Factors Affecting the Sensitivity of Moving Electromagnetic Screen Converters

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Abstract. *The article found that by changing the parameters affecting the sensitivity of the moving screen converters, the screen should be made of materials with a small coefficient of temperature change, even if the specific resistance is large, and the high active resistance of the moving screen does not affect the linearity of the static characteristic.*

Keywords: *moving screen, magnetic system, inductive resistance, magnetic flux, excitation coil.*

The change in the value of the specific magnetic permeability and the number of windings of the measuring coil are considered to be the main factors influencing the sensitivity of the scattering parameter and the moving electromagnetic screen converters. Therefore, the main focus is on improving these parameters when increasing the sensitivity of scattered parameter and moving screen converters. The hypersensitive transducer consists of an E-shaped magnetic conductor, a stacked excitation coil placed on the middle rod, a measuring coil uniformly distributed along this stem, and a moving screen.

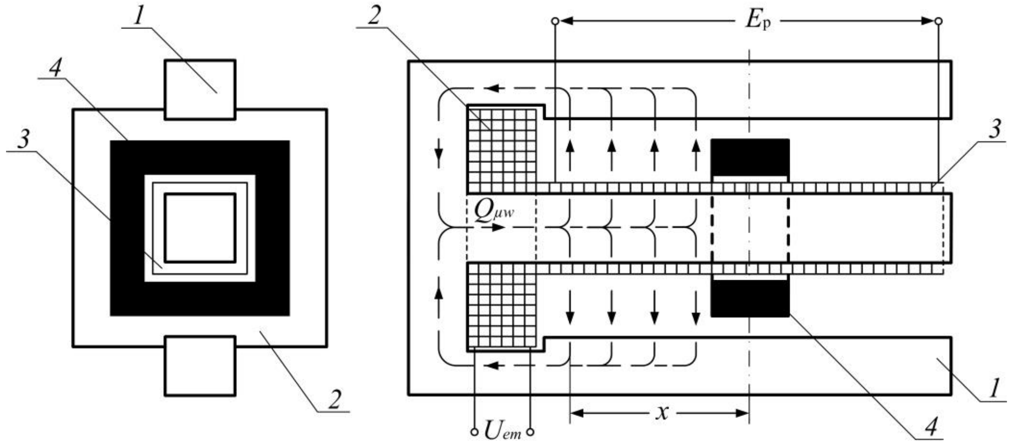

Figure 1. Construction of "E" shaped magnetic conductor: 1 - "E" shaped magnetic conductor; 2 - excitation cap; 3 - measuring cup; 4 - Moving screen

Due to the large surface area of the crack in this structure, its specific magnetic permeability is high. Placing the measuring coil along a long stem allows you to increase the number of coils of this coil without changing the size of the magnetic conductor. Although the transducer is made of an open magnetic conductor, no additional resistance is required for the excitation chain because the measuring coil is evenly distributed along the sliding path of the moving screen. If the active resistance of the excitation coil is not taken into account, the working current in the main magnetic conductor can be given as follows:

$$Q_{\mu w} = \frac{U_{em}}{j\omega w_{\mathrm{m}}} = const.$$

where U_{em} is the voltage of the excitation coil; w_{m} - the number of turns of the excitation ring.

Consequently, the value of the magnetic flux based on the magnetic conductor remains unchanged in any position of the moving screen. Excluding the magnetic resistance of the steel rod and the active resistance of the moving screen, the value of the electromotive force in the measuring vessel is determined using the following expression:

$$E_{\mathrm{p}} = \omega Q_{\mu w} \frac{w_{\mathrm{c}}}{2} x = \frac{U_{em} w_{\mathrm{c}} x}{2 w_{\mathrm{m}}}$$

Where w_{c} -is the specific number of windings of the measuring rod; x - coordinates of the moving electromagnetic screen.

By analyzing this equation, it can be concluded that the electromotive force at the output of the converter changes according to the linear law when the excitation coil is connected to a stable voltage source.

Even when the transducer is made of a closed magnetic conductor, its statistical characterization is linear because the measuring rod is distributed along the stem. The value of the magnetic driving force in the two-section excitation coil remains practically unchanged even when the screen is shifted. In this case, the inductive resistance of the excitation coil does not change, nor does the value of the excitation current generated when supplied by the voltage source.

The magnetic flux generated by the magnetic driving force $U_{\mu m}$ of the first section of the excitation coil on the basis of the magnetic conductor varies according to the displacement of the moving screen and is determined by the following expression:

$$Q_{\mu}^{'} = U_{\mu m} C_{\mu l} (X_{\mathrm{m}} - x)$$

where X_{m} - is the maximum displacement coordinate of the moving screen; $C_{\mu l}$ - air permeability per unit length.

