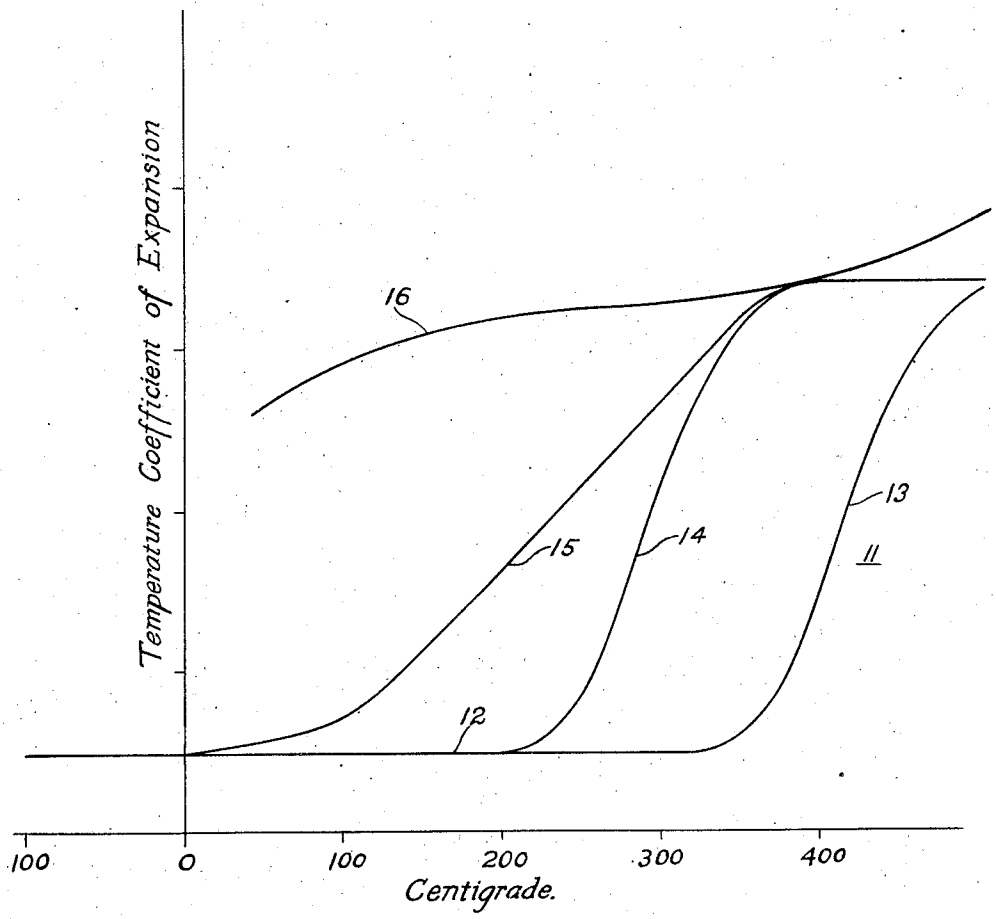
Oct. 30, 1928. 1,689,814

P. H. BRACE

THERMOSTATIC ELEMENT

Filed March 12, 1926



WITNESSES:
C. J. Weller.
G. B. Foflat

INVENTOR
Porter H. Brace.
BY
Wesley G. Carr
ATTORNEY

Patented Oct. 30, 1928. 1,689,814

UNITED STATES PATENT OFFICE.

PORTER H. BRACE, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

THERMOSTATIC ELEMENT.

Application filed March 12, 1926. Serial No. 94,198.

My invention relates to temperature-responsive devices, and particularly to alloys for bimetallic members therefor.

An object of my invention is to provide an alloy for bimetallic devices that is characterized by a low temperature coefficient of expansion over a wide range of temperature.

In practicing my invention, I provide an alloy for a bimetallic member the principal components of which are iron, nickel, cobalt and a minor portion of manganese. The temperature coefficient of expansion of the alloy comprising the above named elements is substantially constant between room temperatures and 300° C. The value of the temperature coefficient of expansion over the range between 0° C. and 300° C. is substantially equal to that of invar at ordinary temperatures.

Between 0° C. and 100° C. the temperature coefficient of expansion of invar is approximately 1 to 2 millionths of its length per degree centigrade. At 200° C., the coefficient of expansion will reach approximately 5 millionths of its length per degree centigrade, and at 300° C., it will increase to substantially 12 millionths of its length per degree centigrade.

I have found that the addition of cobalt to the nickel steels profoundly alters the expansivity or the temperature coefficient of expansion and that, if alloys are prepared having iron, nickel and manganese ratios contained in invar and a substantial proportion of cobalt, it is possible to secure alloys having practically uniform temperature coefficients of expansion between room temperature and 300° C. The value of the coefficient of expansion over the range between room temperature and 300° C. is approximately equal to that of invar at ordinary temperatures.

I provide also as a cooperating element for my new alloy, a metal which has a rapidly increasing temperature coefficient of expansion from room temperature to substantially 375° C. Other alloys which may be used with the above iron, nickel, cobalt and manganese alloy are Monel metal, stainless iron, which is a low-carbon iron-chromium alloy containing from 14% to 20% chromium and cobalt, and the cobalt, chromium or tungsten alloys commonly known as stellite.

