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(54) **PERSONAL AIR-COOLED GARMENT APPARATUS**

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(57) **ABSTRACT**

A personal cooling apparatus includes a ventilation unit connected to an air distribution garment, and is operable to generate a flow of air from the ambient to the air distribution garment. The air distribution garment includes first and second spaced layers of a flexible, but strong material that contours to a person's body when worn, while defining a plenum for the air to flow throughout the air distribution garment. A flexible cuff at a bottom seam of the air distribution garment prevents air within the plenum from escaping from the bottom, thereby forcing the air upward and laterally within the plenum. An air dam is centrally positioned within the air distribution garment for directing the airflow from the ventilation unit in at least two different directions to facilitate propagation of the air throughout the air distribution garment. Air holes are oriented along the outer seam or edge of the air distribution garment to allow air from the plenum to escape and carry heat away from the body. The placement of the air holes is optimized to increase air propagation uniformity throughout the air distribution garment.

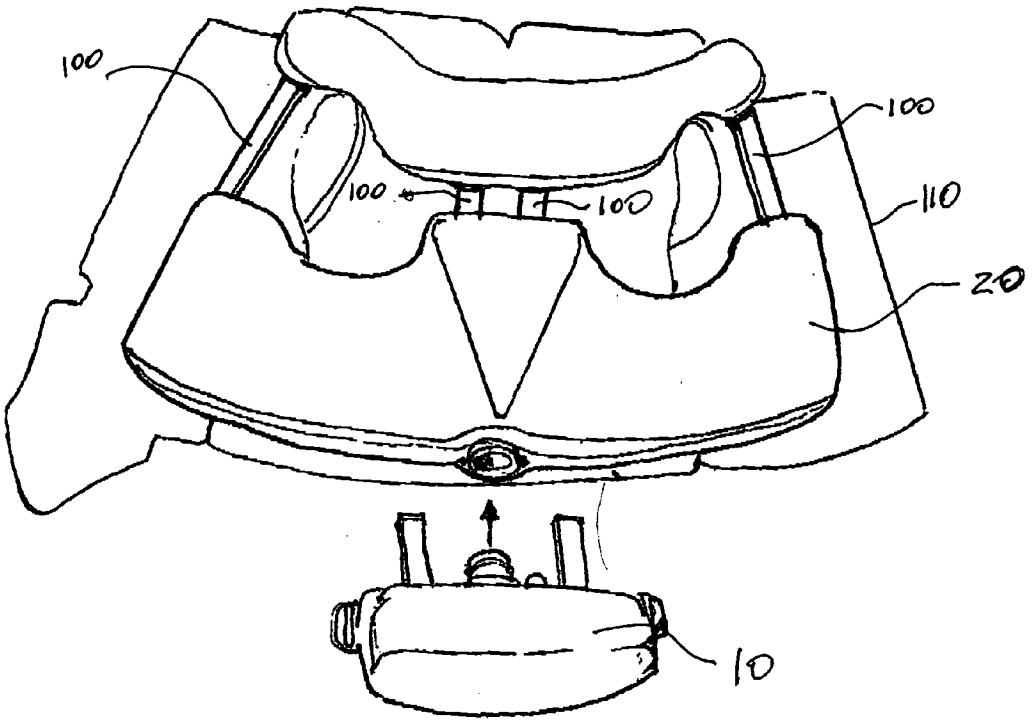


Fig. 1

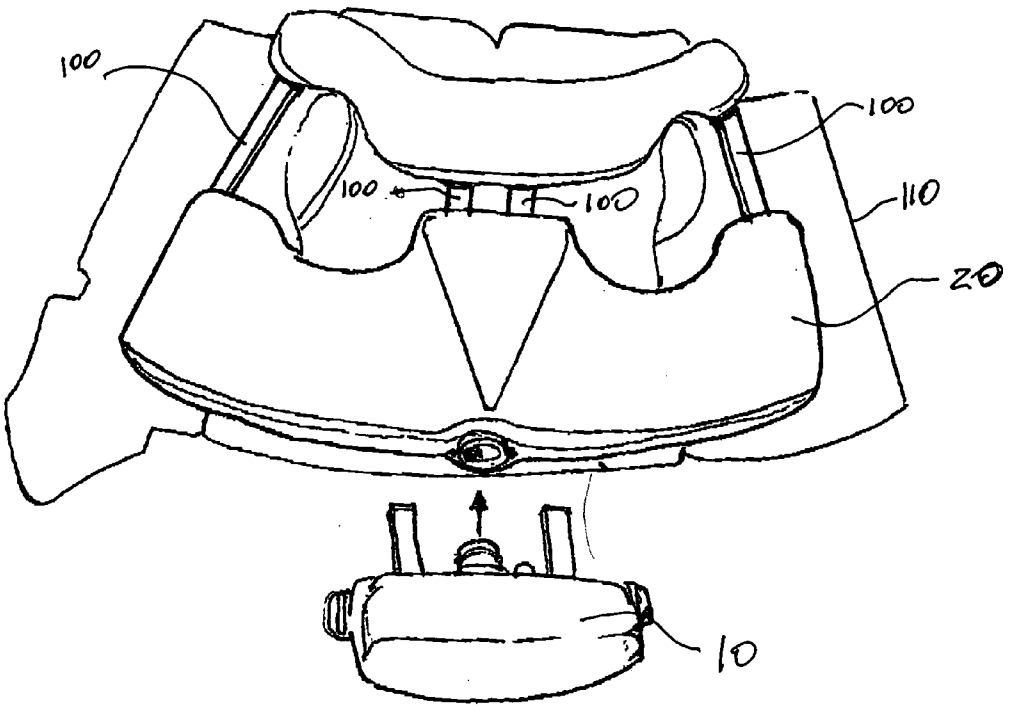


Fig. 3

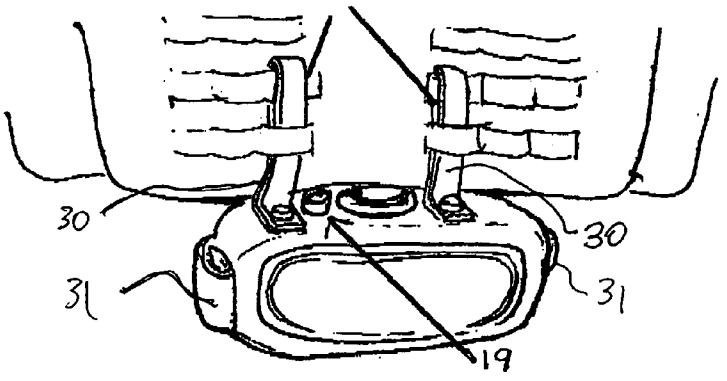


Fig. 2

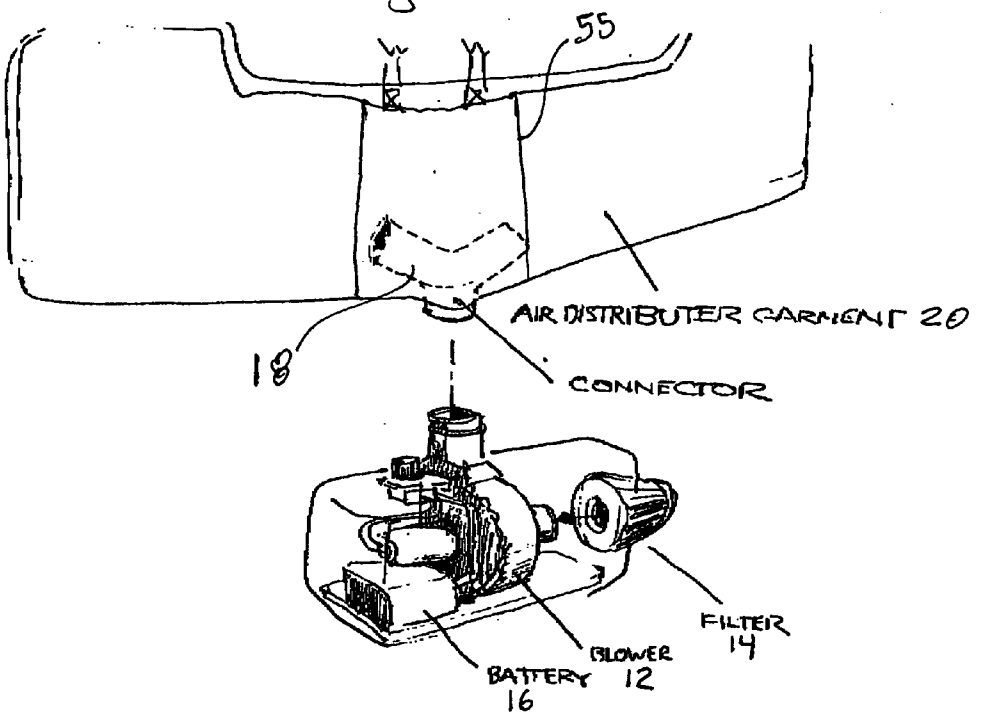

55
AIR DISTRIBUTER GARMENT 20
18
CONNECTOR
