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ALLOY

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This invention relates to alloys and more particularly to alloys for electrical resistance units.

In the patent to Hunter No. 2,005,423, granted June 18, 1935 there is disclosed the addition of calcium to nickel-chromium and nickel-chromium-iron alloys in such amounts that a residue of calcium remains in the alloy. Likewise, in my prior Patents Nos. 2,005,430, 2,005,431, 2,005,432 and 2,005,433, granted June 18, 1935, the addition of molybdenum, zirconium and calcium and calcium, zirconium and aluminum to nickel-chromium and nickel-chromium-iron alloys is disclosed. The alloys disclosed in said patents are particularly useful in resistance units that are subjected to high temperatures such as heating elements. Where a resistance unit is to be used at lower temperatures, such as in rheostats, a less expensive alloy containing less nickel and more iron is frequently used. I have found that the useful life of such alloys can be increased by the addition of various deoxidizers in such amounts that a residue of the deoxidizer or deoxidizers remains in the alloy. Thus calcium, zirconium and aluminum may be added to such alloys in such amounts that from .01 to .20 percent of calcium, .01 to .50 percent of zirconium and .01 to 1.00 percent of aluminum remain in the alloy.

The alloys to which the present invention relates are ones containing more nickel than chromium and in which the range of the metals, nickel, chromium and iron, extends from 20 to 50 percent nickel, 5 to 25 percent chromium and the balance iron. In preparing alloys containing calcium, zirconium and aluminum, the quantities of calcium, zirconium and aluminum are subtracted from the iron content. Thus in preparing alloys in the ranges stated above, the final alloys will contain from 20 to 50 percent nickel, 5 to 25 percent chromium, .01 to .20 percent calcium, .01 to .50 percent zirconium, .01 to 1.00 percent aluminum and the balance iron.

Manganese and silicon may also be added to the alloy and are preferably used within the following limits:

Manganese	.01 percent to 2.0 percent
Silicon	.01 percent to 2.0 percent

The alloys may or may not contain the elements, silicon and manganese, within the percentages stated above and the claims herein incorporated shall be interpreted to cover such alloys with or without the presence of silicon and manganese in the proportions that these elements are usually present in alloys of this character.

The preferred proportions of the alloying elements are as follows:

Nickel	35 percent
Chromium	15 percent
Calcium	.03 percent
Zirconium	.03 percent to .25 percent
Aluminum	.07 percent to .38 percent
Iron	Balance

In this alloy, a proportion of zirconium near the lower limit is preferred.

Nickel-chromium-iron alloys of the character set forth above containing calcium, zirconium and aluminum within the limits set forth have been found by tests to give a greatly increased period of life over similar alloys without the calcium addition. For the purpose of determining the life of such alloys at high temperatures I have tested them by the method of test outlined in "Tentative accelerated life test for metallic materials for electrical heating" of the American Society for testing materials described in vol. 29 of the "Proceedings of the thirty-second annual meeting of the American Society for testing materials" beginning on page 613. The method is substantially as follows:

A sample of the wire to be tested, free from kinks, approximately twelve inches long and of about .025 inches diameter, is mounted vertically on the test board, the upper end being held in position by means of a suitable binding post. A 10 gram weight is attached to the lower end of the specimen. A short piece of wire is attached to the 10 gram weight and projects downward into a cup of mercury where it may move freely up and down. A rheostat and an interrupter are connected in series with the specimen to the power supply. The test is run on constant temperature at a standard temperature chosen for the alloy under consideration for the first twenty-four hours. Thereafter it is run on constant voltage to the burnout. The life in hours up to a 10 percent increase in resistance is known as useful life while the life to the burnout is known as total life. Throughout the test the power is on two minutes and off two minutes. This is accomplished by means of an interrupter.

In testing the alloys of my invention according to the above described method, a reference sample composed of 35 percent nickel, 15 percent chromium and balance iron and having no calcium, zirconium or aluminum addition was used. The life of this sample is considered as 100 percent and the useful life of samples containing calcium, zirconium and aluminum within the

ranges stated was calculated therefrom. The useful life of such samples was found to be much greater than that of the standard.

In the alloys referred to herein small amounts of phosphorous and sulphur may be present as impurities. The nickel may also contain about 1 percent of cobalt.

I claim:

1. A nickel-chromium-iron alloy containing from 20 to 50 percent nickel, 5 to 25 percent chromium, .01 to .20 percent calcium, .01 to .50 percent zirconium, .01 to 1.00 percent aluminum, balance iron.

2. A nickel-chromium-iron alloy containing from 20 to 50 percent nickel, 5 to 25 percent chromium, substantially .03 percent calcium, substantially .03 to .25 percent zirconium, substantially .07 to .38 percent aluminum, balance iron.

3. A nickel-chromium-iron alloy containing substantially 35 percent nickel, substantially 15 percent chromium, substantially .03 percent calcium, substantially .05 percent zirconium, substantially .07 to .38 percent aluminum, balance iron.

4. An electric resistance element consisting essentially of 20 to 50 percent nickel, 5 to 25 percent chromium, .01 to .20 percent calcium, .01 to .50 percent zirconium, .01 to 1.00 percent aluminum, balance iron.

5. An electric resistance element consisting essentially of 20 to 50 percent nickel, 5 to 25 percent chromium, substantially .03 percent calcium, substantially .03 to .25 percent zirconium, substantially .07 to .38 percent aluminum, balance iron.

6. An electric resistance element consisting essentially of substantially 35 percent nickel, substantially 15 percent chromium, substantially .03 percent calcium, substantially .05 percent zirconium, substantially .07 to .38 percent aluminum, balance iron.

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