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(54) **Personal cooling system**

(57) A personal cooling system has a user wearable garment incorporating a fluid path from an inlet port to an outlet port. The fluid path may be in the form of a fluid fillable envelope. A cooling unit is adapted to receive a supply of fluid and to reduce the temperature of the sup-

ply and admit the cooled fluid. A reservoir receives cooled fluid from the cooling unit. A pump is energisable to pump fluid from the reservoir through a conduit to the user wearable garment.

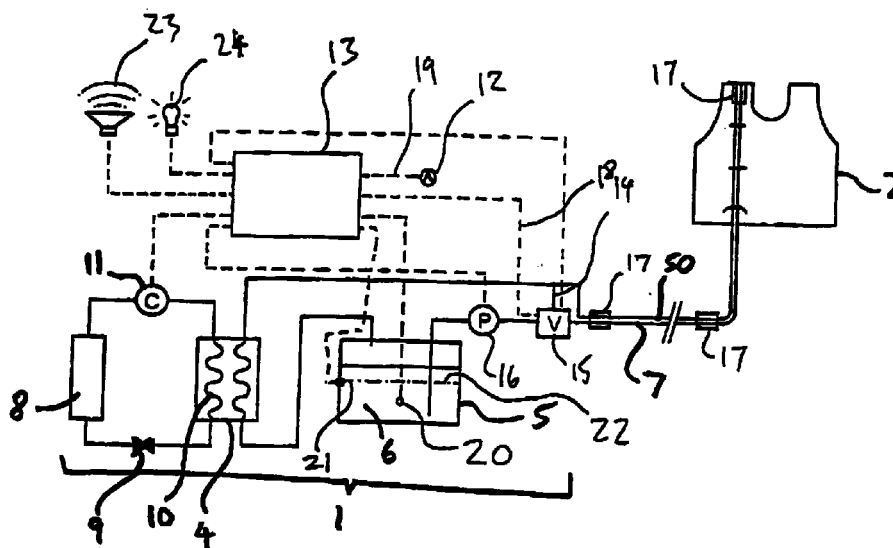


FIG. 4

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Description

BACKGROUND TO THE INVENTION

[0001] This invention relates to personal cooling system and in particular to a personal cooling garment and associated system for surgeons.

[0002] The working environment for the scrub team in an operating theatre is frequently too warm. For other staff within the same room such as the anaesthetist and for the patients themselves it is excessively cool. The reason why the scrub team does become warm is due to a number of factors. Some of these are:

1. The effects of stress.
2. Impervious and insulative clothing worn by the scrub team in an effort to minimize infection.
3. Overhead lights in close proximity.

[0003] The current situation within many operating theatres is that one group of people is uncomfortably hot and another is uncomfortably cool within the same room. No single room temperature will satisfy all. As a result the people who are cool wear extra clothing and a lot of effort and expense is incurred in maintaining the patient's temperature at an acceptable level. The theatre temperature chosen is frequently the highest that the surgeon will tolerate. In many pediatric operations the thermal needs of the patient are thought to outweigh those of the surgeon and these theatres are held at elevated temperatures in which case the surgeon and scrub team tend to sweat and generally suffer the effects of being excessively warm.

[0004] It is an object of the present invention to provide a personal cooling system which at least goes some way to overcoming the above disadvantages or which will at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

[0005] Accordingly in a first aspect the invention consists in a personal cooling system characterised by:

a user wearable garment incorporating a fluid path from an inlet port to an outlet port,
a cooling unit adapted to receive a supply of fluid and to reduce the temperature of a supply thus received and to emit fluid thus cooled,
a reservoir having an inlet means and an outlet means to respectively receive a supply of fluid and allow fluid to be drawn from said reservoir,
fluid circuit forming conduit means connecting said garment, said cooling unit and said reservoir in a circuit, and
fluid pumping means energisable to cause fluid to flow around said circuit.