FILTER 14
BLOWER 12
BATTERY 16

Fig. 4

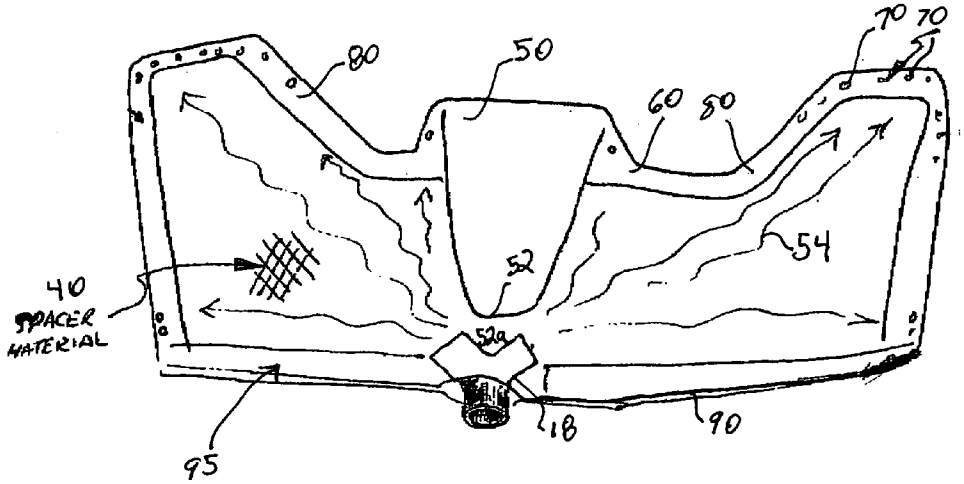

70 70
80
50
60
80
54
52
40
SPACER MATERIAL
52a
18
90
95

Fig.5

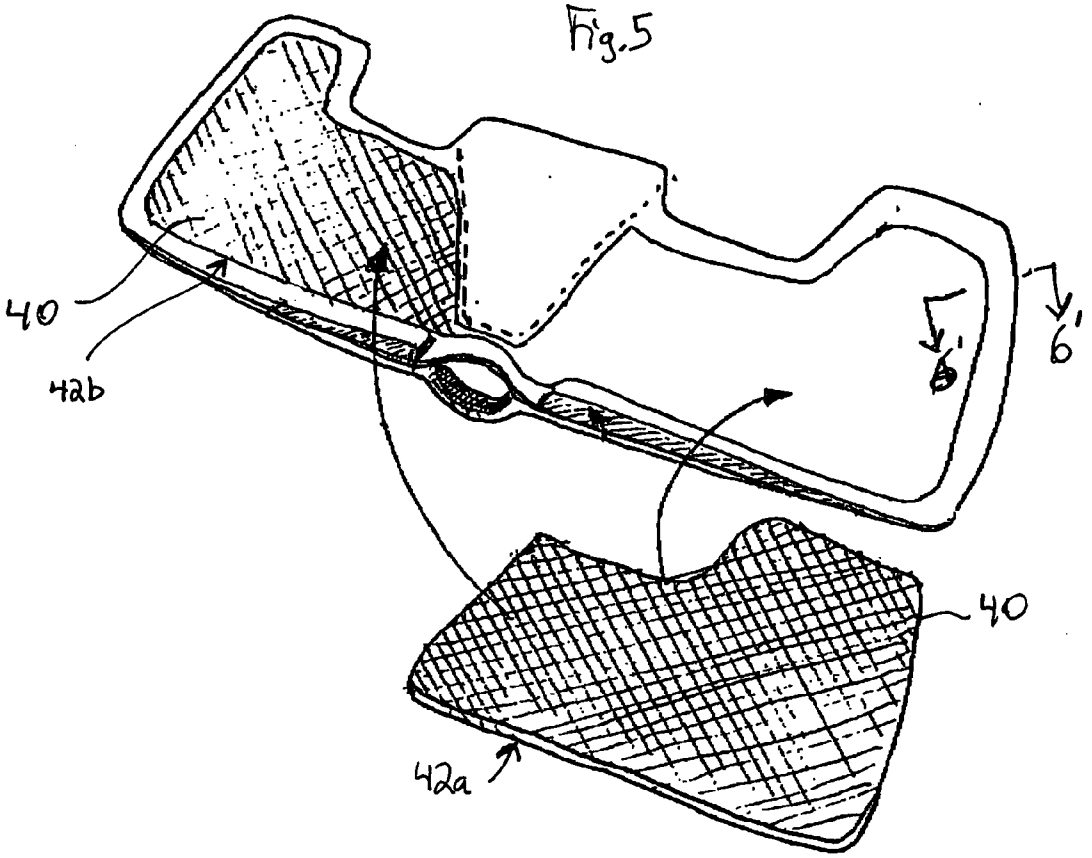


Fig.6

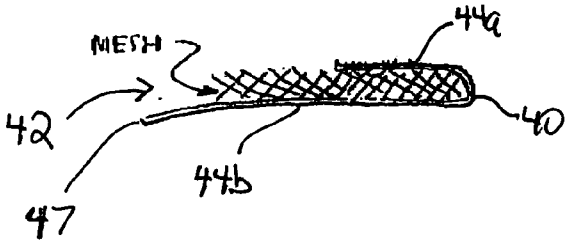


Fig. 7

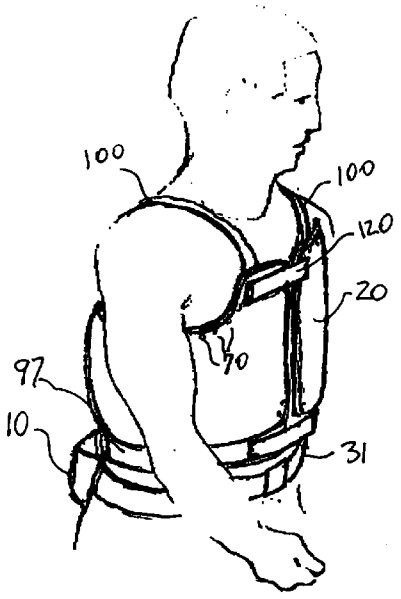


Fig. 9

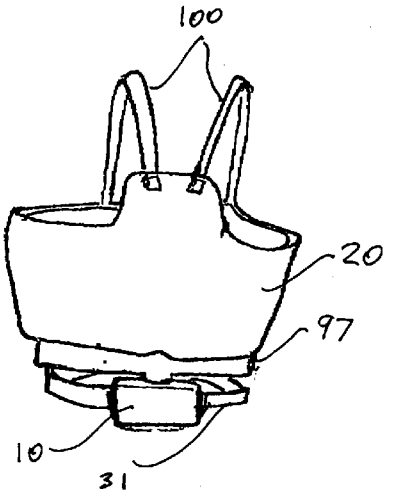
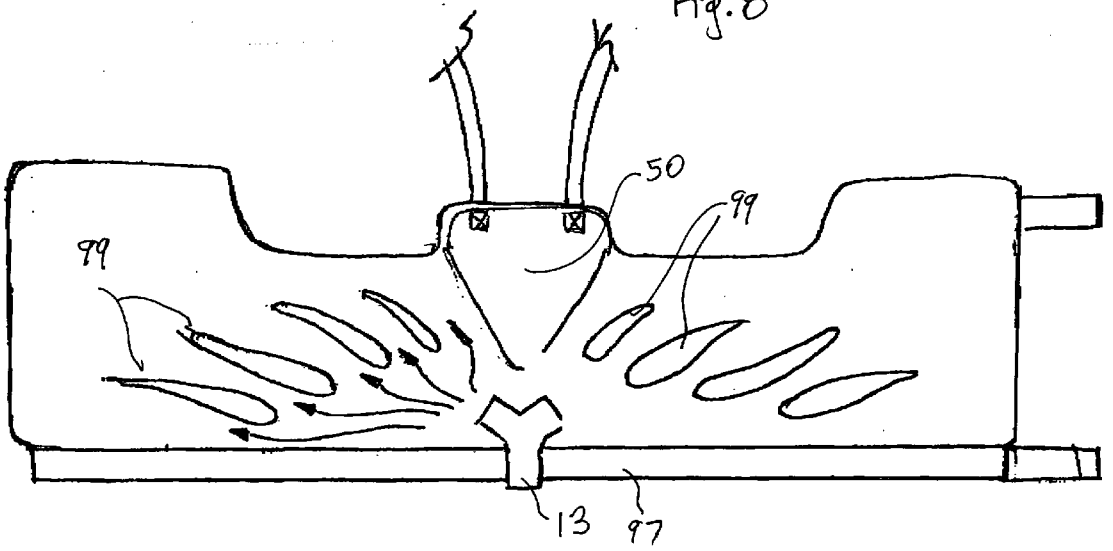


Fig. 8



PERSONAL AIR-COOLED GARMENT APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention is broadly directed to cooling garments worn by persons subjected to elevated temperature and/or humid conditions, and more specifically, to an air-cooled garment that preferably covers an individual's torso, and whose airflow configuration is optimized to ensure wide propagation of the air throughout the garment.

[0003] 2. Description of the Related Art

[0004] Elevated temperatures and/or humidity greatly affect an individual's ability to function, concentrate and remain alert. This may lead to accidents, injuries and even death if heat stress is not properly managed. While heat stress affects all individuals who are required to perform their duties outdoors or in elevated temperature/humidity environments, heat stress management is especially critical for combat soldiers, police, firefighters, emergency responders, and others where life or death decisions require clear thinking and decisive actions.

