

May 5, 1959

C. D. MacCRACKEN
PERSONAL THERMAL DEVICES

2,885,189

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2 Sheets-Sheet 1

Fig. 1.

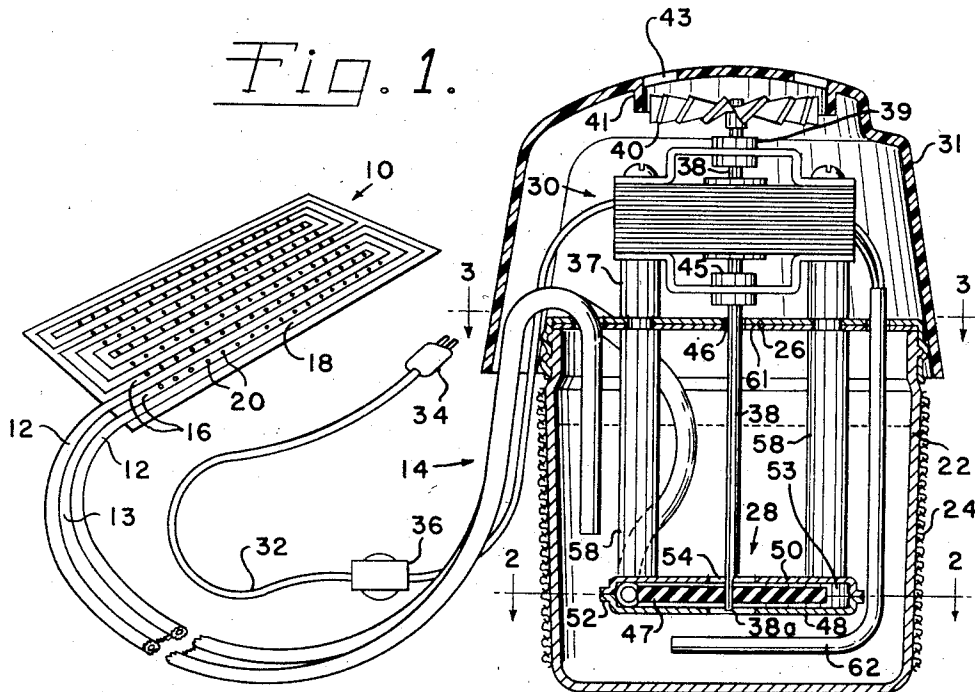


Fig. 3.

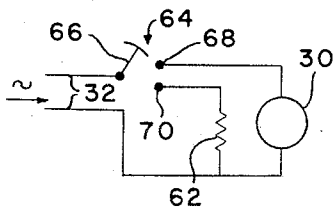
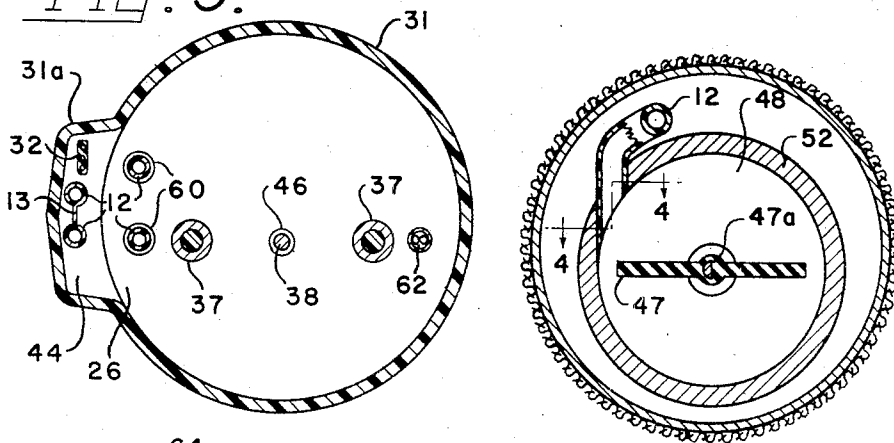
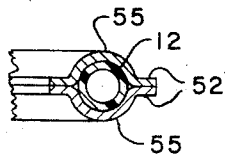


Fig. 5.

