

[54] **AQUARIUM-TANK HEATING CONTROL**

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[22] Filed: **Sept. 18, 1974**

[21] Appl. No.: **507,075**

Related U.S. Application Data

[63] Continuation of Ser. No. 356,224, May 1, 1973, abandoned.

[52] **U.S. Cl.**..... **219/523; 119/5; 219/318; 219/328; 219/336; 219/337; 219/511; 219/442**

[51] **Int. Cl.**..... **H05b 3/06**

[58] **Field of Search** **219/312, 316, 318, 322, 219/328, 331, 335, 336, 337, 338, 381, 437, 442, 511, 516, 523, 544; 119/5**

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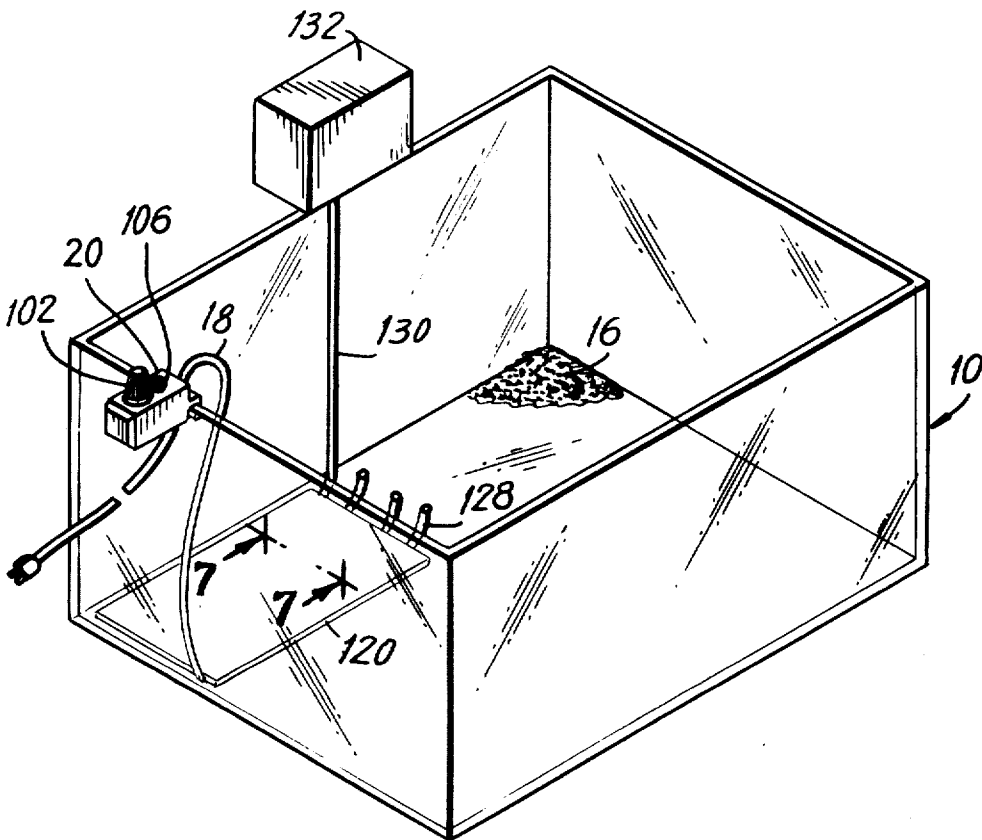
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[57] **ABSTRACT**

Heating devices are provided having a resistive heating element for heating a first region and a temperature control electrically coupled to the resistive heating element and positioned in a second region spaced from the first region. The temperature control is adapted to respond to the ambient temperature at the second region and the amount of current applied to the resistive heating element to maintain the temperature at the first region. The resistive heating element may consist of a length of resistive electrical conductor distributed over an area and encapsulated in a flexible waterproof material so as to define a sheet.

