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(54) Title: HEATING AND COOLING PAD, CONTROL UNIT THEREFOR, SYSTEM AND METHOD

(57) Abstract: A personal, portable heating and cooling system for an individual includes a thin, flexible pad and a control unit in fluid communication with the pad for regulating the temperature of a heat transfer fluid flowing between the pad and the control unit. The pad has an internal chamber for holding the heat transfer fluid. The chamber is partitioned to form therein a passageway that directs the heat transfer fluid to flow there through along a circuitous path. The control unit has a housing enclosing a reservoir for holding the heat transfer fluid, a pump for pumping the heat transfer fluid between the reservoir and the internal chamber of the pad, and a heating and cooling apparatus for regulating the temperature of a heat transfer fluid flowing between the reservoir and the chamber. The control unit includes an electronic control circuit having a user interface that enables a user increase and decrease the temperature of the fluid. An alternate embodiment enables the user to select a temperature of the fluid and still another embodiment where the temperature varies over time in accordance with an individualized custom temperature profile.



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**HEATING AND COOLING PAD, CONTROL UNIT THEREFOR,
SYSTEM AND METHOD
(Docket No. 9798a)**

RELATED PATENT APPLICATIONS & INCORPORATION BY REFERENCE

This application is a PCT application which claims the benefit under 35 USC 119(e) of U. S. Provisional Patent Application No. 60/877,098, entitled "Thermal Electric Heating And Cooling Liquid Circulating Pad," filed December 26, 2006. This related application is incorporated herein by reference and made a part of this application. If any conflict arises between the disclosure of the invention in this PCT application and that in the related provisional application, the disclosure in this utility application shall govern. Moreover, any and all U. S. patents, U. S. patent applications, and other documents, hard copy or electronic, cited or referred to in this application are incorporated herein by reference and made a part of this application.

DEFINITIONS

The words "comprising," "having," "containing," and "including," and other forms thereof, are intended to be equivalent in meaning and be open ended in that an item or items following any one of these words is not meant to be an exhaustive listing of such item or items, or meant to be limited to only the listed item or items.

The word "circuitous" means indirect, winding or meandering.

The word "rectangular" includes square.

BACKGROUND

This background discussion is not intended to be an admission of prior art.

Many individuals use a heating pad for comfort, or as therapy for pain. Many conventional heating pads comprise a pad with wires impeded therein through which electrical current flows to heat the pad. Moreover, particularly when sleeping, the temperature tends to rise, especially when the individual user is covered by a blanket or other bedding and the heating pad is under the user. Thus, the problem which such conventional heating pads is that they are uncomfortable to lie upon and provide only heating. One way to both heat and cool is to employ a variable voltage power supply to enable a user to set the temperature of a "heating and cooling" pad. In general, however, commercially available variable voltage power supplies are expensive.

SUMMARY

Our heating and cooling pad, control unit therefor, heating and cooling system, and method of controlling temperature while in bed has one or more of the features depicted in the embodiments discussed in the section entitled “DETAILED DESCRIPTION OF SOME ILLUSTRATIVE EMBODIMENTS.” The claims that follow define our pad, control unit therefor, system, and method, distinguishing them from the prior art; however, without limiting the scope of our pad, control unit therefor, system, and method, as expressed by these claims, in general terms, one or more, but not necessarily all, of their features are:

One, our heating and cooling system is lightweight, compact, portable, and may be operated at ambient air temperatures substantially from 41° F to 122 ° F. It comprises a pad and control unit adapted to be placed in fluid communication with the pad. The control unit includes a housing having a reservoir for holding a heat transfer fluid and a fluid plumbing network for circulating the heat transfer fluid between an internal chamber of the pad and the reservoir. The fluid pressure within the chamber is at a predetermined level so the pad is comfortable to lie upon, for example, the fluid pressure within the chamber may be substantially from 3 to 20 pounds per square inch (psi). As directed by the user interacting with a user interface of the control unit, a bi-directional heat pump cools or heats the heat transfer fluid as the heat transfer fluid is circulated. The bi-directional heat pump may comprise a thermoelectric unit having a heating mode and cooling mode and through which

1 the heat transfer fluid flows upon being circulated by a fluid pump between an inlet and an
2 outlet of the pad's chamber.

3 Two, a suitable thermoelectric unit is solid-state device utilizing the "Peltier" effect.
4 Such a solid-state device has a first side in heat transfer contact with the ambient air
5 environment and a second side. An outlet of the pad is in communication with the
6 thermoelectric unit so fluid flowing from the pad passes the second side and makes heat
7 transfer contact with this second side. The thermoelectric unit is responsive to alternating the
8 polarity of an applied voltage so heat flows from the second side into the fluid passing
9 thereby or heat flows from the fluid passing thereby into the second side. By alternating the
10 polarity of the applied voltage the fluid temperature is increased or decreased, and depending
11 on the type of user interface employed, the user may select a specific fluid temperature.

12 Three, a control circuit for operating the thermoelectric unit and heat transfer pump
13 within the housing is coupled to the user interface. In one embodiment, the user interface
14 enables the user to simply increase or decrease the temperature of the heat transfer fluid
15 flowing through the chamber, but not select a specific temperature. In another embodiment,
16 the user interface enables the user to select a specific temperature. In still another
17 embodiment, the user interface enables the user to create a program in which a plurality of
18 different temperatures are selected and selectively applied over a period of time. In other
19 words, the user may create his or her own individualized custom temperature profile of the
20 heat transfer fluid over a selected period of time. In these later embodiments enabling the
21 user to select specific temperatures, at least one temperature sensor is used to detect the
22 temperature of the heat transfer fluid. A switching circuit switches the thermoelectric unit
23 between the heating mode and cooling mode as determined by a comparison between a user
24 selected set point temperature and the temperature of the heat transfer fluid as detected by the
25 temperature sensor. A second temperature sensor may be used to detect ambient air
26 temperature along with a microprocessor that controls the rate of increase or decrease in
27 temperature in response to the ambient air temperature detected by the second temperature
28 sensor.

29 Four, our system may employ means for detecting an abnormal and unsafe condition,
30 and upon detection of such condition, turn off the thermoelectric unit, or turn off both the
31 thermoelectric unit and the pump, and provide a signal to the user that an abnormal and
32 unsafe condition exists. For example: Another temperature sensor may be used for detecting
33 the temperature of the heat transfer fluid, thermoelectric unit and pump being turned off when
34 this temperature sensor detects that temperature of the heat transfer fluid is not within

1 predetermined, preset limits. A level sensor on the exterior of the control unit may be used
2 for detecting the spatial orientation of the control unit, thermoelectric unit and pump being
3 turned off when the level sensor detects that the control unit is tipped over. A fluid sensor
4 may be used for detecting the amount of heat transfer fluid in the reservoir, the thermoelectric
5 unit and pump being turned off when the fluid sensor detects insufficient heat transfer fluid in
6 the reservoir.

7 Five, a low cost power supply provides a constant output voltage, for example,
8 substantially from 12 to 24 volts, and its output is electrically coupled to a converting circuit
9 that is interactive active with the user interface. The converting circuit has an operator
10 element that enables the user to increase or decrease the fluid temperature by converting the
11 constant output voltage to a selectable variable voltage. In one embodiment, the variable
12 voltage power supply having a power rating substantially from 200 to 400 Watts over a 24
13 volt range, and the thermoelectric unit has a power rating substantially from 150 to 300 Watts
14 over a 24 volt range.

15 Six, our pad is thin and flexible pad and its internal chamber is partitioned to form
16 therein a passageway that directs the heat transfer fluid to flow along a circuitous path
17 between the inlet and outlet. Our pad may have a length substantially from 12 to 48 inches, a
18 width substantially from 12 to 36 inches, a thickness that does not exceed approximately 1/2
19 inch when the heat transfer fluid flowing through the chamber at said pressure, and it may be
20 substantially rectangular. The chamber may have a volume substantially from 100 milliliters
21 to 2 liters with the heat transfer fluid flowing through the chamber at the pressure from 3 to
22 20 psi. Our pad may comprise a pair of overlying, liquid impenetrable, flexible plastic sheets
23 bonded together by (a) linear welds between facing surfaces of the overlying sheets to form
24 within the chamber a passageway that directs the heat transfer fluid to flow along a circuitous
25 path between the inlet and outlet, and (b) spot welds within the passageway to form fluid
26 mixing or turbulent flow zones along the passageway. Each sheet may have substantially the
27 same dimensions, the sheets may each have edges that are bonded along the edges to form the
28 overall width and length dimensions of the chamber, which are only slightly less than the
29 width and length dimensions of the sheets. The plurality of spot welds may be arranged in a
30 predetermined pattern to form upon the pad being horizontally orientated a plurality of
31 cushion pillows along the passageway for enhanced comfort as the heat transfer fluid flows
32 through the pad at the predetermined pressure. For example, the number of spot welds per
33 square inch of facing surfaces may be from 4 to 25 and the area of each individual spot weld
34 may be substantially from 0.003 to 0.012 square inches. The spot welds may be arranged in a

1 predetermined grid pattern comprising intersecting grid lines with individual spot welds
2 located at intersections of the grid lines.

3 Our method of controlling temperature while in bed comprises the following steps:

4 (a) positioning on the bed an enlarged thin flexible heating and cooling pad having an
5 internal chamber holding a heat transfer fluid, the pad having width and length dimensions
6 sufficient so a substantial portion of a user's body contacts the pad directly or indirectly when
7 lying on the pad, said pad having a maximum height of substantially 1/2 inch when the
8 chamber is filled with the heat transfer fluid at a pressure substantially from 3 to 20 pounds
9 per square,

10 (b) connecting the pad to a control unit having a housing enclosing a reservoir for
11 holding the heat transfer fluid, a pump for pumping the heat transfer fluid between the
12 reservoir and the pad, and a heating and cooling apparatus for regulating the temperature of a
13 heat transfer fluid flowing between the reservoir and the chamber, said control unit including
14 an electronic controller having a user interface that enables a user enables a user to increase
15 or decrease the temperature of the fluid, and

16 (c) increasing or decreasing the temperature of the heat transfer fluid flowing through
17 the pad.

18 These features are not listed in any rank order nor is this list intended to be
19 exhaustive.

20 DESCRIPTION OF THE DRAWING

21
22
23 Some embodiments of our pad, control unit therefor, system, and method, are
24 discussed in detail in connection with the accompanying drawing, which is for illustrative
25 purposes only. This drawing includes the following figures (Figs.), with like numerals
26 indicating like parts:

27
28 Fig. 1 is a schematic diagram of one embodiment of our heating and cooling system.

29 Fig. 1A is a schematic diagram of another embodiment of our heating and cooling
30 system.

31 Fig. 2A is a user interface used with the embodiment of our heating and cooling
32 system illustrated in Fig. 1.

33 Fig. 2B is a user interface used with the embodiment of our heating and cooling
34 system illustrated in Fig. 1A.

1 Fig. 2C is a user interface used with still another embodiment of our heating and
2 cooling system similar to that depicted in Fig. 1A.

3 Figs 3A through 3G depicted different temperature profiles over time employing the
4 user interface illustrated in Fig. 2C.