[0006] To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention will be described with reference to the accompanying drawings in which;

Figure 1 is a perspective view of the personal cooling garment according to the present invention, together with general depiction of a cooling unit according to the present invention and associated connecting conduits,

Figure 2 is a plan elevation of the cooling garment of the present invention with the front and back sides thereof open flat and viewed from what may be considered the outside thereof,

Figure 3 is a view of the garment as shown in Figure 2 but viewed from what may be considered the inside thereof,

Figure 4 is a diagrammatic representation of a personal cooling system according to the present invention,

Figure 5A is a cross section of the garment of Figure 3, and

Figure 5B is a cross section through a hypothetical wearer wearing the garment of Figure 5A demonstrating the effect of the construction depicted in Figure 5A.

DETAILED DESCRIPTION

[0008] This invention consists of three main parts, these are:

1. A cooling/heating and pumping unit 1.
2. A garment 2 which allows a fluid to pass through it's interior and which is used to transfer heat to or from a person.
3. Extension tubes and connections 3 linking the above two parts together.

A description of each of these follows, and the associations and interactions between these parts will be simultaneously described.

THE COOLING AND PUMPING UNIT:

[0009] Referring in particular to Figure 4 the cooling unit 1 cools the fluid to be pumped through a cooling garment 2. This fluid is passed through a heat exchanger 4 and then to a reservoir 5. The fluid 6 within

the reservoir 5 is next pumped through a tube 7 for delivery to the garment 2. Fluid passes through internal passages of the garment 2 where it increases in temperature before returning to the heat exchanger 4 where it is again cooled before repeating the cycle.

[0010] It is envisaged that many variations of heat exchange will be appropriate. By way of example, the applicant proposes two embodiments. The first relies on a vapour compression cycle and the second relies on a thermoelectric device. The vapour compression type cooler uses a conventional refrigeration cycle where a refrigerant is pumped through a condenser 8, expansion valve 9, evaporator 10 and back to the pump 11. The evaporator 10 is constructed as a heat exchanger 4 which cools the fluid which will be pumped into the jacket 2.

[0011] The thermoelectric version of the cooler (not shown) relies on several Peltier elements to cool a continuous flow of fluid. This is achieved by passing the fluid through copper blocks which are affixed to the cool sides of Peltier elements. The warm side of the elements are attached to heat sinks where air fans in close proximity allow heat to be dissipated to the room.

[0012] In either case the operation of the cooling side of the heat exchanger is controlled by a central control unit 13 which may for example be an appropriately programmed CPU. This control unit 13 receives inputs from various sensor and switch devices throughout the cooling unit, and in turn controls operation of the cooling side of the heat exchanger (for example time of operation and/or speed of operation of the compressor 11) a fluid circulation pump 16 which pumps fluid from the reservoir 5 through the garment 2 back to the cooling unit, through the heat exchanger 4 and back to the reservoir 5, a bypass valve 15 and audible 23 and visual 24 indicators on the cooling unit. The sensors and switches providing input to the central control unit 13 include a temperature selection switch or device 12, a pressure sensor integrated with the bypass valve 15, a temperature sensor 20 in the fluid reservoir 5 and a temperature level switch 21 also in the fluid reservoir 5.

[0013] The cooling device preferably has additional heating elements (not shown) which allow the units to be used as heaters of the circulating fluid rather than as coolers. The heating elements also allow the fluid temperature to be raised at a rapid rate to reach a higher desired temperature in a shortened time. These elements may serve a dual purpose in defrosting the evaporator in the vapour compression embodiment.

[0014] For each cooling device there is lagging upon tubes and other objects likely to be held at temperatures below ambient.

[0015] With either fluid cooler a temperature control system is provided to allow the user to alter the temperature of the fluid being delivered to the garment. A temperature selection device such as rotary control 12 provides input 19 to a central control unit 13. The temperature chosen is that most suitable for the wearer of

the garment. One version of this control is located directly on the cooler itself but the selection device may be remotely displaced to a place of greater convenience such as to an outer wall of the room, to an anaesthesia machine or carried by another staff member.

[0016] It is an advantage to give a fast temperature change when the temperature is adjusted. Performance of a temperature ramping function may be useful and comfortable when the user first puts the garment on because a gradual temperature change may be more comfortable than a sudden one.