11 Claims, 11 Drawing Figures



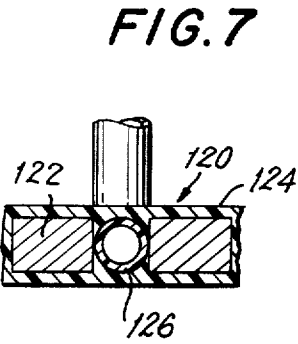
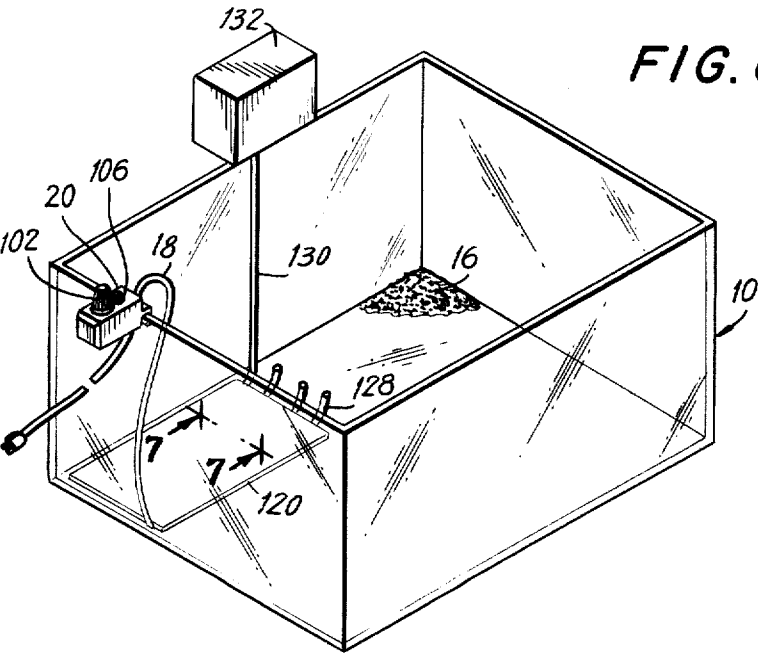
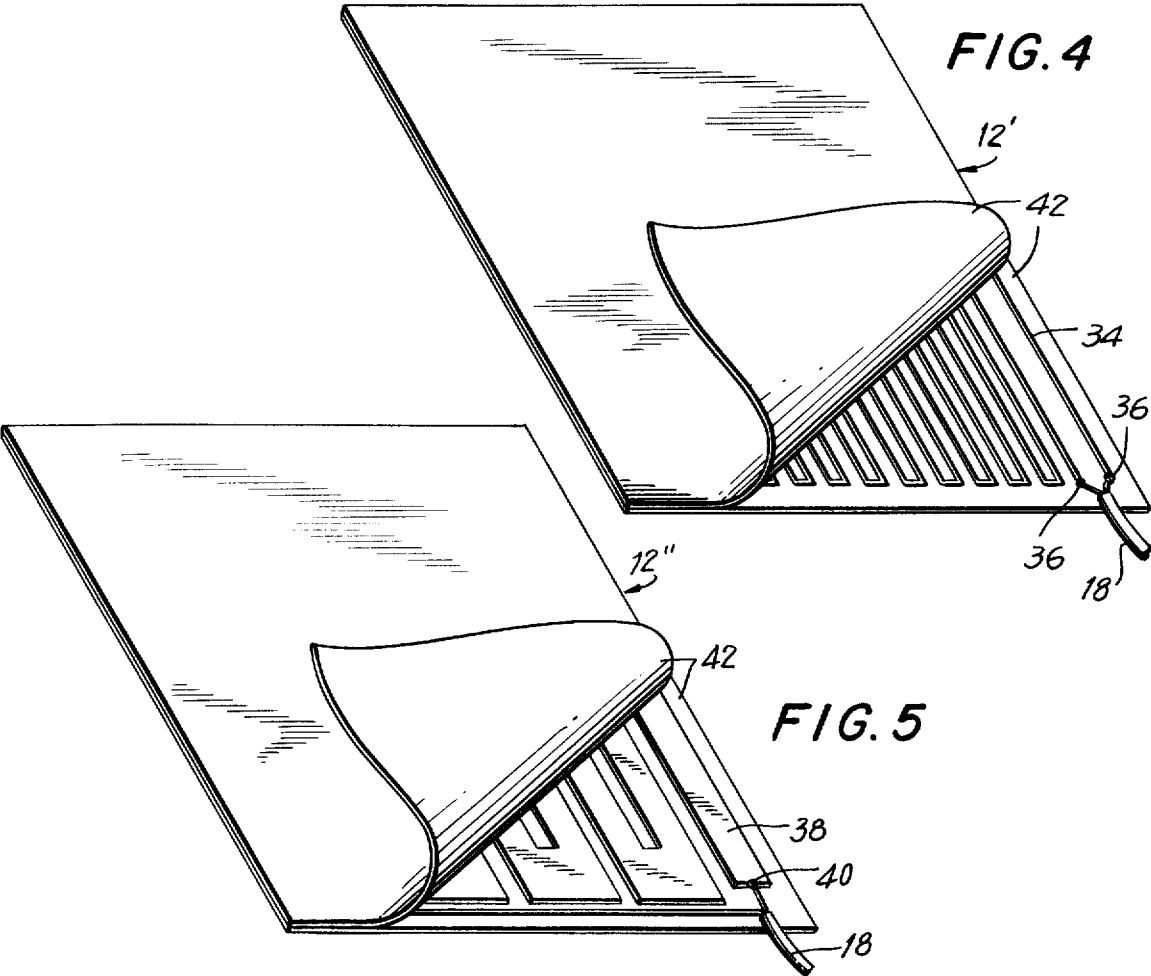


