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UNITED STATES PATENT OFFICE.

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THERMOCOUPLE.

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My invention relates to the preparation of alloys or metallic mixtures and in its preferred form relates to the production of such alloys or metallic mixtures for use in connection with the production of elements for thermo-couples.

My invention has various uses, but I will describe it herein more particularly as applied to thermo-couples. In accordance therewith it is an object of my invention to provide a negative element for a thermo-couple which possesses the properties adapted to produce a larger quantity of electrical energy for a given quantity of heat absorbed at the hot junction of the thermo-couple than is usually the case with this method of generating electrical current.

By a series of experimental tests I have found that thermo-elements formed from an alloy composed of nickel, cobalt and molybdenum are highly negative to nickel-copper compositions, or to an alloy consisting of nickel, cobalt and copper.

In preparing my novel negative element I first prepare a nickel cobalt alloy or mixture and this I do by preparing a melt of nickel and cobalt and raising it to a temperature somewhat above the melting point of nickel. I find that the pure metallic cobalt alloys readily with the nickel. I then prepare a melt using this nickel cobalt alloy as a base metal and introduce molybdenum either in powder or other appropriate form and the result is an alloy or mixture of the three components nickel, cobalt and molybdenum. In the extensive experiments which I have made and covering a period of years, I find that molybdenum readily intermixes or alloys itself with a nickel-cobalt-composition containing not more than approximately ten per cent (10%) by weight of cobalt, as easily as with pure nickel. I have found further in the course of this experimentation and in making sample melts of this alloy, that it is more difficult to make a nickel-cobalt-molybdenum melt which conforms to the properties which I desire, when its three component parts are placed separately in the metallic container or crucible of the furnace. In this case a higher temperature is necessary to dissolve the molybdenum and the resultant alloy is frequently less ductile and in other respects not quite as good for thermo-elements as an alloy prepared in the manner hereinbefore described.

I have discovered that a product consisting of a nickel-molybdenum alloy which contains cobalt is a little more negative to a product consisting of a nickel-cobalt-copper alloy than an element composed of nickel-molybdenum, or of nickel-molybdenum-vanadium. In addition to a slightly higher ohmic resistance, the last named element is also less ductile than a nickel-cobalt composition alloyed with molybdenum. I have further discovered that with relation to the useful thermo-electric properties, such as the thermal electromotive force, electrical conductance, thermal conductance and temperature coefficient, the best result is obtained when the nickel-cobalt alloy as the base metal contains from ninety two per cent (92%) to ninety six per cent (96%) by weight of nickel and from four per cent (4%) to eight per cent (8%) of cobalt, which is then in turn alloyed with fifteen per cent (15%) to eighteen per cent (18%) by weight of molybdenum. Such an alloy is ductile to the extent that it can be drawn into wire and rolled into ribbon form. With an increase in the molybdenum content, however, the ductility of the alloy decreases, while its thermal electromotive force against a nickel-copper alloy, for instance, increases.

A very desirable feature is the fact that negative thermo-elements formed from my new alloy resist oxidation at a fairly high temperature, and at temperatures not exceeding 800° C. (eight hundred degrees centigrade) they have a useful life for a greatly extended period of time. Moreover, such negative elements are also well adapted for spot welding and a joint thus formed with a positive element is not impaired by its subjection to high temperatures.

A thermo-couple in which the positive element is prepared from a nickel-copper alloy, or from a nickel-cobalt-copper alloy, and the negative element from the alloy described above has a relatively high efficiency. This is chiefly due to its high thermal electromotive force, exceeding ninety (90) millivolts at a difference of temperature of 1000° C. (one thousand degrees centigrade), and to the large electrical conductivities of the thermo-couple elements compared with their small thermal conductivities. Another desirable property of both thermo-elements is their low temperature coefficient; the increase of their ohmic resistance with a rise

of temperature is very small when compared with their initial resistance at ordinary temperatures.

I have thus described the preferred form of my invention as I have thus far developed it and it will be apparent from this description that modifications within the scope of the specification and claims can readily be made without departing from the spirit of my invention.

Having thus described my invention, what I desire to claim and secure by United States Letters Patent is:

1. A thermo-couple in which the negative element is an alloy which includes nickel, cobalt and molybdenum in its make-up.

2. A thermo-couple in which the negative element is a ductile alloy which includes nickel, cobalt and molybdenum in its make-up.

3. A thermo-couple in which the negative element is an alloy which includes nickel, cobalt and molybdenum in its make-up, the quantity of nickel present being in excess over the cobalt and molybdenum content.

4. A thermo-couple in which the negative element is an alloy which includes nickel, cobalt and molybdenum in its make-up, and in which the positive element includes nickel, cobalt and copper in its make-up.

5. A thermo-couple in which the negative element is an alloy of molybdenum with a bimetallic composition of nickel and cobalt.

6. A thermo-couple in which the positive element includes nickel cobalt and copper in its make-up and in which the negative element is an alloy of molybdenum with a bimetallic composition of nickel and cobalt.

7. A thermo-couple in which the negative element is an alloy which includes nickel, cobalt and molybdenum in its make-up, the quantity of nickel present being in excess over the cobalt and molybdenum content, and the quantity of molybdenum being in excess over the cobalt content.

In witness whereof, I hereunto subscribe my name this 1st day of September A. D., 1926.

OTTO HERMANN.