The second section of the excitation coil generates a magnetic flux at the second base of the magnetic conductor, respectively, and is

expressed as follows:

$$Q_{\mu}^{''} = U_{\mu m} C_{\mu l} (X_{\mathrm{m}} + x) .$$

When the sections of the excitation coils are connected to each other in opposite directions, the electromotive force in the distributed measuring coil is determined as follows:

$$E_{\mathrm{p}} = -j\omega w_{\mathrm{c}} \left[Q_{\mu}^{'} (X_{\mathrm{m}} - x) - Q_{\mu}^{''} (X_{\mathrm{m}} + x) \right] = j\omega 4 w_{\mathrm{c}} U_{\mu \mathrm{m}} C_{\mu l} X_{\mathrm{m}} x$$

Given that the magnetic force $U_{\mu m} \approx \dfrac{U_{em}}{j\omega w_{\mathrm{p}} 2 C_{\mu l} X_{\mathrm{m}}}$ is determined using the expression, the expression of the electromotive force on the measuring instrument is written as follows: $E_{\mathrm{p}} = \dfrac{2 U_{em} w_{\mathrm{c}} x}{w_{\mathrm{m}}}$

The efficiency coefficient of the converter is determined as follows, taking into account the voltage equation expressed for the primary and secondary circuits, without taking into account the resistance of the windings:

$$\eta = \frac{P_{exit}}{P_{ent.}} = \frac{M^2}{2(M^2 - 2L_{load}L_{\mathrm{m}})}.$$

In this expression, the inductive resistance load is obtained: $\omega L_{load} = \omega L_{\mathrm{m}}$ The greater the mutual induction coefficient M between the excitation coil and the measuring coil, the greater the efficiency coefficient of the converter. In any case, the mutual inductance $C_{\mu l}$ between the coils is directly proportional to the specific magnetic permeability. By making the magnetic conductor of the converter from two coaxial cylinders connecting along the edges of the magnetic chain, it is possible to significantly increase the value of the specific magnetic conductivity. In this case, the surface of the air gap is increased and there is no lateral flow.

The contour of the measuring coil windings In triangular configuration converters, a short-circuited winding is used to shield the working current. The converter in this view is shown in the figure below.

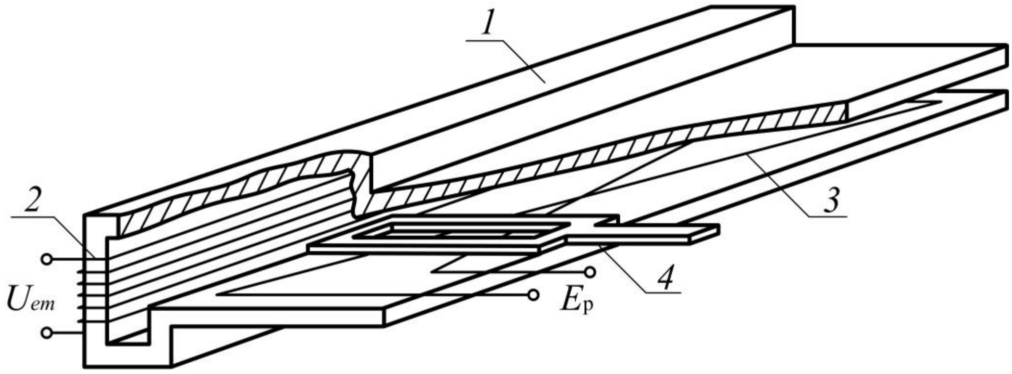

Figure 2. Switch with moving screen and flat measuring tape: 1 - "P" shaped magnetic conductor; 2 - excitation cap; 3 - measuring cup; 4 - Moving screen.

The base of the converter consists of an elongated “P” shaped magnetic conductor with an extended air gap between the two working planes, an excitation coil wrapped around the magnetic conductor, a measuring coil and a moving screen. The measuring cup is made in the form of two series and oppositely connected sections. The moving screen moves parallel to the working planes of the magnetic conductor.

In the absence of a moving screen, the excitation coil generates B induction in the air gap, in which case the magnetic coupling in the measuring coil windings is zero.

When a moving screen is inserted into the air gap, the value of the magnetic induction in this region decreases B_1 to zero when the resistance of the measuring coil is so small that it cannot be taken into account, or until the measuring coil has a significant resistance. In both cases, an increase in the value of the moving screen from the center of the switch to the right or left in the measuring vessel results in an increased electromotive force. (The electromotive force moving screen formed in the measuring loop changes its phase to 180° as it crosses the center of the converter).

In general, the electromotive force in a measuring cup is expressed as follows:

$$E_{\mathrm{p}} = -j\omega(B - B_1)w_{\mathrm{p}}S_e\frac{x}{X_{\mathrm{m}}}$$

where S_e - is the surface of the screen contour.

When the converters are made in this design, their static characteristics are highly linear, reliable protection from the effects of external magnetic fields and temperature stability are provided. In conclusion, it is possible to make moving screens from materials with a small coefficient of variation of temperature from resistance, even if the specific resistance is large. Although the high active resistance of the moving screen leads to a partial decrease in the sensitivity of the converter, but does not affect the linearity of the static characteristic.

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