom and turned in Vertical plane of the roll angle and the horizontal angle of the bevel. Geometric parameters of the shape of buckets and teeth include the number of buckets, their volume and shape, the shape of the cutting teeth, their location and installation on the bucket, as well as the wear of the cutting edges (figure 2.15).

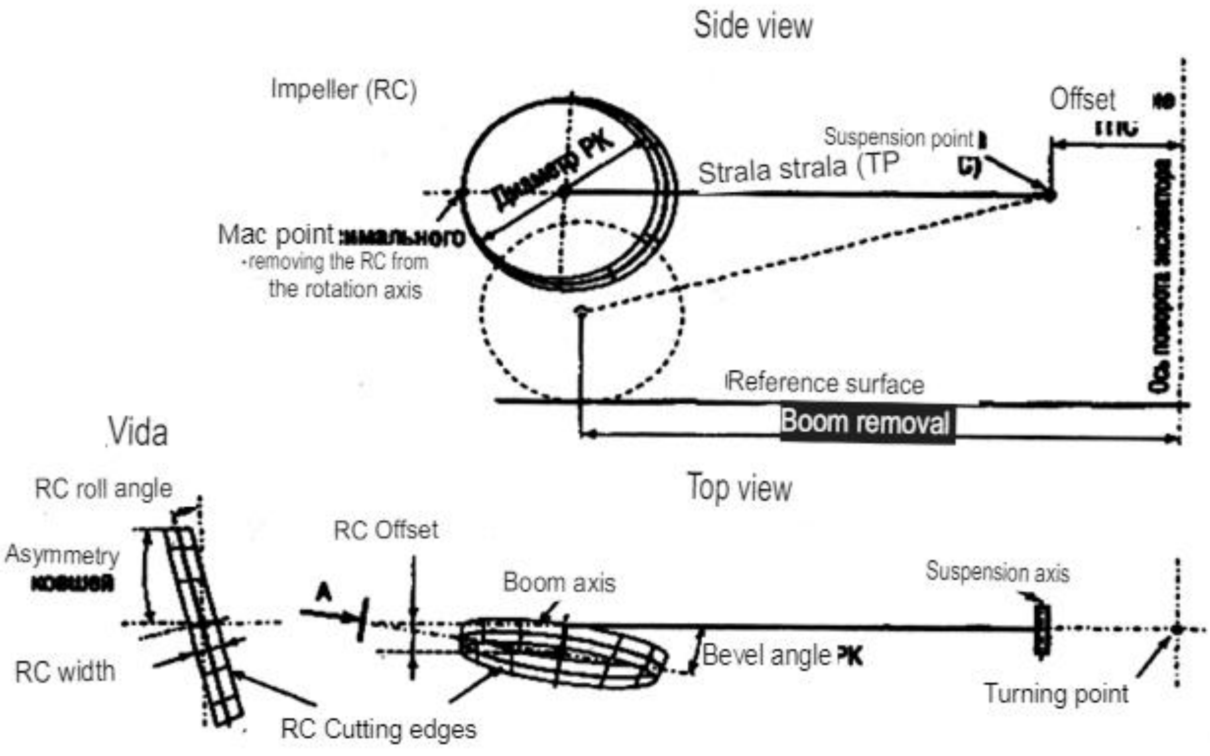


Fig. 2.14 Basic geometric parameters of a rotary excavator

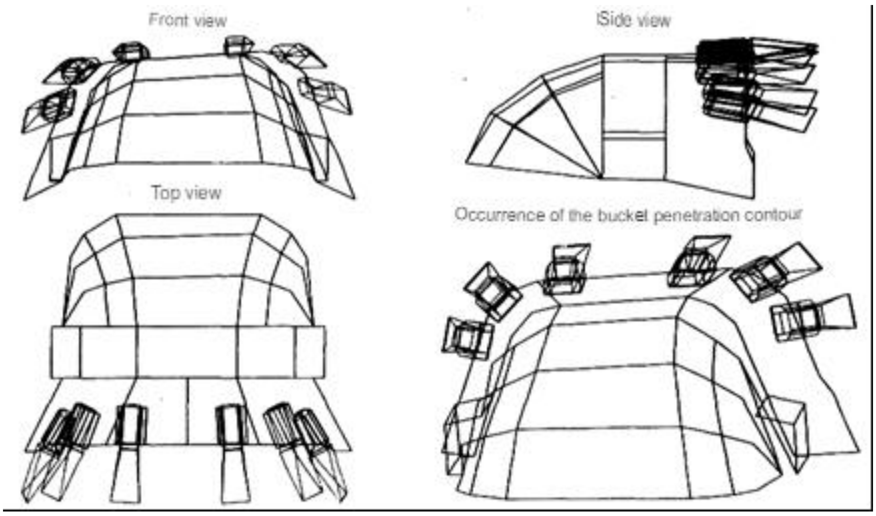


Figure 2.15. Simplified model of the bucket shape of a rotary excavator

The choice of the rock development scheme in the block is determined in accordance with the design parameters of the rotaryexcavator and the physicaland technicalcharacteristics of the developed soil.

Block development can be carried out using horizontal terracesor vertical sections (the so-called method "Drop Cat") or combinedno. The development of rocks by horizontalterraces is most common, and in the case of selective extractionof minerals lying in thinlayers, it is even preferable (figure 2.16).

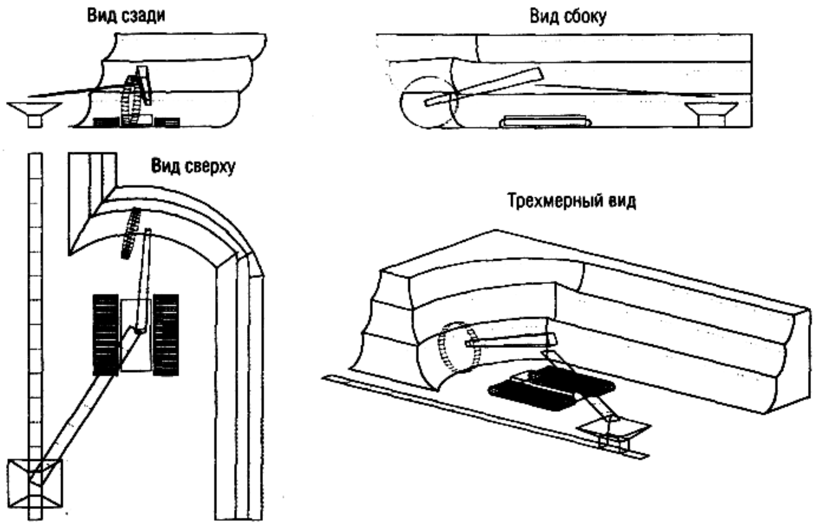


Fig. 2. 16. Geometry of the rock development block using horizontal terraces (shavings)

LECTURE №9. NEW CHISEL DESIGNS FOR QUARRY OPERATIONS DRILLING RIGS.

Plan:

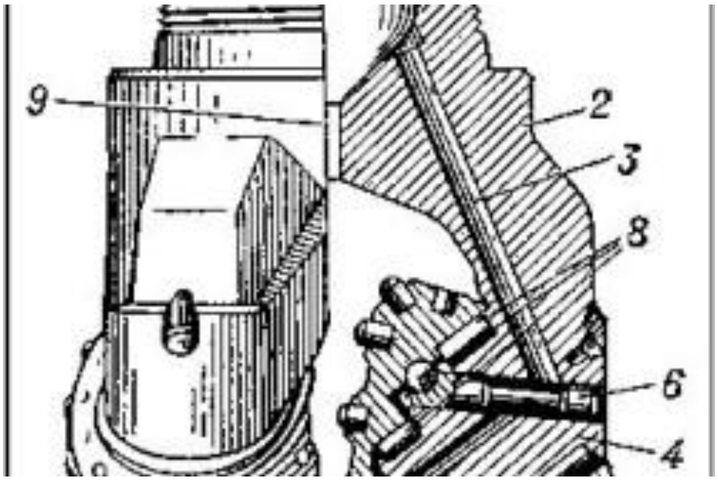
1. Purpose of drill bits: General information.
2. Fundamental disadvantages of cutting drill bits.
3. New designs of drill bits.

The purpose of the lecture: *to study new structures of chisels for mining drilling rigs.*

Key words:: *disadvantages, cutting bits, drilling bit, cutting and rolling bits, self-adjusting bit, rolling bit, rock cutters, purposes of bits, nature of operation, soil destruction.*

Purpose of drill bits: General information.

The chisel is the main component of a special tool for continuous drilling of oil-bearing, gas, water wells and wells for other industrial, technical and construction needs. Its task is to destroy the soil in the limited impact zone (bottom face) of the drill string and deep sinking. Therefore, chisels belong to rock-breaking equipment.



Tricone rock bits for solid drilling in very hard rocks: 1 — external connecting thread cone (nipple); section 2 (paw) drill bits; 3 — channels in the paw and the axle to allow purging of the support; 4 — axle paws; 5 — carbide teeth with a hemispherical working part; 6 — castle finger; 7 — cutters; 8 — rolling bearings; 9 — Central channel for blowing the face and cutters.

The specified element of drilling equipment has many different designs and their modifications. They are determined by the features and methods of drilling various rocks, as well as the technological goals that are set for them. Depending on the design of the chisels, rocks located in the face area are destroyed either by impact or shock-shear action.

Analyzing the nature of operation of this drilling device, it should be noted that it not only destroys the solid ground in the planeof the bottom hole, but also forms the walls of this well. And the more the drill goes deeper into the earth's thickness, the more complex and adverse effects are experienced by its components. In particular, the chisels experience significant cyclic and static loads, the impact of torque. All this leads to various variants of abrasive, impact-abrasive, fatigue and corrosion wear of equipment.

For this reason, drill bits are produced from high-quality grades of steel, hard-alloy metal compounds. Since this element of drilling equipment belongs to the class of single-use tools, its design is designed in such a way that it guarantees an economically justified duration of operation.

Fundamental disadvantages of cutting drill bits.

One of the factors limitingthe further increase in the productivity of quarry drilling rigsis the exhaustion of the capabilities of both cutting and rollingbits. The possibilities for improving these chisels while maintaining their traditional design scheme are very limited.

One of the main, fundamental disadvantages of cutting drill bits with cutting elements rigidly fixed to the body(hard alloy plates or removable cutters) is their constant geometry when drilling rocks with different properties, which inevitably leads to a decrease in drilling speed and increased wear.

When drilling medium-strength rocks, especially fracturedor with solid inclusions, known cutting bit designs often fail due to the dynamic nature of the fracture process. At этом возникают вибthe same time, vibrations of the drilling tool and the machine occur.

In addition , шнековой, но и при пневматиit is quite difficult to ensure sufficiently intensive cooling of the cutting elements of the bit, which is constantly being used in the process of well cleaning, not only with screw cleaning, but also with pneumatic and screw-pneumatic cleaning of wells from destruction products.- they are often in contact with the bottom-hole rock they are destroying.

To eliminate these shortcomings, the Department of mining machines and complexes of KuzSTU developed fundamentally new designs of cutting drill bits with movable rock-destroying elements.

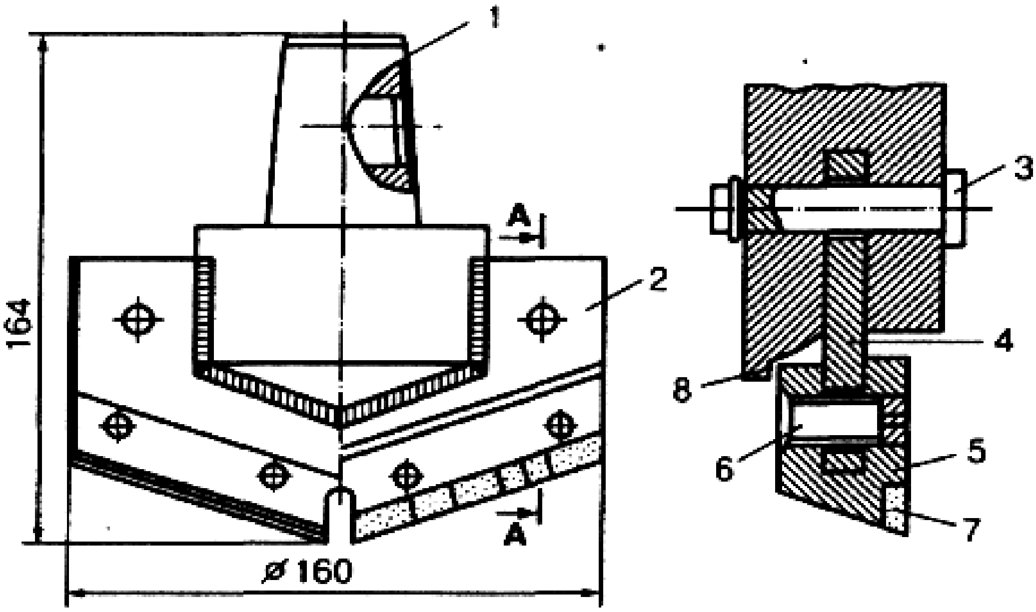


Figure 2.17 Cutting drill bit with shock absorber in the form of a spring

So, the vibration parameters can be significantly reduced if you use shock absorbers built into the chisel (Fig. 2. 17). It consists of a shank 1 welded to the blade 2, in which spring springs 4 are installed using rollers 3.at the free end of the springs, screws 6 fix cutters 5 reinforced with plates 7 of hard alloy VK-8V. The mobility of the incisors is provided by the presence of springs 4.

During drilling, the cutting edges of the cutters destroy the rock at the bottom of the well. The resulting shock loads are smoothed out due to elastic deformation of the spring spring, the stroke of which is limited by the protrusion 8 on the rear wall of the blade.

The chisel not only increases the mechanical drilling speed by 20-25%, but also reduces peak loads by 10-15%. At the same time, the wear rate of the cutting edge is 2.5-3 times less. The design of the chisel allows you to replace the cutters directly at the workplace.

New designs of drill bits.

Niiogrom and KuzSTU developed cutting drill bits equipped with removable annular carbide plates [8]. These plates were fixed on the chisel body with bolts and were cutting rock-destroying elements. They had the shape of conical washers, the peripheral circles of which were cutting edges.

As it dulls cutting edges of the plate-the incisors were rotated. At the same time, a non-blunted section of the cutting edge came into contact with the face. After blunting the entire cutting edge, the plate was replaced with a new one. This design of the cutting elements significantly reduced the time for their replacement.

However, the consumption of hard alloy in this case was quite high, since the cutting plates after blunting their cutting edges were not suitable for further use and were subject to recycling.

It was found that the most rational way to equip породоразрушающимиthe cutting drill bits with removable rock - breaking elements is to install standard rock cutters RK-8B and RB-224 with shortened cylindrical holders on them. At the same time, the greatest effect of their use was achieved by ensuring the mobility of these incisors in the direction of the longitudinal axis. Such mobility was achieved if the tool holders installed in the blind holes-sockets of the housings, were supported on rubber amorphersin the form of washers or bushings of small height. The elongated grooves on the cylindrical tool holders include rollers that limit the stroke of the tools in the axial direction.

A self-priming cutting bit with rotating cutting discs has a much more complex design(figure 2.18) [9].

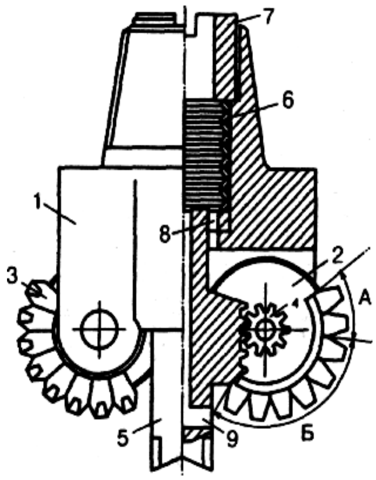


Figure 2.18. Drill bit with rotating parts
cuttingdiscs

On the body *1* of this chisel, disks 2 with hard alloy reinforced cutters 3 are mounted on the axes. On the disks 2, gears 4 are fixed, coupled with slats made on the borehole 5, drilling out the leading well. The borehole is connected to the body 1 by means of a spline connection and rests its shank on Poppet springs 6, compressed by means of an adjustment nut 7. compressed air is supplied through the purge channels 8 and 9 made in the body shank and the borehole to clean the bottom of the well.

In the sector A of disks 2, cutters Z are installed with geometry and reinforcementdesigned for drillingrelatively strong rocks. When drilling weak rocks, the borehole 5 is pushed out of the body / and bores a leading well, and the cutters 3 of sector B destroy the main part of the well face.

When drilling hard rocks, the axial force on the borehole increases, and it compresses the Poppet springs and movesup. This will cause the disks 2 to rotate, as a result of which the cutters of sector A, designed for working on strong rocks, will come into contact with the face. Witha decrease in the strength of the drilled rock, the borehole will move down, re-deploy the disks and put the cutters of sector B. when drilling medium-strength rocks, the disks will rotate only by a small angle, and the wear-resistant cutters of sector A will destroy the peripheral part of the face, and the cutters of sector B-its Central part, weakened by the leading well.

If drilling is carried out on rocks that alternate in strength, then the cutters of sectors A and B will work alternately, which will inevitably improve their cooling, and therefore their wear resistance. In this case, the cutters are replaced automatically, and the bit is adjusted by changing the compression ratio of the Poppet springs using the nut 7.

A fundamentally new technique, based on new principles and having no world analogues, isthe combined cutting-ball chisels developed by KuzSTU and IRSU.

Cutting and ball-breaking chisels (RSHD) have both cutting and породоразрушающиеball-breaking rock-breaking organs (Fig. 2.19).

At the same time, in most known designs, the paws 1 with balls2 are fixed motionlessly on the chisel body 3, and the cutting blades 4 located between the balls rest on an elastic element 5 in the form of steel springs (disc-shaped or spiral), a rubber shock absorber or an air cushion.

When drilling weak rocks, the cutting tool (locatedbelow the balls) under the action of an axial forcetransmitted through the spring, it is embedded in the rock and the chisel works.

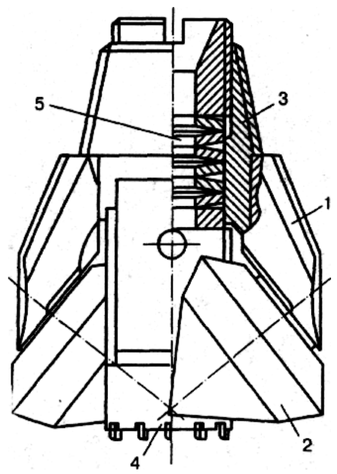


Fig.2. 19. Cutting-ball chisel

As a cutting device. On strong rocks, the increased axial force compresses the spring, and the teeth of the rollers come into contact with the face.

In well-known designs of ball bits, the balls rotate around rigidly fixed axes (trunnions) and cannot move, which eliminates their reconfiguration when the strength of the drilled rocks changes. The rough chisel developed at the same

Department of mining machines and complexes of KuzSTU allows us to eliminate this deficiency and significantly increase the efficiency of drilling rocks of various strengths (Fig. 2.20).

On the body 1 of the chisel, legs 2 with disk balls3 are installed. Movable legs 4 with toothed balls 5 are mated to the body by means of a movable connection of the "swallow tail" type (section A-A).

Poppet springs 6 are installed between the body and the movable legs. when drilling weak rocks, the legs 4 are displaced down and forward by the action of the spring in the direction of rotation of the bit (Fig. 2.20, δ) relative to the axis 1-1 of the bit by an amount of e = 5 - 12 mm. Since the vertices of the cones are

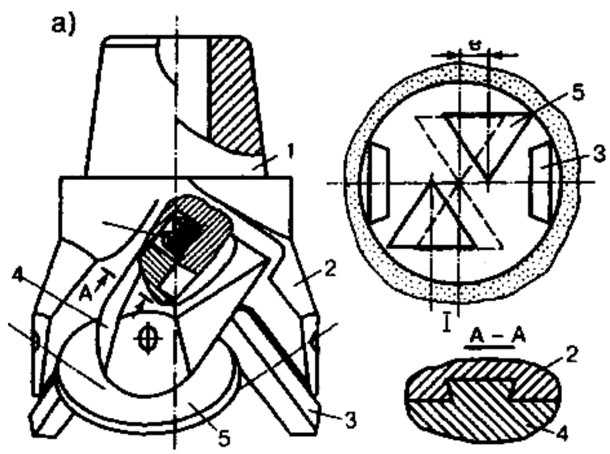


Figure 2.20. self-Adjusting ball chisel

if the balls do not coincide with the axisof the well, then the balls will roll along the face with slippage, whichcontributes to the effective destruction of weak rocks.

As the strength of the rock increases, the resistance will increase theballswill moveup and towards the center of the well (in the position indicated by the dotted line in Fig. 2.20δ), which will prevent them from slippingand ensure effectivedestruction of high-strength rocks.

The use of such aself-adjustingball bit will increase the drilling speed and-effectively drill both weak and stronger rocks without replacement.

Thus, an increase inthe stability of rock-destroying elementsof drill bits, an increase in the drilling rateand a decrease in the energy intensity ofthe process of rock destruction atthe bottom of the well can in some cases be achieved by making the rock-destroying elements of the bits mobile. Atthe same time, the mobility of various types of chisels andballs in the chisels is ensured by the use of steel spring,RAM or spiral springs and rubber shock absorbers.

The test results of the experimentalsamples described above haveshown their operability and significant advantagesin comparison with the currently mass-produced chisels.

LECTURE №. 10. MACHINES AND EQUIPMENT FOR UNDERGROUND MINING

Plan:

1. Conveyor and tire protection chains.
2. wear-Resistant conveyor chains.
3. New tire protection chains

The purpose of the lecture: *to study machines and equipment for undergrounddevelopment .*

Key words:: *conveyor chains, tire protection chains, wear-resistant chains, chain parameters, application of NO materials, heat treatment methods, combined chain, advantages of combined chains, welded link, forged link, двухцепнойdouble-chain conveyor, machine classes, machine load capacity.*

Conveyor and tire protection chains.

A significant increase in the life of conveyor chains only by changing the technology and already testedtemperature conditions of heat treatmentof materials for their manufacture is impossible without increasing the diameter of the rod (chain gauge). However, theimprovement of heat treatment methods can be quite justified if it is used, for example, to improve the surface quality of rounded links in order to reduce abrasive wear. However, withan increase in the strength (increasing the destructive load) of standard materials used for the manufactureof chains, their ductility decreases, and chains becomemore brittle under shock loads. This is a significant obstacle to the developmentof new materials intended for the production of chains.

As is known, the main parameters of conveyor chains used in the mining industryare strength or breaking load, as well as ductility or elongation at break.

German firm J..D . TheilegGmbH &Co. KG (J.D.t.) produces chains for various purposes, which are successfully used in many mines around the world. Currently, the company's specialists have developed a new technologyfor the production of conveyor chains of increased strength and wear resistance from a new особопрочного маspecial-strength material NO (German: Hochoptimisiert - highly optimized), which differs in chemical composition fromthe known alloys.

Wear-resistant conveyor chains.

A new material developed on the basis of high-quality steelsматериал BUT it allowed toincrease the strength of the chains (Fig. 10. 1) and, thereby, increase the destructive load and their service life. Simultaneously materialриал BUT it has such a high ductility that reducing the temperature of its heat treatment practically does not affect the strength of the chains.

This allows their manufacturerto take into accountthe specific application of chains when choosing a thermaltreatment option.

Very often, it is suggested to use special heat treatment methods to increase the strength of conveyor chains. As can be seen in figure 10.3, for the patented J..D..T . materialариала HOWEVERрактерно бо, a higher strength value is characteristic, and forthe standard one, a more dramatic decreaseти при температуре отin ductility at a start-up temperature below 450°C. Chainsmade ofmaterials thathave been processed usingthe same temperatureshave twice the plasticity values. However, the difference between its values for rounding and shelf edgeis not small.

Standard chains with high strength characteristicsfail faster under the influenceof corrosion ifvarious heat treatment methods are used to increase their strength, which negatively affect the ductility of the material.

J.D.T. it is made ofmaterial NO (tensile strength R $_m$-1350 .H/ mm; Brinell hardness HB = 399) to one of the independent institutes Germany forconducting tests for resistanceto corrosion in comparison withstandard material. compliant-щим нормам with DIN 171.15 (R_mRM = 1250 N / mm, HB = 370).Both materials were tested for their breaking properties due to corrosion.

Figure 3.5 shows the results of tests in a normal atmosphere (air) and in a corrosive environment (salt water with a potential difference of 310 mV).The relative tensile strength Z is directly related to the ductility of the material.

Since the material But it lends itself well to forging,and it is now possible to make locks out of it as well, thus creating joints and meshes withthe same mechanical and chemical properties and extending the service life of links, locks and sprockets.

An increase in the chain life can also be achieved by improving the link geometry. An example of this is the combined j.D.T chain. 42 x 146 mm (Fig.6)-consisting of forged vertical and welded horizontallinks. The use of sucha vertical link design allows you to strengthen the weakest area - the "shelf-rounding"transition. At the same time, the contact properties of the shelf can also be improved, which leads to a decrease in pressure on the surface, a decrease in wear and a reduction in drawing during the tempering process.

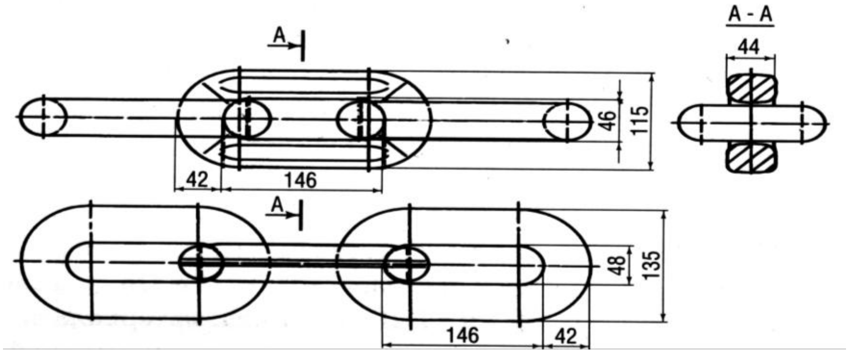


Figure 10.6. Combined chain J..D..T .42 X 146 mm

Advantages of combined circuits:

- better contact with asterisk elements;
- with the same dimensions, improved link and sprocket contact performance;
- low load on the link contact surface;
- reduction of link wear;
- optimal joint conditions;
- the ability to selectthe optimal dimensions of critical contact zones using forging.

The welded horizontal link has an optimal shape with reduced loads in the curves, which allows the best transfer of forces from the sprocket.

The forged vertical link has a lower height and increased service life. When it is used, it reducesthe chain tension when running over the sprocket, and also reduces the load on the chain.

Combined chains J..D..T .they can be manufactured in various sizes and materials.

Thus, the increase in the life of conveyor chains does not necessarily have to be associated with an increase in the size of the chain Due to the creation of a new particularly strong material, BUT it is now possible to produce long-lasting chains. andthe use of which leads to a significant reduction in the cost of mining operations, allows you to increase the productivity of the conveyor by reducing the number of failures and reduce the energy intensity of transportation. Goals from the new material BUT they have a much longer service life, while their price is not much higher than the priceof standard chains.

Improving the geometry of the chain link and using hot-dip galvanizing as a means of corrosion protection also contribute to increasingthe durability of conveyor chains.

Therefore, in the manufacture of chains manufactured by J.D.T. , at the same time applied anti-corrosion protection by hot-dip galvanizing and improved the geometric shape of the links.

Double-chain conveyor of a self-propelled mine car
5BC 15 M produced by JSC "Rudgormash" with a plate chain was replaced by a conveyor with a monolithic grid and a three-row ship chain with a staggered arrangement of scrapers (Fig. 10.7) for any strength and lumpiness of rocks, which eliminated chain gusts and increased its productivity [2]

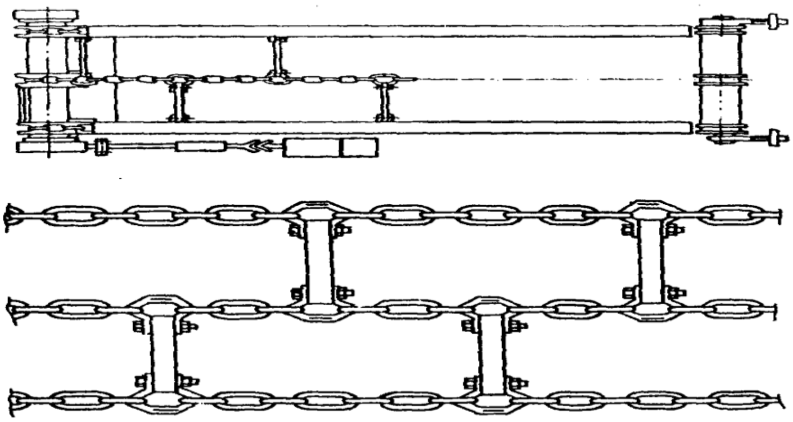


Figure 10.7 three-Row staggered ship chain skrebkov

New tire protection chains Firm RUD chain

In recent years, RUD tire protection chains have been used at the Norilsk mining and metallurgical combine and other mining - enterprises Firm chain RUD. The actual material on the use of tire protection chains on wheeled loading and delivery vehicles (PDMS) operated at Norilsk MMC is discussed below.

Working conditions of the equipment. The mining of polymetallic copper-Nickel ores in the flagship mines of the Russian non-ferrousmetallurgy is characterized by difficult mining conditions.

