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BIMETALLIC ELEMENT

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This invention relates to heat resistant bimetallic elements and more particularly to bimetallic elements for thermostatic controls having a low expansion component formed of a platinum alloy.

A bimetallic strip when subjected to variations in temperature bends because of the different thermal expansion characteristics of the metals that comprise the strip. Such a strip is ordinarily used in the operation of various instrumentalities, as a thermostatic control for making and breaking an electric circuit. Many different metals and alloys have been employed in forming bimetallic strips for thermostatic controls, however, their use is limited to operations at relatively low temperatures and usually to narrow ranges of temperature. These limitations result from many factors, among them being poor resistance of the metals to oxidation at the high temperatures contemplated in this invention, loss of strength due to repeated cycles of heating and cooling, irregular changes in coefficients of expansion, and other characteristics which are explained hereinafter.

A general object of this invention is the provision of a bimetallic strip which may be used as a thermostatic device at temperatures as high as about 2,000° F. Another object is to provide a bimetallic element which will withstand high temperatures and also operate at relatively low temperatures, such as about 300° F. More specifically, an object of this invention is to provide a heat resistant bimetal having a steady and significant deflection within the temperature range of from 300° F. to 2,000° F., and which will operate within this temperature range for a long period of time without developing a permanent set or deformation due to stress and temperature conditions. Further objects and various advantages of this invention will become apparent from the following description, the essential characteristics being summarized in the claims.

It has been found that alloys of platinum and other metals of the platinum group, such as rhodium and palladium and their alloys, may be used to form the low expansion component of a bimetallic element having unusual thermal characteristics. For example, an alloy consisting of platinum and from 10% to 30% rhodium has a mean coefficient of expansion of about

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5.9×10^{-6} inches per inch length per degree Fahrenheit in the range of from 300° F. to 2,000° F. When the coefficients of expansion of this alloy are plotted against temperatures at which the alloy is heated, a relatively straight line is obtained and although there be an increase in the coefficient of expansion as the temperature is raised, this increase is slight as compared with the increase in the expansion of other metals and alloys. Furthermore, there is no sharp inflection in the expansion curves of the low expansion alloys used in this invention as compared with the curves of other metals.

This characteristic of low, linear, and relatively constant expansion is advantageous in the low expansion component of a bimetallic element, since it permits of thermostatic use over a broad temperature range. For example, where it is desired to provide for the breaking of an electric circuit at a temperature of about 1900° F., and thereafter the making of the circuit at a temperature of about 400° F., it is necessary that the bimetallic element move an appreciable amount from its open to its closed position in order that the make and break points will occur sharply at the desired temperatures. If the bimetallic element undergoes only a slight deflection between the extremes of the operating range, the make and break points will not occur sharply at a predetermined temperature. With a component having a relatively low expansion coefficient as is provided by the platinum alloys used in this invention, a bimetallic element will exhibit an appreciable deflection whereby the desired sharp make and break points will be had even at widely separated temperatures. Also, since the expansion coefficients of the alloys used in the low expansion components of this invention are relatively constant and linear the bimetallic element will deflect evenly throughout the operation range, rather than being subjected to intense deflections for limited periods within the operating range.

It has been found that if the rhodium content of the platinum alloy is increased above about 30%, a bimetallic element having a low expansion component formed from such an alloy will not be stable in its deflection. Also, if the rhodium content is less than about 10%, signs of disintegration appear at elevated temperatures. For some uses, a rhodium content of even as low as 5% can be employed and for other uses, the rhodium content may be as high as 50%. The optimum amounts of platinum and rhodium for the purposes of this invention have been found to be about 80% and about 20% respectively.

The metals and alloys which have been used heretofore to form the low expansion layer of a thermostatic metal are not suitable for use within the temperature ranges contemplated by this invention. There are those metals and alloys which are suitable for use at relatively low temperatures but which become soft and lose their strength and resiliency when heated to about 1,000° F., whereby they can offer no expansion resistance to the high expansion element and no deflection of the composite sheet or bar will occur. On the other hand, when alloys such as the heat-resistant alloys are used to form the low expansion layer, it is found that at temperatures beyond about 700° F. their expansion coefficients are all practically the same, thus causing equal expansion of the components with no deflection of the composite strip.

The high expansion component of the bimetallic elements of this invention is formed from the heat-resistant alloys having a relatively high nickel-chromium content. They are recognized for their stability against oxidation at operating temperatures up to 2200° F. These alloys have heretofore been used in forming the high expansion components of thermostatic metals, and this use, per se, is not considered as being novel or as constituting this invention.