5 Fig. 4A is a rear perspective view of one embodiment of our control unit for our
6 heating and cooling pad.

7 Fig. 4B is a bottom perspective view of our control unit shown in Fig. 4A.

8 Fig. 4C is an exploded perspective view of our control unit shown in Fig. 4A.

9 Fig. 5 is a top plan view of one embodiment our heating and cooling pad.

10 Fig. 5A is a cross-sectional view taken along line 5A-5A of Fig 5.

11 Fig. 6 is a schematic diagram of a temperature control board shown in Fig. 1A.

12 Fig. 7A is a schematic diagram of the heat/cool logic for the circuit shown in Fig. 1A.

13 Fig. 7B is a schematic diagram of the safety board logic for the circuit shown in Fig.
14 1A.

15 Fig. 7C is a process flow chart of a program for a microprocessor used with the
16 interface shown in Fig. 2B.

17 Fig. 7D is a process flow chart for the user interface shown in Fig. 2C.

18 Fig. 8A is a schematic cross-sectional front view of a thermoelectric unit used in our
19 heating and cooling system.

20 Fig. 8B is a schematic side view of the thermoelectric unit depicted in Fig. 8A.

21 Fig. 8C is a top plan view of the thermoelectric unit depicted in Fig. 8A.

22 Fig. 8D is a cross-sectional view taken along line 8D-8D of Fig 8A.

23 24 DETAILED DESCRIPTION OF SOME ILLUSTRATIVE EMBODIMENTS

25 26 General

27
28 Our heating and cooling system comprises a pad P and a light-weight, portable,
29 compact control unit CU having within it a bi-directional heat pump that either cools or heats
30 a heat transfer fluid, for example, water, circulating between the control unit CU and the pad
31 P. The control unit CU may use one of the interfaces I, II, and III, shown respectively in
32 Figs. 2A through 2C. These interfaces I, II or III each enable a user to select the temperature
33 of the heat transfer fluid flowing through the pad P on which the user may recline. The pad P
34 is lightweight, flexible, and with the heat transfer fluid flowing through it at a predetermined

1 pressure, the pad is inflated so it is comfortable to lie upon. An example of one embodiment
2 of our pad P is illustrated in Figs. 5 and 5A. A plumbing network PN (Figs. 1 and 1A)
3 comprising any tubes, piping, conduits, connectors, couplers, etc. enabling the fluid to flow
4 between the pad P and control unit CU directs the fluid to pass a side 80a (Fig. 8A) of a bi-
5 directional heat pump that is in heat transfer contact with the fluid prior to the fluid returning
6 to the pad P.

7
8 Fig. 1 & Figs. 8A through 8D
9

10 One embodiment of our heating and cooling system depicted in Fig. 1 is generally
11 designated by the numeral 10, and its control unit CU employs the user interface I illustrated
12 Fig. 2A. Regardless of the interface used, our control unit CU includes a housing 12
13 containing a pump 14, a thermoelectric unit 16, a reservoir R holding the heat transfer fluid,
14 and a power supply PS. New Mark International, Inc. of Los Angeles, California sells a
15 suitable thermoelectric unit 16, which is a solid state device utilizing the "Peltier" effect and is
16 operable over a range of temperatures substantially from 41° F to 122 ° F, power ratings of
17 150 to 300 Watts, and voltages substantially from 0 to 24 volts. The pump 14 circulates the
18 heat transfer fluid between the control unit CU and the pad P, and it may be mounted in a
19 frame (not shown) with cushioned pads that insulate the housing 12 from pump vibrations
20 and permit quieter operation. A relatively low cost, constant voltage power supply PS is
21 used, for example, the power supply sold by Advanced Power Solutions of Pleasanton,
22 California. This power supply PS has a constant 24-volt output at its terminal A and constant
23 12-volt output at its terminal B. Power is provided to the power supply PS is supplied
24 through a main switch MS on the exterior of the housing 12.

25 Terminal A of the power supply PS is connected to a conventional DC-to-DC
26 converting circuit 18 and may be obtained from Amest Corporation of Santa Margarita,
27 California, a detail diagram of such converting circuit identified as #3 is shown in U. S.
28 Provisional Patent Application No. 60/877,098, incorporated by reference herein. The circuit
29 18, which is discussed in greater detail subsequently, converts the constant 24 volt at the
30 terminal A to a user selectable variable voltage, for example, a variable voltage from 0 to 24
31 volts, that is applied to the thermoelectric unit 16 through a DPDT switch 81. The position of
32 the switch 81 determines the polarity being applied to terminals X and Y of the
33 thermoelectric unit 16. With the switch 81 in the cool position in Fig. 2A and in solid lines in
34 Fig. 1, the terminal X has a positive (+) polarity and the terminal Y has a negative (-)

1 polarity. When the switch 81 in the heat position in Fig. 2A and in dotted lines in Fig. 1, the
2 terminal X has a negative (-) polarity and the terminal Y has a positive (+) polarity. The dial
3 83 on the interface I enables the user to either increase or decrease the differential in voltage
4 across the terminals X and Y by rotation in either a clockwise or counter-clockwise direction.

5 The thermoelectric unit 16 heats or cools the heat transfer fluid, functioning as the bi-
6 directional heat pump. As illustrated in Figs. 8A through 8D, the thermoelectric unit 16 has
7 opposed sides 80a and 80b with a plurality of Peltier devices 85 in contact with these sides.
8 The side 80a is in heat transfer contact with the ambient air environment that typically is at a
9 temperature substantially from 41° F to 122 ° F. The side 80b is in heat transfer contact with
10 the heat transfer fluid flowing from the pad P. Specifically, a sinusoidal, corrosion
11 resistance, copper tube 82 sandwiched between the side 80b and a support plate 84 has an
12 influent end 82a in communication with the pump 14 which pumps the fluid from the pad P
13 via the reservoir R into the tube 82. The thermoelectric unit 16 is mounted between the
14 ambient air environment serving as a heat sink and that support plate 84 with brazed copper
15 tube 82. The heat sink permits efficient heat transfer to the environment, while the plate and
16 brazed copper tube 82 permits efficient heat transfer to and from the fluid. The plate and heat
17 sink are separated from each other using a sheet of insulating foam to prevent direct heat
18 conduction between the hot and cold sides of the thermoelectric unit. Depending on the
19 position of the switch 81, the temperature of the heat transfer fluid in the pad P is either
20 increased or decreased and the rate of increase or decrease is governed by the position of the
21 dial 83. The fluid exits the tube 82 from its effluent end 82b that is in communication with
22 the pad P. Thus, the heat transfer fluid flowing from the pad P and then through the reservoir
23 R as it flows through the tube 82, passes the side 80b, making heat transfer contact with this
24 side prior to returning to the inlet 38a of the pad P. Alternatively, instead of using the copper
25 tube 82, a fluid chamber may be built which has the side 80b as a component of a structure
26 having internal metallic walls that create a winding path through its interior. The fluid flows
27 winding path and concurrently being in thermal contact with side 80b.

28 The thermoelectric unit 16 is responsive to alternating the polarity of the voltage
29 applied to terminals X and Y and across the sides 80a and 80b. When the polarity of the
30 applied voltage is as shown in solid lines as depicted in Fig. 1, heat flows from the fluid
31 passing by the side 80b into the ambient air environment that serves as a heat sink. When the
32 polarity of the applied voltage is as shown in dotted lines as depicted in Fig. 1, reversing the
33 polarity at the terminals X and Y, heat flows into the fluid passing by the side 80b. A fan 20
34 constantly blows air past an array of fins 24 through which the heat transfer fluid flows as it

1 circulates. The fan 20 increases or forces heat transfer, and it is operational when the
2 thermoelectric unit 16 is operational. The power supply PS provides power directly for the
3 fan 20 and pump 14, allowing the use of DC fans for quieter operation. The DC-to-DC
4 converting circuit 18 controls the DC voltage and current being supplied to the thermoelectric
5 unit 16, allowing continuously adjustability between the maximum and minimum
6 temperatures the unit is designed to deliver based on user input.

7
8 Fig. 1A
9

10 As depicted in Fig. 1A, an alternate embodiment of our heating and cooling system is
11 generally designated by the numeral 10a, and its control unit CU employs the user interface II
12 illustrated Fig. 2B that enables a user to select the temperature of the fluid flowing through
13 the pad P. Our heating and cooling system 10a includes a plurality of sensors S1, S1A, S2, S3
14 and S4. The sensors S1 and S1A are temperature sensors located in the effluent stream
15 exiting the thermoelectric unit 16 upstream of the outlet 38a. The sensor S2 is a temperature
16 sensor located in the control unit CU that detects the temperature of the ambient air
17 environment. The sensor S3 is a sensor that detects when the control unit CU is tipped and no
18 longer resting on a horizontal surface. The fluid sensor S4 is a sensor associated with the
19 reservoir R that detects when the reservoir is near empty.

20 The control unit CU of our heating and cooling system 10a includes a temperature
21 control board 90 illustrated in Fig. 6 and a safety board 92, and a failsafe, normally open
22 Relay 1 that upon closing energizes the thermoelectric unit 16 and pump 14. The
23 temperature control board 90 and its heat/cool logic circuit 93 depicted in Fig. 7A enables the
24 user to set the temperature of the fluid circulating through our system 10a. The temperature
25 control board 90 has an input 90a (Fig. 1A) connected to the 24 volt terminal A of the power
26 supply PS and an output 90b connected to one terminal T1 of the Relay 1. The 12-volt
27 terminal B of the power supply PS is connected to another terminal T2 of the Relay 1. The
28 safety board 92 is coupled through a coil 91 to the Relay 1. One output Q from the Relay 1 is
29 connected to the thermoelectric unit 16 and another output W from the Relay 1 is connected
30 to the pump 14. The user sets the temperature of the fluid by actuating one or the other of a
31 pair of buttons B1 and B2 of the interface II.

1 Figs. 4A through 4C

2
3 The physical configuration of the control unit CU is designed so the control unit sits
4 on a substantially horizontal surface, and thereby maintains the reservoir R in a substantially
5 vertical orientation so the liquid heat transfer fluid does not easily spill. As illustrated in
6 Figs. 4A through 4C, the control unit's housing 12 comprises a molded plastic top section
7 12a and a molded plastic bottom section 12b that fit snug together to provide a block shaped
8 or cubical console having an interior, which may be insulated, holding the power supply PS,
9 the thermoelectric unit 16, the reservoir R, and the pump 14. The housing 12 is compact, with
10 typical dimensions being a height substantially from 5.5 to 6.5 inches, a length substantially
11 from 12 to 15 inches, and a width substantially from 9 to 12 inches. The thermoelectric unit
12 16 is positioned between the power supply PS and the reservoir R. Its fan 20 that is seated
13 beneath an opening 22 in the top wall 23 to the top section 12a and above front and rear fins
14 24 through which the heat transfer fluid flows.

15 A removable slotted cap 26 fits snug within the opening 22. A pair of gratings 28
16 respectively at a lower front and lower back edge of the top section 12a allows air to flow
17 through the slotted cap 26, past the fins 24, and out the gratings 28 when the fan 20 is
18 operating. The reservoir R is a closed container with an access aperture 30 in its top that has
19 a removable plug 32 protruding through a hole 32a in the top wall 23 for removal when the
20 reservoir needs to be refilled with heat transfer fluid. As illustrated in Fig. 4B, the bottom
21 section 12b has on its underside surface 25 at each of its corners a rubber cushion or foot
22 element 34, which, as discussed subsequently in greater detail, may include the tip over
23 indicator sensor S3 (Fig. 1A) The tip over indicator sensor S3 may be imbedded in a foot
24 element 34 as shown in Fig. 4B.

