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The Procedure and Device of Pulse-Magnetic Loading Parameters Measuring

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Abstract - The device for operative control over parameters of the setup-inductor-billet discharge circuit has been worked out needed when experimentally working off, calculating, developing technological processes of pulse-magnetic processing as well when controlling their stability in production. In the device the method of a two-fold analog-digital conversion has been used.

Résumé - On a mis au point le dispositif de contrôle expéditif des paramètres du circuit de décharge: appareil-inductor-pièce brute, indispensable au perfectionnement expérimental, au calcul, à la mise en œuvre des processus magnétique du formage manétique ainsi qu’au contrôle de leur stabilité à l’entreprise. Le dispositif utilise la méthode de la double conversion analogique-digitale.

When pulse-magnetic processing the essential technological parameter is pressure of magnetic field \[ P = I_1^2 \sin^2 \frac{2 \pi T}{T} e^{-\delta t} \] which is defined by a current 1 through a setup-inductor-billet discharge circuit (Fig. 1a) that is by values of a current \( I_{\text{max}} = I_1 \); period \( T \) and a decrement \( \delta = \frac{\lg I_1 - \lg I_3}{I_3} \).
Eddy currents in the billet dependent on the same values $I, T, \delta$ cause the billet to heat up and affect the quality of the finished parts and units [2]. Any changes in the discharge circuit implies changes in the discharge current. For example, the changes in the current curve can take place at any failures of elements of the pulse-magnetic setup МИУ like imperfect operating of its charger (Fig.2), a failure of one or more condensers (C1-C3) of the energy accumulator. And unstable operation of dischargers (F1-F3) or their asynchronous switching on produce even the change in a number of half-cycles (Fig.1,b). Magnitudes of $I, T, \delta$ change too.

![Fig.2. The scheme of the pulse-magnetic setup](image)

C1-C3 - energy accumulator
F1-F2 - dischargers
L - inductor
1-billet; 2-charger; 3-current transducer

Also the changes of the current curve will go on under the changes of parameters of the inductor and the billet or their relative position. That is why among all the parameters to be controlled under pulse-magnetic processing of metals the most important are current curve's characteristics: $I, T, \delta$. At the present time the oscillographic methods [3] are used for control over parameters of the current curve. However they have a number of disadvantages: complexity of equipment and the measuring procedure, labour consumption of the process of oscillogram recording and decoding. And the usage of the digital methods presents difficulties because of intense pulse electromagnetic interferences [4].

**RECORDER OF DISCHARGE CIRCUIT PARAMETERS**

For operative control over parameters of the dischagre circuits ($I, T, \delta$) the device PIP-1 (recorder of discharge parameters) has been developed. The method of a two-fold analog-digital conversion
is used in the recorder. Its functional scheme is illustrated in Fig.3.

A current transducer (Rogovskiy’s belt) was used as a primary sensor. During the process of discharging the parameters to be measured are translated into analogue signals and recorded into the analogue storage. With the transient processes in МИУ completed the analogue signals from the random-access memory are translated into a digital form and fed into the memory registers for long-term storage and indication. The device developed measures the discharge parameters in two steps. At the instant of discharge the parameters of the signal from the current transducer 1 are recorded by three channels into the analogue storages 2. The maximum amplitude of the current $I_1$ is recorded in the first channel. The amplitude of the third half cycle $I_3$ is recorded in the second channel. The device 4 computes logarithm of the relationship between amplitudes of the first and of the third half-cycles. This relationship characterizes the decrement $\delta = \lg \frac{I_1}{I_3}$. In the third channel a period $T$ of the discharge current is changed to an analogue signal by the time-to-amplitude converter 3 and is stored in the storage 2. After completion of discharge the analogue-to-digital converters 5 translate the parameters of current into a digital code with delay for time of action of electromagnetic interferences in МИУ setup and record them into the memory registers 6 from whence they are brought out to the indicators 7. The contactless current sensor is used to ensure noise-proof feature and galvanic insulation of a measuring circuit with a high-voltage loop. The sensor constitutes an inductive pulse current-to-voltage transducer built as a toroidal coil enveloping the discharge busbar and involving RC integrating circuit. Such a sensor is easily built into the discharge circuit of МИУ without impairing its parameters.

**TECHNICAL SPECIFICATION**

The device ПТП-1 permits registration and storing of results of measuring of parameters of discharge circuit pulse signals of positive polarity having.
- frequency of discharge current: from 50 to 1 KHz
- signal shape: a sinusoidal damping single or seldom repetive signal of the discharge circuit having an oscillatory nature with a number of half-cycles no less than 3.

Ranges of recording of discharge circuit parameters with the help of the external current-transducer being incorporated into the complement are:

- maximum current amplitude: from 5 to 200 kA
- period of oscillations of the discharge current from 20 to 100 microseconds
- decrement: from 0.02 to 2.5 relative units.

Error of the device with the external current-transducer for service conditions outlined does not exceed values as follows: ±(4% of A + 1 count unit), where A is a value of a parameter registered; 1 count unit - discreteness error forming 0.1 percent of the final value of any one of registered parameters. The device provides operation in the uninterrupted mode during no less than 8 hour a day and in the single-acting mode after alapse of readiness time (60 seconds) passes. Long-term storage of results of the discharge circuit parameters measured (I, T, δ) in the «on» condition is provided in the device. Power consumption of the device at rated voltage is no more than 5 VA.

Outside dimension

- of the device: 200x200x70 mm
- of the external current-transducer: 100x30 mm.

Mass of the device including the external transducer is no more than 3 Kg. The external view of the device is shown in Fig 4.

Fig.4. The external view of the device.
DEVICE TESTING

The readings of the device were correlated with the results of oscillation of the discharge current under different operating modes of MIV. Error of measuring of the parameters by these two methods was not more than 2 percent.

CONCLUSIONS

The device is convenient to use under experimental by working off, calculating, developing pulse technological processes and controlling over their stability in production. Through the use of the recorder PIP P-1 failures of elements of equipment may be diagnosed as well slowly progressing changes of the discharge mode impairing the quality of the technological process may be found out.

References