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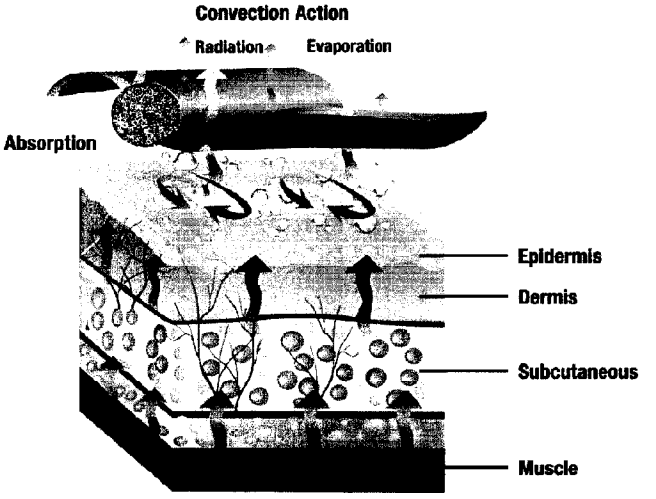
(72) **Inventeurs/Inventors:**
LAI, LAWRENCE S. C., CA;
LAI, FRANCIS C.K., CA

(73) **Propriétaire/Owner:**
SUN ROYAL INNOVATIVE FABRICS INC., CA

(74) **Agent:** OYEN WIGGS GREEN & MUTALA LLP

(54) **Titre : UN TISSU ET UNE METHODE DE FABRICATION ASSOCIEE**
(54) **Title: A FABRIC AND METHOD OF MAKING THE SAME**



(57) **Abrégé/Abstract:**
A method of making a multi-ply fabric. The fabric has a top side and a back side with the top side being adjacent to an external environment when the fabric is in use and the back side being adjacent to an object to be cooled when the fabric is in use. The method includes providing a top yarn to form the top side of the fabric and providing a bottom yarn to form the back side of the fabric, with the bottom yarn having a higher SA:V than the top yarn. The two yarns are combined together to form a single fabric, with the top yarn looping through bobbins in the bottom yarn and the bottom yarn looping through bobbins in the top yarn so that the top and bottom yarns are linked and networked to-one-another.

ABSTRACT

A method of making a multi-ply fabric. The fabric has a top side and a back side with the top side being adjacent to an external environment when the fabric is in use and the back side being adjacent to an object to be cooled when the fabric is in use. The method includes providing a top yarn to form the top side of the fabric and providing a bottom yarn to form the back side of the fabric, with the bottom yarn having a higher SA:V than the top yarn. The two yarns are combined together to form a single fabric, with the top yarn looping through bobbins in the bottom yarn and the bottom yarn looping through bobbins in the top yarn so that the top and bottom yarns are linked and networked to-one-another.

TITLE OF THE INVENTION

A FABRIC AND METHOD OF MAKING THE SAME

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FIELD OF THE INVENTION

The invention relates to the field of fabrics and a method of making the multi-ply fabric. More specifically, the present invention relates to a fabric that is made to regulate moisture dispersal therethrough to enhance its ability to provide evaporative cooling. Even more specifically, the present invention relates to a multi-ply fabric that becomes cool when activated by liquid and remains cool for an extended period of time thereafter, and a method of making the same fabric. By controlling the evaporation process and slowing down the evaporation process, the fabric achieves a lower core temperature which relates the cooler temperature to the object.

BACKGROUND OF THE INVENTION

Enjoying a hot sunny day in the outdoors is sometimes difficult when the outside temperature exceeds high levels. In addition outdoor activities may become unpleasant and or impossible to enjoy or bear if the temperature is too high. In these situations, people may choose to remain indoors in a cool or air conditioned environment to escape the extreme heat. Athletes even explore different times in the day in which to train in order to escape oppressive heat.

Although these solutions may be an option for some, they are however, impractical for those who must remain outside, such as construction workers, public workers, police or professional athletes. A performance fabric may be the answer for some and a necessity to others.

