

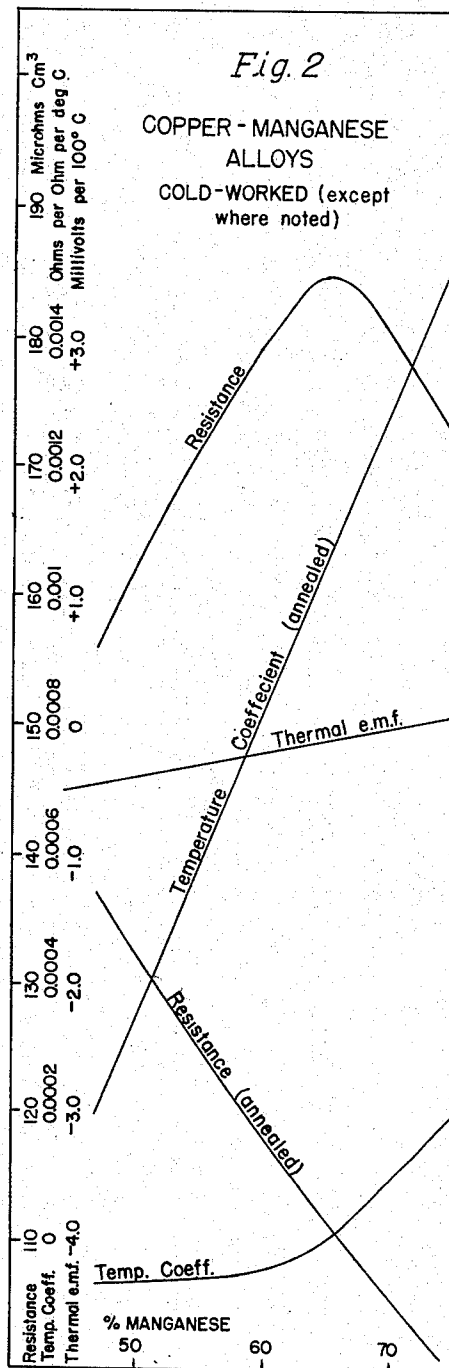
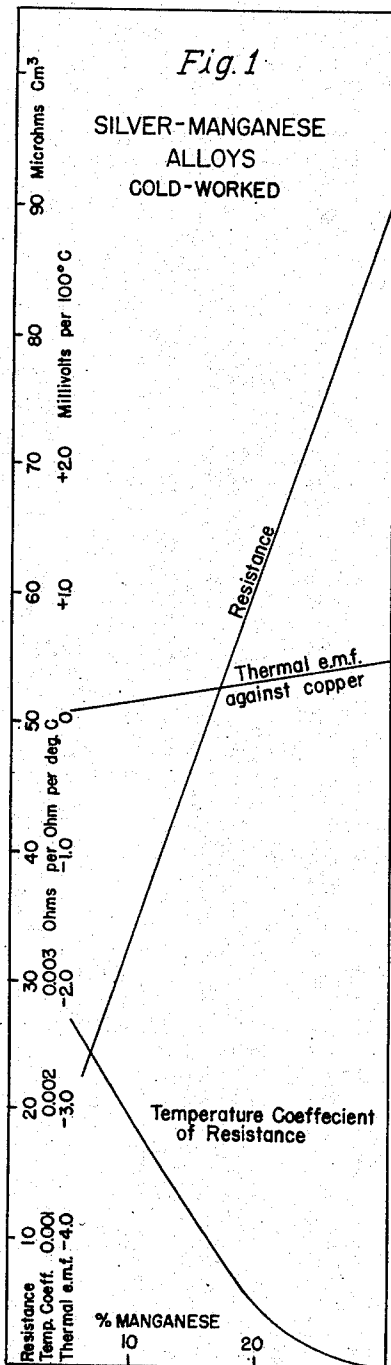
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H. T. HEIMBERGER

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ELECTRICAL RESISTANCE ELEMENT

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Inventor
Harry J. Heimberger

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ELECTRICAL RESISTANCE ELEMENT

Harry T. Heimberger, Rolla, Mo., assignor, by
decees of distribution, to Pansye M. Heim-
berger

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This invention relates to compound resistance wires for use in electrical instruments.

The desirable characteristics of resistance wires are well known, namely, high electrical resistance; low thermal E. M. F. against copper; resistance to atmospheric corrosion; stability of resistance; capability of drawing into fine wire and ease of manufacture, which insures reproducibility.

