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THERMOSTATICALLY CONTROLLED BATH

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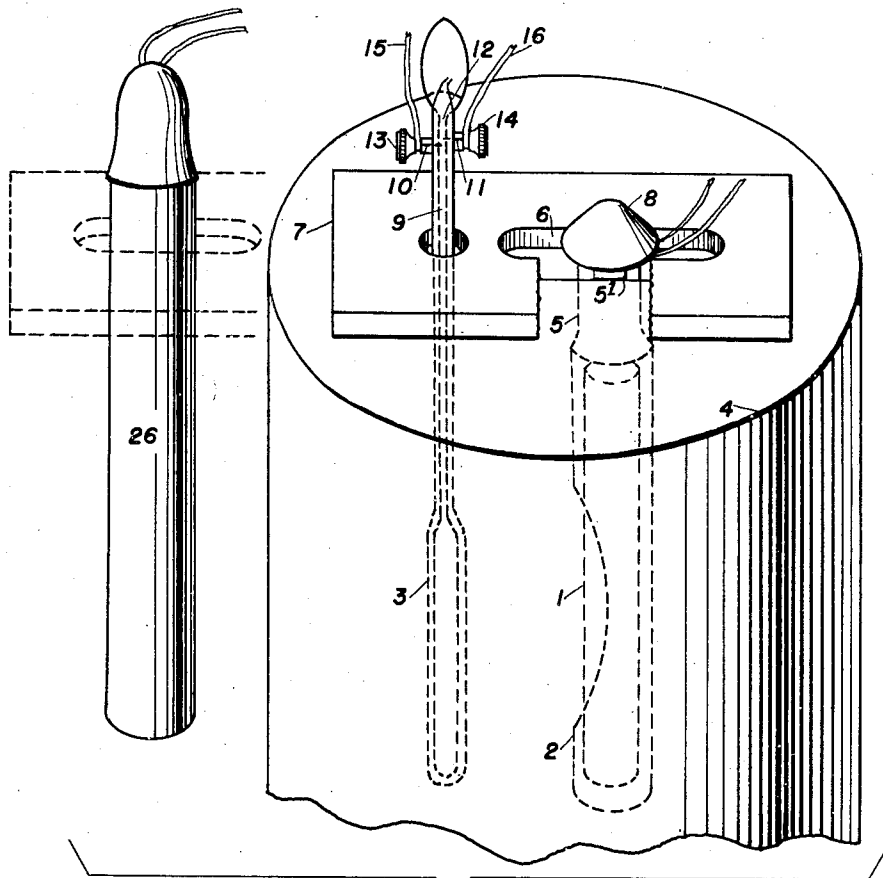


FIG. 1

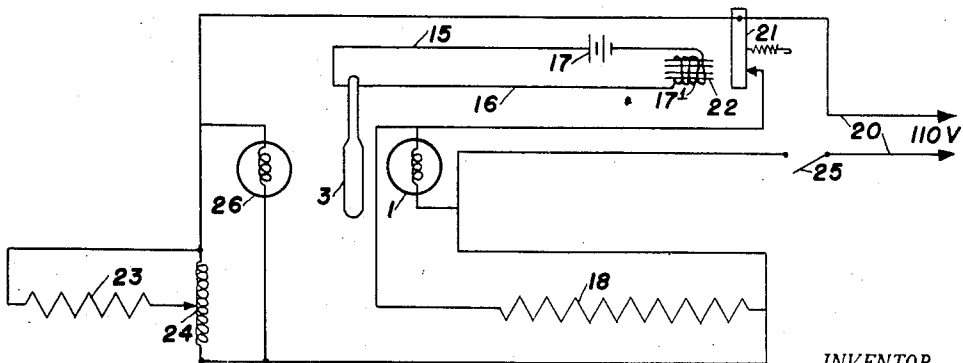


FIG. 2

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THERMOSTATICALLY CONTROLLED BATH

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This invention relates to method and apparatus for controlling the temperature of thermal baths and heating mediums. Although invention is particularly directed to control of liquid baths in which a mercury-expansion type of thermoregulator is employed, it is not limited thereto, but is useful in connection with the control of temperature of fluid heating mediums in general in which a thermostatic control device is used to maintain a predetermined temperature.

The use of thermoregulators or thermostatic control devices in conjunction with electric heating elements are well known for maintaining the temperature of a heating bath or fluid constant. Apparatus for maintaining a constant temperature thermal bath by means of a mercury-expansion type thermoregulator is disclosed in Patent No. 2,037,993. However, when using a device of the type shown in the aforesaid patent fluctuations of plus and minus 0.1° or more from the desired temperature are obtained.

I have discovered that if a low wattage source of radiant energy is placed contiguous to the thermoregulator in an apparatus of the type described in the aforesaid patent temperature variation from the desired temperature of not more than plus or minus 0.01° F. may be obtained.

An object of the invention is to provide a method for substantially eliminating temperature variations encountered in thermostatically controlled heating baths.

