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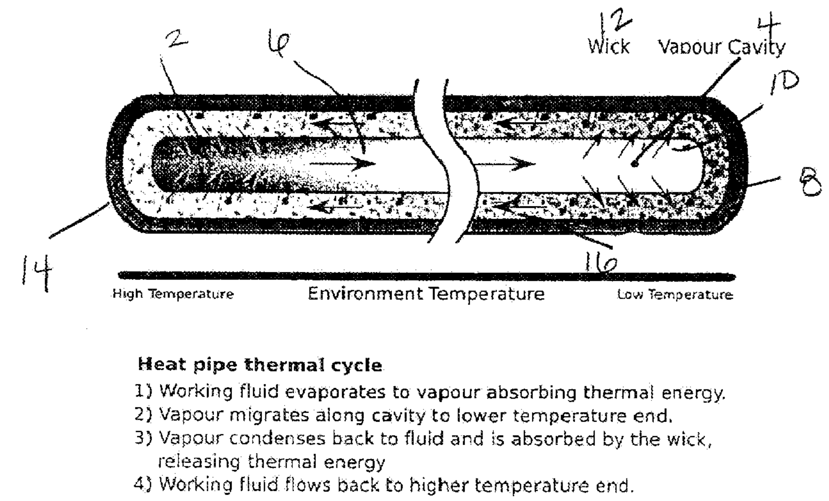

Figure 1

(57) Abstract: A process and system for heating or cooling comprising a ihermoelectric unit having a cooling surface and a heating surface, the cooling surface being thermally insulated from the heating surface is provided. A heat sink is thermally coupled the thermoelectric unit and a wicking material operatively coupled to the heat sink. The wicking material may be substantially saturated with a mixture of water and DNA to dissipate energy. An apparel item incorporating the system for heating and cooling is also provided.

WO 2008/103742 A2

APPAREL WITH HEATING AND COOLING CAPABILITIES

RELATED APPLICATION INFORMATION

This patent application claims priority from U.S. Provisional Application No. 60/903,231, filed on February 23, 2007 wherein the entire contents of which are incorporated herein by reference.

BACKGROUND

1. Technical Field

The present disclosure generally relates to a system and process for heating and cooling the body or a portion of the body and more particularly to apparel with heating and cooling capabilities incorporating the system and process for heating and cooling the body.

2. Description of the Related Art

There are presently two groups of personal thermo-regulated apparel. These two groups are active and passive. Active thermo-regulated apparel is designed to maintain the temperature that the user has selected while passive thermo-regulated apparel is not capable of maintaining the selected temperature over time. Currently available products in the active thermo-regulated apparel group are only capable of single applications such as heating or cooling. Current active heating technologies generally incorporate resistive heating. For example, Polartec® has integrated electrically resistive heating technology into a jacket. Similarly, compressive cooling is typically used in most currently available cooling apparel items.

Passive heating systems are generally chemical reaction heating systems. Likewise, passive cooling systems have included cooling with a phase change material, however, the systems currently available have not provided a system and process for heating and cooling that can be incorporated in wearable apparel for a wide variety of uses.

For example, U.S. Pat. No. 4,856,294 to Scaringe et al. describes a Micro-Climate Control Vest which contains a phase change material with a solid-to-liquid phase change as a cooling medium. The vest may also have an optional second phase change material layer of ice and an optional outer insulation layer. The inner liner containing the phase change material is divided into individual compartments due to the rigidity of the phase change material in its solid state. Thus, the apparel is rigid and inflexible making it uncomfortable to wear.

Another example of apparel incorporating phase change material is described in U.S. Pat. No. 4,894,931 to Senee et al. Senee describes a battery powered electric heating device incorporating phase change material such as salt for warming various body parts. The salt serves as a heat storage medium and as a temperature regulator for the resistance heater since it can absorb a lot of heat without rising above its melt temperature. As in many other devices of this nature, the rigidity of the system along with the rigidity of the salt make the system difficult to incorporate into various apparel items.

U.S. Pat. Nos. 4,572,158 to Fiedler describes a heating pad for warming body parts that use a supercooled phase change material salt solution for heat storage. The phase change material is liquefied and then can be cooled to room temperature without solidifying. A trigger is used to activate the salt, causing an exothermic crystallization. This device is sold with a cloth or neoprene cover to prevent burns when it is placed against the skin. Furthermore, this system is difficult to incorporate into apparel for heating and cooling the body.

U.S. Pat. No. 4,851,291 to Vigo et al. describes another method of making fibers with thermal storage properties by filling the core of a hollow fiber with a phase change material or absorbing a phase change material onto the surface of a non-hollow fiber. The phase change materials described include cross-linked polyethylene glycol and plastic crystals that have a solid-to-solid crystalline phase change. These fibers do not allow absorption of enough phase change material into the containment material to be of practical use in heating or cooling.

U.S. Pat. No. 6,763,671 to Klett et al. describes a closed-cycle cooling and protective apparatus. The apparatus includes a thermal battery cooling source. Unfortunately, this system is rigid and must be completely closed. Furthermore, even a small amount of damage to the system would render the system non-functional making it unsuitable for harsh working conditions.

SUMMARY OF THE INVENTION

Accordingly, the current disclosure relates to a system and process for heating or cooling the body that can be incorporated into a variety of apparel items. The user may direct a small electronic interface to either supply or remove heat to the insert, thus cooling or heating the individual.

The current system according to the current disclosure incorporates the novel design of a heat sink and relates to heat removal from hot side of the thermoelectric unit in cooling applications. Alternatively, it is envisioned that the system may be configured for heating applications.

The current disclosure incorporates a combination of thermoelectric devices and evaporative cooling in form of a novel heat sink attached to thermoelectrics. Additionally, a heat pipe or similar heat transfer system can be used in locations where evaporation cannot happen immediate to hot side of thermoelectric. In one embodiment, the system for heating or cooling includes a thermoelectric unit having a cooling surface and a heating surface, the cooling surface being thermally insulated from the heating surface, a heat sink thermally coupled the thermoelectric unit and a wicking material operatively coupled to the heat sink. The wicking material can be substantially saturated with a mixture of water and DNA to dissipate energy. A breathable layer is disposed on the wicking material to allow evaporation of the water to the environment. Furthermore, a phase change material may be disposed between the body and the cold side of the thermoelectric unit for storage of cold energy to increase the system functioning time. The system may include a unit that can be filled so as to allow a user to resaturate the wicking material with the water and DNA mixture. A battery unit or any other power source may power the thermoelectric unit.

