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OTTO FEUSZNER, OF HANAU-ON-THE-MAIN, GERMANY, ASSIGNOR TO THE FIRM: W. C. HERAEUS GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG, OF HANAU-ON-THE-MAIN, GERMANY, A GERMAN SOCIETY

THERMOELECTRIC GENERATOR

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This invention relates to improvements in thermo-electric generators or thermopiles especially for the measurement of temperatures.

It has already been proposed to manufacture thermopiles or thermo-couples whose thermo-elements consist of alloys. The thermo-electric combinations of this kind hitherto known, have the disadvantage that the thermo-electric properties of the metallic mixtures will change when they are subjected to alternate heating and cooling. The potential difference between such elements at a given temperature will therefore not be sufficiently constant. This applies particularly to all alloys containing base metals. Thermo-electric elements consisting of binary alloys of precious metals, for example palladium-gold, have been proposed but these do not show a sufficient constancy of potential as their properties are considerably changed by the absorption of gas.

It has now been found that thermo-electric couples of a remarkable constancy and excellent qualities will be obtained by making one element or both of alloys containing more than two precious metals preferably simple ternary alloys containing palladium or a similar platinum metal capable in itself of absorbing gas, a precious metal of group one of the periodic system, for example gold and at least one other metal of the platinum group, such as platinum in a relatively small amount.

Such thermo-electric combinations, containing three or more precious metals as defined above, differ from the binary alloys of palladium with gold or silver known in thermo-electric combinations, by exhibiting little or no gas-absorption and by a high constancy of their thermo-electric properties.

For negative elements those ternary alloys of the kind described above are particularly suitable in which a precious metal, such as gold or silver, occupies the first place as regards weight, palladium the second and another platinum metal the third, for example platinum, ruthenium, rhodium, or the like. For example, alloys composed of about 60 parts of gold, 35 parts of palladium and about 5 parts of platinum or ruthenium or the like have proved to be highly efficient.

In this case any metals or alloys of a sufficiently high thermo-power, such as platinum, platinum-rhodium etc., may serve for positive elements.

When using platinum alone as a positive element in conjunction with a negative element composed of a ternary alloy of the kind described, there will be obtained, for example with a permanent application of about 1200° C. a thermo-power of approximately 40 milli-volts. This can be further increased by replacing the platinum element by an element composed of an alloy having a positive thermo-power with relation to platinum.

For positive elements the composition of the ternary alloy must be modified so that the palladium or another gas adsorptive platinum metal predominates in quantity, another platinum metal holds the second place and the metal of group one, such as gold or silver, the third. An alloy adapted for the thermo-electric couple as a positive element contains for example about 55 parts of palladium, 35 parts of platinum, or rhodium or ruthenium and 10 parts of gold.

The absorption of gas in the thermo-elements renders their properties variable. Thermo-couples composed of such gas absorptive alloys will not in general, exhibit the same potential difference when heated at different times to a given temperature. The ternary alloys according to the present invention exhibit remarkable constancy of properties and show little or no absorption of gas. However the effect of such gas absorption as may be exhibited can be nullified to a substantial extent by choosing two elements of such composition that the change of potential caused by gas absorption in one element is compensated for by the change of potential caused by gas absorption in the other element, so that the net potential difference exhibited by the thermo couple is substantially independent of any gas absorption. By way of example, ternary alloys may be used for both elements in accordance with the invention, the negative element, for example, containing gold in the predominating

amount, palladium in the second place and another platinum metal in the third; in the positive element for example, palladium predominates in amount, another platinum metal occupies the second place and gold or silver the third place. In this instance the gas-absorption of each element is very small and in addition the two elements will completely compensate each other.

As a further development of this idea, a thermo-electric couple may be formed in which one element comprises an alloy containing at least three precious metals as defined above and the other element comprises a binary alloy such as gold-palladium or palladium platinum and the ingredients of both elements are so proportioned that the effect of the gas absorption by the ternary alloy tends to compensate for the effect of the gas absorption by the binary alloy.

