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Devices for Breaking and Haulage of Rocks on the Basis of Electromagnetic Motors

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ABSTRACT: In this paper, tractive motors of the electromagnetic type are descnbed for the creation of vehicles and equipment for rock breaking. The technical performances of a conveyor train (CT) and impact machine with electromagnetic motors are presented. The parameters calculated are given for the motors, allowing the design of a conveyor train transport system for wide-ranging exploitation and planning of exploitation at open casts.

1 INTRODUCTION

Recent development in the mining industry in the Republic of Kazakhstan has tended towards the mining of useful minerals by the surface mining method. At the same time, with the increase in the number of open casts, there has been an increase in the output of useful minerals by ore mining at deep levels.

Today, about 70% of the rock mass volume at open casts is transported by road. This kind of transport is mostly used when for the mining of deposits with hard bedding conditions. However, the atmosphere around open casts is polluted by truck exhaust gases, which are emitted when trucks operate at grade, and this substantially worsens the ecological conditions at open casts.

The modern form of mining useful minerals by the surface mining method is unthinkable without drilling-and-blasting operations. Powerful ejections of gas and dust when these operations are carried out have a substantial negative effect on the ecological situation not only at open casts, but also on the environment as a whole.

In addition, damage to the environment as a result of dust-gas ejection leads to potentially dangerous gassing situations, and this causes temporary stoppages of operations.

The constant increase in the labour intensity of mining-transport operations, which is caused by increases in open cast depth and complications in mining and geological conditions, have made the creation of new vehicles necessary and rock-breaking devices with new motors which are not sources of gas-dust ejection, but ensure the output of the mining enterprise.

2 DEVICES FOR HAULAGE AND BREAKING OF ROCKS

Such motors were developed at the Kunaev Institute of Mimng on the basis of electromagnets with internal magnetic conductors (Yedygenov et al., 1993. Patent No. 2573; Yedygenov, 1993. Patent No. 1981) and solenoids (Yedygenov & Sagimbayev, 1988).

In electromagnetic motors, the physical mechamsm used is interaction of the magnetic field forming in the electromagnet when voltage is applied to its winding with a ferromagnetic armature.

Depending on the location of the armature and electromagnet relative to each other, tractive motors are subdivided into electromagnetic motors of the solenoid type and electromagnetic motors with internal magnetic conductors.

In tractive motors of the solenoid type, the working zone, that is, the zone of interaction of the magnetic field with the armature, is the internal area of the electromagnet. In such a motor armature, which is the freight-carrying umt in transport devices, the electromagnet is drawn in and moves internally. In this case, the armature containers are determined with regard to dimensions and type of transporting freight and also the geometrical dimensions of the motor

The working zone of the electromagnetic motor with the internal magnetic conductor is the external surface of die electromagnet. In this motor armature an S-type section is made, which passes over the electromagnet and moves along İt.

Electromagnetic motors those have drooping characteristics, are easily self-synchronized, ensuring non-contact, non-impact interaction with motion tracks, and this increases their reliability and operating longevity.

In addition, achievements in recent years in the creation of high-temperature superconductors on the basis of yttrium-barium ceramics have opened up great potential for motors of the electromagnetic type. The use of superconductor winding will allow increases in the coefficient of efficiency of electromagnetic motors of up to 90-95% due to decreases İn losses from heating.

3 TRANSPORT DEVICES

At the Kunaev Institute, electromagnetic container transport (ECT) for inter-section transportation was developed with electromagnetic motors of the solenoid type. In this transport, tractive motors are located along the line of transportation at a distance S from each other and by means of a commuting device act in turn on a ferromagnetic container When this interacts with a motor, it accumulates kinetic energy, and uses İt to move from one motor to another.

The technical performance of the experimental-industrial ECT device is presented in Table 1.

A container train was also developed, the mover of which is a tractive motor of the electromagnetic type with a magnetic conductor.