The system according to the present disclosure can be incorporated in a wide variety of apparel items as further described below. Some apparel items include jackets, vests, helmets, shows, hats, undergarments, pants and socks.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present disclosure, which are believed to be novel, are set forth with particularity in the appended claims. The present disclosure, both as to its organization and manner of operation, together with further objectives and advantages, may be best understood by reference to the following description, taken in connection with the accompanying drawings as set forth below:

Figure 1 depicts an exemplary heat pipe that may be used in accordance with the present disclosure;

Figure 2 depicts a schematic of an exemplary system in accordance with the present disclosure;

Figure 3 depicts a cross-sectional view of one embodiment in accordance with the present disclosure;

Figure 4 depicts a perspective view of an exemplary heat sink in accordance with the present disclosure;

Figure 5 depicts a perspective view of one embodiment of the system in use in accordance with the present disclosure;

Figure 6 depicts a cross-sectional view of another embodiment in accordance with the present disclosure;

Figure 7 depicts a perspective view of an exemplary embodiment of the system incorporated into a jacket in accordance with the present disclosure; and

Figure 8 depicts cross-sectional view of an exemplary embodiment of the system incorporated into a helmet according to the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

The present disclosure will be described in connection with certain preferred embodiments, with reference to the following illustrative figures so that it may be more fully understood. With reference to the figures, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

Within the context of the present disclosure, the following definitions are used for the terms listed below. It should be noted that some of these terms have other definitions when used in other contexts.

The term "apparel" broadly refers to any article of clothing or similar garment such as jackets, biking shorts, biking shoes, biking jerseys, exercise suits, sport bras, spandex pants, under garments, shorts, tops, shirts, gloves, shoes, boots, ski boots, roller skates, ice skates, roller blades, socks, wrist bands, heart monitors, wrist watches, uniforms, baseball caps, golf caps, visors, head bands, hats, glasses, sunglasses, headphones, medallions, pendants, jewelry, necklaces, bracelets, anklets, chemical suits, bio suits, space suits, space helmets, bullet-proof vests, fire protective suits, motorcycle leathers, goggles, hard hats, construction helmets, welding masks, motor racing helmets, motor cycle helmets, motor racing suits, motor racing under garments, bicycle helmets, football helmets, batting helmets, cricket batting helmets, baseball batting helmets, softball helmets, skiing helmets, skiing suits and under garments, riding helmets, equestrian riding helmets, fencing masks, fencing tunics, shin guards, knee pads, military equipment hats, and military helmets.

The term "phase change material" refers to any material with a high heat of fusion which, melting and solidifying at certain temperatures, is capable of storing or releasing large amounts of energy. One skilled in the art will appreciate that a variety of phase change materials (both inorganic and organic) may be incorporated into the present disclosure such as PCM Latest™ from PCM Energy Pct Ltd. or calcium chloride hexahydrate. Other examples include Heptanone-4, n-Undecane, TEA-16, Ethylene glycol, water, Thermasorb 65 and Thermasorb 43. It is envisioned that a large variety of phase change materials can be incorporated into the system of the present disclosure.

The term "wicking material" refers to any material that has the ability to draw another substance into it. In accordance with the present disclosure, wicking materials include, for example, cotton, wicking fibers such as 4DG fibers, candle wick, super absorbents and sponges.

The term "coolant" generally refers to a fluid which flows through the system according to the present disclosure in order to transferring the heat because produced by the system to other areas of the system to utilize or dissipate the heat. Examples of coolants that may be employed according to the present disclosure include ammonia, water, ethlyl alcohol, polyethylene glycol among others

The term "liquid" refers to a fluid that can freely form a distinct surface at the boundaries of its bulk material. The surface is a free surface where the liquid is not constrained by a container. Liquids that can be used in saturate the wicking material according to the present disclosure include water and ethyl alcohol. It is also envisioned that fluids such as urine may be used in accordance with the present disclosure.

In accordance with the present disclosure, the system and process are based on the thermoelectric effect, which is the simultaneous cooling of one junction and heating of another junction in a thermocouple. The thermoelectric effect occurs when current is passed through two dissimilar metals or semiconductors (N-type and P-type) that are connected to each other at two junctions. Current thermoelectric devices are a network of thousands of P-N junctions with all P-type material facing one side and N-type facing the other side. Depending of the direction of the current, either P-type or N-type surface becomes hot or cold. Accordingly, the thermoelectric units incorporated into the system according to the present disclosure are highly efficient heat pumps that directly convert electricity into heating and cooling power. When power is supplied to the thermoelectric units, the current causes one side of the units (the cool side) to absorb heat. Meanwhile, the other side of the thermoelectric unit (the hot side) releases heat (the hot side). Thus, the thermoelectric unit causes heat to flow from the cool side to the hot side. Reversing the current causes the heat to be moved in the opposite direction thereby reversing the hot side and the cold side. Consequently, the heating and cooling according to the present disclosure may be selected by the user. One of ordinary skill in the art will recognize the various possible reconfigurations of the system according to the present disclosure to provide a variety of heating and cooling effects to a user of the system.

Heat pipes may be used in certain embodiments in accordance with the present disclosure. Heat pipes are thermally conductive tubes that can quickly transfer heat from one point to another by evaporating water at the hot side of the pipe and condensing it at the cold side. A general example of a heat pipe is shown in Figure 1. Working fluid evaporates to vapor absorbing thermal energy as depicted at 2. Vapor migrates along vapor cavity 4 shown at 6 to the lower temperature end 8. At 10, vapor then condenses back to fluid and is absorbed by the wick 12, releasing thermal energy. Working fluid flows back to higher temperature end 14, shown generally at 16.

Now referring to Figure 2, a schematic of a one embodiment of the thermoelectric system is shown. In this embodiment, a flexible heat pipe is incorporated in the system. Cooling plate 20 with embedded thermocouples rests against a portion of a person's body. The heat pipe vapor conduit 22 is connected to the heat pipe condenser unit 24. This heat pipe condenser unit may be clipped to the hip region of an individual or other area to allow for effective use of the system. A battery pack 28 supplies energy to the thermoelectric system and allows an operator to turn the system on or off. Thus, if for example, a person wishes to cool a body part, liquid will evaporate at cooling plate 20 and exit to heat pipe vapor conduit 22. The vapor will travel to condenser unit 24 where the condenser unit will condense the vapor and release thermal energy. The heat pipe liquid return 26 returns liquid to cooling plate 20.

