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THERMOCOUPLE ELEMENT COMPOSITION

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1 Claim. (Cl. 136—5)

This invention relates to thermocouples and more particularly, to a combination of alloy compositions for the two components of a thermocouple to be used for the measurement of high temperatures. The alloy compositions herein described have been found to resist to a high degree the deteriorating effect of furnace atmospheres which would otherwise result in changes in calibration, resulting in errors in temperature determination.

The electromotive force developed by any alloy at any given temperature is sensitive to changes in the nature and quantities of the metallic constituents present in the alloy. There are other constituents too, of a non-metallic nature, which are invariably present in all industrial alloys and which, if varied, have a marked effect in changing the electromotive force of a given alloy combination. These non-metallic constituents include oxygen, nitrogen and hydrogen which are adsorbed by the metallic constituents of the alloy, and they further include compounds such as oxides, nitrides, hydrides and sulfides which are soluble to a significant extent in the matrix of which the alloy is composed.

It is quite possible, industrially, to manufacture alloys of definite composition which will produce a definite electromotive force within specified limits at a given temperature. Both metallic and non-metallic constituents can be readily controlled, the former by metal additions and the latter by oxidizing or deoxidizing agents used in the melting operation. As a result, the thermocouple alloys reach the ultimate consumer with properties conforming to the electromotive force which is desired.

While in many instances the particular atmosphere of the furnace in which the thermocouple is used necessitates the use of alloys in the legs of the thermocouple that are most resistant to change in such atmospheres, there are also instances in which the development of a high E. M. F. versus temperature is extremely important. The thermocouple of the present invention is intended particularly for use in such instances.

I have found that a thermocouple employing as an electropositive element a nickel-chromium alloy containing approximately 8 to 10%, preferably about 9%, of chromium with other metallic elements present in minor amounts and an electronegative element containing 2 to 7% silicon, preferably about 3%, and the balance essentially nickel, produced a high E. M. F. at temperatures above 700° F. At the same time, the alloys of the thermocouple are more resistant to changes in furnace atmospheres that are normally encountered in use as is the present widely used thermocouple in which the positive leg is the same as that herein disclosed and the negative leg is formed of a nickel alloy with a manganese content of substantially 3% and aluminum and silicon in amounts not exceeding 2% each.

The thermocouple of my invention was compared with this prior art thermocouple at various temperatures in an open air furnace. The results are given in the following table:

Temperature, ° F.	Thermocouple of Application mv.	Prior Art Thermocouple, mv.
32	0.00	0.00
100	1.45	1.60
200	3.75	4.01
300	6.08	6.41
400	8.22	8.75
500	10.82	11.01
600	13.20	13.35
700	15.62	15.62
800	18.09	17.94
900	20.58	20.22
1,000	23.03	22.55
1,100	25.59	24.82
1,200	28.10	27.20
1,300	30.62	29.55
1,400	33.04	31.82
1,500	35.40	34.18
1,600	37.70	36.43
1,700	39.96	38.63
1,800	42.20	40.82
1,900	44.40	42.98
2,000	46.55	45.10
2,100	48.64	47.18
2,200	50.78	49.22
2,300	52.82	51.17

The two thermocouples were also compared for stability. Deviation in E. M. F. after being maintained at a temperature of 1945° F. in air for a period of 264 hours was noted. With the thermocouple of this application, the deviation was +0.01 mv. with that of the prior art, it was +0.09 mv. Thus the thermocouple of my invention not only compares favorably in its thermal E. M. F. response with the prior art thermocouple, but it also shows greater stability in air at elevated temperature for a long period of time.

The analyses of the alloys involved in the preceding tests are as follows:

	Percent
Positive Leg:	
C	0.11
Mn	0.01
Si	0.26
Cr	9.36
Fe	0.16
Ni	Bal. (essentially)
Negative Leg:	
C	.01
Si	3.19
Ni	Bal. (essentially)

The alloy of the positive leg, comprising essentially chromium and nickel, except for incidental impurities normally associated with nickel and residual amounts of deoxidizers added to the melt, may contain small amounts, not over 2% each of iron, manganese and silicon without departing from the spirit of the claim. Where special reducing and oxidizing conditions in furnace atmospheres have to be met the alloy may also contain not more than 2% of columbium to counteract green rot formation. Likewise the alloy of the negative leg while essentially a nickel silicon alloy may contain minor percentages of manganese and iron without departing from the spirit of the claim.

I claim:

A thermocouple comprising an electropositive element composed of an alloy of approximately 9 percent chromium, substantially 2 percent columbium, balance essentially nickel, and an electronegative leg composed of an alloy of 2 percent to 7 percent silicon and the balance essentially nickel characterized in that the thermocouple has a high E. M. F. at temperatures above 700° F.

References Cited in the file of this patent

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