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MAGNETIC PULSE METHOD SUPPLYING ENERGY FOR MOVE THE PISTON INTO ENGINE

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The method of magnetically-impulse transmission of energy offers through an inductor to the flat plate, that allows to distinguish considerable instantaneous power with further transformation it in mechanical energy.

Keywords: magnetic pulse method, piston engine, energy storage, electric field, electromagnetic force, energy efficiency

Constantly growing requirements to ecological safety, environment related to contamination by the toxins of machines and mechanisms, oil-fired and combustible gases, and also appeals to the every kind of economy of traditional types of energy dictate a requirement in creations and introduction of the fundamentally new technical decisions based on the receipt of economical and ecologically clean energy sources.

Objective research. This idea can provide a piston engine with the improved indexes of during exploitation, where not use the traditional types of fuel.

Materials and methods of research.An electrophysics method is based up in principle of action of such engine, namely, magnetically-impulse, related to the class of treatment materials of pressure. For technological to the parameters this method is near to the electro-explosion.

Modern work of reciprocator is provided due to force, defiant motion of piston and created due to electromagnetic effects directly in the piston executed from conductive material. Thus no intermediate working environments of transmission of the mechanical affecting piston are not required [3].

The simplified chart over of the magnetically-impulsive method fixed in basis of engine is brought on fig. 1.

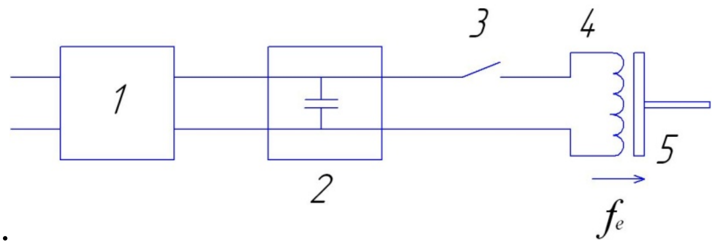

Fig. 1.Simplified chart of magnetically-impulsive supply of energy

From a source of the electric energy 1, the capacitor 2 is charging, in the electric field of that energy accumulates:

$$E_н = \frac{CU_c^{\ 2}}{2}. \qquad (1)$$

By means of switch 3 the charged store of energy is connected to puttee 4, intended for creation of magnetic-field of certain spatial configuration.

The store of energy during short time runs down on a puttee, causative agent, here maximal strength of discharge current of I arrives at hundred and thousand ampere. In the vicinity of causative agent, where a piston is shut-down 5, the quickly changing magnetic field that results in the origin of electromagnetic force is createdF_e. This force causes motion of piston along directing. Thus, energy of electric-field of capacitor banks will be transformed in energy of magnetic-field of causative agent, and then in work of motion of piston and partly in a warmth.

As actually the process of influence flows very quickly, then his time on the whole is determined by duration of charging of store of energy [1, 5].

First setting for the receipt of the brief power magnetic fields created in 20th of Acad. PL Kapitsa.On this setting it was succeeded to attain tension of magnetic-field$H = 10^7 \, A/m$. At the end of 50th and beginning of 60th research options were built, creating the beyond measure strong magnetic fields with tension $H = 10^9 \, A/m$.

The row of devices of the industrial setting, in that the strong magnetic fields are used for technological aims, is afterwards worked out, in particular, for the operations of magnetically-impulsive formation [1].

The row of dignities is magnetically inherent an impulsive method:

- simplicity of equipment;
- absence intermediate working among, transmitter the mechanical affecting object;
- absence of requirement of sealingin of working space et al.

Research results. We will consider physics of process of magnetically-impulsive method on the example of cooperation of electro-impulsive magnetic-field and flat plate. Magnetically-impulsive influence [2] chinks to come true by two methods:

- induction at influence of impulsive magnetic-field that is created by a causative agent with a current, pointed in a flat plate by the field. At it a plate is not plugged in an electric chain;

- electrodynamic at cooperation of currents in a causative agent and flat plate plugged in the chain of discharge of capacitor banks.

An electrodynamic method is based on electromechanics cooperation of conductors where is current flows. This method has a row of substantial defects and can not be stopped up in principle of construction of the offered piston engine.

Most acceptable for us use the induction method.

Near-by the puttee of causative agent (inductor) a flat plate that under the action of electromagnetic forces is set $\vec{F}_e$ removed from a causative agent on some distance. The energy density of the magnetic field is:

$$P_{em} = 0{,}5\vec{B}\vec{H}, \qquad (2)$$

where $\vec{B}$ - magnetic induction; $\vec{H}$ - tension of magneticfield.

For air (environment where a process passes usually) :

$$\vec{B} = \mu_0 \vec{H}, \qquad (3)$$

where $\mu_0 = 4\pi 10^{-7}$ - magnetic permanent, Gn/m.