People have adopted a variety of approaches for cooling themselves outdoors. These efforts are largely ineffective and are not completely satisfying. For example, many people who are exposed to oppressive heat cool themselves by soaking one of the many existing fabric materials, such as a cotton facecloth or a towel, for example, in cold water and holding it against their skin. While this technique is effective, it is effective only for a very short period of time, perhaps a minute or so. The downfall of this technique is that an individual's body heat and the ambient temperature rapidly warm the initially cold water to the point that the water is no longer cool against the skin. The most commonly employed "solution" to this problem is to repeatedly saturate the towel or facecloth in cold water as needed. This technique is not satisfying because it requires much effort, and is not practical because it requires the individual to constantly be near a cold water source.

Other cooling mechanisms employed by individuals have met with limited success. For example, ice is commonly used but its availability in any given situation may be limited, its formation can be costly and its ability to conform to an area of the body is severely limited. Alcohol-dipped towels are not widely used, although they tend to be a focus of professional sports teams' cooling solutions. However, alcohol dries the skin and can lead to rashes and other skin irritations. Phase change materials are chemicals that absorb and transfer heat through changes between solid and liquid state. The chemicals employed for that purpose can be hazardous and ineffective if their carriers are breached. Simple wicking material, while keeping you dry, does little to cool the body down.

Presently, there is no effective non-chemical and safe means to properly cool a

body in order to deal with heat exhaustion. The use of traditional means is impractical and cumbersome and therefore, of little value.

Consequently, there needs to be a better fabric to regulate temperature that is inexpensive and easy to adopt. It would be advantageous for a thermal regulating fabric to control the rate of perspiration evaporation while conforming to a person's body shape, such as around the neck. Evaporative cooling is the natural effect of moisture escaping into the atmosphere at will. The ability to regulate the rate of moisture dispersal and create one's personal cooling environment for an extended period of time in a fabric, is such an answer to this dilemma. It would be desirable for a fabric that can be used like normal every day wear which can provide comfort and effectiveheat control.

A solution is finally created that is easy to use, comfortable to wear, attractive, convenient, flexible, and inexpensive. The fabric of the present invention remains cool for an extended period of time when held against the body.

Other objects of the invention will be apparent from the description that follows.

SUMMARY OF THE INVENTION

The mentioned fabric is a creation of blends of multiple yarns to produce a cooling fabric. The fabric utilizes one liquid conductive yarn and one evaporating yarn.

The cooling is created by the existence of fluids and air movement. When the fabric is moistened and air motion is present, the controlled evaporation lowers the core temperature of the fabric drastically and maintains it lower as long as both events remain present.

An aspect of the invention relates to a method of making a multi-ply fabric. The fabric has a top side and a back side with the top side being adjacent to an external environment when the fabric is in use and the back side being adjacent to an object to be cooled when the fabric is in use. The method includes providing a top yarn to form the top side of the fabric and providing a bottom yarn to form the back side of the fabric, with the bottom yarn having a higher SA:V than the top yarn. The two yarns are combined together to form a single fabric, with the top yarn looping through bobbins in the bottom yarn and the bottom yarn looping through bobbins in the top yarn so that the top and bottom yarns are linked and networked to one another.

It is an object of the present invention to provide a convenient, easy-to-use, flexible fabric that remains cool for an extended period of time when contacted against an object to be cooled, such as a person's skin or an inanimate object for which temperature maintenance is desirable, and a method of making the fabric.

It is also an object of the present invention to provide a moisture management fabric that can assist in maintaining a sustained thermal condition of an object for an extended period of time with minimal effort and no temperature-regulating chemicals in the fabric.

Further, it is an object of the present invention to provide a method of manufacturing such a fabric with such characteristics. The fabric of the present invention is formed by weaving or knitting a plurality of yarns with differing surface area to volume ratios. The composition of the fabric may be varied in that it may be formed of a plurality of materials. The materials are selected to provide certain characteristics through the fabric. The portion of the fabric to be positioned adjacent the object to be cooled (or maintained at a defined thermal condition), that is, the back side of the fabric, is configured to transfer liquid away from the object. The portion of the fabric on the side away from the object, that is, the front side of the fabric, is configured to cause the transfer of liquid out of the fabric to occur at a rate that is slower than the rate at which the liquid

transfers away from the object. For example, the back side is or includes a hydrophobic fiber material and the front side is or includes a hydrophilic fiber material. In an embodiment of the invention, the back side material may be polyester and the front side material may be nylon or combined with polyester to form a homogeneous blend. Other materials used to make the yarns of the fabric may be employed. Further, supplemental materials may be incorporated into the fabric for supplemental purposes. For example, anti-static, anti-microbial and/or anti-odor additive materials may be used. One example of such an additive is a silver thread suitable for its anti-microbial functionality.

