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New Prospects of Science and Technology Development of Energy Industry and Improvement of Conditions for Living on the Planet Earth

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For energetic industry and conditions for living on the planet Earth, the things of primary importance are EM and ED. Nowadays there are about 98% of all electric energy used by the humanity is produced by EGs. From all types of energy combined, that a human uses, there are about 60% of it is used by the ED, which, along with other components, includes one or more EM (EM – electric motor), in order to power a machine or a mechanism.

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Abbreviations used in this document:
EMa – electric machine (EMa is the common name of the EM – electric motor and EG – electric generator)
ED – electric drive

I. Introduction

The main type of energy used by humanity is the electric energy. Whatever the type of energy source is, the renewable energy or some else, it is, mainly, transferred into the electric energy. This is conditioned by the fact that electricity is easier to store and to transport, and, it is the much more versatile type of energy in terms of application than other types.

For energetic industry and conditions for living on the planet Earth, the things of primary importance are EM and ED. Nowadays there are about 98% of all electric energy used by the humanity is produced by EGs. From all types of energy combined, that a human uses, there are about 60% of it is used by the ED, which, along with other components, includes one or more EM (EM – electric motor), in order to power a machine or a mechanism.

Ultimately new concepts, technologies, theoretical and experimental works offered by us, create the basis for the rapid movement through the path of achieving one of the main strategic goals of humanity:

- The development of technologies, effectiveness of electric energy industry by means of more powerful, more compact and more energy efficient EMas and EDs with new functions offered on the market, and the transfer of transport means (land, air, sea and underwater) from ICE (Internal Combustion Engine) to electric drives, while achieving a the high level of technology;
- Creation of favorable conditions for human, flora, and fauna, to exist on the planet Earth by means of reduction of the harmful emissions not only produced by various mechanisms and machines but by electric stations as well, which means the more efficient use of electric energy by it's consumers;

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We should make a notice here, that new technologies would also lead to the reduction of materials consumption ratio, the production cost of mechanisms and machines, as well as to the improvement of their exploitation conditions.

II. Current Problems of Technological Development of the Energy Industry and Improvement of Living Conditions on the Planet Earth

For more than 180 years of development history, the principle of known EMas and EDs was based, in terms of inductive contact in their structure, on two fundamental ideas[5]-[9], which may be referred as single-vector and full-length. (the complete rows of stator and rotor). That's why all known EMa and ED could be called accordingly, the oEMa-FF (single-vector electric machine with complete rows of stator and rotor) and oED-FF (electric drive with complete rows of stator and rotor and single-vector inductive cohesion between them).

Nowadays, the known oEMa-FF and oED-FF systems have reached their maximum capabilities in terms of technical realization. However, oEMa-FF and oED-FF have serious disadvantages: large sizes, limited energy efficiency, functional and structural abilities.

Consider the main factors that constrains the wider use of electric drives in vehicles and the transition from DIC to EM.

Let's cover three main factors, which hold electric drives from the more frequent application in transport and from the ICE (internal combustion engine) to EM transfer. In this relation, the level of technological development of electric cars may be used as an example.

Electric cars that are currently produced (by Tesla and others) use too much electricity for driving, and are also more expensive than cars with ICE, and electric cars are more expensive as well. These oEMa-FF and oED-FF systems, which are mainly expressed by the following factor:

The power P_E of electric current (work per time) is defined by this expression

$$P_E = \mathcal{I}U \quad (1)$$

Where: $\mathcal{I}$ – power of electric current; U – voltage of electric current.

Electric motors of electric vehicles have a value U in the range from 300V to 700V, and the $\mathcal{I}$ value reaches 400A. Such big values of $\mathcal{I}$ and U are necessary for the creation of a significant force of inductive cohesion in a limited volume of electric motors.

The amount of heat, which is emitted during the passage of electric current through the conductor is defined by the law of Joule-Lenz:

$$Q=\mathcal{I}^2\mathcal{R}t, \quad (2)$$

Where: $\mathcal{I}$ – current strength, $\mathcal{R}$ – conductor's impedance, t – time, during which the current was applied.

Because of the big value of $\mathcal{I}$ used in electric motors of e-vehicles, the greater amount of heat is emitted. Such fact leads to the number of issues.

