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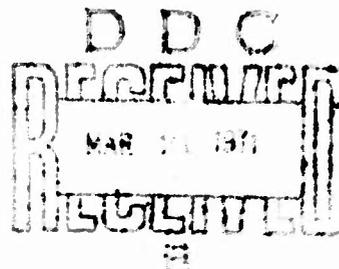


A STUDY OF NOISE IN ROCK STRATA

By

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COUNTRY: USSR



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No. 5, 1967
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Translated for FSTC by Mr. Stephen Evanusa

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A STUDY OF NOISE IN ROCK STRATA

The introduction of remote control and telemetry systems in the walls of coal mines is made difficult by the absence of a reliable and convenient communication channel. The application of metallic communication channels, which are subject to damage caused by collapse of stoping, has an adverse effect on reliability of the systems, and the high cost of cables increases their cost considerably. In addition, the laying of cables in the working space of walls is associated with a large number of technological inconveniences.

Most worthy of development for these purposes is a radio channel organized directly with respect to rock strata, based on the use of low-frequency electromagnetic fields. Selection of operating frequencies in the sound range is associated with sharp reduction in attenuation of the electromagnetic field in rock strata at these frequencies, while the small amount of information flow in the remote control and telemetry systems does not impose particular restrictions on required capacity of the communication channel.

Operating frequencies in the selected range should be allocated on the basis of nature and spectral composition of noise present in the channel. In this connection, the Laboratory of Automation and Remote Control of the Kharkov Institute of Radioelectronics has carried out research on noise active in rock strata.

Noise in the frequency range of 50 to 10,000 Hz was investigated. Noise levels were measured directly in a mine by means of a transistorized selective microvoltmeter of 25 μ V sensitivity. The noise was recorded on magnetic tape to determine the spectral composition. A small tape recorder possessing a linear characteristic in the band 40 to 10,000 Hz was used. The resulting recordings were analyzed under laboratory conditions by means of selective amplifier IGL-60. The most typical portions were photographed on a loop oscillograph.

Magnetic and grounded electrical dipoles were used as receiving element. Grounded electrical dipoles possessing a linear pass band for a wide frequency range are convenient for study of levels and spectra of noise.

A loop antenna was used to study the electromagnetic field structure of noise.

Sources of noise in rock strata, as in mine power circuits, are electromagnetic processes in electric motors, transformers and cables, and electric arcs produced during switching in the power and contact networks [1].

Normally operating electrical machines in the frequency range to 10 kHz are sources of fluctuation noise and noise of the harmonic and combination component type caused by nonlinearity of amplitude characteristics of transformers and electric meters. In addition, asynchronous meters produce spiked emf due to the slotted construction of magnetic circuits in the motors.

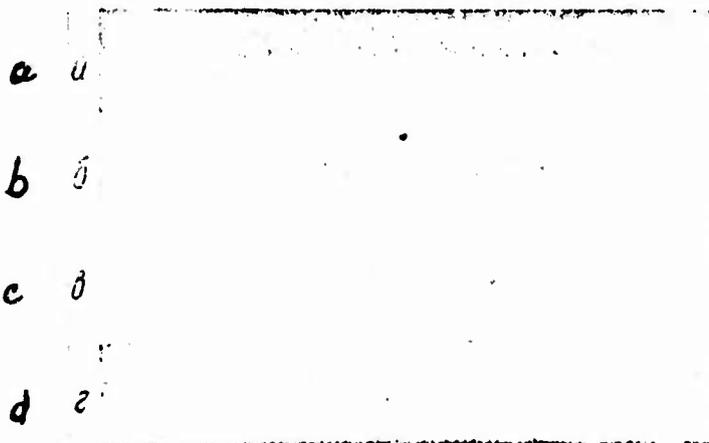


Fig. 1. Oscillograms of noise voltages in rock strata due to various sources:

a - combine UKR-1; b- normally operating drill EBR-19D; c - drill EBR-19D during starting, operation and stopping; d - contact network.

In the sound range the fluctuation noise level is low compared to the harmonic component type [2]. Effective values of harmonic and combination component type noise vary with mechanical load of

machines. Increase in load on the shaft of a machine is reflected in a greater current requirement, with the result that the levels of harmonics rise.

The level of spiked emf, the frequency of which lies within the limits of 1 to 2.5 kHz, also depends to a great extent upon mechanical load on the machine shaft. However, the magnitude of spiked emf drops with load increase.

Presented in Fig. 1a is an oscillogram of noise voltage in rock strata caused by the UKR-1 combine. It is seen that the curve shape which determines the component level does not remain constant, varying instead with load change. Fig. 2 is an averaged distribution of individual harmonic levels of the curve shape of Fig. 1a.

An oscillogram and noise spectrum of the EBR-19D drill in operation are shown in Figs. 1b and 3. The increase in spectrum components at frequencies on the order of 2.4 kHz is explainable by the presence of the spiked emf. Fig. 1c is an oscillogram of noise produced by the electric drill during starting, operation and stopping. A considerable run out emf is produced during switch-off.

To ascertain the mechanism whereby noise enters rock strata from the power network, the structure of the noise field in the proximity of cables was investigated. Measurements carried out by means of a loop antenna indicated that the structure of the noise magnetic field is similar to that of the field of an infinitely long current-carrying cable. It follows that a decisive factor is inductive radiation of noise from power cables.