On the delivery of rock mass during mining excavation and sinkingof mine-workings, track PDMS are used. The working conditions of pneumatic tiresare characterized by a relative humidity of 75-100%, constant water content of-водненностью workings,air temperature up to + 35^{0}C, acid aggressiveness of mine water,constant presence of fine dust in the mine air,which has electrical-conductivity and reducesthe metal's resistance to corrosion.

Ore and host rocks of medium abrasiveness, strengthcoefficient according toProtodyakonov is 15-18. The volume weight of the brokenore is 2.9 t / ^{m3}, and that of the rock is 1.95 t/^{m3}. The maximum piece size is 500 mm.

The machines used. In total, about 160 units of loading and delivery vehicles operate at the underground mines of Norilsk.

According to the load capacity, the machines are divided into three classes::

* up to 4 tons, wheel size 14.00-24L4
• up to 7 tons, wheel size 18.00-25L4

* up to 12 tons, wheel size 26.5-25L4.

The speed of trafficon the road varies from 10 — 15 to 20 — 25 km/h. The delivery shoulder ranges from 50-70 to 180-220 meters, and the longitudinal slopes of the trails range from 5 to 20%.

Technical results of operation of tires without tire protection chains. In the working cycle of driving a full-bucket PDM, theloads on the front tiresreach values of 4, .5, 8 and 15 tons.

PDMS are equippedwith production tiresDneproshina and Bridgestone. These are diagonal tiresthat can freely withstand the above workloads. The use of diagonal tires is due to their relativelylow price compared toradial tires of the samesize and purpose. The design features of radial tires that havesteel strips as a structural element make them more expensive and stronger, but they are notin demand when working with tire protection chains. Theyprovide protection against breakdowns, accelerated abrasion, andoverheating.

The running time of tires without chains in all three sizes does not exceed an average of 450-600 motorcycle hours, which is about one car month .шают в среднем 450 — 600 мото-часов, что составляет около одного машино-месяцаThe primarycause of tire failure is normal tire wear,as well as cuts in the tread and sidewalls on the sharp edges of debris from spills and dumps.

Recoverable damages that occur before the normal wear and tear period expires are promptly repaired. Repair costsaccount for about 10% of the initialcost of tires. During repairs, long machine downtime occurs, which can only be minimized by storing a sufficientnumber of spare tires in the warehouse.

Technical results of working with tire protection chains. On Norilsk MMC uses RUD tire protection chains of RUDthe following designs:

on the "14.00" tires , chains of the MV — 11 SRESial type are used, which have a flat smooth shape of the working link and a four-link configuration of the chain grid (Fig. 10.8, a). the Dimensions of the working links (L x W x C) — 63 x 36 x 21 mm, the thickness of the connectingring is 11 mm. The chain protects about 73% of the surface area of the tread and sidewalls of the tire;

on the "18.00" and "26.5" tiresпользуются цепи типа , R 69 Special chains with working links in the form of rings and a four-link chain grid configuration are used. Working link diameter-56 mm, the thickness of the connectingring is 13 mm (Fig. 3. 8, b). The chain covers about 86% of the area of the ProTector and sidewalls.

Average driving timesare 4,500 motorcycle hours or 10 car months for 14.00 tires and 3,500 motorcycle hours or 9 car months (approximately 400 motorcycle hours per caro- month) for 18.00 and 26.5 tires.

The walking time of tires under chainsincreases by 12-15 times. The width-ceases to be an elementof the running part of the car and it serves only as the basis for a steel protective " chain mail».

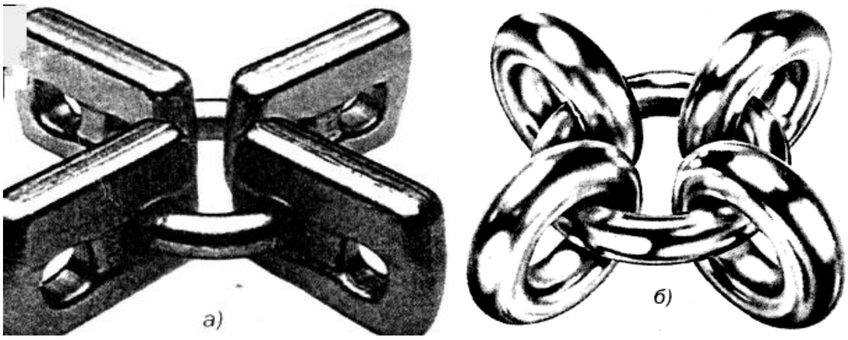


Fig. 10. 8. Constructions of four-zone plate (a)
and ring (b) chains.

A vehicle that accepts the wear and tear ofthe road, the PDM also acquires new qualities, combining the maneuverability of a wheeled vehicle, on the one hand, and the cross-country ability and security ofa tracked vehicle, on the other.

Maintenance of the chains consists in periodically tightening the "sagging" grid. The need for a pull-up occurs after the first quarterof the chain's service life, i.e. after the first 1000-1200 motorcycle hours.Periodicity of lifting — no more than 1 time in 3-4 shifts, the time for liftingchains on one machinedoes not exceed 0.5 hours. The repair ofchains is reduced to the replacement of working rings-located in the areaof the Central axis of the wheel circumference. The links are replaced without removing the chain, directly on the wheel.жа цепи, прямо на колесе.

In addition to the obvious convenience, trouble-free operation and increased-production efficiency, the use of chains directlycontributes to the growth of production volumes, since chains allowthe use of PDM on large-block highly abrasive material without the risk of tire damage. Without wideprotection circuits, this requiresadditional costs for road preparation, including the need to purchase special equipment for this purpose.

The chained machinehas a higher pick-up speed, which ensures that the bucket is fully filled from the first run. At the same time, repeated switches are not required, and fuel is saved. When driving, the chained machine has increased-stability on longitudinal and transverse slopes, which increases the convenienceof machine handling and, ultimately, has a positive effect on shift productivity. The cost of leveling slopes is reduced.

A simple economic analysis makes it possible to evaluatethe effectiveness of using шинозащитtire protectionchains.

Economic efficiency is evaluated by comparingthe following values:

A) the amount of actual costs for the purchase of X pieces of tires plus forspending on X pieces of chains.

B) the sum of estimated costs forpurchasing N x x pieces of tires, where N is the ratio of the service lifeof a tire with a chain to the service life of atire without a chain.

As a very first approximation, the value of N can be equated to the ratio between themechanical abrasion resistance of steeland the strength of rubber.

The expression $Б - А$ shows the amount of absolute cost savings, and the expression $\frac{Б - А}{А}$characterizes the amountof cost efficiency as a percentage.

Here is an abstract example:

1. Tires work with chains. It will be required for 3 cars: 12 tires worth 6500 USDeach . A total of 78,000 USD.

12 chains worth 11400 USDeach . A total of 136800 USD.The actual cost of tires and chains will amount to 214800 USD.

2. Tires work without chains. A tire without a chain serves 900 motorcycle hours, and a tire under a chain serves 3500 motorcycle hours.

Then N = 3500/900 = 3.88.

The sum of estimated costs B = 3.88 x 12 tires x 6500 USD = 302640 USD.

Difference B – A = 87840 USD. This is an absolute saving.

The ratio B - A/A = 87840 / 214800 = 0.408 or 41%.

The application of this standard algorithm for calculating efficiency based on the actual figures ofNorilsk MMC for a total of two years allows us to drawthe following conclusions:

1. for the two smaller tire sizes, the relative savings were:

«14.00» — 46.4% ; «18.00» — 42.5%.

2. For tires of size" 28.5", importedproduction:

A = 4.8-5.5 million us dollars.WITHSHA;

B = 6.4-7.3 million dollars.WITHSHA.

Absolute savingsin the maximum figures were us $ 1.8 million.WithSHA, the relative economyis 32.7%.

3. the value Averaged over the three tire sizes (excluding the number of tires for each size) givesthe company's averagerelative savings of 40.5%.

It should be noted that the calculation is made without taking into account the influenceof factors such as:

* no cost of tire repairs;

• use of low-cost diagonaltires instead радиальof radialtiresных;

• use Tires with LL2 or L3 tread 3instead of LL4 or L5;

• fuel economy;

* reduced maintenance costs for road routes;

* overall increase in mining productivity.

Taking these factors into account brings the final savings calculation to the level of 43-45%.

Thus, the long-term practiceof Norilsk MMC confirms that RUD tire protection chains RUDreally help to eliminate tire wear problems and reduce production costs associated with the operation of wheeled loading and delivery equipment.

b. PEWAG chainPEWAG

PEWAG manufactures RINGSTAR ring chains, designed as a powerful and cost-effective tire protector for heavy-duty wheeled loading and bulldozing vehicles.

Ring chains are increasingly preferred overчтение перед flat-link chains, since ring chains allow for a high economic effect.

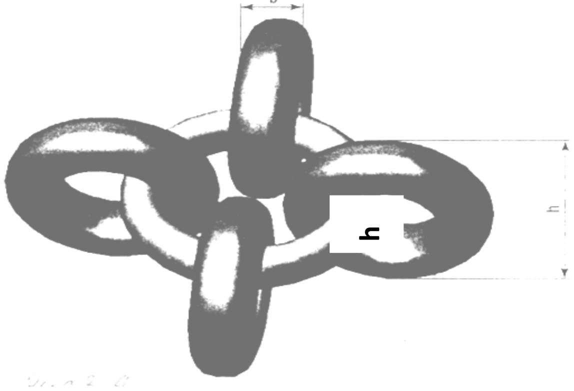


Figure 10.9. Fragment of a four-link chain element
Configurations.
Width: b = 21 mm; height: h = 67 mm

The main feature of the ring structure (Fig. 10.9)is due to the fact that the working link made inthe form of a ring wears out much more slowlythan the analogous weight of the working link made in the formof a plate. When the machine moves, the working ring links that are currently in the "clutch spot" rotate around the axis of the connecting ringlink, like rollers in a bearing. Sliding friction is replaced with rolling friction, which is much more energetically advantageous: the lower the friction, the lower the wear.

In other words, if you take two links of the same weight, but different in shape, one of which is flat, the second is annular, then the second will serve up to fullwear by 30-40% longer than the first.

In addition to increased durability,the ring-shaped chain has many other very importanttechnical advantages, the main ones being:

"a much tighter chain mesh, or, what's the same thing, much smaller gaps between the links. The minimum mesh clearance is only 4.4 cm, which means that rock fragments with a diameterof 4 cm will not be able to damage the tire;

- increased by 40-50% (in comparison with flatзвенными-link chains) the number of elements coming init is located on a 1 m^2 grid. This means that the load from the machine weight is better dispersed between the contact points of the links and the ground, the specific load per 1 contact is reduced, wear occurs more slowly, and the chain life increases;

- the ring chain has better anti-skid performance, as it has a largernumber of contact points with the ground. This quality becomes especially important for underground vehicles, when it is necessary to overcome steep slopes, and the soil of the mine workings is composed of a viscous layer of "masonry rocks".»;

- despite the relatively small gaps between the links, the ring chain has a higher-ability to self-clean from clay fine earth that clogs the chain mesh;

- the connecting rings wear out evenly over the entire inner surface, due to the fact that when the machine moves, the working links not only rotate around the axes of the connecting links, but also shift along these axes. This leads tothe absence of permanent contact zones, where flat workinglinks "saw through" recesses in the connecting rings, leading to the destruction of the chain;

- when hitting obstacles (large blocks, pieces of rock), comparable in size to 0.1-0.4 of the wheel diameter, the ring chain shows an effect that can be described as closely as possible by the word "elasticity", this is manifested in a kind of "-wrapping" of the obstacle with a chain (and therefore with a tire). This reduces the impact on the tireby reducing the "peak" local load on the elements of the tire structure, saving the tire;

- if you look at the ring chain from the sideof the tire, you can also see the advantage here: the ring links rolling over the treaddo not have such a strong effect on the tread asit does with the corners of flatmetal links. This has a very positive-effect on the tire, extending its service life. In addition,it is quite feasibleto install LL2 (E2) low-tread tires under the chain2instead Lof L5 (E5), which leadsto additional savings in operating costs.

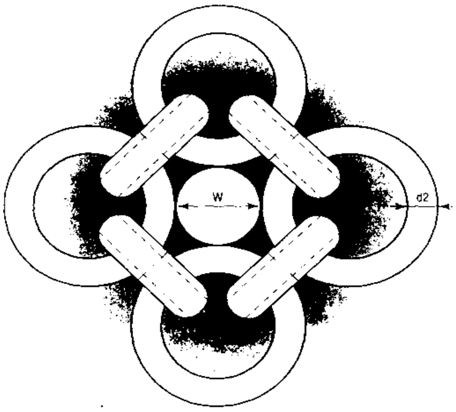


Figure 10.10. tire Protection chain type RINGSTARGRT 16 four-link configuration:
- diameter of the connecting ring:
dD2 = 14 x 18 mm; - grid clearance: W = 44 mm.

Ringstar chains RINGSTAR(figure 10.10) manufactured *by PEWAG,* despite their external simplicity, are the product of the highest technologies used in very fewEuropean enterprises.

In the table.3.1 the main technicalindicators of the new chain are presented.

Table 10.1

Main technical indicators of the chain

Minimum grid clearance, mm	44
Number of working links per 1 m^2 grid, PCs	252
Wear weight per 1^{m2} of mesh, kg	52.92
Weight of 1 working link, kg	0.36
Wear weight of 1 working link, kg	0.21
Wear weight / link weight ratio	59%
Thickness of the surface reinforced layer, mm	1.9
Hardness of steel in the hardened layer, units.Vickers	800

Dimensions of the connecting ring, mm:	
- outer diameter of the ring	54
- diameter of the ring body (in crosssection). sechen-ellipse)	14x18
Cross-sectional area of the ring body, mm^2	167
Link material	Alloy steel Mn-SG-Ni

The cross-sectionalarea of the connecting ring is 167mm^2. Interestingly, a reduction of thisarea by every 10% leads to a reduction in the service life of the chain by 20-30% .

Another example is the ratio of the wear mass to the weight of the"whole " link. In fact, this is the main directindicator долговеч-ностиof chain durability and efficiency. Every 2-3% decrease in this indicator "shortens" the service life of the chain by 10-15% .

All the "quality" indicators listed in the tablefavorably distinguish the RINGSTAR chain from similarchains from other manufacturers.

These parameters can also be used tocompare analogs for the "price" - "quality" parameter. Prices at PEWAG are noticeably lower, and to the same extent as the technical indicators are higher.

KAZAKHMYS Corporation can serve as a good example of high efficiency of tire protection application. RINGSTAR ring chains прошли серьhave been seriously tested for strength and durability in the coppermines of Dzhezkazgan. The chains were tested оплесных погрузчиках caterpillar 980 f co-loaders, on 26.5-25 L2+ tires manufactured by GOODYEAR. Duringthe test period "December 2000 - September 2001", the service life of the chains averaged 5,460 motor hours. Tires that are not protected by chains rarely "survive" to 1000-1200 motorcycle hours.

High-performance mining equipment for coal mines

The fuel and energy complex of the world's States is overwhelmingly based on their own resources. The United States produces 900 million tons annually. Solid fuels account for more than two-thirds of primary energy consumption in countries such as Denmark, Australia, Poland, the Czech Republic, Slovakia, China, etc. Analysis of the global energy trend shows that the role of coal in the fuel and energy complex will continuously increase.

The main energy source in Ukraine is coal, which accounts for 90% of the country's total energy reserves.

In 2000, coal production in Ukraine amounted to 70 million 472 thousand tons, while production from complex – mechanized Stopes reached 61million 351 thousand tons, which is more than 2 million tons higher than in 1999. The average dailyload at KMZ was 658 tons in 2000, compared to 586 tons in 1999.

Reaching 100 million tons of coal production in the next 8-10 years, which is necessary for the development of energy and other sectors of the Ukrainian economy, is possible only with the creation and implementation of high-performance and reliable mining equipment with a capacity of 5-10 thousandtons per day and a resource 2-3 times higher than the resource of the equipment used by mines .

Promising mines in Ukraine are already equipped with high-performance MCD 90 complexes (Fig. 3.11).

The average daily production for each KMZ from all 33 operating complex - mechanized Stopes was 1,359 tons (2 times higher than the industry average), and on one lava at the mine "Krasnolimanskaya" in 1999. the average load was 3000 tons/day, the maximum-5530 tons/day.

In 2000, consistently high performance was achieved by the MCD 90 complexes atthe A. F. Zasyadko Shah tah,
"Krasnolimanskaya", "Krasnoarmeyskaya-Zapadnaya" and others. BazhaNova SCC "Makeyevugol", named after V. V. Vakhrushev SCC "Rovenkianthracite", named afterStakhanov state chemical company "Krasnoarmeysk-Ugol": the average load was 2000 tons/day with мака maximum daily load of up to 5000-6000 tons and a shift load of 900 tons, which indicates high reserves of operational Pro.

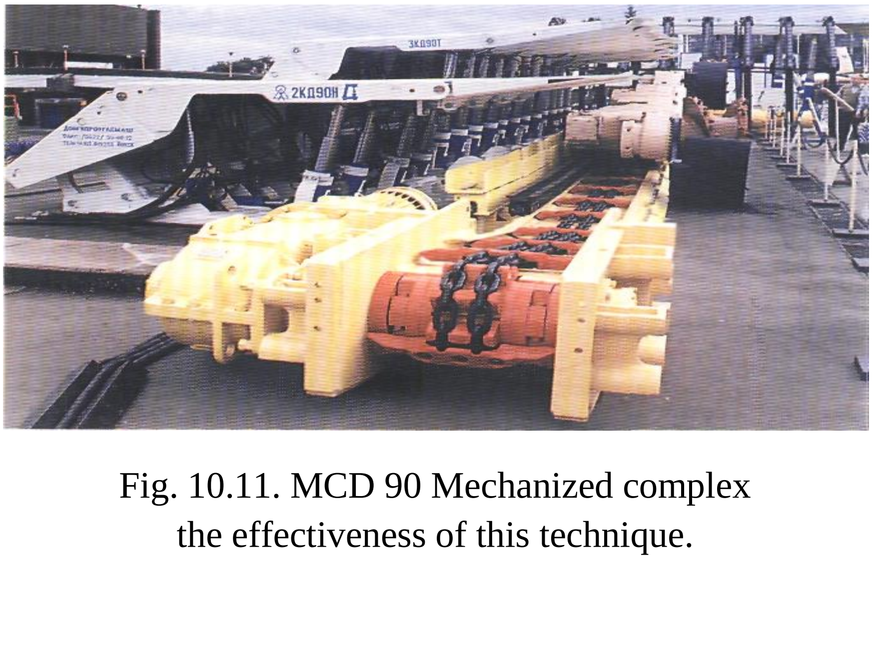


Fig. 10.11. MCD 90 Mechanized complex
the effectiveness of this technique.

According to industry statistics, the operation of five MCD 90 complexes with appropriate tunneling equipment and vehicles gives an annual increase in coal production of 1-1. 5 million tons, which is equivalent to the commissioning of a new mine.

The coal industry of Ukraine in 2000, thanks to the MCD 90 complexes, received an increase in planned production of 7 million tons. only the annual commissioning of 15-20 MCD 90 complexes will increase the volume of coal production by 4-5 million tons. Therefore, the prospect for 3-4 years to solve the problem of extracting coal necessary for Ukraine is quite real

For the conditions of mines in Ukraine Institute "Dongiprouglemash (Donetsk) has developed a double-post single-row KDD support with a high hydraulic sliding coefficient for use in reservoirs with large power fluctuations. It has a high load-bearing capacity, reliability, increased maintainability, and is easy to maintain due to the presence of two passageways between the conveyor attachments and the racks. At the mine "Krasnolimanskaya" in December 2000, acceptance tests of the 1kdd support were completed. .The length of the lava is 260 m, the extracted reservoir capacity is 1.2-1.35 m. On 01.09.2001, the igniting of the lava is 938.2 m. 539.272 thousand tons of coal were Extracted, the maximum daily load is 3300t.

To expand the scope of application of double- post single-row supportsDongiprouglemash has developed documentation for experimental sections of dt supports with a load-bearing capacity of 700-800 kN /^{m2}. Druzhkovsky machine-building plant has started manufacturing DT sections for their subsequent testing in mine conditions.

10-12) was developed by the Institute for working thin and very thin layers with a capacity of 0.8-1.5 m with plow and combine complexes. It also has a double passage between the conveyor and the racks, works effectively in unstable roofs and weak soils, has an increased fastening speed, and is equipped with a mechanism

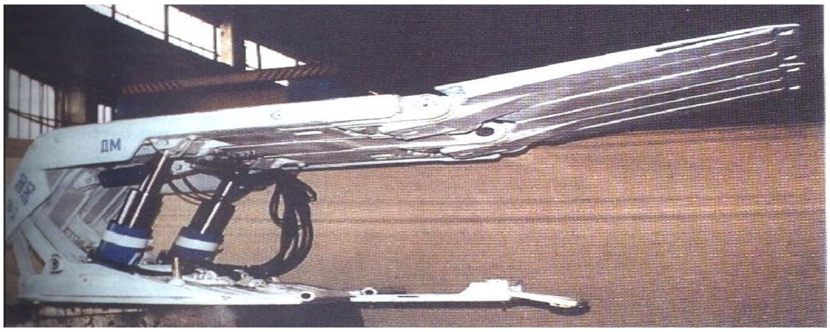


Figure 10-12.Mechanized double-rack panel support DM

lifting toe base and short movable cantileversmi with a compact mechanism for transmitting force from hydraulic racks.

MDM complex consisting of DM support, UKDZ combine (new Development Dongiprouglemash) and the SP301 conveyor have been operated at the Zasyadko mine since may 2001.

Combine UKJ prototype which is made on Novokramatorsky machine-building plant and works at the mine named after A. F. Zasyadko, has the most modern design solutions: the resistance of the coal cutting up to 400 kN/m and the opportunity to work in the most difficult conditions (on the breed, the influx of the roof, the violation of the continuity of the reservoir), the estimated longevity of the power elements of the gear group - 15 thousand.h (2 times higher than in batch harvesters similar purpose). The combine is constantly being improved.

Over the past five years, scraper conveyors of increased reliability and service life have been used in almost all high-loaded lavas: SP 301 / 90U and SP 326 with a traction chain of 24 and 26 mm caliber; SPTS273 and SPTS230 with a traction chain of 26 and 30 mm, mastered by the Kharkiv plant "Svet Shakhtera".

Dongiprouglemash developed and deliveredNovokramatorsk machine-building plant production of the KSD 28 scraper conveyor (Fig.10.13) of a new technical level for highly loaded lavas with a length of 350 m. The conveyor is equipped with drive units with planetary and cylindrical-conical gearboxes and two two-speed electric motors with a power of 250 kW (speed ratio 1: 3). The caliber of the centrally located traction chains is 30 mm, the grid station is based on the new special profile H255 mm, the resource is up to 3 million tons of coal. This is the first conveyor in Ukraine with a capacity of 1000 t / h, capable of providing a load on lava of 10 thousand tons /day.

Figure 10.13. scraper conveyor KSD 28

On the basis of KSD 28, the Institute developed the KSD 27 type conveyor (power of two-speed electric motors 200 kW, caliber of traction chains 30 mm, design capacity-840 t / h and above, resource - 3 million tons). KSD 26 conveyor (respectively, power-160 kW, caliber-24 mm, estimated productivity-516 t / h and more, resource-1.5 million tons). Factory

"Donetskgormashhas already produced a prototype of the KSD 27 conveyor, which will be tested in mine conditions, and it is planned to produce a prototype of the KSD 26 conveyor.

Dongiprouglemashem has created a new technical level of tunneling combines in recent yearsP 110 and P 220. since 1997 NovoKramatorsk machine building district
produces tunneling combinesP 110 (Fig.3.14) of the middle class, since 1999-p 220 combines with increased power supply and the ability to destroy stronger rocks. Combine harvesters provide driving rates of 160-470 m / month. with workings of 13-25^{m2} and fortress cross - sections
the number of quarried rocks is up to 70-100 MPa and is characterized by operational reliability: in a number of mines, their service life exceeds the guaranteed one by 3.5 - 4 times. In January 2001, on
mine "Dobropolskaya gas chemical company Dobropolyeugol" kombaynomП560 m of conveyor drift with a cross-section of 12.9 m^2 was passed along the route 110.

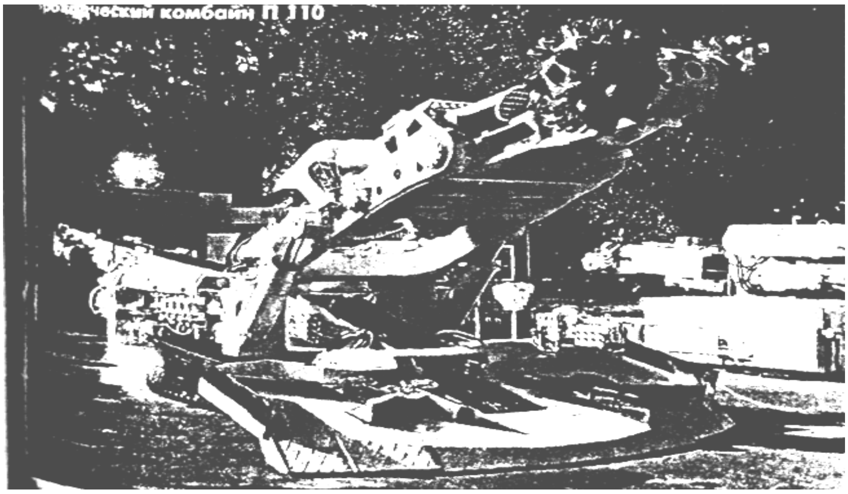


Fig. 10.14. Tunneling combine P110.

With the intensification of mining and high-speed sinking, ventilation requirements increase. Efficient ventilation of 2-and 2.5-km-long tunnel faces is provided проверриванияby the vme2-8 and vme2-9 series local mixing fans."Dongiprouglemash".

The concentration of production also requires a significant increase in the load and operational reliability of coal delivery vehicles, primarily belt conveyors of the main transport in heavy cargo flows. This can only be achieved by creating a new, fourth generation of conveyors, combined into a size range built on the most advanced principle based on a modern material and technical base. For this purpose, promising areas and technical solutions were developed that correspond to the world level, which are recorded in GOST 28628-90 " mine belt Conveyors.

General technical conditions".

In recent years, according to this standard, they have been created and mastered in mass production atKrasnoluchsky machine plant and plant "Donetskgormash" the most popular local conveyors are 1L800, 1LT 1000 , 1LTP 800 and 1L 1000. Their implementation makes it possible not only to replace 75% of the operated conveyors, but also to dramatically increase the technical level of mine conveyor transport in General.

Mine electric locomotives with improved performance

The main developers and suppliers of mine electric locomotives and electric locomotives for open-pit mining were previously organizations and enterprises in Ukraine. Therefore, after the collapse of the USSR, mining enterprises began to feel difficulties in updating the fleet of electric locomotives and providing them with spare parts. In this regard, the all-Russian research and design Institute of electric locomotive construction (enii) has developed several types of electric locomotives for the mining industry, andNovocherkassk electric locomotive plant (nev3) has prepared production for their serial production.

The first Novocherkassk mine electric locomotives KN10 and ARPN14 were created on the basis of electric locomotives K10 Alexandrovsky and ARP14Druzhkovsky machinebuilding plants. Technical parameters of mineelectric locomotives KN 10 and ARPN14 are given in table 10.2.

Table 10.2

Technical characteristics of mine electric locomotives

Parameters	Unit of measurement	Type of electric locomotive	
		KN 10	ARPN14
1	2	3	4
Current source		Contact network	Rechargeable battery 161TNKSH550U5
Rated voltage	V	250	185
Battery power consumption	kW-h	-	120
Hourly speed	km/h	11.5	9.1

Power in hourly mode	kW	66	54
Traction force in hourly mode	kN	23,5	21
Continuous speed	km/h	13.5	14.3
Long-term power	kW	46	20.7
Long-term traction force	kN	12.2	5.4
Design speed	km/h	25	18
number of traction motors	PCs	2	2
Electric locomotive weight	t	10	14
track Width	mm	600/900	900
Overall dimensions:	mm		
-cab roof height		1650	1750
-frame width		1050/1350	1360
- length on buffers of pin couplers		4920	5860
Rigid base	mm	1220	1635
Ground clearance for new bandages, not less	mm	than 100 mm	70

The main attention in creating new electrictrucks is paid to improving reliability and performance.

The schematic diagram of the contact electric locomotive KN10 is the same as that of the electric locomotive K10. The voltage on traction motors is regulated by theirsequential or parallel switching on, as well as by a starting resistor. In order to reducethe thrust forces of the electric locomotiveKN10, 6 starting positions are provided for sequentialconnection of traction motors instead of 5 for K10. For the same purpose, the breakdown of the starting resistor stagesfor parallel connection of motors has been changed,

The KN10 electric locomotive is equipped with a newNB 33/20 traction engine specially designed for this electric locomotive. This is a DC motor, four-pole, sequential excitation with self-ventilation. Engine power in hourly mode is 33 kW. in long-term mode-20 kW. Itsprincipal difference from its analogues is the use of new heat-resistant insulation materials. Theoperating characteristics of the NB 33/20 traction motor are shown in figure 3.15.

The braking performance of the electric locomotive is improved by using special steel inserts in the brake pads and increasing thepower of the brake resistors by

30% compared to the K10 electriclocomotive. For this purpose, resistor CF elements have been replaced with LF elements. This technical solution madeit possible to reduce the volume and weight while increasing the power resistor blocks by about 20 % and increase their reliability.

Coordination of the parameters of the transformer windingsand stabilizer chokes allowsthe electric device to operate at a minimum voltage of 160 V B instead of 170.

