MAGNETIC MEASUREMENT SCALES OF KINEMATOMETERS

A. A. Asmus and Ya. A. Belikhmaer

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Moving-coil kinematometers operate as shown in Fig. 1. The input and output shafts 1 and 2 of the tested kinematic chain are fitted to transducer discs with a magnetic coating. The surfaces of discs 3 and 4 are covered with magnetic markers whose number is proportional to the transfer ratio of the kinematic chain.

The signals induced in the magnetic heads by discs 3 and 4 are fed to amplifier 5 and phase meter 6. If there are no errors in the kinematic chain, the phase shift of the two readout signals remains constant. Any irregularity in the rotation produces a deviation in the phase which is measured by means of phase meter 6 and recording instrument 7.

The reliability of this circuit's operation depends to a great extent on the quality of the magnetic layer in discs 3 and 4 which is now being made from alloy Cu--Ni--Fe (coercive force of $0.9 \cdot 10^5$ 1/π A/m and a residual induction of 0.56T), which is obtained by a non-electrolytic method and used in the Czechoslovak kinematometer IMO-S [1], as well as alloy Co--Ni ([0.5-0.75] $\cdot 10^5$ 1/π A/m and 0.5-0.6T), which is used in the kinematometer transducers of the Chelyabinsk measuring instruments plant.

On the basis of the investigations carried out by the All-Union Scientific-Research Institute of Sound Recording [2] it is recommended to coat drums used in various magnetic storage devices with an alloy of Co--Ni--P ([0.25-0.5] $\cdot 10^5$ 1/π A/m; 0.4-0.5T). The possibility of using alloy Co--Ni--P for recording signals on moving-coil kinematometer transducers was investigated by the Tomsk Polytechnical Institute.

The magnetic properties of alloys obtained electrolytically depend on the composition of the alloy and the conditions of its electroplating. Recommendations are provided in [2-4] for selecting an optimum composition of the electrolyte, its acidity, the content of sodium hypophosphate, the current density and temperature. We used in our research electrolytes and plating conditions which, according to above recommendations, provide alloys with optimum magnetic properties for recording signals.

The alloy was deposited from an electrolyte consisting of NiCl$_2$ $\cdot$ 6H$_2$O - 120 kg/m$^3$; CoCl$_2$ $\cdot$ 6H$_2$O - 120 kg/m$^3$; NH$_4$Cl - 100 kg/m$^3$; KH$_2$PO$_4$ - 9 kg/m$^3$; with an acidity of pH = 3-4, and a current density of 1000-1200 A/m$^2$ at the cathode and 100 A/m$^2$ at the anode and an electrolyte temperature of 50-60°C.

We compared the characteristics of alloys Co--Ni--P and Co--Ni, with the latter being deposited from an electrolyte consisting of NiSO$_4$ $\cdot$ 7H$_2$O - 135 kg/m$^3$; CoSO$_4$ $\cdot$ 7H$_2$O - 120 kg/m$^3$; H$_3$BO$_3$ - 25 kg/m$^3$; KCl - 15 kg/m$^3$. The electrolyte acidity was pH = 4-5; the current density was 150 A/m$^2$ at the cathode and 15 A/m$^2$ at the anode, with an electrolyte temperature of 50-60°C.

Effect of the Coating Thickness. According to the data of D. Ya. Kaznachei and V. M. Zhogina [3] there is no relationship between the coating thickness and the magnetic properties of alloy Co--Ni. This relationship was not studied for alloy Co--Ni--P [2].

We investigated the relationship between the detected signal U and the coating thickness t. The results of this research in the reading-rate range of u = 38-380 mm/sec are shown in Fig. 2. It was taken into account that the signal detected by the magnetic head depends not only on the properties of the magnetic alloy, but also on various other factors which were maintained at a constant value in comparing coatings of different thicknesses. The recording and playback of signals were made with the head of a "Melodiya" tape recorder. Contact recording was used without a gap between the disc and the magnetic head. Signals were recorded from a dc source of about 4.5 V, with a current of about 8-9 mA and a distance between the magnetic marks along the disc surface of about 2.6 mm.

The thickness of the magnetic covering was measured on a universal microscope UIM-21 with attachment IZO-1. A radial mark was drawn on the disc for setting it with respect to the measuring tip. The microscope set-
The amplitude of the output signal was measured with a tube voltmeter V3-4. It will be seen from the graph in Fig. 2 that the output signal rises with an increasing thickness of the coating.

In order to check the data thus obtained a control disc with a coating thickness of 31 μ was used. The position of the experimental points did not depart from the general pattern (see Fig. 2).

Alloy Co-Ni with a coating thickness of 3 to 16 μ was investigated in a similar manner. It was found that the effect of coating thickness on the output signal for alloy Co-Ni was similar to that for alloy Co-Ni-P.

The value of the output signal also depends on the alloy composition. In all the cases for the same coating thickness the output signal was larger for alloy Co-Ni-P than for alloy Co-Ni.

Effect of Recording Density. In all the above investigations signals were recorded at a low density (distances between signals of 2.6 mm) in order to eliminate interaction between signals. For raising the precision of moving-coil kinematometers it is necessary to use a recording with a maximum density.

Recording density is characterized by the number of magnetic marks per 1 mm of length. The effect of recording density on the output signal was investigated by means of the following technique. Sinusoidal signals from an audio oscillator ZG-10 were recorded on each disc with a given coating thickness. The recording and playback were made at a constant linear velocity of 38 mm/sec. For obtaining different densities the recording frequency was changed.

The output signal amplitude drops with a rising recording density. This drop becomes more pronounced with an increasing thickness of coating. For a recording density of more than four points per 1 mm the largest output signal was obtained with a coating thickness of t = 5 μ for alloy Co-Ni-P and with t = 9 μ for alloy Co-Ni, with the signal in the first instance being larger.

The reduction of the output signal with a rising thickness of coating for a recording density exceeding four points per 1 mm is probably due to the rising interaction between the magnetic fields of two adjacent magnetic marks. It was found that the output signal amplitude depends on the recording method. Signals recorded by means of the head of a "Melodiya" tape recorder and a pocket battery (4.5 V and 8-9 mA) did not provide maximum values in replay. Signals recorded by means of audio oscillator ZG-10 provided in replay larger values than those recorded with a pocket battery.

Particular Technological Features of Plating with Alloy Co-Ni-P. The technology of coating with alloy Co-Ni-P has been developed in detail by B. Ya. Kaznachei and V. M. Zhodina and is described in [2, 4]. On the basis of the above research it is possible to make the following additional remarks.

The places intended for coating should not be degreased in an alkali solution, since the high temperature of such a solution (80-90°C) impedes the insulation of places which must not be coated. Completely satisfactory results are obtained by degreasing with French chalk at room temperature.

For isolating places which must not be plated certain enterprises, for instance the Chelyabinsk measuring instruments plant, uses complicated Plexiglas protective devices.

In this method there remain in isolated places between the disc and the device small gaps which harbor solutions used before the basic coating. The presence of copper sulphate is particularly dangerous.