After the fabric is formed by weaving or knitting, the fabric optionally may undergo one or more treatments, such as scouring and bleaching treatments, for example. These treatments may be performed, for example, for the purpose of preparing the fabric for dyeing and/or for printing one or more designs onto the fabric.

After undergoing any optional treatments, including scouring, bleaching, dyeing and/or printing, for example, the fabric is brushed or peached to break some of the yarns and may be sheared to adjust the pile height of the yarns to a selectable value. For purposes of the description of the present invention, the process of making the fabric will be described as including the step of peaching, which word will be used to refer to brushing or peaching as understood by those of ordinary skill in the art. The fabric is mechanically modified, such as by peaching, in a manner that results in fibers on the front side of the fabric being pulled toward the back of the fabric. This is achieved, for example, by peaching the fabric on its back side prior to performing any peaching on its front side.

Present manufacturing processes that include a peaching step perform the peaching on the front side only, or at least do so first, thereby minimizing the ability to pull fibers on the front side toward the back side of the fabric. Instead, the peaching on the front side is done to create texture, pile and/or "hand" on the

front side of the fabric, such as to enhance the insulation characteristics of the fabric with little or no regard for the condition of the back side or establishing a cooling functionality.

The peaching step of the manufacturing method of the present invention involves peaching both the front and back sides of the fabric multiple times each to create a homogeneous blend of the different materials. That is, at least portions of the fiber material of the front side and the fiber material of the back side become entangled with one another. These homogeneous blends of materials having dissimilar characteristics maintain an atmosphere that is conducive to maximizing the uniqueness of the individual fiber properties and thus control/regulate the rate of evaporation.

The fabric of the present invention is configured to facilitate liquid removal from the surface of the object, store liquid therein, and slow the evaporation of liquid away from the fabric to the atmosphere. Any type of prior commercially available fabric designed to cool is limited to causing rapid transport of liquid away from the skin and equally rapid transport of that liquid completely out of the fabric. In other words, prior cooling fabrics using no chemicals to induce cooling artificially, are configured to get liquid away from the skin as soon as possible and nothing more. This may achieve short term cooling, but fails to enable longer term cooling, particularly for individuals who are not exercising (and thereby generating their own moisture to produce evaporative cooling). The fabric of the present invention utilizes the cooling effect available from retained liquid. By withdrawing that liquid, at what is likely to be its highest temperature at the surface of the object, from the surface, storing the liquid within the fabric so that it cools down to become a more effective evaporative agent than it was when at a higher temperature, and restricting the ability of that cooled liquid to quickly evaporate from the atmosphere-side of the fabric, ensures a substantially longer cooling capability than has been made available.

The present invention is directed to creating in a fabric a controlled environment that maximizes wicking where desired and retention of liquid molecules within the fabric structure. The invention utilizes yarns/fibers organized in the manner described herein to maximize fabric traits that interfere with the normal process of evaporation away from the fabric. These traits include diverting liquid from the surfaces of individual fibers near the object to the interior of the fabric and slowing the rate of evaporation from the fabric. As used herein, "evaporation" means the change of a liquid into a vapor at a temperature below the boiling point of that liquid; a condition that exists at the surface of the liquid, where molecules with the highest kinetic energy are able to escape, when this happens, the average kinetic energy of the liquid is lowered, and its temperature decreases. With that in mind, the present invention is configured to facilitate evaporation within the fabric as much as possible to aid in the cooling of the object while also slowing evaporation of liquid from the fabric itself. Fiber characteristics, density and arrangement all have a hand in regulating evaporation rate. The present invention involves fiber selection, positioning and physical modification to achieved desired evaporation control.