FIG. 8

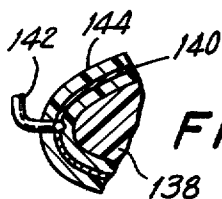
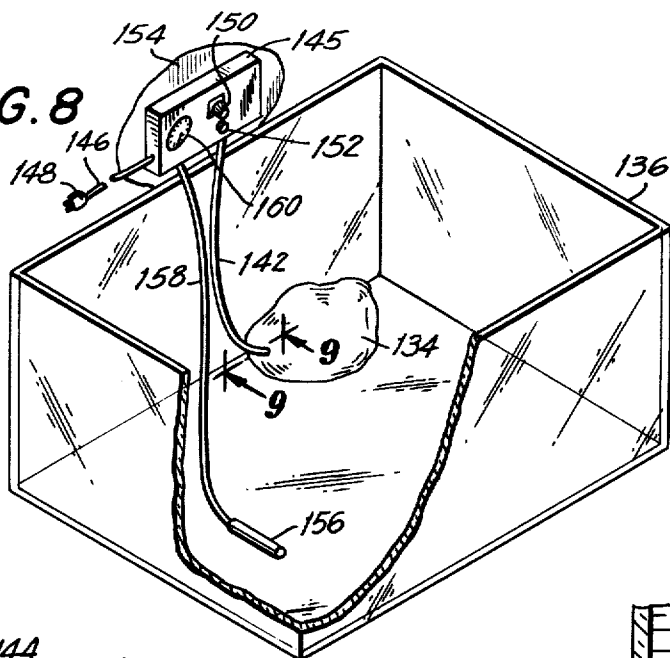


FIG. 9

FIG. 10

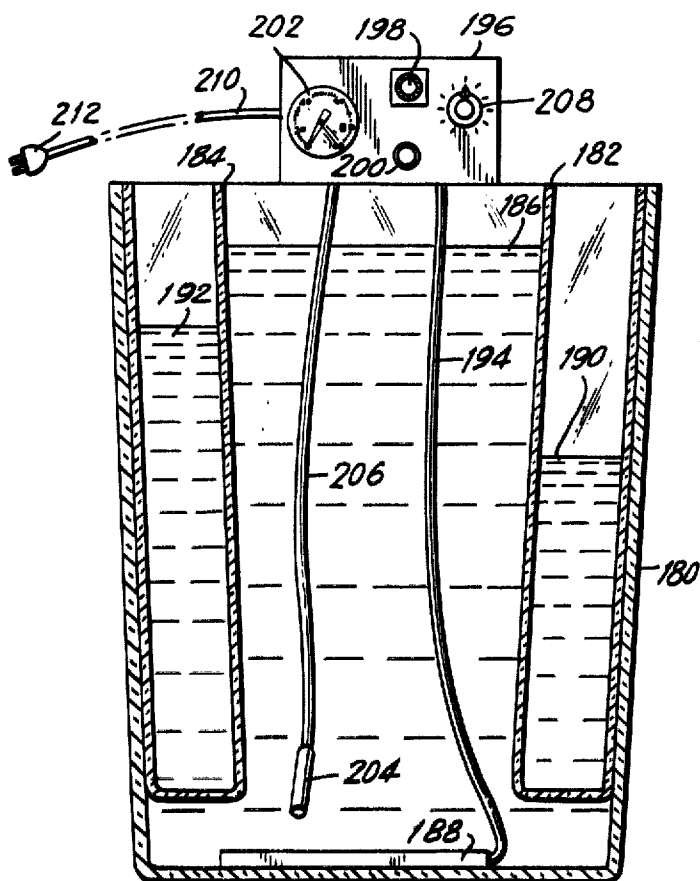
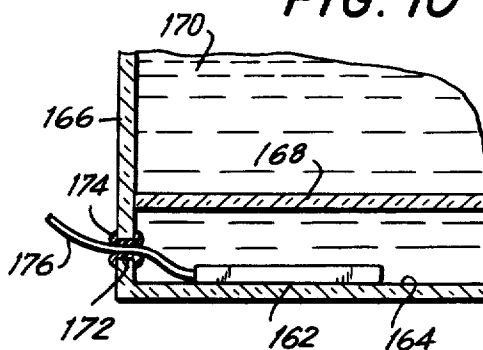


FIG. 11

AQUARIUM-TANK HEATING CONTROL

This is a continuation of application Ser. No. 356,224, filed May 1, 1973, now abandoned.