Another object of the invention is to provide apparatus for maintaining thermal baths and heating fluids at a substantially constant temperature.

Other objects of the invention will become apparent from the following description and the accompanying drawing, of which Figure 1 is a diagrammatic elevational view illustrating one form of the invention, and Figure 2 is a wiring diagram illustrating the manner in which the elements shown in Figure 1 are connected.

Referring to the drawings the numeral 1 indicates a low wattage incandescent tubular-shaped lamp. This lamp may be a 25 watt lamp and is designed to provide a small amount of radiant heat energy as compared to the heating elements in the liquid bath. The lamp 1 is preferably surrounded by a cylindrical shield 2 made of metal or other opaque material which is open directly opposite the mercury-type thermoregulator 3, in order to permit the radiant energy of the lamp to impinge upon the regulator. The shield 2 is placed around the lamp 1 in order to prevent the lamp affecting the thermometer used to indicate

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bath temperature, or other objects or materials, such as viscosity pipettes, which are to be maintained at bath temperature. The lamp 1 and the thermoregulator 3 are immersed in a vessel 4 which contains oil or other liquid, the temperature of which is to be regulated. Where the vessel 4 is made of glass or other transparent material the lamp 1 may be placed outside the vessel but in close proximity to the thermoregulator.

The lamp 1 and shield 2 are adapted to be held in a socket 5 adapted to be supported in the elongated slot 6 of the mounting block 7 above the vessel 4. The socket 5 is preferably provided with grooves 5' on opposite sides thereof to permit the socket to slide back and forth in the slot 6. A cap 8 is screwably mounted on the top of socket 5. The base of the cap 8 is flat and of a greater diameter than the width of the slot 6. By unloosening the cap 8 the socket 5, together with the lamp 1 and shield 2, may be slid in notch 6 toward or away from the thermoregulator 3, and by screwing the cap 8 tightly the lamp is held firmly at the desired position. The mounting block 7 may be either supported on the top of vessel 4 or may be independently supported above the vessel by means of a suitable stand and bracket (not shown).

Thermoregulator 3 is also supported by the mounting block 7. The thermoregulator 3 is of the conventional type containing a column of mercury 9, wires 10 and 11, one slightly above the other, extending into the space 12 in order to contact the mercury column when it expands. The wires 10 and 11 are connected by means of binding posts 13 and 14 to wires 15 and 16 which in turn are connected to a suitable source of electric current 17, which may be one or more dry cells, and to a relay coil 17', connected in series.

The distance between the lamp 1 and the thermoregulator 3 is small and will depend somewhat on the size of the lamp. When using a 25 watt lamp a distance less than one inch gives satisfactory results. Greater distances are preferable with higher wattage lamps. By providing means for sliding the lamp toward and away from the thermoregulator 3 the proper distance to give the optimum temperature regulation can be found and the lamp set in the proper position.

Located in the oil bath in the vessel 4 is an intermittent electric heater 18. The intermittent heater 18 is connected to a source of electric current 20, which may be either A. C. or D. C., through the spring controlled relay switch 21.

Lamp 1 is connected in parallel with the intermittent heater 18 through relay switch 21 to the source of electric current. The relay switch 21 is adapted to be held in open position by the relay 22 when it is energized by current flowing through coil 17' from the battery, or other source of supply 17. Current will flow through the coil 17' and energize the relay 22 only when the temperature of the bath has risen to the desired point, thereby causing the column of mercury in the thermoregulator 3 to expand and make contact with the wires 10 and 11. When the relay 22 becomes energized it will pull the switch 21 open, thereby breaking the circuit through lamp 1 and heater 18. When the temperature in the bath drops below a predetermined point the mercury in the thermoregulator contracts breaking the circuit, thereby closing the switch 21 and causing current to flow through the heater 18 and lamp 1.

Connected to the same source of current as the intermittent heater 18 but in parallel therewith is the continuous heater 23. The heater 23 is connected to an autotransformer 24 in order to enable the heat output of heater 23 to be varied, depending on the temperature which it is desired to maintain in the bath. The heater 23 upon closing the main circuit switch 25 will be connected in the circuit.

A tubular incandescent electric lamp 26 of considerably higher wattage than the lamp 1, for example, a 100 watt lamp, may be connected in parallel with the heaters 18 and 23, independently of the switch 21. The lamp 26 is placed outside the vessel 4 and may or may not have an opaque shield with an opening opposite the thermoregulator 3. Since the lamp 26 is preferably placed on the side of the vessel away from the thermometer and lamp 1 it is not necessary to provide a shield therefor. The lamp 26 is mounted on a suitable bracket adjacent the thermoregulator 3. It will be understood that in order to use lamp 26, a transparent vessel 4 must be used.

An electrically operated stirrer may be provided to keep the bath in a constant state of agitation.

