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Analysis of Methods of Measurement of Magnetic Values during Magnetization and Definition of Bodies

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ABSTRACT: The paper discusses the issues of magnetization, the causes of its occurrence in rail lashes, given the methods of demagnetization of rails in rail welding production, based on a single spatial electromagnetic field. The methods of the known demagnetization methods are considered and the dependences of the strength of a single spatial field on the pulse duration are determined, the parameters of the demagnetization pulses are established, the block diagram of the applied device and its characteristics before and after demagnetization are presented. There are many measurement methods that solve many technical problems. Magnetic characteristics and parameters, such as magnetic flux - F, magnetic moment - M, magnetic induction - B, magnetic field strength - H are to be measured. Measurements are carried out with the aim of finding defects in materials, studying the physicochemical properties, and determining the static and dynamic characteristics of ferromagnetic elements. Measurements of magnetic characteristics and parameters are based on Maxwell's equations, where magnetic and electric fields are combined into a single electromagnetic field.

KEYWORDS: magnetic induction, magnetic moment, devices, electromagnetic fields, demagnetization.

I. INTRODUCTION

Measurements are carried out on the basis of measures of magnetic parameters, which are: Ф of a solenoid with two inductors, which have a mutual induction coefficient of M. The electric current passes through a single inductance coil. Flux coupling is a measure of coil magnetic flux:

$$\Phi = M\Delta I. \tag{1}$$

This measure is used in determining the permanent ballistic galvanometer when checking and calibrating a webermeter.

To determine the magnetic induction special coils, permanent magnets and electromagnets are used. When solenoid B and H are magnetized, they are determined by the parameters of the coils, current strength and the number of turns of the windings.

The most commonly used design is the Helmholtz rings and solenoid. Helmholtz rings are ring coils located along the axis parallel to each other at distances equal to their radii. The field strength in the center on the axis of the rings is:

$$H = 0.72\frac{Iw}{R}, A/m. \tag{2}$$

The solenoid creates a magnetic field of 104*A/m*. The field strength in the center of the solenoid:

$$H = \frac{wI}{\sqrt{l^2+d^2}}, A/м, \tag{3}$$

where w is the number of turns of the winding; I is the amperage; l is the length of the solenoid in meters; d is the diameter of the solenoid in meters; if $d \ll l$, then H = wI/l, A/m. Large values of N (up to 300000A/m) are achieved using permanent magnets or electromagnets. To measure the B, F and H use devices. Instruments for measuring magnetic quantities consist of a transducer and a measuring device [4].

II. PROPOSED METHODOLOGY AND DISCUSSION

They are based on physical laws, force interactions, galvanomagnetic and intra-atomic phenomena. For the measurement of F, a device based on the ballistic method is used and is shown in Figure 1.

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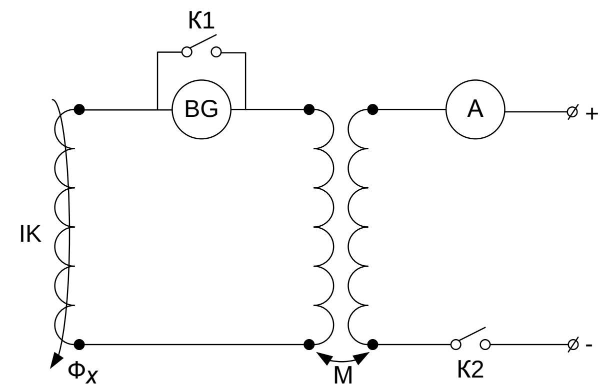

Fig.1. Measurements of f by ballistic method

According to the law of electromagnetic induction, when Φ changes from Φ_x to 0, an EMF occurs at the terminals of the measuring solenoid:

$$e_x = -w_\kappa \frac{d\Phi_x}{dt} = ir + L\frac{di}{dt}, \tag{4}$$

where w_κ-is the number of turns of the measuring solenoid; i-is the current in the solenoid; r-is the active resistance of the solenoid; L-is the inductance of the solenoid [5].

Integrating (4) over time we get:

$$w_\kappa \Delta\Phi_x = Qr; \tag{5}$$

where $\Delta\Phi_x$-reduction of the flow; Q-solenoid charge.

Taking into account the largest jump of the arrow of the galvanometer α_{1m} and the constant of the galvanometer $C_б$- we get:

$$\Delta\Phi_x = \frac{C_б r}{w_\kappa}\alpha_{1m} = \frac{C_\Phi}{w_\kappa}\alpha_{1m}, \tag{6}$$

where C_Φ-is the ballistic magnetic flux constant.

The device, based on the measurement of induction, uses a magnetoelectric system, the equation of the movable part of which can be written in the form:

$$J\frac{d^2\alpha}{dt^2} + P_2\frac{d\alpha}{dt} = Bswi, \tag{7}$$

where J-is the magnetization, that is, the magnetic moment per unit volume of the body.

