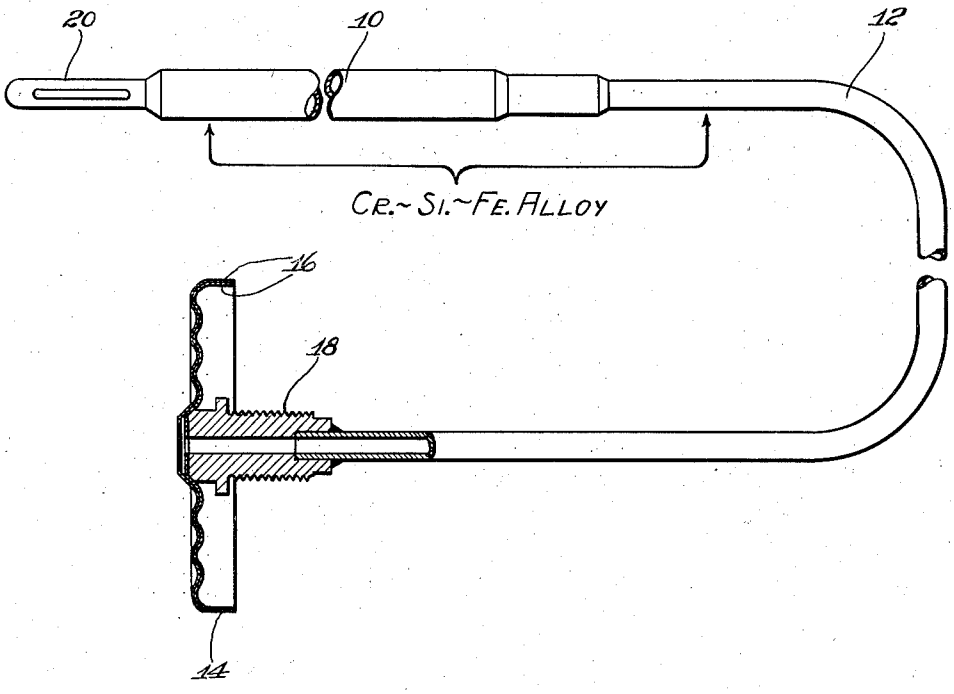
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TEMPERATURE RESPONSIVE DEVICE

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TEMPERATURE RESPONSIVE DEVICE

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This invention relates to thermally operated elements of the hydraulic type used for regulating or indicating temperatures and, more particularly, to the material of which such elements are constructed.

Devices of this character generally comprise a bulb connected by tubing to an actuating element and contain a fluid which is responsive to temperature changes. Mercury is often made use of for charging the thermal element and this invention contemplates such liquid will be used. The tube and bulb portions of these thermal elements as thus charged are commonly made of low carbon steel where the temperature range is low. This limitation is necessary due to the solubility of this steel in mercury which is quite marked in the higher temperature ranges.

Where it is desired to use mercury for charging thermal elements exposed to the higher temperature ranges it is essential that a material more resistant to absorption than low carbon steel be used. It has been proposed to make use of the well-known 18–8 stainless steel under these conditions. The usual composition of this material is 18% chromium, 8% nickel, 0.1% carbon, remainder iron. Such an alloy is not only expensive in such applications but it is difficult to work. Thus, only in relatively few cases is the use of such material justified due to the high cost and its use is also invariably confined to installations operating at elevated temperatures.

An object of this invention is to increase the resistance of thermal elements to absorption by the mercury charge without adding materially to the cost thereof.

Another object of the invention is to permit thermal elements of one material to be used over a wide range of temperatures.

Another object of the invention is to render the thermal element more sensitive to temperature changes.

Another object of the invention is to secure ample resistance to oxidation of the element at high temperatures.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawing which illustrates an hydraulic thermal element of common form constructed in accordance with this invention.

Referring more particularly to the drawing, the hydraulic thermal element may comprise a bulb 10 having the capillary tube 12 secured thereto and connected to the actuating element 14. In this instance, the actuating element consists of a pair of nested corrugated discs 16 having their peripheral edges welded together and having a stud 18 welded or otherwise secured to the central portion of the inner disc. The stud 18 and the inner disc 16 are suitably bored to permit fluid from the capillary tube 12 to enter between the discs and force them apart.