The wear resistance of the gears of the power reduceris increased as a result of the application of specialных режимов thermal strengthening modesdeveloped and tested in the manufacture and operationof similar components of mainline electric locomotives.

A new KM-7 driver controller has been created. To increase its reliability, a new contactor element CE-8 was designed (Fig.),

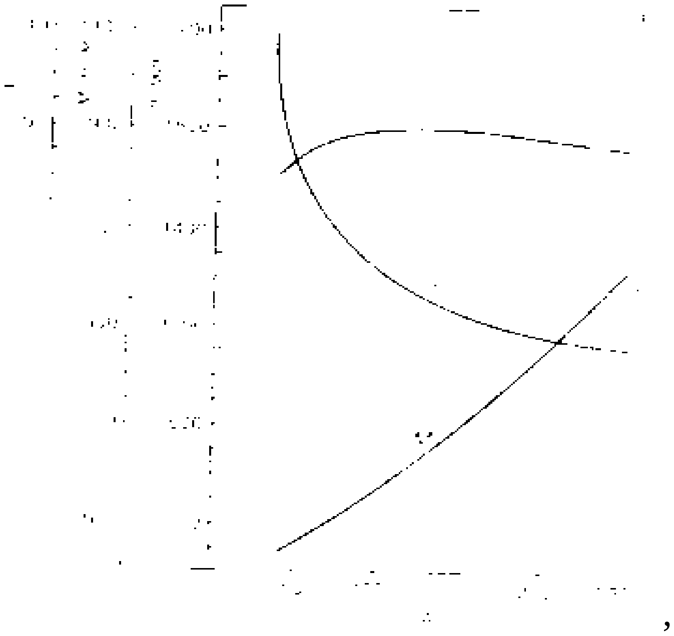
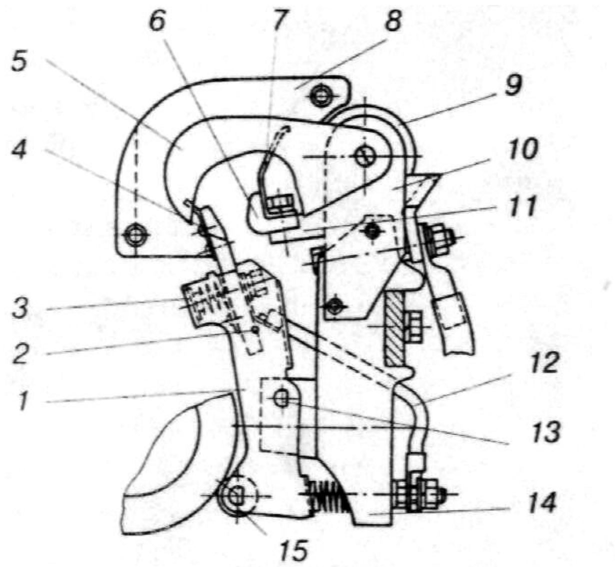


Figure 10.15. Performance characteristics of the NB-33/20 traction motor

designed to operate at a normal voltage of 250 V The Contactorelement KE-8 is interchangeable with the contactor elements of the controller KC-303 of the electric locomotive K10. The KC-303 and KM-7 controllers are completely interchangeable.



10.16. Cam contactor CE-8:

1 — lever;
2 — axis;
3 — spring;
4 — movable contact;
5 — pole;
6 — fixed contact;
7 — horn;
8 — dugogasitelny camera;
9 — choke coilka;
10 — side panel;
11 — holder;
12 — flexible Conntion;
13 — axis;
14 — insulator;
15 — movie

To ensure high reliability ofelectrical wires, a number of special devices and walls have been developedto control the quality of components and accessories during their manufacture.

Experimental electric locomotives KN 10-900 and KN 10-600were tested and tested at the mines "Maiskaya " and" Yuzhnaya".Rostovugol. Tests showed full compliance of electriclocomotives with technical conditions. Trial operation has confirmed their higher reliability comparedto K10, especially in terms of electrical equipment. In this regard, the operational mileage of theKN10 electric car is 2.5-3.0 times higherthan that of other manufacturers ' electric carts under the same conditions.

In addition to two prototypes, a batch of 5 electric locomotives was built. They are operated by the mines of JSC Rostovugol and JSC" Rosoboronexport".Gukovugol".

Documentation has also been developed and a prototype ARPN14 electric locomotive has been manufactured. The power circuit,mechanical part, and largelyelectrical equipment of this electric locomotive are the same as those of the ARP14.

A fundamental innovation is the useof the NB-23,.5 heavy-duty engine designed specifically for the ARPN14 electric locomotive. It's four-pole. explosion-proof motor with sequentialagitation and natural cooling. Power in hourly mode — 23.5 kW, in long-term -9.4 kW. Increased engine reliability is providedby modern types of insulation andprogressive manufacturing technologies, similar to those used in the creation of NB-33/20 traction engines and traction engines of main electricvehicles. The performance characteristics of the NB-23.5 traction motor are shown in Fig. 3.17

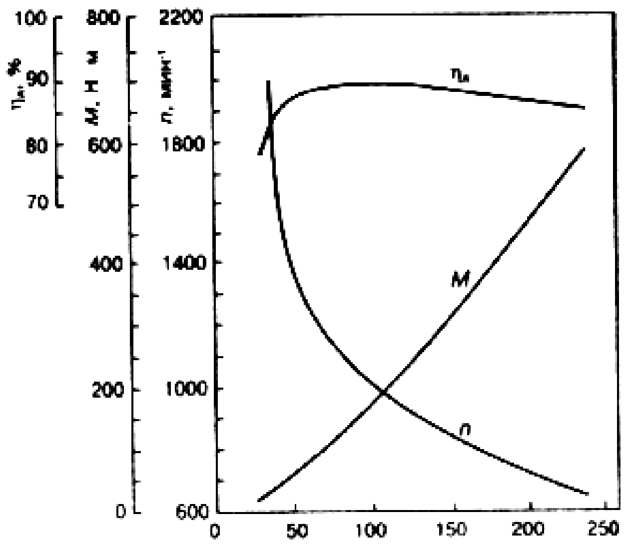


Fig. 10.17. Performance characteristics of the NB-23.5 traction motor

Special equipment for mine transport

Mine transport is characterized by a varietyof transport devices that operate sequentially in the same cargoflow. Connections between homogeneous modes of transport, such конas convoys, are relatively simple. Transfer from conveyor to trolleys, from trolleys to skips, exchange of trolleys in crates, etc. they are associated with shunting and loading and unloading operations, which are mechanized usingspecial machines and mechanisms.

Special machines and mechanisms of minetransport include equipment for unloading trolleys, equipmentused for moving and regulating the movement of individual trolleys or trains at the end points in places where trolleys are loaded and unloaded, in near-trunk yards, at receiving sites of mine buildings and at exchange offices.

Among the various special machines, mechanisms and equipment used to mechanize these technological processes in transport are: gates, feeders, track stops and brakes, trolley tippers, pushers and shunting winches, height compensators, cross carts.

From this list of equipment, trolley tilters, pushers, and height compensators are discussed below.

Tippers serve for unloading trolleys by tilting or turning them to the position that ensures the discharge of cargo.

Tilters are classified according to the following criteria::

1) according to the method of unloading trolleys — circular; side with a rod working body; side with a rotary platform; frontal;

2) for its intended purpose — for unloading single trolleys; for unloading non-separated trains without passing an electric locomotive; for unloading non-separated trains with passing an electriclocomotive;

3) according to the nature of the drive operation — with continuous operation of the engine; with switching on and off of the engine at each cycle;

4) by type of drive — electric; hydraulic;pneumatic;

5) by the number of simultaneously unloaded trolleys — for one or several trolleys;

The most common are circular dumpers, which allow you to fully automate the process of exchanging and unloading trolleys.

Figure 10.18 shows a unifiedwheel tipper designed for overturning trolleys without uncoupling and therefore having a longitudinal axis of rotation that coincides with the axis of the rotating trolley hitch. The body ("drum") of the tippingmachine consists of two parts:

where the unloaded trolley is installed. The rings are supported by two pairs of rollers, of which one pair (the drive one) rotates continuously after starting the electric motor and causes the body to rotate by friction against the rings, while the otherгая— pairis the supporting one. At the end of a full turn, the housing is slightly lifted off the drive rollers andlocked with a "lock" so that the drive rollers rotate idly. Atthe same time, the track stop mounted in the tipper is automatically opened and used with a push rod (or a scooter).) an empty trolley is replaced with a loaded one.

The tipper is then startedby turning off the lock with the handle, so that the rings come back into contact with thewater rollers and the drum starts to rotate.

In some tipper designs, the Shoe is controlled remotelyby means of an electrohydraulic or pneumatic drive.

In the push-pull-over mechanical system, the push-pull and the tipper are electrically locked so that they are automatically triggered alternately. There are also schemes of fully automated complexes, in which the pusher and tipper are-unblocked with a skip loading device.

To work in an automated system,tippers must be equipped with sensors that record in the tipper: the open position of the stoppers, thecorrect position of the trolley, the initial position барабана опрокидываof the tipper drum, as well as the disconnection of the drive of the locking mechanism of the drum.

Trolley tippers are manufactured with a capacity of up to four tipples per minute.

T o l K a t e l I m I call shunting devices designed for the forced movement of individual cars or entire trains in underground workings or on the surface of mines. Pushers make up a large and diverse group of mechanisms.

Pushers are classified according to the following criteria::

- by destination — for the exchange of single trolleys

in crates and tilters; for pushing single trolleys and convoys; pushing uncoupled convoys
through the tipper in the near-trunk yard and pulling trolleys out of the crate;

- according to the method of grabbing trolleys — for the sub-car stop (or for the trolley axis); for the body; for the buffer;
- by location relative tothe lower and upper action sockets;
- type of drive — with an electric, pneumatic, hydraulic in- water;
- by the type of traction organ — chain; rope; piston; witha pushing trolley;
- by type of fists — with single; with double;
- by installation — stationary;movable.

As an example, figure 10.19 shows a stationary chain pusher with a vertically closed chain, designed topush составuncoupled components through the tipper in near-trunk yards. Knuckles pivotally mounted on a chain, moving in the guides, grab the trolleys bya special sub-car stop or by the axle. So that the composition can bereversed, two fists are set up, one against the other.

K o m p e n s a t o R s V s s o t s are designed for lifting individual trolleys moving in a scooter system to the height "lost" in this movement. The compensator (Fig.10.20) consists of a drive 4 located in the upper head part; a traction chain 3 with fists gripping the trolleys by specially welded stops or axles; a tensioning station 1 located in the lower (tail) part; a frame 5.

On the inclined section of the compensator, catchers 2 are installed in pairs on the frame, designed to hold (catch) broken trolleys and prevent the return of the loaded compensator chain. To stop trolleys moving by scooter, a locking device is provided at the lower sprocket.

In the lower and upperparts, the track and chain guidesare profiled along-transition curves.

Automatic control equipment is used to control compensators, which provides: dosage of trolleys; automatic, remote and local switching on and off of mechanisms; blocking the operation of the compensator with the mechanisms of the accumulation section; emergency remote and local switching off of all mechanisms; light signaling about the control mode in which the compensator is currently operating and about the emergency shutdown of mechanisms.

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Navoi mining and metallurgical combine
Navoi state mining Institute

Faculty of mining

Department of Mining electromechanics»

Guidelines for performing practical work

by discipline
" SPECIAL CONSTRUCTIONS OF MINING MACHINERY AND EQUIPMENT".

Topics

Recommended during practical classes on the course "Special designs of mining machines and devices" and methodological guidelines for them.

Introduction

The following topics are broken down for each practical lesson, which are recommended to be studied in this lesson. For each lesson, there are pages from the textbook "Special designs of mining machinery and equipment" [1], as well as [2], [3] and [4].

Practical exercises

Practical work № 1.

TOPIC: IMPROVED METHODS FOR CONNECTING CONVEYOR BELTS.

The purpose of the practical lesson: *to teach students advanced methods of connecting conveyor belts.*

Key words:: *docking, rubber-cloth belts, vulcanization presses, double-layer belts, hot vulcanization, rubber-wire belts, materials for docking, docking technologies, steel cables, docking methods.*

Methods for joining conveyor belts

There are three ways to connect conveyor belts:

- joining of conveyor belts by hot vulcanization method,
- joining of conveyor belts by cold vulcanization method,
- connecting conveyor belts with mechanical connectors.

Each method has its own advantages and disadvantages. When joining using one of the methods, the strength of the conveyor belt connection directly depends on the professionalism of the personnel performing the work, compliance with the standards of work when cutting the ends of the conveyor belt, assembling the joint, and on the quality of the materials used for joining. Joining of conveyor and conveyor belts by hot vulcanization.

Hot vulcanization of the conveyor belt.

For enterprises and industries that use heat-resistant conveyor belts, the best and preferred option is to connect the belts using vulcanization presses. Hot vulcanization of conveyor belts, the advantages of this method are the durability and high walking capacity of the belt with a joint made by the hot vulcanization method. It is comparable to the validity period of the feed itself. When joining in compliance with the milestones of technology requirements and high quality of joining materials, the joint strength is about 98% of the strength of the tape itself. The disadvantages of this method are the need to have a rather expensive vulcanization press, the inseparability of the connection. duration and complexity of the process.

Cold vulcanization of the conveyor belt.

For enterprises that use General-purpose conveyor belts (or frost-resistant ones), the most acceptable method of joining belts is cold vulcanization with two-component imported adhesives. This method is less time-consuming than the hot vulcanization method. Minimization of time, labor intensity and exclusion of the purchase of vulcanization equipment allow us to state the unconditional benefit of using this type of conveyor belt docking. When connecting on working conveyors, you need to carry less equipment, i.e. only hand and grinding tools, as well as the glue used. The joint strength reaches 70% of the strength of the conveyor belt itself. The main disadvantage is that at the end of docking, an additional long-term exposure of the belt at a temperature not lower than 0 °C is required (depending on the joining materials used, from 2 to 24 hours), which significantly increases the downtime of conveyor equipment. Also, in the presence of heavy dust in the room, joining the conveyor belt by cold vulcanization is very difficult to produce, and sometimes simply impossible.

Docking at high humidity (below the dew point) is excluded.

Connecting a conveyor belt with mechanical joints

The mechanical connection method is the fastest and most affordable, but not the most durable and long-lasting way to connect conveyor belts and conveyor belts.

Main advantages of mechanical connection of conveyor belts

- speed of the conveyor belt joining method;
- low financial costs compared to vulcanization;
- this method eliminates the need for a special room and bulky equipment (vulcanization presses);
- mechanical joining of conveyor belts can be performed at subzero temperatures and in rooms with high dust content;
- there is no need to use highly qualified personnel for vulcanization;
- for conveyors where prolonged downtime is unacceptable, mechanical coupling is preferred as a temporary measure (for high-load conveyors) or for permanent operation;
- for conveyors whose length changes frequently, a split mechanical connection is most preferable.

Main disadvantages of a mechanical joint

- low joint strength and service life compared to vulcanization;

additional mechanical wear of rollers, drums and other working parts of the conveyor is observed;

- possibility of spillage at the junction of bulk cargo and materials;
- the possibility of sparking, which is dangerous in certain conditions;
- when transporting hot cargo, it is possible to burn the tape at the joint.

Mechanical connections of conveyor belts and conveyor belts can be all-in-one bolted or riveted and split hinge. The former include rivet and bolt connections in the form of plates. All-in-one bolted joints are used to repair longitudinal cuts of rubber-cloth conveyor belts. A typical representative of an all-in-one joint is flexco Bolt Solid Plate locks, as well as the domestic B3 analog. These mechanical joints are abrasive-resistant, designed for mechanical joining of rubber-cloth conveyor belts with a thickness of 6 to 30 mm with a load of up to 105kn/m.

Detachable mechanical connections of conveyor belts allow you to quickly and easily connect and disconnect belts without disassembling the conveyor, and thus reduce equipment downtime. The complexity of performing mechanical docking of conveyor belts is minimal. Typical split mechanical locks made by FLEXCO of the Alligator type, as well as domestic analogues B1 and B2, allow joining conveyor belts with a thickness of 4 to 19 mm with a tensile strength of 600 KN/m, a minimum drum diameter of 100 mm, and a maximum recommended tension of 70 KN/m.

Docking of rubber bands

STOMILBELCHATOV developed a technology for joining rubber-cloth belts, which ensures a strong connection of tape segments at the junction (Fig. 1.). for joining the tape, vulcanization presses should be used with a minimum average pressure at the junction of 1.2 MPa. The following materials are used for the joining process (which can be supplied together with conveyor belts): lining rubber, interlayer rubber, a solution for cleaning the joined surfaces of joint elements (toluene 80%, tetrachloroethylene 10%, extraction gasoline 10%), as well as cotton cloth for separating the joint surfaces and heating plates of the vulcanizer.

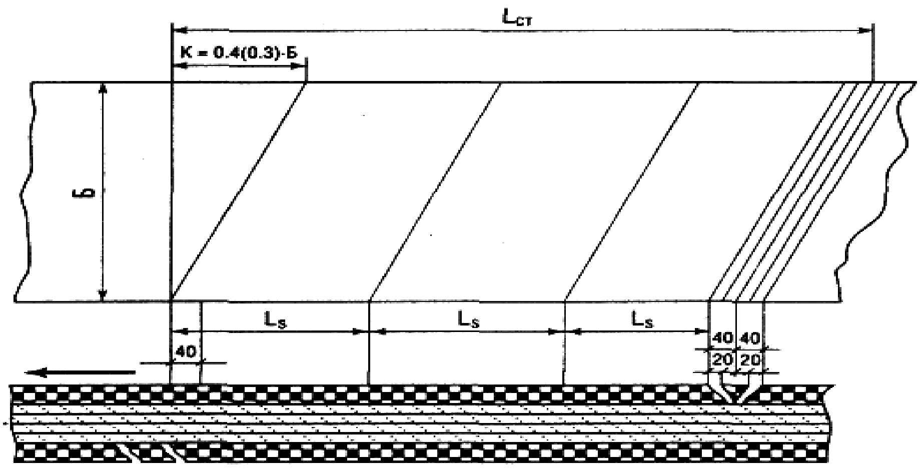


Fig. 1. Diagram of joining rubber bands.

The joint length for rubber-cloth belts in hot and cold vulcanization methods can be determined by the formula:

$$L_{cm} = K + (Z - 1) \cdot L_s . \qquad (1)$$

The conveyor belt after joining can be operated after cooling the joint site to ambient temperature, but not earlier than 2 hours after the end of vulcanization. RTI-KAUCHUK does not present any great difficulties – they are easily and quickly connected using mechanical connectors (all-in-one or split-joint), as well as by hot or cold vulcanization with the installation of an intermediate fabric (aramid) or rubber gasket.

Hot vulcanization is carried out by serial vulcanization presses, which provide a uniform pressure of about 0.8-1.0 MPa over the working surface of the joint and ± a vulcanization temperature of 145.5 ° C.

Docking of rubber cord belts

Developed by STOMILBELCHATOV, the technology of joining rubber-wire belts (ST) ensures a strong connection of tape segments at the junction and assumes their connection only by hot vulcanization methods.

Depending on the type of belt and its width, the connection of conveyor belts with steel cables can be one -, two -, three -, or four-stage. The design of the joints is shown in Fig.2. and the docking parameters in table .1.

Table 1.

Connection parameters

Feed type	ST 800	ST 2000	ST 3500	ST 5000
Number of steps	1	2	3	4
Joint length (D), mm	600	1150	2350	4050
Step length (S), mm	300	400	650	900

PRACTICAL WORK № 2.

TOPIC: THEORY OF A SPECIAL TYPE OF BELT CONVEYOR DRIVE WITH A PRESSURE ROLLER AND ITS ANALYSIS.

The purpose of the practical lesson: *to teach students the theory and analysis of a special type of belt conveyor drive with a pin roller.*

Key words:: *pressing force, roller, roller pressure, conveyor drive, friction, drive drum, tension drum, types of drives, drum diameter, types of devices.*

Drive of belt conveyors.

The belt conveyor drive (Fig. 4.7) consists of an electric motor*1*, a gearbox*3*, a drive drum*5*and couplings*2,4*. The conveyor belt is driven by friction between the belt and the drive drum. A special deflecting drum is used to increase the angle of circumference of the drum with the tape. The drive is mounted on the frame.

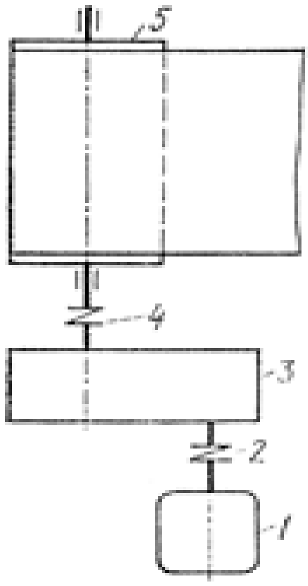


Figure 4.7. drive Diagram of a belt conveyor: 1-motor; 2,4-couplings; 3-gearbox; 5-drive drum

The drive and tension drums are usually installed at opposite ends of the conveyor belt, and deflection drums are placed at the points where the direction changes (see figure 4.1).

According to the number of drive drums, single -, double -, and multi – drum drives are distinguished (figure 4.8); according to the number of motors, single -, double -, and multi-motor drives are distinguished (figure 4.9). The simplest and most common is a single-drum drive with one or two motors. However, in heavy-loaded conveyors of large length, the resistance forces to the belt movement reach significant values and to overcome them, it is necessary to create a very large tension of the traction element (belt). This leads to a significant increase in the weight and cost of the belt, drive and other conveyor elements. Therefore, the use of a single-drum drive in this case becomes economically unprofitable, and sometimes impossible.

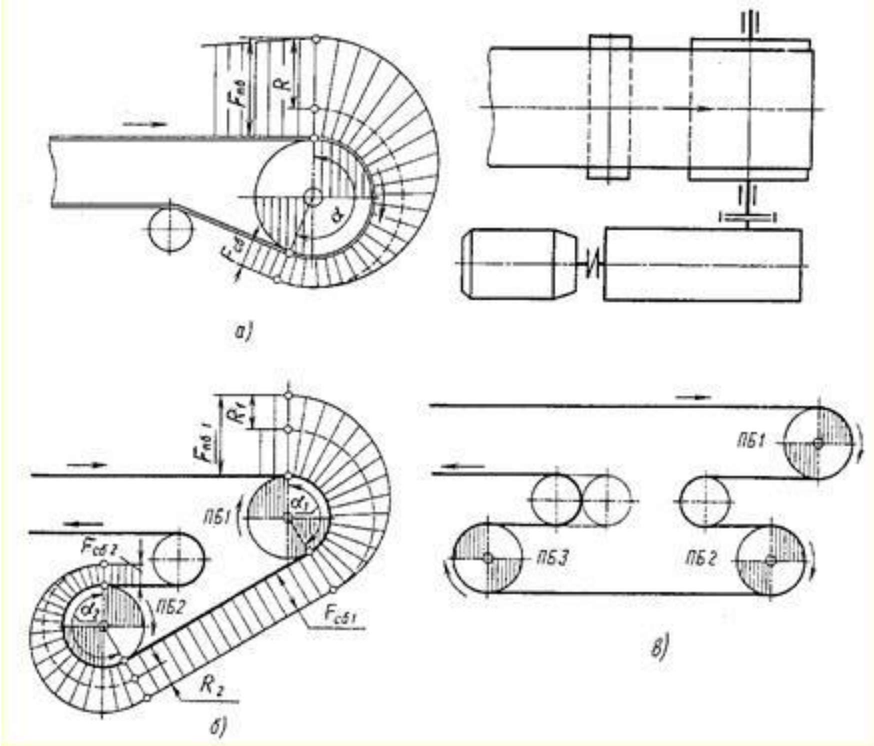


Figure 4.8. diagrams of conveyors with different types of drives: a-single drum;b-double drum;вC-three drum

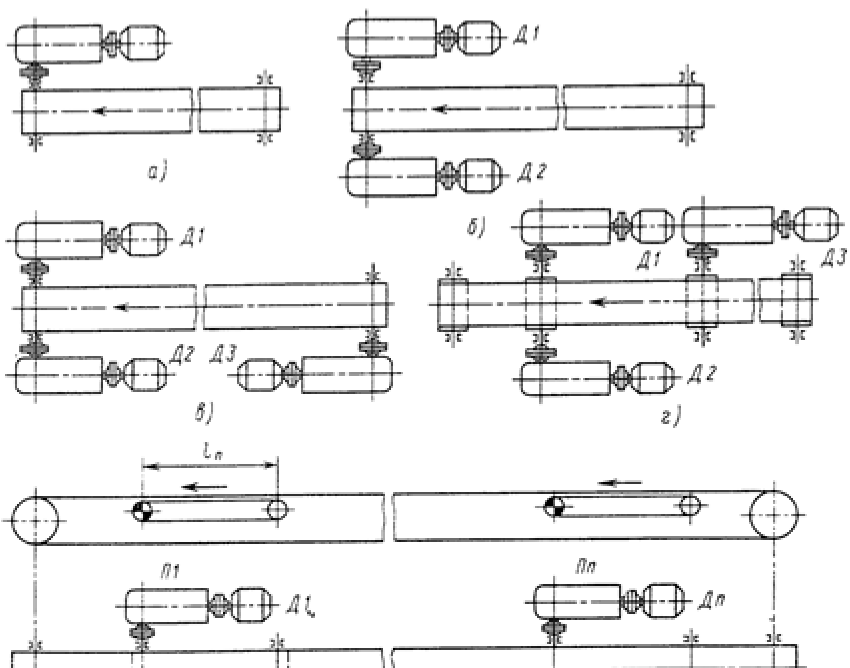


Figure 4.9. arrangement Diagrams of conveyor drives: a-single-engine; b– twin-engine; b,d– three-engine; d– multi-motor with rectilinear intermediate drives; P-drive; D-motor

One solution to this problem is to divide a long pipeline into several short pipelines arranged in series. However, it becomes necessary to transfer cargo from one conveyor to another, which requires the installation of additional unloading, loading and cleaning devices, and in some cases is unacceptable. The most appropriate solution is considered to be the use of a multi-drum drive, i.e. the installation along the length of the conveyor of several consistently operating drive devices with individual electric motors (Fig. 4.9,*d*). In this case, the entire conveyor route is divided into separate sections according to the number of installed drive devices, and each drive takes the load only from its" own " section of the route. This system significantly reduces the belt tension.

The drums are made welded from St3 steel or cast from grey cast iron (Fig. 4.10). to improve the conditions of adhesion of the belt to the drive drum, it is lined (lined) with rubber or other friction material (see Fig.4.10,*в*C).

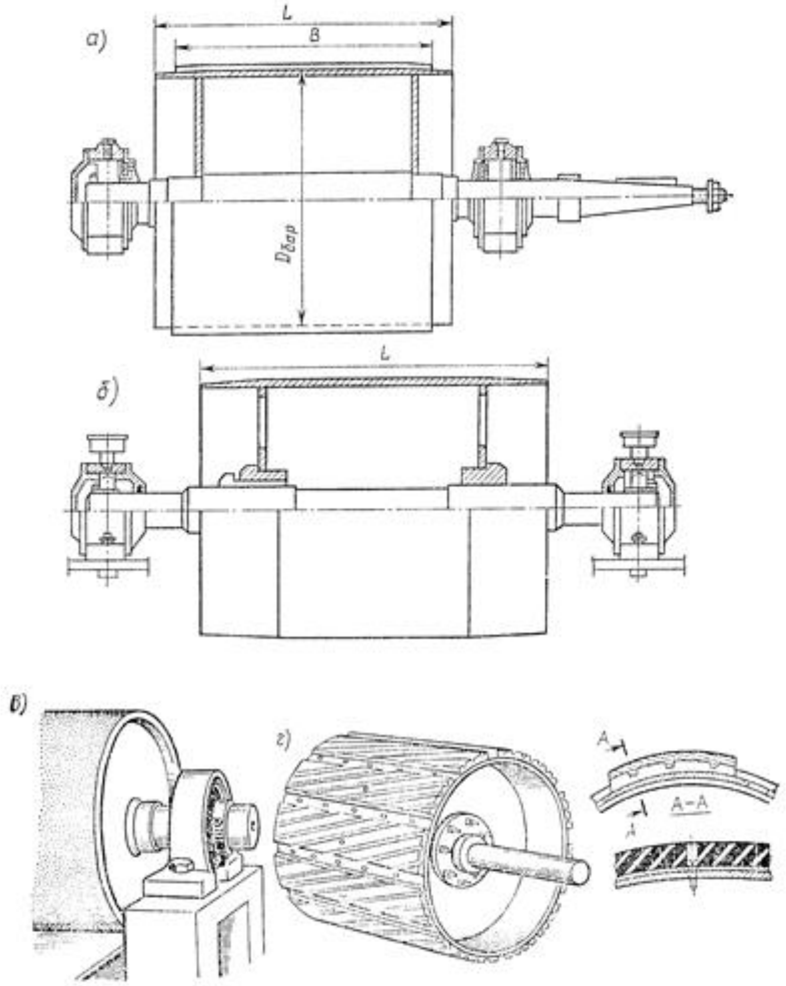


Fig. 4.10. Drums for conveyors with a rubber-cloth belt: a-drive;b-tail and deflecting;вC-lined with rubber;d-option for attaching the lining to the drum

When choosing the drum diameter, two mutually exclusive requirements should be taken into account. On the one hand, it is desirable to have a drum with a minimum diameter in order to reduce the size and weight of the conveyor; on the other hand, with a decrease in the diameter of the drum, the working conditions of the belt worsen – bending stresses increase in it.

