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Impact Machines for Without-Blast Destruction of Rocks

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ABSTRACT: In the paper the principle methods of rock breaking are studied. Electromagnetic impact machine is offered, in which at ihe expense of new power motors using arrangement of the main units was improved and overall dimensions and metal capacity were decreased in comparison with hydraulic rubble-breaking machine. Technical decisions are studied for increasing of effectiveness of oversized material breaking.

I INTRODUCTION

Development of mining industry in the Republic of Kazakhstan is directed on widening of deposits mining by open method. At the same time as increasing of a number of mining enterprises with open method of mining, the further increase of useful minerals mining is connected with exploitation of deeper levels of deposits.

When mining of useful minerals by open method and also when underground mining of hard ores, blasting operations account for 90% of total output volume. And when increasing of depth of mining operations, carrying out of blasting operations exert a substantial seismic effect on constructions of faces, stability of underground constructions. In this connection when underground mining at deep levels without-blast method for rock mass breaking is without-alternative method. Besides using of blasting at modern open casts and underground mines causes the oversized material output in average more than 3%, some times reaching 25-30% of total output, depending on using mining method, parameters of drilling-and-blasting operations, mining-and-geological conditions. Experience of mining enterprises shows that it is possible to decrease of output of oversized material, but full its liquidation is economically inexpedient.

2 METHODS OF ROCK BREAKING

Today about 90% of oversized lumps of all kinds of exploiting rocks and ores are broken with blasting and drilling-and-blasting methods using. These methods, in spite of wide using in industry and possibility to destroy of oversized material of any hardness and size, have a number of substantial disadvantages, decreasing technical-economic indexes of mining enterprises. The disadvantages are: downtime of the main technological equipment when oversized material breaking; scattering of rock pieces when breaking within 400 m distance; considerable consumption of explosive (up to 40% of explosive consumption for primary breaking); increased gas and dust content in mine atmosphere; high costs of operations - up to 35% of total costs for winning operations.

Besides blasting method breaking of oversized material is carried out by thermal and electric-thermal methods, which also have disadvantages, because this equipment is bulky, has high capacity but very low coefficient of efficiency and also high duration of a process of oversized lumps breaking.

Wide propagation have mechanized rubble-breaking machines, which are broken down into the following groups by a method energy accumulation: gravitational, mechanical, blast-mechanical and electrical (Lobanov D.P. & other 1983).

In mechanical hammers potential energy of a head is formed at the expense of potential energy of compressed spring, which is transformed into kinetic energy during a head movement to a side of a working tool.

In pneumatic hammers working body is compressed air, which is prepared in compressor and enters in machine chamber with a help of different valves and throttles. The most powerful mounted pneumatic hammers have energy of isolated impact about 3 kJ. Further increasing of energy of impact requires higher working pressure, and absence of

suitable compressors keeps back further development of pneumatic hammers.

Today hydraulic hammers have wide using. Working liquid in them is oil. In constructions of hydraulic hammer spring, pneumatic and hydraulic accumulators are used. Using of high power-consuming accumulators allows creating hammers, ensuring realization of high energy of impact (up to 20 kJ) when capacity of motor is low.

Besides precision in making and decreasing of technical characteristics as wearing out, common disadvantage of pneumatic, hydraulic and hydro-pneumatic machines of impact action is multi transforming of energy from one form to another and transportation of energy-carrier. For pneumatic machines operating compressed air is required. For its transportation pipes, closing and controlling equipment is needed. For compressed air generation electric motor is required, which consumes energy from supply line or from base machine. Hydraulic impact machines have analogues chain of energy transforming. Losses in them will increase at the expense of more viscous and menial energy-carrier. When hooking up they to hydraulic motor of base machine chain of energy transforming rather simplifies, but it does not increase coefficient of efficiency of all system of transformers and line of energy transmitting.

One of ways, excluding multiple energy transforming, is a blast-pulsed machine creating. As an energy-carrier in such types of machines solid explosives or liquid fuel are used. Disadvantages of blast-pulsed machine: working cycles are not debugged and their interconnection is not worked out: problem of reliable starting is not solved; auxiliary equipment is very bulky; they are dangerous for environment.