In this particular embodiment, the core of the heat pipe can be made of a polycarbonate or similar material such as polyvinyl chloride, Kevlar® composite or a variety of other flexible composite materials and carbon nanotubes or similar material with high thermal conductivity such as silver, carbon fibers and graphite. The heat pipe can be coated with silver nanoparticle paste or carbon nanofibers with thermal conductivity of approximately 200 W/m-K. The ends of the heat pipe can have a high concentration of graphite incorporated into the material and carbon nanotubes with conductivity of 400 W/m-K. Other possible material combinations can be used such as carbon fibers and gold nanoparticles.

The system can, for example, be worn against the torso. A cross sectional view of such a system is shown in Figure 3. A cooling plate 30 incorporating a thermoelectric module 32 is worn against a torso 34 of a person. A cushioning gel 36 can be placed between cooling plate 30 and torso 34 to provide support and comfort for a user of the system. As the body is cooled, for example, vapor in the heat pipes 38 will travel to a condenser unit located away from torso 34. A Velcro attachment 40 can provide an attachment mechanism between the heat pipes 38 and body armor 42. Furthermore, thermal insulation 44 provides for insulation between the heat pipes and cooling plate 30. In addition to cushioning gel 36, a layer of conductive fabric may be placed between the thermoelectric unit and a user's skin.

Once heat is drawn away by the thermoelectric system described above, it must be dissipated. Direct dissipation by means of a heat sink attached to the hot side of the thermoelectric may be difficult to incorporate in this embodiment as the system may be worn beneath a bulky, armored vest. Thus, heat pipes as described above are incorporated to carry the heat away from the thermoelectric to a place where it can be safely and effectively vented to the outside environment.

A heat sink block or strip, which can be a thin aluminum pad (or similar conductive alloy, metal, or material, such as magnesium, carbon-fiber, and/or carbon-carbon materials or composites)of approximately .25 inches thick can be attached to the hot side of each thermoelectric unit through which heat pipes will be run. Various sizes of the heat sink block or strip can be selected based on the application and size of the system. A thermally conductive adhesive, such as double sided tape, epoxy cement, a highly thermally conductive heat film adhesive, or the like, may be used to mount the heat sinks onto the thermoelectric units. The coolant in the heat pipes will absorb the heat and carry it to the dissipater or condenser unit by means of the natural wicking action of the heat pipes.

The heat pipes can be adiabatically insulated to prevent transfer of warmth to the body, and will be flexible to allow for comfort of the user. For example, insulator that can be used include, for example, wool, Thermal Ceramics 400 Mineral Fiber Paper, Thermal Ceramics Min-K Type LW Insulating Tape and Zirconia ZYK-15 Ziconia Cloth.

When the system is shut off, the remaining energy must either be stored or dissipated so that the heat isn't transferred back to the individual using the system. The primary purpose of implementing a heat capacitor is to dissipate energy. The heat energy transferred from the thermoelectric should be constantly dissipated into the outside environment or stored in another form of energy, which will increase the efficiency of the total system. The total system is designed to add or remove about 173 kcal/hour (200 Watts) from a human body. However, by small changes in the design, this capacity can be significantly increased or decreased.

According to the present disclosure, a heat capacitor can be implemented, which is shown in Figure 4. The heat capacitor may be placed by the hip of the user or another location that is convenient for the particular application and use. As shown in Figure 4, the heat capacitor can be a vacuum-sealed container 50 with internal fins 52 that holds water filled with artificially synthesized deoxyribonucleic acid (DNA). Heat pipes 54 runs through fins 52 and heat capacitor 50 such that the heat capacitor dissipates the heat being removed from the individual. The amount of water, the amount of DNA, and the number of fins will depend on the size of the heat capacitor. The heat is dissipated by the evaporation of water and the breaking of the hydrogen bonds within the DNA. To evaporate 10g of water, approximately 6kcal of energy is required. To break a mole of hydrogen bonds, the system requires 10kcal. Preferably the heat capacitor will contain 200g of water with 10 moles of hydrogen bonds present in the DNA.

As described above, heat pipes 54 will run through heat capacitor 50, so heat exchange can occur between the heat pipes and the coolant, which is water and DNA in one embodiment. The use of the heat capacitor, with its large surface area, allows for vastly improved heat transfer from the heat pipes to the coolant. A variety of coolants may be used.

In one exemplary embodiment, the heat capacitor has 1/16" thick square fins that are 1" long. There can be 64 fins per square inch layered over a 2" sq box. This gives 1280 fins per heat capacitor. Laying a thin cover over the fins may help prevent damage and/ or snagging.

This embodiment provides a surface area of 1.6×10^{-4} per fin, or a net finned surface area of 0.205 m^2. If a convection constant of 70 is assumed and a ΔT of 5° C ($T_{ambient}$ is 40° C and $T_{hot\ side}$ of thermoelectric is 45° C), 72 W of heat is dissipated from the box via forced air convection.

The fluid in the heat capacitor box can absorb a net heat of 5434 J. In conditions when the box is taking in the ideal 200 W and losing 143.5 W, there is a net difference of 56.5 W. Thus, the 56.5 W of heat will be stored by a combination of the breaking of the hydrogen bonds and through the evaporation of the water.

An exemplary embodiment of the system incorporated into a vest according to the present disclosure is shown in Figure 5. In this embodiment, a thermoelectric array 70 covers a large portion of the user's torso. Flexible heat pipes 72 are coupled to thermoelectric array 70 as to carry heat away from the user's body. Each thermoelectric unit in the thermoelectric array may be constructed with the heat sink or strip as described above. The heat pipes carry the vaporized liquid to heat capacitor 74. Flexible heat pipes 72 may be attached to heat capacitor 74 with a detachable plug or other means to operatively connect the heat pipes to the heat sink such that heat is dissipated. A battery pack 76 is attached to the system. The battery pack can provide variable temperature control and can attached to body armor, vest or other clothing or apparel a user may be wearing.

The batteries can be selected for the largest possible Ampere/hour (ah) value and minimum weight. Preferably, they will be rechargeable and as lightweight as possible. The back of the vest can contain pockets which snugly hold the batteries. Types of batteries that may be incorporated into the present system include Lithium Ion, Lithium metal hydride, lithium polymer among others. Other power sources may be envisioned. For examples, other sources may be used to power the system such as wind, solar and mechanical sources.