In operation, upon closing the main switch 25, heater 23 will go into operation, as well as intermittent heater 18 since the switch 21 will be closed. Lamps 1 and 26 will also be lighted. The capacity of the heater 23 is such that it will heat the bath to a temperature a few degrees below the temperature which it is desired to maintain. The intermittent heater 18 supplies the required additional heat to bring the temperature of the bath to the desired level. When the bath reaches the desired temperature the mercury in the thermoregulator will expand and close the circuit through the coil 17', thereby energizing relay 22, opening switch 21 and cutting the intermittent heater 18 and lamp 1 out of the circuit.

When the temperature in the bath falls below the desired level the circuit through coil 17' will open deenergizing relay 22 and permitting the spring controlled switch 21 to close, thereby closing the lamp 1 and intermittent heater 18 circuit. Because of the proximity of the lamp 1 to the thermoregulator 3 the mercury therein will be heated more rapidly than it would be due merely to the temperature of the bath, thereby causing the circuit through coil 17' to close, and cutting the heater 18 out of the circuit before the bath rises above the temperature it is desired to maintain in the bath. Thus the lamp 1 eliminates or greatly reduces the time lag ordinarily experienced between the time the bath reaches the

desired temperature and the time the thermoregulator opens the heating circuit. The more closely the lamp 1 is located to the thermoregulator 3 the shorter will be the heating phase of the temperature cycle by the heater 18 and hence the shorter will be the complete temperature cycle, and with a resultant smaller variation in temperature of the bath.

In actual operation, whereas before installation of the lamp 1 it was not possible to maintain the temperature of a 3 gallon oil bath plus or minus 0.10° to 0.20° F., after installation of the lamp 1 the variation in temperature of a 100° F. bath could be held to $\pm 0.01^\circ$ F. and the variation in temperature of a 120° or 210° F. bath could be held to $\pm 0.02^\circ$ F. with a complete temperature cycle; i. e. the period from the time the heater 18 circuit is closed, then opened and again closed, of 60 seconds. In these tests the lamp 1 was a 25 watt incandescent lamp and was located a distance between one-half and one inch from the mercury thermoregulator.

In order to provide a simple means of making fine adjustments in the temperature of the bath which normally involve changing the volume of mercury in the thermoregulator, the lamp 26 is provided. Lamp 26 can be moved toward and away from the thermoregulator 3 depending on the temperature regulation required. By moving the lamp 26 closer to the thermoregulator the mercury in the thermoregulator is maintained at a higher temperature, thus causing an increase in volume of mercury in the regulator. The net effect is to cause a slightly lower temperature in the bath because a lower temperature is required to expand the mercury sufficiently to close the thermoregulator circuit.

Likewise, moving the lamp further away from the thermoregulator 3 produces a lower temperature of the mercury in the thermoregulator, causing it to contract somewhat and requiring a higher temperature to close the thermoregulator circuit. As previously pointed out an opaque shield open only directly opposite the thermoregulator 3 may be placed around the lamp 26 in order to permit the thermoregulator to be exposed to the radiant energy while preventing it from affecting other objects in its vicinity.

Although I have illustrated and described the invention particularly in relation to the control of liquid baths using a mercury-type thermoregulator, it is to be understood that the temperature of a vaporous or gaseous heating means or bath can be controlled in the same manner, and that any thermostatic control device, such as a thermocouple, may be used in place of the thermoregulator.

It is claimed:

1. Apparatus for maintaining the temperature of a fluid heating medium comprising an electric heating element, a second electric heating element connected in parallel with said first mentioned element both of which are adapted to be immersed in said medium, a liquid expansion thermostatic control device adapted to open and close the circuit of said second electric heating element at predetermined temperature adapted to be immersed in said medium, and a source of radiant energy of low output as compared to the output of said second electric heating element, adapted to go on and off simultaneously with said second electric heating element, adjacent to said thermostatic control device and to which said control device is intermittently exposed.
2. Apparatus in accordance with claim 1 in

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which the source of radiant energy is connected in parallel with said second electric heating element.

3. Apparatus in accordance with claim 1 in which the thermostatic control device is a mercury-type thermoregulator.

4. Apparatus in accordance with claim 1 including means for varying the distance between said source of radiant energy and said thermostatic control device.

5. A temperature controlled liquid bath apparatus comprising, a transparent vessel for containing said liquid, an immersion type mercury expansion thermoregulator in said liquid, an electric heating element immersed in said liquid and connected in circuit to be opened and closed by said thermoregulator, a source of radiant energy of low output relative to said electric heating element immersed in said bath close to said thermoregulator, said source of radiant energy being connected in parallel with said heating element, a second electric heating element immersed in said bath and being connected in circuit to operate independently of said first-mentioned heating element, a second source of radiant energy of higher output than said first-mentioned source of radiant energy disposed

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outside said vessel contiguous to said thermoregulator and means to vary the distance between said thermoregulator and said second source of radiant energy.

6. The apparatus in accordance with claim 5 including means for varying the distance between the thermoregulator and said first-mentioned source of radiant energy.

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