Fig. 4.

Fig. 2.



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2 Sheets-Sheet 2

Fig. 7.

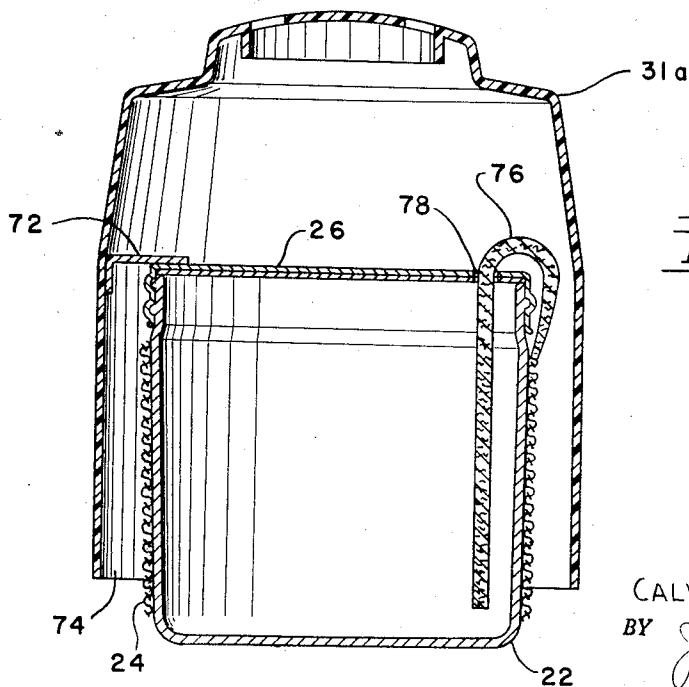
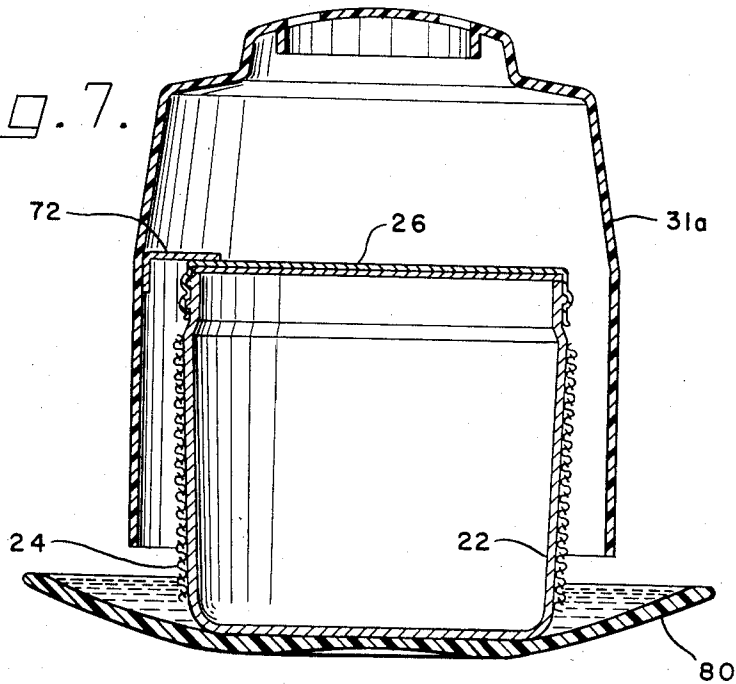


Fig. 6.

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PERSONAL THERMAL DEVICES

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Application July 20, 1953, Serial No. 369,198

10 Claims. (Cl. 257—215)

This invention relates to improvements in personal thermal devices, and particularly to an improved device for individual heating or cooling in which liquid is circulated through a flexible panel for supplying heat to or carrying heat away from a person's body.

