Aug. 19, 1969 J. JACKSON 3,462,724

ELECTRICALLY OPERATED HEAT TRANSFER DEVICES

Filed June 15, 1967

FIG. 1

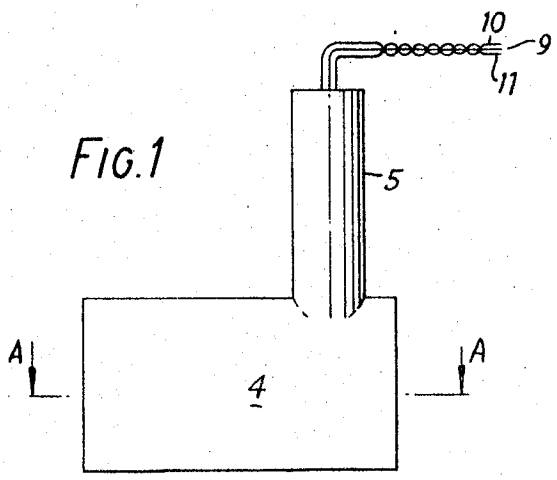


FIG. 2

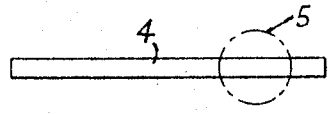


FIG. 3

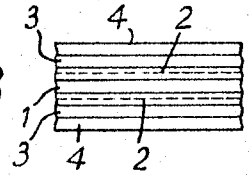


FIG. 4

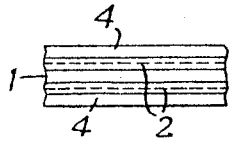


FIG. 5

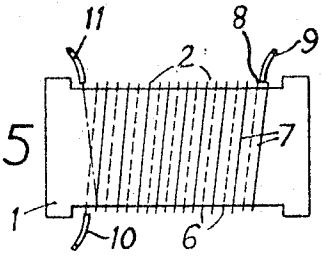
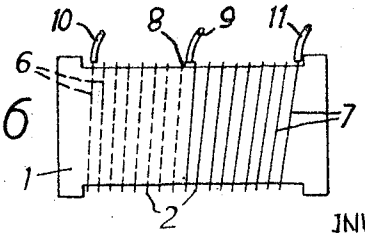


FIG. 6



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ELECTRICALLY OPERATED HEAT TRANSFER DEVICES

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U.S. Cl. 338—229 6 Claims

ABSTRACT OF THE DISCLOSURE

An electrically operated heat transfer device suitable for use as an immersion heater or as a resistance thermometer comprises a flat former which supports an electrical conducting wire and is disposed flatwise between the sides of an envelope which sides are stressed, either by reduction of the pressure in the envelope or by the inherent shape of the side of the envelope, to urge the envelope into contact with the wire.

BACKGROUND OF THE INVENTION

The invention relates to an electrically operated heat transfer device.

STATEMENTS OF THE INVENTION

This invention relates to electrically-operated heat transfer devices. In particular the invention is concerned with immersion heater devices for use in maintaining the temperature of thermostatic baths and also with resistance thermometers.

In a thermostatic bath when the thermoregulator switches on the immersion heater energy is first absorbed by the heater and some time elapses before the internal temperature achieved by the heater permits transfer of heat from the heater at its rated wattage. The temperature of the bath therefore on switching on of the heater initially continues to fall. Similarly, when the heater is switched off by the thermoregulator, the heat retained by the heater passes into the bath causing in the period immediately after switching off a continued rise in the temperature of the bath. These effects give rise to the temperature differential of the bath being greater, often considerably greater, than that of the thermoregulator. The arguments discussed above as to the harmful effects relating to so-called "on-off" are equally applicable in the circumstances of proportional control.

An immersion heater which is suitable for finely controlled thermostatic baths should thus possess as low as possible a heat capacity and time constant, the latter being dependent on the quotient of the heat capacitance and average thermal conductance of the heater. So called "blade" heaters are employed in which a flat former of insulating material, suitably, mica, is wound with a minimum weight of resistance wire suitably in the form of flat Nichrome ribbon and is contained in a flat metal envelope, there being disposed between the ribbon and the envelope, on respective opposite sides of the insulating former, sheets of insulating material, suitably mica. In such a blade heater difficulty is encountered in ensuring that the wire at all points thereof engages through the intermediate sheet of insulating material the metal envelope. Where the wire does not so contact the envelope there tend to be created hot spots owing to the reduced heat conduction from the wire at these points. To minimise risk of damage because of hot spots the dimensions chosen for the components of the heater are generally rather conservative.

Similar difficulties to those described above in respect

of immersion heaters arise with rapid response resistance thermometers where it is important that temperature changes should be suffered as far as possible similtaneously over the whole length of the resistance wire and this means that good heat conductive contact is required between the resistance wire and the metal envelope.

The present invention consists in an electrically operated heat transfer device comprising a flat former of electrically insulating material, an electrically conductive wire closely wound on the former and a metal envelope in which, flatwise between the sides of the envelope, the former and the wire are contained, characterized in that the envelope is a thin-walled, evacuated closed envelope in which the pressure differential between the interior and exterior of the envelope serves to urge together the sides of the envelope and thereby apply substantially uniform pressure over the entire area of the former at opposite sides thereof.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIGURE 1 is an elevational view of an electrically operated heat transfer device according to the invention.

