PRESS EQUIPMENT WITH LINEAR ELECTRIC ENGINES: EXISTING DESIGNS, CHARACTERISTICS AND FIELDS OF USE

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Introduction

One of the main causes of unjustified energy waste in light industry is imperfection of equipment from point of view of power waste. It refers especially to such parts of equipment as gears. Disparity of the type of gear, its working conditions, capacity and other characteristics to parameters of technological operation which is done on the equipment reduces to the big energy waste.

There are a lot of technological operations in light industry which need press equipment in which working organs do return-translational movement only. Basically electromechanical, hydraulic or pneumatic gears are used in it. The main fault of the equipment with such gears is unjustified electrical energy waste during idling of working organs and during loading and unloading equipment with working objects.

Creation of highly efficient press equipment with linear electric engine (LEE) that gives opportunity to use electric energy only during execution of technological operation is urgent task and is interesting for many other branches of industry [1].

Analysis

Linear electric engines present independent class of electric machines which have got a line of specific characteristics. In contrast to electric engines of turning operation that can do long turning motion during continuous exchange by energy among electric and mechanical systems there is limited mechanical gradual and return-translational relocation with discrete energy transformation in LEE.

The main factor that defines constructive peculiarities and technical potentialities of linear electric engine is their principle of action. According to it LEE are subdivided into the following main types that received the largest use at electrical drive: electromagnetic, induction, electrodynamics, inductodynamic, magneto-electric, magnetostrictive and electrostrictive [1, 2].

Action principle of the main types of LEE, their main characteristics, advantages and defects, and application spheres are brought below. Force that engine makes; amplitude of dynamic transference; frequency of motions; efficiency; specific useful power, specific force of traction are referred to the main parameters which characterized LEE. Tentative limiting parameters of linear electric engines are brought in the work [2]. They received by author of this work on the basis of LEE that was made by industry and on the basis of single experimental samples.

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Action principle of linear electromagnetic engines (LEME) grounds on interaction of magnetic field of coil with ferromagnetic pericardium that realizes move on linear trajectory. Polarized LEME with permanent biasing of ferromagnetic pericardium are referred to them, too. Main advantages and faults of these engines will be examined later.

Action principle of linear induction engines (LIE) is based on interaction of magnetic field which is created by alternating magnetic stream with current that is induced by it in the movable part. Possibility of practically unlimited increasing of their speed and receiving practically any transference one can refer to the main advantages of LIE [2].

But this type of engines didn't find practical use in industry because of its unwieldiness and intricacy of producing. The first works of theoretical and practical character about linear induction engines were directed at creation electrical drives for machines of striking action. Unsatisfactory results at the first stages of use of linear induction engines as a drive for machines of striking action essentially reduced interest to them. It is known their application as a drive in hand striking machines for coal industry, big sledge-hammers.

It was not found use in the drive of press equipment of LIE in the most cases because of the slight specific power of traction which is taken away from active surface of inductor. Because of this reason they can't compete with other drives, especially with electromechanical, hydraulic and electromagnetic.

Electrodynamics engines (LEDE) are based on the interaction among magnetic fields which are created by moving and motionless coils. Electrodynamics engines have high speed of operation and higher specific force. The low efficiency one can refer to the main faults.

But using LEDE in the drive of striking action is complicated because of the insufficient strength and reliability of electric part of rotor in cyclic-striking behavior. Using of linear electrodynamics engines as drive of press equipment is ineffective. Their low specific indices of useful capacity and power of traction are causes of this. It's for its part leads to growth of clearance and cost of this equipment.

Interaction of impulse magnetic field of inductor coil with magnetic field of short closed spire is used in linear inductodynamic engines (LIDE). Forces of electrodynamics and electromagnetic origin simultaneously are used in LIDE. Because of it high speed of operation and specific indices which are typical for LEDE and high efficiency of energy transformation that natural LEME are inherent them. High speed of operation limits their use in press equipment with low speeds of slipper that necessary in doing some technological operations [3].

According to real technical and economic indices LIDE one can consider possible creation of press equipment with drive from mentioned engines on the stroke energy to 1·10 3 joule. Creation of presses of bigger capacity is possible by virtue of

quick development of elementary basis of power supply sources of these engines (capacitors, thrusters and other), accumulation of experience of their application.