[0005] A wide range of cooling garments have been developed and introduced in order to manage heat stress. In all these garments, the basic function is to increase the heat from the body that is transferred to the cooling medium within the garment, where it is thereafter dissipated, resulting in greater comfort for the cooling garment wearer.

[0006] Many types of personal cooling garments have been developed to reduce and manage heat stress exposure. Such cooling garments and apparatus include circulating liquid systems, phase change material (PCM) cooling devices, and circulating air systems. In addition, there are numerous systems relying on innovative fabrics to wick away moisture or heat from the skin, thereby providing a cooling effect. These fabric-based systems, however, are less efficient at heat dissipation than the other existing systems described below.

[0007] Circulating liquid systems generally utilize a heat sink or reservoir containing water or other coolant, a pump, and a heat exchanger. The cool liquid is circulated in a closed system through a network of tubes within the garment, where it absorbs heat from the body and then passes through the heat exchanger before circulating back to the heat sink. Weight and size are drawbacks of these types of cooling garments. In addition, the network of internal tubes to distribute the cooling liquid raises the cost and complexity of the garment.

[0008] Phase change material (PCM) cooling devices are garments containing small packets of phase change material, such as ice or certain chemical polymers, that absorb the heat produced by the human body, with the cooling capacity determined by the amount of phase change material contained in the garment. Long-term and remote use of such a cooling garment is impractical, given the weight of the phase change material and the need to re-freeze the phase change material packets periodically.

[0009] Circulating air systems typically comprise an air source and a network of tubes or channels within the garment to distribute air throughout the garment, thus removing excess heat as the circulated air absorbs the body heat. The network of tubes or channels, however, adds to the cost and complexity of manufacture. Moreover, the network of tubes and channels creates internal flow loses, requiring a larger air generating unit to propagate the air through the garment. However, the noise generated by the larger air source may affect the performance of the person wearing the garment, especially soldiers, firefighters and other emergency responders. The noise will also increase a soldier's battlefield signature, increasing the odds of being detected by the enemy.

[0010] Another major drawback of existing cooling devices is that while providing some degree of cooling, many experience problems in propagating the cooling fluid uniformly throughout the cooling garment, especially those relying on ambient air flow where a network of internal tubes or channels are not supplied. For example, while an individual's back may experience sufficient cooling when the air source is located behind the person, the upper shoulders and front torso may not experience sufficient cooling due to inadequate airflow.