In a co-pending application of Robert E. Coleman, Jr. et al., filed September 13, 1952, Serial Number 309,416 and assigned to the assignee of the present invention, there is described and claimed a personal thermal device of the general type with which the present invention is concerned. In the specific embodiment described in the foregoing co-pending application, a heat actuated pump is utilized as a means of circulating liquid through a flexible heat exchange panel, and also as a means of heating the circulated liquid in some instances. While a heat actuated pump has many desirable features for a system of this type, there are certain applications of the system wherein advantages are obtained by the use of the improved circulator described herein with the pump and driving motor thermally isolated from each other.

It is a general object of the present invention to provide an improved personal thermal device of the liquid circulation type, and more particularly to provide a system of this type in which an electric motor-driven pump is utilized as the liquid circulator. In accordance with a preferred embodiment of the invention, the motor and pump are compactly assembled with a container for the liquid to be circulated, the arrangement being such that the circulated liquid can be replaced readily as may be desired. The invention further contemplates and its practice provides an assembly of this type in which the pump and the driving motor are thermally isolated to avoid heating the circulated liquid. In accordance with a further feature of the invention, a simple and economical centrifugal pump is provided which readily clears itself of air when the system is first charged with liquid.

A more complete understanding of the invention, and of further objects and features thereof, can be had by reference to the following description of illustrative embodiments thereof, when considered in connection with the accompanying drawing, wherein:

Figure 1 is an elevational view, partly in section of a circulator embodying the present invention, with the heat exchange panel being shown in perspective,

Figure 2 is a sectional view, taken in the direction of the arrows 2—2 in Figure 1, showing certain features of the pump construction,

Figure 3 is a sectional view, taken in the direction of the arrows 3—3 in Figure 1, showing details of the shape of the motor hood,

Figure 4 is a sectional view, taken in the direction of the arrows 4—4 in Figure 2, showing further details of the pump construction.

Figure 5 is a schematic diagram of the electric circuit for the apparatus of Figure 1, and

Figures 6 and 7 show arrangements for increased evaporative cooling.

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Referring to Figure 1 of the drawing, a personal thermal device embodying the invention comprises a flexible, liquid-conducting panel 10 coupled by a pair of flexible tubes 12 to a circulator 14, described in detail herein-
after.

The panel 10 preferably comprises two superposed sheets of waterproof material, such as one of the vinyl plastics, sealed together along spaced lines 16 to define between the seal lines passages 18 through which liquid can be circulated. To prevent accumulation of moisture such as perspiration or the like on the panel surface, the seal lines 16 preferably are provided with many small perforations 20. The panel 10 may be made in a variety of shapes and sizes, depending on the particular purpose for which it is used. For example, one very beneficial use is as a pillow insert, the panel being placed on the pillow body under the pillowcase to warm or cool the user's head. In a larger size, the panel may be used to warm or cool substantially the entire body of the user, being located for this purpose on the mattress of a bed (beneath the lower sheet), spread over the seat of an automobile, etc. Whatever its location, the panel 10 will carry heat away from or supply heat to the user's body, depending on the relative temperature of the liquid circulated through the passages 18.

As is explained in the above-mentioned co-pending application, it has been found that for cooling purposes it is not necessary to artificially refrigerate the circulated liquid to any material extent. Rather, if the circulated liquid merely is allowed to cool substantially to room temperature before entering the panel, a remarkably pleasant and efficient cooling of the body portion contacting the panel will occur.

To this end, the coupling tubes 12 are made relatively long, say, of the order of six feet, to provide ample heat dissipating surface to cool the liquid as it circulates to and from the panel 10. When the system is used for heating, the coupling lines 12 preferably will be coiled up and may be placed, say, in a small insulated bag or the like (not shown) to reduce heat loss. For convenience in handling, the coupling tubes 12 are joined by a central web 13.

The circulator 14 includes a container 22 for the liquid to be circulated. The container 22 preferably is made of a material that will conduct heat readily, such as aluminum. When the system being described is used for cooling in very hot weather, such that the temperature in the room is at or very near the body temperature, it is sometimes helpful to have some means, such as flocking 24, to aid in cooling the circulated liquid. The flocking 24 can be moistened to aid in cooling the container and its contents by evaporation.

