Various branches of industry are using the high-coercivity alloys YuNDK35T5 (35% Co, 15% Ni, 8% Al, 4% Cu, 5% Ti, the rest Fe) with Br = 8000 G, Hc = 1500 Oe.

By increasing the cobalt content to 38-42% and the titanium content to 7-8%, Hc can be increased to 1700-2000 Oe [1].

Obtaining the highest magnetic properties in these alloys requires careful heat treatment, as follows:

1. Heating to 1250 °C for the YuNDK35T5 alloy and 1220 °C for the alloy with 40-42% Co and 7-8% Ti.

2. Rapid cooling to 850 °C, which prevents precipitation of the face-centered γ-phase at temperatures of 900-1200 °C. Precipitation of the γ-phase sharply reduces the magnetic properties of the alloy.

3. Isothermal annealing in a magnetic field of 3000 Oe for 10-15 min at 800-850 °C, during which the α → α + α' transformation occurs. The isothermal annealing temperature must be equal to or less than the Curie point of the ferromagnetic α-phase precipitated. Only in this case will the anisotropy of the precipitate be arranged in the direction of the applied field and the magnetic properties be maximum.

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4. Tempering (aging) at 550–700 °C, usually in two stages, during which, according to current concepts, more complete separation of the α- and α'-phases occurs.

These critical temperatures are determined experimentally for each new composition of the alloy. The alloy is particularly sensitive to the temperature of isothermal annealing in a magnetic field. Figure 1 shows the variation of coercive force with the isothermal annealing temperature for the alloy with 42% Co, 14% Ni, 8% Al, 4% Cu, 8% Ti, the rest Fe. Metallographic or dilatometric analysis is used to determine the optimal treatment. More precise data can be obtained by measuring the electrical resistivity. Samples of these alloys in the form of rods 6 mm in diameter and 100 mm long were placed in the furnace. Two current-carrying and potentiometric leads were welded to the sample. The precision of the resistivity measurements was ± 0.5%. The sample temperature was measured with a platinum-rhodium thermocouple and potentiometer.

From the variation of the coefficient of electrical resistivity $\alpha_t = f(t)$ one can determine the isothermal annealing temperature for the alloys and the optimal tempering temperature. Figure 2 shows the variation of the coefficient of electrical resistivity with the heat treatment of the alloy containing 35% Co, 14% Ni, 7.5% Al, 4% Cu, 5% Ti, the rest Fe. The highest value of $\alpha_t$ for this alloy is attained at 800 ± 10 °C regardless of the previous heat treatment. This peak conforms with the anomalous coefficient of electrical resistivity at the Curie point of the alloy, since the optimal magnetic properties result at this temperature under the influence of magnetic field.

The $\alpha_t = f(t)$ curves also have another characteristic — an inflection at 600 °C — for samples tempered outside the range of 550–650 °C (curves I, II, VI). Tempering at 550–650 °C is used as the concluding stage of heat treatment for magnetic alloys of this type. The inflection in the curves of alloys tempered above 650 and below 550 °C indicates that the process occurs only at 550–650 °C.

The $\alpha_t = f(t)$ curves are similar for alloys with 35 and 42% Co and the optimal heat treatment conditions are the same. Up to 1% Mn in the YuNDK42T8 alloy does not change the $\alpha_t = f(t)$ curve and the heat treatments of these alloys are also similar.

The YuNDK42T8 alloy was also tested with reduced copper concentrations. Figure 3 shows the $\alpha_t = f(t)$ curves for the alloys with 2 and 3% Cu and the alloy without copper.

These curves are similar at 700–750 °C, i.e., the curves for all three alloys have an inflection at 600 °C. The tempering temperature for these alloys was 650 and 550 °C. With increasing copper concentrations the maximum $\alpha_t$ is at 870 °C for the alloy without copper, 860 °C for 2% Cu, and 840 °C for 3% Cu. The variation of the optimal isothermal annealing temperature in a magnetic field with the copper concentration is shown in Fig. 4.

The temperature of isothermal annealing in a magnetic field determined by the electrical resistivity method was compared with the temperature found experimentally (by measuring the coercive force after isothermal annealing at different temperatures).