The current in the webermeter is determined by the value of the EMF produced by changing the flow:

$$J\frac{d^2\alpha}{dt^2} + P_2\frac{d\alpha}{dt} = \frac{Bsw}{r}\left(e_x - L\frac{di}{dt}\right). \tag{8}$$

Integrating this expression:

$$P_2\Delta\alpha = \frac{Bsw}{r}\int_0^t edt = \frac{Bsw}{r}\Delta\Phi_x w_\kappa, \tag{9}$$

where P_2-is the damping factor or moment of braking forces at angular velocity.

For the angle of rotation of the instrument webermeter get:

$$\Delta\alpha = \frac{w_\kappa}{Bsw}\Delta\Phi_x = \frac{w_\kappa}{C_\phi}\Delta\Phi_x, \tag{10}$$

When measuring magnetic parameters using other webermeters. The basis of webermeters is photoelectric or Hall effect. Intraatomic phenomena are also used, in which the precession of atomic nuclei is associated with the induction of an external field:

$$\omega_0 = \gamma B, \tag{11}$$

where ω_0- is the precession frequency; γ - coefficient taking into account the relationship M of the atomic nucleus to the moment of momentum.

To find the static parameters of magnetic materials using induction-ballistic method, the scheme is shown in Figure 2.

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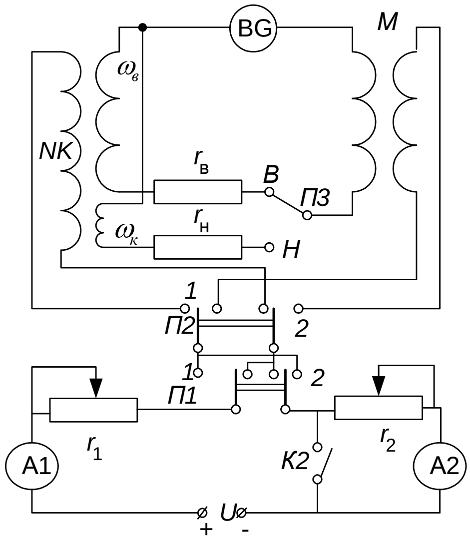

Fig.2. Induction-ballistic method for determining static characteristics

This scheme allows the selection of sensitivity separately for *B* and for *H*. In addition, it allows you to determine the constant of the galvanometer, while *П2* is closed in side 2, while reducing *I* through the solenoid. The switch *П3* is closed in position *B* (or *H*). At the same time, the direction *I* is changed in the solenoid by means of switching on *П1* and the deflection of the needle of the ballistic galvanometer β_{1m} is recorded. The constant of the galvanometer is determined by the formula:

$$C_{\phi} = \frac{M\Delta I}{\beta_{1m}}, \text{ w/div}, \tag{12}$$

where *ΔI* is the change in current (when changing the direction of the current *ΔI = 2I*).

The demagnetization of bodies is carried out by reducing the current from the maximum to 0 with continuous changes in its direction. Using this scheme, the maximum point of the magnetization curve is determined.

To measure the dynamic characteristics using an ammeter and a voltmeter, as well as a ferrometer. A diagram of the use of an ammeter and a voltmeter to measure ferromagnetic materials is shown in Figure 3.

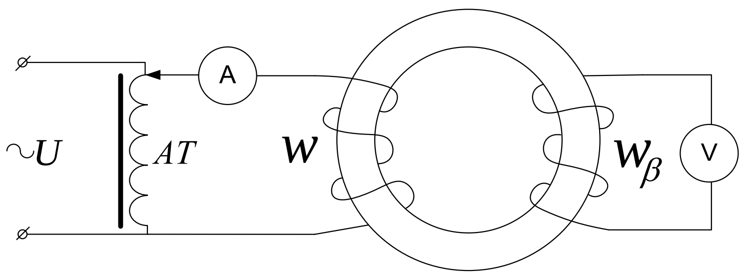

Fig. 3. Measurement of ferromagnetic materials in variable fields

According to the scheme, *H* is determined by *I* in the magnetizing solenoid and its characteristic, and the induction by the indication of a voltmeter of the average voltage value (EMF) in the measuring winding:

$$H_{m\text{э}} = \frac{\sqrt{2}Iw}{l_{cp}};\ B_m = \frac{E_{cp}}{4fw_B S_{o\text{б}p}};\ \mu = \frac{B_m}{\mu_0 H_{m\text{э}}}. \tag{13}$$

Using a ferrometer, magnetic induction and magnetic field strength are measured. The main elements of the ferrometer are a ring coil, a mechanical rectifier powered by a phase regulator rotor. In addition, there is a mutual induction coil, which plays the role of a differentiating device, an autotransformer for current control, a mill volt meter, resistance shops for changing the sensitivity of a millivolt meter. The diagram of the ferrometer is shown in Figure 4.