The container 22 is provided with a threaded cover 26 adapted to be removed readily from the container 22. This is found to be convenient not only for initially filling the system with liquid, but also for recharging the system with liquid when the container has been in a very warm ambient for a long period of time before use. For example, it frequently happens that the temperature in a bedroom or the like will be rather high during the day, thereby raising the temperature of the system liquid to a relatively high value. Even though the room temperature falls off at night, it may take some time for the system liquid to cool. If so, it is a simple matter to unscrew the container and recharge it with fresh tap water at a lower temperature so that the system does not start operating with abnormally warm liquid.

A pump 28, a driving motor 30 and a protective hood 31 are carried by the cover 26. The motor 30 is a conventional electric motor adapted to be energized by cur-

rent supplied through a cord 32 having a plug 34 for insertion in the usual household outlet receptacle. The cord 32 also has an on-off switch 36 for controlling the motor in the usual manner, and also for controlling a heating element as described hereinafter.

The motor 30 is mounted above the cover 26 on support legs 37, and includes a shaft 38 which extends above the motor through a bearing 39 and carries a cooling fan 40. In addition to protecting the motor, the hood 31 also serves to direct the fan air over the motor 30 for cooling purposes. To this end, the hood 31 carries a depending annular ring 41 which surrounds the fan blades 40 and serves as a shroud to cooperate with the fan blades in directing a flow of cooling air upwardly and out through exit openings 43 in the top of the hood. The air inlet to the hood is through a channel 44 formed by an offset portion 31a in one side of the hood (see Figure 3), which channel also accommodates the coupling tubes 12 and the electric cord 32. In this way, the motor heat is carried upwardly away from the container 22.

The motor shaft 38 also extends downwardly into the container 22 through a bearing 45 and an opening 46 in the cover 26. The lower end 38a of the shaft carries a two bladed impeller 47 for the centrifugal pump 28. The impeller 47 may be of molded rubber construction, with a semicircular central hole 47a for making a press fit on the partially flattened end 38a of the shaft 38.

The impeller 47 is located in a housing which comprises a pair of opposed flat circular plates 48, 50, having offset abutting annular flanges 52 that are sealed together by welding or the like to enclose between the plates 48, 50 a shallow cylindrical cavity 53. In order that the pump can clear itself of air when the system is first charged with liquid, the cavity 53 is made deep enough, says, one and one half times the width of the blades 47, to provide a substantial clearance space between the impeller 47 and the upper plate 50. It has been found that if there is substantially no clearance other than a bare running clearance between the impeller 47 and the upper plate 50, air bubbles will collect at the outer ends of the impeller blades and will continue to travel around the housing at the end of the impeller blades without clearing from the system. Such trapped air makes the pump operation inefficient and rather noisy which is sometimes objectionable, especially for use in sleeping quarters. However, with adequate clearance between blade and top plate, air bubbles have a tendency to move to the center of the housing, where they can escape through the central opening 54 through which the pump shaft enters the housing. The same opening serves as a liquid inlet to the housing. For simplicity of manufacture, the upper and lower housing plates 48, 50 are cut identically so that there is a central opening 54 in the lower housing plate 48 as well as in the upper plate, although this opening in the lower plate is not required for proper operation of the pump. The housing flanges 52 also have aligned depressions 55 formed therein (see Figure 4), defining a tangential peripheral liquid outlet from the housing.

Suitable openings 60 are provided in the cover plate 26 through which to pass the connecting tubes 12. One of these tubes 12 is connected into the opening formed by the depressions 55 in the housing plate flanges 52 to conduct liquid from the pump to the cooling panel, while the other tube simply opens into the container 22 to discharge liquid returning from the panel. As best shown in Figure 2, the pump and the motor are offset toward the front of the container 22, as viewed in the drawing, to leave a space at the rear of the pump housing for accommodating the the coupling tubes 12.