It has been discovered that thermo-electric combinations of excellent qualities can be produced by taking a thermo-element containing at least three precious metals as described above, in conjunction with a second thermo-element which is not composed of a precious metal or of a mixture of precious metals, but of a metal of the iron-group, such as iron itself, or a high-melting metal of group 6 or 7 of the periodic system, such as chromium, manganese, molybdenum, tungsten or the like. The second thermo-element may consist of an alloy of several of the said metals for example nickeliferous or chrom-steel, or the steel known in Germany as V_2A-steel. There may be added to such element, if desired, one or more of the high-melting metals of group one of the periodic system.

The second thermo-element referred to in the last paragraph is especially suitable as a positive element in conjunction with a negative element composed of a ternary alloy of the kind already referred to. The composition of the second thermo-element referred to may, however, be so adjusted that it may be employed as a negative element in conjunction with a positive element composed of a ternary alloy of the kind already referred to.

The metals and alloys of the iron, nickel and cobalt groups in combination with the ternary or higher alloys have particularly proved advantageous when their constancy of potential at any given temperature, resistance to gas and to steam as well as their resistance to oxidation is increased by special means. This may, for example be done by adding chromium, tungsten, manganese and the like. Such properties may also be imparted to the metals or alloys in question for example in their production, for example, by a high compression, by pressure, by their preparation in the electrical way or through other known improving processes.

I claim:

1. A thermo-couple having at least one element composed of an alloy of more than two precious metals among which there is one a highly gas-absorptive platinum metal, another a precious metal of group one of the periodic system and at least a third an additional platinum metal.

2. A thermo-couple having both elements composed of an alloy of more than two precious metals among which there is one a highly gas-absorptive platinum metal, another a precious metal of group one of the periodic system and at least a third an additional platinum metal.

3. A thermo-couple having at least one element composed of an alloy of more than two precious metals among which there is one palladium, another a precious metal of group one of the periodic system and at least a third an additional platinum metal.

4. A thermo-couple having at least one element composed of an alloy of more than two precious metals among which there is one palladium, another gold and at least a third an additional platinum metal.

5. A thermo-couple having at least one element composed of an alloy of palladium, gold and platinum.

6. A thermo-couple having at least one element composed of an alloy of palladium, gold, platinum and ruthenium.

7. A thermo-couple in which the negative element consists of an alloy containing a predominating weight of a precious metal of group one of the periodic system, a highly gas-absorptive platinum metal and a minor proportion of at least one additional platinum metal.

8. A thermo-couple as claimed in claim 7 in which the alloy for the negative element contains a weight of precious metal of group one of the periodic system approximately double the weight of highly gas-absorptive platinum metal applied.

9. A thermo-couple as claimed in claim 7 in which the alloy for the negative element contains about 60 parts of gold, about 35 parts of palladium and about 5 parts of platinum.

10. A thermo-couple in which the positive element consists of an alloy containing a predominant weight of a gas-absorptive platinum metal, at least one additional platinum metal and a minor proportion of a precious metal of group one of the periodic system.

11. A thermo-couple as claimed in claim 10 in which the alloy for the positive element contains the gas-absorptive platinum metal in weight approximately double that of the additional platinum metals.

12. A thermo-couple as claimed in claim 10 in which the alloy for the positive element contains about 55 parts of palladium, about 35 parts of platinum and about 10 parts of gold.

13. A thermo-couple as claimed in claim 7

in which the positive element consists of an alloy containing a predominating weight of a gas-absorptive platinum metal, at least one additional platinum metal and a minor proportion of a precious metal of group one of the periodic system.

14. A thermo-couple as claimed in claim 1 in which the second element consists of an alloy comprising two precious metals.

15. A thermo-couple as claimed in claim 1 in which the second element consists of an alloy comprising platinum and palladium.

16. A thermo-couple as claimed in claim 1 in which the second element comprises a metal of group eight of the periodic system.

17. A thermo-couple as claimed in claim 1 in which the second element is composed of an alloy comprising metals of group eight of the periodic system.

18. A thermo-couple as claimed in claim 1 in which the second element is composed of an alloy containing at least one metal of group eight of the periodic system and at least one metal of groups six, seven and one of the periodic system.

19. A thermo-couple as claimed in claim 1 in which the second element is composed of an alloy containing at least one metal of group eight of the periodic system and at least one metal with high melting point of group six, seven and one of the periodic system.

In testimony whereof I affix my signature.

DR. OTTO FEUSZNER.