In constructing the thermal elements of this nature the bulb 10 is left open at the outer end 20 in order that the device may be charged with the fluid. Preferably, the charging is performed under vacuum so that substantially complete filling of the device with fluid will occur. After the element is thus charged with the fluid, the open end of the bulb 10 may be permanently closed by flattening or crimping the end 20 and sealing it by welding or other suitable means.

While various liquids may be used for charging purposes the one which this invention contemplates will be used is mercury. As previously mentioned, the tube 12 and bulb 10 of such mercury charged thermal elements used in connection with thermostats and thermometers have commonly been made of low carbon steel. This material is soluble to some extent in mercury, particularly at elevated temperatures, but is relatively inexpensive and easy to work. Stainless steel of the 18% chromium, 8% nickel composition previously described has been used to overcome the disadvantage of the low carbon steel at high temperatures, but this alloy introduces disadvantages of its own.

In accordance with this invention the bulb 10 and capillary tube 12 are made of a chromium-silicon iron alloy having a considerably lower solubility in mercury than the ordinary low carbon steel. The preferred composition is as follows:

	Per cent
Chromium	5
Silicon	1.5
Molybdenum	0.5
Carbon	0.12
Iron	Remainder

As shown by the following table, the solubility of an alloy of the foregoing composition is greatly reduced over that of the common low (0.08–0.18%) carbon steel in mercury. The table shows the relative solubility as effective in reducing the wall thickness of bulbs of each material, such reduction being expressed in thousandths of an inch per year at various temperatures as follows:

Temperature, degrees F.	Carbon steel	Special alloy
900	4	0.2
1,000	9	0.5
1,100	22	1.1
1,200	53	2.5

By the use of such an alloy for the parts of the thermal element the resistance to absorption by the mercury charge is greatly increased. This advantage is achieved without adding materially to the cost of the thermal element due to the

relatively inexpensive nature of the material when compared with the aforementioned 18–8 stainless steel. Moreover, the material lends itself to the construction of thermal elements for use over a wide range of temperature changes, thus avoiding the substitution of stainless steel for low carbon steel in certain applications as has been necessary in the past.

In making the tube and bulb of the thermal element from the material described herein it is possible to reduce the wall thickness of the bulb 10, due to the better stability at high temperatures of the alloy than the low carbon steel. Hence, the thermal element is rendered more sensitive to rapid temperature changes than in the case of elements made of low carbon steel. The alloy material of this invention is considerably more resistant to oxidation at high temperatures than the ordinary carbon steel and therefore requires less protection.

Ordinarily, the actuating element 16 (which includes the stud 18) of such devices has been made of stainless steel of the composition defined herein and this procedure may be retained where the chromium-silicon iron alloy is used for the bulb and capillary tube. It is, however, contemplated as within the scope of this invention to use the chromium-silicon iron alloy described herein as the material of the actuating element 16 as well as that of the bulb and tube.

Thermal elements manufactured in accordance with this invention may find many and varied uses and although the invention is described with reference to a particular embodiment thereof, it is not to be limited thereto except insofar as is necessitated by the prior art and the scope of the appended claims.

I claim:

1. An hydraulic thermal element containing mercury for use at temperatures up to about 1200° Fahrenheit and consisting of a bulb, a capillary tubing and an actuating element, said tubing and bulb being formed of an alloy steel substantially insoluble in mercury at said temperatures and having the following analysis:

	Per cent
Chromium	5
Silicon	1.5
Molybdenum	0.5
Carbon	0.12
Iron	Remainder

2. A temperature responsive device of the hydraulic type having a bulb, a capillary tubing and an actuating element charged with mercury, said actuating element being formed of stainless steel and said bulb and tubing being formed of an amalgamation resistant alloy steel having the following composition:

	Per cent
Chromium	5
Silicon	1.5
Molybdenum	0.5
Carbon	0.12
Iron	Remainder

3. An hydraulic thermal element having a bulb, a capillary tubing and an actuating element as component parts charged with mercury, at least two of said parts being formed of alloy steel being substantially insoluble in mercury and consisting of approximately 5% chromium, 1.5% silicon, 0.12% carbon, and 0.5% molybdenum, the remainder being iron.

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