The art is familiar with alloys of manganese, copper and nickel which have been used for this purpose under various trade names, such as Constantan and Manganin. These alloys have specific electrical resistance of the order of 100 microhms per centimeter cubed. They are moderately good in other respects. More recently there have been introduced alloys of silver, manganese and tin with specific resistances of approximately 75 microhms per centimeter cubed. Finally, alloys of copper and manganese and of copper, manganese and nickel made with electrolytic manganese have been described. These alloys, containing around 65% manganese, have specific electrical resistances as high as 195 microhms per centimeter cubed. They have a very low temperature coefficient of electrical resistance and low thermal electromotive force against copper. They are, however, not as corrosion resistant as desired.

In the drawing, Figure 1 shows a graph of the silver-manganese alloys used in the sheath of my resistor, and Figure 2 shows a graph of the copper-manganese alloys used in the core of my resistor.

In my invention I make use of the desirable high resistances of the high manganese alloys in combination with silver alloys having relatively high electrical resistance low temperature coefficient and high corrosion resistance. Basically, I start with alloys of manganese and copper, the electrical properties of which are represented in Figure No. 2. I then develop a silver alloy sheath having suitable electrical characteristics, so that a wire of the manganese-copper alloy, sheathed with a silver alloy, will have substantially zero temperature coefficient of electrical resistance and very low thermal electromotive force against copper.

For example, I take an alloy of copper and manganese, containing 50% manganese. It will be seen from Figure No. 2 that such an alloy has approximately the following properties:

Resistance—about 170 microhms per centimeter cubed.

Temperature coefficient—about -52×10^{-4} .

Thermal electromotive force—about $-.45$ millivolt against copper at 100°C .

I sheath this with an alloy of silver and manganese selected from the electrical data on silver-manganese alloys in Figure No. 1. These data, like those on manganese-copper alloys, are for cold drawn wires, except where noted.

It will be seen that with an alloy of approximately 18% manganese the properties are:

Resistance—about 55 microhms.

Temperature coefficient—about $+7.0 \times 10^{-4}$.

Thermal electromotive force—about $+.45$ millivolt against copper at 100°C .

To obtain a zero temperature coefficient, it is evident that the silver sheath must carry .52/7.0 or 7.5% of the current. Since the ratio of resistance is 55/170, the cross section of the silver sheath must be 2.42% of the cross sectional area of the compound wire. The properties of the compound wire will then be:

Resistance—about 161.37 microhms per centimeter cubed.

Temperature coefficient—substantially zero.

Thermal electromotive force—against copper substantially zero.

The silver-manganese alloy is highly corrosion resistant and very ductile and easily worked.

It will be obvious to those skilled in the art that many compound elements can be worked out using silver-manganese alloys as sheaths for copper-manganese alloys. The silver-manganese alloys can be alloyed with relatively small percentages of other elements, such as tin, and the manganese-copper alloys can be alloyed with other elements, such as nickel or zinc, without departing from my invention, which resides in using a sheath of corrosion resisting silver alloy on a high resistance manganese alloy so as to obtain an electrical resistance wire having high electrical resistance, high corrosion resistance, low temperature coefficient and low thermal electromotive force against copper.

Heat treatment may be resorted to, in order to vary the properties of one or both of the alloys in the compound resistance element without departing from my invention.

In making the compound elements of my invention, methods known in the art may be used, but I prefer to cast the high manganese alloy in the form of a cylinder and, after cleaning thoroughly, cast around it the silver alloy. The whole is then drawn to any desired size of wire.

The sheath of a ductile silver alloy aids in drawing fine wire even if the alloy of the core is less ductile.

Compound forms, other than wire, can be used, such as lamellar tapes, without departing from my invention.

I claim:

1. A compound resistance element having as a core an alloy of manganese 40-90, copper 2-60, nickel 2-60, said alloy having a negative temperature coefficient of electrical resistance and a

sheath of an alloy of silver and manganese containing at least 50 percent silver and having a positive temperature coefficient of electrical resistance.

2. A compound resistance element having a core of a manganese copper alloy containing about 50 percent manganese and a sheath of manganese silver alloy containing about 18 percent silver, the sheath having approximately 2.5 percent of the cross sectional area of the compound wire.

HARRY T. HEIMBERGER.