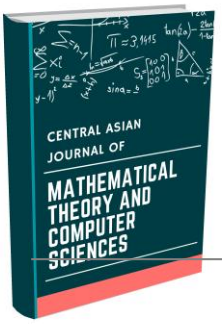

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INTELLIGENT OPTOELECTRONIC DEVICES FOR MONITORING AND RECORDING MOVEMENT BASED ON HOLLOW FIBERS

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Annotation

Optoelectronic converters are very promising for measuring the displacements and sizes of various objects. Among optoelectronic converters, converters based on hollow fibers [8, 10] are insufficiently studied and developed, which, when using ring [8, 10] radiation receivers with lumped radiation sources located symmetrically along the axis of the hollow fiber, allow measuring small displacements with high sensitivity and accuracy. with continuous automatic control [4].

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An optoelectronic converter based on a hollow fiber (Figure 1) consists of a concentrated radiation source 1, a hollow fiber 2, a radiation receiver 3 and a longitudinal moving reflective disk 4 that modulates the light flux Φ0 (x) during movements and is rigidly connected to the rod 5, on which displacement X is affected.

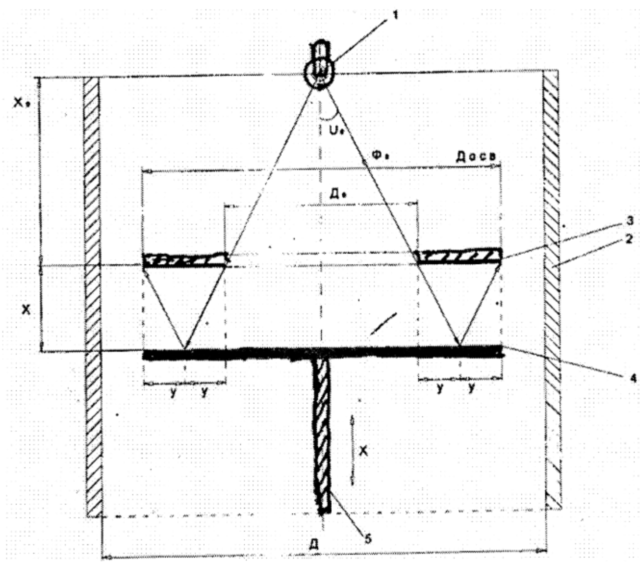

Figure 1 - Physical model of an optoelectronic displacement transducer

The luminous flux Φ0 propagating from the radiation source 1, located at a distance x0 from the radiation receiver 3, passing through the hole falls on the light-sensitive surface of the disk 4 and reflected from it falls on the light-sensitive surface of the radiation receiver 3.

In the initial position at x=0, the disk 4 is pressed against the radiation receiver 3 and the light flux Φ does not pass to the light-sensitive surface of the radiation receiver 3 and the output voltage of the bridge measuring circuit in the arm that the receiver 3 is connected to is equal to zero (Uout = 0).

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In the presence of displacement x (x^O), the luminous flux Φ0 entering the hole of the radiation receiver 3 at an angle U0 falls on the disk 4 and, being reflected from it, falls on the radiation receiver forming an illuminated annular surface with a diameter of Dos equal to

Dosv \u003d D0 + 4y,

where: D0 is the diameter of the aperture of the radiation receiver 3, y is a parameter depending on the displacement x.

Taking into account the fact that the tangent of the angle U0 is equal to:

$$tgU_0 = \frac{Д_0}{2x_0} = \frac{y}{x} \quad (1)$$

the y parameter is determined from the expression

$$y = x\frac{Д_0}{2x_0} \qquad Д_{осв} = Д_0 + 2x\frac{Д_0}{x_0} \quad (2)$$

The illuminated surface of the radiation receiver 3 when the disk 4 is moved over a distance will be determined from the expression

$$S_{осв}(x) = \frac{\pi(Д_0 + 4y)^2}{4} - \frac{\pi Д_0^2}{4} = \frac{\pi}{4}\left[(Д_0 + 4y)^2 - Д_0^2\right] \quad (3)$$

An annular radiation receiver in the form of a photoresistor Rfr is included in the bridge measuring circuit [4, 6].

The output voltage of the converter bridge circuit is determined from the formula

$$U_{вых} = U_m \frac{K}{(K+1)^2} \cdot \frac{\Delta R_{фр}}{R_{фр}} \quad (4)$$

where: k is the symmetry factor of the bridge circuit; ΔRfr - increase in the resistance of the photoresistor with a change in x.

The formula for calculating the change in the resistance of the photoresistor is obtained as:

$$\Delta R_{\phi p} = U_{\phi p}\left[\frac{1}{I_ц(x)} - \frac{1}{I_ц(x_{\min})}\right] \quad (5)$$

where: Ufr - voltage on the photoresistor; Ic - current in the photoresistor circuit;

at low illumination current

$$I_ц = I_\phi = K_\phi \Phi(x) \quad (6)$$

where: If - thermistor photocurrent; Kf - coefficient of proportionality;

$$\Phi(x) = I_0 \frac{S_{осв}(x)}{(x_0 + 2x)^2} p_1 e^{-k_x(x_0+2x)} \quad \textbf{(7)}$$

where: I0 - light intensity of the radiation source; ρ1 is the reflection coefficient of the surface of disk 4; kx is the absorption coefficient of the light flux;

Figure 2 shows the design and measurement scheme of an optoelectronic converter for automatic control of the thickness of tape materials that are transported using rolls or other devices [14].

