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CONTACTLESS ELECTRIC DEVICES WATCHING SYSTEMS

G.S. Kerimzade

Department of Electric Equipment and Automation of Productions, Azerbaijan State Oil Academy
Baku, Azerbaijan, gulaya68@mail.ru

Abstract- Modern scientific and technical progress is closely connected with development and automatics introduction. Automatic control is carried out on the basis of the information at use of a complex of means of automatics, including the various automatic devices serving for reception, transfer, transformation and storage of the controllable information, its comparison with program, transfers of the command information for influence on operating process. Contact less electric devices of automatics have found application in watching systems for synchronous transfer of linear and angular moving on distance. Recently, contact less watching systems of the big and small linear moving are developed. They differ simplicity of designs and manufacturing techniques, the big reliability, sensitivity and accuracy of the control of a target signal (moving and effort).

Keywords: Watching System, Moving, Effort, Magnetic System.

I. INTRODUCTION

Contact less electric devices of automatics have found application in watching systems for synchronous transfer of linear and angular moving on distance. Such systems are used for moving of latches, shutters of power devices, wheels at planes and courts, the control of level of a liquid and displacement of working body of cars and mechanisms, for registration of moving of mobile parts of machine tools and robotechnical devices.

Recently contact less watching systems big (to some tens centimeters) and small (to some millimeters) linear moving are developed. They differ simplicity of designs and manufacturing techniques, the big reliability, sensitivity and accuracy of the control of a target signal (moving and effort). We will consider linear watching systems with mobile and levitation elements which possess above listed advantages.

II. METHODOLOGY

The watching system consists of setting and reception magnetic systems. Each system represents long O-shaped magnetic conductor bearing on short cores identical windings of the excitation included the passer each other and fed from the same source of alternating voltage *U*. Each of windings of setting system joins consistently with a corresponding winding of reception system. A mobile part of each of systems is the short-circuited coil the screen which can move along one of long cores magnetic conductor.

Inductance of windings of setting and reception systems depends on an arrangement of a short-circuited coil in relation to end faces magnetic conductor with excitation windings.

At moving of a short-circuited coil at setting system from the centre of a long core of inductance of coils of this system become unequal, the parity of currents of excitation changes. At reception system the induction in section of long cores is redistributed also area with zero value of an induction in section displaced from the central site.

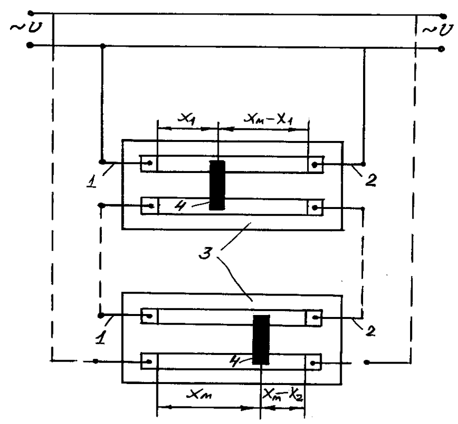

Figure 1. Linear watching system with the mobile screens

In a short-circuited coil of reception system it is induced EMP which causes a short circuit current. Last co-operating with a stream of windings of excitation, creates the effort displacing a coil in area where the induction is equal in section of a long core to zero.

The effort operating on the mobile screen of the converter, the receiver carrying out a role in system, is as a difference of two efforts:

$$\Delta F = F' - F'' \quad (1)$$

where F' is the effort created by a current I' and F'' is the effort created by a current I''.

Sizes of these efforts are defined from expressions:

$$F' = kI_e\Phi'_y$$
$$F'' = kI_e\Phi''_y \quad (2)$$

where I_a is a current proceeding in the screen of the reception converter; to converter factor; and Φ'_y and Φ''_y are specific values of the streams falling to unit of length magnetic conductor and created by currents I' and I''.

