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PRINCIPLES OF CONSTRUCTION OF THE ADAPTIVE CONTROL SYSTEM OF THE CONTACTLESS ON-OFF INDICATOR

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Let's consider a problem of adaptive control of technological process of change of the specific information by means of contactless on-off indicator (fig. 1 see). The indicator is constructed on located among constant magnets CM with longitudinal magnetisation. Between magnets electromagnets EM with magnetic core are located. On the magnetic core both basic BW and additional control windings AW are located. CM are located between polar tips EM and have possibility to rotate round own vertical axis of symmetry. In this case, the plane of the specific information is created by flat elements which are built on on everyone, identical on design data and the properties, a rotating magnet. Advantage of such indicator consists that at removal of external revolting influences the indicator consisting of magnets, without any external power influence, is independently established in a plane of an arrangement of constant magnets how magnetic power lines become isolated not on air space, and on magnetic core operating electromagnets because of the minimum resistibility to a magnetic field. Such feature also provides not only reliability of work of the indicator under trying conditions industrial production in the presence of vibrations and other undesirable mechanical influences, but essential reduction of consumption of electric energy.

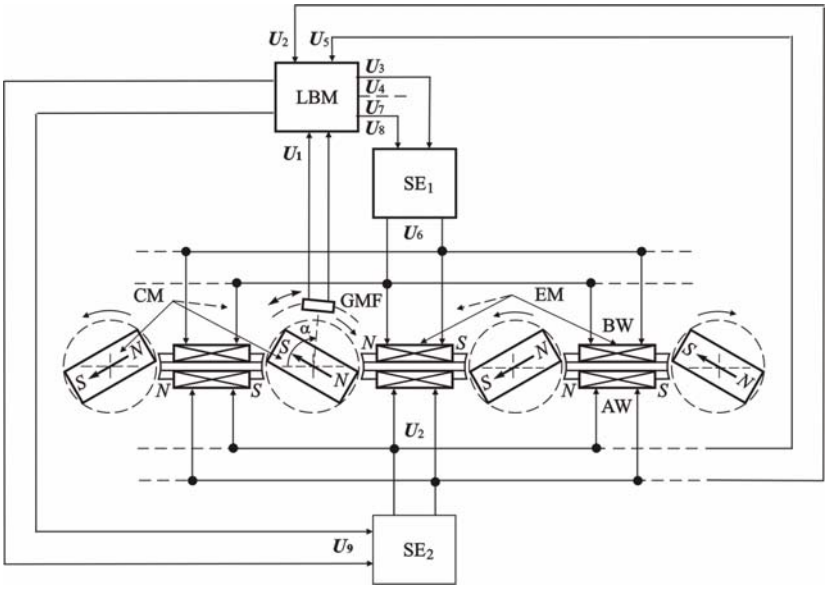

Fig. 1. Functional scheme of adaptive control of the contactless on-off indicator

It is known that any rotating system in static and dynamic operating modes is described by one or several equations of voltage and one equation of the moments [1-7]. It is obvious that for the specified description of movement of mobile parts of a control system it is necessary to consider their electric, magnetic and design features. Thus, because of presence of operating and additional windings of excitation it is necessary to add one more equation of voltage, and for overcoming of the summable additive making moments of inertia of separate rotating parts of system, the specified system of eqations will register in a kind:

$$\begin{cases} \dfrac{d\Psi_1}{dt} + R_{L_1} I_1 = U_1 , \\ \dfrac{d\Psi_2}{dt} + R_{L_2} I_2 = U_2 , \\ \sum\limits_{i=1}^{n} I_i \dfrac{d^2\beta}{dt^2} + D\dfrac{d\beta}{dt} + \sum\limits_{j=1}^{m} (M_{df} + M_{vf} + M_{bm})_j \, sign\left(\dfrac{d\beta}{dt}\right) = \sum\limits_{k=1}^{p} M_{elm_k} \end{cases}$$

where Ψ_1 is flux linkage between a winding of the basic electromagnet and a magnet,

