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THE INTRODUCTION OF ENERGY-SAVING TECHNOLOGY FOR TRANSPORTING ROCK MASS BY CREATION ELECTROMAGNETIC HOISTING INSTALLATION

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In light of the Strategy of Industrial and Innovation Development of Kazakhstan for 2003-2015 and the State program for accelerated industrial-innovative development of Kazakhstan for 2010 - 2014 years, which provides a course to upgrade outdated technology, machinery and equipment with the latest scientific and engineering achievements , the decision of problem of transportation of rock from the deep levels is impossible without the creation of a new mine and quarry hoisting machine for more efficient ways for lifting the rock mass.

Keywords: Mining, machine, magnet, lifting, installation.

Stationary lifting unit is an essential link in the chain of transport minerals from the mine or quarry to the surface. But the application of existing outdated, inefficient mine winders has increased the cost of minerals several times [1].

The effective work of mines and open-cast mines is mostly defined by reliable work of underground transport and lifting installations of vertical trunks along which delivery of minerals and breed, delivery of the equipment and materials to the surface is carried out.

At present time in the mining industry the transportation of mined mass is carried out by rope lifting installation which consists of a hoist engine, ropes to which the lifting vessel (skip) is suspended, a skip moves on directing conductors in a trunk [2]. Owing to introduction of high-performance rope lifting installations and high-capacity skips reliability and durability of elements of the lifting complex decreased, and conductors and directing devices of lifting vessels are exposed to intensive mechanical wear. Emergencies because of other lifting elements have become more frequent that is explained by high level of dynamic loadings became frequent. Meanwhile material and labor inputs on repair and maintenance of elements of the lifting complex are increasing.

There is continuous growth of expenses for lifting of mined mass from mines and, respectively, it concerns the prime cost of minerals. Besides, application of rope lifting installations in deep mines is limited, first of all, because of durability of steel ropes, and also the whole complex of shortcomings of technical, operational and economic character.

The similar picture is observed in open-cast mines where traditional means of transport (railway, conveyor, automobile and rope skip) don't allow to solve economically effectively a problem of lifting of mined mass from deep fields on prospect because of a number of the technical, economic, technological and organizational reasons, i.e. to solve the problem of decrease in cost price of transportation of mined mass.

The solution to this problem is the creation of an electromagnetic lift installation. With this setup transportation of much greater weight is possible, spending less energy resources in comparison with existing technologies [3,4,5].

The principle of work of electromagnetic installation is based on the phenomenon of a magnetic levitation.

Magnetic levitation for transportation of rock mass wasn`t applied anywhere in the world. The creation of this installation involves the introduction of innovative new technologies of transportation of a rock mass both in the extraction industry and in other industries for lifting and transportation of cargo (in the construction).

Most of the technical applications of magnets based on their ability to attract and retain metallic objects. In these applications, electromagnets have tremendous advantages over permanent magnets, because the change of current in the coil of the electromagnet can regulate its lifting force. The force, with which a magnet attracts metal, decreases sharply with increasing distance between the magnet and the metal. Therefore, to determine the lifting force of the magnet it is agreed to call the force with which the magnet holds the metal located in close proximity to it, that is, the lifting force of the magnet is the force that is necessary to tear away the clean piece of soft iron from the magnet [6].

Electromagnets with a big lifting force are used in the technique for very different purposes. For example, an electromagnetic crane is used in steel and metal working factories, ports for carrying scrap iron and finished products. In the metalworking plants tools of the so-called magnetic tables are often used, where processed metal product is fixed by attraction strong electromagnets. It is sufficient to switch on current for securely fixing the product in any position on the table. It is enough to switch off the current to release it. During separation of magnetic from nonmagnetic materials, for example separation of iron ore pieces from the waste rock (ore processing), magnetic separators are used. The purified material passes through a strong magnetic field of electromagnets, which gets out all the magnetic particles. In recent years, powerful electromagnets with a big area of the poles have new important applications in the design of accelerators, i.e., special devices, in which electrically charged particles - electrons and protons are accelerated to enormous speeds, corresponding to energy equal to the hundreds of millions and billions of electron volts [7,8,9,10].

