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C. E. FRY

THERMOSTATIC METAL

Filed May 31, 1921



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UNITED STATES PATENT OFFICE.

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THERMOSTATIC METAL.

Application filed May 31, 1921. Serial No. 473,802.

This invention is directed to the provision of a thermostatic metal or thermostatic couple which is superior to those heretofore commonly used, particularly with respect to the range of temperature over which the metal may be used, the amount of work which the metal may be made to perform and the accuracy of the indications obtained even though the metal be subjected to a wide range of temperature variations.

A common practice heretofore in the manufacture of thermostatic metals has been to employ a nickel-steel such as invar steel and brass as the metals from which the thermostatic couple is made. Invar steel is a nickel steel having a nickel content of about 36% and it is of special value in a thermostatic couple for the reason that its coefficient of expansion with changes of temperature is practically zero at low temperature ranges. Brass is used as the other metal of the couple because it has a relatively high coefficient of expansion. Such a thermostatic couple, though widely used heretofore, is not suited for use in obtaining accurate results under conditions which subject the metal to relatively high temperatures, for instance, temperatures running well above 400° F. Furthermore, the load that may be imposed upon such a thermostatic strip, especially at relatively high temperatures, must be small since otherwise the accuracy of the indications given by the movements of the strip will be greatly impaired.

There are many uses for thermostatic metals under conditions such that the metal would be subjected to temperatures running up to 600° F. or even 800° F. or 900° F. Also, it is frequently desirable to have the thermostatic metal move a valve or damper or some other element which imposes a load upon the strip greater than could be borne under the same temperature conditions by the strips heretofore commonly used without substantial loss of accuracy.

When a thermostatic strip of the type hitherto usually employed and containing brass as the high expansion element is heated to a temperature in excess of 600° F., it assumes a curved configuration by reason of

the different expansion coefficients of the two elements; and when the strip is allowed to cool to its original temperature, it does not assume its original shape exactly and the difference between its original and final shape represents the loss of accuracy.

This alteration in the original shape of the thermostatic couple is due to the effect of the high temperatures upon the molecular structure of the brass whereby its elastic characteristics are so altered that when the couple is cooled to its initial temperature, it takes a set slightly different from its original one. This permanent set takes place, particularly when the temperature variations run up relatively high, as for instance well over 400° F., under the stresses imposed by the unequal expansion of the two metals and by any working load which the couple may be caused to carry, such as the movement of a damper or valve.

It has been found that the stresses along the boundary zone between the two elements of the couple are truly enormous, making it highly desirable not only that the joint shall be extraordinarily tenacious but also that both metals shall have appropriate elastic properties to enable them to recover their original configuration when these enormous stresses are removed.

I have found that the elastic characteristics and properties of ordinary brass, particularly at temperatures above about 400° F., are such as to render this metal unsuitable for use as the high expansion element in thermostatic-couples designed for use under the conditions and for the purpose mentioned. Thus, brass, in contradistinction to many other alloys, such as the alloy steels, does not present the same substantial recovery from the combined effects of stress and high temperature. On the contrary, ordinary brass will take on a substantially permanent set or permanent change in its configuration, when subjected to these influences, the change being the more pronounced when the stress and temperature conditions are continued for a substantial period of time.

By using in place of the brass a high expansion coefficient metal which at the same

time possesses a much higher resistance to permanent distortion under the combined effects of stress and high temperature, a thermostatic couple is produced which is adapted for use under relatively high temperature conditions and when subjected to the stresses specified, and accurate indications may be obtained in response to temperature variations even when those variations run up relatively high. The metal should be such that subjecting it to a high temperature, such for instance as a temperature well over 400° F., will not cause a flow of the metal or a molecular change, such that when cooled to its original temperature, it would take a set different from its original shape.

A good example of a metal which, like brass, has a relatively high expansion coefficient, and which, unlike brass, possesses a much higher resistance to permanent distortion under the combined effects of stress and temperature, is an alloy of nickel and copper having a copper content materially lower than that of brass. A nickel-copper alloy which is well adapted for this use is Monel metal, an alloy containing approximately 66% to 68% of nickel and 26% to 29% of copper. It has a relatively high coefficient of expansion with changes of temperature, its elastic limit is substantially higher than that of brass, and its desirable property of resisting permanent distortion under the combined influence of stress and temperature is not materially affected by changes of temperature running up to 600° F., or somewhat higher, or at least they are not affected to such extent as would materially impair the accuracy of indications obtained from a thermostatic strip having one of its elements made of that metal.