Ψ_2 – flux linkage between a winding of an additional electromagnet and magnet,

R_{L_1} – active resistance of a winding of a basic electromagnet,

R_{L_2} – active resistance of a winding of an additional electromagnet,

I_i – the moment of inertia of ith element of a rotating design,

β – an angle of rotation of a rotating design containing a magnet,

U_1 – operating voltage of a winding of a basic electromagnet,

U_2 – operating voltage of a winding of an additional electromagnet,

D – air factor of a friction,

M_{df_j} – the moment of a dry friction of jth site of a rotating design,

M_{vf} – the moment of a viscous friction of jth site of a rotating design,

M_{bm} – the friction moment arising because of bending of a plate,

M_{elm_k} – the moment created by kth electromagnet.

If we will consider that circumstance that energy of each electromagnet can create rotating moment which is calculated under the formula:

$$M_{elm} = -\frac{1}{2}\Psi\frac{dI}{d\beta} = -\frac{1}{2}LI\frac{dI}{d\beta},$$

and control of turn of each k^{th} magnet to 180^0, is carried out also by k^{th} and $k+1^{th}$ electromagnet using only on one basic winding then, for this case the equation of dynamics for system the eletromagnet-magnet-electromagnet will register as follows:

$$\sum_{i=1}^{n} I_i \frac{d^2\beta}{dt^2} + D\frac{d\beta}{dt} + M_\Sigma sign\left(\frac{d\beta}{dt}\right) = -\frac{1}{2}(L_{1,k}I_{1,k} + L_{1,k+1}I_{1,k+1})\frac{dI}{d\beta} \ .$$

In the event that, the electromagnet is supplied by additional windings which can be used as simultaneously with the cores and irrespective of the cores then at the combined control the equation of dynamics will become:

$$\sum_{i=1}^{n} I_i \frac{d^2\beta}{dt^2} + D\frac{d\beta}{dt} + M_\Sigma sign\left(\frac{d\beta}{dt}\right) = \begin{cases} -\dfrac{1}{2}(L_{1,k}I_{1,k} + L_{1,k+1}I_{1,k+1})\dfrac{dI}{d\beta}, \ while & t_1 \le t \le t_2; \\ -\dfrac{1}{2}(L_{2,k}I_{2,k} + L_{2,k+1}I_{2,k+1})\dfrac{dI}{d\beta}, \ while & t_3 \le t \le t_4; \\ -\sum\limits_{k=N}^{N+1}\dfrac{1}{2}(L_{1,k}I_{1,k} + L_{2,k}I_{2,k})\dfrac{dI}{d\beta}, \ while & t_5 \le t \le t_6. \end{cases}$$

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The resulted equations of dynamics can be solved numerical methods, and in particular, a method of Runge-Kuta.

For reduction of duration of adjustment and automatic control realisation it is necessary to spend three preparatory stages:

I stage – is in each specific case spent object studying (limiting value of energy input, amplitude of fading fluctuation, number of fluctuations and establishment time is established);

II stage – it is established comprehensible parametres of control (power consumption size, the maximum value of an impulse of an operating signal and duration of its action, the moments of switching and duration of inclusion of the basic and additional windings of control);

III stage (7-9) – adjustment and start of automatic system for the subsequent transfer in an adaptation mode.

I stage (fig. 2, diagrammes (1-3). From the spent researches it is visible that at giving of sufficient capacity and any duration of an impulse "start" is reliably provided turn of rotating system on 90^0. If action of an impulse we will not clean, the system will stop itself how action of an external field and a field of magnets will be unidirectional. It promotes fast attenuation of fluctuations. If to disconnect an operating impulse, right after passages of a mark of degrees further process in a vicinity of 180^0 degrees becomes fading how the turn was carried out also already magnets through magnetic core electromagnets create braking fields. From here follows that in any case process fading, however depends on duration of action of an impulse of control the expense of electric energy, and in some cases we will receive the big fluctuations that in some cases are unacceptable.