At the beginning of discharge of store of energy (during ten of microseconds) near-by the puttee of causative agent on the internal side of flat plate tension of magnetic-field $\vec{H}_1$ great, and on external is tension $\vec{H}_2$ small.

In the single volume of space of inside of flat plate the density of magnetic energy is equal:

$$0.5\vec{H}_1\vec{B}_1 = 0{,}5\mu_0\vec{H}_1^{\,2}. \qquad (4)$$

On external part equal:

$$0{,}5\vec{H}_2\vec{B}_2 = 0{,}5\mu_0\vec{H}_2^{\,2}, \qquad (5)$$

where $\vec{B}_1$ and $\vec{B}_2$ – values of magnetic induction accordingly on internal and external parties of flat plate.

Dimension of the energy density $\left(L^{-1}MT^{-2}\right)$the same, as pressures. Therefore for both sides the flat plastic arts different magnetic pressures correspond the densityes of energy $\vec{P}_{m1}$, $\vec{P}_{m2}$.Density f_e electromagnetic forces on the area of flat plate presents the difference of magnetic pressures $\vec{P}_{m1} - \vec{P}_{m2}$ with internal and external parties. These magnetic pressures are perpendicular to the vector $\vec{B}$ numeral equal to the local density of magnetic energy:

$$\vec{P}_{m1} = 0.,\mu_0\vec{H}_1^{\,2}.. \qquad (6)$$

$$\vec{P}_{m2} = 0.5\mu_0\vec{H}_2^{\,2}. \qquad (7)$$

Then the superficial density of electromagnetic forces will be equal:

$$f_e = \vec{P}_{m1} - \vec{P}_{m2} = 0.5\mu_0\left(\vec{H}_1^{\,2} - \vec{H}_2^{\,2}\right) \qquad (8)$$

Vector f_e directed in a that side where the magnetic field is weaker, in this case on the inside of flat plate inoutside. That a magnetically-impulsive action happened, it is necessary, that tension of magnetic-field on both parties of flat plate substantially differed from each other. Tension H_2 magnetic-field into a flat plate relaxes due to a current I_n, current pointed by the changing magnetic field I in a conductive plate plate. By rule of Lenz the current has such direction, as magnetic field that is created by agent into a contour, where the current is. A plate, and more precisely chain of the current, possesses the certain inertance characterized in the simplest cases permanent to time τ_n. The more τ_n as compared to duration of flowing of discharge current, the the electromagnetic inertance of conductive flat plate is stronger expressed and the weaker at the beginning of discharge the magnetic field, being characterized sizes $\vec{B}_2$ and $\vec{H}_2$ on her exteriority. To execute the indicated condition, time of discharge of capacitor banks, i.e. time of growth of magneticfield, it must be as few as possible. At a magnetically-impulsive action a flat plate is heated by the given current. Losses depend on heating, in particular, from speed of change of magnetic-field can make a to 20 % energy accumulated by a capacitor banks.

It should be noted that during a discharge on causative agent, mechanical forces, by value equal to the effort attached to the flat plate, operate according to the third Newton's law. In addition, there are efforts because of cooperation of currents in a causative agent. Therefore the construction of causative agent must beat very hard and durable, that will be one of major tasks at constructing of engine [2].

For description of electric processes what be going on at a magnetically-impulsive effect, a discharge chain can be presented by the chart of substitution totality of the idealized elements such, as inductive and capacity [5, 4].A chart is presented on a fig. 2.

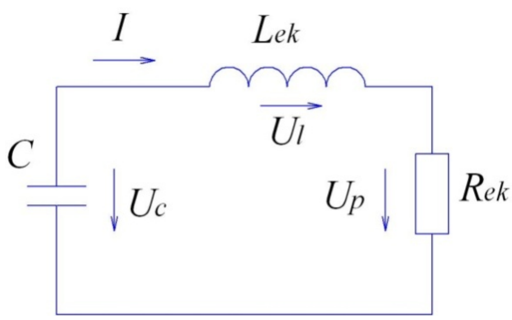

Fig. 2. Chart of substitution

Value of equivalent inductance of discharge chain L_{ek} determined by the magnetic stream of dispersion, that is not used for influenceThis inductance depends on configuration of causative agent, long leads, and also from electromagnetic properties of flat plate, who is the center of the causative agent. At affecting flat plate and her moving away from a causative agent equivalent inductance L_{ek} some changes, however this change it is possible to ignore due to small value of equivalent inductance. Equivalent resistance, R_{ek} that reflects all irreversible losses in a discharge chain: electric heating of elements, work after affecting plate etc. Exactly equivalent resistance usually is not can be succeeded calculating, therefore use approximately value.