In 2009, Russian Sciences proposed a magnetic levitation conveyor with "V"-shaped magnetic suspension. This conveyor is an innovation in the mining transport, and nowadays its characteristics is unique and requires further research. In 2008, the United States granted a patent (US 7,422,100 B2) on a steady magnetic suspension conveyor belt [11].

Currently, exist magnetic levitation trains, which can develop tremendous speed up to 400-500 km/h. The principle of magnetic levitation trains is taken as the basis of an electromagnetic lift installation. At the moment there are three basic technologies of magnetic suspension trains: 1) the superconducting magnets (electrodynamics suspension), 2) the electromagnets (electromagnetic suspension), and 3) a permanent magnet, is a new and potentially the most economical system. Composition levitates due to repulsion of similar poles of the magnets and, conversely, attraction of different poles. The movement is conducted by a linear motor, located either on the train or on the road, or on both sides. We use electromagnets to create the lift units. A major problem of designing trains is a great weight of powerful magnets, because it requires a strong magnetic field to maintain the massive structure in the air. But as for the transportation of the rock mass great speed is not required and mass of the loaded skip is much smaller than the mass of the train, it is possible to create a stable electromagnetic system which allows to carry the cargo at a rate of 10-20 m/s, and it is fully satisfies the needs of transportation in the extraction and construction industries [6,12].

Currently, there is not enough of generalized theoretical and experimental studies that could be used in the calculation and design of electromagnetic hoist based on magnetic levitation.

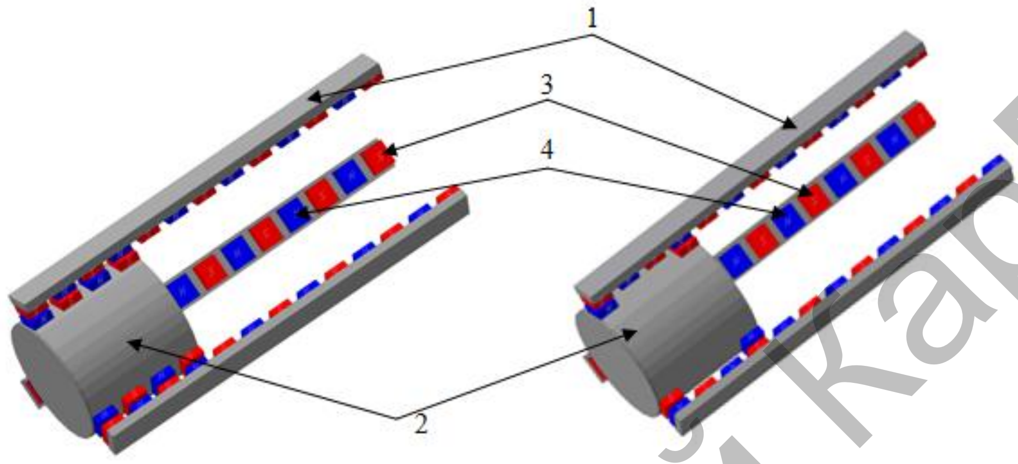
The essence of the offered technology consists in application a skip of force of an electromagnetic field (a magnetic levitation) for lifting and movement for implementation of ropeless lifting.

Electromagnetic lifting installation consists of a lifting vessel (skip), electromagnets (or constant magnets) and directing conductors [13]. The vessel is set in motion by force of electromagnetic interaction. As there is a gap between a skip and directing devices, the friction is excluded, and the only braking force is aerodynamic resistance.

Unlike existing lifting engines, installation possesses bigger loading capacity at smaller expenses of the electric power and other energy resources therefore this technology of transportation can be referred to the energy saving.