BACKGROUND OF THE INVENTION

This invention is directed to improved heating devices, and in particular, to heating devices suitable for heating confined regions such as fish tanks, terrariums, film development tanks and the like.

In the art, heating devices for fish tanks and film developing tanks have generally consisted of resistive heating devices immersed in the tank and controlled by a thermocouple control likewise immersed in the liquid. This arrangement has proved both expensive, and inefficient. The system required substantial variations in the temperature of the liquid for operation. Frequently, such temperature variations are caused by variations in the ambient temperature but the prior art temperature control arrangements respond to the effect of the ambient temperature changes, rather than directly to ambient temperature changes. By providing a temperature control device responsive to ambient conditions and to the energy applied to the resistive heating element, the foregoing deficiencies in the prior art are avoided.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, a heating device is provided having resistive heating element means for heating a first region, temperature control means positionable in a second region spaced from said first region for controlling the temperature at which said first region is maintained, and electrical cable means extending between the resistive heating element means and temperature control means. The temperature control means is adapted to control the current applied to the resistive heating element means in response to ambient temperature and energy applied to said resistive heating element means. The temperature control means may include a pair of contact means positioned for selective engagement, at least one of the contact means being mounted on a bimetallic element, and a resistive member mounted in series circuit with said contact means and said resistive heating element means and in proximity with said bimetallic element so that the opening and closing of said contact means by the displacement of said bimetallic element means is in response to the combined effect of ambient temperature at said second region and the heat generated by said resistive member.

Manual adjustment means may be provided for selectively positioning one of the contact means relative to the other for selecting the temperature at which the first region is maintained. The other of said contact means may be mounted on a further bimetallic element.

The resistive heating element means may consist of a length of resistive electrical conductor means distributed over an area and enclosed by a waterproof insulating material. The length of resistive electrical conductor may be disposed substantially in a plane to define, together with said waterproof insulating material a flexible sheet. In a fish tank, said sheet may be received beneath the sand or gravel on the bottom of the tank. Said insulating waterproof material may also receive air-conducting tubes having an outlet end projecting there-

from, and an inlet coupled by a further air-conducting tube to a source of air under pressure.

In another embodiment, said length of resistive electrical conductor means is distributed in the region of the surface of a rock-shaped member, the surface of said rock-shape member being defined by said waterproof, insulating material. In still another embodiment, a liquid tank is provided with an inner partition defining a chamber and positioned so that at least a portion of said partition is engaged by the liquid in the balance of said tank, said resistive heating element means being received within said chamber, said chamber being formed with an aperture in a wall thereof for the passage of said electrical cable means therethrough. Said aperture may be formed with means for providing a water tight seal with said electrical cable means.

The heating device in accordance with the invention may be utilized in fish tanks, terrariums, film developing tanks and the like. Said temperature control means may be mounted in a housing carrying lamp means connected in series with said electrical cable means to provide a visual indication of the application of current through said resistive heating element, and a temperature indicating means operatively coupled to a temperature measuring means positioned in said first region for detecting the temperature at said first region for display on said temperature indicating means.

Accordingly, it is an object of this invention to provide an improved heating device for controlling energy input to a resistive heating element through response to ambient temperature and energy applied to said resistive heating element means.

A further object of the invention is to provide an improved heating device including a flat flexible sheet-shaped resistive heating element, which is waterproof, for positioning in a liquid tank.

Still another object of the invention is to provide an improved fish tank and terrarium heater capable of positioning beneath the gravel in a fish tank or terrarium.

A further object of the invention is to provide an improved fish tank heater shaped as a rock.

Still a further object of the invention is to provide an improved fish tank heater incorporating air-flow passages for the aeration of the water in a fish tank.