The diameter of the drive drumD_{BP}(mm) is determined based on the condition of ensuring sufficient durability of the rubber-cloth conveyor belt, depending on the strength of the fabric $\sigma_p$and the number of gaskets$z$:

$D_{\text{BP}}=K_D\times z$, (4.8)

where*KD is the*$_{drum}$diameter coefficient, taken as a function of*the fabric strength σp*:

σ_p, N/mm	
K_D, mm	125...140 140...160 160...170 170...180 180...190 190...200

Larger values$K_D$of KD are taken for tapes of larger width, for example, for gaskets made of polyamide yarns with a strength σ_p= 150 N/mm, *KD = 160 is taken*$_D$with a tape width*of B* =650 mm andK_DKD = 170 with$B$= 3000 mm.

When using rubber wire belts, the diameter of the drive drum (mm) is calculated by the formula

D_{BP}= 500×d_{Tr},

where$d_{Tr}$is the cable diameter, mm.

The diameters of the tensioning$D_{bn}$and deflectingd_{Bo}drums are assumed to be equal, respectively

D_{bn}= 0.7×D_{BP};D_{Bo}= 0.5×D_{BP}. (4.9)

The obtained drum diameter values are rounded to the nearest standard values in accordance with GOST 22644-77: 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1400, 1600, 2000 and 2500 mm.

The drum length$L_b$is taken at 100...200 mm more than the width of the tape*In*.

The selected diameter of the drive drumD_{BP}(mm) is checked by the pressure of the tape on the drum surfaceR_l(MPa):

$p_л$RL = 360×(f_{SB}+f_{NB})/(a×p×D_{SN}×B) £ [$p_л$RL], (4.10)

where$f_{SB}$and$f_{NB}$are the tension of the tape branches running down from the drum and running up on the drum, respectively, at steady state, H; a is the angle of girth of the drum with the tape, deg; *B*is the width of the tape, mm; [p_l] is the permissible pressure assumed to be 0.2...0.3 MPa for a rubber-cloth tape and 0.35...0.55 MPa for a rubber-wire tape.

If the pressure$p_л$RL is higher than the permissible value, then one or more parameters should be increased: drum diameter DD_{BP}, belt width*B*, girth angle a, number of drives.

Tension, deflection, and braking devices.

The tensioning deviceis designed to create and maintain the belt tension within the specified limits, which ensures the necessary adhesion of the belt to the drive drum and limits its sagging between the roller supports.

As a rule, the tensioning device is installed on the conveyor sections with minimal belt tension, which reduces the tension force and, consequently, reduces the weight and dimensions of the device. However, in long conveyors, the tensioning device and the drive are often combined into one unit, which is due to the convenience of maintenance and repair.

According to the principle of operation, ***tensioners***are divided into cargo, mechanical, hydraulic and pneumatic.

In*the cargo (tail) tensioner*(Fig. 4.11,*a*), the tensioning drum*3*automatically maintains a constant tension of the belt with the help of the load*1*connected by a pulling rope *2*with a trolley*4*, on which the axis of the drum*3*is installed .

Figure 4.11,*b*shows*a load (intermediate) tensioning device*with a tensioning drum moving vertically.

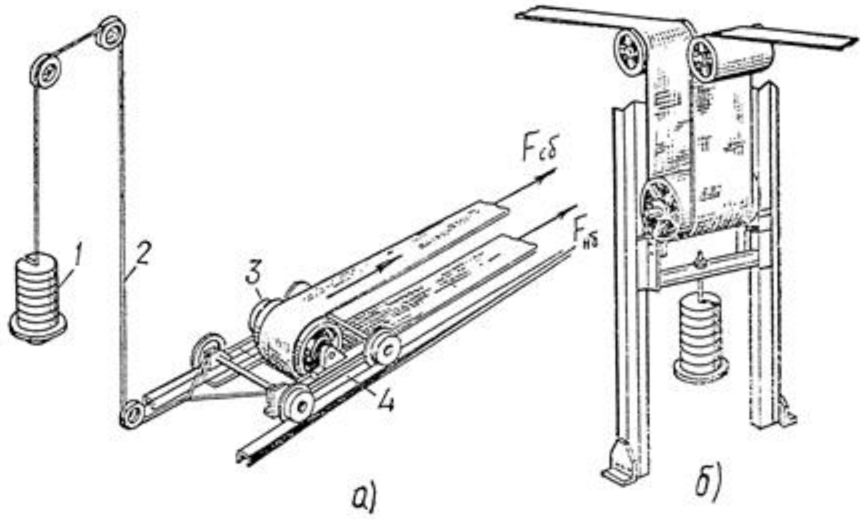


Fig. 4.11. Cargo tensioners: a-tail unit; b– intermediate

The disadvantages of cargo devices include large dimensions and a large mass of cargo, so they are usually used for stationary, powerful conveyors of long length.

In*a mechanical tensioner* belt tensioning is usually performed manually using some kind of mechanism (screw – nut transmission, rack-and-pinion mechanism, winch, etc.). Its disadvantage is the need to periodically adjust the belt tension as it is drawn, and its advantage is the simplicity of design and compactness.

On conveyors of small and medium length (up to 80 m), screw tensioners are often used (Fig. 4.12), in which the belt tension*is 1* it is carried out by moving the tension drum*2*, rotating in bearings mounted on sliders, along the guides*3*using screws*4*and nuts*5*.

*Hydraulic and pneumatic tensioners*are practically not used at metallurgical enterprises.

Since the belt extension depends on its length, the amount of travel of the tensioner drum is assigned in fractions of the conveyor length and is usually assumed to be 1...2 % for rubber-woven belts and 0.1...0.2% for rubber – cord belts.

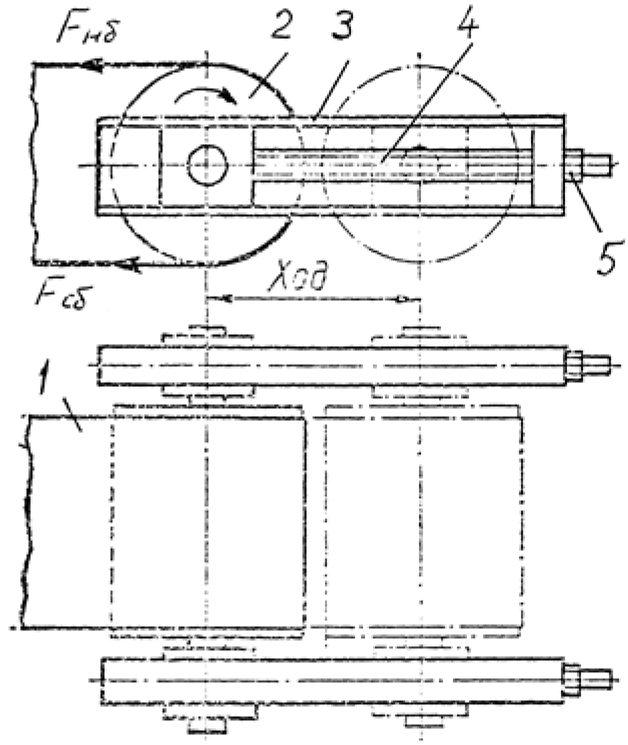


Fig. 4.12. Screw tensioner

The forcef_{NAT}, which must be provided by the tensioning device for moving the tensioning drum, with parallel branches of the belt is equal to

F_{NAT}=F_{NB}+f_{SB}+F_{plz}"F_{NB}+F_{SB}, (4.11)

where$f_{NB}$and$f_{SB}$are the tension of the conveyor belt branches running up on the tension drum and running down from it, respectively;$F_{plz}$is the resistance force to the movement of the sliders.

The direction of movement of the belt is changed by means***of deflecting devices***: end revolving drums, deflecting drums and roller batteries.

Deflecting drumsare used for the idle branch of the conveyor, as well as for the working branch with single-roller supports.

For conveyors with grooved roller bearings, the belt movement direction is changed using*a roller battery*(see figure 4.1), consisting of roller bearings with three to five rollers, the distance between which is 2...2.5 times less than the step of roller*bearings* l_{PP}on a straight section of the working branch.

To avoid the appearance of significant additional bending stresses in the belt when it passes through deflecting devices, the drum diameters are determined by the formulas (4.9), and the radii*r*(m) of the curved sections on the deflecting roller battery according to the following recommendations:

- for a convex section$r_{вып}$= > 12×B,
- for a concave sectionr_{VOG}> >F_{VOG}/ (q_g+q_l),

where*B is the*width of the belt, m;$f_{VOG}$is the tension of the belt in front of the curved section, N;$q_g$and$q_l$are the running weight of the load and the belt, N/m.

Braking devicesare used in inclined belt conveyors to prevent spontaneous reverse movement of the belt under the influence of the load lying on it, and in horizontal conveyors – to reduce the length of the belt run when the drive motor is turned off.

To increase the pressure of the belt against the drive drum, and, consequently, to increase the friction force between them, use pressure rollers pressed by springs (Fig. 3).

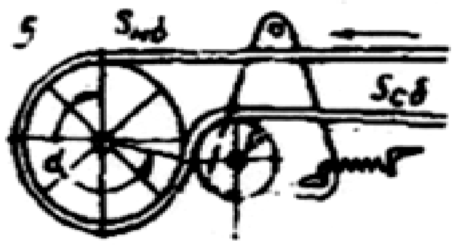


Fig. 3. drive Diagram of a belt conveyor with a pressure roller.

The force P pressing the roller against the drive drum is equal to the difference between the spring pressure and thepressing force of the belt tension. In this case, the pressure roller is simultaneously deflecting, and the force P acts at the point where the tape runs off the drum.

To reduce the specific pressure on the belt at the point where the roller is pressed, it is always covered with a thick layer of particularly elastic technical rubber.

Roller pressure with concentrated forceP creates a frictional force between the belt and the drum $P\mu$. Therefore, for scheme 5, when the traction force is equal to the total friction force

$$S_{нб} = (S_{сб} + P\mu)\cdot\lambda^{\mu\alpha}; \qquad (2)$$

$$W_0 = S_{нб} - S_{сб} = (S_{сб} + P\mu)\cdot\lambda^{\mu\alpha} - S_{сб} = \\ = S_{сб}(\lambda^{\mu\alpha} - 1) + P\mu\cdot\lambda^{\mu\alpha} \qquad (3)$$

or:

$$W_0 = S_{нб} - S_{сб} = S_{нб} - \frac{S_{нб} - P\mu\cdot\lambda^{\mu\alpha}}{\lambda^{\mu\alpha}} = S_{нб} - \frac{S_{нб}}{\lambda^{\mu\alpha}} + P\mu = \\ = S_{нб}\left(1 - \frac{1}{\lambda^{\mu\alpha}}\right) + P\mu = S_{нб}\left(\frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}\right) + P\mu.$$

(4)

From equation (4) we find $S_{нб}$:

$$S_{нб} = \frac{W_0 - P\mu}{\frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}} = \frac{(W_0 - P\mu)\cdot\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1} = W_0\cdot\frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1} - P\mu\cdot\frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1}.$$

(5)

For comparison purposes, we present the corresponding parameters for a conventional belt conveyor drive:

$$W_0 = S_{\text{нб}} - S_{\text{сб}} = S_{\text{сб}}(\lambda^{\mu\alpha} - 1) = S_{\text{нб}} \cdot \frac{\lambda^{\mu\alpha} - 1}{\lambda^{\mu\alpha}}$$

(6)

where from

$$S_{\text{нб}} = W_0 \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1} \qquad (7)$$

If we compare expressions (4) and (5) with expressions (6) and (7) for a conventional drive, it turns out that in the presence of a pressure roller with the same $S_{\text{нб}}$ the traction force W_0 is obtained by an amount $P\mu$ greater, and with the same traction force $S_{\text{нб}}$ by an amount $P\mu \cdot \frac{\lambda^{\mu\alpha}}{\lambda^{\mu\alpha} - 1}$ less, than in the absence of a pressure roller.

PRACTICAL WORK № 3.

TOPIC: STUDY OF THE SCHEME OF THE LIFTING SYSTEM OF AN AUTOMOBILE QUARRY LIFT.

The purpose of the practical lesson: *to teach students the schemes of the lifting system of an auto-mobile quarry lift.*

Key words:: *lifting system, trolley, quarry, dump truck, kinematic diagram, gearbox, gear train, mechanism diagram, engine, engine power.*

The essence of the lifting system is as follows. The lifting system (Fig.4*)* consists of tworacks on wheel travel 1,2 with the possibilityof placing on them, respectively, loaded 3 and empty *4* dump trucks. At the same time, dump trucks can be placed both in the longitudinal and transverse directions relative to the trolleys. Trolleys are installed on inclined rail tracks 5, 6 at an angle β to the horizon.

In the slots of the horizontally oriented flooring 7 of each trolley are placed on two parallel axes 9*, 10,* perpendicular to the longitudinal axis *8* of the dump truck, and with a gap to each other wheels with elastic coatings *11, 12* with the possibility of supporting on them the drive 13 or non-*drive 14* wheels of the dump truck3 or *4.* Axis 9*, 10* made the cut *15,* mounted in bearings 16 bogie frames *1, 2* and cinematically, through the shafts *17* and 18 with a conical pairs *on 19, 20* and cylindrical gear pairs *21, 22,* associated with Privolnymi blocks *23, 24,* 25 envelope of a rope and usoriginal equipment with the possibility of rotation of od-Noah fixed axis *26.* In this case, the shaft *17* кинеkinematically connects the axis 9 with the odd driveblocks 23, and the shaft *18*-the axis 10 with the even drive blocks 24; the shafts themselves are located on opposite sides from the axes 9 and *10* with theaxes 11 and 12. The rope 25 is closed on the reverse blocks 27, *28,* 29, mounted on the frame 30,secured on Board 31 of the quarry. The freeends 32 and 33 of the rope 25 are also closed there.

Thus, both trolleys aremechanically connected to each other throughthe Central block 28 placed on Board the quarry by a system of double polispasts. The multiplicity of polispasts is selected depending on the load-liftingcapacity of the dump trucks being moved. As the results of the research have shown, the optimal lifting system is with four-fold polispasts. In this case, the drive blocks *23, 24* can be single - and multi-lobed (for example, two-lobed); *34* — the horizon of the quarry from whichheavy dump trucks are lifted; 35, 36 - stops for trolleys in the lower and upper positions.

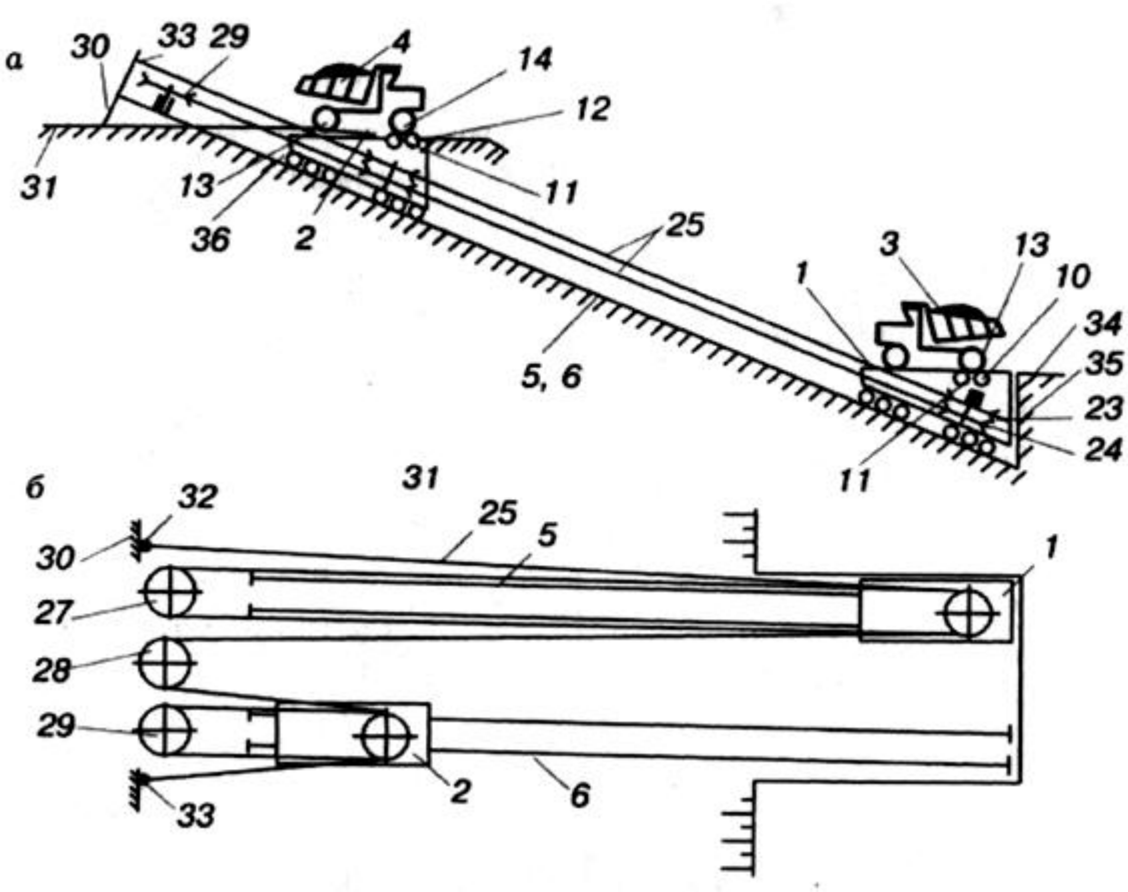


Fig. 4. System of lifting dump trucks on Board the quarry and launching them into the quarry:

a – side view, with the dump truck placed longitudinally on the trolley;

Kinematic diagram of the lift

Lifts are also very common mechanisms. A distinctive feature of these devices is the constancy of the sign of the moment of resistance acting on the engine when lifting and lowering the load. The main requirements for such structures are smooth start-up and braking, which is ensured by regulating the speed of cargo movement.

The kinematic diagram of the lift is shown in Fig. 3.

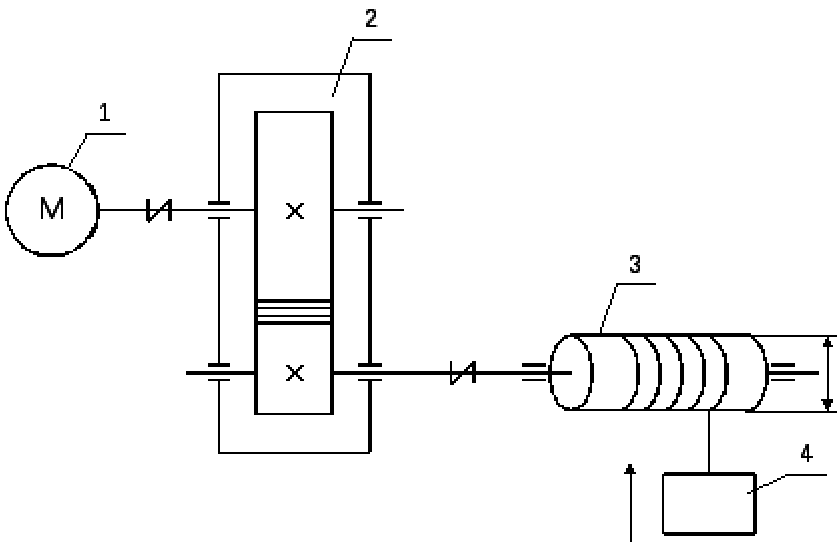


Fig. 3. Kinematic diagram of the lift

1-engine; 2-cylindrical gearbox (gear ratio i_1); 3-reel of the winding device with a diameter $D_б$ of [m]; 4-load weighing $m_{гр}$ [kg], V [m/s] – lifting speed of the load.

The calculation procedure is similar to the one described above. First, we find the angular speed of rotation of the drum

$$\omega_б = \frac{2 \cdot V}{D_б},$$

then we drive this speed to the motor shaft

$$\omega = \omega_б \cdot i,$$

where $i = i_1$ is the gear ratio of the entire mechanism, in this case it is the gear ratio of the gearbox.

The traction force is determined by the weight of the load being lifted

$$F = m_{гр} g,$$

and the power required to lift the load is defined as

$$P = F \cdot V,$$

where F [N] is the traction force; V [m/s] is the linear speed of the conveyor (specified in the technical specification).

We take into account the efficiency of individual parts of the mechanism and define the efficiency of the entire mechanism as the product of the efficiency of its individual parts

$$\eta = \eta_1 \cdot \eta_2^2,$$

where $\eta_1 = (0{,}9 \div 0{,}97)$ is the efficiency of the gear train;

$\eta_2 = 0{,}98$ - coupling efficiency.

The design power of the motor must not be less than the total mechanical power of the lift

$$P_{дв} \geq \frac{P}{\eta}.$$

We present the moment of inertia of the lift mechanism to the motor shaft based on the balance of kinetic energies, which is illustrated in Fig. 3

$$J_п = \frac{1}{i^2} \cdot J_{мех},$$

The total moment of inertia is determined by the sum $J_\Sigma = J_{дв} + J_п$.

Data for calculating the lift motor power are given in table 2.

Table 2. data for calculating the lift engine power.

№	V (м /с)	$D_б$ (м)	i_1	m (кг)	$I_{мех}$ (кг*м^2)
1	0,45	0,40	15	5000	0,70
2	0,43	0,40	15	4900	0,75
3	0,41	0,39	14	4800	0,80
4	0,39	0,39	14	4700	0,85
5	0,37	0,38	13	4600	0,90
6	0,35	0,38	13	4500	0,95
7	0,33	0,37	12	4400	1,00
8	0,31	0,37	12	4300	1,05
9	0,30	0,36	11	4200	1,10
10	0,29	0,36	11	4100	1,15
11	0,28	0,35	10	4000	1,20
12	0,27	0,35	10	3900	1,25
13	0,26	0,34	9	3800	1,30
14	0,25	0,34	9	3700	1,35
15	0,24	0,33	8	3600	1,40
16	0,23	0,33	8	3500	1,45
17	0,22	0,32	7	3400	1,50

For example, consider the scheme of the feed mechanism of metal-cutting machines, in which the motor moves the tool (product) to ensure the cutting process. A special feature of this mechanism is the impact application of the load to the engine and mechanical parts. The main requirement for such structures is to ensure smooth running of the cutter, regardless of the loads acting on the mechanism.

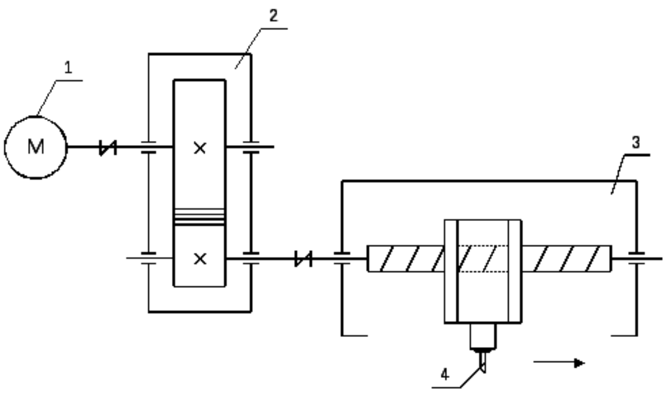


Fig. 4. Kinematic flow diagram of a metal-cutting machine

1-motor; 2 – cylindrical gearbox; 3-screw-nut transmission; 4-cutter (travel speed V [m/s]).

We start the calculation by determining the angular velocity of rotation of the transmission screw 3

$$\omega_3 = i_2 V k,$$

where $k = 100 \div 120$ [1/m] is the design transmission coefficient,

then we drive this speed to the motor shaft

$$\omega = \omega_3 \cdot i_1.$$

The feed force required for linear movement of the cutter is determined by the ratio

$$F = 4{,}5 \cdot F_n + mg\mu,$$

where F_n [N] is the feed force; m [kg] is the mass of the cutter support; μ – coefficient of friction (specified in the technical specification); $g = 9{,}81$ [m/S2] is the acceleration of gravity. The power required for cutting is defined as

$$P = F \cdot V,$$

where F [N] is the force, V and [m/s] is the linear speed of the conveyor (specified in the technical specification).

Given the efficiency of individual parts of the mechanism, we find the efficiency of the entire device as the product of the efficiency of individual nodes of the circuit:

$$\eta = \eta_1 \cdot \eta_2^2 \cdot \eta_3,$$

where $\eta_1 = (0{,}9 \div 0{,}97)$ is the efficiency of the gear train;

$\eta_2 = 0{,}98$ - coupling efficiency;

$\eta_3 = (0{,}8 \div 0{,}9)$ - transmission efficiency of the "screw-nut" type.

The rated power of the motor must not be less than the total power supplied to the feed mechanism,

$$P_{\partial в} \geq \frac{P}{\eta}.$$

Let us give the moment of inertia of the feed mechanism of a metal-cutting machine to the motor shaft, as in the previous examples, then

$$J_n = \frac{1}{i^2 k_1} \cdot m_{мех},$$

where $k_1 = 90 \div 95$ [1/m2] is the reduction coefficient . $i = i_1 \cdot i_2$ The total moment of inertia is determined as a result by the equation

$$J_\Sigma = J_{дв} + J_n.$$

Data for calculating the engine power of the feed mechanism are given in table 3.

Table 3. Data for calculating the engine power of the feed mechanism.

№	V (м / с)	i_1	i_2	F_n	m (кг)	μ
1	0,0250	7,0	35	500	15,0	0,050
2	0,0255	7,0	35	490	14,5	0,050
3	0,0260	6,5	33	480	14,0	0,050
4	0,0265	6,5	33	470	13,5	0,050
5	0,0270	6,0	31	460	13,0	0,045
6	0,0275	6,0	31	450	12,5	0,045
7	0,0280	5,5	29	440	12,0	0,045
8	0,0285	5,5	29	430	11,5	0,045
9	0,0290	5,0	27	420	11,0	0,040
10	0,0295	5,0	27	410	10,5	0,040
11	0,0300	4,5	25	400	10,0	0,040
12	0,0305	4,5	25	390	9,5	0,040
13	0,0310	4,0	23	380	9,0	0,035
14	0,0315	4,0	23	370	8,5	0,035
15	0,0320	3,5	21	360	8,0	0,035
16	0,0325	3,5	21	350	7,5	0,035
17	0,0330	3,0	20	340	7,0	0,035

PRACTICAL WORK № 4.

TOPIC: STUDY OF THE MAIN ELEMENTS AND TECHNOLOGICAL SCHEME OF OPERATION OF A QUARRY CONTAINER ELEVATOR.

The purpose of the practical lesson: *to teach students the basic elements and technological schemes of operation of a quarry container lift.*

Key words:: *kinematic diagram, container lift, operation diagrams, quarry, dump truck, technical capacity, underground mining, container storage, frames, side of the quarry.*

A fundamentally new container lift has been proposed at the NIIKMA Institute. It is designed for the delivery of loaded containers (dumptrucks, dump cars or their removable bodies) from the quarry and at the sametime launching empty ones into the quarry. The kinematicscheme of the lift is designed in such a way that it contains not one, but several loaded andadjacent containers, which allows you to maintain a steady state of operation.increase the technical productivity of the lift when the pit is being deepened and thus eliminate one of the main reasons for the outstripping growth of transportcosts.

Figure 5 shows a schematic diagram of the specified lift. Two kinematically connected parallel and adjacent to each other frames 1 and 2 are mounted on the side of the quarry or in an undergroundexcavation and are connected to each other, for example, throughrods 3 connected to a double-arm lever *4.* The leveris sharpened by means of a hinge 5 to the base. Frames *1* and *2* are divided into compartments by partitions 6. in the compartments on partitions 6, loaded 7 and empty *8* containers are placed. Each compartment has a mechanism formoving containers into the compartments of the adjacent frame.The Elevator *4* is equipped with a drive 9. When used as containersof dump truck bodies or dump cars, the Elevator is equipped with devices for removing them and installing them on the vehicle base. To ensure the rhythmic operation of the lift, its loading and unloading parts can be equippedwith container storage devices.

Figure 6 shows the technological schemeof the Elevator operation. In the initial position (see Fig. 6, a*)*в, a loaded container 7 enters the lower compartment of the frame 1, and *an empty container 8 enters the upper compartment of the frame* 2. Drive 9 moves the lift to the position shown in Fig. 6,δ, and stops to exchangecontainers between the frames / and*2.* In thiscase, the heavy container *7* is moved to the second lower compartment of the frame *2,* and the empty container *8 is* moved to the second upper compartment of the frame. After that, frames *1* and *2* перевоare moved to their starting position (see figure 6C), and the liftstops again to exchange containers between the frames, load the next loadedcontainer into frame *1* and empty container into frame 22. Next, thelift is transferred sequentially to the positions. 6 (d, e,and I) during stops, regular container exchanges are performed betweenframes.