[0017] Internally within each cooling device there is a bypass 14 including a bypass valve 15 downstream from the pump 16 which allows fluid to short-circuit its usual route and pass directly from the pump 16 to the heat exchanger 4. This bypass valve activates if any of the water line connections 17 is disconnected or in the event of some other part of the tubing or garment becoming blocked or partially occluded. A pressure sensor or a flow sensor may be included, with the bypass valve activated on the basis of its output 18. Alternatively the bypass valve could be mechanical in nature requiring back pressure of a sufficient level to be present from the garment to remain open to the garment.

[0018] The central controller may also be configured to electrically shut down the system in the event of an overpressure or under pressure within the fluid downstream of the pump on the basis of the output of the pressure sensor. An underpressure could be caused by a fluid leak.

[0019] Within the reservoir of each cooling device is a water level monitor switch. If the water level drops to be below a certain minimum level 22 then on the basis of the output of the switch 21 the central control unit 13 will activate a shutdown of the circulating, cooling and heating functions of the device. Simultaneously a visual and audible indication of the reason for the shutdown will be given through speaker 23 and light 24. A reduction in reservoir water level indicates a fluid loss in the system, probably a leak.

[0020] Each cooler preferably has several temperature sensing devices located at strategic locations within their interiors. One of these, temperature sensor 20, allows the fluid temperature to be monitored. Others may cause a shutdown in event of excessively high or low temperatures at particular locations. The temperature sensor 20 is located within the reservoirs. Others may be located close to the cooling regions for either cooling device. A shutdown due to over temperature or under temperature would simultaneously activate a visual and audible indication via speaker 23 or light 24 of the reason for the shutdown.

[0021] The fluid used within the cooler may contain a biocide to keep that fluid free of bacterial and fungal growth.

[0022] The reservoir used within the cooler has a filling cap which may have a hydrophobic material as

part of its construction. This material allows the passage of air to and from the reservoir but will not allow the passage of fluid. Such use of a hydrophobic material prevents fluid from overflowing from the reservoir.

[0023] The cooler may have a mechanism to retract the tubing leading to the cooling garment so that it is kept off the floor.

THE COOLING GARMENT

[0024] The fluid-containing garment is adapted to be worn by a user. Referring to Figures 1 to 3 the garment is in the form of a "poncho" style vest, having a front panel 30 and back panel 31, a head/neck hole 32 and means 33 at the edges 34, 35 of the front and back panels to secure the edges together. Internal pathways exist within the garment through which fluid is able to flow.

[0025] The fluid pathways are provided in the form of a pair of fluid envelopes 34, one fitted to each of the front and back panel of the garment. The garment has a hole 32 through which a person's head can fit when wearing the garment. When worn the garment is able to simultaneously transfer heat from the front and back of the person's torso.

[0026] The fluid envelope 34 of the garment is primarily constructed from polymer film. Two sheets of this film are heat sealed in such a way as to provide internal pathways through which fluid can pass. The pathways have parallel circuitry to provide alternate routes for the fluid. The part of the garment formed by the film is flexible. Outer layer 35 of the jacket supports the fluid envelope, provides limited insulation, and protects against fluid sprays if a leak occurs (for example due to inadvertent puncture). The further layer 35 is preferably a cloth layer to which the fluid containing envelopes are stitched or bonded. Referring to Figure 5A it is preferred that a thick layer 36 of soft and resilient material is fixed between the cloth layer 35 and the fluid envelope 34. As indicated in Figure 5B the soft layer 36 compresses in some regions e.g. 37 less than in others e.g. 38 at the small of the back so that the fluid containing envelopes 34 are pressed against the user's body over a greater proportion of the surface thereof. The soft, resilient material may for example be a polymer foam material such as expanded polyurethane foam which has the additional benefit of providing significant thermal insulation. To improve the effectiveness of the foam impressing fluid containing envelopes against the wearer the foam may be thicker in specific areas or regions, such as that which is expected to be adjacent the small of the user's back. For structural strength it is preferred that the outer layer, such as a cotton fabric layer, has any adjustment straps connected thereto.

[0027] Fluid enters and leaves the garment via tubing 41 which may be an integral part of the garment. When worn by the user, these tubes are at the top of the garment so that the fluid fills the garment evenly, with-

out airlocks. One tube provides an inlet to the garment and another provides an outlet. This tubing is joined to the fluid envelope in such a way as to provide a good seal and not allow leakage of fluid. Trailing tubes 42 connect to the tubes 41 are attached to the remainder of the garment at about shoulder level when the garment is being worn and are long enough to reach the ankles of the person wearing the garment.