Another object of the invention is to provide an improved film development tank heater.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a heating device in accordance with the invention mounted on a fish tank;

FIG. 2 is a sectional view taken along lines 2-2 of FIG. 1;

FIG. 3 is a sectional view taken along lines 3-3 of FIG. 2;

FIGS. 4 and 5 are perspective views of two partially assembled embodiments of the resistive heating element means in accordance with the invention;

FIG. 6 is a perspective view of a further embodiment of a heating device incorporating air passages in accordance with the invention, mounted on a fish tank;

FIG. 7 is a sectional view taken along lines 7-7 of FIG. 6;

FIG. 8 is a perspective view of still another embodiment of the heating device in accordance with the invention mounted in conjunction with a fish tank;

FIG. 9 is a sectional view taken along lines 9-9 of FIG. 8;

FIG. 10 is a fragmentary sectional view of a further embodiment of a fish tank incorporating the heating device in accordance with the invention; and

FIG. 11 is a sectional view of the heating device in accordance with the invention mounted on a film developing tank.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, a fish tank 10 is depicted having a resistive heating element 12 mounted on the bottom 14 of said tank beneath a layer of sand or gravel 16 shown broken away in FIG. 1. An electrical cable 18 interconnects resistive heating element 12 in a temperature control device 20. Said temperature control device is mounted on the lip of a side wall 22 of fish tank 10 by means of a clip 24 formed integral with housing 26 of temperature control 20 and defining a channel 28 dimensioned to receive the lip of side wall 22 of fish tank 10 (FIG. 3).

Power for the resistive heating element is obtained through electrical cable 30 which interconnects temperature control 20 and a conventional plug 32.

The resistive heating element 12 is depicted as being in the form of a flexible sheet. Heat is produced by the passage of electrical current through a resistive conductor. Two embodiments of the resistive heating element 12' and 12'' are respectively depicted in FIGS. 4 and 5. In both embodiments, a length of resistive electrical conductor is distributed over an area to define a heating array. In the embodiment of FIG. 4, the length of resistive electrical conductor defined by a resistive wire 34 is connected at its ends 36 to cable 18. Wire 34 may be resistance wire, woven wire or the like. In the case of the embodiment of FIG. 5, the resistive electrical conductor is formed by a foil 38 which may be etched or die cut and electrically connected at its end 40 to cable 18. The arrays defined by resistive wire 34 and foil 38 are each enclosed between sheets of a suitable waterproof material 42 by a laminating and bonding technique adapted to insure a waterproof seal along the periphery of the sheets 42 and the maintenance of the respective arrays in position. In place of the laminating technique illustrated in FIGS. 4 and 5, the sheet may be molded, in which case the insulation for cable 18 may be simultaneously molded with the molding of sheet 12 so as to avoid a seam or joint at the interface between cable 18 and sheet 12 at which leakage may occur. A wide range of materials may be utilized in forming the sheet including neoprene, silicone rubber, flexible fiber glass, nylon, natural rubber, synthetic rubber and plastic materials. One plastic material found to be particularly suitable for molding and encapsulating the array formed by wire 34 or foil 38 is polyamidine.