Principle of work of linear magneto-electric engines (LMEE) is based on the interaction of permanent magnet with magnetic field of coil with current. Using LMEE in different branches of industry was problematic because of the high cost and deficiency of alloys which were used for making stable magnet. Engines had low specific efficiency and didn't secure necessary reliability. They have perspectives of use at today's stage, because magnetic energy (BH) max of modern stable magnets made from alloys neodymium-iron-boron and samarium-cobalt can come to 400 kilojoules/ m3 and highly exceed magnetic energy of electromagnets. Creation of impact-proof stable magnets on the basis of newest technologies will allow use them in engines of such type for machines that work in cycling-striking behavior.

Changing sizes of bodies made from ferromagnetic and ferroelectric materials by action on them with magnetic and electrical fields, it's possible to come transformation electric energy into mechanical. Magnetostrictive (LMSE) and electrostrictive (LESE) engines are constructed on such principle.

In the drive of press equipment LMSE there weren't found use because of small dimensions of transferences that don't exceed 2 mm and specific useful work, big linear sizes and cost, specificity of work use.

Linear electrostrictive engines have simple construction, small clearances; make traction force to 100 Newton. LESE have high technology of producing and reliability of work, low metal containing, and high specific indices.

In the drive of press equipment LESE aren't used because of the low values of traction forces, transferences, insufficient dynamic strength of rotor [2].

For determination what type of examined electric engines has had the biggest use as drive of press equipment there were hold literary and patent search. Patent search was hold on the basis data about author certificates and patents: State Service of Intellectual Property (Ukraine); Federal Institute of Industrial Property (Russia); Eurasian Patent and Informative System that includes 12 national patent organizations, 40 data bases, 35 million descriptions; search base in international and national patent funds patentscope, that contains information about patents about 40 world countries and counts 2.2 million published international applications for patents and patent documents from regional and national funds in amount of 28 million; national base of patent department of the USA USPTO PatFT/AppFT; national base of patent department of Japan JPL IPDL etc.

Survey of different types of LEE and press equipment with them as drive showed that linear electromagnetic engines and press equipment on their bases are developed and patented the most often. The most patents on this basis are in Russia, USA, England, Japan, and China. Linear inductodynamic engines and used equipment

are patented less. Linear inductodynamic engines are similar by their construction to linear electromagnetic engines.

On the basis of received data we can do a conclusion that the largest use as drive of press equipment LEME received. Overwhelming majority of practical using machines is equipped by such engines.

Mechanical transmission id absent in LEME and LIDE. They don't need high exactness of manufacturing components. They have simple construction, big possibilities in increasing reliability and durability of work. It's possible to regulate dimension of effort, frequency of motions in the large limits. Possibility of automatization, simple steering, and impossibility of overload during doing of technological processes are other advantages [1, 4].

Having analyzed approximate limited indices of different types LEE [1, 2] and compared them with characteristics necessary for doing technological operations of light industry (stamping, perforating, installing of metal tools, thrusting and branding etc.), one can make a conclusion that LENE and LIDE suit the best as a drive in equipment for their execution.

Limited mechanical gradual and return-gradual transference is done in linear electromagnetic engines, as it was mentioned, with discrete energetic transformation. Discrete energetic transformation will give opportunity to press equipment with LEME appointed for execution of technological operations of light industry to use electric energy during their execution only.

But despite of known advantages of electromagnetic drive, its use in equipment of light industry is little. It's explained by that reason that there is no mass production of drive electromagnetic engines with high specific indices. There are no exact methodologies of calculation and projecting of equipment with LEME.

Large use of equipment with LEME in the production was controlled because of the absence of purposeful researches and recommendations according its running. It caused to such situations that such equipment was created on the basis of casual, electromagnetic engines at little use. Because of this unsuccessful, bulky, not productive constructions appeared that had low reliability because of increased electromagnetic engines.

Because of the absence technical literature today which would contain generalized experience of drive use with linear electromagnetic engines that necessary for substantiated choice of the engine type and its parameters for execution of concrete technological operations we'll do analysis of their use in different of technology?

LEME as drive of press equipment are used in machine-building, radio-electronic, building, foundry industries etc.

It is known a set of patents, author certificates, inventions, and proposals in the sphere of use electromagnetic engines in presses, press-hammers, riveters, forming machines appointed for many spheres of industry.

It is known use of press equipment with LEME for technological operation of stamping from different materials in a lot of spheres of industry.

It is known equipment on the basis LEME in holding of seismic prospecting works; in mountain, oil and gas industry, in water economy; medicine; in agricultural complex etc.

Today scores constructions of press equipment with linear electromagnetic engines that differ by technical characteristics and spheres of use have done in countries of near and far foreign countries.