When in its finished form, the fabric of the present invention may be used for anyone or more of a large variety of purposes and to partially or wholly form a large variety of products, including, but not limited to, those purposes and products that are later described herein.

The cooling properties of the fabric of the present invention, which may include maintaining an object at a selected temperature for a period of time, makes it amenable to being used in a large variety of applications. For example, the fabric may be used to wholly or partially form a plurality of apparel and personal products that can be worn or otherwise used by a person in the hot sun or while exercising to keep cool. As another example, the fabric may be used to wholly or partially form a plurality of skin-associated medical health products that can be used to keep a patient cool. The fabric of the present invention satisfies this

need because it becomes cool at its interface with the patient's skin by wicking away any "warm" liquid (e.g., perspiration).

The fabric may also be used to keep inanimate objects cooled, such as materials to be transported, for example. The fabric created through the combination of materials and manufacturing steps described provides maximum wicking and absorption where needed near the object, and moisture storage characteristics that allow for evaporative cooling within the fabric and reducing the rate of normal liquid evaporation away from the fabric.

These and other features and advantages of the invention will be apparent upon review of the following detailed description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the invention will be described by reference to the drawings thereof in which:

Fig. 1 is a close-up cross-sectional view of a prior art Y+O yarn;

Fig. 2 is a close-up cross-sectional view of a prior art wicking yarn with increased surface area for enhanced wicking;

Fig. 3 illustrates the movement of body heat and moisture from the human body to the environment through the fabric of the present invention;

Fig. 4 illustrates the movement of body heat and moisture from the human body to the environment through the fabric of the present invention;

Fig 5. illustrates the movement of moisture and heat transferring from the human body to the environment of the present invention;

Fig. 6 is perspective view of a a cross fiber of Fig. 2;

Fig. 7 is a close up view of the fabric of the present invention showing a general form of the fabric stitching pattern including plurality of wrap yarns and single weft yarns;

Fig. 8 is a demonstration of the pattern construction form and arrangement of the yarns in perspective to a knitting machine;

Fig. 9 is a close up view of the fabric of the present invention showing a general form of the front of a single jersey knit face stitching pattern;

Fig. 10 is a close up view of the fabric of the present invention showing a general form of the back of a single jersey knit face stitching pattern;

Fig. 11 is a close up view of the fabric of the present invention showing a general form of the stitching of a type of yarn that will be combined in order to generate a final fabric;

Fig. 12 is a close up view of the fabric of the present invention showing a general form of the stitching of another type of yarn that will be combined in order to generate a final fabric;

Fig.13. is a close up view of the fabric of the present invention showing a general form of the combination of the two types of yarns combined in order to accelerate the hydraulic abilities knit face stitching pattern;

Fig. 14 is a close up view of the fabric of the present invention showing the positioning of the bobbins and sinker on a knit machine in order to conduct the fabrication of the fabric;

Fig. 15 is a sample of the vertical wicking benefits of a yarn utilized in the present invention in comparison to other types of yarns;

Fig. 16 is a sample of the diffusion area that a yarn utilized in the present invention in comparison to other types of yarns; and

Fig. 17 is a sample of the specification of the fabric utilized in the present invention in comparison to other types of yarns.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Objects with higher surface area to volume ratios (SA:V) move liquid molecules at a faster rate than objects with lower SA:V. This explains why fine salt crystals dissolve quicker in water than coarse salt crystals for any given mass. This occurs because objects with higher SA:V allow molecules to diffuse more quickly and easily than objects with lower SA:V. For this very reason, our lungs have a cluster of porous arteries and fish gills have numerous spikes in order to move molecules of air.

An increase in SA:V results in a corresponding increase in exposure to the environment. More contact with an environment increases the rate of absorption or loss of water. Objects with higher SA:V are also effective at regulating temperatures in unfavorable environments; for example, cacti have numerous pines and lizards spread their gills in order to dissipate heat. The higher the

SA:V an object possesses the faster a particle (including air or water) responds to change in environmental condition such as temperature or moisture.

