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Study of the Static Characteristics of New Biparametric Resonant Motion Sensors

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ABSTRACT: The study of the static characteristics of the displacement developed by the BPRD showed that growth β due to an increase $Z_{\mu п}$, $C_{\mu п}$ and $X_{м}$, and leads to an increase in the degree of nonlinearity of the static characteristic and a decrease in the sensitivity of the sensor.

KEYWORDS: Biparametric resonance displacement sensors.

I.INTRODUCTION

Automation of various technological processes, which requires the use of a complex of primary transducers – sensors, makes it quite easy to perform labor-intensive processes, save energy resources, reduce the cost of production and improve its quality by providing close to optimal operation of objects of control and management in both normal and emergency situations.

One of the main obstacles to this is the lack of motion sensors (speed, acceleration, vibration, etc.) that meet modern requirements when working in extreme operating conditions with high dust, humidity, significant temperature difference, etc.

A comparative analysis of the main characteristics of the existing displacement sensors shows that the most promising direction in solving the actual problem of more efficient use of monitoring and control systems is the use of biparametric resonance sensors (BPRD) movement, which in their properties (high reliability and stability characteristics in extreme operating conditions, as well as high power output) best meet the modern requirements of monitoring and control systems [1].

II. STAGES OF STUDYING THE STATISTICAL CHARACTERISTICS OF THE SENSORS

1. The static characteristic of autoresonant iparametrics sensors move with the movable coil. The expression of the static characteristic of this sensor is determined on the basis of the mathematical model of the magnetic circuit (1) as

$$\dot{E}_a^o = -j\omega w Q_{\mu 2}^o(x) = -\frac{j\omega w^2 \dot{I}_p \gamma}{\Delta_{нд}^o}\{sh(\gamma X_{м}) - sh[\gamma(X_{м} - x)] + sh(\gamma x)\}, \quad (1)$$

The impact of social spam is already significant. A social spam message is potentially seen by all the followers and recipients' friends. Even worse, it might cause misdirection and misunderstand-ing in public and trending topic discussions. For example, trending topics are always abused by spammers to publish comments with URLs, misdirecting all kinds of users to completely unrelated web-sites.

where $Q_{\mu o}$ – the total magnetic flux created by the excitation winding; $\gamma = \sqrt{2Z_{\mu п}C_{\mu п}}$ – the coefficient of propagation of the magnetic flux along the magnetic circuit; Δ – belonging to its differential magnetic circuits; $\dot{I}_p$

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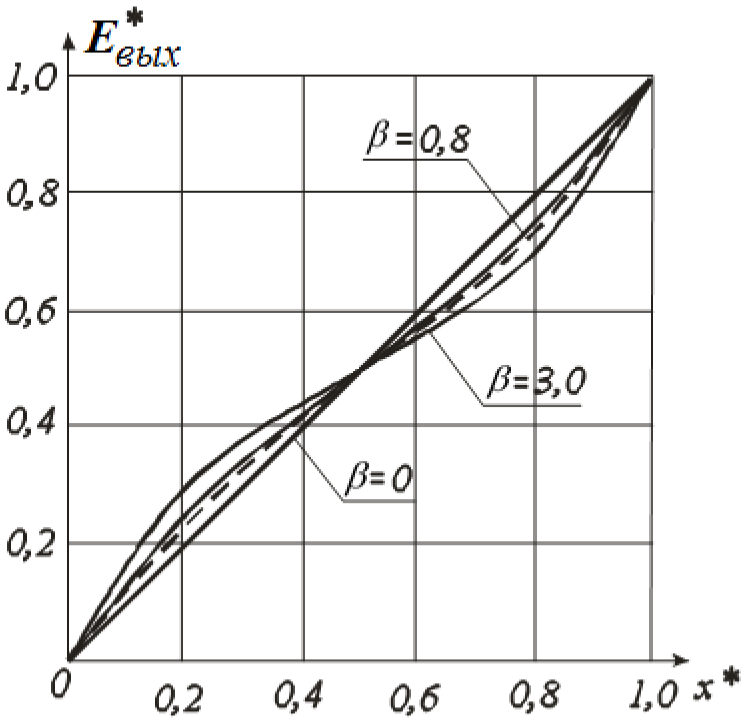
– resonant current; ω – angular frequency; w – the number of coil turns; $(X_{м} - x)$ – length of sections; $C_{\mu п}$ – unning values of magnetic capacitances; ρ_{μ} – the specific magnetic resistance of the material (steel) of the magnetic circuit; $Z_{\mu o}$ – the magnetic resistance of the magnetic base of the magnetic circuit.

