MAGNETIC FIELD BETWEEN POLAR HEMISPHERES: REMARKS ON THE DISLOCATION OF ZONES OF A CONSTANT GRADIENT AND FORCE FACTOR

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Abstract: To create an inhomogeneous magnetic field, in which there would be zones with a practically constant value of the magnetic gradient (MG) and / or magnetic force factor (MFF), an original solution was indicated: the use of an electromagnetic system with spherical poles. In this case, the coordinate dependences of MG and MFF in the interpolar region are extreme and the zones localized in the domain of the extrema are practically stable, referred to as the MG_{Const} and MFF_{Const} zones, with individual coordinates x_{extr} of their conditional centers and length Δx (with an allowable error changes in MG and MFF data within these zones). The data following from experimental studies is given on the dislocation of the indicated zones between the poles-hemispheres of diameter *D*, separated by different distances *b*; the values of x_{extr}/D and $\Delta x/D$ depend on *b/D*. It is shown that the dependencies x_{extr}/D on *b/D* obtained separately for the MG_{Const} and MFF_{Const} zones, demonstrating, like the dependencies $\Delta x/D$ on *b/D*, mutual similarity (up to a constant multiplier), obey power functions with exponents of 0.5 and 0.4, respectively. A closer (to the center-to-center line of pole-hemispheres) and more compact (in length) dislocation of the MFF_{Const} zones compared to the MG_{Const} zones was revealed: almost 1.3 times both in x_{extr}/D and in $\Delta x/D$.

Key words*:* Spherical pole pieces, magnetic parameters, gradient, force factor, zones of constancy of parameters, inhomogeneous magnetic field.

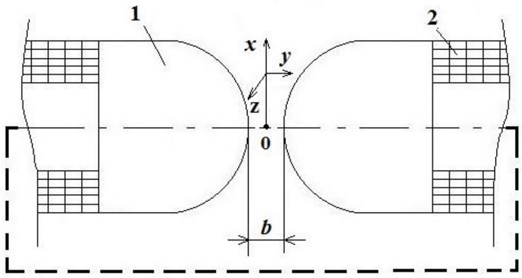

Fig. 1. Illustration of the use of spherical pole pieces in an electromagnetic system, which allow creating local zones of almost constant values of the magnetic gradient and magnetic force factor; 1 - pole piece, 2 - winding of the electromagnetic system

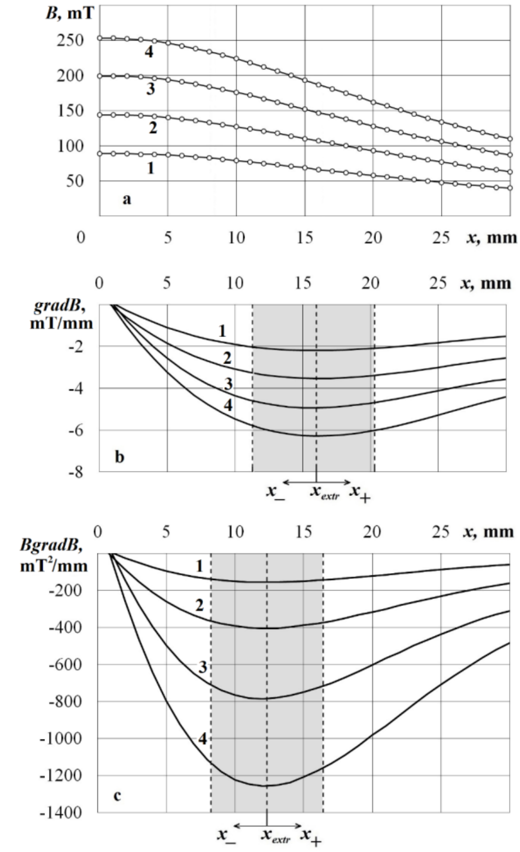

Fig. 2. An example of coordinate magnetic characteristics between hemispherical poles with a diameter *D* = 100 mm and a distance *b* = 13 mm: *a*) winding for induction (points - experiment, line - approximation by a polynomial of the fourth degree), *b*) extreme for MG, *c*) extreme for MFF; 1 - *Iω* = 3000 A, 2 - 6000, 3 - 12000, 4 - 22500; the MG_{Const} and MFF_{Const} zones are dimmed.

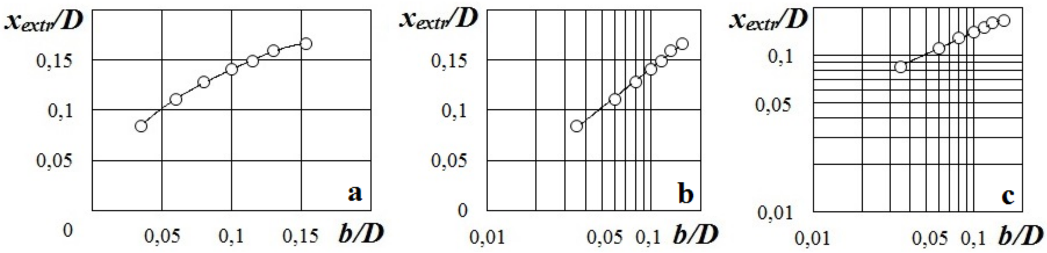

Fig.3. Influence of the relative distance *b/D* between the polar hemispheres on the relative coordinate x_{extr} */D* of the conditional center of the zone MG_{Const}; *a*) in conventional coordinates, *b* and *c*) respectively in semi-logarithmic and logarithmic coordinates.