- The efficiency of the electric motor and battery decreases – sufficient portion of electric energy is consumed during the unnecessary and undesired process of heat emission;
- The electric motor has to have a greater amount (up to 700 kg) of expensive electric batteries;
- Tt complicates the structure, increases the weight and production cost of the electric drive – it is necessary to use effective (liquid) cooling system in order to maintain working temperature of electric motor and battery;
- Decreases the lifetime of an electric motor and electric battery – works under extreme conditions;

We also can note the fact that the quantitative ratio of electric vehicles to ICE vehicles is rather low nowadays and equals about 0,1%. At the same time, exhaust gases of ICE vehicles produce about 80% of air pollution in large cities and metropolises. Electric motors are installed only on small aircrafts and even those are experimental models. And the other fact is that ICE offers a 30-35% efficiency rate.

All the above mentioned facts show how undeveloped, in terms of technologies, are energy industry and the idea of provisioning the favorable conditions for living on the planet Earth.

For instance, our up-to-date technologies may help to decrease the level of energy consumption and heat emission in electric vehicles by 3 and 9 times accordingly. However, such indexes of our technologies in this field are not as big as they could possibly be.

III. Our Offer of New Technologies/ Concepts and Their Scientific and Technological Solutions

Our new scientific and technological solutions for the development of energy industry and improvement of living conditions on planet Earth are based, at least, on one of several concepts/ technologies [5]-[9].

- Multi-vector electric machine (mEMa-(FF)) andэelectric drive (mEMD-(FF));
- Multi-section (multi-vector and single-vector) electric machine (EMa-(jk) and electric drive (ED-(jk));
- ED with ZV- draught, under the constant or adjustable directions of it's draught vectors;
- Single plane systems with "self-compensating rotating moments" and/or with "cross-section of maximum energy efficiency" ED;
- Round-multi-vertex-rotating EMa and ED.

The notations used above:

j – The number of sections of active zones on the surface of inductive cohesion (electromagnetic groups) on the stator;

k – The number of sections of active zones on the surface of inductive cohesion on the rotor;

F – Shows that stator or rotor (depending on it's position in sequence F) has a complete row

Notice: All technical solutions are registered and protected by law.

IV. Main Technical and Commercial Advantages of New Technologies/ Concepts and Their Scientific and Technical Solutions

Electric machines mEMa-(jk) and electric drives mED-(jk), which are created based on concepts of multi-vector and multi-section inductive cohesion, would have many advantages in comparison with already known oEMa-FF and oED-FF, which were created based on concepts of single-vector inductive contact and complete row of stator and rotor.

Multi-vector character of EMa and mED (mEMa-FF, mED-FF) has the following advantages before oEMa-FF and oED-FF:

- Specific output power in relation to the volume is 2 to 4 times bigger due to the increased square of inductive contact surface;
- Material consumption rate is twice less;
- Higher efficiency rate, especially for low and medium power, provided by the decrease of ineffective part of the winding, which in it's turn consumes a significant portion of electric energy (to the useless and for useless and harmful resistance of the electrically conductive material).

The multi-section nature of EMa and mED {EMa-(jk) and ED-(jk)}, also provides new capabilities in comparison with svEMa-FF and svED-FF, such as structural diversion due to the spatial scattering of multi-sector inductive contact of EMa-(jk) and ED-(jk), and the improvement of energy efficiency rate due to the increase of quality of inductive cohesion t at EMa-(jk) and ED-(jk) systems.

Multi-vector and multi-section nature of EMa and mED {mEMa-(jk) and mED-(jk)} lead to the addition of abovementioned abilities usually present at multi-vector {mEMa-FF, mED-FF} and multi-section {EMa-(jk) and ED-(jk)} systems – mEMa-(jk) has capabilities of mEMa-FF and EMa-(jk), whereas the mED-(jk) has capabilities of mED-FF and ED-(jk).