The thermoelectric array can consists of approximately 6 to 9 thermoelectric units. This number can be increased or decreased to accommodate for persons of various sizes. In one embodiment, each thermoelectric is attached to a steel pad approximately 1/16" thick steel. The steel pad thermally couples the heat sink and the thermoelectric unit on one side and on the other side it acts to increase conductivity between the torso and the thermoelectric unit.

Each thermoelectric unit can be attached to the surface of a user's vest, on top of aluminum mesh, for example, to act as the heat sink or strip, with the base of the aluminum cup, which is an encasing for the thermoelectric unit. Preferably, each thermoelectric unit is thin and is approximately no more than 0.5 inches this. Similarly, the aluminum cup can have very thin walls to reduce thermal resistance as well as weight. A previously described, other suitable materials that may be used in place of the aluminum mesh such as steel mesh or carbon fiber fabric. Carbon nanotubes can also be used as heat sink replacing aluminum. A composite material made of CNT, Polymers and fibers can also be used to perform the heat transfer and also act as the heat sink.

These thermoelectric units provide effective and direct heat transfer away from the body. Thermal backwash is solved through a timing circuit. Thus, when the system is turned off, the power supply is not disconnected immediately, which prevents thermal backflow until the temperatures are in equilibrium.

By way of example, when the system according to the present disclosure is incorporated into a vest, the system may include a snug-fitting, natural cotton vest onto which a metal blend 'fabric' panel is attached such that it sits across the user's chest. This panel can be made of aluminum-dipped cotton thread to allow for effective heat exchange between the thermoelectric and the body. Aluminum, with its thermal conductivity (k) value of 222 W/m-K, provides essentially negligible thermal resistance so the user will feel the same temperature as that on the cold side of the thermoelectric, while the cotton core provides additional strength in tension.

This vest can also be constructed without the fabric, using thin aluminum contact pads connected directly to the cotton fabric of the vest, though the fabric may provide more comfort to a user.

The thermoelectric system according to the present disclosure, may have a large possible range of operating temperatures, which are also current dependent. The heat transfer rate is directly proportional to the current that passes through the thermoelectric. A current regulator control can be attached to the thermoelectric array so that the user can control the temperature of the vest to suit their situation. A current regulator will also prevent battery waste, because thermoelectric units are not self-regulating in their draw of current from a battery.

In a preferred embodiment, while heat pipes may be used, they are not necessary. An example cross section of this embodiment is shown in Figure 6. At least one thermoelectric unit 80 sits against the body of a user. A cushioning gel may be placed between a thermoelectric unit and the user for additional comfort. In addition to cushioning gel, a layer of conductive fabric or other conductive material may be placed between the user and the thermoelectric. A phase change material can be thermally coupled to the side of the thermoelectric facing the torso for storing heat or acting as a heat absorbent material to increase the singe use life lifetime. These lays may be connected by way of an adhesive or other connective material. A battery 82 is attached to the thermoelectric unit such that is provides electricity to the thermoelectric unit. On the hot side of the thermoelectric unit 80 is an aluminum, or similar conductive alloy, metal, or material, such as magnesium, carbon-fiber, and or carbon materials or composites heat sink 84, which may be partially or fully exposed on a hot side of the thermoelectric unit. As previously discussed, when power is supplied to the thermoelectric unit or units, the current causes on side of the thermoelectric unit to absorb heat, which the other side releases heat (the hot side). The thermoelectric unit causes heat to flow from the cool side to the hot side. If the current is reversed the heat will move in the opposite direction, allowing a person to heat rather than cool a body part. As the cool side of the thermoelectric cools the body, the heat is drawn to the hot side of the thermoelectric and through the aluminum or other alloy heat sink 84.

A wicking material 86, such as cotton is disposed on the aluminum heat sink. Wicking material 86 can have water and DNA such that heat is dissipated by the evaporation of water and the breaking of the hydrogen bonds within the DNA. In the heat sink the water can be mixed with DNA to act as heat capacitor. DNA has hydrogen bonds and when the water with DNA is heated the hydrogen bonds break by absorbing heat. The DNA is recharged when the system is switched off such that is supply of heat to the heat sink is stopped. This makes the DNA a good self recharging material to be used in the system according to the present disclosure. Wicking material 86 absorbs energy and facilitates and the dissipation of the energy. A breathable fabric or as another alternative, a porous material coupled to the wicking material allows the water to evaporate into the atmosphere.

If it is not feasible or is impracticable to allow for evaporation to the outside from certain areas of an apparel item, heat pipes may be used to carry the heat to a heat capacitor located at the hip, armpit or other area conveniently located to allow for heat dissipation and evaporation of water from the wicking material.

Furthermore, as the water evaporates, it may become desirable to add more water to the system. An optional pack may be operatively connected to the system to refill the system as desired. This pack may be carried on a users body and connected at all times or be carried separately and attached when needed. It is desirable to use water as the evaporating liquid, however, other liquids such as ammonia or ethyl alcohol can be used.

Another example is shown in Figure 7. A temperature controller 92 is located on a user's jacket to allow for easily accessible control of the system. Temperature controller 92 is operatively connected a battery pack 94 to provide energy to a thermoelectric units 96. The thermoelectric units can be selected such that the cold side is closest to the body or the hot side is closest to the body depending on the desired use of the system according to the present disclosure. An aluminum or other acceptable material as described above is disposed about the thermoelectric unit to act as a heat sink 98. A wicking material 100 having water and DNA is used as previously describe to dissipated energy into the atmosphere. A breathable layer operatively disposed on wicking material 100 allows the water or similar material to evaporate outside of the jacket 102.

A helmet incorporating the system is shown in Figure 8. The thermoelectric 110 may sit directly again a user's hear or have a gel or cushioning material between the user and the thermoelectric. A battery 112 supplies power to the thermoelectric. A heat sink material 114 is operatively connected to the thermoelectric. A wicking material 116 is operatively connected to the aluminum heat sink. Wicking material has water and DNA or other liquid which evaporates and dissipates energy. A phase change material 118 allows for evaporation to the environment from the helmet. Alternatively, if there it is not feasible to allow for evaporation at the point of the thermoelectric, the heat may be carried to another portion of the helmet or body to allow for evaporation in a different area. Furthermore, the entire helmet can act as a heat sink and allow water or another liquid to evaporate from the entire surface.

It is envisioned that the system according to the present disclosure can be incorporated into a large variety of apparel items as listed above.

