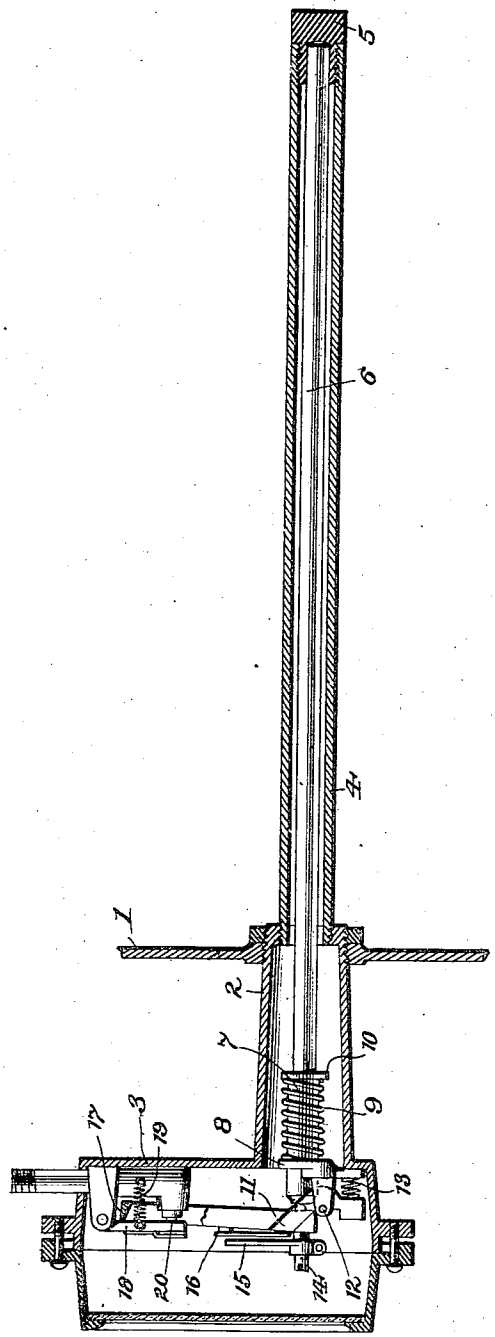
Dec. 23, 1924. 1,520,549

A. J. OTTO ET AL

THERMOSTATIC COUPLE

Filed May 24, 1923



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UNITED STATES PATENT OFFICE.

ARTHUR J. OTTO AND CARL A. OTTO, OF MILWAUKEE, WISCONSIN, ASSIGNORS TO JOHNSON SERVICE COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

THERMOSTATIC COUPLE.

Application filed May 24, 1923. Serial No. 641,168.

To all whom it may concern:

Be it known that we, ARTHUR J. OTTO and CARL A. OTTO, citizens of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Thermostatic Couples, of which the following is a specification.

This invention relates to thermostatic couples and particularly to such couples available for use at high temperatures as the responsive element in known types of temperature responsive mechanism, such as pyrometers, thermostatic regulators and the like.

Such couples operate by differential expansion. Hence the prime requisite of any two materials to be used conjointly is that they have different coefficients of expansion. The ideal condition is that each substance shall have a substantially constant coefficient of expansion throughout the regulative temperature range, or at any rate that the differential coefficient of the two substances shall be as nearly constant as possible within this range. Otherwise the sensitiveness of the instrument will vary with the temperature.

At ordinary temperatures these requirements can readily be met by simple selections of material. At high temperatures many special considerations enter. The substances must be fusible only at high temperatures. They must be chemically inert so as to resist chemical interaction with each other, and with chemically active gases (such as furnace gases, vapors met with in metallurgical furnaces, etc.) even at high temperature. They must not be subject to changes of form or to progressive changes of either physical or chemical characteristics either by long continued heating, or by alternate heating and cooling. They must be reasonably good conductors of heat, to ensure rapid response to temperature changes. They must not be subject to fracture by relatively rapid and marked changes of temperature. Finally the materials must be susceptible of standardized manufacture, both as to composition and form.

Remembering that these devices, to be useful at all, must be capable of a reliable regulating function within a few degrees Fahrenheit, it is readily seen that their effective differential movements are extremely minute, and that the maintenance uniform of the properties, alluded to above is necessary in the very highest degree. Many substances which on careful preliminary consideration seem highly promising develop defects, often very elusive, when subjected to the conditions of actual service.