25
26 Figs. 5 and 5A

27
28 As best depicted in Figs. 5 and 5A, our pad P is thin, flexible, substantially
29 rectangular in configuration, and it may be rolled up for storage. The pad P allows the heat
30 transfer fluid to pass through it without tubes or pipes or without being crimped by the weight
31 of the person on the pad. It has an internal chamber 36 (Fig. 5A) for holding the heat
32 transfer fluid and an inlet 38a and outlet 38b in fluid communication with the chamber.
33 Water tight, quick connect-disconnect couplers 40 at the inlet and outlet prevent fluid
34 leakage. As the heat transfer fluid flows through our pad P, the fluid fills the chamber 36 and

1 inflates the pad. In an unrolled condition, the pad P has a length *l* (Fig. 1) substantially from
2 12 to 48 inches and a width *w* substantially from 12 to 36 inches. In an un-inflated state our
3 pad P has a thickness *t* that does not exceed 1/32 inch. When inflated with fluid filling the
4 chamber 36 at a pressure substantially from 3 to 20 pounds per square inch (psi), preferably
5 from 4 to 6 psi, our pad P has a maximum thickness *t* (Fig. 5A) that does not exceed
6 approximately 1/2 inch, and typically ranges substantially from 1/8 to 1/3 inch. The
7 chamber 36 has a volume substantially from 100 milliliters to 2 liters with the heat transfer
8 fluid flowing through the chamber at the designated pressure.

9 Referring to Fig. 5A, the pad P comprises a pair of liquid impenetrable, plastic sheets
10 42a and 42b welded together and partitioned to form between them a circuitous fluid
11 passageway 44 within the chamber 36. A 200 denier urethane coated nylon sheet has been
12 used and may be obtained from Plas-Tech, Inc. of Corona, California. Each sheet 42a and
13 42b is substantially rectangular, each sheet has substantially the same dimensions, the sheets
14 each have edges ED1 through ED4 and are bonded along these edges to form the overall
15 width and length dimensions of the chamber 36, which are only slightly less than the width
16 and length dimensions of the sheets. The inlet 38a and the outlet 38b are next to each other
17 along the side edge ED4 of the pad P and are in fluid communication with the passageway
18 44. The passageway 44 includes a plurality of cushion pillows 46 that are inflated as the
19 heat transfer fluid flows through the pad P upon the pad being horizontally orientated and
20 filled with the heat transfer fluid at the pressure substantially from 3 to 20 pounds psi.
21 Excessively high pressure may open the welds, causing the fluid to leak from the pad P, and
22 make the pad too stiff and uncomfortable. Excessively low pressure may result in a poor heat
23 transfer to the user and cause the pad to be uncomfortable. Thus, maintaining the pressure
24 substantially from 3 to 20 pounds psi is important.

25 Welding together the overlying plastic sheets 38a and 38b may be accomplished by
26 heating selected portions of the contacting facing surface of the sheets. For example, there
27 may be linear welds 50 through 57 that may be wavy, for example, sinusoidal, and a plurality
28 of spot welds 58 in the body of the pad P. The linear welds 50 through 53 each project along
29 a straight line that is adjacent an edge ED1, ED2, ED3, or ED4, as the case may be. The linear
30 welds 54, 57 are within the body of the pad P, with the linear welds 54 and 57 at a right angle
31 with respect to each other, the linear welds 56 and 57 at a right angle with respect to each
32 other, and linear welds 53 and 55 at a right angle with respect to each other. This
33 arrangement of the linear welds 50 through 57 forms within the body of the pad the circuitous
34 passageway 44. The plurality of spot welds 58 are arranged in a predetermined pattern to

1 form the cushion pillows 46 upon the pad being horizontally orientated and inflated with the
2 fluid. The cushion pillows 46 provide fluid mixing zones along the passageway 44. The
3 number of spot welds 58 per square inch of facing surfaces is substantially from 4 to 25, the
4 area of an individual spot welds is substantially from 0.003 to 0.012 square inches, and the
5 spot welds may be arranged in a predetermined grid pattern comprising intersecting grid lines
6 60 and 62 with individual spot welds located at intersections of the grid lines, for example, at
7 the intersections a through k.

8
9 Figs. 6 through 7D

10
11 In our system 10a a user sets the temperature of the heat transfer fluid to be within the
12 range of substantially from 50 ° to 125° F and is adapted for operation at ambient air
13 temperatures substantially from 41° F to 122° F. In our system 10a (a) the temperature sensors
14 S1 and S1A detect the temperature of the heat transfer fluid, with the thermoelectric unit 16
15 and pump 14 being turned off when the temperature sensor S1A detects that the temperature
16 of the heat transfer fluid is not within predetermined limits set at the factory when the system
17 10a is manufactured, (b) the sensor S2 detects ambient air temperature and feeds this
18 information to the circuit shown in Fig. 7A, (c) the level sensor S3 on the exterior of the
19 control unit CU detects the spatial orientation of the control unit, with the thermoelectric unit
20 16 and the pump 14 being turned off when the level sensor detects that the control unit is
21 tipped over, and (c) the fluid sensor S4 detects the amount of heat transfer fluid in the
22 reservoir R, with the thermoelectric unit 16 and pump being turned off when the fluid sensor
23 detects insufficient heat transfer fluid in the reservoir R. These sensors S1 through S4 and
24 their associate circuits as discussed herein subsequently provide means for detecting an
25 abnormal and unsafe condition, and upon detection of such condition, turn off the
26 thermoelectric unit 16, or turn off both the thermoelectric unit 16 and pump 14, and provide a
27 signal to the user that an abnormal or unsafe condition exists, for example, by activating an
28 audio alarm or a warning light 97 (Fig. 2B) on the user interface II.

29 As shown in Fig. 2B, the user interface II has a selection mechanism comprising a
30 pair of temperature advancing buttons B1 and B2 that enables the user to select a set point
31 temperature of the heat transfer fluid. The selected temperature is displayed by a liquid
32 crystal display LCD on the user interface II. Pressing the button B1 increases the
33 temperature and pressing the button B2 decreases the temperature. The actual temperature of
34 the fluid in the effluent stream is normally displayed in the liquid crystal display LCD, but

1 upon pressing one of the buttons, the selected set point temperature is momentarily displayed
2 in the liquid crystal display LCD, for example, 75° F. As shown in Fig. 7A, a comparator 98
3 compares the user selected set point temperature with the fluid temperature detected by the
4 temperature sensor S1. If required based on this comparison, the thermoelectric unit 16 is
5 signaled to increase or decrease the temperature of the heat transfer fluid flowing between the
6 reservoir R and the pad P. A microprocessor 96 (Fig. 6) governs the rate of increase or
7 decrease the temperature of the heat transfer fluid as determined by the ambient temperature
8 detected by the sensor S2. If the temperature sensor S1A detects that fluid temperature is
9 outside the limits set during manufacture at the factory, the thermoelectric unit 16 and pump
10 14 are turned off and the warning light 97 is activated.

11 As illustrated in Fig. 6, the temperature control board 90 (Fig. 1A) is used to enable
12 the user to select the temperature of the heat transfer fluid flowing through the pad P. This
13 board includes the DC-to-DC converting circuit 18, the heat/cool logic circuit 93, a
14 microprocessor 96, a random access memory RAM, a read only memory ROM, and a display
15 drive circuit 98 for the display LCD. A program 100 for processing the information required
16 for control operations of the microprocessor 96 is stored in the read only memory ROM. The
17 temperature of the fluid and the ambient air temperature respectively detected by the sensors
18 S1 and S2 and the fluid temperature selected by the user are feed to the microprocessor 96
19 which signals the DC-to-DC converting circuit 18 to process this information to control the
20 fluid temperature as the user desires. The comparator 98 in the heat/cool logic circuit 93
21 compares the user selected (set point) temperature with the fluid temperature to determine if
22 heat should flow into or from the fluid in heat transfer contact with the side 80b as the fluid is
23 circulated through the plumbing network PN and past the side 80b. If the comparator 98
24 indicates that the set point temperature is above fluid temperature, the relay 102 is in the
25 position shown in solid lines in Fig. 7A and the side 80b causes heat to flow into the fluid. If
26 the comparator 98 indicates that the set point temperature is below the fluid temperature, a
27 coil 104 is energized and the relay 102 is moved to the position shown in dotted lines. This
28 reverses the polarity of the voltage being applied to the side 80b, causing heat to flow from
29 the fluid.

30 The safety board 92 logic circuit 106 as shown in Fig. 7B includes a pair of
31 comparators 108a and 108b having their respective outputs connected to the inputs of an OR
32 gate 110. The output of the OR gate 110 is connected to one input 112a of another OR gate
33 112. The signals from the sensors S4 and S3 are respectively connected to additional inputs
34 112b and 112c of the OR gate 112. Unless the signals at all three inputs 112a, 112b, 112c

1 indicate that a safe condition exists at each input, the output of the OR gate 112 applies a
2 signal through a buffer 114 to the light 97 indicating that an unsafe condition exists and the
3 Relay 1 power is not supplied to the thermoelectric unit 16 and the pump 14. If there is no
4 fault, a signal is applied to the Relay 1 through the buffer 114a. Thus, (a) if the temperature
5 sensor S1A detects that temperature of the heat transfer fluid is not within predetermined
6 limits, the thermoelectric unit 16 and pump 14 are turned off, or (b) if the level sensor S3
7 detects that the control unit CU is tipped over, the thermoelectric unit 16 and pump 14 are
8 turned off, or (c) if the sensor S4 detects insufficient heat transfer fluid in the reservoir R, the
9 thermoelectric unit 16 and pump 14 are turned off. When the signals at all three inputs 112a,
10 112b, and 112c indicate that a safe condition exists, the output of the OR gate 112 signals the
11 coil 91 to be energized to close the Relay 1 and supply electrical power the thermoelectric
12 unit 16 and the pump 14, thereby providing a failsafe mechanism.

13 The microprocessor 96 is programmed to interact with the user interface II (Fig. 2B)
14 in accordance the program outlined in the process flow chart shown in Fig. 7C. The chart
15 shows the set point temperature of the heat transfer fluid selected by the user pushing the
16 button B1 or B2. The selected temperature is displayed for a predetermined time period (a
17 few seconds) after which the actual temperature of the fluid is normally displayed.

18 In an alternate embodiment similar to that depicted in Fig. 1A, the set point
19 temperature may be varied in accordance with a temperature-time profile custom designed by
20 the user. In this embodiment the user interface III is used that includes a bank of
21 potentiometers 118 with sliders 120 that enable the user to select a plurality of different
22 temperature of the fluid over a prolonged time period, for example, 8 hours. A selection dial
23 124 may be used to select the time interval between temperature changes, for example, 1
24 minute, 5 minutes, 10 minutes, and 1 hour. The microprocessor 96 is programmed to interact
25 with the user interface III (Fig. 2) in accordance the program outlined in the process flow
26 chart shown in Fig. 7D. The chart shows the set point temperatures of the heat transfer fluid
27 selected by the user and the time intervals the user selected. As Figs. 3A through 3G
28 illustrate a wide variety of temperature-time profiles 126a through 126g respectively may be
29 provided using interface III. Thus, the interface III and associated circuitry enables the user
30 to program the control unit CU to provide an individualized custom temperature profile of the
31 heat transfer fluid over a selected period of time including adjusting the individualized
32 custom temperature profile to operate over portions of the selected period of time and for
33 adjusting the duration of the selected period of time.

Sample Specifications

1. Thermoelectric Unit 16 (TEU):

- a. TEU heat transfer capacity $Q_{\max} = 150 - 300$ Watts
- b. Delta temp 60°C or greater across the sides 80a and 80b over 24 volt range
- c. Expected range of ambient temperatures for normal operation 5°C to 50°C (approx 41°F to 122°F)
- d. Interfaces between TEU and heat conducting surfaces (heat sinks and heat transfer fluid) to be thermally well-coupled, using high thermal conductivity grease.