In all embodiments as described above components that make up the personal heat-control device may include an operational switch, a control circuit board (printed or otherwise), one or more thermoelectric units, one or more batteries and one or more water (or other suitable material) supply. The components may be distributed within and/or permanently or temporarily attached to an item of apparel incorporating the system according to the present disclosure. Depending upon the particular application or garment, two or more of the components may be co-located or combined. These components may be broken down into smaller sub-components, for example, one or more thermoelectric units may be located remotely from one or more other thermoelectric units to provide a more distributed cooling effect. Likewise, batteries may be distributed throughout the apparel or in one located depending on the application and desire of the user.

An operational switch may be communicatively coupled to a control circuit board and the control circuit board operatively coupled to the to the thermoelectric units to receive temperature information such that the duration of the heat transfer cycle or other adjustments may be made by the user.

The operational switch can be a solid-state electronic timing switch operable by a user to activate and deactivate heat transfer cycles modulated by optional electronics, such as a timer and/or other monitoring or control circuitry. According to one embodiment, the optional electronics provide timed cycling (pulsing) of the thermoelectric units to extend operational time per battery charge, to avoid overcooling, to increase the comfort of the user, and/or accommodate battery recovery. According to some embodiments of the present invention, control circuit board may be a programmable logic device such that they may be programmed to pulse of cycle the thermoelectric units in certain patters. These patterns may be programmed via an external computing source, such as a laptop computer. According to some embodiments of the present invention, the control circuit board may also include a radio receiver or transceiver and be programmed and/or reprogrammed via radio signals.

The transmission of one or more of control signaling and/or status information among several of the distributed components is can be via wireless means. In other embodiments, the transmission of one or more of power, control signaling and/or status information among several of the distributed components is via one or more fine conductive wires formed as part of the material of an apparel item.

It will be understood that various modifications may be made to the embodiments disclosed herein. Therefore, the above description should not be construed as limiting, but merely as exemplification of the various embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

WHAT IS CLAIMED IS:

1. A system for heating or cooling comprising:

a thermoelectric unit having a cooling surface and a heating surface, the cooling surface being thermally insulated from the heating surface;

a heat sink thermally coupled the thermoelectric unit; and

a wicking material operatively coupled to the heat sink.

2. The system according to claim 1, wherein the wicking material is substantially saturated with a mixture of water and DNA to dissipate energy.

3. The system according to claim 1, wherein the heat sink and wicking material maximize the surface area for evaporation.

4. The system according to claim 2, further comprising a breathable layer disposed on the wicking material to allow evaporation of the water to the environment.

5. The system according to claim 2, further comprising a phase change material operatively coupled to the thermoelectric unit.

6. The system according to claim 2, further comprising a unit to resaturate the wicking material with the water and DNA mixture.

7. The system according to claim 2, further comprising a battery unit to power the thermoelectric unit.

8. The system according to claims 2 incorporated into an apparel item.

9. The system according to claim 8, wherein the apparel item is selected from jackets, vests, helmets, shows, hats, undergarments, pants, socks.

10. The system according to claim 1, wherein the heat sink is a layer of aluminum.

11. The system according to claim 1, wherein the heat sink is selected from a layer of aluminum, metal or composite material.

12. An apparel item for heating or cooling comprising;

a thermoelectric unit having a cooling surface and a heating surface, the cooling surface being thermally insulated from the heating surface:

a heat sink material thermally coupled the thermoelectric unit;

a wicking material operatively coupled to the heat sink; and

a battery unit to power the thermoelectric unit.

13. The apparel item according to claim 12, wherein the wicking material is substantially saturated with a mixture of water and DNA configured to dissipate energy.

14. The apparel item according to claim 13, further comprising a breathable layer disposed on the wicking material to allow evaporation of the water to the environment.

15. The apparel item according to claim 13, further comprising a phase change material operatively coupled to the thermoelectric unit.

16. The apparel item according to claim 13, further comprising a unit to resaturate the wicking material with the water and DNA mixture.

17. The apparel item according to claim 13, wherein the apparel item is selected from jackets, vests, helmets, shows, hats, undergarments, pants, socks.

18. The apparel item according to claim 13, wherein the heat sink is a layer of aluminum.

19. A process for heating or cooling comprising the steps of:

providing an apparel item including a thermoelectric unit having a cooling surface and a heating surface, the cooling surface being thermally insulated from the heating surface;

providing a heat sink material thermally coupled the thermoelectric unit;

providing a wicking material operatively coupled to the heat sink; and

providing a battery unit to power the thermoelectric unit.

20. The process according to claim 19, wherein the wicking material is substantially saturated with a mixture of water and DNA configured to dissipate energy.

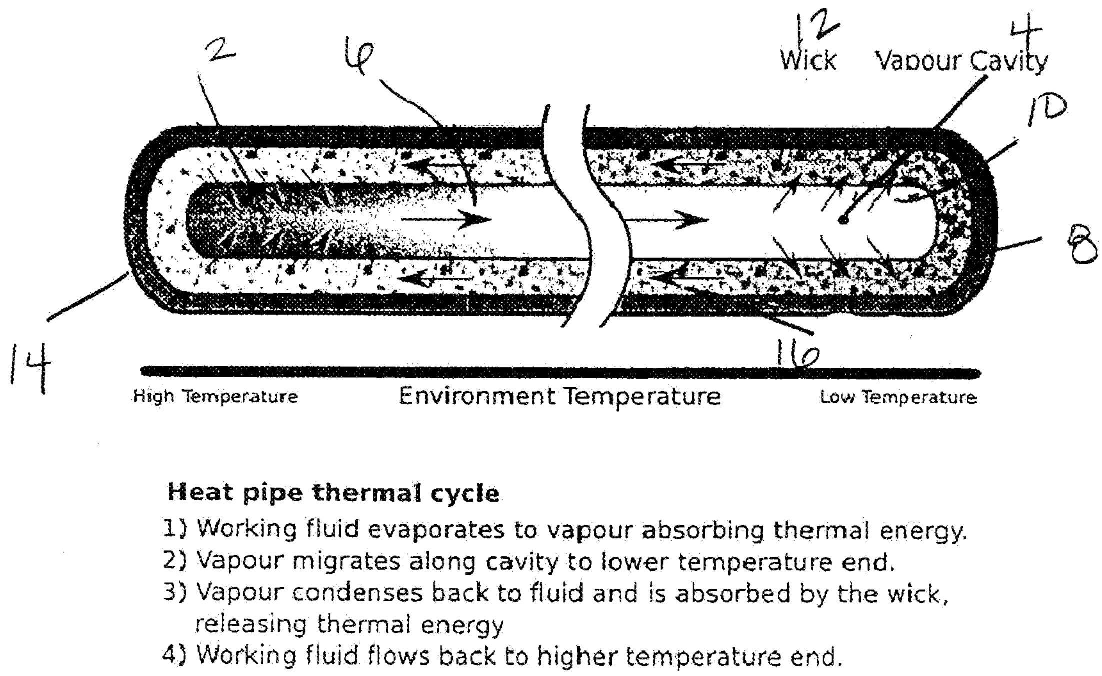
2
6
12
Wick
4
Vapour Cavity
10
8
14
16
High Temperature
Environment Temperature
Low Temperature
Heat pipe thermal cycle
1) Working fluid evaporates to vapour absorbing thermal energy.
2) Vapour migrates along cavity to lower temperature end.
3) Vapour condenses back to fluid and is absorbed by the wick, releasing thermal energy
4) Working fluid flows back to higher temperature end.