The characteristics of mEM-(jk) given above are proven by results of theoretical and experimental works:

- Firstly, based on the mathematical analysis and computer modeling of mEM-FF (mEM-FF – multi-vector electric motor) with complete-row-stator and rotor), described in the report of the international conference[6]—(https://waset.org/Publication/volume-density-of-power-of-multivector-electricmachine /10007686);
- Secondly, based on the experimental test of the mSRM-31 (mSRM-31 – multi-vector switched reluctance motor with three-section-rotor and one-section-stator) laboratory sample created by us https://drive.google.com/file/d/1SIiPcbqDH6DKCsB EcZ CsxwRgE_ Vi6u2n/view?ts=5aa157f1.

Independent testing[9] and examination by commissions, including the field team, (Excerpt from Protocol of official meeting of Administration of "National agency for technological development", or – "NATD", dated September 04, 2017 No. 43/17[9], have shown that the very first laboratory sample of mEMn-(jk) in the world, presented by the mSRM-31 system, has twice more specific output power per given volume than known single-vector analogs.

The concept of ZV-draught with the constant or adjustable direction of it's vectors of draught force, and various structures of systems for it's realization in ED system are based on the purposeful effective use of multidirectional jet forces or pressure differences created by the engine in the given environment. At the same time, this concept may be successfully used for moving objects along the edge of two different environments, whether it is a vacuum, gas or liquid. Energy efficiency of ZV-draught concept is connected with the fact that at least two out of four side vectors of multidirectional jet force or pressure differences in the given environment created by the engine, which usually compensates one another, are changing their direction of force in order to perform the useful work. This idea is realized by means of special structure surfaces with constant or adjustable profile and/or position of, at least, one of the system's components, which create ZV-draughts.

For instance, this concept allows increasing the amount of useful work of engine with horizontal draught, which would increase energy efficiency rate in the horizontal direction and at the same time it would create single-direction vertical draught and/or single-direction side draught. In such case, the useful work is performed in front of the engine and/or behind it.

The technology of achieving the maximum energy efficiency of two interconnected cascades of paddles in single-plane ED with the multi-cascade paddle of single-plane-blade would allow to increase the energy efficiency rate of ED, help to increase all of it's technical and dimensional characteristics.

The technology of achieving the self-compensation effect of the torque in ED with the multi-cascade paddle of the single-plane blade would help in getting rid of various issues connected with the transfer of the torque force to immovable rests of ED and would allow creating a single-plane blade with two or more cascade paddles for the self-movement unit. For instance, technologies of "self-compensating of the torque" and "cross-section of maximum efficiency" would allow creating aircraft with straight vertical take-off by means of a single blade with electric drive, which would be 10 times more energy efficient and would consume 30% less material for production than other known systems.

Particularly, the helicopter with such ED would not require the second co-axial main rotor or the tail wing with the control rotor, which is used for compensation of the torque momentum transferred from the main rotor to the helicopter itself. Known technologies consider using the two co-axial main rotors or the tail control rotor, which significantly decreases the energy efficiency rate, increases the consumption of materials and the overall weight of the aircraft, and these technologies are connected with issues of transferring the torque momentum to the body of the helicopter.

Newly developed technologies of round-multi-vertex rotating EMa and ED allow assigning them any geometrical form or shape.

V. Marketing. the Market of the Annual em and Ed Consumption

Conceptually new EMa and ED offered would have more compact dimensions, greater energy efficiency rate, new functional capabilities and structural diversion in comparison with known oEMa-FF and oED-FF systems. These advantages have such a great importance for energy industry and for the human, flora, and fauna in general, that the technologies offered here are considered as "disruptive innovation" /https://www.publish.ru/articles /201009_15118689/, "which totally changes the values ratio on the market, and essentially

disrupts (substitutes) products and services previously prevailed on the market.

Areas of use of the EMa and ED is rather wide and it's production is highly profitable. EMa and ED are so widely spread and used that any unit of industrial or household appliances has one or more EMa and/or ED component.

With the great degree of probability, one may expect, that new type of mEM and ED offered by us would occupy the multi-billion share of the world market in no time.

a) The market of electric motors (MEM)

Let's review some of the known statistic data (http://en.moment-expo.com/electric-motors), which only cover the export of electric motors. The annual export rate of top-10 exporters of electric motors in 2010 has reached the following indexes (by countries): China – 7 billion dollars with 13% growth per year; Germany – 6 billion dollars with annual growth of 9%. Moreover, besides China and Germany top-10 world exporters of EM also includes Japan (3 billion dollars), USA (3 billion dollars), Mexico (2 billion dollars), France (2 billion dollars), Italy (2 billion dollars), Czech Republic (1 billion dollars), Switzerland (1 billion dollars) and Thailand (1 billion dollars).