2. Water Pump 14:

- a. Capable of providing at least 0.25 -1 gallons per minute (GPM) at 6-20 psi.
- b. Components in contact with heat transfer fluid to be oxidation and corrosion resistant and tolerate exposure water, ethylene glycol and propylene glycol for a minimum of ten years without degradation of function.

3. Fan 24-Heat Sink:

- a. Fan/fins be capable of dissipating 150-300 Watts of heat and have a thermal resistance no greater than $0.15^{\circ}\text{C/Watt}$
- b. Forced convection type heat sink, fans low noise

4. Safeties:

- a. Water pump, fluid reservoir, and all tubes/vessels carrying water to be physically separated and isolated from the electronics, so that an internal leak unlikely to result in water on the electronic components.
- b. A user-resettable circuit breaker to be installed which will cut power to the unit in the event of a short circuit.
- c. Low water level interlock on fluid reservoir.
- d. Factory settable high and low temperature interlocks on fluid temperature (not user adjustable).
- e. High temperature interlock or thermal fuse on TEU to shut down the system in the event TEU temperature exceeds maximum design temperature, (typically 150°C).
- f. Tip-over detector on housing exterior

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SCOPE OF THE INVENTION

The above presents a description of the best mode we contemplate of carrying out our heating and cooling pad, control unit therefor, heating and cooling system, and method of controlling temperature while in bed, and of the manner and process of making and using them, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains to make and use our pad, control unit therefor, system, and method. Our pad, control unit therefor, system, and method are, however, susceptible to modifications and alternate constructions from the illustrative embodiments discussed above which are fully equivalent. Consequently, it is not the intention to limit our pad, control unit therefor, system, and method to the particular embodiments disclosed. On the contrary, our intention is to cover all modifications and alternate constructions coming within the spirit and scope of our pad, control unit therefor, system, and method as generally expressed by the following claims, which particularly point out and distinctly claim the subject matter of our invention:

CLAIMS

- 1
2
- 3 1. A personal, portable heating and cooling system for an individual comprising
4 a thin and flexible pad having an internal chamber for holding a heat transfer fluid
5 and an inlet and outlet connected to the chamber,
6 said chamber partitioned to form therein a passageway that directs a heat transfer fluid
7 to flow along a circuitous path between the inlet and outlet, said pad comprising a pair of
8 plastic sheets welded together by a plurality of spot welds arranged in a predetermined
9 pattern to form upon the pad being horizontally orientated a plurality of cushion pillows
10 along the passageway as the heat transfer fluid flows through the pad at a pressure
11 substantially from 3 to 20 pounds per square inch, and
12 a control unit having a housing enclosing a reservoir for holding the heat transfer
13 fluid, a pump for pumping the heat transfer fluid between the reservoir and the internal
14 chamber of the pad, and a heating and cooling apparatus for regulating the temperature of a
15 heat transfer fluid flowing between the reservoir and the chamber.
16
- 17 2. The system of claim 1 where the pad has a length substantially from 12 to 48 inches
18 and a width substantially from 12 to 36 inches and a thickness does not exceed 1/2 inch when
19 the heat transfer fluid flowing through the chamber at said pressure.
20
- 21 3. The system of claim 2 where the chamber has a volume substantially from 100 to 2
22 liters with the heat transfer fluid flowing through the chamber at said pressure.
23
- 24 4. The system of claim 3 where the pad has a substantially rectangular configuration.
25
- 26 5. A personal, portable heating and cooling system for an individual comprising
27 a thin and flexible pad having an inlet and outlet connected to an internal chamber for
28 holding a heat transfer fluid that flows between the inlet and outlet,
29 a control unit having a housing enclosing a reservoir for holding the heat transfer
30 fluid, a pump for pumping the heat transfer fluid between the reservoir and the internal
31 chamber of the pad, and a thermoelectric unit having a heating mode and cooling mode and
32 through which the heat transfer fluid flows upon being circulated by the pump between the
33 inlet and outlet of the chamber, and

1 a control circuit for operating the pump and the thermoelectric unit, said control
2 circuit including
3 a user interface having a selection member that enables the user to select a set point
4 temperature of the heat transfer fluid flowing through the chamber,
5 a temperature sensor for detecting the temperature of the heat transfer fluid, and
6 a switching circuit that switches the thermoelectric unit between the heating mode and
7 cooling mode as determined by a comparison between the set point temperature and the
8 temperature of the heat transfer fluid as detected by the temperature sensor.

9
10 6. The system of claim 5 including a variable voltage power supply having a power
11 rating substantially from 200 to 400 Watts over a 24 volt range, and the thermoelectric unit
12 has a power rating substantially from 150 to 300 Watts over a 24 volt range.

13
14 7. The system of claim 5 including means for detecting an abnormal and unsafe
15 condition, and upon detection of such condition, turning off the heating and cooling apparatus
16 and providing a signal to the user that an abnormal and unsafe condition exists.

17
18 8. A personal, portable heating and cooling system for an individual adapted for
19 operation at ambient air temperatures substantially from 41° F to 122 ° F, said system
20 comprising

21 a thin and flexible pad having an inlet and outlet connected to an internal chamber for
22 holding a heat transfer fluid that flows between the inlet and outlet,

23 a control unit having a housing enclosing a reservoir for holding the heat transfer
24 fluid, a pump for pumping the heat transfer fluid between the reservoir and the internal
25 chamber of the pad, and a thermoelectric unit having a heating mode and cooling mode and
26 through which the heat transfer fluid flows upon being circulated by the pump between the
27 inlet and outlet of the chamber, and

28 a control circuit for operating the pump and the thermoelectric unit, said control
29 circuit including

30 a user interface having a selection member that enables the user selected a set point
31 temperature of the heat transfer fluid,

32 a microprocessor for controlling the operation of the pump and thermoelectric unit,

33 a first temperature sensor for detecting ambient air temperature,

1 a second temperature sensor for detecting the temperature of the heat transfer fluid,
2 and
3 a comparator to compare the user selected set point temperature with the temperature
4 detected second temperature sensor and, as required based on said comparison, signal the
5 microprocessor to operate the thermoelectric unit to increase or decrease the temperature of
6 the heat transfer fluid flowing between the reservoir and the chamber,
7 said microprocessor controlling the rate of increase or decrease in temperature in
8 response to the ambient air temperature detected by the first temperature sensor.

9
10 9. A personal, portable heating and cooling system for an individual comprising
11 a thin and flexible pad having an internal chamber for holding a heat transfer fluid
12 and an inlet and outlet connected to the chamber,
13 said chamber partitioned to form therein a passageway that directs a heat transfer fluid
14 to flow along a circuitous path between the inlet and outlet,
15 a control unit having a housing enclosing a reservoir for holding the heat transfer
16 fluid, a pump for pumping the heat transfer fluid between the reservoir and the internal
17 chamber of the pad, and a heating and cooling apparatus for regulating the temperature of a
18 heat transfer fluid flowing between the reservoir and the chamber,
19 a temperature sensor for detecting the temperature of the heat transfer fluid, said
20 heating and cooling apparatus being turned off when the temperature sensor detects that
21 temperature of the heat transfer fluid is not within predetermined limits,
22 a level sensor on the exterior of the control unit for detecting the spatial orientation of
23 the control unit, said heating and cooling apparatus and pump being turned off when the level
24 sensor detects that the control unit is tipped over, and
25 a fluid sensor for detecting the amount of heat transfer fluid in the reservoir, said
26 heating and cooling apparatus and pump being turned off when the fluid sensor detects
27 insufficient heat transfer fluid in the reservoir.

28
29 10. The system of claim 9 including means for selecting the set point temperature of the
30 heat transfer fluid in the reservoir and displaying said selected set point temperature for a
31 predetermined time period after which the actual temperature of the fluid is displayed.

32

1 11. The system of claim 9 including means for enabling the user to program the heating
2 and cooling apparatus to provide an individualized custom temperature profile of the heat
3 transfer fluid over a selected period of time.

4
5 12. The system of claim 11 including means for adjusting the individualized custom
6 temperature profile to operate over portions of the selected period of time and means for
7 adjusting the duration of the selected period of time.

8
9 13. A personal, portable heating and cooling system for an individual comprising
10 pad including an internal liquid-tight chamber having an inlet and an outlet, and
11 a portable, compact control unit adapted to be placed in fluid communication with the
12 chamber,
13 said control unit including a housing having a reservoir for holding a heat transfer
14 fluid, a fluid plumbing network that circulates the heat transfer fluid at a pressure
15 substantially from 3 to 20 pounds per square inch between the chamber and the reservoir
16 upon placing the pad outlet in fluid communication with the reservoir and the reservoir in
17 fluid communication with the pad inlet, a bi-directional heat pump that cools or heats the heat
18 transfer fluid as said heat transfer fluid is circulated, and a user interface for controlling the
19 temperature of the heat transfer fluid as it flows through the chamber of the pad.

20
21 14. A personal, portable heating and cooling system for an individual comprising
22 a thin and flexible pad having an internal chamber for holding a heat transfer fluid
23 and an inlet and outlet connected to the chamber,
24 said chamber partitioned to form therein a passageway that directs a heat transfer fluid
25 to flow along a circuitous path between the inlet and outlet,
26 a control unit having
27 a housing enclosing a reservoir for holding the heat transfer fluid,
28 a pump for pumping the heat transfer fluid between the reservoir and the
29 internal chamber of the pad,
30 a heating and cooling apparatus for regulating the temperature of a heat
31 transfer fluid flowing between the reservoir and the chamber,
32 a power supply that provides a constant output voltage substantially from 0 to
33 24 volts, and

1 a converting circuit coupled to the power supply that is interactive active with
2 a user interface, said converting circuit having an operator element that enables a user
3 to set the temperature of the fluid by converting the constant output voltage to a
4 selectable variable voltage.

5
6 15. The system of claim 16 where the converting circuit provides a variable voltage from
7 0 to 24 volts and the power supply has a power rating substantially from 200 to 400 Watts
8 over a 24 volt range, and the heating and cooling apparatus has a power rating substantially
9 from 150 to 300 Watts over a 24 volt range.

10
11 16. A personal, portable heating and cooling system for an individual adapted for
12 operation in an ambient air environment at temperatures substantially from 41° F to 122 ° F,
13 said system comprising

14 a thin and flexible pad having an internal chamber for holding a heat transfer fluid
15 and an inlet and outlet connected to the chamber,

16 said chamber partitioned to form therein a passageway that directs a heat transfer fluid
17 to flow between the inlet and outlet, and

18 a control unit having a housing enclosing a reservoir for holding the heat transfer
19 fluid, a pump for pumping the heat transfer fluid between the reservoir and the internal
20 chamber of the pad, and a thermoelectric unit having a first side in heat transfer contact with
21 the ambient air environment and a second side,

22 said outlet of the pad being in communication with the thermoelectric unit so fluid
23 flowing from the pad passes the second side and makes heat transfer contact with said second
24 side,

25 said thermoelectric unit being responsive to alternating a polarity of an applied
26 voltage so heat flows from said second side into the fluid passing thereby or heat flows from
27 the fluid passing thereby into the second side,

28 said control unit including an electronic control circuit having a user interface that
29 enables a user to select the temperature of the fluid and compares said selected temperature
30 with the temperature of the fluid and alternates the polarity of the applied voltage until the
31 temperature of the fluid is substantially equal the selected temperature.

1 17. A thin and flexible heating and cooling pad comprising
2 a pair of liquid impenetrable flexible plastic sheets welded together to form between
3 said sheets a circuitous passageway, and
4 an inlet and an outlet in fluid communication with the passageway,
5 said passageway including a plurality of cushion pillows as the heat transfer fluid
6 flows through the pad upon the pad being horizontally orientated and inflated with a heat
7 transfer fluid at a pressure substantially from 3 to 20 pounds per square inch.