[0028] The tubing 42 is attached at key points 43 down the back of the garment in such a way as to provide strain relief for the tubing 42 if it is pulled on.

[0029] The garment has cutouts 44 in the vicinity of the shoulder to allow the free movement of the wearer's arms so that movement should not be restricted, especially when the arms are in front.

[0030] The garment is made in a poncho style. When initially fitted by the user the front 30 and back 31 of the garment will hang free and there will be no attachment on either side. In order to adjust the garment to suit the wearer and to give better contact between the garment and the wearer, the garment needs to be adjusted. The adjustments 33 consist of straps 45 distributed down both sides of the garment. The adjustments 33 may be in the form of velcro strapping (to connect with receptive pads 46) in combination with elastic or they may take some other form such as a buckle or tie ribbon.

[0031] When the straps of the garment are tightened, drawing the outer fabric layer of the garment front panel and back panel together, this causes the foam layer to compress and press the fluid envelope into natural body indents and generally provide improved contact than would be the case in the absence of the foam layer.

[0032] The garment may have a quantity of biocide within it. This biocide limits bacterial and fungal growth during storage.

[0033] The garment is constructed in such a way as to have a low resistance to fluid flow so that low pressures can be used. To do this large diameter tubing is used and there may be parallel pathways within the fluid envelope of the garment itself.

[0034] The free ends of both the inlet and outlet tubing have connections 47 which can be plugged in and out of the cooler or to the extension tubing which is mentioned below. These connections have an automatic shutoff valve integral to their construction which prevents the flow of fluid after the connectors have been disconnected. The inlet and outlet connections are preferably constructed and held together in such a way that they can both be connected and disconnected with one hand and do not need to be connected or disconnected individually.

THE CONNECTING TUBES AND CONNECTIONS:

[0035] Referring to Figures 1 and 4 the tubing of the garment can be connected directly to the cooler in use.

Alternately, an additional length of tubing 50 can be connected between the cooler and the garment. This extension allows the wearer to venture further from the cooler unit.

This tubing 50 is made of a material with a thickness and stiffness so that it is not easily occluded when stood upon by a person or when other stress or pressure is applied to it. The inlet and outlet tubing are held close together so that they are parallel and move as one. In addition to this there may be a thermally insulative layer on the outside of the tubing.

[0036] The connections on the extension are such that when the tubes are disconnected an automatic shutoff valve integral to that connection prevents the flow of fluid after it has been disconnected.

[0037] The inlet and outlet connections of both ends of the extension tubing are constructed and held together in such a way that they can be connected and disconnected with one band and do not need to be connected or disconnected individually.

SUMMARY

[0038] In summary the invention provides a garment and associated system for the cooling and warming of people. A person wears a garment to allow the transfer of heat. The device operates by delivering either warm or cold fluid to the garment which will cause that person to either lose or gain heat.

[0039] A specific application of this device is for use by medical staff within an operating theatre. It can also be used in other situations where medical staff are finding their physical comfort is being compromised by less than ideal working temperatures. In the operating theatre the people of particular interest are the scrub team and the surgeon in particular.

[0040] Other medical applications include the warming and cooling of patients in hospitals and also of people outside of the hospital who have thermoregulatory problems.

[0041] Outside of the medical arena the device will also find applications. A specific example of this is in the steel industry where staff are sometimes required to work in uncomfortably warm conditions.

[0042] The features disclosed in the foregoing description, in the claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

Claims

1. A personal cooling system characterised by:

a user wearable garment (2) incorporating a fluid path from an inlet port to an outlet port, a cooling unit (4) adapted to receive a supply of fluid and to reduce the temperature of a supply

thus received and to emit fluid thus cooled, a reservoir (5) having an inlet means and an outlet means to respectively receive a supply of fluid and allow fluid to be drawn from said reservoir, fluid circuit forming conduit means (7) connecting said garment (2), said cooling unit (4) and said reservoir (5) in a circuit, and fluid pumping means (16) energisable to cause fluid to flow around said circuit.