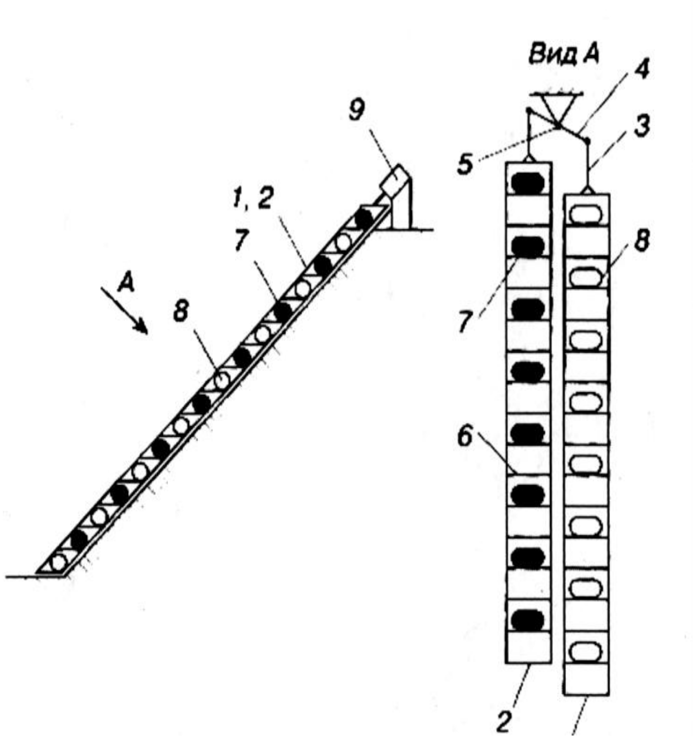
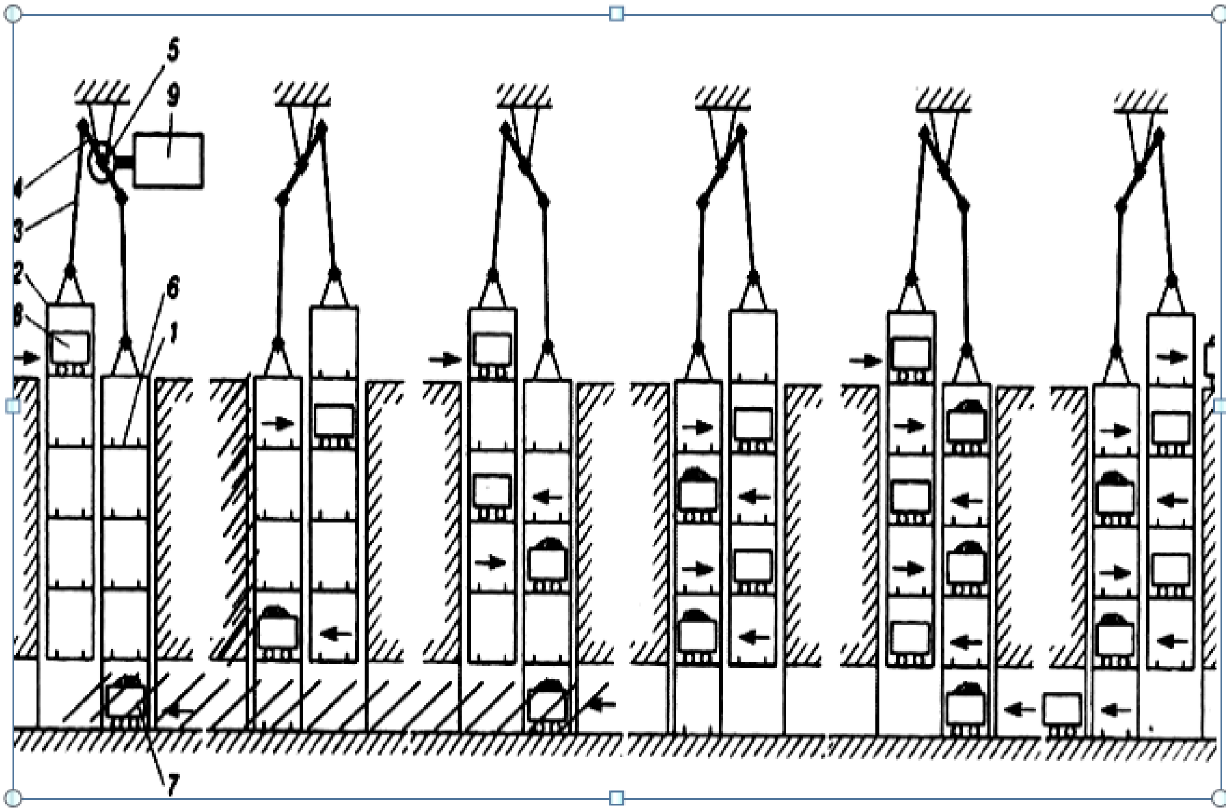


Fig. 5 container lift Devices.



Basic technological scheme of container lift operation.

After moving the mechanism to the position shown in Fig. 6, e, осуществляется выгрузка из the loaded container on the surface and the-adjacent container in the quarry are unloaded from the compartment. This position (see Fig. 6E) fixes the output of the lift to the nominaloperating mode.

Method of container transportation of bulk materials through a pipeline.

The invention relates to pipeline transport, namely to a method for transporting bulk materials with simultaneous grinding (in particular, ore mass). The method is characterized by the fact that its implementation uses ball containers that are loaded to 50% of their internal volume. The rolling speed of the ball containers is set such that the grinding of bulk materials occurs while simultaneously moving them through the pipeline. Effect: invention makes it possible to increase the efficiency of transportation of bulk materials through a pipeline with simultaneous self-grinding.

The invention relates to pipeline transport, namely to a method of transporting bulk materials, in particular ore mass, with the process of simultaneous processing of the transported material.

A known method for transporting bulk materials through a pipeline, including loading containers, introducing them into the lock chamber, and supplying a compressed working medium acting on the container body.

A well-known installation for implementing this method, containing a closed cargo duct, container loading and unloading chambers, and a pneumatic container supply system. A pipeline container pneumatic transport system is also known. The system includes a pipeline with blowers and container loading and unloading stations. The method implemented using this system is as follows. At the loading station, containers are loaded and then moved through the pipeline. Blowers are used to move containers through the pipeline. Containers are decelerated and then unloaded before the unloading station.

Significant disadvantages of this method are high specific energy consumption and functional limitations due to the fact that energy and time are spent only on the process of moving containers without performing additional work with the transported material.

The objective of the invention is to increase the efficiency of transportation of bulk materials by performing an additional operation - creating the possibility of their grinding during the movement of containers from the loading station to the unloading station.

The problem is solved by the fact that in the method of pipeline container movement of bulk materials, which includes loading containers with bulk materials, moving them at an adjustable speed through the pipeline using a blower unit, it is proposed to load ball containers with bulk materials up to 50% of their internal volume and when moving containers through the pipeline, give them plane-parallel movement with a rolling speed determined by the formula

$$v_0 = \sqrt{\frac{2\sigma_д}{\rho}}, \quad (1)$$

where v_0 is the rolling speed of the spherical container, m / s;

σ_d - dynamic strength of bulk material particles, MPa;

ρ - particle density of bulk material kg/^{m3}.

The procedure for implementing this method is as follows.

Spherical containers up to 50% of their internal volume are filled with bulk materials and sealed. At the loading station, containers are loaded into the pipeline and moved in the longitudinal direction of the pipeline using a blower unit.

As a result, the containers will perform plane-parallel movement, which includes translational movement from the main blower units and rotational movement. At the same time, spherical containers must develop sufficiently high rolling speeds to have significant centrifugal forces acting on the ore mass particles inside the drum and causing these particles to hit the surface of the container and thus self-grind. Obviously, if the diameter of the rolling container is small, the gravitational component of the impact force will be small compared to the centrifugal component, which ensures self-grinding of ore in the container. We set the rolling speed of the container sufficient to obtain the centrifugal force of collision of ore mass particles with the inner surface of the container, which ensures the destruction of the ore mass.

The rotation of the ore mass relative to the center of the ball generates a centrifugal force

$$F_{C.\,b} = m\omega^2 R,$$

where m is the mass of the ore particle,
R is the radius of the circle along which the particle moves,
ω - the angular velocity of its movement.

When colliding with the inner surface of the sphere, the ore particles are subjected to mechanical pressure, which leads to their crushing.

Rotation of the container around its geometric center is provided by compressed air pressure due to the fact that the coefficient of rolling friction $K_{Tr.K.}$ for a steel-steel pair with a container radius of r~1 m is 0.01, the coefficient of sliding friction for this pair is much larger. As a result, there is a resultant moment of force that ensures the rotation of the ball container. As a result, there is no need for additional blowers that create tangential air flow.

The plot of velocities of points on the surface of a rolling container has the form shown in the drawing.

The speed of points varies from zero at point P to a maximum at point A. the average speed of movement of the container can be taken as the speed v_0 of the center of the container.

The velocity plot is simplified and to some extent sums up the vector velocities of ore mass particles that collide both with each other and with the inner surface of the container moving at an average speed v of 0. This speed is determined by setting the condition for the destruction of large particles of ore mass inside the drum when hitting the walls of a rolling container.

Let us represent the process of collision of ore mass particles and the container wall as the process of impact on the wall of an infinitely large number of particles with a unit volume ω of 1 $= 1\times1\times1$. Then the kinetic energy of a moving particle$_1$T1 with a unit volume will be equal$_1$to T1 = T/ 1ω_1, where T is the total kinetic energy,

$$T = \frac{m\bar{v}_0^2}{2},$$

where m is the mass of a particle of unit volume.
Then

$$T_1 = \frac{mv_0^2}{2\cdot\omega_1} = \frac{\rho v_0^2}{2},$$

where ρ is the density of the ore mass.

According to the theory of dimensions, the dimension T_1 will be

$$\left|\frac{кг\cdot м^2}{м^3\cdot с^2}\right| = \left|\frac{Н}{м^2}\right|,$$

that is, the dimension T1has the dimension of voltage. Therefore, the condition for effective destruction of particles when hitting the container wall is the inequality

$$\frac{\rho\cdot v_0^2}{2} > \sigma_д, \quad (2)$$

where σ_d is the dynamic strength of ore mass particles.

By solving (2) with respect v to 0, we obtain

$$v_0 > \sqrt{\frac{2\sigma_д}{\rho}}, \quad (3)$$

where v_0 is the rolling speed of a spherical container, m/s;

σ_d is the dynamic strength of bulk material particles, MPa;

ρ and d is the density of bulk material particles, kg/^{m3}.

These distinctive features: the use of ball containers; loading ball containers with bulk materials to 50% of their internal volume; setting the rolling speed of ball containers, at which the disintegration of bulk materials occurs simultaneously with their movement through the pipeline, give the method a new quality, which consists in increasing the efficiency of transporting bulk materials through the pipeline. To implement the method, spherical containers (spheroids) are used, having a lid through which the container cavity is loaded, as a result of loading approximately 50% of its volume, conditions are created for rolling the material when the container moves, which leads to forced abrasion of the material delivered to the place of its final processing (in the case of ore), or for direct sorting and use (as a building material).

Method of container movement of bulk materials through a pipeline, consisting in loading containers, moving them at an adjustable speed through a transport pipeline using blower units, characterized in that spherical containers are filled with bulk materials up to 50% of their internal volume, and when moving through a transport pipeline, spherical containers are given plane-parallel movement with a rolling speed determined from the expression

$$v_0 = \sqrt{\frac{2\sigma_д}{\rho}},$$

where v_0 is the rolling speed of a spherical container, m/s;

σ_d is the dynamic strength of bulk material particles, MPa;

ρ and d is the density of bulk material particles kg/^{m3}.

PRACTICAL WORK № 5.

TOPIC: USE OF GRAVITY FORCES FOR CARGO TRANSPORTATION FROM UPLAND QUARRIES (STUDY AND ANALYSIS OF MECHANICAL EQUIPMENT).

The purpose of the practical lesson *is to teach students how to use the forces of gravity to transport cargo from mountain quarries.*

Key words:: *gravity forces, rails, dump trucks, cargo transportation, mechanical equipment, quarry, machinery, drum, rail tracks, highways.*

Recently, transportation devices - so-called gravity devices-have been increasingly used in our industry *гравитационные устройства*. The main and extremely valuable property of transport devices is that they make it possible to move loads using gravity, the weight of the most moved loads and do not need any engines. Such transport devices do not require large capital expenditures and are characterized by simple design, low cost of operation, high reliability in operation and other advantages.

Machines of the second group include swinging, inertial roller, screw, vibrating, pneumatic and hydraulic conveyors,*and gravity devices*.

Mechanical conveying machines of continuous operation are divided into the following groups: machines with a flexible traction body, machines without a traction body and *gravity devices*.

For uniform distribution of condensate generated on the cooled surfaces over the heated evaporation surfaces, the thermal rectification columns are equipped with special centrifugal or hydraulic pumps. *gravity devices*. Due to this, thermal rectification columns are also very promising for separating so-called negative systems, the separation of which in conventional film apparatuses is difficult due to the inability to create a stable liquid film on the surface of the nozzle.

Roller conveyors are devices in which sliding of a gruea on guides is replaced by movement on rollers thanks to what becomes possible to move loads with small angles of inclination *a gravity device*.

In bunkers, gravity (gravity) transport means are widely used for transport installations, which include drains, trays and pipes, cascade and screw descents. *Gravity devices* are designed for feeding bulk cargo from bunkers and individual cargo on loading units.

In these devices, as mentioned earlier, gravity is used to transport goods. *The simplest gravity device* is an inclined plane, chute or pipe, along which the transported cargo rolls down. Gutters, planes and pipes are made of metal, asbestos cement or iron-clad wood.

These devices use gravity to transport cargo. *The simplest gravity devices* are an inclined plane, a chute, a rough surface, along which the transported cargo rolls down.

Mechanisms for turning the load-bearing device of a crane on a flexible suspension are divided into three groups: mechanical, hydraulic and gravity. In *gravity devices* rotate under the action of the load's own weight.

Other special technical means of sending documents or information are also known. Such means include, for example, grapple installations, belt conveyors, *gravity devices*, pneumatic communication, special telephone communication, Telegraph and photo-Telegraph communication, television communication, radio, administrative and industrial call signalling.

Gravity devices allow you to forward documents using the gravity of the cargo being transported. Unloading of the lock usually occurs only at one point - at the end of the lock, although unloading is also possible at several points using doors or valves located in certain places that block the lock. *Gravity devices* can be used to deliver documents to the nearest points of the room located on the same floor, as well as from the upper floor to the lower one. When the points between which documents are transferred are located in different horizontal planes, gravity devices are convenient to use in combination with belt conveyors that carry out horizontal movement of documents.

Gravity devices that move cargo under the influence of gravity include trays, ramps, and non-drive roller conveyors (Fig. 3), spiral descents. To move loads under the influence of gravity, roller coasters are installed with a slight slope. *Gravity devices* are structurally very simple, cheap to manufacture and operate, take up little space and operate either as an independent vehicle or as additional devices, such as trays that feed parts from the conveyor to the workplace. With the help of pneumatic transport equipment, cargo is moved in special pipelines: bulk cargo - in the air stream, piece cargo - in calibrated containers moved under air pressure.

Machines whose working body (belt, chain, rope, screw, scrapers, tray, etc.) moves continuously, without stopping to receive and return cargo, and moves the cargo to its destination in a continuous flow, are called continuous-action machines. These include conveyor belts (belt conveyors, plate conveyors, and scraper conveyors), grain elevators, and so on.*Roller, screw, vibrating conveyors, various gravity devices* (inclined and spiral descents, chutes), as well as pneumatic and hydraulic transport devices move cargo in a continuous flow without a traction body.

Below is one of the possible schemes (Fig. 1) for transporting cargo in a quarryusing gravity forces. In the cargo transportation scheme, which includes tracks with trolleysmoving along them, connected to each other by a flexible traction element,the track corresponds to the profileof the quarry side (see figure).-дой площадке уступа оборудоThe tracks on each platform of the ledge are equipped with two vertical walls with rails located on both sides of the platform, and the trolley has additional wheels that interact with the rails of the vertical walls.женными по обе стороны от тележки, а тележка имеет дополнительные колеса, взаимодействующие с рельсами вертиFor tension of the traction body, the rails installed on the platform of the ledge and the rails parallel to them on the vertical wall have a slope towards the developed space, the value of which is greater than the value of the coefficient of resistance to movementof the track along the rails. In addition, flat sections of rails have a slope towards the developed space, determined by the formula

$i>>k = P/G$

where k is the coefficient of resistance to movement
trolleys on rails;
P is the drag forceof the trolley movement
on a horizontal path;
G is the weightof the cart.

This slope corresponds to the angle α . Meetingthe conditions
$i>>k$ provides thenecessary rope tension.

The device for cargo transportation worksas follows. Dumptrucks are mounted on trolleys at the same time: for example, an empty dump truck is placed on the lower trolley, and a loaded dump truck is placed on the upper one. Then, when the drive drum rotates, the lower trolleymoves along the platform of the ledge by the traction organ, the upper one - towards the developed space underthe action of its own weight. At the same time, the lower wheels of the trolley roll along the lower rails, andthe additional wheels roll along the side rails, which ensures the horizontal position of the trolley platform. Then the carts move along the slopes of the ledge: the lower one - up, and the upper one-down.In this case, the drive unit operates in the generatormode and recovers energy to the grid.

When the trolley is moved along the slope ata distance equal to the distance between the axles of the lowerand upper wheels, the additional wheelsmove out of contact with the side rails, and thetrolley moves along the lower rails.

This solution allows you to eminimum to reduce the cost of preparation of the track, to exclude mining-related wypracowanie side of the pit under the track for ways to ensure the descent of dump trucks in a quarry on the shortest path, to reduce operating costs for maintenance of the trucks , reducingat capturing Stripping volume for the account of the reductionof the width of the carriageway of roads, tookchit capacity of dump trucks and tonecnon account to reduce the cost of transportation by about 10-15 %.

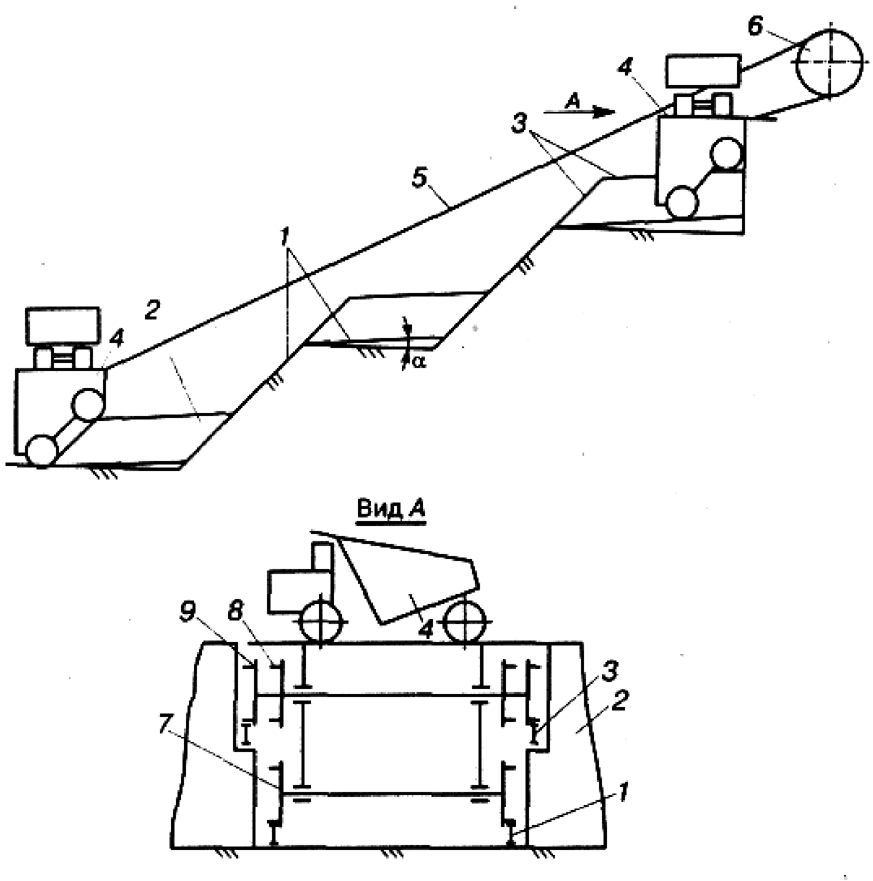


Fig. 1. Diagram of the device for cargo transportation:

1, 3 - lower and lateral rail tracks, respectively; 2-vertical wall; 4-bogies; 5-flexible (traction) body; 6-drive drum; 7, 8, 9-lower, upper and additional wheels, respectively.

This scheme is also applicable in principle for the case of lifting the load up, then the empty dump truck will go down under its own weight.

Gravity devicesfor cargo transportation are made in the form of inclined or spiral descents, along which the cargo moves under its own gravity.

2,*a*) consists of three sections: on section*1*with a large angle of inclination, load*2*accelerates to a given speed, on section*3*slows down, and then stops on section 4 .*4*.

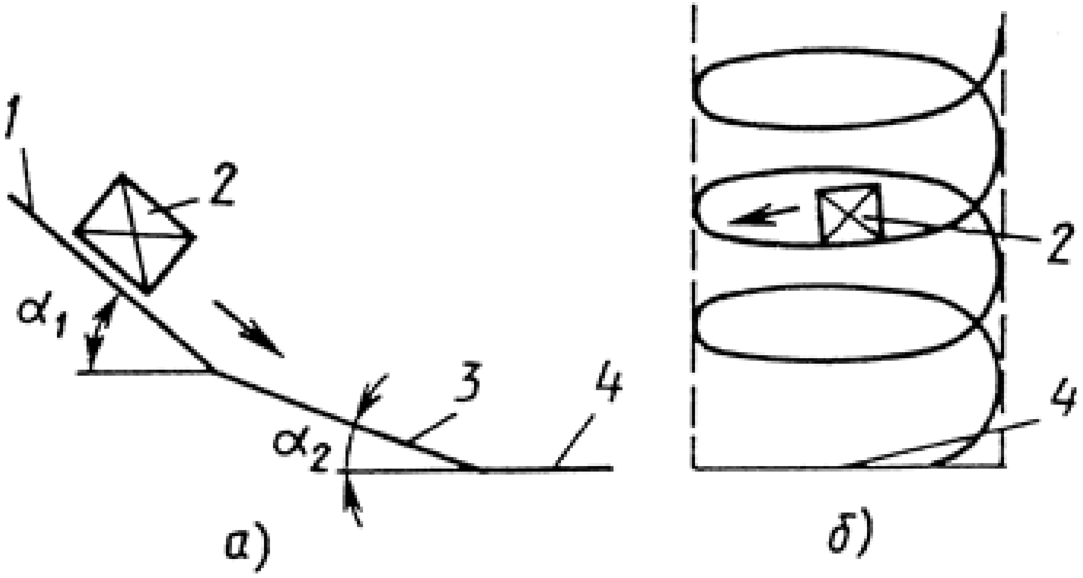


Figure 2. Diagrams of gravity transport devices:
a-oblique; *b*-screw type

Screw gravity devices (Fig. 2,*b*) have a smaller housing width and are therefore more compact.

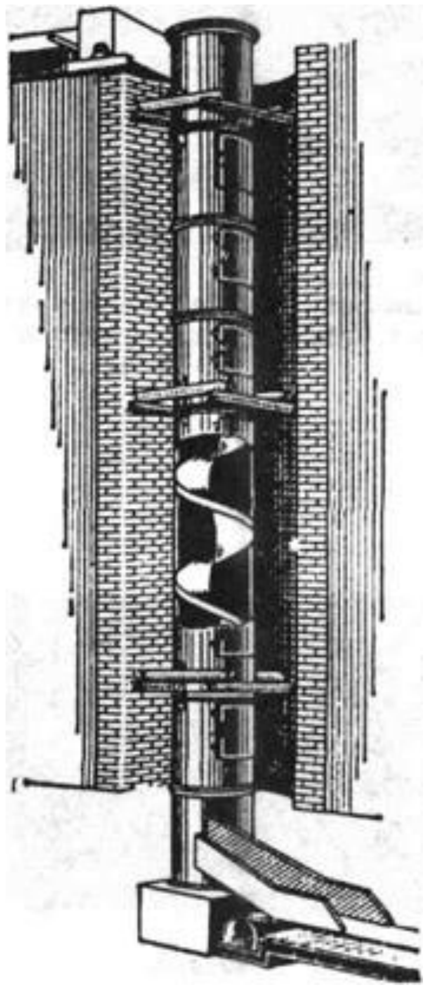


Fig. 3. Screwdescentforbulkcargo

The main characteristic of a conveying machine is its *productivity*, which is understood as quantity (mass) or the volume of cargo passing through a given cross-section per unit time.

For bulk cargo, there is a distinction between mass P_M(t / h) and volume p_V(^{m3}/h) of productivity, which are related to each other by the dependence

$$N_M = N_V \times r_V, \quad (1)$$

where $_{RV\ is\ the\ density}$ of the bulk cargo, t/^{m3}.

When calculating the productivity of continuous transport machines, three cases of cargo transportation are considered: transportation of bulk cargo in a continuous stream; bulk cargo in separate portions; and piece cargo.

The mass productivity (t / h) of a machine that moves bulk cargo in a continuous flow is determined by the formula

$$N_M = 3600 \times A \times u \times r_V, \quad (2)$$

where A is the cross-sectional area of the bulk cargo, ^{m2}; u is the speed of movement of the cargo, m/s; r$_{RV\ is\ the}$ bulk density of the cargo, t/^{m3}.

Taking into account the continuity of the flow of the transported cargo, the productivity of the machine can also be expressed in terms of the linear mass (density) of the cargo r_L(kg/m). To do this, we find the relationship between the linear density of the load on the conveyor r_L and the bulk density of the load $\times r_V$:

$$r_L = m / l = (1000\ r_V\ A\ l) / l = 1000\ r_V\ A$$

or

$$r_V = r_L / (1000 \times A), \quad (3)$$

where m is the mass of the load on the conveyor section of length l.

Substituting expression (3.3) in (3.2), we obtain:

$$N_M = 3600 \times A \times u \times r_L / (1000 \times A) = 3.6 \times r_L \times u. \quad (4)$$

The capacity of the conveying machine can also be expressed in terms of the linear load or linear gravity q_g(N/m) of the bulk load:

$$N_M = 3.6 \times q_g \times \mathbf{y} / g. \quad (5)$$

Here $q_R = g \times r_L$, and g = 9.81 m/c^{S2} is the acceleration of gravity.

If bulk cargo is transported in portions, for example, in separate vessels (buckets, pallets, ladles, etc.) with a capacity $V_{of\ V0}$(m3$^)$with an average filling coefficient of each vessel y, with a vessel pitch*of* *s*(m), then the running mass$_{RL}$(kg/m) of the cargo is equal to:

$$r_L = (y \times V_0 \times r_V)/s. \quad (6)$$

In this case, substituting expression (6) into (4), we obtain:

$$\Pi_{Nm} = 3.6 \times u \times (y \times V_{V0} \times {}_V RV)/s. \quad (7)$$

When moving individual loads, the conveyor capacity Z (PCs/h) depends on the step between individual loads*s*(m):

$$Z = 3600 \times \upsilon / s \quad (8)$$

When transporting individual loads with a mass$M_0$of M0 (kg) each, arranged in increments*of* *s*(m), the conditional running weight (kg/m) of the transported cargo and the mass productivity (t/h) of the machine are equal, respectively:

$$r_L = M_0/s; \; N_M = 3.6 y \, M_0/s. \quad (9)$$

Having determined the required capacity and type of cargo to be transported, you can start calculating and designing the belt conveyor.

PRACTICAL WORK № 6.

TOPIC: STUDY AND ANALYZE THE MAIN TECHNICAL CHARACTERISTICS OF SOME OF THE WORLD'S LARGEST BELT CONVEYORS.

Purpose of the practical lesson: *to teach students the analysis of technical characteristics, as well as the main technical parameters and methods of General calculation of belt conveyors.*

Key words:: *conveyor characteristics, belt conveyors, material transportation, rope-belt conveyor, single-span structures, conveyor design, roller diameter, drum diameter, drive power, distinctive features.*

The world leader in the production of long-distance conveyors is the "bulk materials Transportation" division of METSOMINERALS(England).

Until the middle of the 20th century, any conveyor with a length of more than 1 km was considered the highest technical achievement, and in 1953 the rope-belt conveyor "established" a record value for the length of one passage- more than 10 km. The 14.6 km long rope and belt conveyor, which was put into operation in 1971 in Uniontown, Kentucky, USA14.6 км, was one of the longest systems.

This achievement remainedthe highest until 1984, when эксплуатаthe " WorsleyAlumina "conveyors were put intoWorsleyAluminaoperation.

The characteristics of some of the world's longest rope-and-belt conveyor systemsare presented in table 2.

WorsleyAlumina'sconveyors, which were put into operation more than 20 years ago, still remain unsurpassed in their parameters.Despite the intensive development of systems andtechnological innovations in the productionof traditional conveyors (when the traction force is transmittedto the load-bearing belt), the longestsingle-axle design is still a system with a length of about 16 km, i.e. almost half less than the longest rope-belt conveyor.

However, single-span structures are only part of a complex consisting of several conveyors combined together and forming a very long system for transporting bulk materials.

A large distance of transportationof bulk cargo can be considered a distance from 10 km up to 100 km

Table-2.

Location	Year of introduction	Length, m	Productivity, t / hour	Material	Speed, m / s	Installed power, kW	Distinctive features
1	2	3	4	5	6	7	8
Scotland	1951	720	130	Raw coal	1,14	75	First serial belt conveyor
England	1961	4207	870	Raw coal	2,29	750	Underground
USA	1971	14598	1360	Crushed coal	4,19	1865	Surface
USA	1978	9913	2000	Copper ore	4,19	1865	Surface
England	1981	9200	2700	Raw coal	7,50	8750	Inclined conveyor designed for 14200 m
Zambia	1981	11385	850	Copper ore	3,50	1200	Large horizontal bend
Australia	1981	10400	2500	Coal	4,00	2500	Surface
Australia	1983	30441	2300	Bauxite	6,00	8000	The longest conveyor belt in the world
Australia	1983	20712	2300	Bauxite	6,00	5200	The second longest conveyor in the world
Jamaica	1984	14192	1428	Bauxite	4,00	1865	Surface
India	1985	14550	1800	Bauxite	4,70	2000	Surface
Israel	1987	18113	800	Potash	4,60	4000	The world's longest bending conveyor
Canada	1997	6000	2200	Raw coal	6,00	6000	Steeply inclined
Jamaica	1991	7866	1000	Bauxite	3,25	750	Surface descending with turns
Venezuela	1992	4232	1600	Bauxite	4,00	2500	Large regenerative conveyor
USA	1992	6415	700	Crushed coal	3,25	1350	Very difficult terrain
USA	1992	10745	1360	Raw coal	4,19	1865	Moving conveyor Anamax
Philippines	1996	5775	1000	Limestone	3,50	600	Bend with a radius of 400 m
Canada	1997	10390	1070	Raw coal	4,80	1365	Descending with bends

							with a radius of 430 m

General calculation of the belt conveyor.

