CONTACTLESS METHOD OF DETERMINING CURRENTS IN UNDERGROUND METALLIC STRUCTURES

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The currents passing through underground metallic structures are measured by the contactless method [1] by poking or at special outlets, which complicates investigations on the current distribution and the quantitative determination of the danger of corrosion.

For contactless measurements based on determining the magnetic field around a wire carrying a current it is of value to use industrial type portable Z-magnetometers, such as those used in field geophysics [2-4], which provide a means of measuring magnetic fields up to 48-60 A/m with an accuracy of $(8\text{-}16)\cdot 10^{-3}$ A/m. Since the pickups in these instruments are compensated the effect of external magnetic fields (the soil, electrified transport, and so on) can be significantly reduced.

The relation between the current I passing through tubular underground metallic structures and the magnetic fields set up by them is defined by the equation

$$I = \frac{2\pi H_T [(h_0 + \Delta h)^2 + x^2]}{x}, \quad (1)$$

where H_T is the magnetic field current intensity, h_0 is the depth to which the structure is buried, and Δh is the height of the pickup above the surface of the ground.

It follows from Eq. (1) that the sensitivity of the pickup is a maximum when it is mounted on the side of the structure at a distance

$$x = h_0 + \Delta h.$$

The current direction is calculated directly from the deviation of the instrument pointer in accordance with the law of Bio and Savar and the special design features of the magnetometer pickup. The anodic and cathodic zones are revealed by means of local current measurements along the part of the structure under investigation. In passing along the pipe the current strength falls off at the anodic zones and increases at the

* Deceased.

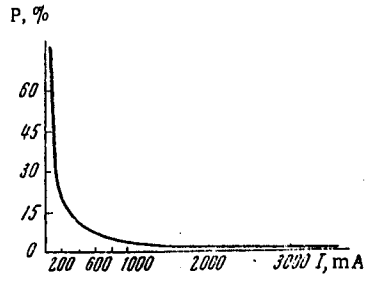

Fig. 1

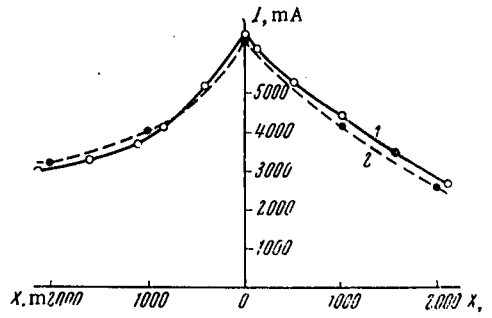

Fig. 2

Fig. 1. Relative error P as a function of the current strength I.

Fig. 2. Current distribution at a cathodic protection station along a gas pipe, as given by 1) the contactless method and 2) the contact method.

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cathodic zones. The possibility of measurement at practically any point and at such conveniently small distances between the points of observation provides a means of finding the points of damage to the insulation, i.e., by recording the maximum leakage current density.

The contactless method provides a means of studying in detail the laws governing the distribution of protective and stray currents, and of studying the line dynamics at control and measuring points.

As regards functions determining the magnetic field current or the anomalous magnetic field of the structure itself, with the aid of the contactless method it is possible to determine the position and depth of burying of the structure, both of which are required in order to calculate the current [1]. The use of different types of cable searchers [5] and conduit searchers for this purpose is difficult, especially because of the necessity of connecting special generators to the structure.

The contactless method has been tested on specimens of MKSAB cable over a six-months period and on gas pipes and communication cables under actual service conditions. The measurements were carried out with a Soviet magnetometer and were controlled with an ammeter, which was connected into a break in the circuit of the structure, for example, at a flange, coupling, valve, and so on.

The curve for the relative error P versus current strength (Fig. 1) shows that the true sensitivity of the method amounts on the average to 200-300 mA. In measuring such currents the value of P never exceeds 15-20%. As I increases the relative error rapidly falls, and at $I > 100$ mA does not in practice exceed 3%.

The above possibilities of the contactless method were tested and confirmed in tests on underground gas pipes and communication cables. As an illustration, Fig. 2 shows the almost coincident distribution curves for the cathodic protection station on a gas pipe, as given by the contact and contactless methods.

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