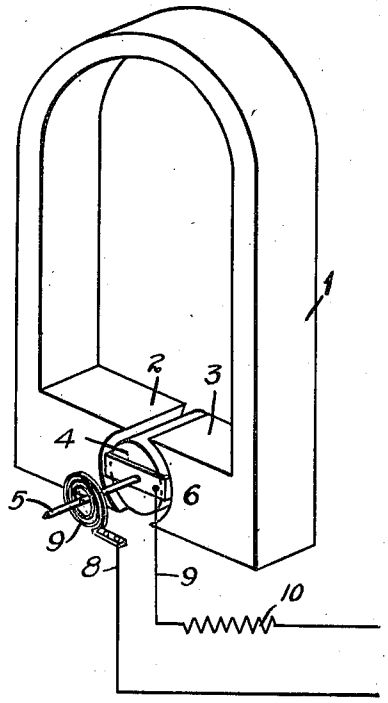
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RESISTOR ALLOY

Filed Sept. 2, 1922



Nickel Copper Alloy
Containing Magnesium

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UNITED STATES PATENT OFFICE.

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RESISTOR ALLOY.

Application filed September 2, 1922. Serial No. 585,855.

This invention relates to alloys, more particularly to alloys capable of utilization as electrical resistance materials and characterized by a negative temperature coefficient of resistance.

Alloys of this type, I have found, are especially adapted for use in measuring instruments of a delicate nature, such as meters and the like. A meter, as generally constructed, comprises a permanent magnet between the poles of which is a rotatable copper coil, the terminals of which are connected into a suitable circuit to be measured. A helical spring is secured to the copper coil, the force of said spring opposing the deflection of the copper coil, which is proportional to the current flowing through it. Changes in temperature cause unequal changes in these elements.

The effect of a rise of temperature upon the elasticity of the spring and the strength of the magnet is a tendency to allow the copper coil to increase its deflection upon the passage of current therethrough. This tendency to increase the deflection has been balanced to some extent by placing in series therewith a sufficient amount of resistance having a low temperature coefficient of resistance of the entire circuit approximately equal to the temperature coefficient of the balancing resistance. Up to this time, wire having approximately zero temperature coefficient was used.

I have inserted, in place of the zero-temperature-coefficient wire previously used, a wire having a negative temperature coefficient, such that it balances the variations caused by the other elements of the meter. By reason of the use of such a resistor, the compensation for the temperature effect of the other elements may be effected with a considerably smaller amount of resistance, so that the measuring instrument becomes more sensitive.

In carrying my invention into effect, I provide an alloy of copper and nickel which possesses, at ordinary room temperature and above, a negative temperature coefficient of resistance which may be utilized for various compensation purposes, such as in electrical systems, the total resistance of which is to be maintained constant, irrespective of changes in temperature. More specifically, I have found that such alloys having from 35% to 55% of nickel and containing a small amount of magnesium in the composition thereof are most effective for this purpose.

The addition of magnesium also facilitates the workability of the alloy. I have found that as little as 0.1% of magnesium is sufficient for this purpose and I prefer not to add a materially greater amount, since larger amounts tend to make the material more difficult to work.

I am enabled to utilize ordinary technical nickel in my invention since the small amounts of iron and cobalt therein do not interfere with the development of the desirable properties of my new alloy.

In the accompanying drawing, constituting a part hereof, the single figure is a diagrammatic view of a meter embodying the subject matter of my invention.

A permanent magnet 1 has, between the poles 2 and 3 thereof, a core 4 fixed on a shaft 5 and a copper coil 6 is secured to said core. A helical spring 7 has its inner end secured to the shaft 5 and its outer end to a fixed point of the meter. Leads 8 and 9 are secured to the spring and one end of the copper coil, respectively, and a resistor 10 of my new alloy placed in series with said copper coil. The leads 8 and 9 may be connected, in a suitable electrical circuit, the characteristics of which are to be measured.

Although I have found that the proportions of ingredients of my new alloy may be varied within certain limits, I have found that the specific composition which has the highest negative temperature coefficient at room temperature is approximately 50% nickel and 50% copper. The negative temperature coefficient thereof persists for a considerable rise in temperature, 450° C. or more, when it suddenly becomes positive in value. The alloy may be heated to this temperature in the open air without deterioration by reason of oxidation thereof, and, therefore, 450° C. constitutes the upper limit to which an instrument embodying my alloy may be used. Such a temperature is never attained in commercial measuring instruments. The coefficient is still negative at temperatures approaching that of liquid air.

I have prepared a number of alloys of dif-

ferent compositions, all of which have negative temperature coefficients and of which the following are typical:

	Per cent.	Per cent.
Copper	60.23	50.07
Nickel	39.70	49.85
Magnesium	0.1	0.1
Specific elec. resist. at 20° C. microhm cm.	45.7	51.8
Temperature coeff.:		
At 20° C	—.000047	—.000082
At 400° C	—.000155	—.000134

The temperature coefficients of my new alloys vary from approximately —.00005 to —.00016. The thermal electro-motive force thereof to copper is approximately the same as that of the zero temperature coefficient material hitherto used. My new alloys solder very readily with soft solder and hard solder may be used thereon with good results.

Although I have described my invention stating that a composition of 50% nickel and 50% copper is a preferable one, it should be understood that my invention is not limited to this specific composition. The value of the temperature coefficient for a given range of temperature may be adjusted by changing the composition of the alloy, and my invention contemplates such changes for uses requiring various temperature coefficients.

I claim as my invention:

1. A resistance alloy consisting of equal parts of nickel and copper and about .1% of magnesium.

2. A resistance alloy consisting of 35 to 55 parts of nickel, 65 to 45 parts of copper and magnesium in amount from a trace to .1%, said alloy having a negative temperature coefficient of resistance.

3. A resistance alloy consisting of about equal parts of nickel and copper and a substantial amount of magnesium in amount from a trace to .1%, said alloy having a negative temperature coefficient of resistance.

In testimony whereof, I have hereunto subscribed my name this 17th day of August, 1922.

NORMAN B. PILLING.