2. A personal cooling system as claimed in claim 1 wherein in said circuit, said pump (16) immediately follows said reservoir (5) and immediately precedes said user wearable garment (2).

3. A personal cooling system as claimed in either claim 1 or claim 2 wherein said user wearable garment (2) comprises a garment wearable in relation to a user's torso, said garment (2) includes one or more fluid fillable envelopes (34) having a substantially planar character, and said inlet and outlet ports are provided at or adjacent the uppermost portion of said one or more envelopes (34).

4. A personal cooling system as claimed in claim 3 wherein said garment (2) includes a front panel (30) and a back panel (31) delineated by the presence of a head/neck opening (32), and securing means (33) associated with the edges or edge regions of said front and back panels to secure said front panel (30) to said back panel (31) to surround a user's torso in use.

5. A personal cooling system as claimed in claim 4 wherein said garment includes fluid transporting conduit (42) extending from said inlet and outlet ports and secured along the back panel (31) of said garment (2) and extending for a substantial distance greater than the length of said back panel (31).

6. A personal cooling system as claimed in claim 5 wherein said fluid transporting conduit (42) secured to said garment (2) has a length such that in use it may extend from a user's shoulder to near the vicinity of a user's ankles.

7. A personal cooling system as claimed in any one of claims 4 to 6 wherein said garment (2) includes in the region of said head/neck opening (32) large rebates (44) into said garment from the sides thereof further delineating said front and back panels (30, 31) such that said panels are connected by a pair of bridges for spanning over the shoulders of a wearer and supporting the garment (2) in use, said rebates (44) being of sufficient size that a user's arm movement is substantially completely

unrestricted.

8. A personal cooling system as claimed in any one of claims 3 to 7 wherein said garment (2) includes an outer carrier web (35), said one or more fillable envelopes (34) supported from said outer carrier web (35), and a layer of soft resilient material (36) between said outer carrier web (35) and said one or more fluid fillable envelopes. 5
9. A personal cooling system as claimed in any one of claims 1 to 8 wherein throughout said circuit, fluid carrying connecting conduits are of a large diameter and fluid flow within said garment (2) is via a plurality of parallel paths such that the resistance of said circuit to fluid flow is low. 10 15
10. A personal cooling system as claimed in any one of claims 1 to 9 wherein a quantity of biocide is present in said fluid reservoir (5) and/or said garment (2) sufficient to keep fluid flowing through said system sterile for at least one month. 20
11. A personal cooling system as claimed in any one of claims 1 to 10 wherein said system includes user setting means (12) adjustable by a user to vary the temperature of fluid flowing to said garment (2), 25
temperature measuring means (20) for measuring the temperature of the fluid flowing within said circuit at a point between the exit from said cooling means (4) and the inlet port of said garment (2), and 30
cooling system control means (13) adapted to receive indications of a desired temperature setting from said user setting means (12) and of the temperature of said fluid from said temperature measuring means (20) and control operation of said cooler (4) and of said fluid pump (16) in response thereto. 35 40
12. A personal cooling system as claimed in any one of claims 1 to 11 wherein said system includes a bypass diversion valve (15) in the fluid path between said pump (16) and said garment (2), said valve (15) adapted to, either at the control of said controller (13) or in any other manner, divert fluid flowing in said circuit through a bypass conduit (14) to bypass said garment (2) and rejoin said circuit between the outlet port of said garment (2) and the inlet to said cooler (4). 45 50
13. A personal cooling system as claimed in any one of claims 1 to 12 wherein said system includes pressure monitoring means in said circuit between the inlet to said pump (16) and the inlet to said garment (2), and said controller (13) is adapted to control operation of said pump (16) and to provide an indi- 55

cation of error in response to adverse readings from said pressure monitoring means.

14. A personal cooling system as claimed in claim 13 wherein said pressure monitoring means comprises means for monitoring electrical load characteristics of said pump in (16) operation for changes in system conditions.