In a prior patent, to A. J. Otto, No. 1,337,367, is described and claimed a thermostatic couple composed of fused silica and alundum, and this type of couple has gone into extensive use and has successfully met the requirements of high temperature regulation. It has however, some practical limitations which we have succeeded in overcoming by the present invention.

Alundum used for the tube or sheath element is fragile and is subject to fracture when used in furnaces, by mechanical injuries received during charging of the furnace. Moreover, the white fused silica which was heretofore used in practice, although a remarkably stable substance, was found to be subject after long periods of use to slight devitrification at the surface sufficient to change the adjustment of the thermostat.

The white silica ware is made by fusing silica sand, while the transparent ware is made by fusing transparent rock crystal. The transparent ware is stronger and has a slightly higher specific gravity but aside from these characteristics the two classes of ware are generally considered as substantial equivalents. We have found, however, that under the conditions of use as the neutral element of the thermostatic couple, the transparent silica is far better than the white silica for the reason that it is virtually free from the devitrification above described. The probable explanation is that the white silica ware contains minute air bubbles which form nuclei for devitrification.

In the preferred form of the couple forming the subject matter of this application, I use transparent fused silica as the relatively inert element and one of the heat resisting so-called nickel chromium alloys as the relatively expansible element.

The term "nickel chromium alloy" is more or less elastic. For very high temperatures, say those in excess of 2000° F., the best alloy known to us consists approximately of 80% nickel and 20% chromium. For relatively lower temperatures, such as 1400° F., a much

less expensive alloy containing over 50% iron, together with nickel and chromium, will meet all practical requirements. Furthermore, as is well known, it is possible to substitute for chromium, in whole or in part, other metals of the chromium group. By the chromium group we mean the group as defined in the periodic table, namely: chromium, molybdenum, tungsten and uranium.

Similarly, we may substitute for nickel other metals in the nickel group which includes nickel, cobalt and iron. One such specific substitution, i. e., the substitution of iron, for part of the nickel, has been suggested.

A considerable range of alloys having the desired properties is available and the selection of a particular composition for a particular case is dependent upon economic conditions and the maximum temperature to be encountered. As a general rule, the higher the temperature the less quantity of iron it is permissible to use in the alloy, and as pure, or even approximately pure, nickel chromium alloys are expensive, it is commercially impractible to use the pure alloy except where necessary to meet extreme high temperature conditions.

The resistance to oxidation offered by these alloys is an important factor when they are used in conjunction with fused silica, for the reason that metallic oxides attack fused silica in some degree so that their presence, particularly at high temperatures, is to be avoided.

The preferred construction of the couple and its application to a thermostatic control device of the pneumatic type, are shown in the accompanying drawing, which is chiefly in vertical axial section.

In this drawing 1 is a supporting plate into which is threaded the nipple 2 making part of the body 3 of the thermostat. Into the end of nipple 2 is threaded a tube 4 of an alloy such as above described. The rear end of tube 4 is closed by a threaded plug, preferably also of the same alloy. This plug 5 is formed at its inner end with a recess or seat to secure and support the rear end of the fused silica rod 6. The front end of rod 6 is housed in and abuts against a thimble 7 which is guided in a guide 8. A spring 9 confined between the guide 8 and a flange 10 in the thimble 7 urges the thimble, and hence the rod 6 to the rear.

A lever 11 pivoted at 12 in the body 2 of the device is actuated by thimble 7 in one direction and by spring 13 in the reverse direction. An adjustable screw 14 forms a thrust connection between lever 11 and thimble 7, and a hand 15 readable against a dial 16 indicates the adjustment.

The lever 11 through a knife edge 17 actuates in an opening direction a hinged valve 18 urged in the opposite direction by a spring 19. The valve 18 controls the leak port 20, forming a part of a well known system of temperature regulations.

This structure, with the exception of the couple 4, 6 is familiar to those skilled in the art and is illustrated merely to make clear one practical application of the invention.

What is claimed is:

1. An expansible element for mechanical thermostats composed of an alloy consisting of 55% or more of a metal or metals of the nickel group and the remainder of a metal or metals of the chromium group.

2. An expansible element for mechanical thermostats composed of an alloy consisting of 80% nickel and 20% chromium.

In testimony whereof we have signed our names to this specification.

CARL A. OTTO.
ARTHUR J. OTTO.