When we apply this phenomena to textile yarn, a yarn with an intricate cross section has a higher SA:V than an ordinary spherical round yarn. An intricately cross sectioned yarn, therefore, moves moisture much faster than a spherical yarn or hollow yarn. A cross sectioned or Y section yarn diffuses water from a person's skin into the air at a very high rate. Textiles made from these yarns are typically referred to as wicking yarn as shown in Figs. 1 and 2.

Figs. 3 to 5 generally illustrate the workings of the present fabric. Advantageously, the present invention employs a combination of two yarns in constructing a singular fabric. The fabric is created by either knitting or weaving two yarns with differing SA:V. Doing so regulates the rate of water flow within the fabric and controls the rate of evaporation of a person's perspiration. By creating a fabric with two yarns of differing SA:V, the fabric cools a person's skin more rapidly than traditional wicking fabric.

The two yarn system of the present invention combines a yarn with higher SA:V with a yarn with a lower SA:V. The fabric is constructed so that the yarn with the higher SA:V is situated next to a person's skin (bottom yarn) and the yarn with the lower SA:V (top yarn) is placed over the fabric with the higher SA:V, and is exposed to the external environment as best illustrated in Fig. 7. The bottom yarn is placed next to a person's skin so that water molecules (sweat) are absorbed at a fast rate and conducted away from the skin through yarn bobbin linkages between the bottom and top yarns. Water molecules stored at the surface of the top yarn will evaporate due to the flow of air from the environment or body heat. The evaporation of liquid into the air absorbs heat energy from the body to help cooling down a person's body temperature.

Currently, there are many fabrics made from a single yarn with high SA:V ratios such as: Coolmax™, Coolpass™, Coolbest™, Cooltouch™, and Cooldry™. These fabrics are produced from Y cross sections and other various cross sections as shown in Figs. 1, 2 and 6. Such fabrics also tend to maximize their SA:V of their yarns in order to maximize their wicking properties and are hydrophilic in nature.

Unlike these traditional wicking fabrics, which use a single wicking yarn, the present invention uses a two yarn multi SA:V system. The combination of two yarns with differing SA:V is applicable to not only synthetic fibers, but to various combinations of yarns for example, combinations of synthetic fiber with natural fibers.

To increase the SA:V of a particular yarn, one can also break the yarn structure by brushing, sanding or peaching. When a yarn is brushed or peached, the SA:V is increased to help trap more liquid and to increase the variance of SA:V among the two layers of yarn.

Yarns embedded with a polymer with additional features such as: anti-odor, anti-microbial, and infra-red absorption, does not affect the cooling feature of the present invention so long the bottom yarn (the yarn next to a person's skin) has a higher SA:V than the top yarn (the yarn exposed to the external environment).

The present invention is a multi-ply fabric. The present fabric: cools when exposed to a liquid, such as perspiration from an individual's body, for example; is able to wick (transport) perspiration, water or other liquid from an object such as an individual's skin; is able to absorb a liquid at a weight that is a plurality of the weight of the fabric; efficiently regulates the evaporation rate and retains a liquid with minimal loss of the liquid over an extended period of time; controls moisture release, that is, it provides moisture management; and is reusable, while retaining all of these characteristics from use-to-use. The present invention

also is a method of making the fabric having these characteristics.

The side of the fabric to be positioned adjacent to the object to be cooled, referred to herein as the back side, is configured to enhance the transfer of liquid away from the object, such as by wicking, while the other side of the fabric that is spaced away from the object is configured to slow evaporation. The back side may be relatively more porous than the front side as a mechanism to facilitate liquid transfer. Further, its wicking characteristics may be optimized, such as by using fibers made of hydrophobic material and/or with large peripheral surface area. On the other hand, the front side may be relatively less porous than the back side as a mechanism to slow liquid evaporation (by trapping the liquid, or at least slowing its progression to the outer surface of the fabric). Further, its wicking characteristics may be minimized, such as by using fibers made of absorptive or at least relatively hydrophilic material and/or with reduced peripheral surface area.