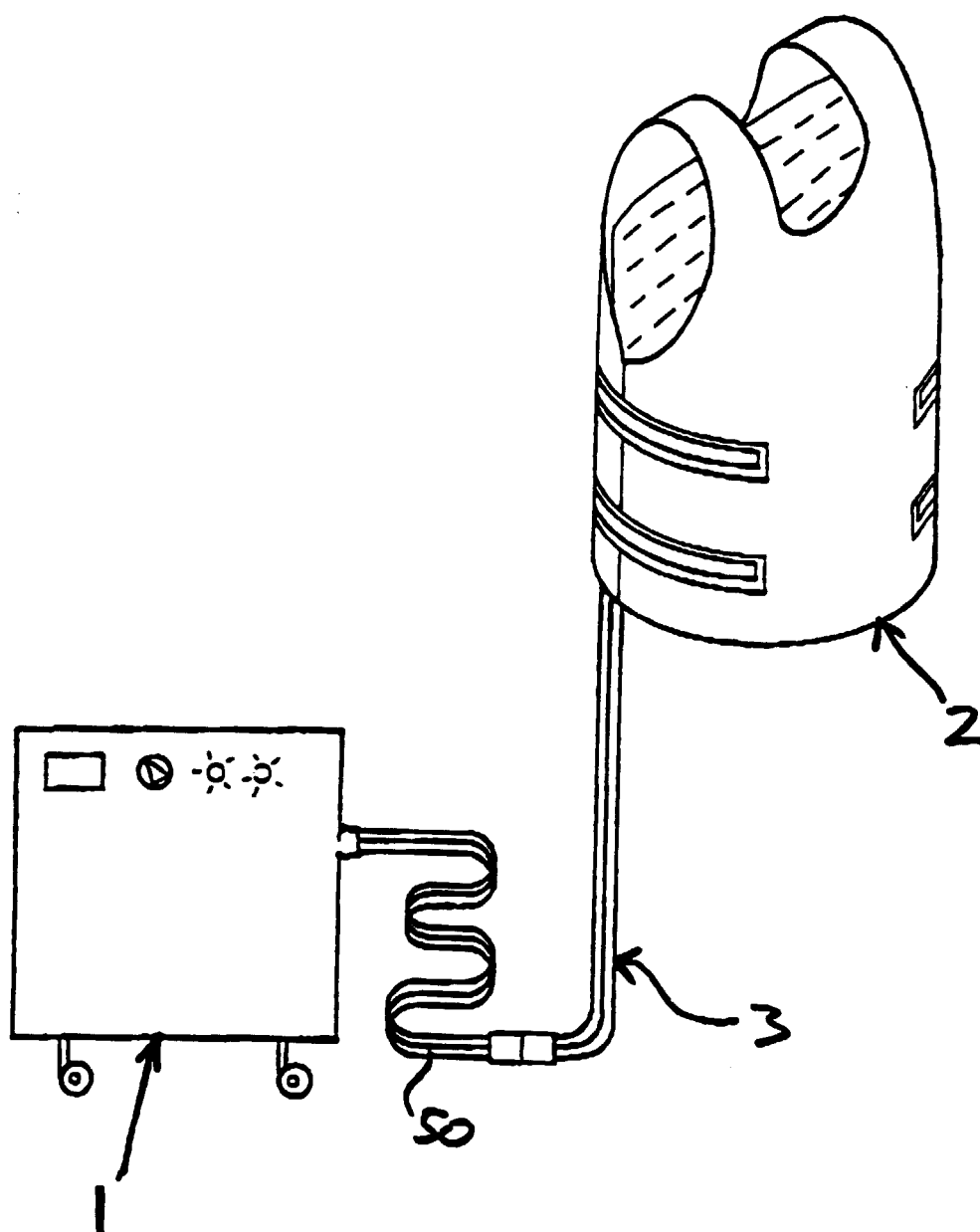


FIG. 1

FIG. 2