[0011] Accordingly, there is a continuing need and desire for a lightweight, portable and long duration cooling garment that can efficiently and uniformly distribute air throughout the garment even without a network of internal tubes to carry the air.

SUMMARY OF THE INVENTION

[0012] The present invention is directed to a personal air-cooled garment that addresses one or more of the limitations of the present devices.

[0013] The present invention provides a personal cooling apparatus including a ventilation unit operable to generate a flow of air, with an outlet connector to funnel the generated air to an air distribution garment. The air distribution garment includes first and second spaced layers of a flexible, but strong material that contours to a person's body when worn, while defining a plenum for the air to flow throughout the air distribution garment. An air dam is centrally positioned within the air distribution garment for directing the airflow from the ventilation unit in at least two different directions to facilitate propagation of the air throughout the air distribution garment. A means for preventing air from flowing out the bottom of the air distribution garment is also provided.

[0014] The air dam may be a length of fabric disposed on an inner surface of the air distribution garment, or a triangular shaped air dam disposed within the air distribution garment.

[0015] Preferably, the outlet of the ventilation unit comprises a Y-shaped or T-shaped connector where it connects to the air distribution garment, to facilitate funneling the air in separate directions both prior to and after the air enters the air distribution garment.

[0016] Air holes are oriented along the outer edge or seam of the air distribution garment to allow air from the plenum to escape and carry heat away from the body. The placement of the air holes is optimized to increase air propagation uniformity throughout the air distribution garment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above objects and other advantages of the present invention will become more apparent by describing

in detail the preferred embodiments thereof with reference to the attached drawings in which:

[0018] FIG. **1** is a perspective view of the ventilation unit and air distribution garment of an embodiment of the invention;

[0019] FIG. **2** is a more detailed perspective view of the connection between the ventilation unit and air distribution garment of FIG. **1**;

[0020] FIG. **3** is a perspective view of the ventilation unit and air distribution garment connected by straps;

[0021] FIG. **4** is schematic view of the interior configuration of the air distribution garment of FIG. **1**;

[0022] FIG. **5** is a perspective view of the flexible spacer material and how it is integrated into the air distribution garment;

[0023] FIG. **6** is a side cross-sectional view taken along the line **6'-6'** in FIG. **5**;

[0024] FIG. **7** is a perspective view of the air distribution garment as worn by an individual;

[0025] FIG. **8** is a modified view of FIG. **4**, illustrating an embodiment having shaped inserts positioned within the plenum; and

[0026] FIG. **9** is a perspective view of the air distribution garment having a means for preventing air from flowing out of the lower edge of the air distribution garment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0027] The present invention will now be described more fully with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. Rather, the embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the concept of the invention to those skilled in the art.

[0028] Broadly described, the present invention includes a ventilation unit operable to generate a flow of air, and an air distribution garment connected to the ventilation unit to distribute the generated air uniformly throughout the air distribution garment. In one embodiment, when the air distribution garment is worn by a person it substantially covers the person's torso. The spacing of the layers comprising the air distribution garment, the directionality of the air flow, and the spacing of air holes surrounding the seams or edges of the air distribution garment, are all optimized to ensure the most uniform propagation of airflow throughout the garment when it is worn by the individual. In all cases, the present invention uses ambient air to flow about the torso of the person to lower the heat stress on the individual.

[0029] Possible users for such a cooling garment are numerous, and comprise anyone requiring cooling of the body while carrying out a particular task. Examples of potential users include combat soldiers, police, firefighters, rescue workers, outdoor workers and laborers, athletes, sportsman, and any other persons performing an activity in elevated temperature and/or humid environments, whether indoors or outdoors.

[0030] For example, heat stress is prevalent for combat soldiers loaded with equipment. The soldiers are encumbered with multiple layers of fabrics of clothing, armor protection and load bearing harnesses. The present invention provides an integrated, lightweight, portable, and long duration device that is able to relieve heat stress, even when the soldier is wearing full battle gear.

[0031] More specifically, as shown in FIG. **1**, an embodiment of the invention includes a ventilation unit **10**, operable to generate a flow of air, which is connected to an air distribution garment **20**, operable to distribute the air throughout the garment and thereby cool the wearer of the garment.

[0032] As shown in FIG. **2**, the ventilation unit **10** includes a DC blower **12** for suctioning air into the ventilation unit **10**. The source of air is preferably ambient air, but may include pressurized air by connecting a container of the pressurized air to the ventilation unit **10**. Also, while a DC blower is preferred, one of skill in the art would realize the invention could be adapted to incorporate, if needed, an AC blower (with a suitable AC power source). A filter **14** may be provided downstream of the ventilation unit intake and upstream of the blower **12** to filter the suctioned air.

[0033] FIG. **2** shows a battery **16** functioning as the DC power source for the ventilation unit **10**. The battery **16** may be disposable or rechargeable, and may include for example, a NiHM, Lithium-Ion, Zinc Air, or Lithium Sulfur Dioxide battery. Other existing or emerging battery technologies may be incorporated in the present invention. Preferably, the batteries may be housed in the ventilation unit **10** itself, or attached to the ventilation unit **10**, although they need not be. In addition, the power source may comprise any other suitable form, such as fuel cells, solar cells or other emerging portable power generating technologies.