For the optimal indexes of process by the parameter of discharge chain C, R_{ek}, L_{ek} choose such, that current it was periodically attenuation, and speed of his change at the beginning of discharge of condenser small. $R_{ek}=\sqrt{L_{ek}/C}$ the period of eigentones of dischargecurrent is determined:

$$T = 2\pi\sqrt{LC}. \tag{9}$$

Peak current $I_{\max}$ at the end of the first fourth of period $\tau = 0.25T$ set by correlation:

$$I_{\max} = 0.5U_{xp}\sqrt{\frac{C}{L_{ek}}}. \tag{10}$$

If a flat plate is executed fromferromagnetic, then inductance L_{ek} increases, and frequency diminishes accordingly. According to expression (10), for the increase of electromagnetic force $\vec{F}_e$ it is necessary to promote tension of magnetic-field $\vec{H}_1$ on the internal side of plate (fig. 2). It takes place at large forces of discharge current and high-rate of his change. Electromagnetic forces are especially great in the first fourth of period of discharge. If to consider that strength of current I at the beginning of discharge increases on a linear law, then concordantly (9) and (10) speed of growth of current in the first fourth of period:

$$\frac{\partial I}{\partial \tau} = I_{\max} \cdot 0{,}25T = 0.3\frac{U_c}{L_{ek}} \tag{11}$$

From where:

$$I = \left(0{,}3\frac{U_c}{L_{ek}}\right)\tau. \tag{12}$$

According to the law of complete current for a contour tension of magnetic-field on the internal side of plate:

$$H_1 = k_1 NI, \tag{13}$$

where k_1 – permanent; N – number of coils of causative agent; I – strength of current.

In accordance with expression (12) at the beginning of discharge the field tension $\vec{H}_1$ grows on a linear law.

Tension of magnetic-field $\vec{H}_2$ into a plane changes considerably weaker. And according to the law of complete current, for a contour L_2 field tension $\vec{H}_2$ determined by strength of the discharge current tI in the puttee of causative agent, so the current pointed by force I_n in a plate. By rule of Lenz the given current prevents changes of the field into a plate, therefore:

$$H_2 = k_2 NI - k_2 I_n, \tag{14}$$

wherek_2 – permanent.

In obedience to expression (14), at the beginning of discharge on exteriority of plate tension of magnetic-field increases gradually H_2 ("magnetic pillow"), electromagnetic force F_e falls.

It takes place the later, than anymore permanent to time τ_n.One of necessary terms of magnetically-impulsive interaction is inequality:

$$\tau_n > 0.5T. \tag{15}$$

If this condition is executable, then the height of strength of the given current does not have time after the change of dischargecurrent I. Tension of magnetic-field on exteriority of plate $H_2 \approx 0$ a magnetic pillow is absent. If permanent to time of chain of the given current small, then tension for both sides the plate fast becomes same level, and density f_e and superficial forces falls. A Magnetically-impulsive action will be not effective. Indexes of cooperation of causative agent and plate will be the best, when the radius of plate approaches the radius of puttee of causative agent and a gap between a plate and puttee is minimal. Inductance of discharge chain is minimal.

If inequality (15) is executed, it is possible to consider that $H_2 \approx 0$ and then taking into account expressions (8) and (13) density of electromagnetic forces:

$$f_e = 0.5\mu_0 (k_1 N)^2 I^2. \tag{16}$$

According to correlation (12) and (16), density grows with the increase of initial tension U_c capacitor banks, number of coils N and inductances. At the beginning of discharge the density of electromagnetic forces is equal to the zero (fig. 3)

Taking into account expression (12), density of electromagnetic forces is:

$$f_{e\max} = 0.12\mu_0 (k_1 N)^2 I^2 U_c{}^2 \frac{C}{L_{ek}}. \tag{17}$$

For the increase of electromagnetic forces needed, puttee of causative agent with the large number of coils N, but by small inductance, and initial tension U_c and capacity of dischargechain must be high. Size $f_{e\max}$ determined by the density of energy in an object, i.e. relation of the energy accumulated in condensers, to the volume of working space into a causative agent.

During the first semiperiod (fig. 3) considerable part of the energy accumulated by a capacitor banks is distinguished. In the second semiperiod direction of the magnetic fields changes for both sides a flat plate, but direction of electromagnetic force is saved.