8
9 18. The pad of claim 16 where each sheet is substantially rectangular, each sheet has
10 substantially the same dimensions, the sheets each have edges and are bonded along the
11 edges to form the overall width and length dimensions of the chamber, which are only
12 slightly less than the width and length dimensions of the sheets.

13
14 19. The pad of claim 18 having a length substantially from 12 to 48 inches, a width
15 substantially from 12 to 36 inches

16
17 20. The pad of claim 17 where the inlet and outlet are nearby each other.

18
19 21. A thin and flexible heating and cooling pad comprising
20 a pair liquid impenetrable flexible plastic sheets bonded together to form between
21 them an internal chamber for holding a heat transfer fluid and an inlet and outlet in
22 communication with the chamber, said pad having a maximum thickness of substantially 1/2
23 inch when said chamber is filled with the heat transfer fluid,
24 said sheets overlying each other and bonded together by (a) linear welds between
25 facing surfaces of said overlying sheets to form within the chamber a passageway that directs
26 a heat transfer fluid to flow along a circuitous path between the inlet and outlet, and (b) spot
27 welds within the passageway to form fluid mixing zones along the passageway.

28
29 22. The pad of claim 20 where the number of spot welds per square inch of facing
30 surfaces is substantially from 4 to 25.

31
32 23. The pad of claim 20 where the area of spot welds is substantially from 0.003 to 0.012
33 square inches.

34

1 24. The pad of claim 20 where the spot welds are arranged in a predetermined grid pattern
2 comprising intersecting grid lines with individual spot welds located at intersections of the
3 grid lines.

4
5 25. A control unit for a heating and cooling pad comprising
6 a housing containing a reservoir for holding a heat transfer fluid, a temperature
7 sensor for detecting the temperature of the heat transfer fluid, a pump for pumping the heat
8 transfer fluid, a heating and cooling apparatus for regulating the temperature of a heat transfer
9 fluid, and a control unit,

10 said control unit including an electronic controller having a user interface on an
11 exterior of the housing that enables a user to set the temperature of the fluid,

12 said electronic controller including a comparator to compare a user selected set point
13 temperature with the temperature detected by temperature sensor and, if required based on
14 said comparison, signal the heating and cooling apparatus to increase or decrease the
15 temperature of the heat transfer fluid.

16
17 26. The control unit of claim 25 including a temperature sensor for detecting the
18 temperature of the heat transfer fluid, said heating and cooling apparatus being turned off
19 when the temperature sensor detects that temperature of the heat transfer fluid is not within
20 predetermined limits.

21 27. The control unit of claim 25 including a level sensor for detecting the spatial
22 orientation of the control unit, said heating and cooling apparatus being turned off when the
23 level sensor detects that the control unit is tipped over.

24
25 28. The control unit of claim 25 including a fluid sensor for detecting the amount of heat
26 transfer fluid in the reservoir, said heating and cooling apparatus being turned off when the
27 fluid sensor detects insufficient heat transfer fluid in the reservoir.

28
29 29. The control unit of claim 25 including means for detecting an abnormal and unsafe
30 condition and upon detection turning off the heating and cooling apparatus and providing a
31 signal to the user that an abnormal and unsafe condition exists.

32

1 30. The control unit of claim 25 including means for selecting the set point temperature of
2 the heat transfer fluid in the reservoir and displaying said selected set point temperature for a
3 predetermined time period after which the actual temperature of the fluid is displayed.

4
5 31. The control unit of claim 25 including means for enabling the user to program the
6 heating and cooling apparatus to provide an individualized custom temperature profile of the
7 heat transfer fluid over a selected period of time.

8
9 32. The control unit of claim 25 including means for adjusting the individualized custom
10 temperature profile to operate over portions of the selected period of time.

11
12 33. The control unit of claim 32 including means for adjusting the duration of the selected
13 period of time.

14
15 34. The control unit of claim 25 including a fan and a radiator device for facilitating heat
16 transfer.

17
18 35. A control unit for a heating and cooling pad comprising
19 a housing containing a reservoir for holding a heat transfer fluid, a pump for
20 pumping the heat transfer fluid, a heating and cooling apparatus for regulating the
21 temperature of a heat transfer fluid, and a control unit including
22 a power supply that provides a constant output voltage substantially from 0 to 24
23 volts, and
24 a converting circuit coupled to the power supply that is interactive active with a user
25 interface,
26 said converting circuit having an operator element that enables a user to set the
27 temperature of the fluid by converting the constant output voltage to a selectable variable
28 voltage.

29
30 36. A method of controlling temperature while in bed comprising
31 (a) positioning on the bed an enlarged thin flexible heating and cooling pad having an
32 internal chamber holding a heat transfer fluid, said pad having width and length dimensions
33 sufficient so a substantial portion of a user's body contacts the pad directly or indirectly when
34 lying on the pad, said pad having a maximum height of substantially 1/2 inch when the

1 chamber is filled with the heat transfer fluid at a pressure substantially from 3 to 20 pounds
2 per square inch,

3 (b) connecting the pad to a control unit having a housing enclosing a reservoir for
4 holding the heat transfer fluid, a pump for pumping the heat transfer fluid between the
5 reservoir and the pad, and a heating and cooling apparatus for regulating the temperature of a
6 heat transfer fluid flowing between the reservoir and the chamber, said control unit including
7 an electronic controller having a user interface that enables a user enables a user to increase
8 or decrease the temperature of the fluid, and

9 (c) increasing or decreasing the temperature of the heat transfer fluid flowing through
10 the pad.