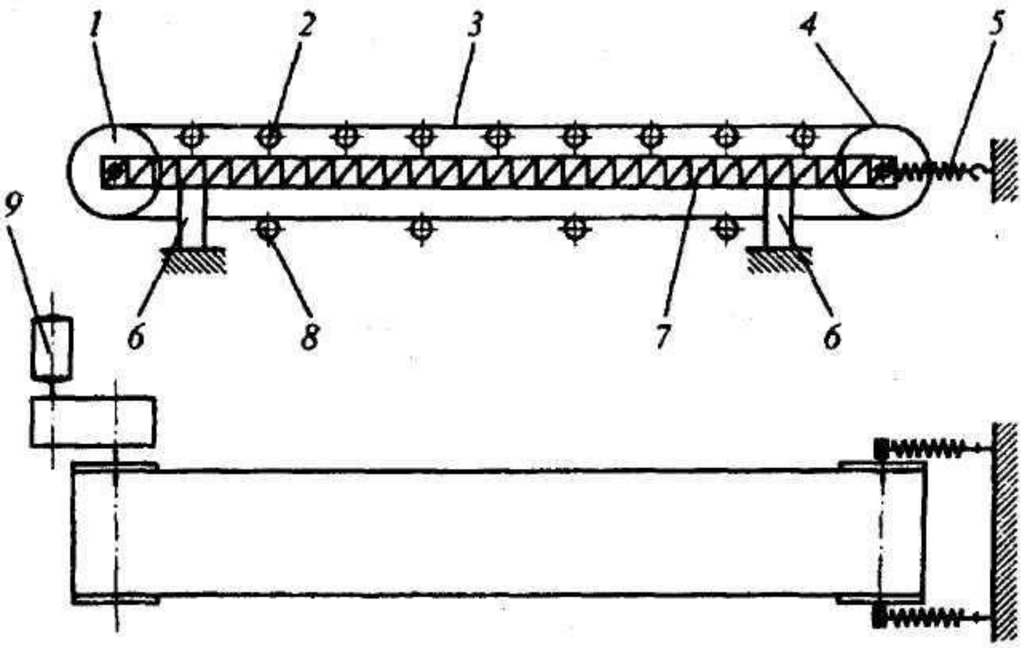


Fig. 1. Diagram of the belt conveyor:
1-drive drum; 2-roller supports of the cargo branch; 3-belt; 4 – tension drum; 5-tension device; 6 – conveyor support; 7-frame;
8 – idling branch roller support; 9-conveyor drive.

Initial data for calculating option № 5
Transported material-dry ash,
mass conveyor capacity-Q=60 t / h,
conveyor length-L=100m,
conveyor lift or slope angle-γ=0º,
type of upper roller supports –two-roller.

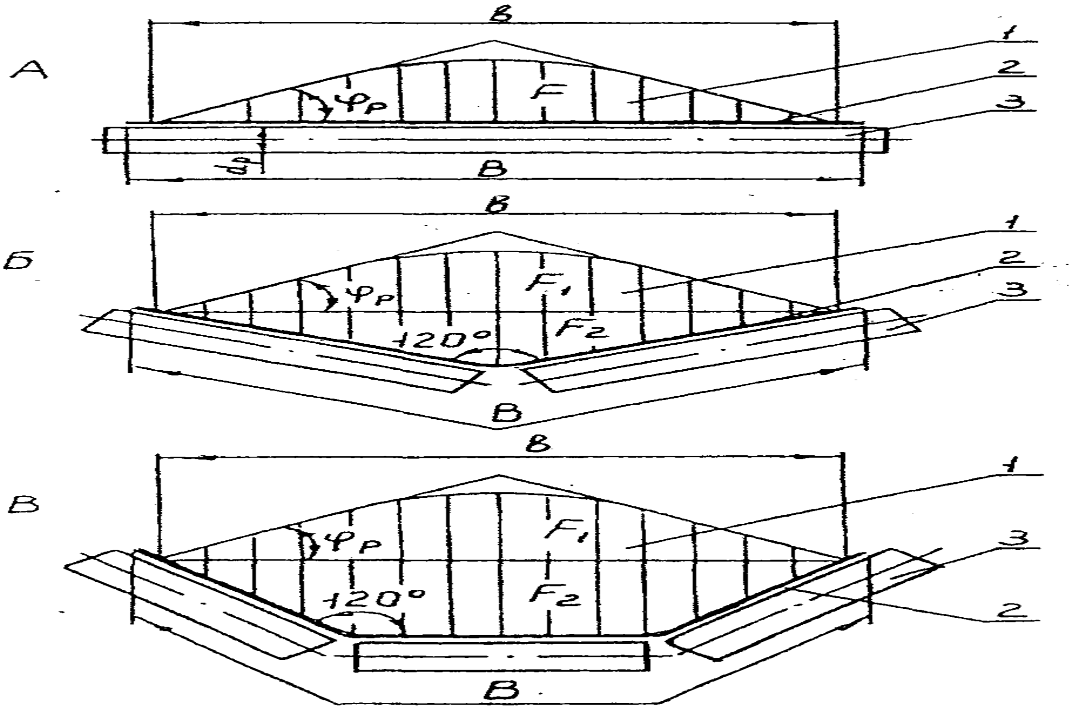
Conveyor transport is the technological process of moving rock masses using conveyors in underground and open-pit mining operations. In a broad sense, it is a complex that combines conveyors and auxiliary equipment (for example, bunkers, feeders, etc.), technical means of managing the production of works, as well as maintenance and repair.

The belt conveyor consists of the following main elements: the conveyor belt itself, the drive, the stand with roller supports, the loading and tensioning device.

Belt catchers, cleaning mechanisms, weighing mechanisms, etc. are also installed on the conveyors.

The belt conveyor (figure 3) can be divided into three main parts: head, middle and tail. As a carrier (transporting) and traction body, rubber-cloth belts with a smooth surface are used.

Mechanization of loading and unloading operations is one of the most important reserves for improving the economic efficiency of technological operations with bulk cargo. The variety of bulk materials, which differ in their properties and purpose, determines the use of various bunkers, hopper devices, loading devices, flow stabilizers, feeders, etc. All of them relate to the system of transportation mechanisms for complex mechanization of cargo flow



Calculation sequence

We take the camber angle between the rollers in the roller supports 120^0, then the cross-sectional area of the material on the tape F and the width of the tape B can be expressed as follows:

for two-roller supports

$F = ¼\, b^2\, (f\, tg\varphi_p + tg30^o)$, (1.1)

where b is the width of the base of the material sections on the tape, m;

f= 0.8- rounding factor of the material section cap

on the move;

φ_p- calculated angle of natural slope of the material, deg., [1, table 1, P. 13].

The cross-sectional area of the material on the belt F is determined by the given mass productivity of the conveyor Q and the accepted belt speed V_l[1, table 1, P. 13].

Q/δ=3600 F V k , (1.2)

Hence $F = Q/ (3600·δ * V_l k) = 60/ (3600·0,6·0,8·0,9) = 0,038\ m^2$

where Q is the mass productivity of the conveyor, t / h;

δ- material density, $t/^{m3}$[1, table 1, P. 13];

V_l **is** the accepted speed of the belt movement, m/s [1, table 1, P. 13];

k = 0.9 - coefficient of uneven loading of the conveyor.

Then,

$b = 2\cdot \sqrt{F/(f \cdot tg\phi_p + tg30^\circ)} = 2\cdot \sqrt{0{,}038/(0{,}8 \cdot tg10 + tg30^\circ)}$ =0.46 m , (1.3)

B = b + 0.1 = 0.46+0.1=0.56 m, (1.4)

We accept the nearest value of the tape width B according to the standard row (GOST 22644-77). B = 650 mm. B_f= 650 mm [1, P. 5; 3, P. 1]

2. Calculation of the updated value of the tape speed

$V_y = Q / 3600·δ·F_f·k = 60/ (3600·0,6·0,054·0,9) = 0,6$ m / s , (1.5)

where F_f is the actual cross-sectional area of the tape material,^{m2}.

For single-roller supports

$F_f = ¼\ b_f^2(f\ tgφ_p+tg30^o) = ¼\ 0.55^2(0.8\ tg10^o+tg30^o) = 0.054^{m2}$, (1.6)

$b_f = B_f – 0.1 = 0.65-0.1 = 0.55$ m, (1.7)

where in_f, is the actual width of the tape, m;

f=0.8 - rounding factor of the" cap " of the section

of the material;

$φ_p$- calculated angle of natural slope of the material, deg.

[1, table 1, P. 13].

3. Calculation of drum diameters, roller diameters, and quantity upper roller supports

$d_b=0.5_{C\ f}$= 0.5 * 650=325 mm, (1.8)

L_b=WF +100=650+100=750 mm , (1.9)

d_{DP}=0.1 In f_f= 0.1 * 650=65 mm, (1.10)

$n_p = \frac{L}{t}$, NP = = $\frac{100}{1{,}4} = 72$ PCs, (1.11)

where B_f **is** the accepted width of the tape, mm;

L - conveyor length, m;

t is the distance between the upper roller supports, m [1, table 6, P. 17];

D_b– drum diameter, mm;

d_p– diameter of rollers, mm;

n_p- number of upper roller supports, PCs.

4. calculation of conveyor drive power

$N= (Q/360\ η_0)\ ·s(L_r± N)+0.02·s\ q\ L_R V_y$=

= [60/ (360·0,8)] ·0,06(100+ 0) +0,02·0,06·19,5·100·0,6 = 2,7 kW, (1.12)

where Q is the mass productivity of the conveyor, t / h;
C = 0.06 - the total resistance coefficient of the tape movement;
L_r= L cosy = 100·cos0=100 m - transportation distance horizontally;
H = L Siny = 100·sin 0 = 0-horizontal conveyor;
y - angle of lift or slope of the conveyor, for horizontal lines conveyors H=0, for lifting or descending conveyors
H is taken with the + or-signs, respectively.
q =30B_f=30•0.65= 19.5 - mass of one linear meter of moving objects conveyor elements, kg/m;
In_f- the actual width of the tape, m;
V_y- specified speed of the tape movement, m/s;
$N0_0$ = 0.8 is the total efficiency of the drive.

PRACTICAL WORK № 7.

TOPIC: STUDY OF DEVICES AND EQUIPMENT INCLUDED IN THE ROTARY COMPLEX OF THE ANGRENSKY OPEN-PIT MINE.

The purpose of the practical lesson: *to teach students the design and equipment that are part of the angrensky rotary complex.*

Key words:: *section "ANGRENSKY", system, rotary complex, rotary excavator, transportation system, equipment of the complex, design parameters, geometric parameters, reloader, telescopic conveyor.*

An example of the use of a rotary complex in the mining industry of Uzbekistan is the open-pit mine "Angren" OA "Uzbekugol". A thyssenkruppfordertechnik rotary complex has been installed and operates here. The system consists of a rotary excavator, a self-propelled conveyor reloader, a combined self-propelled loading and cable trolley (Fig. 8, a), a conveyor unit, a mobile telescopic conveyor and a dump truck (Fig.8, b). the system of conveyor units consists of mobile and stationary units.

On the cross-section "Angren" in August 2003, started commercial operation of complex equipment "Rotary complex No. 1 firm "Thysscn Krupp For-dertcchnik", comprising the following process chain: bucket wheel excavator SCH RS 200 - conveyor truck BRS 1200 - charging trolley with rail trolley for cable drum W1200-LT500 -installation 1200н conveyor (conveyor system - downhole; trunk; intermediate; depleted) - loop trolley BR\V1200- spreader ARS1200. The rotary complex is designed for operation in a coal mine "Angrensky" and mining of colored kaolin with a bulk weight of 1.65 t / m3 and a loosening coefficient of 1.3.

Design parameters of the rotary complex:

* actual capacity-1073 m3 / h;

* utilization rate - 69.7%;

* permissible block height: total excavation height -30 m;

* distribution of the total height of the excavation - 3 blocks with a height of each block -11 m;

* block width -17 m;

* the maximum total slope is 1:15.

An example of the use of a rotary complex in the mining industry of Uzbekistan is the open-pit mine "Angren" OA "Uzbekugol". A thyssenkruppfordertechnik rotary complex has been installed and operates here. The system consists of a rotary excavator, a self-propelled conveyor reloader, a combined self-propelled loading and cable trolley (Fig. 8, a), a conveyor unit, a mobile telescopic conveyor and a dump truck (Fig.8, b). the system of conveyor units consists of mobile and stationary units.

The rotary excavator scoops up the material, loads it to a conveyor loader, which transfers the material to the conveyor through the receiving hopper. The loader compensates for changes in the distance and height between the excavator and the conveyor system.

Transportation system as a long conveyor line between the front of mining operations and the place atthe masonry dump of overburden rocks, transports the rock mass to a mobile telescopic conveyor, which through loop devices reloads the material to the connecting dumper. From there, the overburden rocks are poured along the boom of the dumper into the spent part of the quarry.

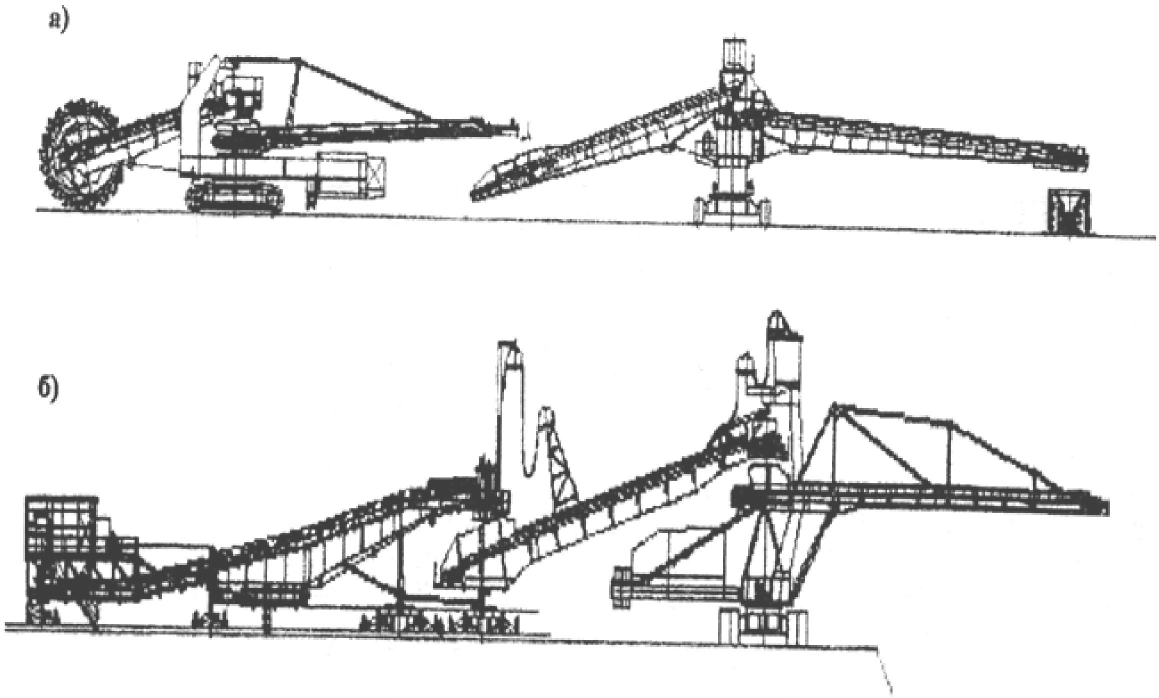


Fig. 8. equipment of the rotary complex of the open-pit mine "Angrensky".

The main design parameters of the rotary excavator that affect the efficiency of the excavation process are the geometric parameters of the machine and running equipment, as well as the kinematic parameters of the drives and the shape of the teeth and buckets.

The geometric parameters of the excavator and running equipment significantly affect the size of the mining block and the efficiency of the rotary excavator in the block, and the geometric parameters and shape of the buckets and toothb-on the cutting force and energy consumption for the digging process.

The main geometrical parameters of the excavator include the diameter and width of the impeller, the asymmetry of the buckets, the coordinates of the suspension point and the boom reach, as well as the installation angles and displacement of the impeller on the boom (Fig. 9). To improve the process of unloading buckets and to prevent the boom structure from contacting the rock slope in the block, the impeller of the rotary excavator can be shifted relative to the boom axis and rotated both in the vertical plane by the roll angle and in the horizontal plane by the bevel angle.

Backhoe operations play a significant role in the process of open-pit mining. Depending on the accepted type of excavator, the appropriate mode of transport and elements of the development system are largely determined, as well as the performance of machines throughout the entire technological process.

One of the main ways to increase labor productivity and perform large volumes of work in deposits with strong rocks is through pipelining and introducing in-line technology for overburden and mining operations. The role of the excavating machine increases with the in-line organization of production and the use of conveyor transportэкскавационной. Therefore, ensuring efficient and reliable operation of excavators, improving their design and development schemes for overburden and mining faces with different rock strengths are becoming relevant for open field development.

When developing deposits with layers of complex structure that require selective excavation, rotary excavators are now practically the only type of equipment that directly provides the necessary granulometric composition of the excavated rock mass and creates the necessary prerequisites for the widespread introduction of conveyor transport.

Prospects for the widespread use of rotary excavators in Uzbekistan in particular at the open pit mineAngren, difficult geological and climatic conditions make the following basic requirements: structures, mechanisms, actuators and control systems, various kinds of auxiliary devices and equipment needs to ensure the work of the excavator with a guaranteed operational reliability in all operating range of temperatures (from +50 to -40 C) and under high dust air;

Parameters of the rotary excavator, machines of the complex and auxiliary equipment, as well as technological schemes of operation should ensure that the operational performance of the excavator is as close as possible to its theoretical performance.;

The design and parameters of the working equipment must provide the requiredAccording to GOST, the granulometric composition of excavated mass and the necessary degree of rock selection in the development of the face;

The structures of the excavator, machinery of the complex and auxiliary equipment should have the greatest possible degree of unification of mechanisms and components and ensure the necessary maintainability;

Rotary excavator control booths and permanent maintenance areas must meet the requirements of ergonomics, industrial hygiene and sanitation.

The wide scope of application of rotary excavators leads to a significant variation in the main technological and kinematic parameters and generates a variety of design solutions for both the basic layout of machines as a whole and their main components. The search for constructive solutions to create these unique machines is far from over.

PRACTICAL WORK № 8.

TOPIC: STUDY AND ANALYSIS OF NEW BIT DESIGNS FOR OPEN PIT DRILLING RIGS.

The purpose of the practical task: *to teach students to analyze new designs of chisels for mining drilling rigs.*

Key words:: *bit structures, cutting bits, shock absorbers, drilling process, rotating discs, spline joints, Poppet springs “ "crown-ball", armament structures, bearing Assembly.*

KuzSTU has developed fundamentally new designs of cutting drill bits with movable rock-breaking elements.

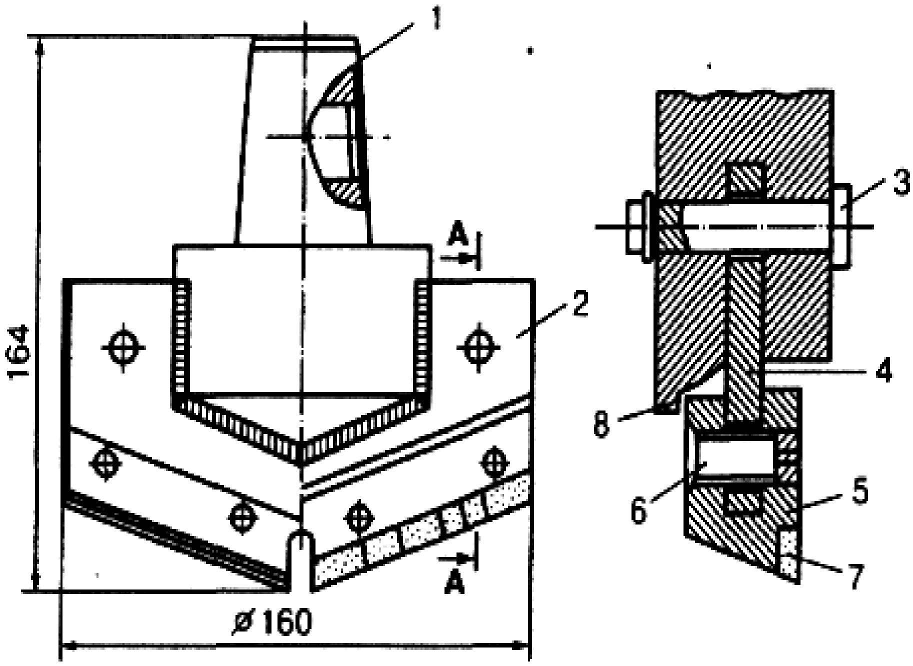


Figure 10. Cutting drill bit with shock absorber in the form of a spring

So, the vibration parameters can be significantly reduced if you use shock absorbers built into the chisel (Fig.10). It consists of a shank 1 welded to the blade 2, in which spring springs 4 are installed using rollers 3.at the free end of the springs, screws 6 fix cutters 5 reinforced with plates 7 of hard alloy VK-8V. The mobility of the incisors is provided by the presence of springs 4.

During drilling, the cutting edges of the cutters destroy the rock at the bottom of the well. The resulting shock loads are smoothed out due to elastic deformation of the spring spring, the stroke of which is limited by the protrusion 8 on the rear wall of the blade.

The chisel not only increases the mechanical drilling speed by 20-25%, but also reduces peak loads by 10-15%. At the same time, the wear rate of the cutting edge is 2.5-3 times less. The design of the chisel allows you to replace the cutters directly at the workplace.

Значительно более сложную конструкцию имеет самонасA self-priming cutting bit with rotating cutting discs has a much more complex design(Fig. 11) [9].

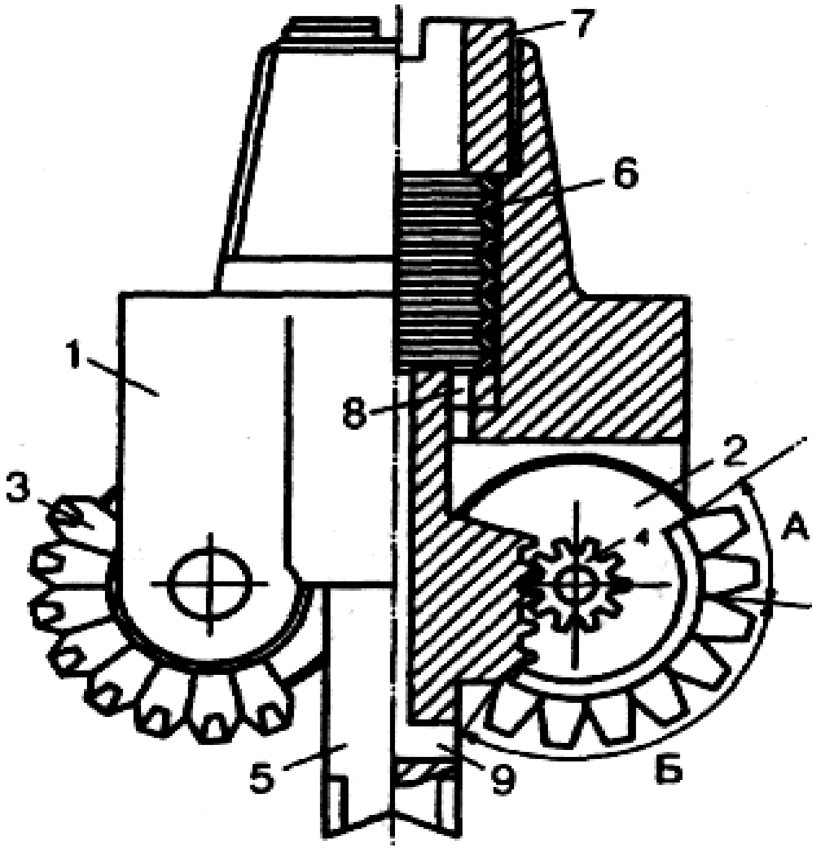


Figure 11 .Drill bit with rotating cuttingdiscs

On the body *1* of this chisel, disks 2 with hard alloy reinforced cutters 3 are mounted on the axes. On the disks 2, gears 4 are fixed, coupled with slats made on the borehole 5, drilling out the leading well. The borehole is connected to the body 1 by means of a spline connection and rests its shank on Poppet springs 6, compressed by means of an adjustment nut 7. compressed air is supplied through the purge channels 8 and 9 made in the body shank and the borehole to clean the bottom of the well.

In sector A of disks 2, cutters 3 are installed with geometry and reinforcementdesigned for drillingrelatively strong rocks. When drilling weak rocks, the borehole 5 is pushed out of the body / and bores a leading well, and the cutters 3 of sector B destroy the main part of the well face.

When drilling hard rocks, the axial force on the borehole increases, and it compresses the Poppet springs and movesup. This will cause the disks 2 to rotate, as a result of which the cutters of sector A, designed for working on strong rocks, will come into contact with the face. Witha decrease in the strength of the drilled rock, the borehole will move down, re-deploy the disks and put the cutters of sector B. when drilling medium-strength rocks, the disks will rotate only by a small angle, and the wear-resistant cutters of sector A will destroy the peripheral part of the face, and the cutters of sector B-its Central part, weakened by the leading well.

If drilling is carried out on rocks that alternate in strength, then the cutters of sectors A and B will work alternately, which will inevitably improve their cooling, and, consequently, their wear resistance. In this case, the cutters are replaced automatically, and the bit is adjusted by changing the compression ratio of the Poppet springs using the nut 7.

Scientific novelty, ball bearing chisel.

1. new designs have been Developed that increase the efficiency породоразрушающегоof large-diameter rock-breaking drilling tools by equipping them with more aggressive centrifugal-volume-reinforced weapons, increasing the stability of the support bearing unit of prefabricated balls, and improving washing conditions by equipping them with a universal Central hydro-monitoring washing unit.

2. new designs of centrifugal-volume-reinforced armament of rock-breaking drilling tools have been Developed, which increase their resistance by 1.5 times.

3. new prefabricated roller structures have been Developed, which increase the stability of the drilling tool support unit by 25%.

4. a new design of the universal Central hydro-monitoring flushing unit has been Developed, which increases the efficiency of large-diameter drill bits by 15-20%. The design is implemented in 29 standard sizes of large-diameter drill bits from 393.7 mm to 660.4 mm at JSC "Gazprom Neft".Sarapulsky Mashzavod".

5.a set of equipment and technological equipment for the production of centrifugal-volume-reinforced armament of rock-breaking drilling tools at a specially created pilot-industrial site has been Developed and created at CJSC "Plant of experimental machines".

The efficiency of a rock-crushing drilling tool is mainly determined by the operability of its three main elements: armament, support and flushing unit.

Considering the main types of drilling tool armament, it is possible to divide them into toothed surface-reinforced and hard-alloy according to their design features. In the first case, the prismatic tooth is formed during milling or casting and further strengthened by applying tungsten carbide - "relit" - to the tooth surface. In the second case, a hard-alloy tooth made of VK is pressed into the body of the ball with guaranteed tightness.

The difference between the physical and mechanical characteristics of the base material (steel) and the reinforcing (hard alloy), both for surface -reinforced gear and for hard-alloy weapons, determines its wear. Basically, all types of wear of weapons are reduced to fatigue in the process of impact and to abrasive. Wear of the gear armament is accompanied by peeling off the reinforcing layer from the tooth surface, exposing the unprotected steel core and its intense wear, which leads to blunting of the tooth. The carbide tooth is chipped, broken off or completely falls out of the ball during operation. This leads to the accumulation of hard-alloy material (scrub) on the bottom face and, as a result, to a decrease in drilling performance.

The above considerations apply not only to drill bits, but also to the vast majority of rock-breaking drilling tools. These are various drilling machines, rock-breaking tunneling породоразрушающиеcomplexes, and rock-breaking cutters.

Our analysis shows that the existing designs and technological processes for manufacturing drilling tool armaments are labor-intensive, metalo-and machine-intensive. In some cases, it is irrational to use a deficient hard alloy.

We have developed a method of centrifugal reinforcement of the drill bit ball armament. The essence of the method is to combine the processes of centrifugal casting and reinforcement. The result is a new design of weapons with the placement of reinforcing grains of hard alloy not on the surface of the tooth, but in the volume of its working part.

There is an attempt to use this method for reinforcing the gear armament of solid-cast drill bits and for obtaining centrifugal-reinforced teeth. However, a stable quality of reinforcement of the gear armament, especially for multi-ring balls, was not obtained, and the task of obtaining equal-resistant crowns with identical reinforcement quality indicators remained unresolved.

The proposed work considers the possibility of constructive placement of reinforcing material in the volume of the working part of the armament with centrifugal-volumetric reinforcement of small volumes at the same level to obtain equal-resistant, with the required quality indicators of armament reinforcement, individual centrifugal-volumetric-reinforced crowns of rock-destroying drilling tools.