[0034] Preferably, the ventilation unit **10** will provide a low flow rate of 10 cubic feet per minute (cfm) at a minimum of 3 inches of water pressure head (about 0.1 psi), although other flow rates are contemplated, so long as the air is uniformly propagated throughout the air distribution garment **20**. The use of a low flow rate ventilation unit **10** has certain advantages, in that it reduces the size and cost of the required blower **12**, reduces the required size of the battery **16** to power the unit for a certain period of time (or uses a certain battery size for an extended period of time), and reduces the noise associated with generating the airflow.

[0035] To comply with certain performance specifications, such as the military, the ventilation unit **10** can be made more robust or rugged by adding a lightweight foam or protective layer around the entire unit, and/or by separately ruggedizing the individual components of the unit.

[0036] The outlet connector of the ventilation unit **10** preferably has a plurality of outlet orifices to funnel the generated air in at least two separate directions as it enters the air distribution garment **20** as described more fully later. The outlet connector **18** may be Y-shaped as shown in FIG. **2**, or T-shaped, which both direct the air upward and/or laterally within the air distribution garment **20**. Of course, the outlet connector **18** may also have more than two orifices to facilitate air propagation within the air distribution garment **20**. Preferably, in whatever configuration, the flow of air from the ventilation unit **10** is split before entering the air distribution garment **20** to facilitate airflow in different directions.

[0037] At the very least, the connector **18** may also be a straight in-line connector or any other shape, so long as the air generated by the ventilation unit **10** can pass to the air distribution garment **20**, and there were some means within the air distribution garment **20** to allow the air to propagate in different directions.

[0038] The detachable connection between the ventilation unit **10** and air distribution garment **20** may be engineered with any suitable fastening device sufficient to secure the two units while in use. Preferably, another suitable supporting apparatus for connecting the units, such as connecting straps **30** shown in FIG. **3**, may be used to provide additional securing means. Similarly, waist straps **31** extending from the ventilation unit **10** and around the person's waist or hips (see FIG. **3** and FIG. **7**) may be provided as an additional securing means to eliminate shifting of the ventilation unit **10** when the person is moving or performing strenuous activity.

[0039] A power switch **19** is preferably a push-on, push-off type that is fitted with a water resistant boot and guard since the invention will likely be used in extreme environments. Other types of on-off switches are contemplated within the scope of the present invention.

[0040] Referring to FIG. **4**, the internal construction and features of the air distribution garment **20** will be described in greater detail. The garment **20** is preferably made of a flexible polypropylene material **40**, with two spaced layers **44***a*, **44***b* defining a plenum **42** (see FIG. **6**) for the air to flow throughout the air distribution garment **20**. The spacer material **40** is basically a three dimensional fabric that should be flexible enough to contour to the body, but does not crush under the weight of multiple layers of clothing and equipment typically worn by those working in elevated temperature/humidity environments. In fact, as shown in FIG. **6**, the spacer material **40** essentially forms a porous, cage-like structure with sufficient strength to maintain the integrity of the plenum **42** while minimizing restrictions to airflow. Note that the present invention eliminates any internal tubes or channels that must carry air throughout the garment, thereby minimizing flow loses within these tubes and channels, while simultaneously increasing air propagation efficiency and uniformity. An additional benefit of this design is that the invention is simpler and cheaper to manufacture. Preferably, the plenum **42** is 0.25-0.375 inches in thickness, providing the optimum tradeoff between weight, garment thickness/profile, individual mobility and air propagation. Of course, other plenum thicknesses are contemplated within the scope of the present invention.

[0041] Other suitable materials for the spacer material **40** include polyethylene, polyolefin or equivalent materials, both natural and synthetic, exhibiting the proper flexibility and strength characteristics. The spacer material should also be fire retardant when used for specified functions.

[0042] As further shown in FIG. **4**, the lower seam **90** of the air distribution garment **20** is widened and contains a lightweight foam insert **95** that functions as a means of preventing air from escaping from the bottom of the air distribution garment **20**. This forces the air within the plenum **42** upward and laterally to increase the air propagation uniformity throughout the air distribution garment. The foam insert **95** would be shaped or tapered to conform to a person's body, with a greater thickness at the center of the back, and a reduced thickness as the foam insert **95** spans out to the edges of the air distribution garment **20**.

[0043] More preferably, as shown in FIG. **9**, the means for preventing air flow from the bottom comprises an elastic cuff **97** attached to the bottom of the air distribution garment, which prevents the air from escaping from the bottom of the garment **20**. The elastic cuff **97** may be made of any flexible material such as Lycra, neoprene, or other suitable material. Similar to the foam inserts **95**, the elastic cuff **97** forces the air within the plenum **42** upward and laterally to increase the air propagation uniformity throughout the air distribution garment.

[0044] An air dam is centrally positioned on, or within, the air distribution garment **20**. As shown in FIG. **4**, for example, a substantially triangular shaped air dam **50** is centrally positioned within the air distribution garment **20**. Other shapes are contemplated within the scope of the present invention. The air dam **50** is made of non-porous foam or equivalent material. As shown in FIG. **4**, the apex **52** of the air dam **50** may be curved, or it may have a more angular design. In either case, the apex **52** is positioned adjacent to the Y-connector **18** from the ventilation unit **10** where it enters the air distribution garment **20**. The Y-connector **18** initially splits and funnels air from the ventilation unit **10** in separate directions as the air enters the air distribution garment **20**. The air dam **50** shape and positioning further assist this directional flow of air, and ensures the air is propagated **54** throughout the air distribution garment **20**.