When the system being described is used for cooling purposes, it is important that no extraneous heat reach the liquid in the container 22. Accordingly, the pump 28 and the motor 30 should be thermally isolated so that none of the heat from the motor will pass downwardly

into the liquid in the container 22. This, in part, is accomplished by having the fan 40 move air upwardly over the motor and out the top of the hood, as already described. To prevent conduction of motor heat to the pump, the motor support rods 37 preferably are made of insulating material. A suitable material for this purpose is one of the so-called plastics, such as acrylic resin. Similarly, the pump housing 48, 50 is supported from the cover plate 26 by rods 58 of insulating material to prevent conduction of heat downwardly into the liquid chamber. Also, the underside of the plate 26 preferably is separated from the container by a layer of insulating material 61, such as waxed cardboard, rubber or the like. The shaft preferably is made of stainless steel because of its relatively low heat conductivity in addition to its corrosion resistance.

In order that the system of the present invention can be used for heating as well as for cooling purposes, there is mounted on the cover plate 26 a heating element 62 of the immersion heater type. This heater element is made in an L shape to extend downwardly along one wall of the container 22, with the lateral portion of the L extending under the pump housing. The heating element is connected to be supplied with current through the same cord 32 that carries current to the motor 30. In units having a heat element, the switch 36 will be of the three-way type, having an off position, a motor energizing position, and a motor-plus-heater energizing position. This is shown schematically in the wiring diagram of Figure 5, showing a circuit including input leads 32 connected to supply current either to the motor 30, or to the motor and a heater element 62 in parallel, through a switch 64. The switch has a movable contact 66 adapted either to engage a single fixed contact 68 for completing the motor circuit, or to engage two fixed contacts 68, 70 simultaneously to complete both the motor and the heater circuits. Of course, when the movable contact 66 touches neither of the fixed contacts 68, 70, the circuit will be open.

As was previously mentioned, the cooling action of the system described herein can be augmented, if desired, by evaporative cooling action. When the panel 10 is used as a mattress cover, for example, the amount of body heat picked up by the circulating liquid may require cooling lines of inconvenient length to dissipate the heat. In Figures 6 and 7 there are shown arrangements for facilitating evaporative cooling of the system liquid. In both Figure 6 and Figure 7, the pump and the motor of Figure 1 have been omitted to simplify the drawing.

In the Figure 6 construction, the motor hood 31a is shown extended downwardly nearly to the bottom of the container 22. The motor hood 31a is mounted on spacers 72, so that the hood is spaced slightly from the cover 26 and from the container 22, leaving an annular channel 74 through which air will flow on its way to the fan 40 (not shown in Figure 6). Also, the container 22 is covered by material 24 to which water will flow from inside the jar through a wick 76 that extends from the covering material 24 into the container 22 through an opening 78. Of course, it is evident that the material 24 may comprise flocking, as previously indicated, or may comprise a removable jacket of absorbent cotton cloth or the like that will serve as a distributing medium for the liquid and that will be readily removable for washing.

With the arrangement shown in Figure 6, air flowing over the moist material 24 will speed the evaporative action and thereby improve the cooling. The material 24 will be continually supplied with moisture through the wick by capillary action.

An alternative to the use of the wick 74 is to place the container 22 in a shallow dish 80 containing a small quantity of water, as shown in Figure 7. Here the jacket material 24 obviously will be kept moist by contact with the water in the dish. This arrangement has the advantage

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tage that it does not exhaust the water from the container 22, so that the supply of water can conveniently be maintained without removing the cover 26.

I claim:

1. An improved liquid circulator for circulating cooled liquid through a personal thermal system of the type including a liquid-conducting heat-exchange panel through which said cooled liquid is circulated for removing heat from a person's body and then cooled and recirculated again, said improved liquid circulator comprising a liquid container, a removable cover plate on said container, an electric motor, heat insulating means mounting said motor over said cover plate, said motor having a shaft extending below said plate into said container, and a centrifugal pump comprising impeller blades mounted on the lower end of said shaft for rotation therewith, an impeller housing enclosing said blades and defining a shallow cylindrical cavity of depth substantially greater than the height of said blades, said housing comprising a pair of opposed flat circular plates having offset abutting annular flanges, said flanges having aligned depressions therein defining a tangential peripheral liquid outlet from said housing, the upper one of said housing plates providing a substantial clearance space above said impeller blades and having a large central opening therein to admit liquid to said housing and to allow air to escape therefrom, and supporting means of heat insulating material suspending said housing from the underside of said cover plate, said cover plate having openings therein through which said conducting tubes enter said container, said impeller housing outlet opening being connected to one of said liquid conducting tubes.