Temperature control device 20 is more particularly depicted in FIGS. 2 and 3. The principal elements of temperature control device 20 are mounted within housing 26 by means of a support post 44 secured to said housing. Mounted on said post and separated from housing 26 by an insulating spacer 46 is support plate 48. A pin-shaped insulating spacer 50 is mounted on the end of support plate 48 spaced from post 44. Mounted on post 44 adjacent support plate 48 is one end 54 of a resistive member 52 such as a nichrome strip which is characterized by the fact that it is heated by the passage of current therethrough in proportion to the amount of the current passing therethrough. Said one end 54 of resistive member 52 is mounted intermediate support plate 48 and electrical contact member 56 so as to be electrically connected to said electrical contact member. The other end 58 of resistive member 52 is mounted on post 44 separated from electrical contact member 56 by insulating spacer 60. A first bimetallic strip 62 is mounted on post 44 adjacent to and in electrical connection with end 58 of resistive element 52. The central portion 64 of resistive member 52 is positioned in proximity to bimetallic strip 62 so that the heat generated by said resistive member is applied to said first bimetallic strip. A second bimetallic strip 66 is mounted on post 44 separated from said first bimetallic strip by an insulating spacer 68. A second electrical contact member 70 is mounted on post 44 adjacent to and electrically engaging second bimetallic strip 66, an adjustment support plate 72 being mounted on said post separated from the second contact member 70 by an insulating spacer 74. A first contact 76 is mounted on first bimetallic strip 62 in facing relation to a second contact 78 mounted on second bimetallic strip 66. The end 80 of second bimetallic strip 66 is engaged by insulating pin 50. Second bimetallic strip 66 is formed with an aperture 82 (FIG. 2) therethrough in registration with an inclined region 84 on first bimetallic strip 62 and with a threaded aperture 86 in adjustment support plate 72. An adjusting shaft 88 is mounted on adjustment support plate 72 by a threaded portion 90 thereof received within threaded aperture 86. An insulating pin 92 projects from the end of adjusting shaft 88 through aperture 82 in second bimetallic strip 66 to engage the inclined portion 84 of said first bimetallic strip. The extent of rotation of adjusting shaft 88 is limited by means of a stopper member 94 having a pair of laterally extending arms 96 which engage against an upwardly projecting post 98 mounted on adjustment support plate 72 at two rotational positions of shaft 88. Adjusting shaft 88 projects through an opening 100 in housing 26 and is provided with a knob 102 on the exterior of said housing. Electrical cable 18 is connected between second contact member 70 and a connecting point defined by insulating cap 104. Cable 30, connected to the source of power, is connected between said connecting point and first contact member 56 to define a series circuit passing from cable 30 to first contact member 56, through resistive member 52, through first bimetallic strip 62, through first and second contacts 76 and 78 (if closed), through second bimetallic strip 66, through second contact member 70, through cable 18 to the resistive heating element 12 and back to cable 30. A lamp 106 is mounted in an aperture 108 in housing 26 and electrically connected by leads 110 and 112 to second contact member 70 and the connecting point defined by insulating cap 104 re-

spectively to provide a visual indication of the closing of the above-described series circuit due to the closing of contacts 76 and 78.

Temperature control device 20 is used as follows. Assuming the user wishes to bring water temperature of a setting of 80° within the tank and maintain it at that temperature while the room temperature or ambient temperature is 72°. The top surface of housing 26 in registration with knob 102 is marked with scale markings 114 (FIG. 1) for the selective positioning of knob 102. The user turns the heating device on by rotating the control knob past the position at which light 106 is lit, indicating the engagement of first and second contact 76, 78. The electric circuit is closed, causing current to be applied to the resistive electrical conductor of resistive heating element 12 to begin heating the water. This current is also passing through resistive member 52 causing said resistive member to likewise heat up, which heat causes first bimetallic strip 62 to distort so as to displace first contact 76 away from second contact 78 to open the circuit. Such distortion takes a finite period of time during which the water is heated. At the initial setting, the contacts will not normally open before the water temperature reaches the desired level, in this example 80°. A thermometer is used to check the temperature in the tank and when the temperature reaches 80°, knob 102 is turned until light 106 is turned off, indicating the opening of contacts 76 and 78. The heating device is now set to maintain the tank at 80°.

As the resistive member 52 cools, the first bimetallic strip straightens until contacts 76 and 78 close to start the cycle of the heater again. After sufficient energy is applied to the resistive heating element 12 as indicated by the heating of resistive member 52, first bimetallic element 62 distorts sufficiently to open contacts 76 and 78. The device will continue to cycle a certain number of times each day to maintain the desired temperature. If a change in the room temperature occurs or if the humidity in the room changes, bimetallic strips 62 and 66 will change their respective shapes to compensate for the changes in ambient conditions to cause the heater to cycle more or less times as required to maintain the temperature in the tank at the desired level. In this manner, the device responds to changes in ambient temperature before such changes can adversely effect the temperature of the liquid in the tank.

The formation of resistive heating element 12 as a flexible sheet and the positioning of said flexible sheet beneath the sand and gravel of the tank is particularly convenient since an otherwise unsightly heater is out of view, and, in addition, effective heat transfer between the sheet and the liquid in the tank can be achieved over a relatively large area. Further, the positioning of the heating element beneath the gravel causes certain waste particles to be freed from the gravel and to rise to the surface for easy removal.

Frequently, it is desired to provide a source of air under pressure to a fish tank for increasing the oxygen content of the water. For this purpose, the resistive heating element may be formed with air-conducting tubes as shown in the embodiment of FIG. 1. Like reference numerals are applied to elements in FIG. 6 corresponding to like elements in FIG. 1. In place of resistive heating element 12, resistive heating element 120 is provided having an array formed from resistive electrical conductor 122 encapsulated in a waterproof plas-

tic material 124 (FIG. 7). In addition to the resistive array, an interconnected array of air-conducting tubes 126 is likewise encapsulated within plastic material 124. The array of air-conducting tubes is provided with three upwardly projecting outlets 128 positioned and dimensioned to project through and above the level of the gravel or sand 16 on the bottom of tank 10. An inlet tube 130 interconnects an air pump 132 mounted on the side wall of tank 10 and the air-conducting tubes 126 within the sheet 120. In all other respects the heating device of FIG. 6 functions in the same manner as the device of FIG. 1.