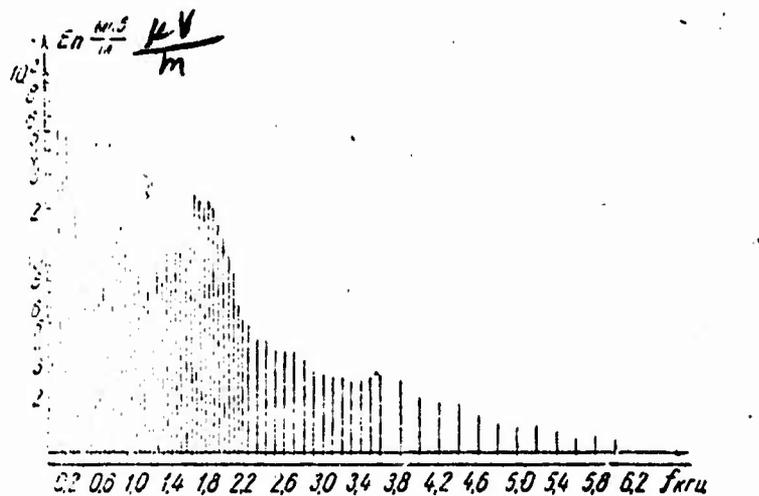


Fig. 2. Noise spectrum of combine UKR-1

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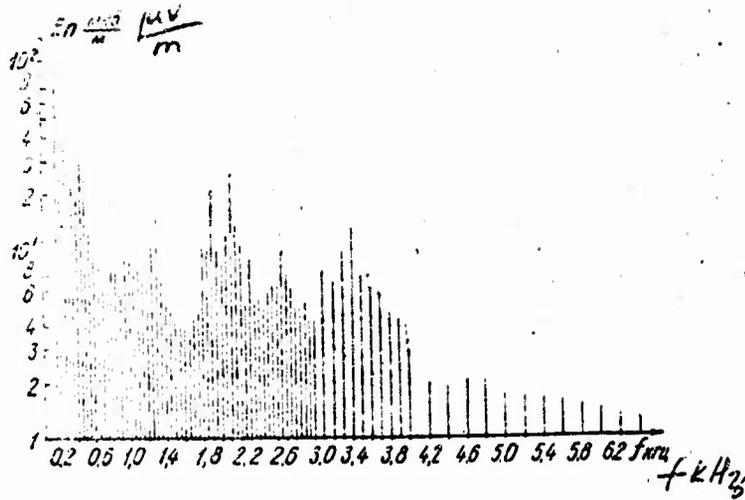


Fig. 3. Noise spectrum of electric drill EBR-19D.

A special feature of the contact network of the electric transportation system as a source of noise in rock strata is the direct contact of rails used as return conductor and the rock strata. Due to the linear resistance of the rails, which increases abruptly when contact at junctions is disturbed, a considerable portion of contact network current flows into surrounding strata [3]. As the electric locomotive travels current density drops rapidly with distance.

The variable current component of the electric locomotive, due to pulsations of the supply voltage, results in the harmonic component type of noise (fig. 4).

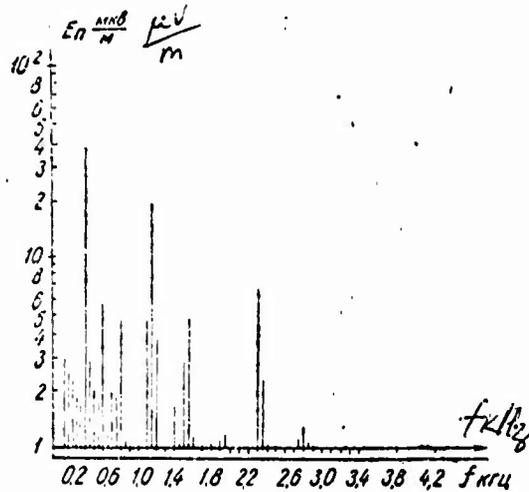


Fig. 4. Noise spectrum due to voltage pulsations in the contact network.

The switching process and especially an intermittent arc between the slip ring and contact drive generate pulse noise in a wide frequency band. Particularly high noise levels are observed in sections where the rails are flooded or heavily covered by rock and coal. Water reduces the contact resistance between the rails and rock, which results in a greater density of current spreading through the rock, while clutter on rails is a cause of frequent loss of contact between rail junctions.

Fig. 1d is an oscillogram of noise voltage in rock strata a short distance from a moving electric locomotive. The illustration shows definitely that the noise is of a pulse nature.

Noise level in rock strata varies from point to point, depending upon relative location of noise sources, configuration of power network, length of receiving dipole and orientation of latter in space, and the conductivity of rock. The spatial distribution of noise field strength in stratified media is exceedingly complex. For this reason noise levels were measured in prospective locations for the receiving dipole in the entry, since in most cases the receiving apparatus of remote control systems should be set up at the distribution point of a section.

The spectral characteristics presented above are typical, and may be applied to allocation of transmitter frequencies for various remote control systems in a selected range.

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