If to neglect active resistance of windings and the screen having solved the equations of pressure made for a chain of excitation and a chain of the screen, we will receive:

$$I_e = \omega_b (I' + I'') \quad (3)$$

Specific values of streams if neglecting magnetic resistance of a steel are defined as:

$$\Phi'_y = I' \omega_b g$$
$$\Phi''_y = I'' \omega_b g \quad (4)$$

Hence, the effort operating on the screen of the reception converter,

$$\Delta F = \omega_b g (I'^2 - I''^2) \quad (5)$$

If to substitute values of currents we will receive:

$$\Delta F = \frac{U_b^2 2(x_m - x_1 - x_2)}{\omega_b^2 g \omega^2 (x_1 + x_2)(2x_m - x_1 - x_2)} \quad (6)$$

III. DISCUSSIONS AND CONCLUSIONS

From the analysis of the received expression follows, that balance of system (ΔF=0) will come at $x_м$ - x_1 = x_2. Hence, to each coordinate of a mobile part of the setting converter x_1 there corresponds coordinate of a mobile part of the reception converter x_2. Number of coils of a winding of excitation in each section of the converter for watching system equally 600, diameter of a wire 0.8mm, the sizes of section of the screen-10x10mm, a screen material - aluminum. The general dimensions of the converter 240x80x80 mm. a working course of a mobile part 140 mm. the basic lacks of watching system are:

1. A dry friction between the screen and a core magnetic conductor.
2. Dependence of errors of target signals (moving X and effort F) from fluctuations of pressure U and frequency of a network ω, from temperature of overheat of the screen and a winding.

The effort operating on the mobile screen of the converter, the receiver carrying out a role in system, is as a difference of two efforts: $\Delta F = F' - F''$ (where F' is the effort created by a current I' and F'' is the effort created by a current I''). Balance of system (ΔF = 0) will come at $x_м$-x_1=x_2. Hence, to each coordinate of a mobile part of the setting converter x_1 there corresponds co-ordinate of a mobile part of the reception converter x_2.

The watching system (Figure 1) consists of two opened the Ш -image magnetic systems. Windings 1′ and 1″ transferring and reception magnetic systems 3′ and 3″ can have various numbers of coils that allows regulating transfer factors on moving and efforts:

$$K_x = \frac{x_2}{x_1}$$
$$K_F = \frac{F_2}{F_1} \quad (7)$$

where x_1 and x_2 are moving of the screen of transferring and reception magnetic systems; F_1 and F_2 are entrance and target efforts of systems. Moving x_1 and x_2 on the screen are set by levers 2′ and 2″. The basic characteristics of watching system are functional dependences x_2 (x_1) and F_2 (F_1). If magnetic systems identical, that is windings, screens and magnetic conductors have absolutely identical parameters dependences inductances from moving x_1 and x_2 will be defined as:

$$L_1' = L_{1S} + W_1^2 \lambda (l_c - x_1)$$
$$L_1'' = L_{1S} + W_1^2 \lambda (l_c - x_2) \quad (8)$$

Total inductance: $L = L_1' + L_1''$.

Because of the errors caused by active resistance of windings r_1 and the screen r_2, and also because of active resistance of wires of communication target moving x_2 appears less than entrance moving x_1. If $x_2 \approx x_1$ that a resultant inductance is equal:

$$L = 2\lambda W^2 (l_c + \frac{h_1}{3} - x_1) \quad (9)$$

The force F_2 operating on working mechanism (WM) (Figure 1) can be defined from expression: $F_2 = 0.5(IW)^2 \lambda$. For regulation of force F_2 it is enough to change the relation of number of coils of transferring and reception magnetic systems or to execute their screens with different sections:

$$S_2' = C_2' h_2'$$
$$S_2'' = C_2'' h_2'' \quad (10)$$

In this case currents and the forces operating on the screen will be different:

$$I_2' = I \frac{W_1'}{W_2'}$$
$$I_2'' = I \frac{W_2'}{W_2''} \quad (11)$$

$$F_1 = 0.5(IW_1')^2 \lambda$$
$$F_2 = 0.5(IW_1'')^2 \lambda \quad (12)$$

From the received expressions follows that for regulation of forces F_1 and F_2 or moving x_1 and x_2 it is enough to change relations of number of coils W_1'/W_1'' and specific magnetic conductance's air backlashes (λ). Hence, contact less watching systems of the big and small linear moving, different are developed by simplicity of designs, manufacturing techniques, the big accuracy of the control of a target signal, reliability, sensitivity. Contact less electric devices of automatics have sewed wide application in watching systems for synchronous transfer of linear, angular moving on distances.