Despite of electric engines of turning action of general purpose, linear electromagnetic engines are not standardized, but by individual firms (for example, firm Etel) attempts of working out of unified sets of linear electromagnetic engines for different technological equipment carried [5].

Siberian department of Academy of sciences of Russian Federation in common with scientific-industrial enterprise “Aviastek” set producing of small-scale but rather powerful electromagnetic press-hammers made on the basis of impulse electromagnetic engines. They are used in electrotechnical industry for stamping printed cards, components from mica and plastic; in machine-building with availability variable technological equipment people do wide spectrum of different technological operations – pressing, cutting, stamping, extract, breaching, marking, forming, pressing (of oil seal, hoops etc.). One of the most perspective drives that provides maximum meaning of kinetic energy on the short place and force action on massive object is linear induction-dynamic drive of striking action. Such drive, that do return-advancing movement of rotor with executive elements, is used in many systems of different purpose. In straight motion of rotor useful work is done, for example deformation of object, and in return motion of reversion into primary stage. But efficiency of indicated drive as a rule doesn’t increase 10-15%.

Linear induction-dynamic engines can be divided into 2 types:

- of cylindrical type with rotor, that is pulled in coil;
- with disc inductor [6].

Linear inductive-dynamic engines with disc inductors aren’t known jet in technical literature as magnetic-impulse [7].

Striking linear inductive-dynamic engines find a large use in many spheres of sciences, engineering, and technology. They are used as drive of equipment for destruction of rocks and building constructions, refinement technological equipment, researching of goods and devices according to striking action, progressive technologies of metal treatment, momentum of objects to high speeds, welding of materials, stamping etc. [8].

LIDE with capacious accumulators of energy can do powerful force impulses with necessary parameters and wide range of energies. Its stipulates their wide use for implementation technological tasks in different spheres of industry.

Their famous use as electromagnetic technologies for forming, perforation, and peening of automobile backs. One of the main problems at some enterprises of metallurgical complex, concentrating factories, during discharging of railway trains is a problem of sticking of formal mass and friable materials in bunkers, cleaning of metallurgical dippers from slags etc. Such equipment is used in the role of causative agents of mass movement in bunkers, dippers. Impulse engines of such type that are installed on the walls of bunker or dipper periodically turned on to the battery of capacitors that charges through power unit from electric system. During turning on puttee links of engine energy which is accumulated in capacitor battery changes during some milliseconds into energy of electromagnetic field and then into mechanical energy of working organ. Destruction of mass that sticked or parched happens by means of this energy. This type of equipment is used for laying out too big stones in quarry.

Equipment of LIDE can do a stroke with force that regulates to necessary places of object. It let use it for solving different technological problems. There are no exception technological tasks of light industry, in particular it can be operations of felling and perforation components of foot-wear in light industry.

Conclusions

1. Reasonability of use in press equipment drives with linear electric engines for fulfillment operations with return-gradual movement of working organs that will bring to reducing energetic waste, metal capacity, occupied place and increasing of labour productivity was determined.
2. Types of linear electric engines which have perspectives to be used in press equipment for fulfillment operations of light industry were fixed.

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MONITORING TRANSMISSION OF THE ENERGY IN DRIVING SYSTEMS OF MACHINES

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Introduction

One of the main tasks of technical diagnostics used to determine the state of the machine. Modern machinery and equipment systems are very complex, consisting of in many parts of components and assemblies. Correct operation of one of the components is often of great importance to the implementation of the tasks performed by other components.

The machine is generally driven mechanism or set of mechanisms designed to perform the requested work associated with the production, transformation of energy [10].

The work carried out to improve the reliability of the machines will bring you to explore and define different diagnostic relations and reliability, giving rise to the inference of the current state of the machine. Knowledge of the status of the machine allows you to take actions to increase operational safety and reduce the cost of operating the machine and the cost of repairs. Therefore, it is important to be monitored machine and warn the user about irregularities in the operation or the occurrence of certain symptoms of machine conditions that may cause damage or destruction. Conducting this type of action is particularly important in the case of continuous motion machines, where each unexpected break from work can lead to large losses.

To support the operation and to ensure greater safety of such equipment, systems mounted continuous surveillance tool, also known as condition monitoring systems [7].

Energy flow in the drive system

The drive system, which is an example of the active element machines, transforms and transfers energy to further its components form a team of interconnected mechanisms. Members in this system involved in transforming and transmitting energy from the driving member's passive members, the resistance forces loaded. Not all, however, the active work force is used for the intended purposes useful

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