Figure 1

ClimaGear Product Schematic

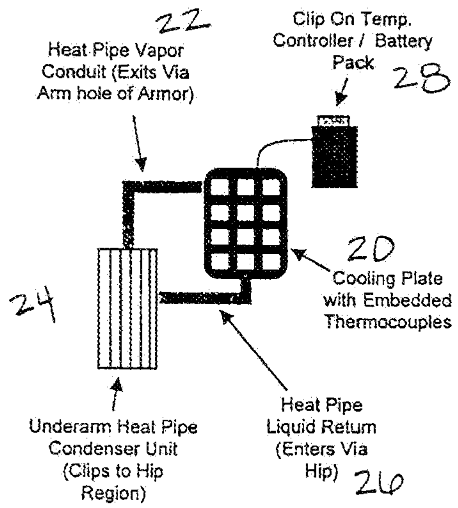

Figure 2

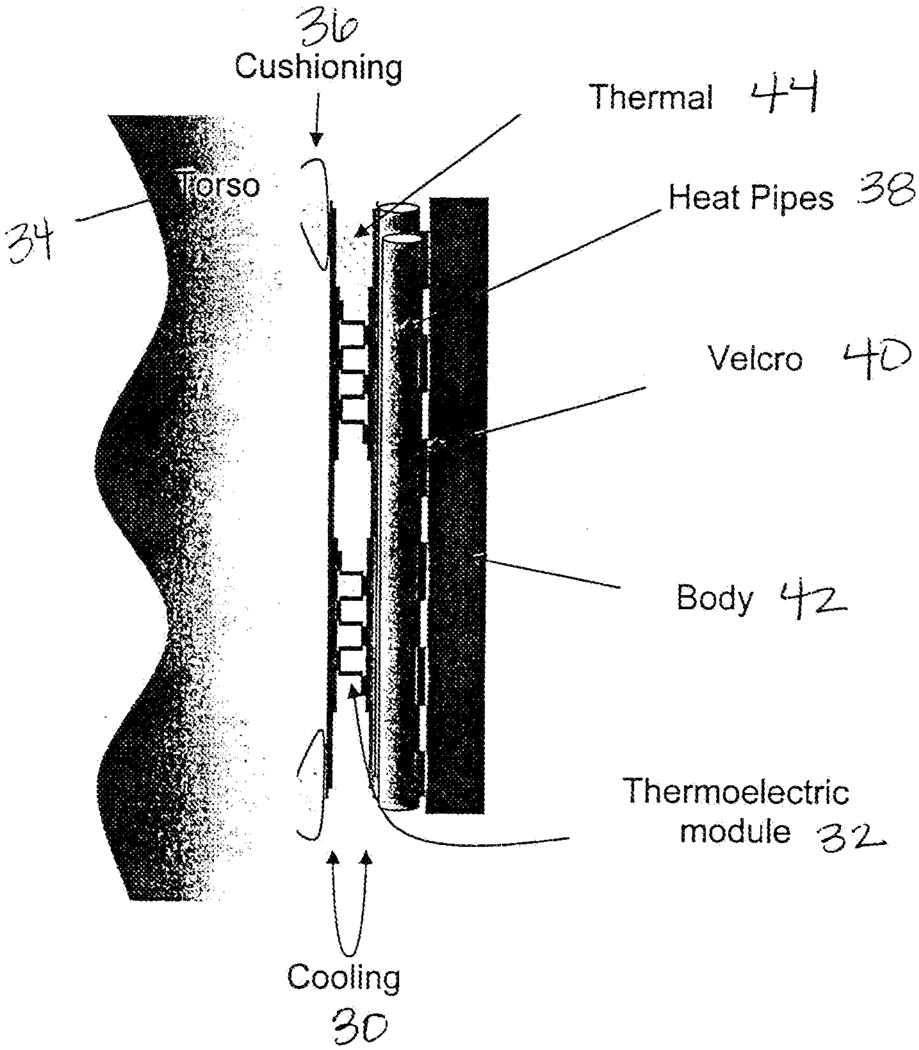
36
Cushioning
Thermal 44
Torso
34
Heat Pipes 38
Velcro 40
Body 42
Thermoelectric
module 32
Cooling
30

