Patented May 5, 1931

1,803,468

UNITED STATES PATENT OFFICE

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ELECTRICAL-RESISTANCE ALLOY

No Drawing. Application filed July 3, 1930. Serial No. 465,644.

This invention relates to an alloy for electrical resistance materials.

Nickel-chromium is the alloy generally used for the making of electrical resistance wires. Since its introduction about twenty years ago there have been few commercial improvements.

One of the objects of this invention is to provide an alloy having greater electrical resistance than a nickel-chromium alloy.

Another object is to provide a series of alloys having different electrical resistances which are higher than nickel-chromium. Still another object of the invention is to provide a series of alloys some of which can be worked cold and others hot. A still further object is to provide a series of high resistance alloys which are capable of use as electrical resistance materials.

The commercial alloy of nickel and chromium almost always contains iron. We found that an alloy of 65% nickel 15% chromium and the balance iron gives the highest electrical resistance.

The variation of the proportions of the alloy affects the electrical resistance as well as other properties. For instance:

% Ni	% Cr	% Fe	Resistance in ohms CMF
65	15	Balance..	675
60	15	Balance..	670
60	20	Balance..	650
30	20	Balance..	580
30	15	Balance..	560
30	10	Balance..	550
25	15	Balance..	525
20	15	Balance..	485
10	20	Balance..	475
10	10	Balance..	445

Increasing the nickel and chromium to the exclusion of the iron lowers the resistance from 675 to 650 ohms. Likewise, if the percentage of nickel is lowered 5% from 65 to 50% and the chromium is raised 5% from 15% to 20% the resistance is lowered from 675 to 650 ohms CMF. The effect of a small quantity of iron and the proper quantities of metal and chromium is to raise the resistance 25 ohms CMF. We found that if aluminum was added to a nickel-chromium iron base that with 2½% or less that the resulting alloy is ductile and readily drawn and worked. That as the aluminum is increased the workability becomes more difficult and that at 10% of aluminum the alloy could not be readily worked either hot or cold. The addition of aluminum could be made to add 75 ohms CMF resistance which represents the maximum practical introduction of aluminum. For instance:

% Ni	% Cr	% Al	% Fe	Resistance in ohms CMF
10	10	2½	Balance..	635
20	15	5	Balance..	655
60	15	5	Balance..	740
73	15	10	Balance..	too hard.

We found that if vanadium was added to a nickel, chromium, iron base, that a similar condition occurs, that is, that over 10% vanadium makes the product too hard to work. We further found that a lesser quantity of vanadium raises the resistance 115 ohms CMF above the base. For instance:

% Ni	% Cr	% Va	Fe	Resistance in ohms CMF
10	20	2½	Balance..	500
10	10	3½	Balance..	550
30	15	2½	Balance..	575
40	10	2½	Balance..	615
60	10	1	Balance..	650
60	15	2½	Balance..	44
75	15	2½	Balance..	790
70	15	5	Balance..	790
67	15	10	Balance..	810
32	15	20	Balance..	too hard.

We found that if the same nickel, chromium, iron base was alloyed with aluminum and vanadium that not only was the electri-

cal resistance increased over that of either alone with the base but that the electrical resistance could be raised from 650 ohms CMF to over 1,000 ohms CMF. For instance:

%Ni	%Cr	%Va	%Al	% Fe	Resistance in ohms CMF
20	15	2	5	Balance..	640
60	15	2½	5	Balance..	950
73	15	2	6	Balance..	925
68	15	3½	5	Balance..	1,055
73	15	2	5	Balance..	925
73	15	3½	5	Balance..	1010

It should be noted that when the nickel is high and the iron content is low the cold working properties increased and the electrical resistance is high and when the iron is high and the nickel content is low the hot working properties increased and the electrical resistance is high. Therefore, a high electrical resistance alloy of over 1,000 ohms CMF can be made which will have either hot or cold working properties as desired and which will contain the same elements but in different proportions. An alloy of nickel, chromium, vanadium, aluminum and iron has a higher electrical resistance if made in the proper proportions than an alloy of the base (Ni, Cr and Fe) or the base and either aluminum or vanadium.

It will thus be seen that we have invented a series of alloys whereby a high electrical resistance material can be made and worked either hot or cold and which will have higher electrical resistances than can be obtained by the use of the nickel chromium base either alone or in combination with either of them.

What we claim is:

An electrical resistance alloy comprising aluminum 5%, vanadium between 2 and 3½%, chromium 15%, nickel between 60 and 75% and the balance iron.

Signed at Newark, in the county of Essex and State of New Jersey, this 11th day of June, A. D. 1930.

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