At the same time, the greatest effect of the new armament design is achieved for chisels of large diameters above 393.7 mm with weapons of the "M" and "S"types. Our research has shown that the use of centrifugal-volume-reinforced weapons with specified quality characteristics requires the implementation of combined balls. At the same time, it is important to note that in the new prefabricated structure, the rock-destroying toothed crown is attached to the stamped body of the roller. This significantly increases the stability of the support unit in comparison with mass-produced large-diameter chisels with cast balls for "M" and "S" type chisels. At the same time, the condition for ensuring sufficient strength of the crown-ball joint must be met.

Along with the armament, another element that determines the performance of a rock-breaking tool is a support or bearing unit. As is known, by design and manufacturing technology, the support units of rock-breaking drilling tools are divided into rolling bearings and plain bearings. Rolling bearings with the classic "roller-ball-roller" scheme are used for high-speed tools, mainly for the turbine drilling method, and plain bearings are used for the low-speed rotary drilling method.

It is also known that in the manufacture of drill bits of large diameter and especially of the "M" type with the most developed reach and tooth shape, the technology of casting balls according to melted models is used. As a result, the Central part of a stationary cast ball gets the worst metal structure, has discontinuities and negative inclusions. At the same time, it is the area of the support bearing unit.

Since the physical and mechanical characteristics of permanently cast metal are 25-30% lower than those of stamped metal, we have conducted research to overcome this disadvantage. As a result, it was found that one of the most effective ways to increase the stability of the support unit is to increase the wear resistance of bearings by improving the physical and mechanical characteristics of their material by using new steels in the balls of a combined structure.

The analysis showed that the existing methods of fixing crowns in prefabricated balls are either time-consuming or do not provide sufficient strength for fixing crowns. The creation of more advanced methods for attaching the crown to the body of the ball will make it possible to obtain an effective rock-destroying drilling tool with weapons and a support of increased durability.

The third element, along with the armament and the supporting bearing unit, which actively affects the operation of a rock-crushing drilling tool, is its washing unit.

The main problem with the operation of chisels, especially of the "M" and "S" types, is the formation of an oil seal on the armament of the chisel, especially when drilling clay rocks. At the same time, it is difficult to insert the tooth into the pillar of the rock, which dramatically reduces the efficiency of face destruction and, accordingly, the technical and economic performance of the chisels.

It is known that the efficiency of hydraulic monitoring bits depends on the design of the flushing unit, which is able to direct the liquid jet directly to the bottom of the well with the lowest hydraulic losses.

The issues of improving the flushing system are especially relevant for large chisels, since when drilling wells with increased diameters, the volume of rock drilled increases and it becomes more difficult to remove it from the bottom surface and arm the bit.

The efficiency of the flushing unit directly depends on its reliability. In this regard, one of the ways to improve the efficiency of large-diameter chisels is to develop new designs for Central hydraulic monitoring washing units.

Since it is for the "M" and "S" type chisels that it is first of all necessary to solve the problem of eliminating oil seals, the development of a more efficient design of a universal Central hydraulic monitoring washing unit for these chisel sizes is a very urgent task.

Thus, the analysis of existing designs, manufacturing technologies and operation features of large-diameter rock-crushing drilling tools allowed us to find new technical solutions for arming, supporting and flushing units, which, when implemented separately or in combination, lead to an increase in the main technical and economic indicators of drilling in General.

In connection with the above, to achieve the goal set in the work, it is necessary to solve the following tasks::

* analyze the design and technological features of a rock-breaking ball drilling tool;
* develop a new design of centrifugal-volume-reinforced armament, obtained by the method of centrifugal-volume reinforcement of small volumes at the same level;
* to design weapons of a new design, determine and study the physical and mechanical characteristics of a centrifugal-volume-reinforced material;
* develop new design schemes for prefabricated drilling tool balls with research to ensure the required strength of the "crown-ball" joint»;
* develop effective design schemes for a universal Central hydro-monitoring flushing unit in the course of studying the process of face and bit flushing, simulating the drilling process;
* develop a set of equipment and tooling for the production of new structures of centrifugal-volume-reinforced drilling tools;
* verify research results during bench and industrial testing and develop recommendations for industrial use.

PRACTICAL WORK № 9.

TOPIC: STUDY AND ANALYSIS OF CUTTING-BALL AND SELF-ADJUSTING BALL BITS.

The purpose of the practical lesson: *to teach students the analysis of cutting-ball and self-adjusting ball bit.*

Key words:: *cutting and rolling bits, self-adjusting bits, rolling bits, cyclic loading, cutting elements, conical thread, axial force, rock breaking, combined tool, rock strength.*

In quarries, drilling rigs of the SBSH (ball drilling machine), SBR (cutting drilling machine), SBU (rotary impact drilling machine) and combined (SBUSH) types are used, designed for the use of ball, cutting, pneumatic impact and other drilling tools.

The most widely used two basic models of domestic ball drilling machines-SBSH-200 and SBSH-250, which are still undergoing a long stage of evolutionary development. Machines of these two groups are manufactured by a number of factories in various modifications and differ in the principle of construction of rotary-feeding mechanisms that determine their design appearance and technological capabilities.

When evaluating the effectiveness of drilling rigs for drilling blast wells in quarries, special attention should be paid to the design features, modes and operating conditions of ball bits.

A ball chisel is a multi-part mechanism that uses the principle of free rotation of several (usually three) balls on independent axes (supports with rolling bearings). The stepper motor consists of sections welded together, on the trunnions of the legs of which the mounted rollers rotate and are thus non-separable structures, as a result of which the entire chisel is rejected when one roller or its support fails.

The high efficiency of ball drilling in hard rocks is explained by the large working surface area of the ball bit and the high contact pressures of the teeth on the rock. These design features provide a significant service life of the wear resistance of the ball bit and the ability to transmit high power and contact loads to the face that exceed the contact strength of the rock. At the same time, ball drilling requires large values of axial loads, power, machine weight and its cost.

The main reasons for the failure of supports are the penetration of rock fines through the gap between the ball and the paw into the bearing cavity, which leads to blockage of the support, increased bearing wear, reduced support resistance and jamming, but the main disadvantage of ball bits is the weak adaptation of the specific design of the stepper motor to changes in the properties of drilled rocks, which forces it is advisable. At the same time, when drilling complex-structured ledges, the advantages of the spherical method may be lost. Hence, there is a need for special approaches to the choice of rational SD structures for quarries, including the use of toothed-disc balls, cutting-ball (RSH) and other various combinations. However, these innovations have not yet found widespread industrial application.

When drilling complex rock formations characterized by fluctuations in physical and mechanical properties in depth, significant shock loads and vibrations often occur, which result in an increase in cyclic stresses throughout the drilling body. At the same time, 80% of failures occur due to the destruction of the rolling bearings of the drill bit balls. Also, during the drilling process, various complications arise that are a consequence of the failure of the drilling tool. At the same time, the most effective solution is to adjust the operating parameters in a timely manner and smooth out shock loads.

The analysis carried out showed that a lighter machine when forming shock loads creates a less rigid feed of the working body. As a result, the impact factor and impact response are reduced. This can lead to an increase in the durability of the chisels, as shown in Fig. 12. thus, for drilling complex rock formations, in the absence of adaptive mechanisms and an adaptive drilling automation system, it is recommended to use lighter machines.

In addition, the analysis of the penetration of individual brands of spherical chisels with a diameter of 215.9 mm, produced by the Belgorodsky, Volgaburmash, Uralburmash plants (figure 13) and with a diameter of 244.5 mm, produced by the Belgorodsky, Volgaburmash, Glubur, Uralburmash plants (figure 14) was carried out.

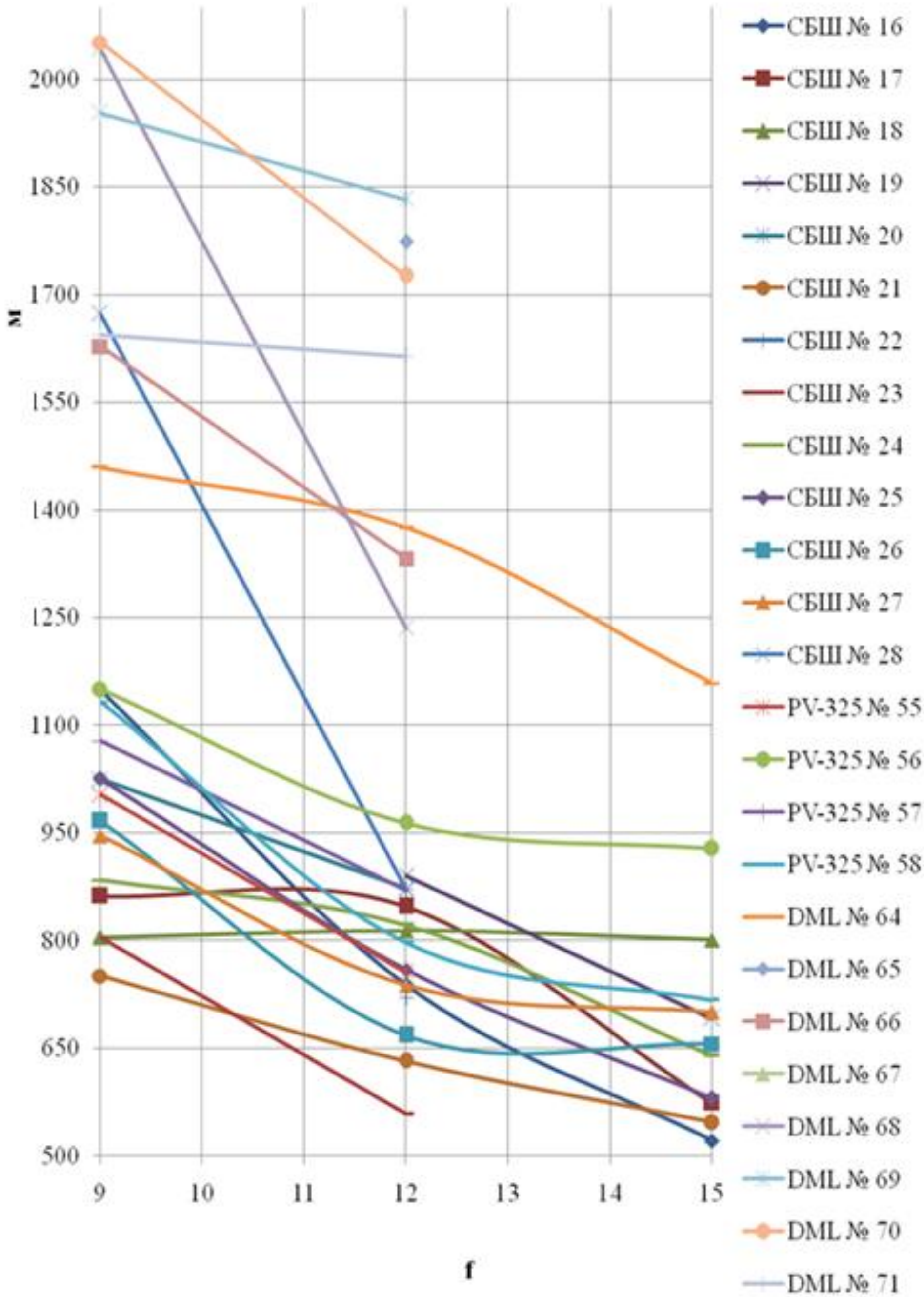


Fig. 12. Dependences of the penetration of spherical chisels depending on the strength of rocks (on the scale of Prof. Protodyakonova) when drilling blast wells with separate machines

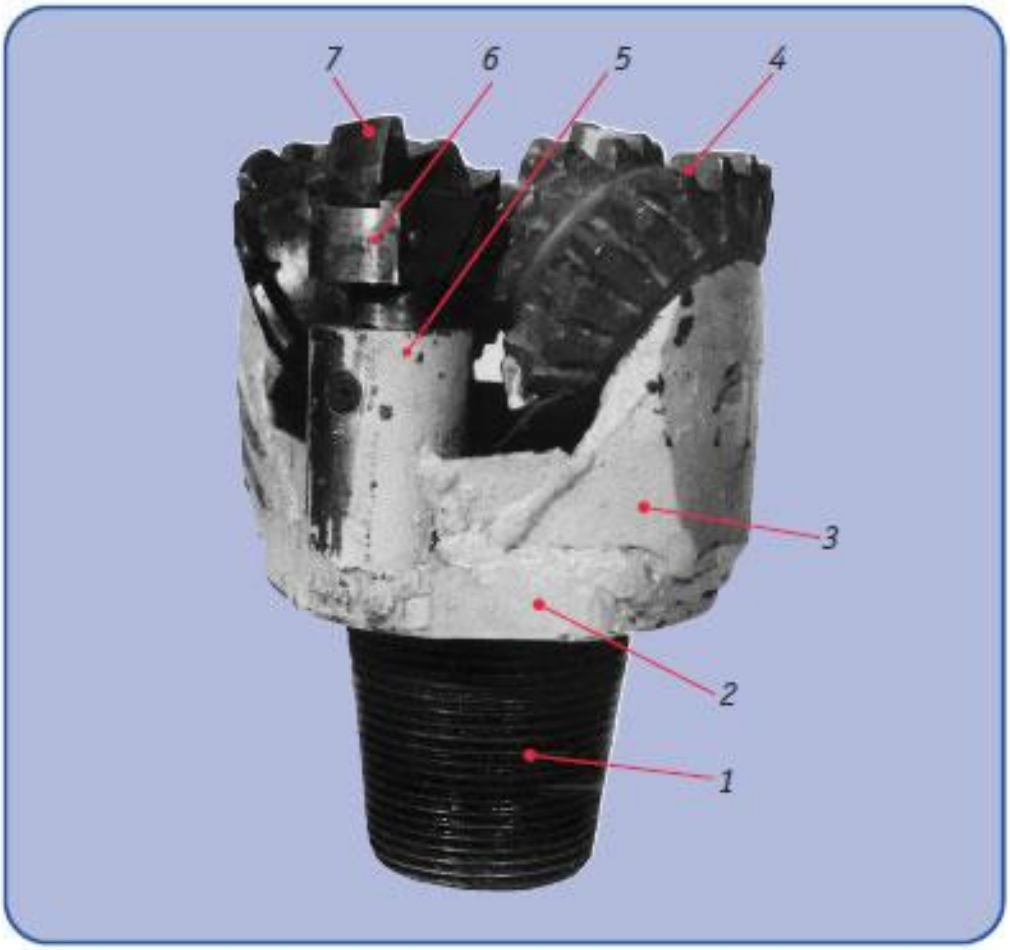
The results of the research and production tests show that the most promising type of drill bits should be considered combined cutting-roller cone bits (RCB), which have no analogues in foreign practice.

When drilling non-abrasive formations, these bits can successfully replace expensive and deficient roller cone bits.

Structurally, cutting-roller-cone bits can be performed according to various schemes, which differ from each other in the mutual arrangement of the cutting bodies and cones on the bit. The most rational are the RChDs with cutting blades located between the cones. These blades can be stationary relative to the body and rigidly fixed on it or rest on an elastic element, which allows them to move in the axial direction. As a resilient element in most of the proposed designs, springs of various types are used. In this case, the spring-supported cutting element is made as a single unit and contains two blades with solid cutting edges or intermittent ones formed by removable cutters.

However, from the point of view of the effectiveness of rock destruction and to increase the wear resistance of the bit, it is advisable to equip the RPM with two independent cutting elements.

Such an element can be made as a holder on which removable cutters are mounted, equipped with a shank resting on an elastic shock absorber. In this case, it is most rational to use rubber shock absorbers placed in the holes into which the shanks of the cutting parts of the bit enter.



Resistive amortizers, on which the needles are supported, can be performed as Lines dry with a hole in the center, substituted in the metal. With uniaxial compression, such an element acquires a barrel-shaped shape. At the same time, from the moment of touching its side on top of the glass, the effect of the object is manifested a lot of squeezing, the stiffness of squeezing my element rises sharply, and it is limited there is a further movement of the tails, playing the role of a buffering device.

Under cyclic loading during drilling, the shock absorber may heat up. In addition, the adjacent bit body also heats up. Heat generation accelerates the physical, mechanical and chemical processes in the rubber shock absorber and reduces its strength. For most rubbers, the threshold of temperature stability is 80–100 ° C, therefore, it is necessary to provide for cooling the glasses in which the shock absorbers are installed. Cooling of the bit itself is carried out by compressed air supplied to the bottom of the well to clean it from drill fines.

It is rational to equip the movable cutting bodies of the bit with removable standard cutters RK-8B or RB-224.

The cutters can be replaced with new ones or re-sharpened as they wear out. This increases bit life and reduces tooling costs.

Roller cutter shares can be used from serial C or T type roller cutter bits, which are welded to the bit body. In this case, due to the inaccuracy of machining and assembly, it is possible to install the cones inaccurately, as a result of which they will be unevenly loaded, therefore the chisel paws must be assembled on the jig.

Taking into account the foregoing, at the Department of Mining Machines and Complexes of KuzGTU, a cutting-roller cone bit, shown in the figure, was designed, manufactured and tested. It is a two-rotor chisel with a body 2 made in one piece with a shank 1 equipped with a standard tapered thread. Paws 3 with cones 4 are welded to the body. In the cups 5, which are also welded to the body, there are movable holders 6 resting on rubber shock absorbers. Removable cutters 7 are fixed on the holders, which are cutting bodies.

When drilling soft rock, the bit works like a cutting bit. With an increase in their strength, the shock absorbers are compressed under the action of an axial force, and the cutters come into operation. In this case, the destruction of the rock occurs under the action of the combined action of the cutting and roller cutter tools.

As experience in the design and testing of bits has shown, the combination of cutting and roller cutters in them allows, when drilling wells in brittle rocks of medium hardness (with f = 5–6), to reduce the energy consumption of the destruction process by 15–20%.

Comparative tests of bits carried out at the enterprises [3] show that RCBs have significant advantages over serial roller cone bits.

The combined drilling tool can be used on rotary (roller cone) drilling rigs manufactured by the industry, and should be widely used. However, the serial production of combined bits has not yet been established and requires investment in organizing their production.

A fundamentally new technique, based on new principles and having no analogues in the world, are the combined cutting-roller cone bits developed by KuzGTU and IrGGU.

Cutting-roller-cone bits (RCB) have both cutting and roller-cone rock-cutting bodies (Fig. 15).

In this case, in most of the known designs, the paws 1 with cones 2 are fixedly fixed to the bit body 3, and the cutting blades 4, located between the cones, rest on an elastic element 5 in the form of steel springs (disc or spiral), a rubber shock absorber or an air cushion.

When drilling weak rocks, the cutting tool (locatedbelow the balls) under the action of an axial forcetransmitted through a spring, it is embedded in the rock and the chisel works as a cutting tool.

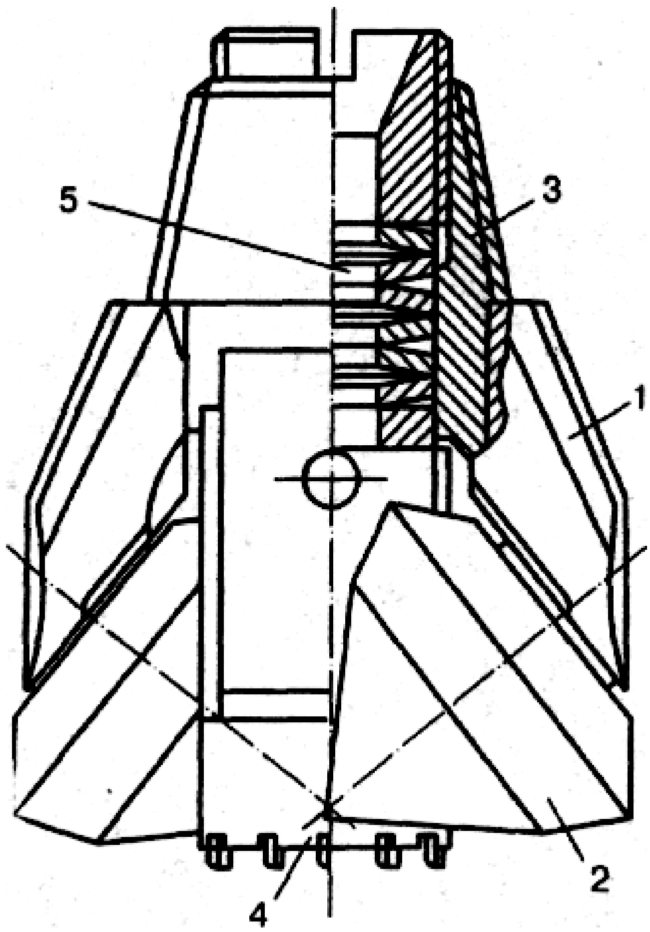


Figure15 .Cutting-ball chisel

On strong rocks, the increased axial force compresses the spring, and the teeth of the rollers come into contact with the face.

In well-known designs of ball bits, the balls rotate around rigidly fixed axes (trunnions) and cannot move, which eliminates their reconfiguration when the strength of the drilled rocks changes.The rough chisel developed at the same Department of mining machines and complexes of KuzSTU allows us to eliminate this deficiency and significantly increase the efficiency of drilling rocks of various strengths(Fig. 16).

On the body 1 of the chisel, paws 2 with diskballs 3 are installed.movable paws 4 with toothed balls 5 are mated to the body by means of a movable connection of the "swallow tail" type (section A-A).

Poppet springs 6 are installed between the body and the movable legs. when drilling weak rocks, the legs 4 are displaced down and forward by the action of the spring in the direction of rotation of the bit (Fig. 16) relative to the axis 1-1 of the bit by the value e = 5-12 mm. Since the tops of the cones of the balls do not coincide with the axisof the well, the balls will roll along the face with slippage, whichcontributes to the effective destruction of weak rocks.

As the rock strength increases, the rolling resistance ofthe balls will increase, and they willovercome the resistance of the springs and moveup and towards the center of the well (in the position indicated by the dotted line in Fig. 16, δ), which will prevent them fromslipping and ensure effectivedestruction of rocks of increased strength.

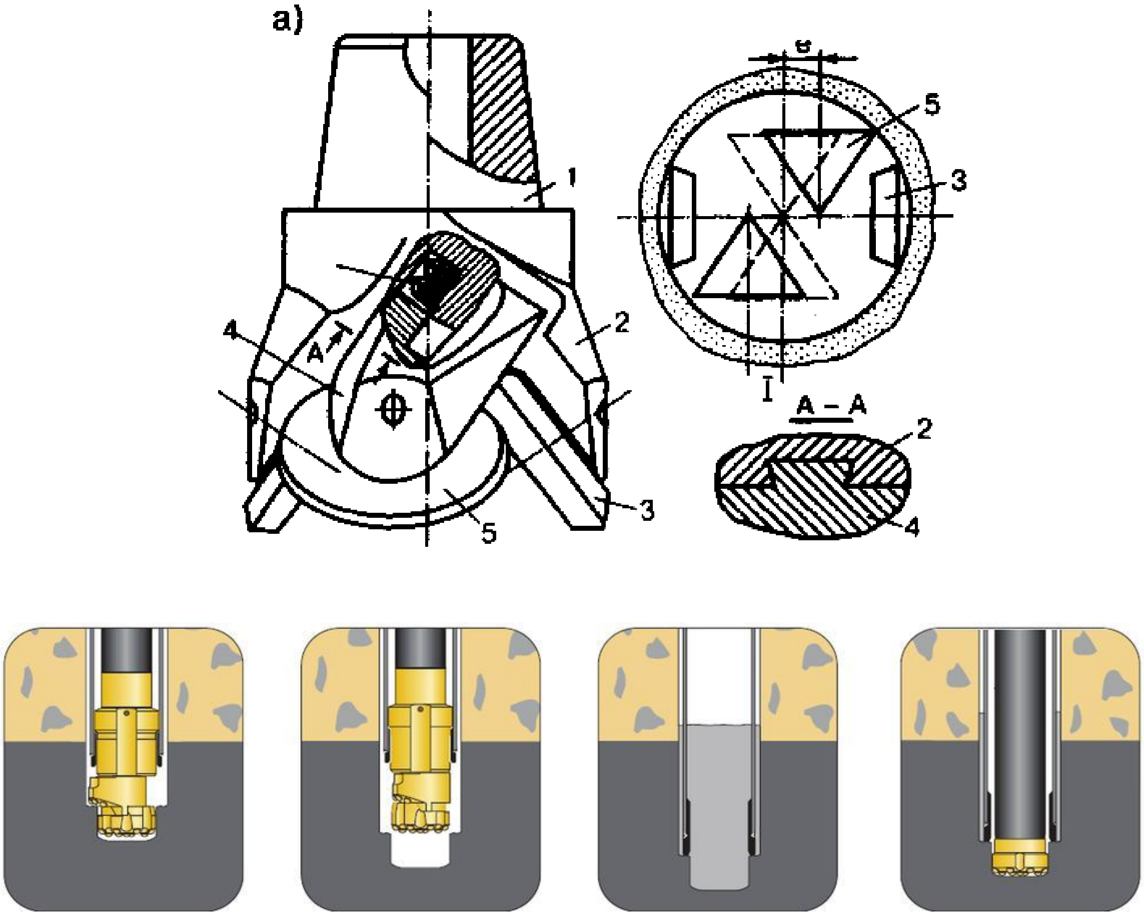


Fig. 16. self-Adjusting ball chisel

The use of such aself-adjustingball bit will increase the drilling speed and-effectively drill both weak and stronger rocks without replacement.

RACTICAL WORK № 10.

TOPIC: STUDY OF TROLLEY TIPPER AND EQUIPMENT THEIR MAIN ELEMENTS, SCOPE AND CONDITIONS OF APPLICATION.

The purpose of the practical lesson: *to teach students the basic elements of equipment and tilters for trolleys, as well as the scope and conditions of their use.*

Key words:: *tippers, classification of tippers, circular tippers, tipper start-up, tipper assignment, trolleys, pushrod-tipper, automated complex, drive operation, drive rollers, support rollers*

Purpose and classification of tilters

Overturners are designed for unloading trolleys with a blind (rigidly fixed on the frame) body. They are installed in near-trunk yards of skip or conveyor lifts, as well as in overhead buildings of crate lifts and other places where mineral resources are transferred from periodic transport devices to continuous transport devices.

Tippers used in mining enterprises are divided according to the following characteristics::

· as intended - for unloading single trolleys and non-detachable trains;

· in the direction of tipping – circular (unloading through the side wall of the trolley) and frontal (unloading through the end wall of the trolley);

· in terms of the angle of rotation of the trolley during unloading – incomplete (reversible) and full-turn (non-reversible);

· according to the mode of operation of the drive motor – with continuous operation and periodic switching on of the motor (at each cycle of unloading of the trolley);

· by the number of trolleys being unloaded at the same time – for one or several trolleys;

· according to the principle of operation of the slewing mechanism drive - with friction and chain drives;

* by type of drive – with electric, hydraulic or pneumatic drives.

Also available are tilters designed to allow locomotives to pass through them (to reduce the length of workings in the near-trunk yard and simplify shunting operations).

The most widely used are non-rotary circular tilters with side unloading and a friction mechanism for turning the drum, as well as full-turn circular tilters with side unloading and a chain mechanism for turning the drum.

Both types of tippers allow you to unload non-detachable trolleys and are characterized by high productivity.

Tipper serve for unloading trolleys by tilting or turning them to the position that ensures the discharge of cargo.

Tilters are classified according to the following criteria::

1) according to the method of unloading trolleys — circular; side with a rod working body; side with a rotary platform; frontal;

2) for its intended purpose — for unloading single trolleys; for unloading non-separated trains without passing an electric locomotive; for unloading non-separated trains with passing an electriclocomotive;

3) according to the nature of the drive operation — with continuous operation of the engine; with switching on and off of the engine at each cycle;

4) by type of drive — electric; hydraulic pneumatic;

5) by the number of simultaneously unloaded trolleys — for one or several trolleys;

The most common are circular dumpers, which allow you to fully automate the process of exchanging and unloading trolleys.

The body ("drum") ofthe tipper consists of two steel rings, connecting trusses and sheets, and a section of rail track mounted inside the drum, on which the unloaded trolley is installed. The rings are supported by two pairs of rollers, of which one pair (the water roller) rotates continuously after starting the electric motor and causes the body to rotate by friction against the rings, while the other-pair is a support roller. At the end of a full turn, the housing is slightly lifted off the drive rollers andlocked with a "lock" so that the drive rollers rotate idly. Atthe same time, the track stop mounted in the tipper is automatically opened and the empty trolley is replaced with a loaded one using a push rod (or a scooter).

The tipper is then startedby turning off the lock with the handle, so that the rings come back into contact with thewater rollers and the drum starts to rotate.

In some tipper designs, the Shoe is controlled remotelyby means of an electrohydraulic or pneumatic drive.

In the push-pull-over mechanical system, the push-pull and the tipper are electrically locked so that they are automatically triggered alternately. There are also schemes of fully automated complexes, in which the pusher and tipper are-unblocked with a skip loading device.

To work in an automated system,tippers must be equipped with sensors that record in the tipper: the open position of the stoppers, thecorrect position of the trolley, the initial positionof the tipper drum, as well as the disconnection of the drive of the locking mechanism of the drum.

Trolley tippers are manufactured with a capacity of up to four tipples per minute.