Figure 3

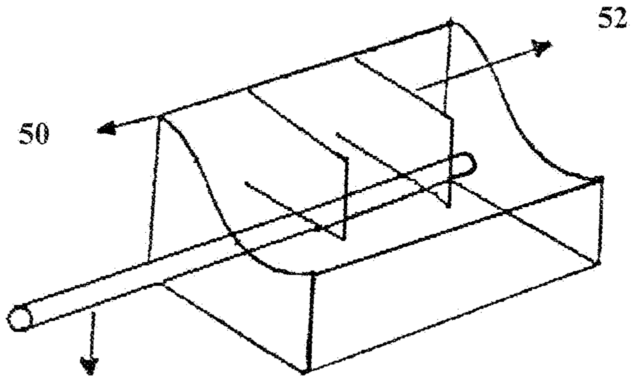

Figure 4

Cross-sectoral view

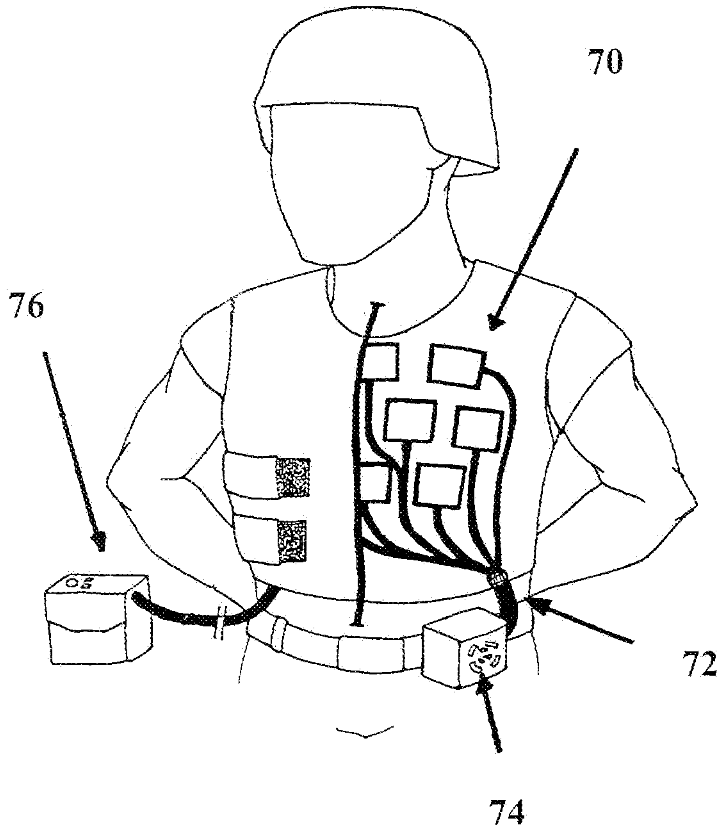

Figure 5