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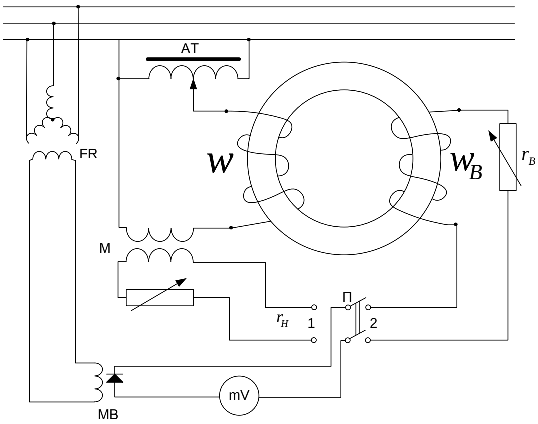

Fig.4. Diagram of a ferrometer for measuring *H* and *B*

When determining the *H* key *P* is closed in side 1, while the readings of a mill voltmeter:

$$U_{1cp} = \frac{1}{T}\int_{t_1}^{t_1+\frac{T}{2}} u_1 dt\,;\ u_1 = e_1\frac{r_{np}}{r};\ e_1 = -M\frac{di_1}{dt}, \qquad (14)$$

where e_1 is the emf secondary winding mutual inductance M; r_{np} -- resistance of the device; i_1- current in the primary winding of the coil M; r - resistance of the millivoltmeter circuit, defined: $r = r_{np} + r_1 + r_н$; r_1 - the resistance of the secondary winding of the coil M.

Magnetizing coil voltages:

$$U_{1cp} = -M\frac{r_{np}}{r}\frac{1}{T}\int_{t_1}^{t_1+\frac{T}{2}} di_1 = -M\frac{r_{np}}{r}\frac{1}{T}\left(i_{t1+\frac{T}{2}} - i_{t1}\right). \qquad (15)$$

Due to the fact that $i_{t1} = -i_{t1+\frac{T}{2}}$, therefore:

$$U_{1cp} = \frac{2Mr_{np}f}{r}i_{t1};\ H_t = \frac{i_{t1}w}{l_{cp}};\ U_{1cp} = \frac{2Mr_{np}f\,l_{cp}}{rw}H_{1cp}. \qquad (16)$$

As can be seen from (1.72) U_{1cp} is directly proportional to the instantaneous value of H.

To determine the induction it is necessary to close switch П to position 2. The readings of a mill voltmeter will be:

$$U_{2cp} = \frac{1}{T}\int_{t_1}^{t_1+\frac{T}{2}} u_2 dt;\ u_2 = e_2\frac{r_{np}}{r};\ e_2 = -w_B\frac{d\Phi}{dt}, \qquad (17)$$

where $r= r_{np} + r_2 + r_в$of the resistance of the device; r_2 is the resistance of the measuring winding; $w_B$is the number of turns of the measuring winding.

The average voltage value is proportional to the instantaneous induction value:

$$U_{2cp} = -\frac{r_{np}}{r}w_B\frac{1}{T}\int_{t_1}^{t_1+\frac{T}{2}} d\Phi = -\frac{r_{np}}{r}w_B\frac{1}{T}\left(\Phi_{t_1+\frac{T}{2}} - \Phi_{t_1}\right). \qquad (18)$$

Considering that $\Phi_{t_1} = -\Phi_{t_1+\frac{T}{2}}$, we get:

$$U_{2cp} = \frac{2r_{np}w_B sf}{r}B_{t_1}. \qquad (19)$$

With the help of a phase regulator, changing the phase voltage, you can get the top of the dynamic hysteresis loops. In addition, you can get hysteresis losses and eddy currents:

$$P = U_2 I_1 cos\varphi\frac{w}{w_B}\frac{1}{m}, \qquad (20)$$

where $U_2$is the effective voltage on the measuring coil; I_1- - effective magnetizing current; φ is the shift angle between $U_2$and I_1; m is the mass.

III. CONCLUSION

The developed converter and control system are built according to a modular principle, which allows to include additional functional modules, which, in combination with the built-in software, allow to obtain various values of the parameters of the rail lash demagnetization device based on a single spatial electromagnetic field.

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REFERENCES

1. Халиков А.А., Колесников И.К., Курбанов Ж.Ф. Исследование и разработка единого пространственного электромагнитного поля и устройств на их основе. //Монография//. Изд. “Fan va texnologiya”, Ташкент 2019, С.113-121.

2. Курбанов Ж.Ф., Колесников И.К. Устройство и система управления контроля процессами размагничивания рельсовых плетей. «Муҳаммад Ал-Хоразмий авлодлари», 2(8)2019 ТУИТ им. Ал-Хоразмий, Ташкент 2019, С.125-127.

3. Колесников И.К., Курбанов Ж.Ф., А.А. Саитов, Ф.Б. Джурабаева. Размагничивание рельсовых плетей в рельсосварочном производстве с помощью единого пространственного поля // «Проблемы энерго- и ресурсосбережения», №3-4 ТашТГТУ, Ташкент 2016, С.35-41.

4. Колесников И.К., Курбанов Ж.Ф. Программное обеспечение системы управления единым пространственным полем // Современные состояние и перспективы применения информационных технологий в управлении, доклады республиканской научно – технической конференции, 5-6 сентябрь 2016 г., Джизак, С.236-242.

5. Kurbanov J.F., Kolesnikov I.K. The control system and the hardware implementation of a single unit of the spatial field // Perspectives for the development of information technologies, ITPA – 2015, 4-5 November, Tashkent university of information technologies (TUIT), Tashkent – 2015, P. 171-175.