The selected materials and material configurations for the back side and the front side, when peached as described herein, act in concert to enhance the movement/transportation of liquid from the surface of the object to the core of the fabric's construction. Cooled liquid either moves back toward the object or dwells long enough within the fabric to establish a sufficient heat gradient to effectively draw heat away from the object surface. This results in moisture movement in a controlled manner that enhances and extends the ability of the fabric to transfer heat between the object and the interior of the fabric. In effect, warm liquid adjacent to the surface of the object is drawn away from the object surface at the back side of the fabric and moved to the front side, while cooled liquid within the fabric is sufficiently close to the object at the back side to effect cooling. The regulated slower evaporation of the liquid from the fabric at the top side provides the extension of time for the cooled liquid within the fabric to act as a heat sink for the object.

While some manner of making a fabric creates interstices that act as fluid pathways, the combination of the material selection and peaching of the fabric as described herein makes that pathway characteristic much more substantial, creating a capillary web system that stores and orients the moisture molecules and holds them in suspension until such time as the fabric is activated; thus setting the molecules in motion and causing a disorientation of the moisture molecules so that they are inclined to move toward or away from an object to be cooled or maintained at a temperature. This recycling of moisture to and from the fabric core creates a regulated, controlled, extended evaporative cooling device.

The present invention has been described with respect to various examples. Nevertheless, it is to be understood that various modifications may be made.

While embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only.

CLAIMS

What is claimed is:

1. A method of making a multi-ply fabric, the fabric having a top side and a back side, said top side being adjacent to an external environment when the fabric is in use and said back side being adjacent to an object to be cooled when the fabric is in use, the method comprising:

providing a top yarn to form said top side of the fabric, said top yarn having a surface area to volume ratio (SA:V);

providing a bottom yarn to form said back side of the fabric, said bottom yarn having a higher SA:V than said top yarn; and

combining said top and bottom yarns together to form a single fabric, said top yarn looping through bobbins in said bottom yarn and said bottom yarn looping through bobbins in said top yarn so that said top and bottom yarns are linked and networked to-one-another.

2. The method of claim **1** further comprising weaving said bottom yarn into a terry surface into said back side of the fabric.

3. The method of claim **1** further comprising peaching said bottom yarn.

4. The method of claim **1** wherein weaving comprises circular knitting with a single sided knitting machine.

5. The method of claim **1** wherein weaving comprises separate yarn inflow

knitting with a double sided knitting machine.

6. The method of claim **1** wherein said top and bottom yarns are each hydrophilic, each yarn having different cross-sections.

7. A multi-ply fabric, the fabric having a top side and a back side, said top side being adjacent to an external environment when the fabric is in use and said back side being adjacent to an object to be cooled when the fabric is in use, the fabric comprising:

a top yarn to form said top side of the fabric, said top yarn having a surface area to volume ratio (SA:V);

a bottom yarn to form said back side of the fabric, said bottom yarn having a higher SA:V than said top yarn;, wherein said top and bottom yarns are combined together to form a single fabric, said top yarn looping through bobbins in said bottom yarn and said bottom yarn looping through bobbins in said top yarn so that said top and bottom yarns are linked and networked to-one-another.

8. The fabric of claim **7** wherein said bottom yarn is weaved to produce terry surface into said back side of the fabric.

9. The fabric of claim **7** wherein said bottom yarn is peached.

10. The fabric of claim **7** wherein said top and bottom yarns are each hydrophilic, each yarn having different cross-sections.