The car with a bottom conveyor of the VK type (bunker-car) is designed for receiving, accumulating, transporting and unloading rock mass during horizontal mining operations. The hopper car consists of a body mounted on trolleys. A double-chain scraper conveyor is built into the bottom of the body, powered by pneumatic or electric motors connected at loading and unloading points. The body is pivotally connected to the front bogie by two levers, and to the rear bogie by horizontal hinges that allow the body to be raised and lowered in a vertical plane. With the help of a hydraulic cylinder located under the bottom of the body, the front part of the body is lifted and slid onto the rear part of the body of the previous car, which ensures uniform filling with rock mass of all cars connected to the train (a bunker train formed from separate bunker cars).

After loading, the wagons are lowered into the transport position, rejected by the locomotive and the rock mass is unloaded into the ore outlet alternately from each car using a bottom scraper conveyor.

The advantages of bunker cars are the movement of rock mass by a bottom scraper conveyor along the body of a large capacity, unloading of cars without additional mechanisms, as well as the formation of a bunker train with a capacity that provides transportation of all the rock mass recaptured in the preparatory face of the mine workings during the drilling and blasting cycle.

Vnipirudmash Institute has developed tunneling wagons with a bottom conveyor of the VPK-7bivpkne-7 type with a track of 600, 750 and 900 mm. The main difference between these cars is the type of drive of the bottom scraper conveyor: pneumatic — on vagonevpk-7 and electric-on vagonevpkne-7.Parameters of the car: load capacity 23 tons; body capacity 7 m3; length without coupling devices 8900 mm; width 1350 mm; height 1500-1650 mm; unloading time of one car 60-90s.

The company "Haglund" (Sweden) produces hopper cars with a scraper conveyor located in the body obliquely. In this case, the front part of the car is not lifted, but inserted into the loading (rear) part of the previous car.

Domestic bunkers-trains consisting of articulated sections with side walls and a bottom, with a scraper conveyor mounted in the bottom along the entire length of the train, are not widely used due to jamming and floating of the scraper chain when working on rounded sections and roughness of the track. Another type of bunker train, which used a scraper unit located on a self-bunker train instead of a scraper conveyor, also did not find industrial use due to its bulkiness and low operational productivity.

Device and scope of trolleys

The VG type trolley consists of a body , frame, half-rails, buffers, couplers and a sub-car stop.

The trolley body is made of welded steel sheets 4-8 mm thick with a semicircular or rectangular bottom. To increase rigidity, the body is reinforced with stiffeners and external strapping. In order to increase the durability and corrosion resistance of the trolley body, it is made of low-alloy steels.

The trolley frame is also welded. It is used for fixing the body, half-ramp axles, buffers and hitches.

Depending on the capacity of the body, the half-ramp axles are connected to the trolley frame either rigidly or by means of rubber-metal shock absorbers, which are designed to reduce dynamic loads on the undercarriage when the trolley moves along uneven tracks and switches, as well as to evenly distribute the load from all the trolley wheels to the rails.

Buffers of trolleys are made rigid cast or elastic with spring or rubber shock absorbers.

Depending on the purpose of the trolley and the capacity of the body, link or automatic couplers are installed, which are performed non-rotating or rotating. Rotating couplers provide the possibility of unloading trolleys in circular tippers without uncoupling the train. All couplings have a six-fold safety margin.

In trolleys with a small body capacity, link couplers are used. Connecting trolleys is carried out manually by throwing the link of one hitch on the hook of the second hitch. In trolleys with a large capacity body, automatic rotating couplers are used, which ensure that the trolleys are connected automatically when they collide.

The most advanced designs are the VG4,5A, VG9A, VG10A blind body trolleys upgraded by the Vnipirudmash Institute and with a folding side

VB4A, which are designed for transportation of rock mass with a density in bulk up to 3 t / m3. 18a), consisting of two wheels 1, mounted on the axis 2 with the help of roller bearings. The bearings are sealed on the inside by a labyrinth ring 3, and on the outside by a cover 4.

In heavy-duty trolleys of the VG9A type, the body rests on two-axis running trolleys (Fig. 18b) using spherical spores welded to the bottom 5. the Trolley consists of a balcy6, sidewalls 7 pivotally connected to it, half-ramps 1 and rubber-metal shock absorbers 8.Thanks to this design of running trolleys, the conditions for passing trolleys on uneven and curved sections of the track are improved.

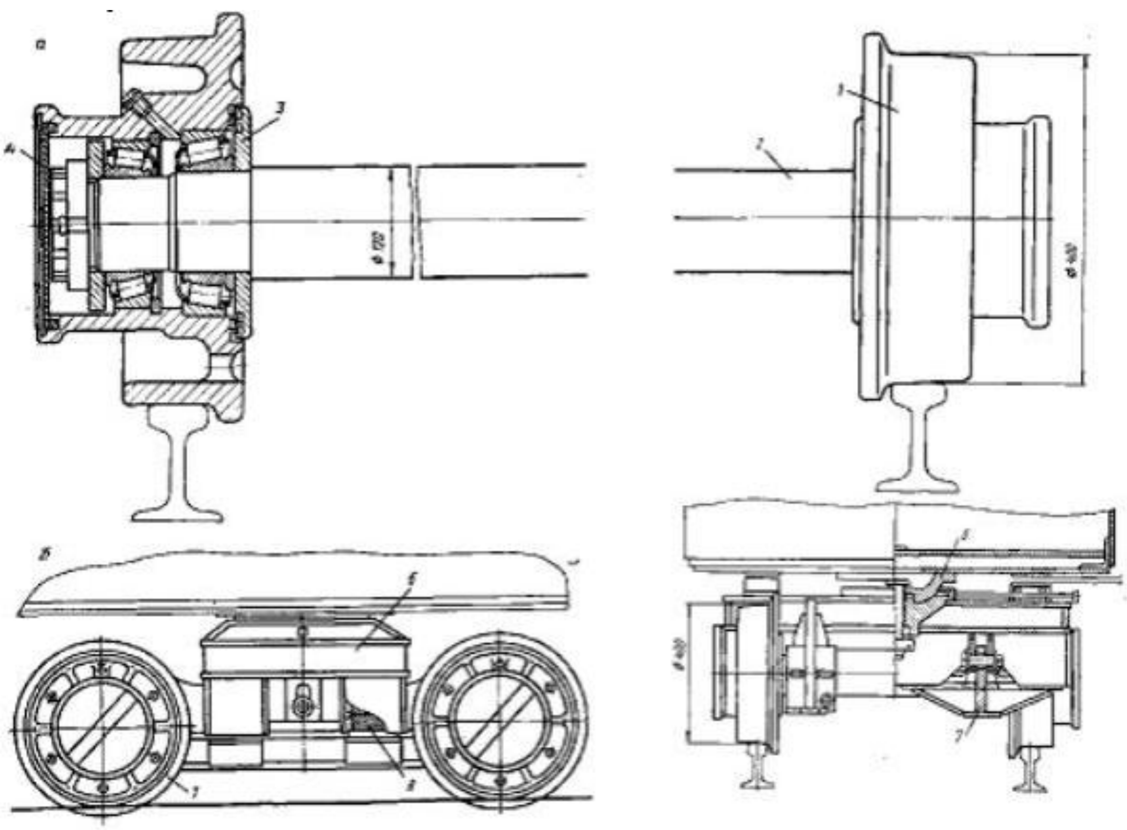


Fig**. 18.* Unified semi-slopes of mine trolleys (a***) and two-axis running trolley trolley VG9A ***(b)***

VG4 trolleys.5A and VG9A are equipped with an automatic or rotating link hitch.

The automatic rotating hitch (Fig. 19,***a)***consists of a housing *1*assembled, a shock absorber *2*and a locking device*3*.A locking mechanism is integrated into the hollow body of the hitch. The hitch shock absorber includes two springs: an external spring that perceives shock-traction forces, and an internal spring that provides centering of the hitch body in axial stress.

The locking device*4*consists of two Cam half-couplings, one of which rotates around the rod, and the other slides along it. Half couplings under the influence of the centering internal spring are constantly engaged and hold the body of the automatic coupling in a fixed axial position.

The coupling of trolleys equipped with an automatic coupling occurs automatically when they collide, and disconnection occurs when the lever of the release mechanism of one of the couplers is pressed. Unloading of trolleys equipped with rotating couplers is carried out in circular tippers without uncoupling the train.

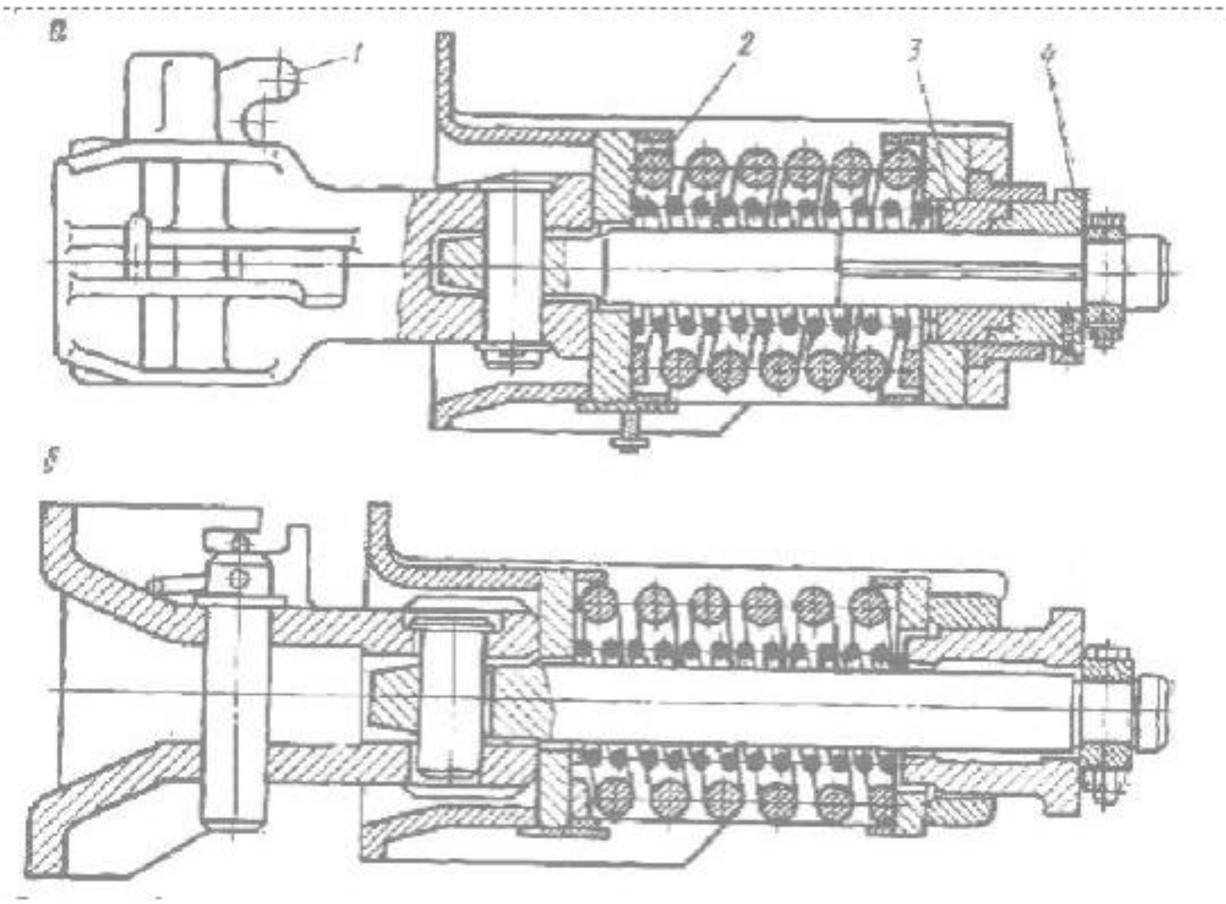


Figure*19.*Trolley hitches:

a-automatic rotating;

b-rotating link

The rotating link hitch (Fig. 19,***b***) is similar in design to an auto-hitch. Basic parameters of trolleys (see table.1): the capacity of the body (indicated in cubic meters after the letter designation of the trolley type); own weight; load capacity; tare coefficient (the ratio of own weight to load capacity); specific resistance to movement; dimensions; track width and rigid base (the distance between the axles of the half-ramp wheels).

The type and parameters of trolleys for specific ore mines are selected on the basis of technical and economic calculations, taking into account the cost of maintaining the car fleet, loading and unloading complexes and other costs. The optimality criterion is the minimum of the given costs.

When choosing the capacity of the trolley body, take into account the length of the rollback and the productivity of the mine or horizon (table 2). in Addition, the type and capacity of the trolley body for transporting bulk cargo should also be chosen taking into account the mating mining equipment (crates, tippers, stoppers, pushers, etc.).

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Navoi mining and metallurgical combine
Navoi state mining Institute

Faculty of mining

GLOSSARY

by discipline:

“SPECIAL DESIGNS OF MINING MACHINERY AND EQUIPMENT”

Glossary

Head – the pressure H or h pressure generated by the turbomachine. The pressure measurement units are the heights of liquid columns (water, mercury, alcohol, etc.) or the atmosphere: physical and technical.

The slider is used in crank mechanisms of double-acting compressors. It is tightly connected to the piston rod, and movable with the connecting rod by means of a finger.

A pumping unit in the mine is necessary for pumping water to the surface. There is a local drainage system for pumping water from a site (or group of sites) to the level of the near-trunk yard of the mine and the main drainage system for issuing water from the level of the near-trunk yard to the surface.

A pneumatic installation is necessary to produce compressed air used in the mine for the operation of jackhammers and drill hammers, pneumatic motors, winches, local pumps, etc.

Pistons of single-stage simple-acting compressors are made hollow, in the form of a glass, in the inner part of which a connecting rod pin is installed, fixed in the holes of the piston wall. Double-acting compressors use disc pistons. For better sealing of the piston in the cylinder, spring rings made of gray cast iron are used, placed in recesses around the circumference of the piston.

The compressor station operates in three shifts, coal operations are carried out in two shifts, and the mine operates on a continuous working week.

Technical object – any object that is subject to calculation, analysis, testing and research in the process of its design, manufacture, application, maintenance, repairs, storage and transportation in order to ensure the effectiveness of its functional purpose (hereinafter referred to as an object - a machine-building product: equipment; unit; machine; node; part).

Equipment is a collective term that includes all types of technological-equipment, machines, mechanisms andother objects with related metal structures (-pipelines, lining, etc.) that participate in the production process by performing certain technological functions.

Aggregate - a set of a number of machines,mechanisms, devices and structures connected by a single technological process and designed for joint efficient operation.

Machine - a set of mechanismsdesigned to perform useful work related to the process ofproduction or transportation, or energy conversion.

Mechanism - a system of kinematically interconnected components and parts- designed to transform the type of movement or to transmit power.

Node - a split or one-piece connection of several parts.

Repair unit - a connection of several partsthat can be madeindependently of othermating parts of the mechanism, as well as removed or installed in assembled form as a whole.

Part - a product made as a single unit and whose separation into parts is impossible without damaging the product itself.

Spare part - a component part of a product intendedto replace the same part that was in service for the purposeof maintaining or restoringthe serviceability or operabilityof the product.

The dredging (cleaning) combine is a machine that separates coal from the mass by cutting andloads it to the bottom-hole conveyor (on flat and inclined layers).

The combine harvester, working in combination with a mechanized (-individual) support and conveyor in accordance with the state of shelterand soil, extracts a layer of a certain capacity.

Plow installation -mining machinery for excavation and nawalka seams flat and inclined (up to 35°) fall love with podpisaniem along strike, fall or rebellion consist of the same parts and components, but differ in the location of the traction chain body relative to the conveyor structure,traction installation, type supports the Struga is on the conveyor or soil formation and some characteristics of these elements.

Drilling machinesand installations are called mining machines designed for drilling boreholes.

Drilling rigs are mining machines designed for drilling wells.

Drilling tool in the form of a single drill or consisting of a drill rod and a cutter or drill bit, reinforced with a hard alloy is used for drilling boreholes

Dredging and transporting machine(bulldozer, scraper, grader, etc.)- a mining machine that excavates rock and moves it in front of the working body or in it for a certain distance by drawing.

Tunneling and mining combines and complexes are mining machines designed for carrying outmining operations on rocks with a strength factor f of up to 8 units. and upto byche shale, potash salts, manganese ores with short-column systems.

Conveyor - a continuous-action machine for moving bulk, lump orpiece loads.

Belt conveyors provide transportation of goods over a considerable distance by a special belt moving along roller supports, which is both a load-carrying and traction body

Loading of rock is mechanized by means of loading, post-loading and transport, loading and delivery machines and scraper complexes

WORKING CURRICULUM

On the course: SPECIAL DESIGNS of MINING MACHINERY and EQUIPMENT

for students of the master's degree program:

5A310705-Mining machinery and equipment

Area of expertise	300,000	–	Industrial and technical sphere
Education area	310,000	–	Engineering business
Direction of education	5A310705	–	Mining machinery and equipment

Semester	**3**
Total number of hours	130
Of these,:	
Lecture	36
Practical exercises	36
Independent work	58

NAVOI-2020

INTRODUCTION

Master's students of the specialty 5A310705 - "Mining machinery and equipment", during their bachelor's studies, study a number of specialization disciplines and there they become familiar with the designs of standard machines and equipment, the basics of their theory and calculation, the areas and conditions of application of these machines.

The course "Special constructions of mining machines and equipment" provides for the study of special, non-standard and new machines and equipment, improved components and equipment of standard multi-series machines and, therefore, there can be no standard textbook for this course, designed for students to use for many years.

The low availability of imported equipment due to its high cost has forced many countries with a developed mining industry to rapidly develop their own developments in the entire range of machines and equipment in relation to the conditions of their mining production, to establish the production of these machines in their country by creating a new or serious modernization of existing production for the production of competitive mining equipment.

The desire of each state to develop its own production of mining machines has given rise to a wide variety of created mining equipment of the same functional purpose, not only in terms of design and layout solutions, but also in terms of technical, economic, operational and other parameters. Fundamentally new design solutions began to appear, for example, to create means of transporting rock mass from deep quarries, and much more

Therefore, the compilation of a complex on the course "Special structures of mining machinery and equipment" is accompanied by a search, viewing and selection of materials from many different sources, mainly from specialized journals, collections of scientific papers, articles and reports, and other periodical literature, the INTERNET.

Attention is drawn to the manufacturability, prospects of new solutions, technical and economic indicators.

The discipline is related to the following courses: "Fundamentals of mining engineering", "electrical And structural materials", "Hydraulics and hydraulic machines", "Theory of machines and mechanisms", "machine Parts", "Fundamentals of mining", "drilling and Blasting operations", "Theoretical foundations of electrical engineering" and is the basis for studying other disciplines of the direction.

COURSE CONTENT

MINING and PRODUCTION MACHINES and INSTALLATIONS (16 hours).

History and development trends of mining machines and installations, scientific and regional problems, achievement of equipment and technology, results of socio-economic surveys on the operation of mining machines and installations.

Overview of typical machines and installations used at mining enterprises, properties, differences in their special designs (4-hours).

Overview of typical designs of belts, rollers, and belt conveyor drives. New designs of belt conveyors. Stomilbekhatov and RTI-Kauchuk tapes. Improved methods for connecting belt conveyors. New and improved conveyor roller designs. Perfect methods of connecting conveyors, their design, application conditions, advantages and disadvantages (4 hours).

Special upgraded types of belt conveyor drives (4 hours).

Special types of belt conveyors:

Steeply inclined conveyors; belt and wire conveyors; single-and double-tensioned chain conveyors; "Hestermann" design of belt and chain conveyors (4 hours).

General structures, basic elements, operating principle, operating conditions and equipment-economic indicators of conveyors.

OPEN PIT mining MACHINES and INSTALLATIONS (16 hours).

Special designs of vehicles that transport cargo from deep quarries:steep-slope conveyors with a pressure belt; long-distance conveyors; quarry car lifts; means of using gravity forces when transporting goods from quarries. Their General design, basic elements and operating principle, advantages and disadvantages (8-hours).

Equipment of rotary complexes. Krupp rotary excavators KRUPP. Main connections, operating principle and design properties, special application conditions, technological schemes of the installation, technical and economic indicators. Features of the application of thyssenkruppfordertechnik rotary complexes ThyssenKRUPPFordertechnikat the Angren section. New and improved bit designs of open pit drilling rigs, their fundamental differences and advantages from the ones used. Cycle-in-line technologies and application of suitable machines and equipment at Navoi MMC (8-hours).

Machinery and equipment for UNDERGROUND WORK (4 hours).

Wear-resistant new tire protection flails, their materials, link shapes, structures, test results and technical and economic indicators.

High-performance equipment for coal mines, mechanized complexes, tunneling combines, scraper conveyors, etc. Underground electric locomotives with improved performance characteristics, drives specially made for them and their characteristics.

Special equipment of underground Railways: equipment used for overturning trolleys, pushers, sub-car chains, high-rise expansion joints and their structures, basic elements, operating principles and conditions of use (4-hours).

Topics of LECTURES (36 hours).

1. mining Machinery and equipment. New conveyor belts (4 hours).

2. Advanced methods for connecting conveyor belts (2 hours).

3. Conveyor rollers of new and improved designs (4 hours).

4. Special types of belt conveyor drives and their theory (4 hours).

5. Machines and equipment for open-source development. Special vehicle designs for lifting cargo from deep quarries. Steeply inclined conveyors with a pressure belt. (4 hours).

6. Car career lifts (4 hours).

7. Quarry container lift (4 hours).

8. Krupp rotary excavators KRUPP (2 hours).

9. New chisel designs for quarry drilling rigs (4 hours).

10. machinery and equipment for underground mining (4 hours).

PRACTICAL TRAINING TOPICS (36 hours)**.**

In practical classes, students will study the design features, calculation methods and methods of analysis of non-standard machines and equipment of mining enterprises.

1. Advanced conveyor belt docking techniques (2 hours).

2. Calculation of a special type of belt conveyor drive with a pressure roller and its analysis (2 hours).

3. Study of the scheme of the car quarry lift system (4 hours).

4. Study of the main elements and technological scheme of operation of a quarry container lift (4 hours).

5. Using gravity forces to transport cargo from upland quarries (study and analysis of mechanical equipment) (4 hours).

6. Study and analyze the main technical characteristics of some of the world's largest belt conveyors (4 hours).

7. Study of devices and equipment included in the rotary complex of the section (4 hours).

8. Study and analysis of new bit designs for mining drilling rigs (4 hours).

9. Study and analysis of cutting-ball and self-adjusting ball bits (4 hours).

10. Study of the trolley tipper and equipment of its main elements, scope and conditions of use (4 hours).

TOPICS FOR SELF-STUDY (58 hours).

1. New conveyor belt chains.

2. Improved designs of new conveyor rollers.

3. Main technical parameters of some long coveyers.

4. Geometry of mineral development on a horizontal terrace.

5. New upgraded bit designs for open pit drilling rigs.

6. New mining machines and equipment of Navoi mining and processing complex.

7. New conveyor seams protected from wear.

8. Technical characteristics of underground electric locomotives of the kN 10 and ARPN14 brands.

9. Parameters of pushers of underground trolleys.

EVALUATION CRITERIA

students ' knowledge based on the rating system for the subject "Special designs of mining machinery and equipment»

These assessment criteria were developed in accordance with order No. 333 of August 25, 2010 of the Ministry of higher and secondary specialized education of the Republic of Uzbekistan.

These evaluation criteria for the discipline " Special designs of mining machinery and equipment» designedfor students of the master's degree program: 5A310705 - Mining machinery and equipment.

Introduction

The main goal of the national training program is to improve the quality of education. In higher education institutions, students ' knowledge is evaluated according to the rating system. Assessment of students ' knowledge according to the rating system allows students to constantly work to improve their acquired knowledge, and is also a reward for the development of creative activities in the learning process.

These evaluation criteria for the discipline " Special designs of mining machinery and equipment» they are recommended for wide use in assessing students ' knowledge and provide complete information to students on the number of points that they can get during the current, intermediate and final controls.

In the first lesson, students are introduced to the assessment criteria, types of control, the maximum score for each control, as well as passing points.

1. Types of control and evaluation procedure

In accordance with the curriculum of the master's degree program: 5A310705 - Mining machinery and equipment."Special constructions of mining machinery and equipment»it is completed by the instructor of the course for the 3rd semester. In order to meet the degree of knowledge and assimilation to the state educational standard, the following types of control are provided::

current control – a method of determining the acquired knowledge in the discipline " Special designs of mining machinery and equipment»during practical exercises. Evaluation is carried out by checking solutions to problems for variants of each practical work, as well as a survey on the topic;

intermediate control – a method for determining the degree of knowledge on completed topics. Intermediate control is carried out twice during the semester, the form and score are determined in accordance with the allotted amount of hours in the curriculum.;

final control– a method of determining the obtained theoretical knowledge and practical skills. The final control is based on basic concepts and is conducted in writing.

Students are graded on a 100-point scale during each semester in their subjects. 70 points are allocated for intermediate and current control, 30 points – for the final control.

Rating table.

For the master's degree program: 5A310705-Mining machinery and equipment.

(3rd semester).

n/a	Course	Semester	Number of weeks	Total number of hours (rating score)	The lecture	Practical exercises	Laboratory classes	Hours for self-study	Sat-point for independent work	Types of control												For a discipline with a course project
										Total hours in %	TC	TC-1	TC-2	Personal computer	PC-1	PC-2	∑TC+PC	Initial	IR score	Form of conducting an IC	Assimilation rate	
1	2	3	18	130	36	36		58	AB / Sat	100	35	18	17	35	18	17	70	39	30	IPR	100	

3rd semester

3. " Special designs of mining machinery and equipment»

3.1. Rating development

P. n	Type of control	Qty	Score and Qty	Total points
1. TC total score 35				
1.1.	Practical exercises	10	10*3=30	35
1.2.	Independent work	1	1*5=5	
2. PC total score 35				
2.1.	First intermediate work (3 questions)	1	3*5=15	35
2.2.	Second intermediate work (3 questions)	1	3*5=15	

2.3.	Self-sustained operation	1	1*5=5	
∑TC+PC				**70**
3. IR				
3.1.	Final control work	1	10X3=30	30
Total				**100**

3.2 evaluation Criteria for current control

3.2.1 Practical works are evaluated at 3-2.6 points, for participation in the lesson, performing practical work and for answering questions in full. If the student has completed the practical work efficiently, then 2.6 – 2.1 points are awarded depending on the answers to the questions балла. If the student does not answer the questions in full, then 2.1 – 1.7 points are awarded depending on the performance of practical work.

Topics of PRACTICAL CLASSES (36 hours).

1. Improved methods for connecting conveyor belts.

2. Calculation of a special type of belt conveyor drive with a pressure roller and its analysis.

3. Study of the scheme of the lifting system of an automobile quarry lift.

4. Study of the main elements and technological scheme of operation of a quarry container Elevator.

5. Use of gravity forces to transport cargo from upland quarries (study and analysis of mechanical equipment).

6. Study and analyze the main technical characteristics of some of the world's largest belt conveyors.

7. Study of devices and equipment that are part of the rotary complex of the section.

8. Study and analysis of new bit designs for open pit drilling rigs.

9. Study and analysis of cutting-ball and self-adjusting ball bits.

10. Study of trolley tipper and equipment their main elements, scope and conditions of application.

3.2.3. the Interim control is conducted in writing and requires answering three questions. Each question is rated up to 5.0 points:

- if the essence of the question is fully revealed, the answers are correct and accurate, and creative thinking is present, then a total of 4.3-5pointsis awarded.;
- if you answer the question in a General form, but if the essence of the question is not fully summarized – you get a total of 3.7 – 4.3points.;
- if you try to answer the question correctly, but find some ambiguities, you get a total of 3.7– 2.8 pointsa.

Control questions on the discipline "Special constructions of mining machinery and equipment".

Roller drilling machines - (roller, rotator, feed, mast, movement mechanism, cleaning and dust suppression mechanism, drive, hydraulic system, diameter, rod, drilling depth).

Design schemes of single-bucket excavators - (design scheme, lifting and pressure mechanisms, moving and turning mechanisms, ropes, saddle bearing, straight and reverse shovel, hydraulic excavator, dragline).

Executive mechanisms of drilling rigs - (impact, rotary, vibration mechanisms, drilling station, rod, make-up, air supply, lifting of the stave).

Working equipment of mounted rippers - (Ripper, frame, buffer, rack angle, tooth, suspension, trench, trench width and depth).

Hydraulic monitors and dredgers - (hydraulic washout, hydraulic monitor, dredger, dredger, pipeline, hydraulic dump, washout order).

Mechanical shovel and dragline - (excavation, loading, digging effort, excavation, excavation cycle, dragline).

The main components and elements of single-bucket excavators - (bucket, boom, handle, rotary platform, superstructure, running equipment, working mechanisms).

Physical and mechanical properties of rocks that affect the operation of machines and mechanisms - (properties, mechanics, strength, hardness, strength, non-condition, loosening coefficient,).

Drilling machines and machines for OGR - (drilling methods, crown, ball, chisels, rotary feed mechanism, cleaning method, main components, working mechanisms).

General information about OGR mining machines- (open pit mining, system, process, technology, excavation, drilling, loading, dump formation, drilling rig, excavator, bulldozer).

Main parameters and indicators of drilling rigs of OGR.

Multi-bucket excavators and their application conditions - (rotor, chain-scoop working body, radial, longitudinal and transverse digging, working mechanisms).

Tools for drilling machines - (chisels, crown, ball, rod, tool for ball, impact, rotary, thermal drilling).

Selection and layout of equipment of OGR-complexes (conveyor, drilling machine, excavator, transport, dumper, connections between equipment, machine operation scheme, machine selection).

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