2. In a circulator for circulating liquid through a personal thermal device of the type comprising a liquid-conducting, flexible, heat-exchange panel through which to circulate liquid, and heat-dissipating liquid-conducting tubes leading to and from said panel, said circulator being of the type comprising a liquid container, a removable cover on said container, an electric motor mounted on said cover and having a shaft extending downwardly into said container, a centrifugal pump comprising impeller blades mounted on the lower end of said shaft for rotation therewith, and an impeller housing enclosing said blades, the improvement which comprises a pair of support rods of heat insulating material suspending said housing from said cover.

3. An improved liquid circulator for use in circulating cooled liquid through a personal thermal system of the type including a liquid-conducting, heat-exchange panel through which said cooled liquid is circulated for removing heat from a person's body and then cooled and recirculated again, said improved liquid circulator comprising a liquid container, a motor having a shaft extending into said container, a centrifugal pump comprising impeller blades mounted on said shaft for rotation therewith, an impeller housing enclosing said blades and defining a shallow cylindrical cavity of depth substantially one and one-half times the height of said blades, said housing comprising a pair of opposed flat circular plates having offset abutting annular flanges, said flanges having aligned depressions therein defining a tangential peripheral liquid outlet from said housing, the upper one of said housing plates having a central opening therein to admit liquid to said housing and to allow air to escape therefrom, and mounting means of heat insulating material for said housing thermally isolating said pump from said motor.

4. In a personal thermal system for dissipating heat from the body of a person and comprising a pump connected in a liquid circuit which includes a thin, flexible, liquid-conductive heat exchange panel through which to circulate a liquid and being adapted to be placed in thermal contact with a person's body which is to be cooled to absorb heat therefrom, and an electric motor for driving said pump, the improvement which comprises a second

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heat exchanger comprising extended-surface-area thin-walled coupling tubes in said circuit intermediate said pump and said panel of length sufficient to provide heat-dissipating surfaces adequate to transfer to the ambient substantially all of said heat absorbed by said liquid, whereby the liquid entering said panel will be substantially at the ambient temperature, and heat insulating means thermally isolating said motor from said pump so as to prevent the transmission of heat from said motor to said liquid in said circuit.

5. In a personal thermal device for dissipating heat from the body of a person and comprising a pump connected in a liquid circuit which includes a liquid container and a thin, flexible, liquid-conductive heat exchange panel through which to circulate a liquid and being adapted to be placed in thermal contact with a person's body which is to be cooled to absorb heat therefrom, and a motor for driving said pump, the improvement which comprises a second heat exchanger comprising extended-surface-area thin-walled liquid conductive tubing constituting a portion of said circuit and providing sufficient heat-dissipating surface area to transfer to the ambient substantially all of the heat absorbed by said liquid in circulating through said panel, whereby the liquid entering said panel will be substantially at the ambient temperature, and means thermally isolating said motor from said pump so as to prevent the transmission of heat from said motor to said liquid in said circuit, said last named means including, as mounting means for said pump and said motor, a removable cover for said container, supporting means of heat insulating material mounting said motor above said liquid container and said pump being mounted below said motor to extend downwardly into said container, whereby to induce motor heat to flow upwardly away from said pump and said container.