The design of the offered electromagnetic lifting installation is shown in figures 1,2. Basic elements of installation are directing conductors (1), a skip (2), electromagnets (3,4). Installation can be carried out in two options:

The skip is performed in the form of the cylinder (fig. 1). Three directing conductors (1) are located from each other at an angle 120 degrees. On all length of directing conductors electromagnets (3,4) with alternation of the south pole (S) (3) and the north pole (N) (4) are established.



a) b)

a) electromagnets are located on all height of the skip;
b) electromagnets are located on the bottom and top edges of the skip

Fig.1. Electromagnetic lifting installation with a skip in the form of the cylinder.

On the skip electromagnets (or constant magnets) (3,4) with alternation of the south pole (S) and the north pole (N) are also located. The quantity of electromagnets on a skip can be on all height of the skip (fig. 1, a) or on the bottom and top edges of the skip (fig. 1, b).

Electromagnets are located in such a way that when different poles of electromagnets on the conductor and the skip are attracted, the poles of electromagnets of the same name make a start. Thus, the skip is set in motion. Speed of movement of the skip is regulated by the electromagnetic force of electromagnets depending on the feeding tension. The arrangement of directing conductors at an angle 120 degrees allows to center skip movement.

2) The skip is performed in the form of a parallelepiped (fig. 2). Four directing conductors are located concerning the center of the lateral planes of the skip. On all length of directing conductors electromagnets (3,4) with alternation of the south pole (S) (3) and the north pole (N) (4) are established. On the skip electromagnets (or constant magnets) (3,4) with alternation of the south pole (S) and the north pole (N) are also located. The quantity of electromagnets on the skip can be on all height of the skip (fig. 2, a) or on the bottom and top edges of the skip (fig. 2, b).

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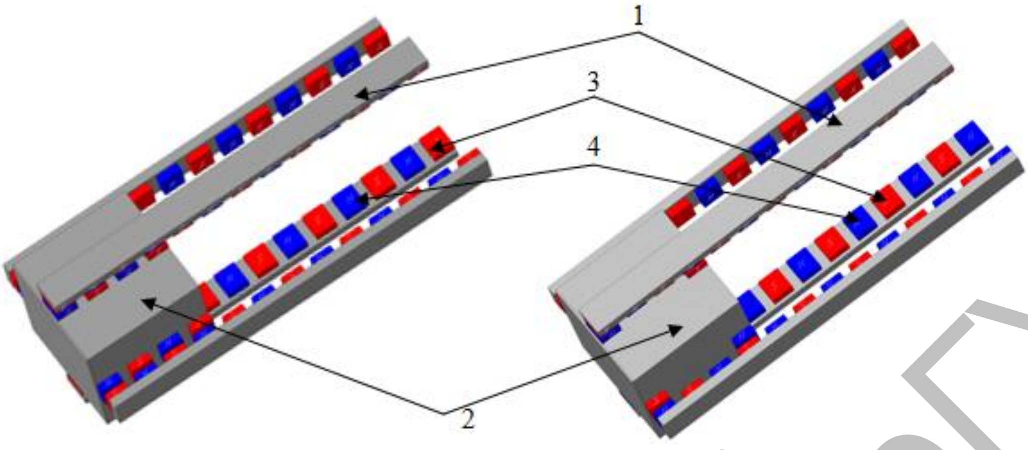
In the formation of a competitive market economy the industry problem of reducing the cost of transportation of the rock mass, and hence the cost of minerals becomes crucial not only in Kazakhstan but also in the world.

Creation of electromagnetic installation will allow to solve the problem of high-performance and economically effective delivery of mineral from the deep horizons of fields.



a) b)

a) electromagnets are located on all height of the skip;
b) electromagnets are located on the bottom and top edges of the skip

Fig.2. Electromagnetic lifting installation with the skip in the form of a parallelepiped.

Enterprises of mining and processing of minerals for a long time need to modernize transportation of rock, in the implementation of the new hoist to transport high performance, speed, reliability, security at a relatively low energy consumption.

The creation of energy-saving technologies of transportation of rock involves development of the mining industry, its rise to a new level to get capable for competition products, such as in Kazakhstan and in the world market.

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