The conveyor train (CT) is a vehicle consisting of a flexible system of running trucks, with a freight-carrying belt for moving large-sized rock mass, which continuously move between points of load and discharge. Tractive motors are located at stationary points along the train way and the distance between them is equal to or slightly shorter than the train length, ensuring semi-steep transportation of rock mass, as the magnetic field of the motor acts on the conveyor train as the haulage rope of a winder. Testing of the train showed mat electromagnets with internal magnetic conductors are more effective than linear asynchronous electric motors (LAEM), which are now used when carrying out design work for conveyor trains. The effectiveness of the electromagnetic motor increases due to the absence of the "final effect", which is typical for LAEM. This tractive motor has no current collection devices and this simplifies its design and allows it to be used in dangerous conditions when explosions can occur.

Conveyor trains with electromagnetic motors can transport rock mass over long distances and they have a small radius of curvature in the horizontal and vertical planes.

In comparison with regular railway transport systems, the conveyor train leads to decreases in the haulage distance of 3-5 times and decreases İn the duration of one transport cycle of 2-4 times.

In addition to electromagnetic motors in a conveyor train system, the use of electric energy and creation of the magnetic field at the same time act on the motion trucks with no contact, and this ensures non-impact interaction, increased reliability and operating longevity, with the potential for high speed of movement.

The substantial advantage of CT is its relatively simple design. Conveyor trains have a modular design. The CT module consists of the tractive motor, motion trucks, guides, and a system of control by motors. By varying the number of modules, it is possible to change the production capacity of the transport system and the distance of transportation. It is possible to replace failed motors or motion trucks quickly and easily with new motors or motion trucks. Such repair operations have practically no effect on the continuity of the transport process. The advantages of this vehicle also include me possibility of control by productivity depending on demand by way of additional trains or the removal of trains from transport communications, and the fact that the CT route can be located in areas with any relief and by pit walls

Table I. Technical performance of the lectromagnetic container transport device.

Parameters	Unit of measurement	Value of parameter
Production capacity	t/h	2.0
Distance of transportation	m	45.0
Dimensions of electromagnetic motor-		
length	m	0.71
width	m	0 42
height	m	0 32
Motor capacity	kV	50 0
Container load-canying capacity	t	0 2
Container dimensions		
length	m	081
width	m	0.4
height	m	1.5
Type of transporting freight		Finished products lo lathes

with aiigies of inclination up to 30-40°. CT is ecologically clean because as a motor of functional aggregates, it uses electromagnetic motors.

At the Kunaev Institute of Mining, the technical design of a conveyor train with electromagnetic motors (CT with EMM) was developed. Details of its performance are presented in Table 2.

On the basis of die theory of similarity with experimental data by testing the experimental design of the electromagnetic tractive motor, parameters of the tractive motors were obtained for a range of carrying capacity values of the conveyor trains, as presented in Table 3. In the table, the parameters of a motor operating at the horizontal part of the route are presented in the numerator, while the parameters of a motor operating at an inclined part of the route when a = 30 are presented in the denominator.

Table 2. Technical performance of CT with EMM

Parameters	Value of Parameters
Production capacity, m'/h.	500-1000
Distance of transportation, 1cm	10
Speed of movement, m/s	
by main line	6-8
at loading-discharging site	1-2
Angle of inclination, degrees	up to 40
Granularity of material, mm	0-1500
Train length	250-300
Capacity of tram, m^1	126
Number of tractive stations	30-40
Number of motors in tractive station	5-7
Power of motor, kw	230

Table 3. Parameters and type dimensions of tractive motors.

Motor parameters	Carrying capacity of conveyor train, tons			
	30.0	60.0	120.0	160.0
1	2	3	4	5
Force of traction, kN	3 5/50	6.0/50	12/100	16/200
Current, A	300/620	450/620	690/12400	900/2400
Voltage, V	200/600	300/600	300/600	300/600
Number of turns	600/1020	680/1020	700/1100	800/1200
Dimensions, m	0.6x0.25x0.1	06x0.7x0.1	1.2x0.15x0.1	I 2x0.8x0.1
	1.2x0.7x0.2	1.2x0.7x0 2	1.5x0.8x0.3	1.5x0.8x0.3
Number of tractive motors coming into operation simultaneously at tractive station	1/3	1/6	1/6	1/4

The parameters of the motors obtained by calculation allow the design of a conveyor train transport system for wide-ranging exploitation and planning of exploitation in open casts.