11

Fig. 1

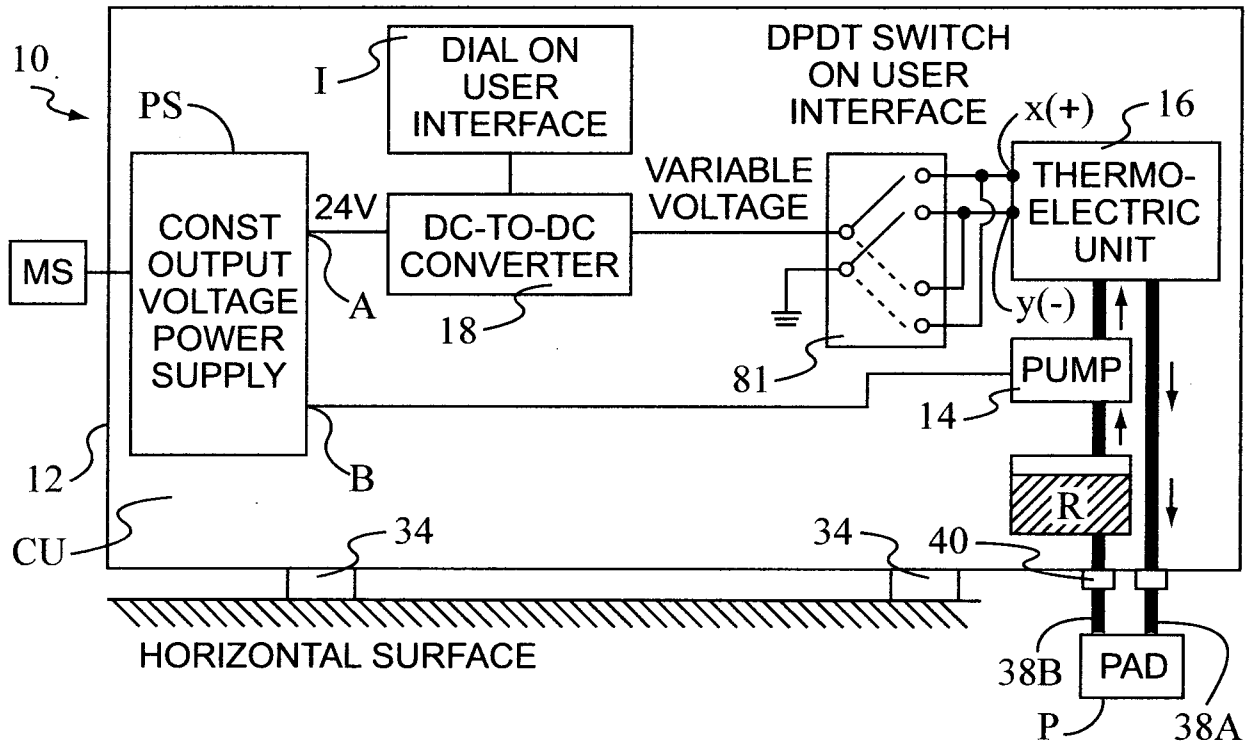


Fig. 1A

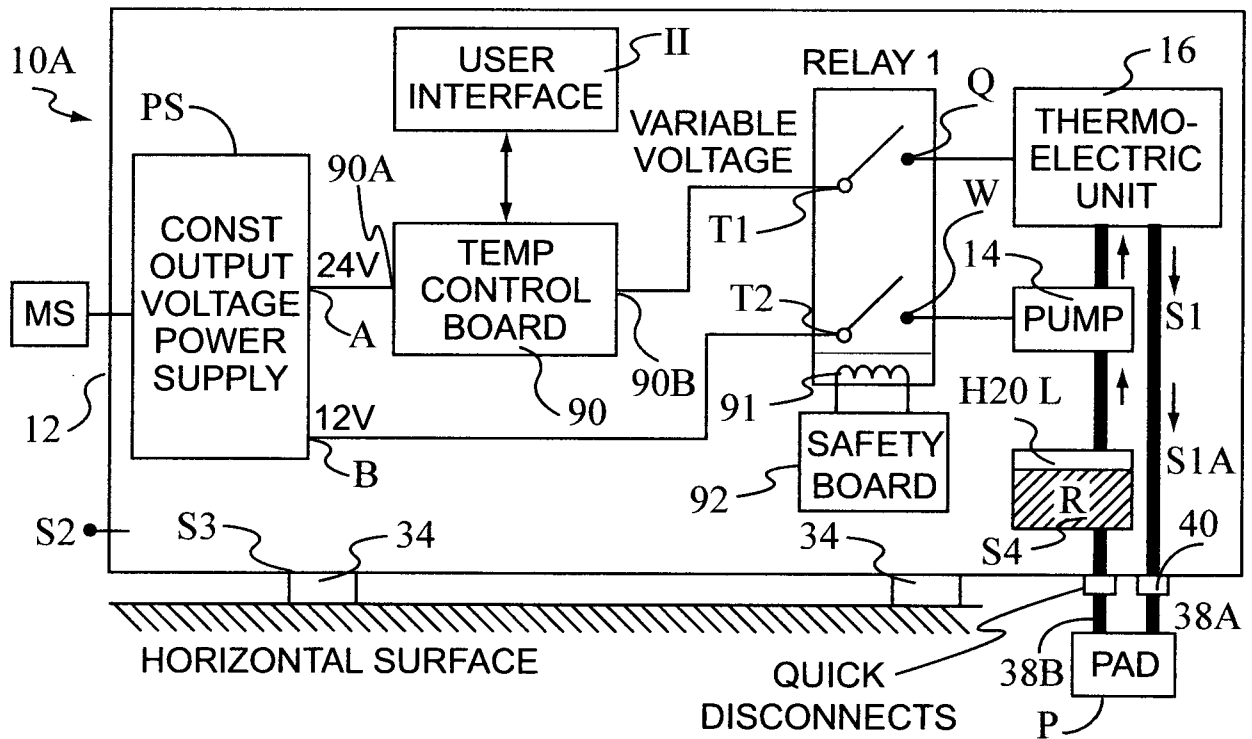


Fig. 2A

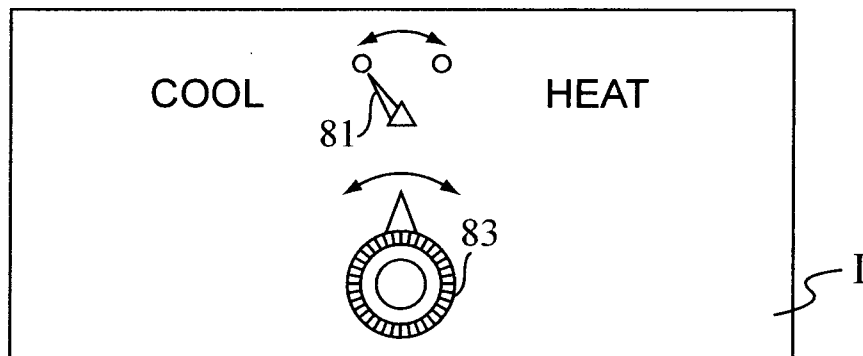


Fig. 2B

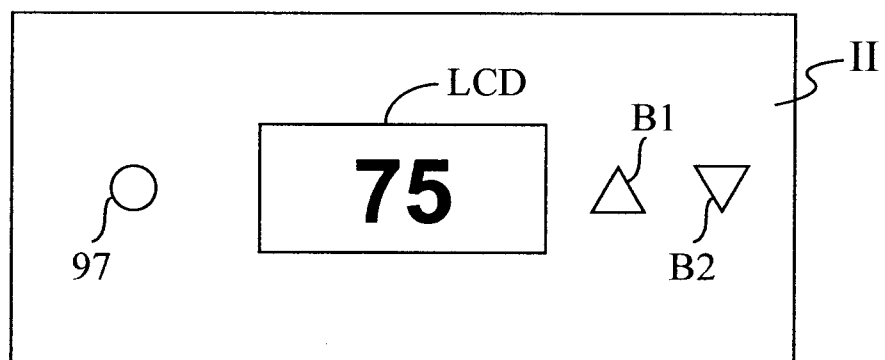


Fig. 2C

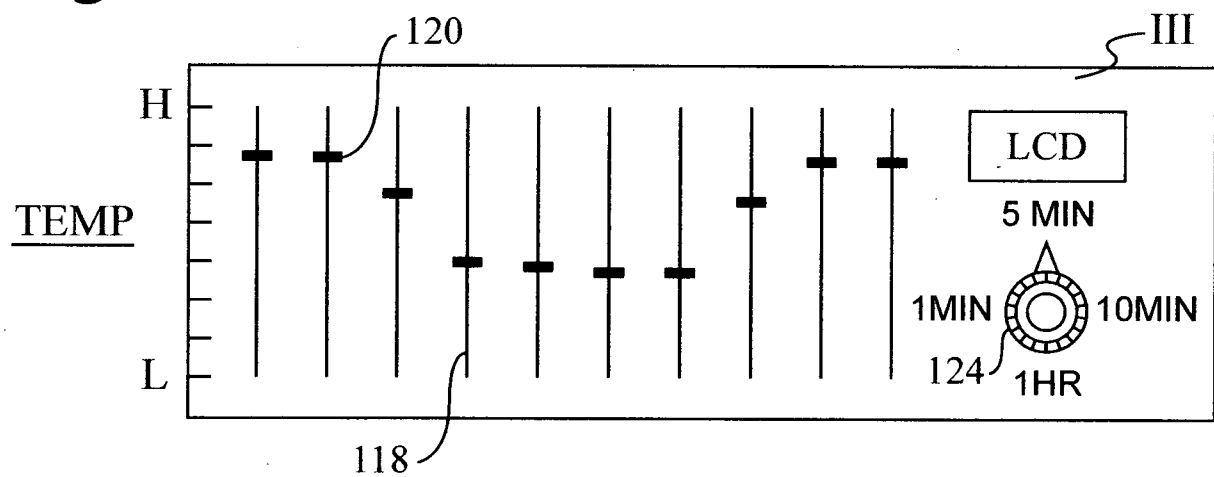


Fig. 3A

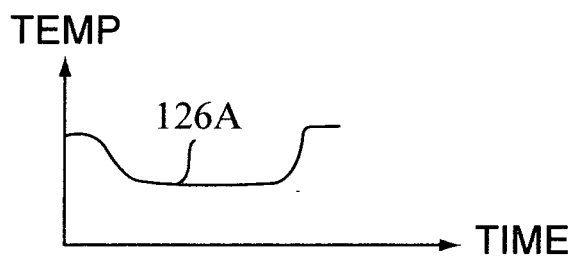


Fig. 3E

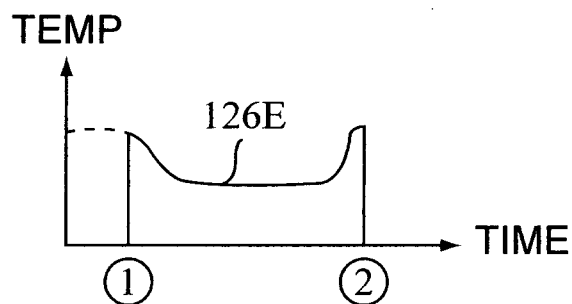


Fig. 3B

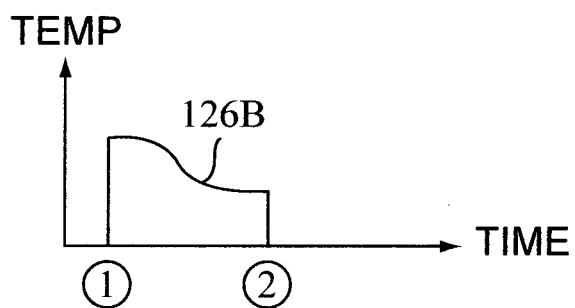


Fig. 3F

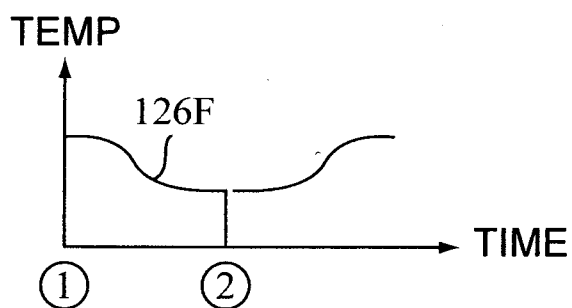


Fig. 3C

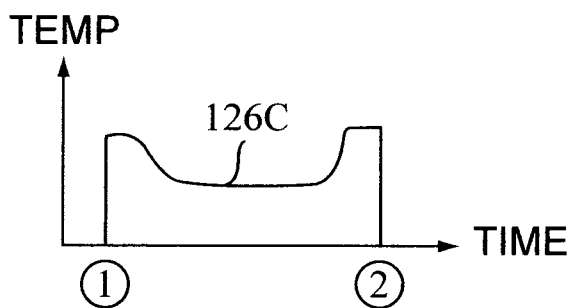


Fig. 3G

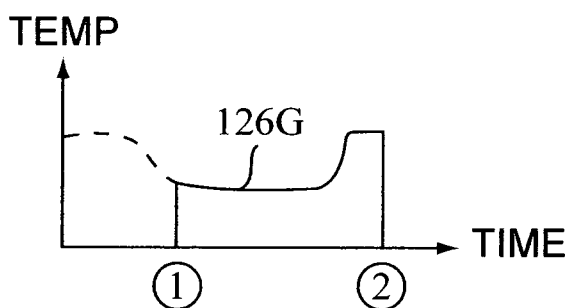
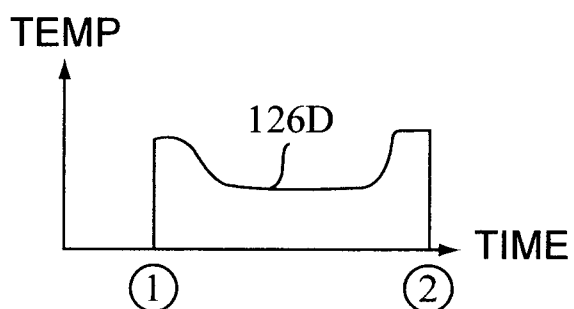