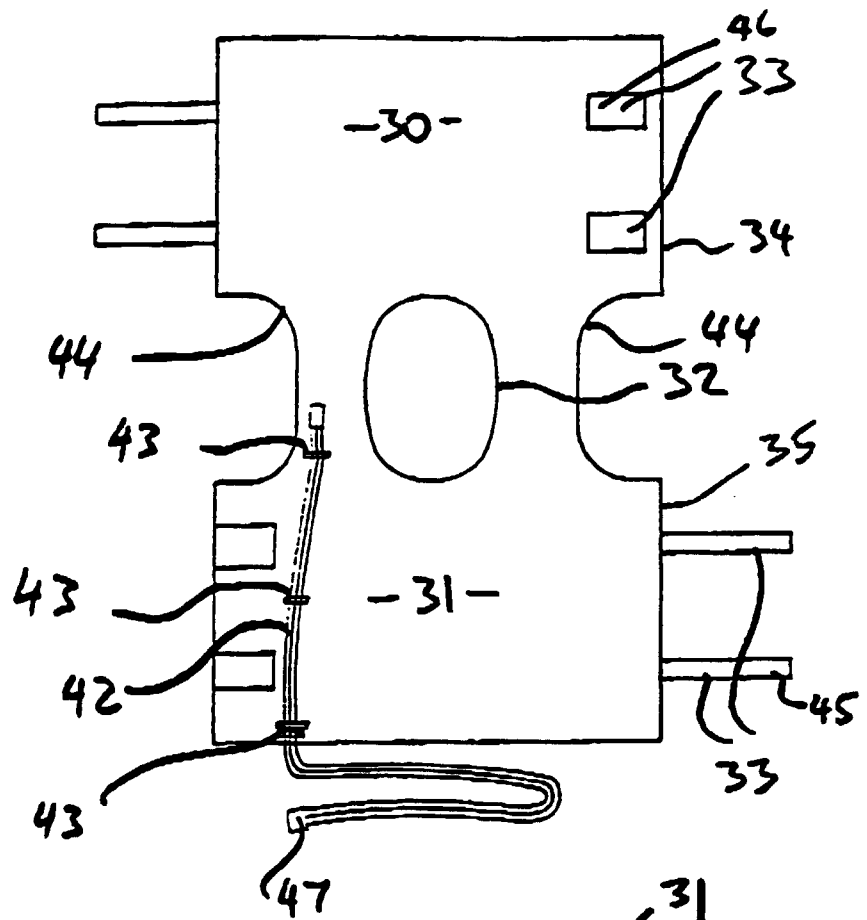
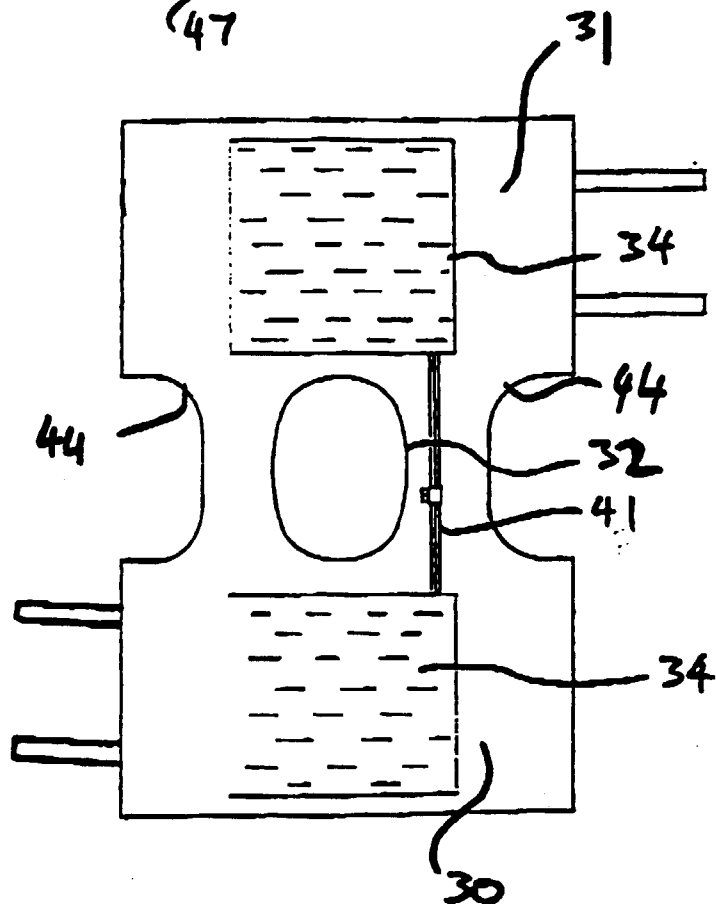