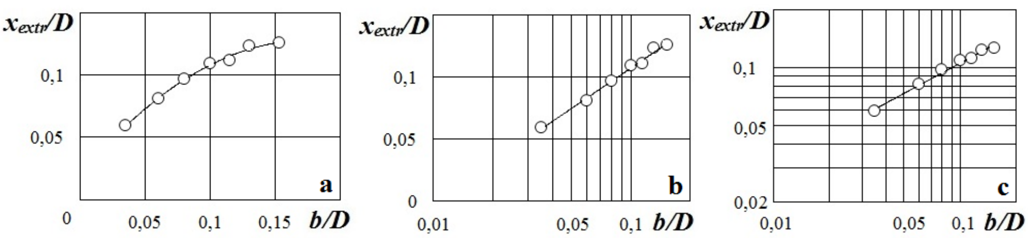

Fig. 4. The same as in Fig.3, but for the conditional center of the zone MFF_{Const}.

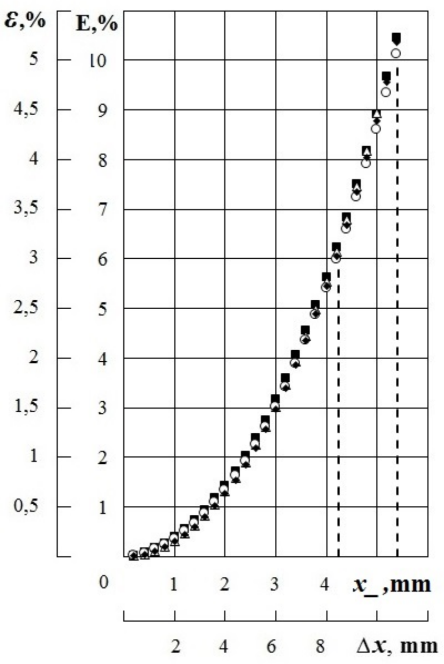

Fig.5. Obtained from the data of Fig. 2b and relations (4), (6) dependence of the indices *E* and *ε* on the step-by-step displacement *x_* in the half-zone MG_{Const} and the length $\Delta x \cong 2x\_$ of the zone; ♦ - $I\omega$ = 3000 A, ○ - 6000, Δ - 12000, ■ - 22500.

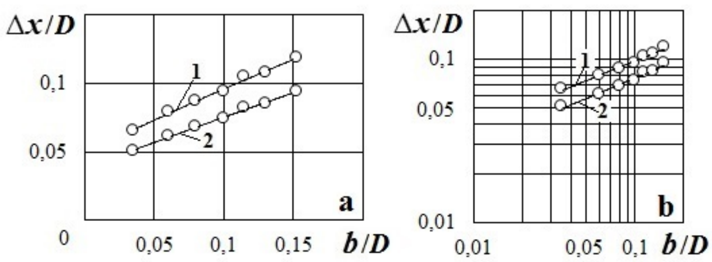

Fig.6. Influence of the relative distance *b/D* between the polar hemispheres on the relative length *Δx/D* of the zone MG_{Const}: when the current data deviates from the average values up to 5% (line 1) and up to 3% (line 2); *a*) and *b*) in ordinary and logarithmic coordinates.

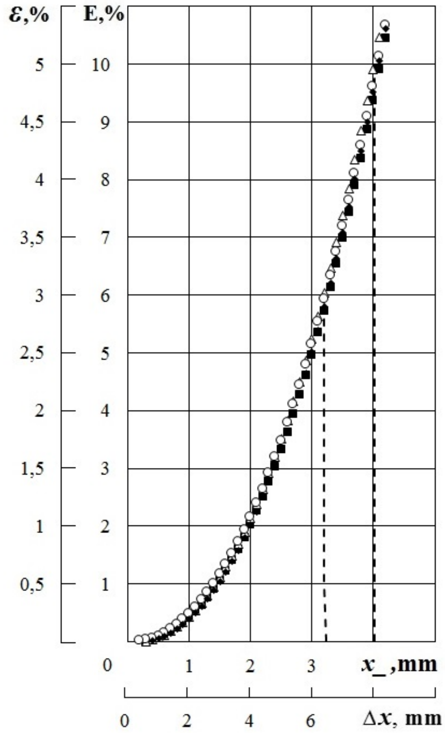

Fig.7. Obtained from the data in Fig. 2c and relations (5), (8) dependence of the indices *E* and *ε* on the step-by-step displacement *x_* in the MFF_{Const} half zone and the length $\Delta x \cong 2x\_$ of the zone; ♦ – Iω = 3000 A, ○ – 6000, Δ – 12000, ■ – 22500.

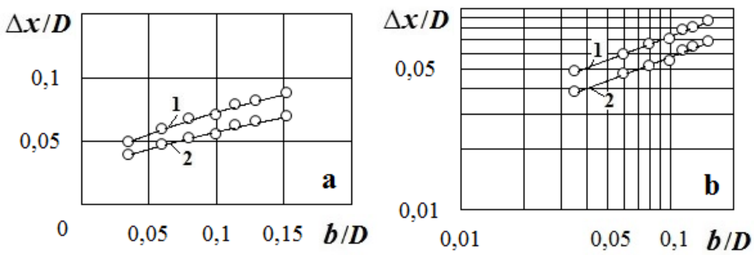

Fig.8. The same as in Fig.6, but for the MFF_{Const} zone.