Often transformation of horizontal moving x_1 in vertical x_2 (Figure 2) is required. Thus the factor of transfer of moving is defined as:

$$k_x = \frac{x_2}{x_1} \quad (13)$$

To moving x_1 and x_2 there correspond forces F_1 and F_2, therefore the factor of transfer of force will be defined as:

$$k_F = \frac{F_2}{F_1} \quad (14)$$

Forces F_1 and F_2 are defined:

$$F_1=0.5(IW_1')^2\lambda_1$$
$$F_2=0.5(IW_1'')^2\lambda_2 \quad (15)$$

where λ_1 and λ_2 are specific magnetic conductivity of workers air backlashes of magnetic systems:

$$\lambda_1 = 2\mu_0\frac{b_1}{c_1}$$
$$\lambda_2 = 2\mu_0\frac{b_2}{c_2} \quad (16)$$

Then

$$k_F = \left(\frac{W_1''}{W_1'}\right)^2 \frac{b_2}{b_1}\cdot\frac{c_1}{c_2} \quad (17)$$

$F_1=P_x$, as external force of P_x is compensated by force F which is created by interaction of currents of a winding and the screen of the transferring mechanism.

Inductive resistance of windings:

$$x_1' = x_{1s}' + \omega\lambda_1(l_c - x_1)(W_1')^2$$
$$x_1'' = x_{1s}'' + \omega\lambda_2(l_c - x_2)(W_1'')^2 \quad (18)$$

Currents of windings:

$$I = \frac{U}{x_1} = \frac{k_uU}{x_1' + x_1''} = \frac{k_uU}{x_s + x_o} \quad (19)$$

or

$$I = \frac{k_uU}{x_s + \omega\lambda_1(W_1')^2\left[n_\lambda l_c - (x_1 + m_\lambda x_2)\right]} \quad (20)$$

where are designated:

$$x_s = \omega(W_1')^2\lambda_1\frac{h_1'}{3} + \omega(W_1'')^2\lambda_2\frac{h_1''}{3} = \frac{1}{3}(h_1' + m_\lambda h_1'')(W_1')^2\lambda_1\omega$$

$$x_o = \omega\lambda_1(l_c - x_1)(W_1')^2 + \omega\lambda_2(l_c - x_2)(W_1'')^2 = \omega\lambda_1(W_1')^2 \times$$
$$\times\left[n_\lambda l_c - (x_1 + m_\lambda x_2)\right]$$

$$n_\lambda = 1 + m_\lambda$$

$$\mathrm{m}_\lambda = \frac{\lambda_2}{\lambda_1}\left(\frac{W_1''}{W_1'}\right)^2 \quad (21)$$

Considering conditions $F_1=P_x$ and $F_1=0.5(IW_1')^2\lambda_1$ from current expression it is found:

$$x_1 = A_1 - m_\lambda x_2$$
$$x_2 = A_2 - x_2 \quad (22)$$

where

$$A_1 = \frac{x_s}{\omega\lambda_1(W_1')^2} + n_\lambda l_c - \frac{U_1\lambda_1}{2P_x}\cdot k_uW_1'$$
$$A_2 = \frac{x_s}{\omega\lambda_1(W_1')^2 m_\lambda} + l_c\left(\frac{n_\lambda}{m_\lambda}\right) - \frac{U_1\lambda_1}{2P_x m_\lambda}\cdot k_uW_1' \quad (23)$$

From the received expressions follows that for regulations of forces F_1 and F_2 or moving x_1 and x_2 it is enough to change relations of number of coils W_1'/W_1'' and specific magnetic conductivity's air backlashes λ_2/λ_1.

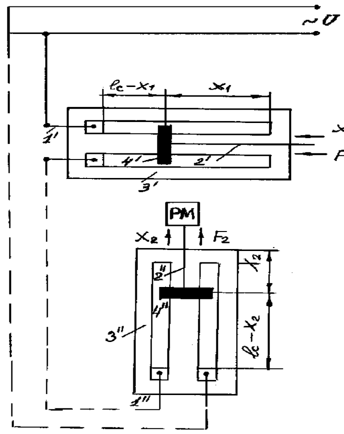

Figure 2. Watching synchronous system for transformation of horizontal moving in vertical (with levitation the screen)

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BIOGRAPHIES

Gulshen Sanan Kerimzade is a Doctor of Technical Sciences, and chairs of the "Electric Equipment and Automation of Plants" in Azerbaijan State Oil Academy, Baku, Azerbaijan. She has ended her doctorate in power faculty of the Azerbaijan State Institute of Oil and Chemistry (nowadays Azerbaijan State Oil Academy) in 1990. Prof. Kerimzade has defended her thesis for a Doctor of Technical Sciences degree on a theme of "Working out of Optimum, Multinomial High-Precision Stabilizers of an Alternating Current with Use of Effect of Induction Levitation" in 2004.