Still another embodiment is depicted in FIGS. 8 and 9 wherein the resistive heating device is not in the form of a sheet, as depicted in FIG. 1, but rather, is in the form of a simulated rock 134 on the bottom of tank 136. As more particularly shown in FIG. 9, said simulated rock is formed with a core 138 having an encapsulated array of a resistive electrical conductor 140 secured to the surface thereof and electrically connected to cable 142. The encapsulating material 144 would be waterproof and adapted to protect the resistive electrical conductor. A temperature control device such as was described above would be mounted within housing 145 and electrically connected to cable 142 and cable 146, which in turn is connected to plug 148. The temperature control device would be operated by the manipulation of knob 150, light 152 being provided as an indication of the operation of the heating device. Housing 145 would be mounted on a wall 154 above tank 136. Further, the embodiment of FIG. 8 is provided with a temperature sensor 156 coupled by cable 158 to a temperature dial 160 mounted on housing 145. By this means, a continuous reading of actual tank temperature is provided although the temperature control device continues to function in an automatic mode.

An alternate approach for the positioning and mounting of the resistive heating element in accordance with the invention is depicted in FIG. 10, wherein resistive heating element 162 is received within a special chamber 164 formed in the bottom of tank 166 by means of partition 168. Chamber 164 is filled with liquid so that the heat generated by resistive heating element 162 is distributed over the entire bottom of the tank, transmitted through partition 168, and even applied to the liquid 170 in the main portion of the tank. One wall of chamber 164 is formed with an opening 172 which receives a seal member 174 through which cable 176 from resistive heating element 162 extends in water tight relation.

The heating device in accordance with the invention may be applied to applications other than fish tanks and terrariums where confined spaces are to be heated. An example of such a further application is illustrated in FIG. 10 wherein a film development tank 180 is depicted. Received within film developing tank 180 are smaller chemical tanks 182 and 184. The film developing tank 180 is filled with water 186 which is maintained at the desired temperature by a resistive heating element 188 in accordance with the invention. The heated water in the film developing tank 180 in turn maintains the temperature of the chemicals 190 and 192 in chemical tanks 182 and 184 at the desired temperature. Said chemical tanks are held in position by brackets (not shown). Resistive heating element 188 is coupled by cable 194 to a temperature control device in accordance with the invention mounted within hous-

ing 196 mounted above tank 180. The temperature control device is provided with a control knob 198 and indicating lamp 200 as in the above-described embodiments. In addition, the housing carries a temperature indicating dial 202 coupled to a temperature sensing device 204 through cable 206 and a mechanical timer 208 for use in the film-developing process. Cable 210 connects plug 212 to the temperature control device within housing 196.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A heating device comprising resistive heating element means for heating a first region; temperature control means positionable in a second region spaced from said first region for controlling the temperature at which said first region is maintained by said resistive heating element means; and electrical cable means extending between said resistive heating element means and said temperature control means for applying current to said resistive heating element means, said temperature control means being adapted to control the current applied to said resistive heating element means in response to temperature at said second region, said temperature control means including first and second contact means; first and second bi-metallic element means respectively carrying said first and second contact means in facing relation for displacement thereby into and out of engagement with each other; and a resistive member mounted in series circuit with said contact means and said resistive heating element means and positioned in proximity with a side of said first bi-metallic element means opposite to the side thereof facing said second bi-metallic element means, so that the displacement of said first contact means by said first bi-metallic element means is at least principally in response to the heat generated by said resistive member and the displacement of said second contact means by said second bi-metallic element means is at least principally in response to the temperature at said second region, said resistive heating element means including a length of resistive electrical conductor means distributed over an area; and water-proof, electrically insulating material enclosing said length of resistive electrical conductor means.