6. In a personal thermal device for dissipating heat from the body of a person and comprising a pump connected in a liquid circuit which includes a liquid container and a thin, flexible, liquid-conductive heat exchange panel through which to circulate a liquid and being adapted to be placed in thermal contact with a person's body which is to be cooled to absorb heat therefrom, and a motor for driving said pump, the improvement which comprises a second heat exchanger comprising extended-surface-area thin-walled liquid-conductive means constituting a portion of said circuit and providing sufficient heat-dissipating surface area to transfer to the ambient substantially all of the heat absorbed by said liquid in circulating through said panel, whereby the liquid entering said panel will be substantially at the ambient temperature, and means thermally isolating said motor from said pump so as to prevent the transmission of heat from said motor to said liquid in said circuit, said last named means including as mounting means for said pump and said motor, a removable cover for said container, said motor being mounted on the upper side of said cover and having a shaft extending downwardly into said container, said pump comprising an element mounted for rotation on the lower end of said shaft, a housing within which said rotatable element is adapted to rotate, and said means thermally isolating said motor from said pump further including at least one support member of heat insulating material suspending said housing from said cover.

7. In a circulator for circulating liquid through a personal cooling and heating device of the type comprising a liquid-conducting, flexible, heat-exchange panel through which to circulate liquid, and heat-dissipating liquid-conducting tubes leading to and from said panel, said circulator being of the type comprising a liquid container, a removable cover plate on said container, an electric motor mounted on top of said cover plate and having a shaft extending above said motor and also extending downwardly through said cover plate into said container, and a centrifugal pump comprising impeller blades mounted on the lower end of said shaft for rotation therewith,

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the improvement which comprises a hood attached to said plate covering said motor and having bottom air inlet and top outlet openings, and a fan mounted on the upper end of said shaft for rotation therewith to draw cooling air through said hood inlet opening and over said motor and to discharge motor-heated air upwardly away from said cover plate and through said outlet opening, an impeller housing enclosing said blades and defining a shallow cylindrical cavity of depth substantially one and one-half times the height of said blades, said housing having liquid inlet and discharge openings therein, heat insulating means suspending said housing from the underside of said cover plate, said cover plate having openings therein through which said conducting tubes enter said container, and means connecting said impeller housing discharge opening to one of said liquid-conducting tubes.

8. An improved circulator for use in a personal cooling system of the type wherein cooled liquid is circulated through a heat-exchange panel adapted to remove heat from a person's body and wherein the liquid is cooled and then recirculated through said heat-exchange panel, said improved circulator for recirculating the cooled liquid to said heat-exchange panel comprising a liquid container, an electric motor, heat insulating support means supporting said electric motor above said liquid container, said motor having a shaft extending downwardly into said container, a pump including impeller blades mounted on said shaft for rotation therewith and a housing enclosing said blades, at least one support member of heat insulating material extending into said liquid container and being secured to said pump housing, whereby said motor is thermally isolated from said container and said pump is thermally isolated from said motor.

9. An improved circulator for circulating cooled liquid in a personal cooling system of the type wherein cooled liquid is circulated through a heat-exchange panel adapted to remove heat from a person's body and is cooled and then is circulated again through said panel, said improved circulator including a liquid container, an electric motor, heat insulating means supporting said motor spaced from said liquid container, said motor having a shaft extending into said container, said shaft being of low effective heat conductivity, and a pump in said container, said pump having an impeller on said shaft and driven thereby,

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whereby said electric motor is thermally isolated from said liquid container and is thermally isolated from said pump.

10. An improved circulator for circulating cooled liquid in a personal cooling system of the type wherein cooled liquid is circulated through a heat-exchange panel adapted to remove heat from a person's body and is cooled and then is circulated again through said panel, said improved circulator including a liquid container, an electric motor, heat insulating motor support means supporting said motor above said liquid container, a hood over said motor and including a skirt portion extending downwardly beyond the top of said liquid container, said skirt portion being spaced outwardly from said liquid container forming an air passageway upwardly past said liquid container into said hood, said hood having a vent near the top, said electric motor including a shaft extending upwardly into said hood, an air blower on said air passageway past said liquid container into said hood and past said motor and out of said vent, thereby cooling said motor with air flowing upwardly away from said container to carry the motor heat away from the container, said motor having a shaft extending downwardly into said container, a pump including impeller blades mounted on the lower end of said shaft for rotation therewith and a housing enclosing said blades, and heat insulating support means for said housing whereby the motor heat is carried away by said upward draft and said motor is thermally isolated from said container and said pump housing is thermally isolated.

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