In the accompanying drawing, 11 is a curve which represents the relation of the temperature coefficient of expansion to the temperature to which the alloy of my invention is subjected. For my improved alloy, the temperature coefficient of expansion is substantially constant from 0° C. to 300° C. and from 300° C. to substantially 500° C. the temperature coefficient of expansion increases very rapidly and is proportional to the temperature.

A specific form of the alloy represented by the curve 11 contains approximately 58% iron, 32.6% nickel, 9% cobalt and .4% manganese.

By decreasing the nickel content and increasing the iron and cobalt content of the alloy represented by the curve 11, it is possible to shift the horizontal portion 12 of the curve 11 so that it extends from minus 100° C. to plus 200° C. For temperatures exceeding 200° C., the portion 14 of the curve is substantially of the same shape as the portion 13 of the curve 11.

In order to obtain the characteristics set forth above, the iron and nickel elements of the alloy may be varied from and between the ratios of 3 parts of iron to 1 part of nickel and 1 part of iron to 1 part of nickel; the cobalt content may be varied from 1% to 20%, and the manganese may be varied from 0% to .8%.

A curve 15 represents the relation of the temperature coefficient of expansion to temperature for metal such as invar, and a curve 16 represents the relation of the temperature coefficient of expansion to temperature for a metal alloy such as Monel.

In providing a thermostatic material in bimetallic form which comprises invar steel and my improved alloy represented by the curve 11, I have found that the difference between the temperature coefficients of said alloys at ordinary temperatures below 100° C. is very small, but between 100° C. and 400° C. there is a marked increase in the difference between the temperature coefficients thereof. It is readily seen from the drawings that the difference in temperature coefficients of expansion is substantially proportional to the temperature between 100° C. and 375° C. A bimetallic material composed of these two metals is suitable to operate as a thermostat over a temperature range between 100° C., and 375° C., because the largest change between the temperature coefficients of expansion takes place between those two temperature limits. At temperatures below 100° C.,

the device would be inoperative and internal stresses set up as a result of differences between the temperature coefficients would be materially reduced. Above 375° C. the difference between the temperature coefficients of expansion of the two metals is again materially reduced, with the result that the material will not be stressed above the elastic limits thereof at those temperatures.

Other metals may be used with the alloy represented by the curve 11 to produce a thermostatic material, and I do not wish to be limited to the use of invar or Monel metals therewith. Some of the metals, other than those hereinbefore mentioned, that may be used in cooperation with the metal represented by the curve 11 are pure nickel, 45% nickel-steel or brass.

My present application is closely related to my copending application Serial No. 192,559, filed May 19, 1927, in which the particular alloy represented herein by the temperature expansivity curve 11 is described and claimed.

Various modifications may be made in my invention without departing from the spirit and scope thereof. I desire, therefore, that such limitations shall be placed thereon as are imposed by the prior art and the appended claims.

I claim as my invention:

1. A temperature-responsive device comprising metallic elements, one of said elements being an alloy of nickel having relatively high temperature coefficient of expansion, and the other of said elements being an alloy which contains iron and nickel in the ratios of from 3 parts of iron to 1 part of nickel and cobalt in amounts varying from 1% to 20% of the alloy content.

2. A temperature-responsive device comprising metallic elements, one of said elements being an alloy of nickel having a relatively high temperature coefficient of expansion, and the other of said elements being an alloy which contains iron and nickel in the ratios of from 1 part of iron to 1 part of nickel and cobalt in amounts between 8% to 12% of the alloy content.

3. A temperature-responsive device comprising metallic elements, one of said elements being an alloy of nickel having a relatively high temperature coefficient of expansion, and the other of said elements being an alloy which contains iron and nickel between the ratios of 3 parts of iron to 1 part of nickel to 1 part of iron to 1 part of nickel, and cobalt in amounts between 1% to 20% of the alloy content.

4. A temperature-responsive device comprising metallic elements, one of which is a nickel steel and the other of which is an alloy containing substantially 58% of iron, 32.6% of nickel, 9% of cobalt and 0.4% of manganese.

5. A temperature-responsive device comprising a pair of cooperating elements, one of said elements being an alloy of iron, nickel, cobalt and one or more metals of the vanadium group, said iron and nickel being present in the ratio of 3 parts of iron to 1 part of nickel, said cobalt being present in amounts from 1% to 20% of said aggregate alloy, and said metal or metals of the vanadium group being present in amounts from 0.1% to 0.8% of said alloy content, and the other of said elements being a nickel steel alloy.

6. A temperature-responsive device comprising a pair of cooperating elements, one of said elements being an alloy of iron, nickel, cobalt and one or more metals of the vanadium group, said iron and nickel being present in the ratio of 3 parts of iron and 1 part of nickel, said cobalt being present in amounts from 1% to 20% of said aggregate alloy, and said metal or metals of the chromium group being present in amounts from 0.1% to 0.8% of said alloy content, and the other of said elements being a nickel steel alloy.

In testimony whereof, I have hereunto subscribed my name this 4th day of March, 1926.

PORTER H. BRACE.