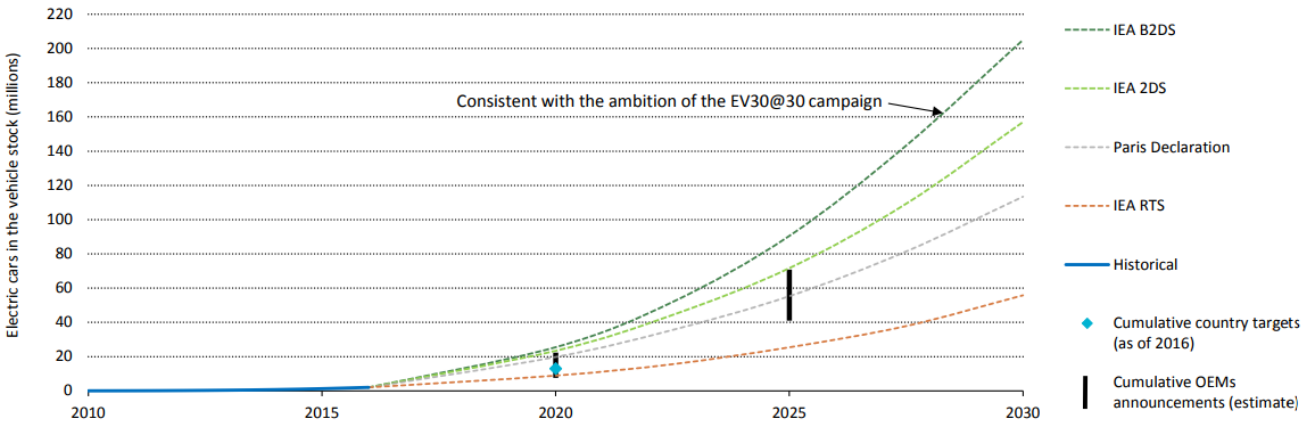
At the same time, one may observe the significant annual increase of EM production rates. For instance, Chinese export in the year 2010 has increased by 13% and German export in the same year has increased by 9%.

b) The market of electric drives (MED) (let's look only at automotive and aerospace industries)

i. *The vehicle market*

In 2010 the German government has accepted the program of production and exploitation of electric vehicles. The goal of this program was to reach 1 million electric vehicles present in the country by 2020, and by the year 2030, the amount of such electric vehicles should reach 6 million. At the same time, this program suggests several methods of stimulation of the demand for such vehicles. The Chinese government plans that by 2020 there would be 5 million electric vehicles on the country (https://hightech.fm/2017/07/03/china_batteries), and by 2030 China would completely shift to electric cars. The Minister for Transport of Russia has announced the schedule and deadlines of shifting to electric vehicles by the year 2027 (http://tass. ru/ekonomika/4475736). Governments of 20 more countries (India, Norway, Ukraine and etc.) have also announced such plans being scheduled to be completed in 2027-2032.

The global vehicle market is equal to 1,6 trillion dollars. According to forecasts the world market of vehicles would reach 121 billion US dollars by the year 2020 http://www. strategyr. com/Market Research/Electric_Motors_Market_Trends.asp, and the growth of sales, according to various forecasts, would be equal to 25-70 million electric vehicles by 2025.



Different scenarios of the growing number of electric vehicles in the world, from 5 up to 14 million units per year. (https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf)

Taking into consideration the fact that the cost of electric drive is about 30% of the cost of the whole vehicle (https://www.quora.com/Can-anyone-provide-a-cost-analysis-of-converting-gasoline-powered-cars-to-a-plug-in-hybrid-cars), the share of electric drives market for electric vehicles in 2020 would be equal to about 40 billion dollars.

c) The market of ASI (ASI – Aero-space industry)

Nowadays the annual income from ASI only in the USA is equal to about 180 billion dollars, which is roughly 0,6% of the total world GDP. Annual turnover in other sectors of the economy, which are immediately connected with the use of aerospace technologies is about 10 times bigger than the turnover of the aerospace industry itself.

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