The thermal characteristics of the heat-resistant alloys make them peculiarly adaptable for use as the high expansion component of the bimetallic elements of this invention. The mean expansion coefficients (from 300° F. to 2000° F.) exceed 7×10^{-6} in./in./°F., the preferred value being about 9×10^{-6} in./in./°F. Although at relatively low temperatures, as up to about 300° F., some species of this group of alloys have relatively low expansions, they expand rapidly at temperatures up to about 400° F. and thereafter as the temperature is increased, there is only a very slight increase in expansion and following the initial abrupt rise in expansion at low temperatures, these alloys are characterized in having a linear expansion. Accordingly, when these alloys are joined to the low expansion components of this invention, a composite element is formed which has a constant and substantial deflection over a broad temperature range.

Another desirable characteristic of these heat-resistant alloys is their high melting points, whereby they retain their hardness and resiliency at the elevated temperatures herein contemplated.

In manufacturing a thermostatic element of the nature herein contemplated, it is desirable to roll a relatively thick bar or strip to the thinness contemplated in the final structure. This rolling process may be performed either before or after the components of the bimetals are bonded together as by welding or by brazing with a high temperature brazing alloy. The high expansion component should, therefore, be of a material that can be wrought or forged rather than requiring forming by casting.

Among the heat-resistant alloys that are suitable for forming the high expansion component of the bimetals of this invention, and which have the above-mentioned properties and characteristics, are the well-known special alloys such as Inconel and Nichrome. An alloy of 16% chromium, 25% nickel, and 6% molybdenum, known as Timken 16:25:6 may be used as well as one having 25% chromium, 21% nickel and 2% silicon. These alloys may contain small amounts of manganese, carbon, phosphorus, sulfur, tungsten, titanium, columbium and other known elements and compounds that are used to form the heat-resistant alloys. Nichrome (about 80% nickel and about 20% chromium) has been found to be especially suitable. The nickel content of these alloys is anywhere from 9% to as high as 80%, and the chromium is present in an amount as low as about 10%, usually not less than approximately 13%, and up to about 29%. Aside from these specific metals, there is no other element which is present in substantial amounts in all of the species. In referring to these alloys as a class, it is, therefore, impractical to attempt to define them in terms of their compositions, and it is believed that those skilled in the art will readily distinguish the heat-resistant nickel-chromium alloys from other alloys which are not suitable for forming the high expansion components of the bimetallic elements of this invention. While alloys which contain chromium and nickel have been described for the high expansion component, it will be understood that the nickel can be replaced, partly or wholly, by cobalt.

When a heat-resistant alloy layer is bonded to a platinum alloy layer as described above, a bimetallic element is formed which has sufficient mechanical strength to flex steadily between the extremes of the temperature range herein contemplated. The components retain their high resiliency and do not become permanently deformed even after long and repeated cycles of heating and cooling. Furthermore, the products of this invention have a linear deflection which permits of their use for controls where narrow temperature ranges are contemplated. The bimetallic elements are resistant to oxidation and are substantially free, therefore, from oxidation which would otherwise be detrimental to the satisfactory operation of the element.

In the foregoing, examples have been given which enable anyone skilled in the art to produce materials in accordance with the invention, but we wish it to be understood that our invention is not limited to those examples, as the relative proportions of the ingredients, the nature of the metals to be alloyed with the principal metals and the mode of bonding the layers may be varied, provided always that the end product consists of a thermostatic metal having the above described properties. For example, small amounts of nickel or chromium may be incorporated in the platinum alloy. Furthermore, it is obvious that the composite metal may comprise a plurality of layers having outside layers of the alloys herein described.

What we claim is:

1. Thermostatic metal strip, comprising a plurality of layers, the higher expansion bonded layer being a heat-resistant alloy comprising chromium in an amount of from 10% to 29% and metal of the group consisting of nickel and cobalt, said metal being present in an amount of from 9% to 80%, the lower expansion layer comprising essentially platinum alloyed with another metal of the platinum group, said other metal being present in the amount of from about 10% to about 30%.

2. A bimetal strip element comprising a high expansion layer bonded to a low expansion layer, said high expansion layer containing chromium

in an amount of from 10% to 29% and metal of the group consisting of nickel and cobalt, said metal being present in an amount of from 9% to 80%, said high expansion layer having a mean coefficient of thermal expansion of about 9×10^{-6} in./in./° F. in the range of from 300° F. to 2000° F., said low expansion layer consisting of platinum alloyed with another metal of the platinum group, said other metal being present in an amount of from 10% to 30%.

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