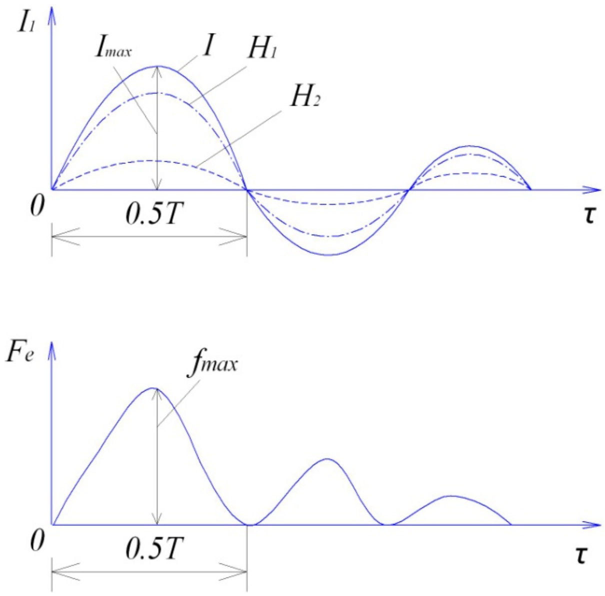

Fig. 3.

It is necessary to find out for the calculation character action of forces, how the density of electromagnetic forces is up-diffused on the thickness of plate. At the change of magnetic induction in the superficial layer of plate arises up E.M.F., defiant the given current a density I_n, directed so that to detain the change of magnetic induction in a plateof electromagnetic forces $\vec{f}_{ev} = \vec{I}_n \vec{B}$

Induction $\vec{B}_1$ magnetic-field into a plate in a superficial layer becomes equal $\vec{B}_{1n}$ and changes to the value $\vec{B}_{2n}$ on an external surface. Outside a plate induction of magnetic-field is equal $\vec{B}_2$. Density of magnetic forces f_e it is possible to find, integrating a size $\vec{f}_{ev}$ on the thickness of plate. There is a density of superficial forces on the internal border of plate, in obedience to expression (8) equal:

$$f_{e1} = 0.5B_1H_1 - 0.5H_{1n}B_{1n} = 0.5H_1^2(\mu_0 - \mu_n),$$

where H_{1n} and B_{1n} –accordingly the field tension and magnetic induction on the internal surface of plate ($H_{1n} = H_1, B_{1n} = 0,5\mu_n H_{1n}$).

Because of superficial effect magnetic induction and currents pointed in a plate are up-diffused unevenly and concentrated mainly in a superficial layer. Superficial density of forces f_e grows, since an internal surface, and arrives at a maximum value f_{e2} on the external surface of plate. Depth of penetration of magnetic-field, thickness of superficial layer δ_n must not exceed the thicknesses of plate h_n. Otherwise there can be a "magnetic pillow" ($H_2 \neq 0$)creating reverse magnetic pressure on a plate and reducing density of electromagnetic forces f_e.

Motion of flat plate is possible, if the surface of density of electromagnetic forces exceeds some level depending on resistance to motion of plate, from counteraction of forces of loading from exteriority of plate. In the first approaching $f_e > f_{e2}$.If this inequality is executed, then motion of plate begins right after beginning of discharge. A movingplate accumulates large kinetic energy. If during the first fourth of period a plate did not move away from a causative agent, then affecting it proceeds. As for the first and second to the fourth of period identical energy of discharge is distinguished approximately, effort for the half of period almost twice as much, what for a fourth. Influence can take place during the second, third and subsequent semiwaves of discharge current. It is caused by the action of electromagnetic forces though less by value. Therefore common influence is determined by a total impulse for all the time of discharge.

Conclusions

It ensues from all foregoing, that magnetically-impulse method allows energy, applying the source of feed comparatively of small power, to distinguish in an object considerable instantaneous power with further transformation it in mechanical energy.The concentration of energy at impulsive supply of energy gives an opportunity to intensify a process, reduce its energy intensity, and on occasion, in particular, in a reciprocator, to get such results that is fundamentally unattainable at traditionally supply of energy. And absence of inertia environment through that pressure is usually passed creates the unique features of the use of magnetically-impulsive method.

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МАГНІТНО-ІМПУЛЬСНИЙ МЕТОД ЯК ОСНОВА РОБОТИ ПОРШНЕВОГО ДВИГУНА

В.В. Концур, Д.С. Комарчук

Запропоновано метод магнітно-імпульсної передачі енергії за допомогою індуктора до плоскої пластини, що дозволяє виділяти значну миттєву потужність з подальшим перетворенням її в механічну енергію.

Ключові слова:магнітно-імпульсний метод, поршневий двигун, накопичувач енергії, електричне поле, електромагнітна сила, енергоефективність

МАГНИТНО-ИМПУЛЬСНЫЙ МЕТОД КАК ОСНОВА РАБОТЫ ПОРШНЕВОГО ДВИГАТЕЛЯ

В.В. Концур, Д.С. Комарчук

Предложен метод магнитно-импульсной передачи энергии при помощи индуктора к плоской пластине, что позволяет выделять значительную мгновенную мощность с дальнейшим преобразованием ее в механическую энергию.

Ключевые слова:магнитно-импульсный метод, поршневой двигатель,накопитель энергии, электрическое поле, электромагнитная сила, энергоэффективность