Fig. 3D



- ① Unit turned on
② Unit turned off

Fig. 4A

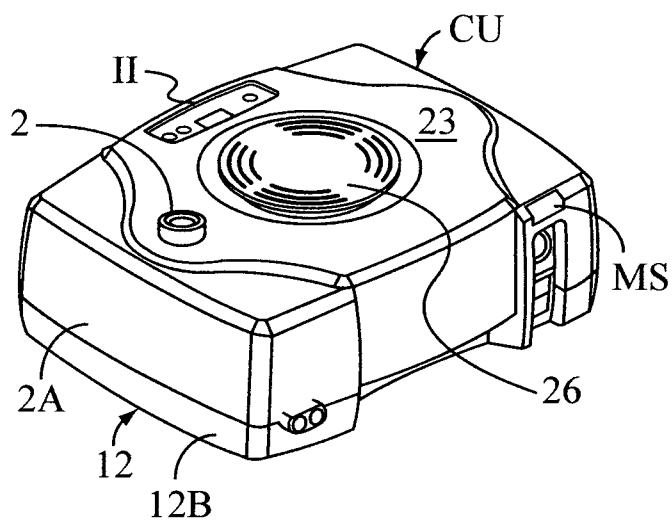


Fig. 4B

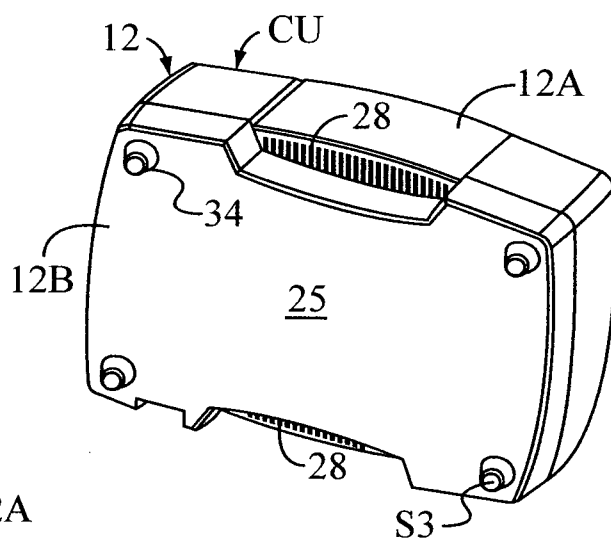


Fig. 4C

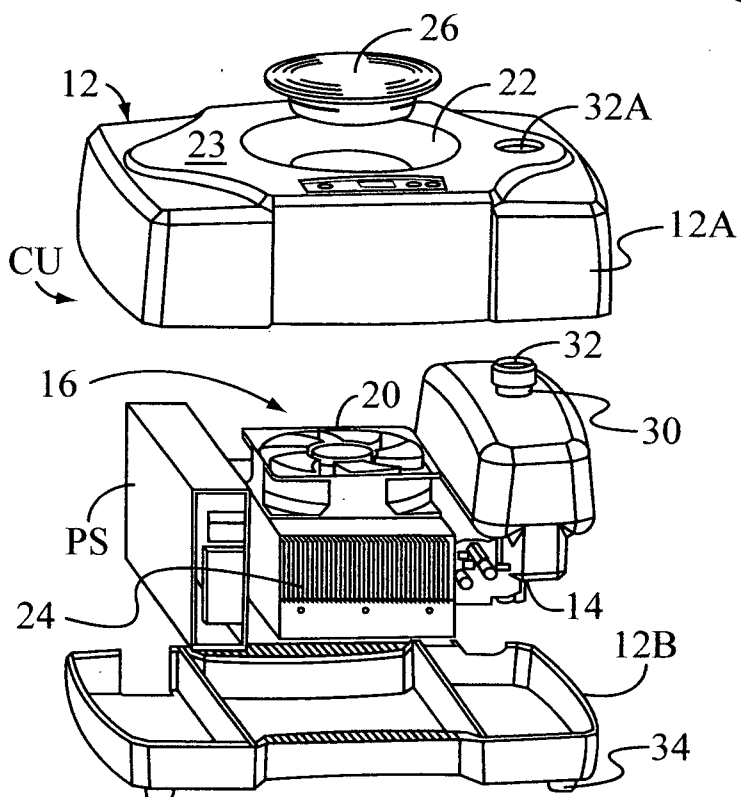


Fig. 5

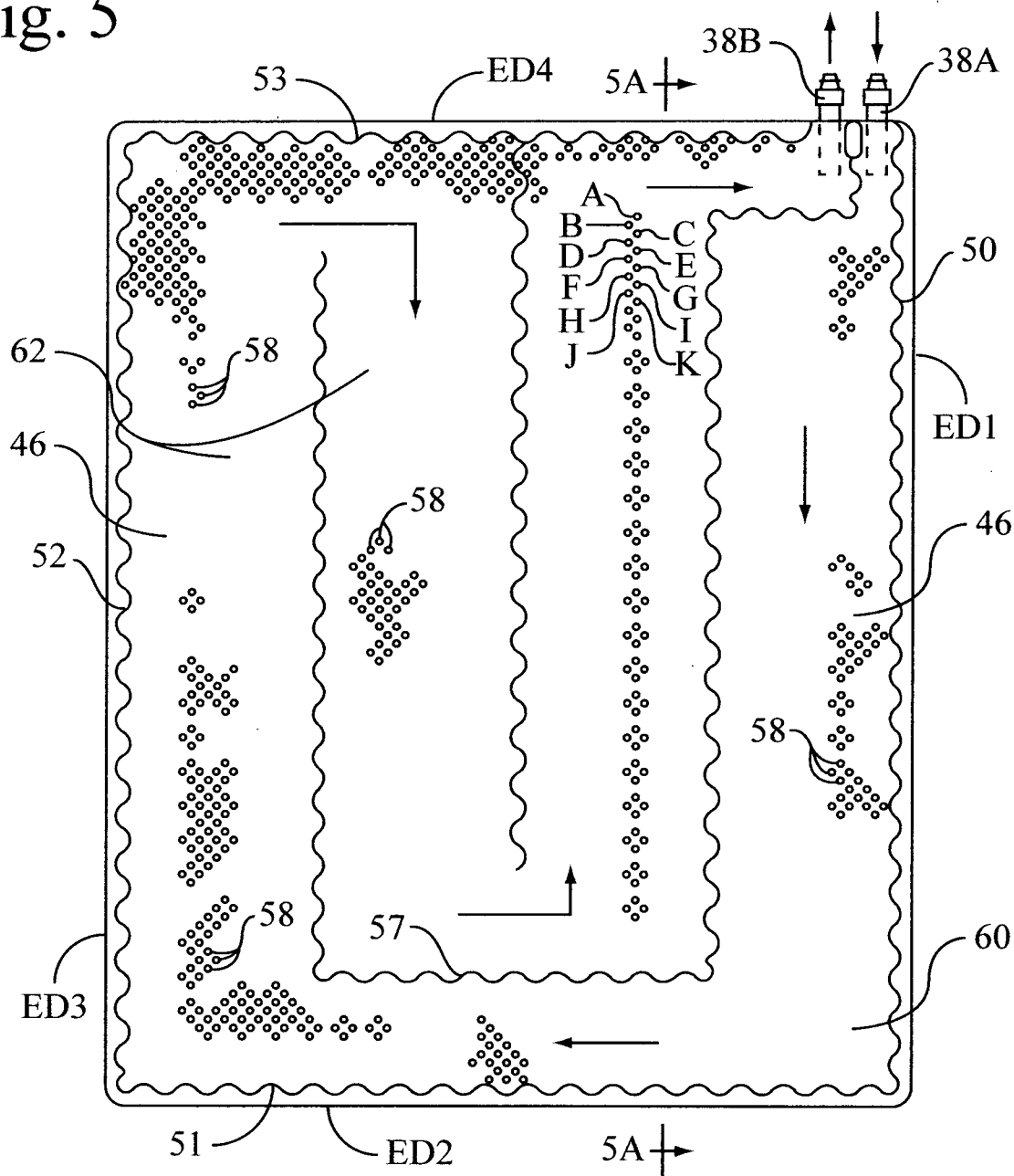
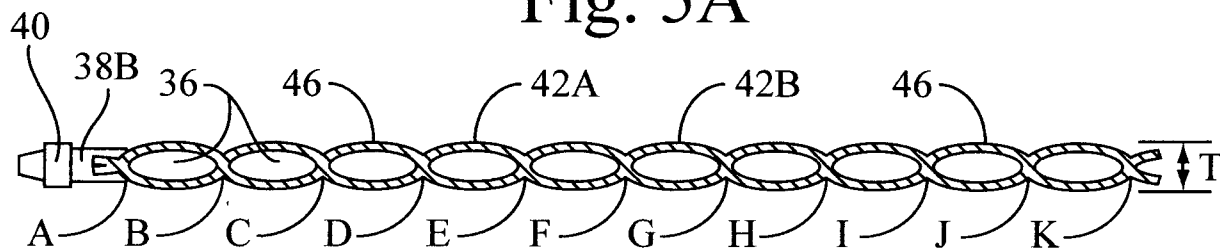


Fig. 5A



SUBSTITUTE SHEET (RULE 26)