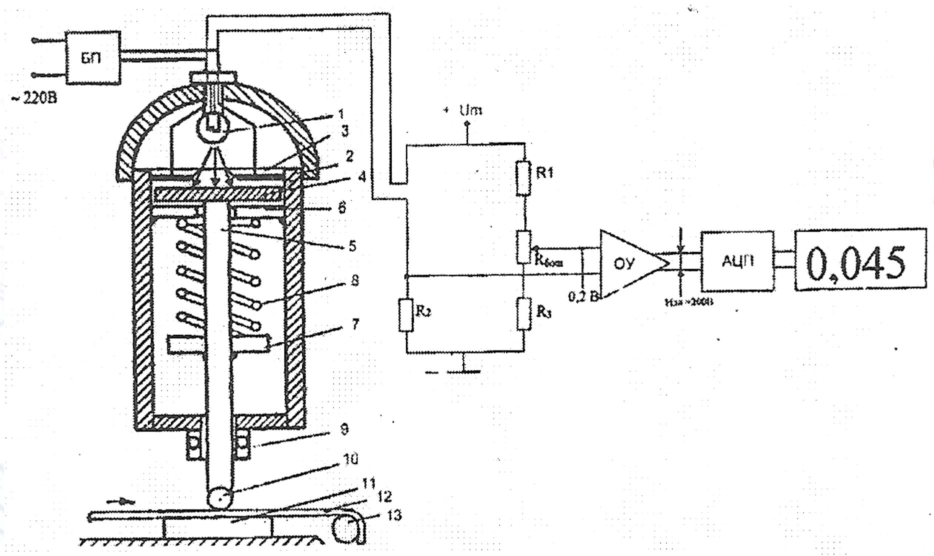

Figure 2 - Design and measurement scheme of the displacement transducer

The main structural elements of this optoelectronic converter are: radiation source (incandescent bulb) 1; hollow fiber 2; ring photoresistor 3; reflective disk 4; rod 5; stops 6 and 7; spring 8; guide tip, 9; roller 10; measuring support 11; tape material 12; roll 13; base 14.

In order to control the thickness of the tape material 12, the optoelectronic converter is set to a certain thickness (nominal), which is determined by the standard and the requirements for this material. During thickness control, deviations of the thickness (size) are automatically recorded and the output signal is used both for continuous control and for automatic control of the material thickness [3, 7, 13].

Figure 3 shows the static characteristics of the optoelectronic converter at different reflection coefficients pr of disk 4. The maximum sensitivity is achieved with the following parameters: ρ1=0.1;

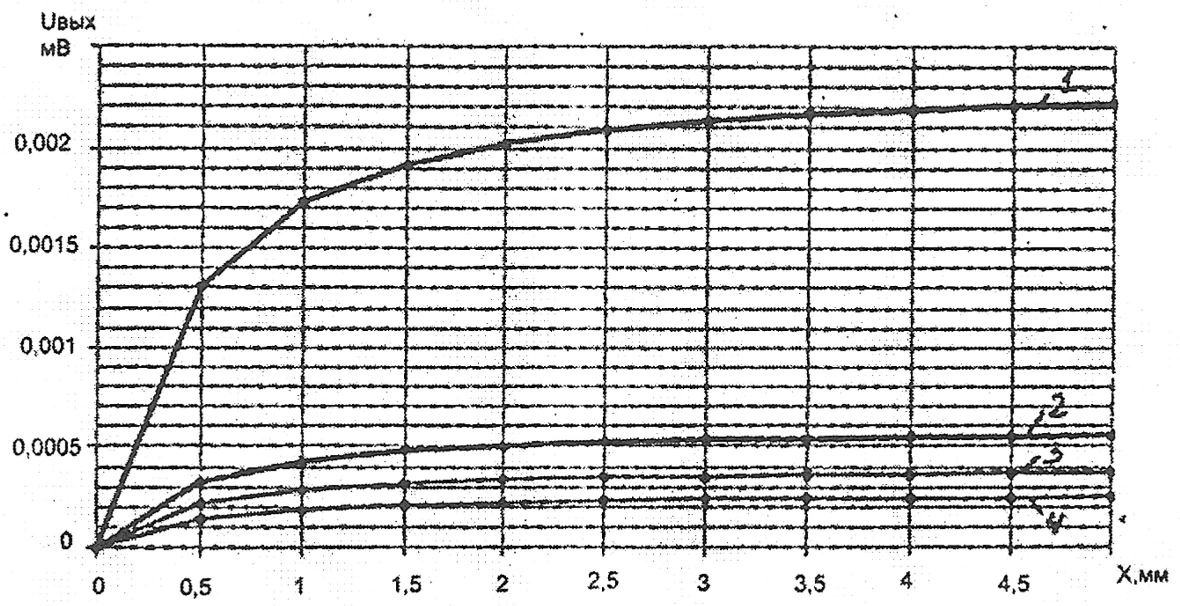

Figure 3 - Comparative characteristics of the dependences of the output voltage on displacement; 1 – ρ1= 0.1; 2 – ρ1=0.4; 3 - ρ1 = 0.6; 4 – ρ1 = 0.9

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