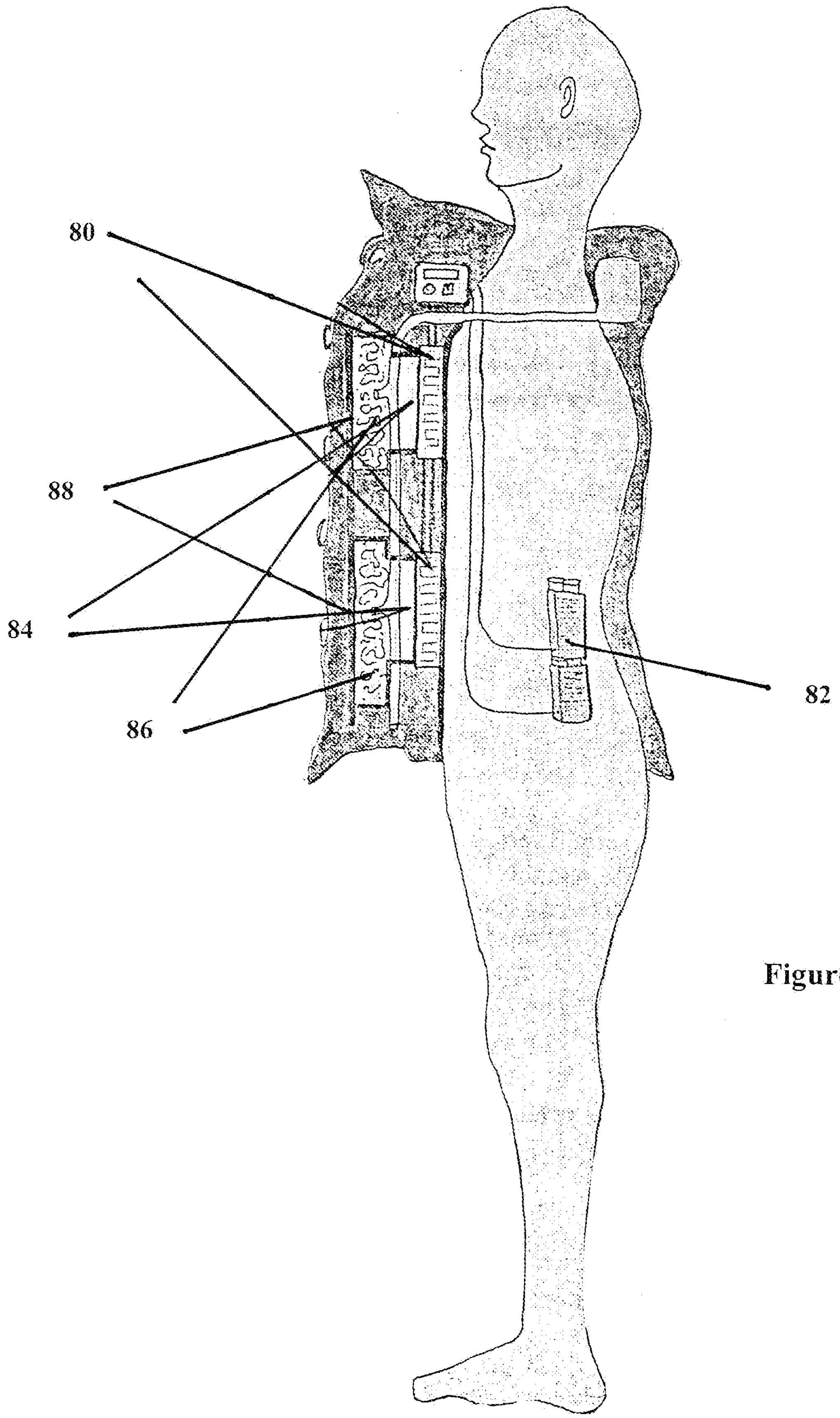

Figure 6

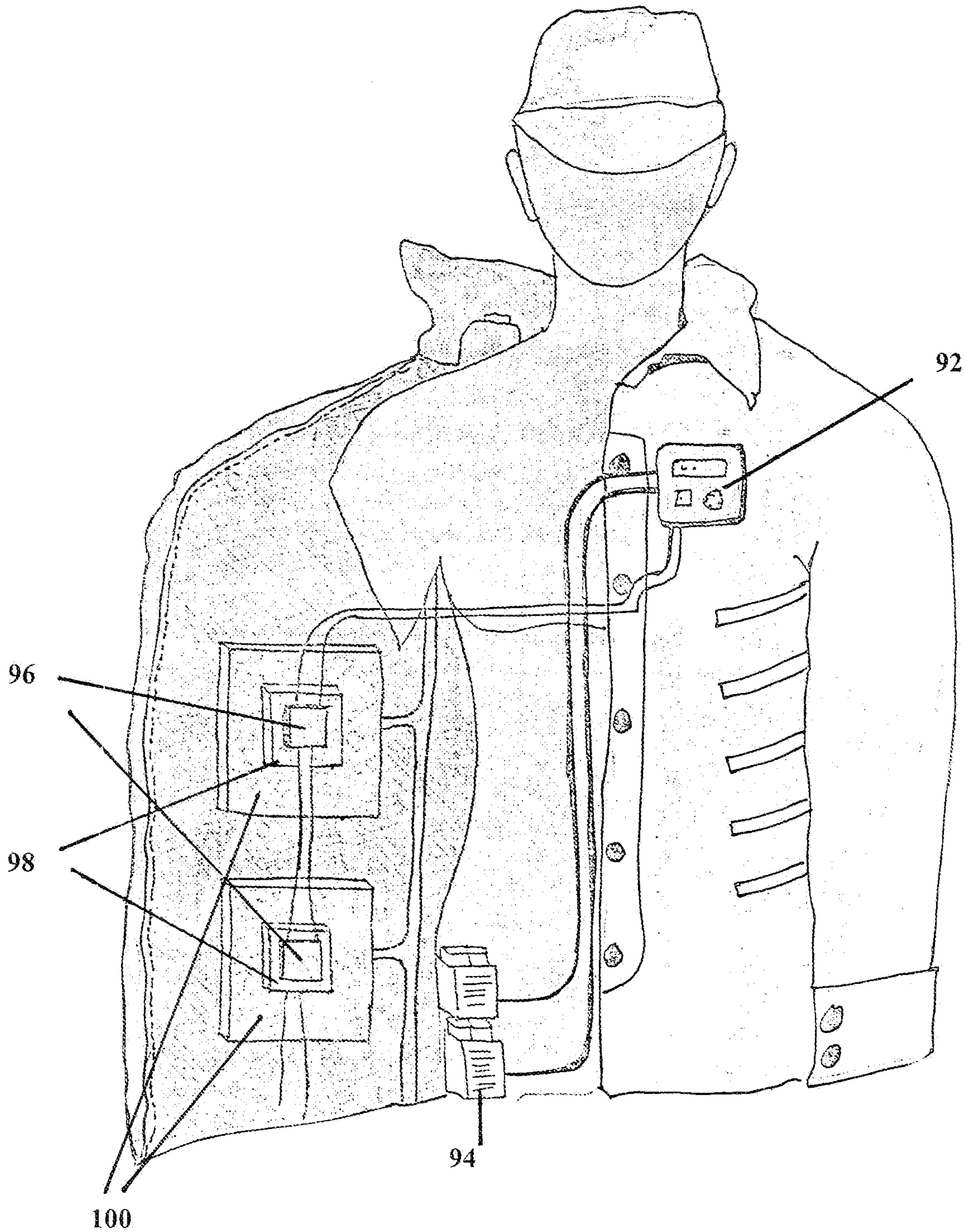

Figure 7

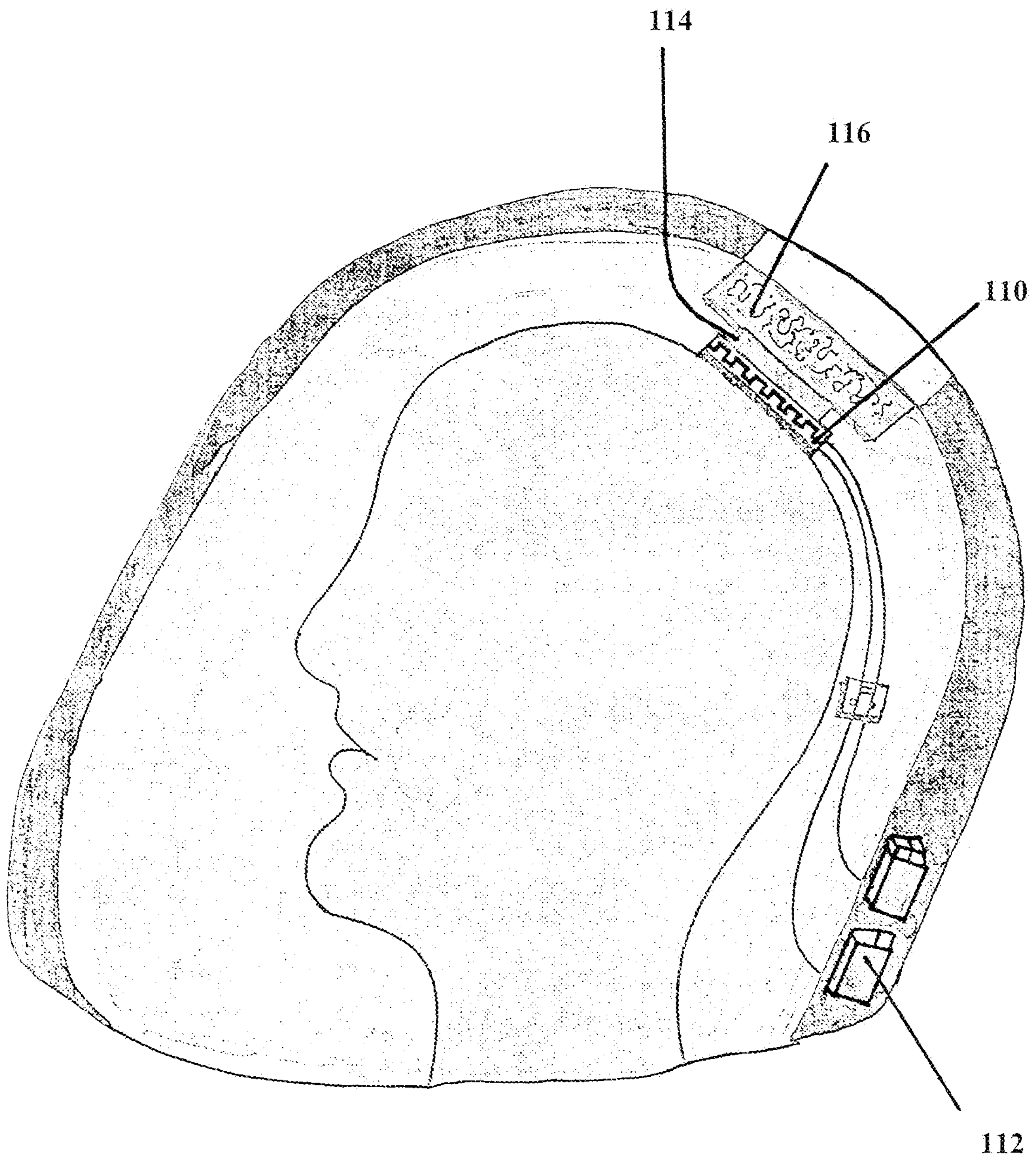

Figure 8