[0045] Preferably, the apex **52** of the air dam **50** conforms to the recessed portion **52***a* of the Y-shaped connector **18**, thereby sealing and creating, either physically or functionally, two sub-plenums **42***a*, **42***b* (see FIG. **5**) within the air distribution garment **20** because the air will not be able to cross over the combination of the air dam **50** and Y-connector **18**.

[0046] Another suitable air dam **55** is shown in FIG. **2**. In this embodiment, the triangular shaped air dam **50** within the air distribution garment **20** is replaced by a permeable or non-permeable fabric **55** substantially spanning a vertical dimension on an inner surface (closest to the person's body) of the air distribution garment **20**, where the air distribution garment **20** connects to the ventilation unit **10**. The fabric air dam **55** may be of various shapes, including for example, rectangular, triangular or diamond shaped.

[0047] It has been found that this fabric air dam **55** captures a certain portion of the air originally entering the air distribution garment **20** from the ventilation unit **10**, creating an initial cooling effect. Moreover, movement by the person creates a certain pumping action, which in conjunction with the contours of a person's back, helps to distribute the inlet air in different directions throughout the plenum. The air dams **50**, **55** may be used individually or in combination to achieve the desired effect of uniformly propagating air throughout the air distribution garment **20**.

[0048] FIG. **5** is a perspective view of the flexible spacer material **40** and how it is integrated into the air distribution garment **20**, providing two separate plenums **42***a*, **42***b* that are fed by the Y-connector **18**. FIG. **6** is a side cross-sectional view taken along the line **6'-6'** in FIG. **5**, and more clearly illustrates the plenum **42** between the two spaced

layers **44***a* and **44***b*, and the three dimensional cage-like structure of the spacer material **40**.

[**0049**] The outer layer of the spacer material **40** (i.e., the layer not in contact with the person) is lined with a light-weight, non-porous coated nylon fabric **47** to prevent the air from flowing directly out of the three dimensional spacer material **40** in all directions. In addition to flowing through the plenum **42** and along the person's body, the air is allowed to escape though air holes provided near or along the outer seam or edge of the air distribution garment as described later.

[**0050**] Preferably, the air distribution garment **20** is of sufficient size to suitably cover the torso of a person. Referring to FIG. **2** and FIG. **4**, the air inlet section, comprising Y-connector **18** and air dam **50** or **55**, is preferably positioned such that when the person wears the air distribution garment **20**, the air dam **50** or **55** is placed in the middle of the lower back of the person. Because the air is divided and supplied equally to both halves of the air distribution garment **20**, and combined with the placement and configuration of the air dam **50** or **55**, the greatest propagation of air flow throughout the garment is realized.

[**0051**] In FIG. **4**, note that upper seam **60** has an undulating shape, whereby the center and ends are higher than the intervening sections. This is to accommodate a person's underarms when placing the garment **20** around the torso, while still providing a maximum cooling surface area and sufficient mobility when worn. See FIG. **7**, which illustrates the garment **20** positioned properly on an individual.

[**0052**] The undulating shape described above takes advantage of the underarm as an escape route for the airflow. Since each person's body shape and movement mechanics are slightly different, even when the garment **20** is properly positioned and fitted correctly, when a person moves a certain amount of air will escape from the underarm arm area, and to a lesser extent the neck area, thereby cooling the person. The heat emanating from the individual's body is thus carried away by the airflow within the garment **20** and exhausted into the ambient air. Moreover, during elevated ambient temperatures when body perspiration is present, the present invention moves air across the torso and creates an evaporative cooling effect that helps to further relieve heat stress.

[**0053**] As shown in FIG. **4**, airflow and air propagation paths **54** within the garment **20** may also be increased by placing air holes **70** near or along the outer seam **60** or edge of the garment **20**. Alternately, the air holes **70** may be positioned near or along the outer edge of the outer fabric layer **47** described with reference to FIG. **6**. This alternate embodiment would be preferable, for example, if a Lycra or neoprene fabric was placed around the upper or side edges of the air distribution garment **20**, to achieve a greater body-conforming fitting scenario. Of course, air holes **70** can be positioned anywhere in the outer fabric layer **47**.

[**0054**] In either embodiment, air within the plenum **42** is thus allowed to escape through these air holes **70** and pass into the ambient air. One of skill in the art will realize that the air holes **70** create a pressure differential within the air distribution garment **20** as well as allow the air within the plenum **42** to escape. By positioning and repositioning the air holes **70** near or along the outer seam **60**, experiments can be conducted to ensure any "hot spots" (areas with insufficient or constricted air flow) are relieved by positioning an air hole **70** near the hot spot before finalizing manufacture. This will draw a portion of air within the plenum **42** toward the newly positioned air hole **70**, thereby cooling the hot spot and providing more uniform flow throughout the air distribution garment **20**. Also, by positioning the air holes **70** along the underarm area **80**, air at the back of the torso can be brought to the front of the torso, and provide sufficient cooling for the front of the torso, an advantage not seen in existing ambient air cooling systems without internal tubes or channels to carry the air.