Disadvantages of foregoing machines cause carrying out of investigations on creating of electrical impact machines recip-rocaling action - electrical-mechanical with springs or compressing-vacuum mechanism and electromagnetic.

In electrical-mechanical rubble-breaking machines cocking of a head is carried out with a help of a grip, which is set in motion by crank-collecting rod mechanism with electrical motor. After disengaging of grip and head, head is brought up to speed under action of spring and hits on working tool. In rubble-breaking machines with compressmg-vacuum mechanism when mutual moving of internal chambers vacuum space is lormed, which draw head in a position of cocking. Changing of vector of moving of a chamber forms zone of compressing above a head, and as a result head moves and interacts with working tool.

3 PERSPECTIVE DIRECTIONS ON CREATING OF IMPACT MACHINES FOR ROCK DESTRUCTION

Perspective way of development of electrical machines of impact action is creation of electromagnetic hammers. The main advantages of these rubble-breaking machines in comparison with other types of machines of impact action are: electrical energy is transformed immediately to kinetic energy of rectilinear motion of head; relative simplicity of construction and absence of details of high class accuracy in making; possibility electrical energy transmitting for a long distance - this is a very important factor when creating of a number of machines; high possibilities in increasing of reliability and efficiency of operating.

Substantial successes in creating of electromagnetic machines of impact action for different industrial purposes are achieved in the Institute of Mining of Siberian Department of Russia Academy of Sciences (IM SD RAS) (Malov A.T. & other 1979). In this Institute plant was worked out for crushing of oversized lumps with average volume 6 nr with energy of isolated impact up to 6 U, frequency of impacts - up to 100 imp./min and consuming power - 35 kW. Scientists of this Institute created electromagnetic hammer for driving light-weight piles (mass up to 250 kg) and anchors with energy of impact 2 kJ, frequency of impacts - 90 imp./min and consuming power - 15 kW.

In impact machines, worked out in IM SD RAS, as motors electromagnets are used armored type (solenoid).

Analogues developments for creating of multi-cascade systems with using of solenoid motors for electromagnetic machines for over-sized material destruction were carried out also in the Kunayev's Institute of Mining.

Disadvantage of using as motor electromagnets of solenoid type is substantial influence of increasing of machine capacity on its geometrical dimensions.

In the Laboratory of destruction and haulage of rocks of the Kunayev's Institute of Mining new type of electromagnetic motor - with internal magnetic-conductor was worked out (Yedygenov E.K. 1993), on the basis of which impact machine was worked out (Yedygenov E.K. & other 1993, Yedygenov Ye.K. 2001). For this machine overall dimensions were decreased at the expense of changing of arrangement of tractive motors, and energy of impact is regulated depending on volume of oversized lumps and their properties.

In the Institute technical design was worked out of impact machine, having the following technical characteristics (Table I).

In table 2 technical characteristics of hydraulic impact machines of Rammer Company are presented

for comparison with foregoing characteristics of worked out electromagnetic impact machine.

When comparing characteristics of electromagnetic rubble-breaking machine with hydraulic one it may be noted that having the same energy of isolated impact the first machine has metal-capacity and dimensions less by 1.5 times.

In the Laboratory model of electromagnetic machine of impact action was worked out and made and laboratory tests were carried out (Fig.l).

Table I Technical characteristics of electromagnetic machine of impact action

Parameters of machine	Value
Energy of impact, J	2000... 2500
Frequency of impacts imp./min	150...200
Mass, kg	980
Overall dimensions, mm:	
height without tools	1320
diameter of a body	730

Table 2 Technical characteristics of Rammer impact machines

Parameters	Machiine mark					
	S27/C	E64/C	E66N/C	E68/C	S83	G120/C
Energy of isolated impact, kJ	1.0	2.3	2.8	4.0	5.2	9.0
Mass, kg	600	1040	1330	1710	2260	3800
Length, mm	1700	2000	2200	2400	2500	2800

The model (Fig. 2) includes top 1 and bottom 2 frames, struts 3, guide bushes 4, coils of direct 5 and reverse 6 motion, internal magnetic-conductor 7, mobile external magnetic-conductors 8, which arc rigidly connected together and with a head 9, and working tool 10. Coils of direct and reverse motion are reeled up on common metallic ferromagnetic framework. Every coil of direct and reverse motion includes two section of winding. For winding copper wire PSDK type is used 2.3 mm in diameter. Depending on mechanical strength of rock, current with a help of commuting device is entered on electromagnets 5, in which magnetic field is formed. Magnetic field of all using magnets effect, at the same time, on external magnetic-conductor 8 and it moves along electromagnets 5 together with head 9 to the side of frame 1. When magnetic-conductor 8 reaching its top position swilching-off coils of reverse motion 5 takes place and coils of direct motion 6 are switched. Under action of magnetic forces head 9. acting on mobile magnetic-conductors 8, accelerates to the side of working tool 10 and impacts it.