For rice.1 the curves of the static characteristics of the self-resonant biparametric displacement sensors with a movable winding at different values are given . The analysis of curves shows that with the increase of the attenuation coefficient of the magnetic flux in the magnetic circuit, the nonlinearity of the static characteristic increases. It should be noted that in autoresonance sensors the distributed parameters of the magnetic circuit do not affect the resonance mode over the entire range of the measured value conversion.

2. The static characteristic of the controller BPRD move with the movable coil. The curves $E_{нд}^{o*} = f(x^*)$ do not differ from the curves $E_a^{o*} = f(x^*)$ (see Fig.1).



Rice.1. Curves of static characteristics of the autoresonance biparametric sensor: solid lines – theoretical data; dashed lines – experimental data

3. The static characteristic of the differential BPRD move with a movable screen. The curves of the static characteristics of the differential BPRD with a movable screen in relative units are shown in Fig.2. The analysis of these curves showed that the degree β of $Z_{\mu o}$ nonlinearity of static characteristics increases with increasing [2].

4. Nonlinearity of static characteristics of the motion BPRD. The degree of nonlinearity of the static characteristics of the developed autoresonance biparameter sensor – with a magnetic circuit and a movable winding is defined as:

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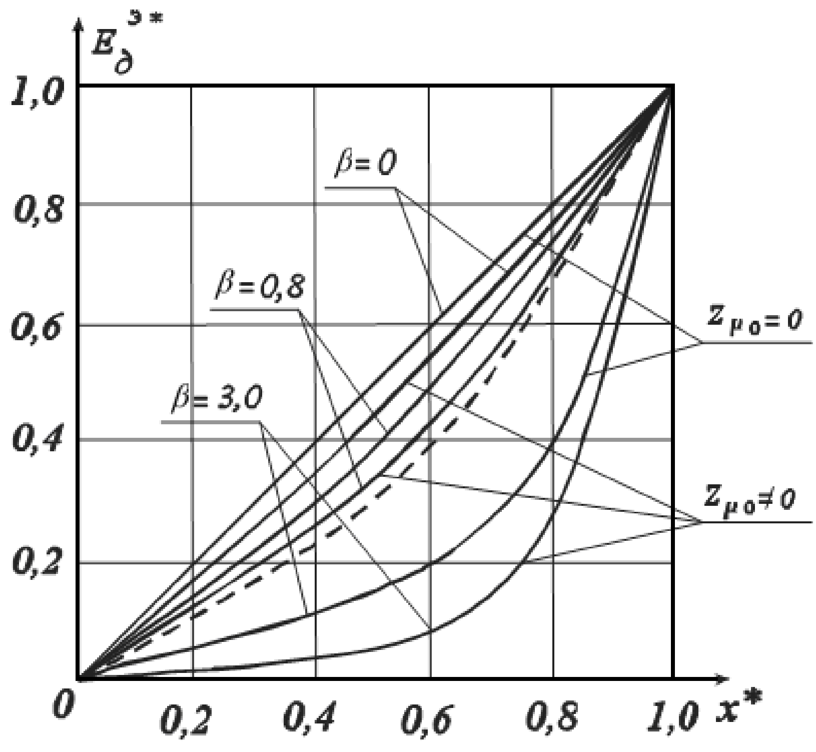
$$\varepsilon^{o}_{a(p)} = \left(\frac{1}{\beta} arch \frac{sh\beta}{\beta ch\frac{\beta}{2}} - \frac{ch\frac{\beta}{2}\, sharch\frac{sh\beta}{\beta ch\frac{\beta}{2}}}{sh\beta}\right)\cdot 50\%. \quad (2)$$

The degree of nonlinearity of the studied sensors with the known P–shaped magnetic core is as follows

$$\varepsilon^{o}_{u} = \left(\frac{1}{\beta} arch \frac{sh\beta}{\beta} - \frac{sharch\frac{sh\beta}{\beta}}{sh\beta}\right)\cdot 50\%. \quad (3)$$

For rice.3 shows the dependence curves and $\varepsilon_p = f(\beta)$ e $\varepsilon_u = f(\beta)$.



Rice.2. Curves of static characteristics of differential BPRD: solid – calculated data; dashed – experimental.

They indicate that the BPRD with – shaped magnetic core has a lower degree of nonlinearity of the static characteristic.