FIGURE 2 is a plan view of FIGURE 1.

FIGURES 3 and 4 are fragmentary sectional views on an enlarged scale taken on the line A—A of FIGURE 1 respectively appropriate to the device when used as a heater and as a resistance thermometer, and

FIGURES 5 and 6 show alternative windings employed in the heater devices of the preceding figures.

In the drawings like parts have been given the same reference numerals.

Referring first to FIGURES 1 to 3 of the drawings, an immersion heater comprises a flat former **1** formed from mica sheet of thickness 0.010 inch on which is wound an electrical winding **2** formed from flat Nichrome ribbon of thickness 0.002 inch. On each side of the winding in contact therewith is disposed a further sheet **3** of mica insulation of thickness 0.003 inch and the whole is contained in a closed envelope of copper comprising two copper sheets **4** each of thickness 0.005 inch and somewhat larger than the Nichrome wire wound former and soldered or otherwise secured together at their edges. The envelope is evacuated so that the sides thereof are pressed together by reason of the reduced pressure in the envelope.

The pressing together of the sides of the envelope causes each side thereof to be urged flatwise into engagement with the adjacent mica sheet covering the Nichrome wire. In this way a uniform pressure is exerted over substantially the entire surface of the wire except, of course, for the reverse bends thereof and good contact is thus established through the intermediary of the mica sheet between the wire and the adjacent sides of the copper envelope.

The envelope connects with a hollow stem **5** which is sealed at its upper end and in which is a content of water absorbent material such as activated alumina or silica gel which takes up moisture which may conceivably be given off by the insulating material of the immersion heater.

In the structure described the heat capacitance is reduced to a minimum and the average thermal conductance is of a high value. The time constant of the immersion heater is thus kept to an optimum value.

It will be appreciated that the dimensions given above are by way of example only.

As an alternative to the mica sheets **3** between the wire and the envelope there may be employed sintered p.t.f.e. or silicone rubber sheets and the Nichrome wire may itself be moistened with a non-volatile fluid such as silicone fluid. Such an arrangement provides through the silicone rubber or p.t.f.e. intimate contact of the Nichrome ribbon and the envelope. As a further alternative to the mica sheets there may be employed high thermal con-

ductivity refractories, such as beryllia, in sheet form of appropriate thickness.

In another embodiment of the invention illustrated in FIGURE 4 there is provided a resistance thermometer the structure of which is similar to that described above in connection with the immersion heater except that the Nichrome ribbon is replaced by resistance wire which is insulated by being enamelled or by being provided with a silk covering which is in direct contact with the copper envelope and with the former **1**. If desired, in order to ensure that bare spots on the resistance wire do not cause shorting thereof, there may be introduced between the wire and the sheets **4** of the envelope thin sheets of insulation (as shown in the embodiment of FIGURE 3). This insulation may suitably be mica or the other substances mentioned above.

In order to cope with different conditions which arise in practice it is useful to have the above described heater devices able to provide for different electrical outputs. This is accomplished by having as illustrated in FIGURES 5 and 6 different windings **6** and **7** which in the case of FIGURE 5 are interwound and in the case of FIGURE 6 are wound end to end. The windings are connected together at a common end point **8** thereof to which is connected a lead **9** and leads **10** and **11** are connected to the ends of the windings **6** and **7** remote from the point **8** thereof. The leads **9**, **10** and **11** are brought out through the table **5** and suitably are coated with p.t.f.e. It will be apparent that connections can be made to the leads **9**, **10** and **11** so that either of the windings **6** or **7** is in circuit or both windings are connected in circuit either in series or in parallel.

It will be noticed that the former **1**, is generally I-shaped and in practice narrow strips of insulating material are provided to render the assembly of the former rectangular, thickness of the narrow strips being the same as the combined thickness of the former and the winding.

Suitably by applying to the external surfaces of the envelope a thin film of p.t.f.e. or a silicone preparation, the envelope surface is not wetted in use and the tendency of gas bubbles to separate out from the aqueous liquid in which the device is immersed and lodge on the surface of the device is inhibited if not prevented.

I claim:

1. An electrically operated heat transfer device, comprising a flat former of electrically insulating material, an electrically conductive wire closely wound on the former and a metal envelope in which, flatwise between the sides of the envelope, the former and the wire are contained,

characterized in that the envelope is a thin-walled, evacuated closed envelope in which the pressure differential between the interior and exterior of the envelope serves to urge together the sides of the envelope and thereby apply substantially uniform pressure over the entire area of the former at opposite sides thereof.

2. A device as claimed in claim **1**, wherein the wire is wound on the former and at each side of the former there is provided between the wire and the envelope a thin sheet of electrical insulating material.

3. A device as claimed in claim **2**, wherein two wires are wound on the former and connected together at a common end point thereof, there being provided connecting leads extending respectively to said common end point of the wires and to the end of each wire remote from said common end point.

4. A device as claimed in claim **2**, wherein the wires are wound end to end along the former.

5. A device as claimed in claim **2**, wherein the wires are wound with the coils thereof each alongside the other.

6. A device as claimed in claim **1**, wherein the envelope has its exterior surface coated with material such as a thin layer of p.t.f.e. or a silicone preparation to inhibit wetting of the envelope when the envelope is immersed in aqueous liquid.

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E. A. GOLDBERG, Primary Examiner

U.S. Cl. X.R.

29—421, 611; 219—534; 338—234, 235, 237, 243, 261