2. A heated aquarium, comprising a fish tank, resistive heating element means for heating a first region within said tank; temperature control means positionable in a second region outside of said tank for controlling the temperature at which said first region is maintained by said resistive heating element means; and electrical cable means extending between said resistive heating element means and said temperature control means for applying current to said resistive heating element means, said temperature control means being adapted to control the current applied to said resistive

heating element means in response to temperature at said second region, said temperature control means including first and second contact means; first and second bi-metallic element means respectively carrying said first and second contact means in facing relation for displacement thereby into and out of engagement with each other; and a resistive member mounted in series circuit with said contact means and said resistive heating element means and positioned in proximity with a side of said first bi-metallic element means opposite to the side thereof facing said second bi-metallic element means, so that the displacement of said first contact means by said first bi-metallic element means is at least principally in response to the heat generated by said resistive member and the displacement of said second contact means by said second bi-metallic element means is at least principally in response to the temperature at said second region.

3. In combination, a liquid tank having an internal partition defining a chamber, liquid within said chamber, resistive heating element means positioned within said liquid-filled chamber for the transmission of heat through said liquid and partition to liquid within the balance of said tank; air-exposed temperature control means positionable at a location external to said tank for controlling the temperature at which tank liquid is maintained by said resistive heating element means; and electrical cable means extending between said resistive heating element means and said temperature control means for applying current to said resistive heating element means, said temperature control means being adapted to control the current applied to said resistive heating element means in response to temperature at said location, said temperature control means including first and second contact means; first and second bi-metallic element means respectively carrying said first and second contact means in facing relation for displacement thereby into and out of engagement with each other; and a resistive member mounted in series circuit with said contact means and said resistive heating element means and positioned in proximity with a side of said first bi-metallic element means opposite to the side thereof facing said second bi-metallic element means, so that the displacement of said first contact means by said first bi-metallic element means is at least principally in response to the heat generated by said resistive member and the displacement of said second contact means by said second bi-metallic element means is at least principally in response to the temperature at said second region.

4. The combination of claim 3 including means in said chamber wall opening for providing a water-tight seal between said chamber wall and said electrical cable means.

5. An aquarium-tank heating system, comprising a resistive water-heating element of relatively large radiation-surface area and adapted for continuous water-immersion in an aquarium tank, temperature-control means adapted for ambient-air exposure adjacent and external to the tank for controlling the temperature at which tank water is maintained by said resistive water-heating element; and electrical cable means including a connection extending between said resistive water-heating element and said temperature-control means for supplying current to said resistive water-heating element means, said temperature-control means including a thermostatic switch and

being adapted to control current applied to said resistive water-heating element means in response to ambient-air temperature and the amount of energy applied to said resistive heating element means; said temperature-control means including a local thermostat-heater element in heat-radiating proximity to said thermostatic switch to the substantial exclusion of tank water, and both said heater elements being connected for coordinated and concurrent energizing and de-energizing by said switch.

6. An aquarium-tank heating system, comprising a resistive water-heater element of relatively large radiation-surface area and adapted for continuous water immersion in an aquarium tank, and an electric-power supply connection to said water-heater element and including a thermostat-control device adapted for ambient-air exposure external to the tank; said control device including an adjustable thermostatic switch connected for on-off control of electric energy supplied to said water-heater element, a thermostat-heater element in heat-radiating proximity to said thermostatic switch, both said heater elements being connected for coordinated and concurrent energizing and de-energizing, and housing means for the switch and heater element of said control device, said housing means being adapted for continuous external-area exposure to ambient air, whereby energy supplied to said water-heater element is on a duty-cycle basis wherein average water-heating energy matches average tank-heat radiation to local air for a predetermined water temperature in relation to ambient-air temperature and in spite of changes in ambient-air temperature.

7. A heating system as recited in claim 6, wherein said water-heater element is in the form of an essentially flat, flexible sheet, resistive electrical conductor means being distributed substantially over the plane defined by said sheet.

8. A heating system as recited in claim 6, in which said water-heater element is enclosed by electrical insulating material, and including air-conducting tubes enclosed within said waterproof insulating material and having at least one inlet and one outlet opening projecting outside of said material.

9. A heating system as recited in claim 6, in which said water-heater element is enclosed by electrical insulating material, and wherein said resistive heating element means is formed in the shape of a rock having said resistive electrical conductor means distributed over the region of at least a portion of the surface thereof enclosed within said waterproof insulating material.

10. A heating device as recited in claim 6, in which said water-heater element is enclosed by electrical insulating material, and wherein said waterproof insulating material is molded to encapsulate said resistive electrical conductor means and said electrical cable means as a unit.

11. The combination of the heating device of claim 7 and a fish tank, and sand or gravel on the bottom of said fish tank, said sheet-shaped resistive heating element means being positioned beneath said sand or gravel.

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