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THERMO-ELECTRIC NICKEL-BASE ALLOYS

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Alloys on a nickel base are often used as thermo-electric elements with high thermo-electric force whereby the positive component consists of a nickel-chromium alloy with a chromium content of about 10% and with varying contents of manganese or silicon. The negative component consists usually of a nickel-aluminium alloy with varying quantities of manganese and silicon. The electromotive force of the respective components can be changed by small changes of the compound and are usually adjusted so that the electromotive force of the thermo-electric element at different temperatures corresponds to certain standardized values. Thus U. S. A. have in the National Bureau of Standards Research Paper RP 767 drawn up standard tables for the positive component, chromel, and the negative, alumel, as against platinum as well as for the combination of chromel and alumel. The standardized values of the thermo-electric force make possible a general use of measuring instruments with a fixed graduation in millivolts or temperature degrees.

It is of importance that both components of the thermo-electric element besides the thermo-electric requirements possess as high a fire resistance as possible.

The highest temperature, at which the thermo-electric element types hitherto manufactured can be used in oxidating atmosphere, is principally limited partly by the scaling of the material, partly by the change of the thermo-electric force resulting from the oxidation of components in the alloy, and partly by the melting point of the alloy.

The highest temperature at which the thermo-electric element can be used is determined by the composition of the material and may to a great extent be influenced by small additions of certain alloy elements. Thus for instance the fire resistance of the positive component may be considerably improved by addition of zirconium. In this respect the negative component hitherto manufactured does not attain the same values as the positive component, which fact limits the highest temperature at which the thermo-electric element can be used. Thus there has been a demand for producing an alloy with suitable thermo-electric force to be used as a negative component in thermo-electric elements with high thermo-electric force, the fire resistance of which is considerably better than that of alloys hitherto manufactured.

The present invention relates to a negative thermo-electric alloy which, besides suitable thermo-electric force, possesses improved fire resistance properties corresponding to those obtainable for the positive alloy type with for example, zirconium. This alloy is characterized in that its base consists of nickel with a silicon content preferably up to 3% and has an addition, preferably up to 1.5%, of one or several metals of such a kind that a change of their amount of 0.01% causes a change of maximum 0.4 millivolt in the thermo-electric force as against platinum. Cobalt, iron, titanium, zirconium, tantalum, copper, chromium, tungsten molybdenum, alkaline earth metals and the rare earth metals may be stated as examples for metals to be added. By adding these metals in comparatively small quantities the thermo-electric force is moderately influenced and can thereby be exactly graduated.

To the alloy also those metals may suitably be added that favourably influence the working of the alloy and/or increase its resistance to gas attacks, for instance manganese in a quantity of up to 1.5%.

The proportion between the silicon content and the content of the additional metals influencing moderately the thermo-electric force is regulated so that the thermo-electric force of the thermo-electric element corresponds to the standard prescribed and at the same time a high fire resistance is obtained. Researches have proven that too low silicon contents, for instance below 1.5%, are not suitable for the purpose in question, as neither suitable thermo-electric properties nor the desired fire resistance are obtained thereby.

In the following table some examples are stated as to suitable compounds of alloys according to the present invention, whereby the quantity is in percentage, and nickel is the rest.

	Example 1	Example 2	Example 3	Example 4
Si	2.0–2.5	2.2–3.0	2.0 –3.0	2.3 –2.8
Co	0.2–0.6	0.2–0.4		0.1 –0.4
Fe			0.1 –0.3	
Ti		0.1–0.3	0.1 –0.3	
Zr			0.05–0.15	
Be				0.1 –0.3
Ce				0.05–0.25

	Example 5	Example 6	Example 7
Si	2.5 –2.9	2.3–2.8	2.5 –2.9
Co	0.3 –0.5	0.1–0.4	0.3 –0.5
Ca		0.1–0.2	
Fe	0.05–0.15		
Mn	0.2 –0.5		0.2 –0.5
Mg			0.05–0.15

We claim:

1. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.05 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being a metal which will cause a maximum change of 0.4 millivolt in the thermo-electric force against platinum when the content of said metal in said alloy is changed by 0.01%, the balance being nickel.

2. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.05 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being a metal which will cause a maximum change of 0.4 millivolt in the thermo-electric force against platinum when the content of said metal in said alloy is changed by 0.01%, and 0.2 to 1.5% manganese, the balance being nickel.

3. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.01 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being a metal which will cause a maximum change of 0.4 millivolt in the thermo-electric force against platinum when the content of said metal in said alloy is changed by 0.01%, the balance being nickel.

4. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.01 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being a metal which will cause a maximum change of 0.4 millivolt in the thermo-electric force against platinum when the content of

said metal in said alloy is changed by 0.01%, and a small amount up to 1.5% manganese, the balance being nickel.

5. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.01 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being a metal which will cause a maximum change of 0.4 millivolt in the thermo-electric force against platinum when the content of said metal in said alloy is changed by 0.01%, and 0.2 to 1.5% manganese, the balance being nickel.

6. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.01 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being a heavy metal selected from the group consisting of cobalt, iron, titanium, zirconium, tantalum, copper, chromium, tungsten, molybdenum, and the rare earth metals, which will cause a maximum change of 0.4 milli-volt in the thermo-electric force as against platinum when the content of said metal in said alloy is changed by 0.01% the balance being nickel.

7. A negative thermo-electric nickel base alloy comprising 1.5 to 3% of silicon and 0.01 to 1.5% of an auxiliary metal for influencing the thermo-electric force of the alloy, said auxiliary metal being an alkaline earth metal which will cause a maximum change of 0.4 millivolt on the thermo-electric force against platinum when the content of said metal in said alloy is changed by 0.01% the balance being nickel.

References Cited in the file of this patent

UNITED STATES PATENTS

764,174	Bristol	July 5, 1904
1,057,755	Marsh	Apr. 1, 1913
1,076,438	Marsh	Oct. 21, 1913
1,529,277	Rohde	Mar. 10, 1925
1,637,822	Hermann	Aug. 2, 1927
1,925,075	Miller	Aug. 29, 1933
2,049,443	Hermann	Aug. 4, 1936
2,587,391	Seaver	Feb. 26, 1952

FOREIGN PATENTS

28,554	Great Britain	1904