5. Sensitivity of biparametric resonant motion sensors with movable screen.

$$S^{э}_{\partial} = \frac{(1+2Z_{\mu o}C_{\mu п}X_{м})(1+2Z_{\mu o}C_{\mu п}X_{м} + Z^2_{\mu o}C^2_{\mu п}X^2_{м} + Z^2_{\mu o}C^2_{\mu п}X^2_{м}x^{*2})}{(1+2Z_{\mu o}C_{\mu п}X_{м} - Z^2_{\mu o}C^2_{\mu п}X^2_{м} - Z^2_{\mu o}C^2_{\mu п}X^2_{м}x^{*2})^2}. \quad (5)$$

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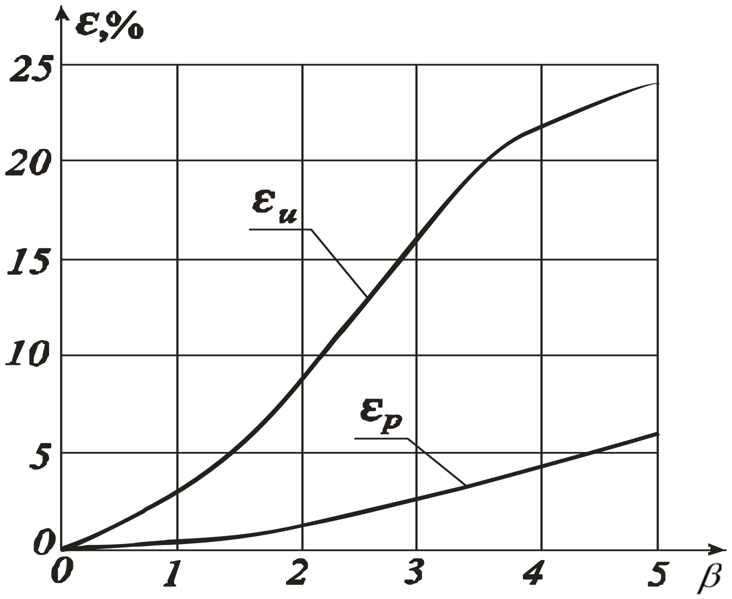
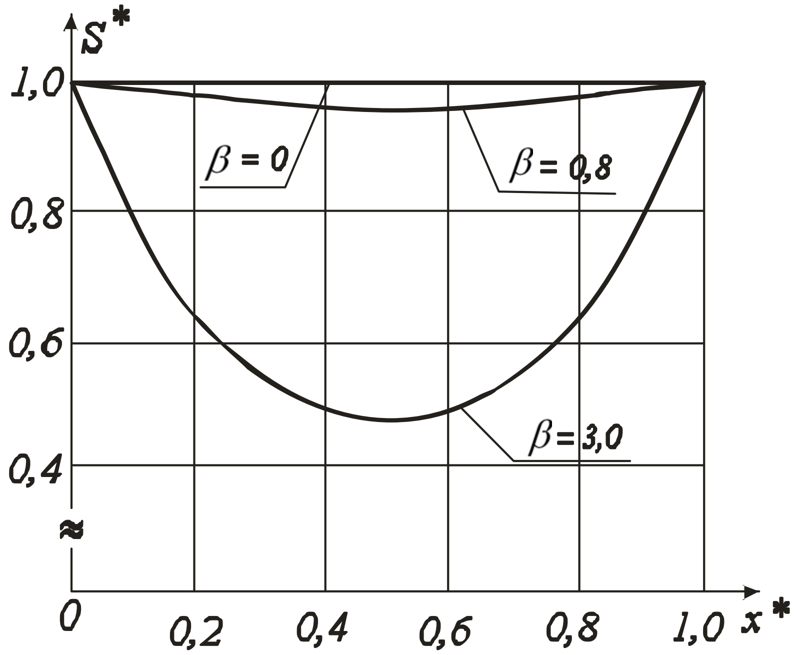


Rice.3. Dependency curves $\varepsilon = f(\beta)$



Rice.4. Curves of relative sensitivity of autoresonant biparametric sensor x^*.

III. CONCLUSION

The study of the static characteristics of the developed BPRD movement shows that the increase due to β the increase $Z_{\mu п}$, and $C_{\mu п}$ e $X_{м}$ leads to an increase in the degree of nonlinearity of the static characteristics and reduce the sensitivity of the sensor. It is established that the $\beta = 0$ e $Z_{\mu п} = 0$ static characteristic is linear, and the sensitivity is maximum and constant over the entire range of movement of the moving part of the sensor. When $\beta > 0$ the sensitivity is not constant within the range and has a minimum value when it is $x = 0{,}5X_{м}$. Shown that the $\beta \le 0{,}5$ degree of nonlinearity of the static characteristic does not exceed $1{,}5\%$ [3,4].

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