Possibility of this machine to regulate of energy of isolated impact by a way of varying of a number ot using electromagnets and to return head into initial position by lower number of electromagnets allows substantially decreasing energy consuming in comparison with existing electromagnetic machines.

During testing impact machine with electromagnetic motor showed stable and reliable operation with the following technical characteristics (Table 3).

Table 3 Technical characteristics of experimental model of impact machine

Parameters name	Units	Indexes
Striking pin mass	kg	70
Head mass	kg	17.2
Head stroke	mm	150
Current	A	90
Voltage	V	120
Head speed	m/s	2.7
Energy of isolated impact	J	62
Frequency of impacts	impacts/min	200

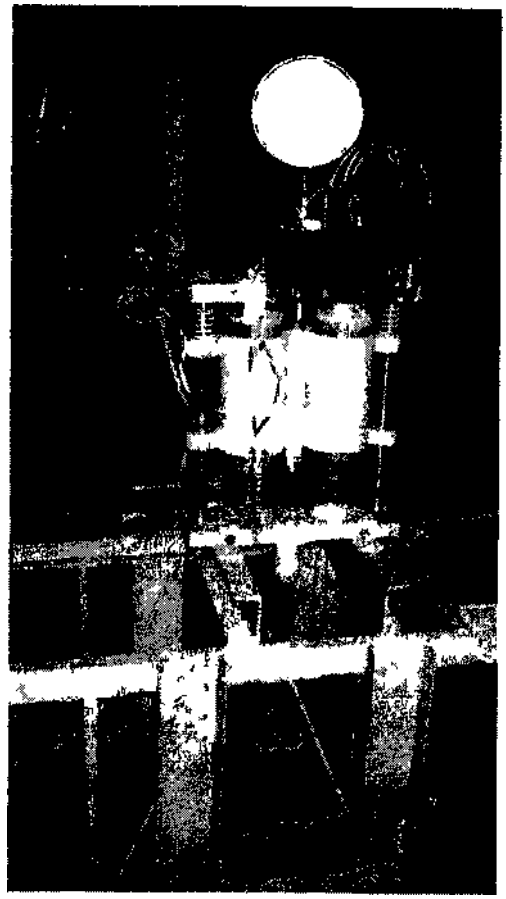
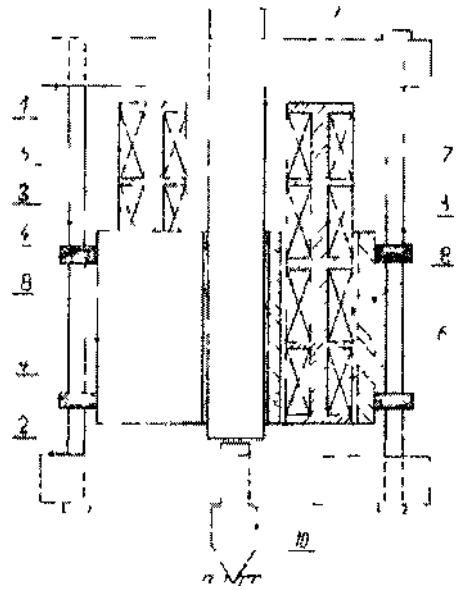


Figure I Model ot electiomagnelic machine ot impact actum

4 CONCLUSIONS

Substantially lower oveiall dimensions and metal-capacit) absence ol additional chains ol eneigy transforming fiom one kind to another absence ot oil station and systems ot hydraulic energy iiansmitting are the factois ensuring impact machines with electromagnetic motor competitiveness in companson with hydraulic impact machines especially in haid natuial conditions



Figuie 2 Scheme of electromagnetic machine ot impact action

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