FIG. 3



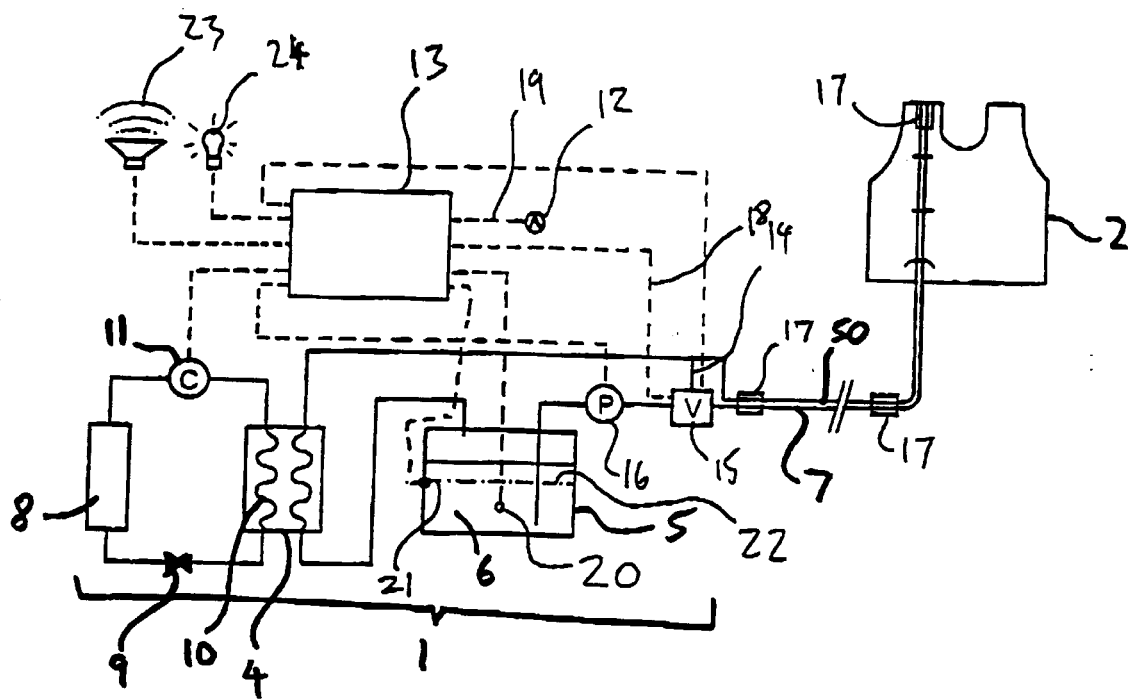


FIG. 4

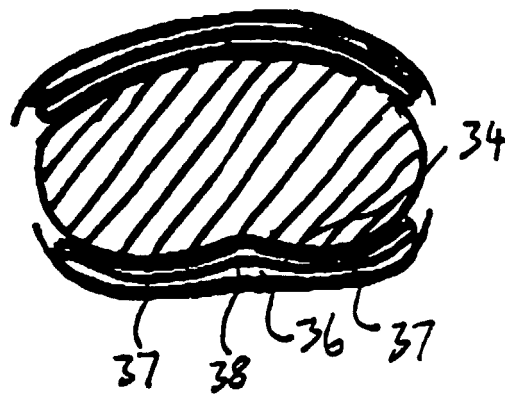


FIG 5B

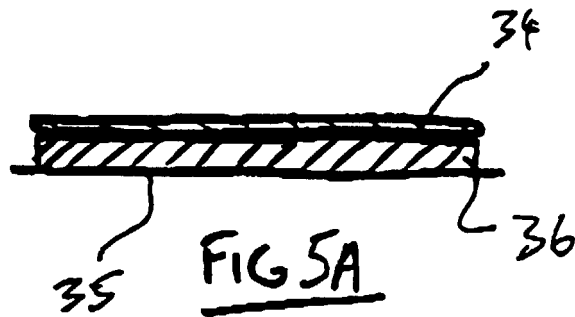


FIG 5A