Fig. 6

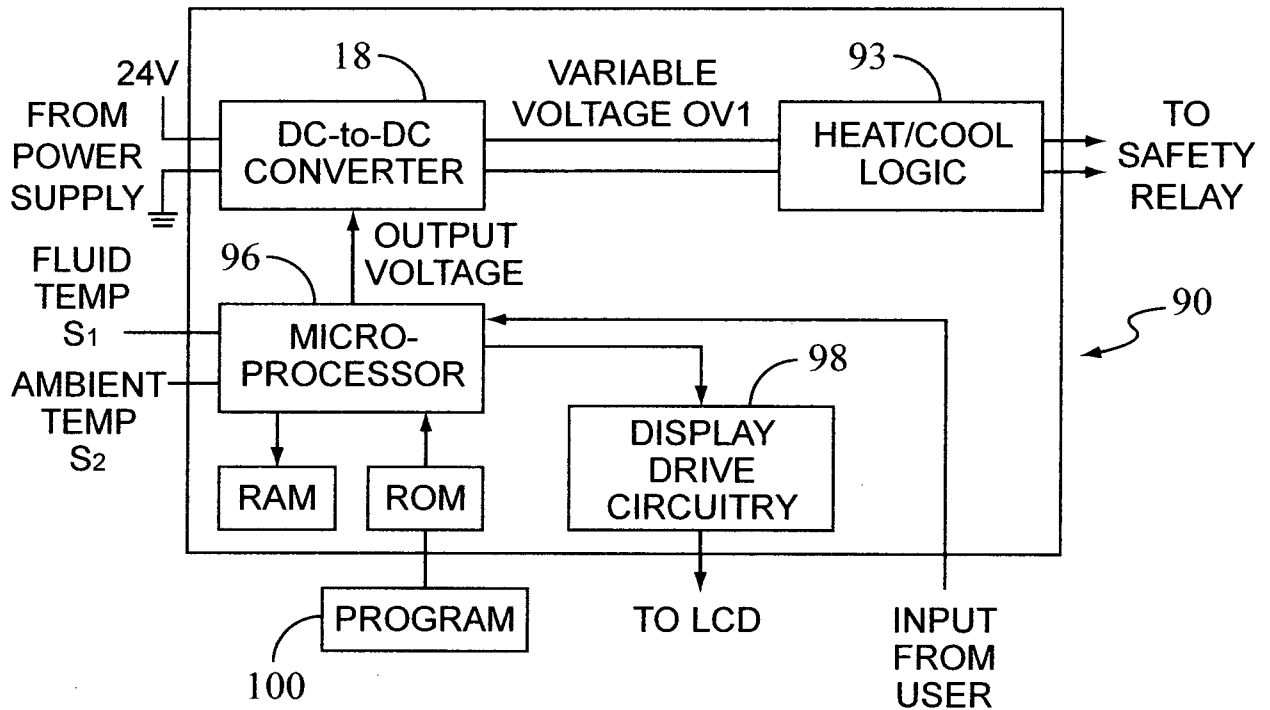


Fig. 7A

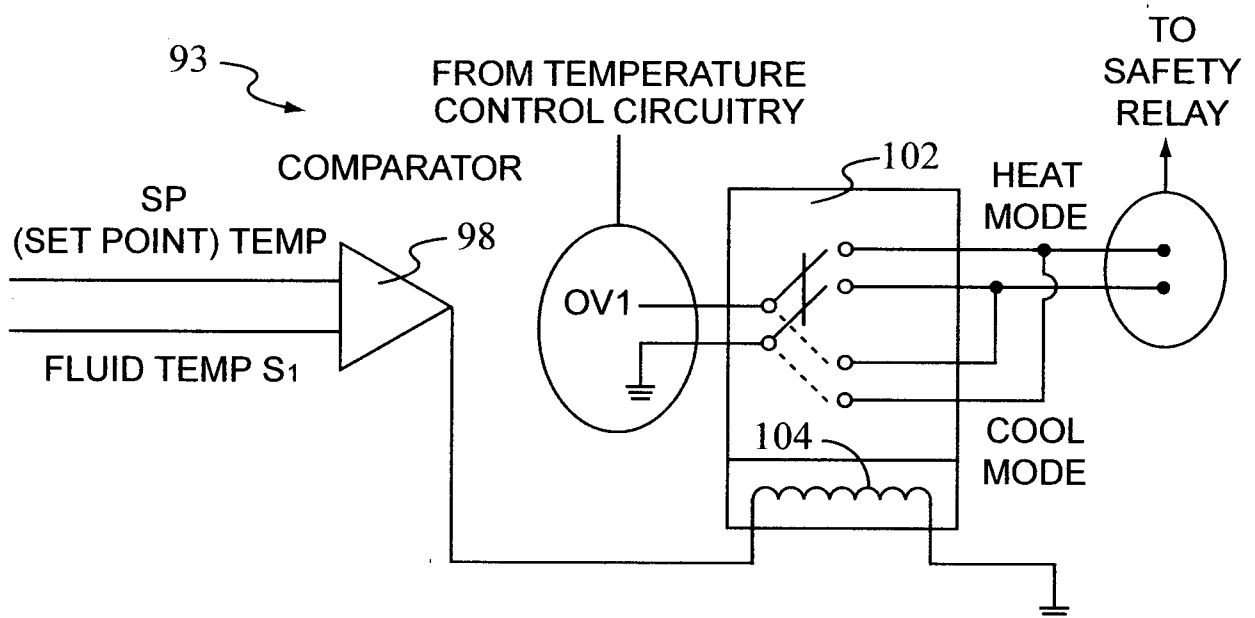


Fig. 7B

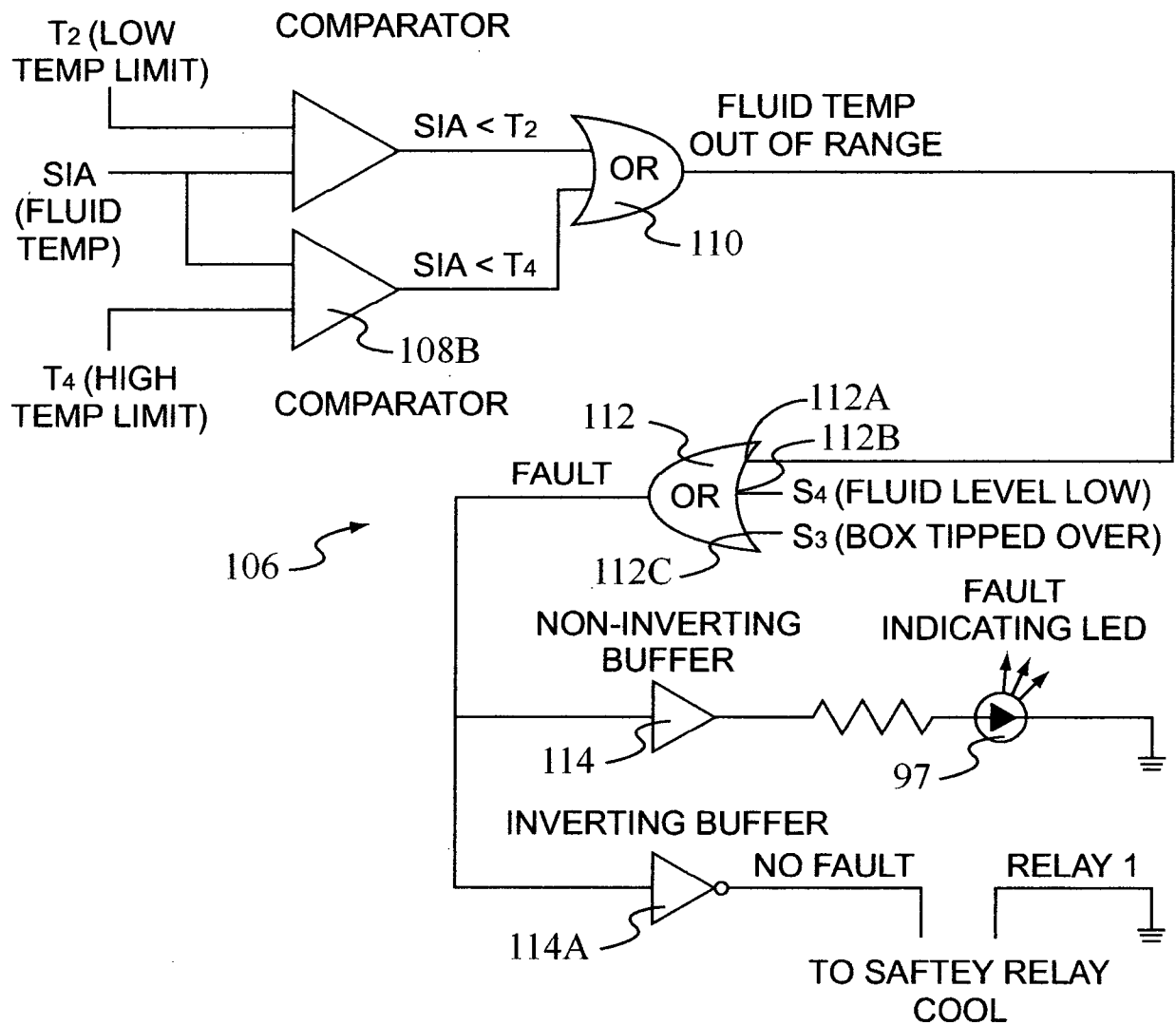


Fig. 7D

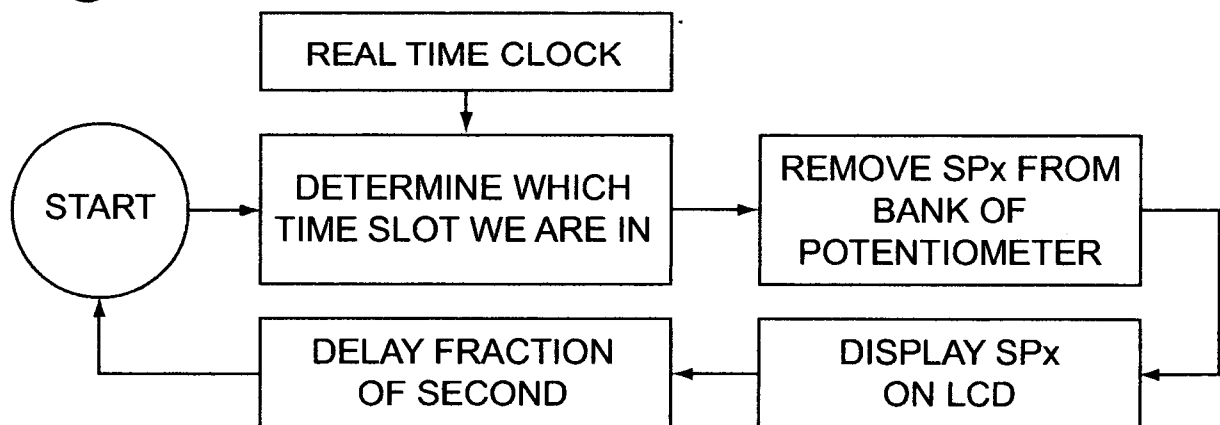


Fig. 7C

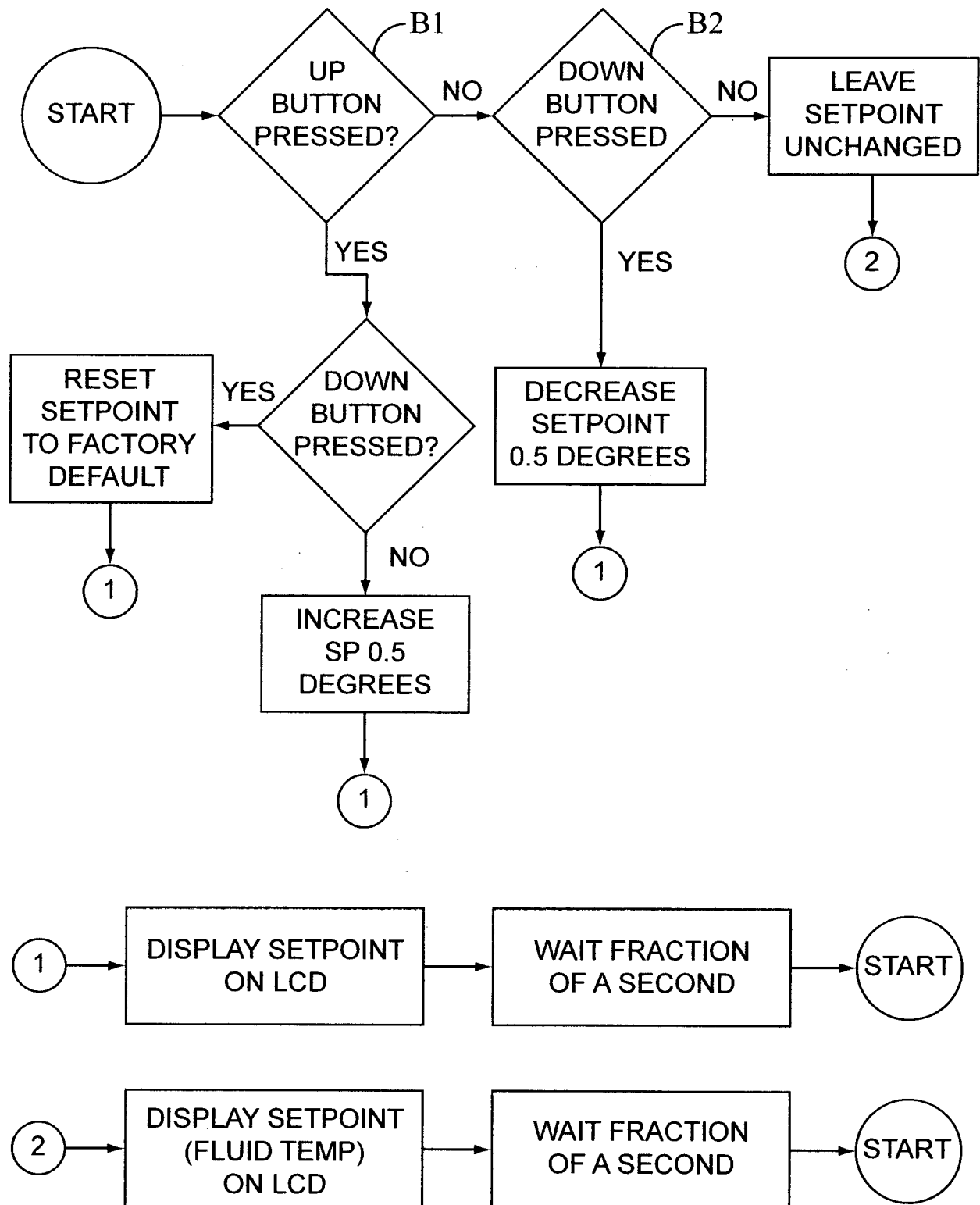


Fig. 8A

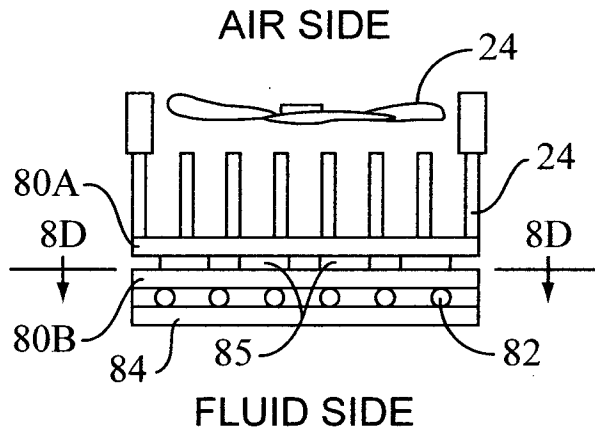


Fig. 8B

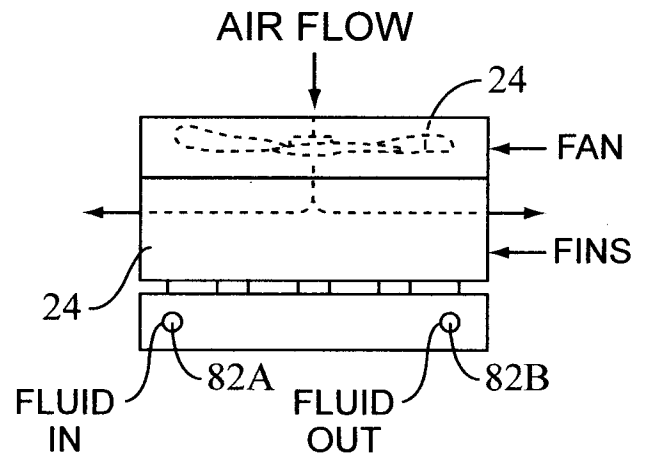


Fig. 8C

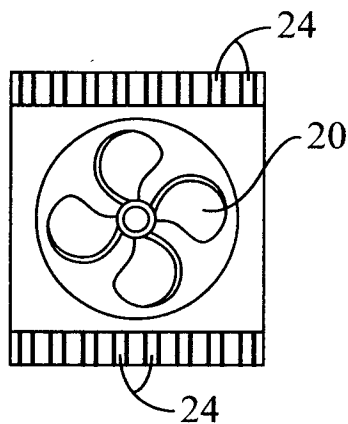


Fig. 8D