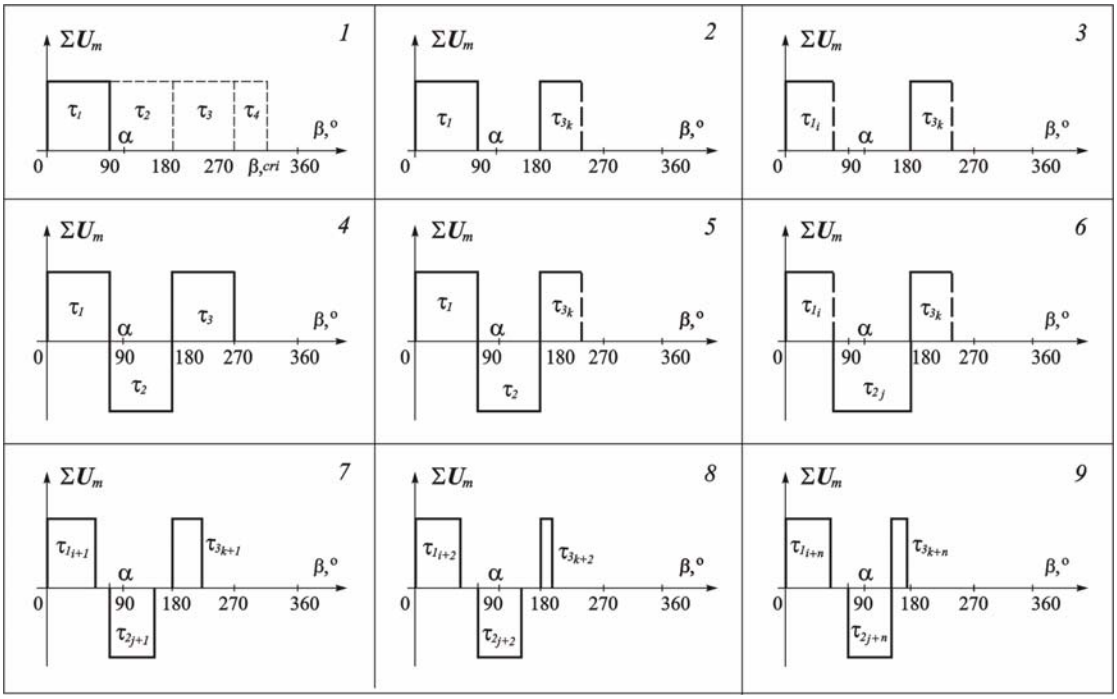

Fig. 2. Diagrams of pulse signals of adaptive control

II stage (fig. 2, diagrammes (4-6)). Under the influence of an operating impulse after passage of a corner of 90^0-degrees the operating winding is switched on opposite polarity. Thus already opposite directed field brakes rotating design moving under the influence of inertia. It is obvious, it is possible that to brake before a turn in 180^0, and it is necessary to switch polarity once again further.

At such control the quantity of fluctuations decreases, but the expense of electric energy remains big.

At the **III stage** (fig.2, diagrammes (7-9)) it is applied the received results of the second stage – duration of time of consecutive controls (start, braking, acceleration). Consecutive cyclic and in each subsequent cycle it is carried out such control at which transition from one condition in the second occurs for the least time, the expense of electric energy is finished by reduc-

tion (increase) in duration of an impulse of braking and achievement of a critical limit of time of acceleration to is minimum admissible value, and fluctuations are completely excluded.

The indicator with the simplified control system: ***expands*** functionality of the device for the account of increase in overall dimensions and possibility to display two various drawing, a sign, colour or indication of a sign-variable traffic sign; ***reduces*** expenses of electric energy, a magnetic powder, winding electromagnet wires, for the account of creation not only the compound display element which longitudinal size has increased twice, arrangements of electromagnets among between rotating constant magnets, and also, but also realisation of pulse control; ***provides*** speed of change of the information for the account of application electromagnetic absorber; the weight-dimensional of indicators for the account of application of the easy bilaterial elements intended for an arrangement of the specific information ***reduces*** inertance by reduction; ***Increases*** coefficient of efficiency duty for the account of reduction of an air backlash between electromagnets and magnets that leads to reduction of consumed electric energy.

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