4 IMPACT DEVICE

Electromagnetic motors with internal magnetic conductors may be used in the design of impact devices (Yedygenov et al., 1993. Patent No.2136).

An electromagnetic device of impact operation (EMTD) includes (Fig. 1) a mobile installed in guiding pipe 1 armature 2 and fixed in it by means of top 3 and bottom 4 brackets power electromagnets 5, connecting with commuting device 6. Power electromagnets 5 are located with clearance in longitudinal openings 7, which are made by perimeter of armature 2 symmetrical its longitudinal axis. Armature 2 interacts with its working tool 8, and power magnets aie installed on brackets 3 and 4 with the possibility of longitudinal movement.

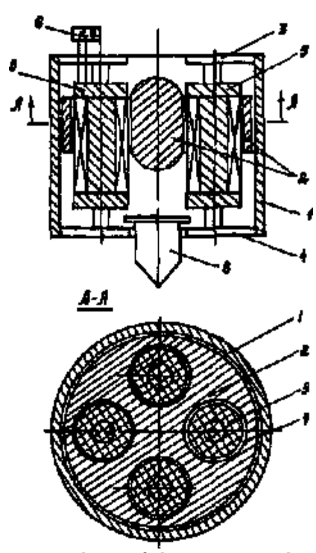

Figure 1 Scheme of electromagnetic device of impact operation

Depending on the energy necessary when impacting, the voltage, by means of commuting device 6, is applied to one, two or all, for example four, power magnets 5, and in each of them a magnetic field appears. At the same time, the magnetic fields of all acting power electromagnets 5 act simultaneously on armature 2, and as a result it is brought up to speed along guiding pipe 1 and power electromagnets 5 from top bracket to working tool 8. Armature 2, when interacting with working tool 8, transmits its kinetic energy to the working tool.

After energy transmission by armature 2 to working tool 8 by means of commuting device 6, for example, by way of polarity of magnetic field changing in one or some power electromagnets 5, forces, directing on opposite side of the working tool, begin to act on armature 2. By the action of these forces, armature 2 moves along, aligning its movement guiding pipe 1 and power magnets 5 from impact tool 8 to top bracket 3, that is, to the initial position at the beginning of operation. When the armature reaches top bracket 3, commuting device 6 again changes the polarity of magnetic fields in power electromagnets 5, running for return of armature 2 to initial position, and then the cycle is repeated.

Use of the electromagnetic device of impact operation makes it possible to control the energy of unit impact due to the varying number of operating power electromagnets. In addition, it is possible to reduce energy cost due to control of the number of electromagnets used for return of the armature to the initial position.

The technical design of the electromagnetic impact device (EMID) was developed at the Kunaev Institute of Mining. Details of its technical performance are presented in Table 4.

Table 4. Technical performance of EMID.

Parameters of impact device	Value of parameters
Energy of impact, J.	2000-2500
Frequency of impacts, l/min.	150-200
Mass, kg	98
Overall dimensions, mm:	
height without tool	1320
diameter of body	730
Capacity by the hour (number of broken quarry stones per hour) when breaking of rocks with coefficient of hardness ip according to Protodyakonov and volume of quarry-stone V:	
q>= 10, V = 2.0-2.5 nr[1]	15-20
q>= 15, V= 1.0-1.5 m^3	10-15

5 CONCLUSIONS

The electromagnetic motor with internal magnetic conductor that was developed at the Kunaev Institute of Mining may be used for a variety of purposes when producing different types of mining and transport equipment.

REFERENCES

Yedygenov, Ye.K., Sagimbayev, D.T., Yedygenova.Z.V. 1993. Linear electric motor. Patent No. 2573. Republic of Kazakhstan.

Yedygenov, Ye.K. 1993. Linear electric motor. Patent No. 1981. Republic of Kazakhstan.

Yedygenov, Ye.K., Sagimbayev, D.T. 1988. Perspectives of conveyor trains using when useful minerals mining by surface mining method. Alma Ata: KazNHNTI, 45 p.

Yedygenov, Ye. K., Dzhansugurov, S. I., Yedygenova, Z.V. 1993. Electromagnetic machine of impact type of operation. Patent No. 2136. Republic of Kazakhstan.