The invention is employed to the best advantage by making a thermostatic strip from invar steel and Monel metal, the invar steel being employed for the reason which has led to its use heretofore, namely, its negligible expansion coefficient at ordinary temperature ranges, and Monel metal being used because of its relatively high expansion coefficient and its characteristic of retaining its desirable elastic properties when subjected to temperature changes extending over a relatively wide range.

The primary advantage incident to this combination of materials rather than that heretofore employed as above described, is that it may be used under conditions which subject it to changes of temperature running much higher. After being subjected to these relatively higher temperatures and then allowed to cool, the thermostatic metal returns to substantially its original condition so that the accuracy of the indications afforded by the metal is not materially affected by the high temperature conditions. Furthermore it is permissible to impose a

greater load upon a thermostatic strip made from this improved metal without a substantial sacrifice of accuracy, as for instance, by arranging the strip to operate a valve, damper or switch member or similar device. The new metal will operate with accuracy under more severe load conditions throughout the ranges of temperature commonly met with in the operation of thermostatic strips, but this capacity of the new metal is particularly pronounced when the variations of temperature to which the strip is subjected include relatively high temperatures.

The accompanying drawing is a representation of the improved thermostatic metal. The drawing shows strips of invar steel and nickel-copper alloy fused together throughout their entire length in any suitable manner.

I claim:—

1. A thermostatic couple consisting of two elements having different coefficients of expansion fused together, both elements consisting of alloys of nickel, and the element having the higher temperature coefficient having the larger nickel content.

2. A thermostatic couple consisting of two elements fused together, one having a relatively low temperature coefficient and being composed of a nickel-steel alloy, and the other having a relatively high temperature coefficient and being composed of a nickel alloy having a nickel content larger than that of the other element.

3. A thermostatic couple consisting of two elements having different coefficients of expansion fused together, the element having the lower coefficient being a nickel-steel alloy and the other element consisting primarily of nickel.

4. A thermostatic couple consisting of two elements having different coefficients of expansion fused together, both of said elements containing nickel and the element of higher coefficient having the higher nickel content.

5. A thermostatic couple consisting of two elements fused together, said elements being made of metal having different coefficients of expansion, the element of lower coefficient being a nickel alloy containing less than 45% of nickel and the element of higher coefficient containing more than 45% of nickel.

6. A thermostatic couple consisting of two elements fused together, said elements being made of metal having different coefficients of expansion, the element of lower coefficient being a nickel-steel containing less than 45% of nickel and the element of higher coefficient containing more than 45% of nickel.

7. A thermostatic couple in which the element of the couple having the lower expansion coefficient is a nickel-steel alloy and the element of the couple which has the higher

expansion coefficient is composed of an alloy of a relatively large proportion of nickel and a relatively small proportion of copper, substantially as described.

8. A thermostatic couple in which the element which has the relatively low expansion coefficient is a nickel-steel alloy and the element which has the relatively high coefficient is composed of an alloy of approxi-

mately 26% to 29% copper and 66% to 68% nickel, substantially as described.

elements fused together, one composed of 9. A thermostatic couple consisting of two elements fused together, one composed of invar-steel and the other composed of Monel metal substantially as described.

In testimony whereof I affix my signature.

CLAYTON E. FRY.

expansion coefficient is composed of an alloy of a relatively large proportion of nickel and a relatively small proportion of copper, substantially as described.

- 5 8. A thermostatic couple in which the element which has the relatively low expansion coefficient is a nickel-steel alloy and the element which has the relatively high coefficient is composed of an alloy of approxi-

mately 26% to 29% copper and 66% to 68% nickel, substantially as described. 10

elements fused together, one composed of

9. A thermostatic couple consisting of two elements fused together, one composed of invar-steel and the other composed of Monel 15 metal substantially as described.

In testimony whereof I affix my signature.

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Certificate of Correction.

Patent No. 1,643,809.

Granted September 27, 1927, to

CLAYTON E. FRY.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 3, line 8, claim 8, after the word "high" insert the word *expansion*; same page, and claim, line 12, strike out the words "elements fused together, one composed of"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of October, A. D. 1927.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.

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