[**0055**] Even though the present invention does not provide tubes and channels for carrying air, shaped inserts **99** may positioned with the plenum **42** to increase air propagation uniformity throughout the air distribution garment as shown in FIG. **8**. Rather than carrying air internally as done in tubes, these shaped inserts **99** divert, deflect or distribute air due to their shape and placement in the plenum **42**. For example, the shaped inserts **99** may be shaped like airfoils, creating certain pressure differentials in desired locations to draw air towards the shaped inserts **99**, thereby increasing the air propagation uniformity throughout the air distribution garment **20**. Of course, one of skill in the art could determine the optimum positions and shapes of the inserts **99** without undue experimentation. The inserts **99** may be attached (by sewing, use of adhesives or other suitable means) to the flexible material **40** to fix the positions.

[**0056**] The cooling garment of the present invention can be worn under many layers of clothing or equipment without affecting the mobility of the wearer. In order to ensure the cooling garment stays in its proper orientation during use (i.e., without slipping down or rotating about the torso), a series of over-the-shoulder straps **100** as shown in FIG. **1**, FIG. **7** and FIG. **9** may be provided.

[**0057**] FIG. **1** shows, for example, that the air distribution garment **20** of the present invention can be integrated with an Interceptor Ballistic Armor (IBA) vest **110** worn by combat troops. The over-the-shoulder straps **100** are threaded though loops in the IBA **110**. The garment **20** positioning, adjustments and attachments are carried out prior to donning the IBA **110** to enable the soldier to put on both at the same time. Hook and loop fasteners **120** (see FIG. **7**) located on the front of the air distribution garment **20** allow for final adjustment and precise and secure fitting.

[**0058**] While the present invention has been described in detail with reference to the preferred embodiments thereof, it should be understood to those skilled in the art that various changes, substitutions and alterations can be made hereto without departing from the scope of the invention as defined by the appended claims. For example, although a vest covering the torso has been illustrated in the above embodiments, it is understood that any other type of clothing, such as a jacket, coat, trousers or coveralls, may utilize the teachings and principles of the present invention.

What is claimed is:

1. A personal cooling apparatus, comprising:

a ventilation unit operable to generate a flow of air, and having an outlet connector to funnel the generated air;

an air distribution garment connected to the outlet connector of the ventilation unit to distribute the air

generated by the ventilation unit throughout the air distribution garment, the air distribution garment comprising

first and second spaced layers of a flexible material that contours to a person's body when worn, while defining a plenum for the air to flow throughout the air distribution garment, and

a means for preventing air within the plenum from escaping from a bottom of the air distribution garment, thereby forcing the air upward and laterally within the plenum.

2. The apparatus of claim 1, further comprising an air dam centrally positioned in proximity to where the air distribution garment connects to the ventilation unit, the air dam being capable of directing the airflow from the ventilation unit in at least two different directions to facilitate propagation of the air throughout the air distribution garment.

3. The apparatus of claim 2, wherein the air dam comprises a non-permeable fabric substantially spanning a vertical dimension on an inner surface of the air distribution garment in contact with a person's body, where the air distribution garment connects to the ventilation unit.

4. The apparatus of claim 2, wherein the air dam is substantially triangular shaped, and is centrally positioned within the air distribution garment for directing the airflow from the ventilation unit in at least two different directions to facilitate propagation of the air throughout the air distribution garment.

5. The apparatus of claim 4, the triangular shaped air dam having its apex positioned adjacent the outlet of the ventilation unit.

6. The apparatus of claim 5, wherein the apex of the air dam conforms to a shape of the outlet connector of the ventilation unit, thereby creating two sub-plenums within the air distribution garment.

7. The apparatus of claim 6, wherein the outlet connector of the ventilation unit comprises a plurality of outlet orifices for initially funneling air in two separate directions upon entry into the air distribution garment.

8. The apparatus of claim 7, wherein the outlet connector is one of a T-shaped connector or Y-shaped connector.

9. The apparatus of claim 1, wherein the means for preventing air within the plenum from escaping from a bottom of the air distribution garment includes an elastic cuff material that conforms to a person's body.

10. The apparatus of claim 2, wherein the air dam is positioned such that when the air distribution garment is worn by a person, the air dam is adjacent the middle of the lower back of the person.

11. The apparatus of claim 10, wherein the air distribution garment is of sufficient size to suitably cover the torso of the person.

12. The apparatus of claim 1, wherein an upper seam of the air distribution garment has an undulating shape to accommodate a person's underarms while allowing sufficient mobility when worn.

13. The apparatus of claim 12, further comprising a non-porous material substantially covering an outer surface of the air distribution garment not in contact with the person.

14. The apparatus of claim 13, further comprising air holes positioned along an outer edge of the air distribution garment to allow air from the plenum to escape to the ambient air.

15. The apparatus of claim 14, wherein the air holes are oriented and optimized to increase air propagation uniformity throughout the air distribution garment.

16. The apparatus of claim 15, further comprising shaped inserts positioned with the plenum to increase air propagation uniformity throughout the air distribution garment.

17. The apparatus of claim 1, wherein the ventilation unit is a low pressure unit containing a blower for suctioning ambient air into the ventilation unit.

18. The apparatus of claim 17, wherein the ventilation unit generates airflow of about 10 cubic feet per minute (cfm).

19. The apparatus of claim 17, further comprising a battery to power the ventilation unit.

20. The apparatus of claim 1, further comprising straps for providing additional means for securing the ventilation unit to the air distribution garment.

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