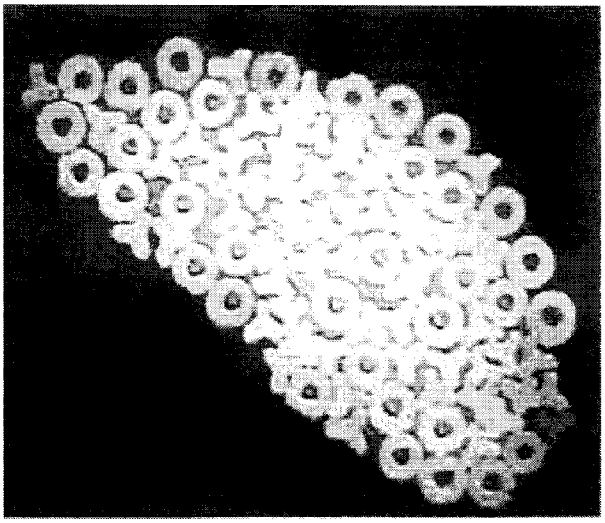


Fig. 1
PRIOR ART

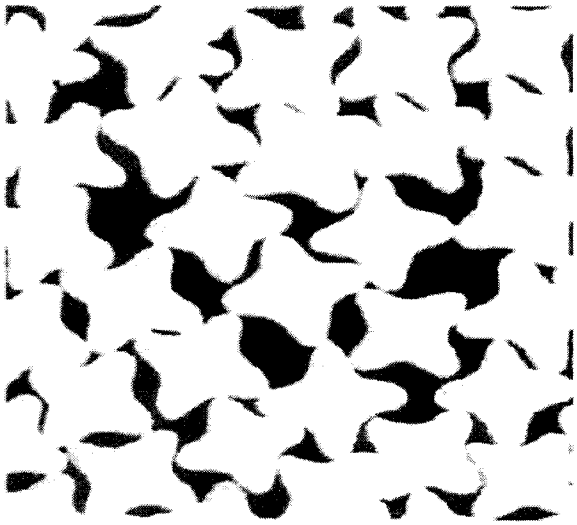


Fig. 2
PRIOR ART

ILLUSTRATION 3:

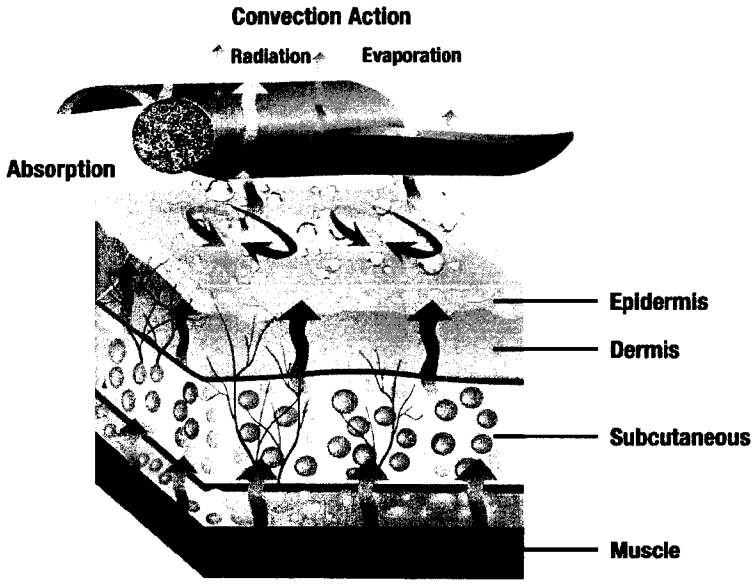


Fig. 3

ILLUSTRATION 4:

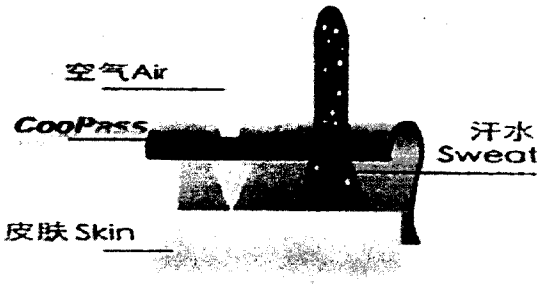


Fig. 4

ILLUSTRATION 5:

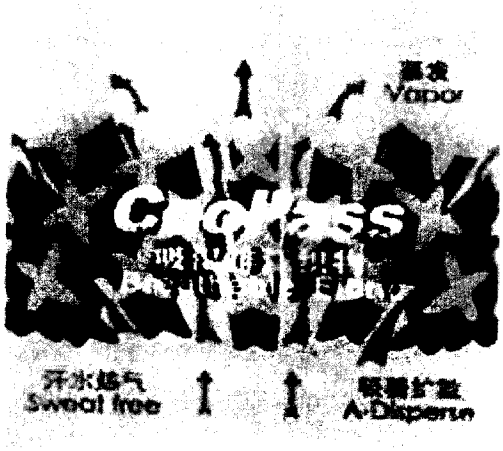


Fig. 5

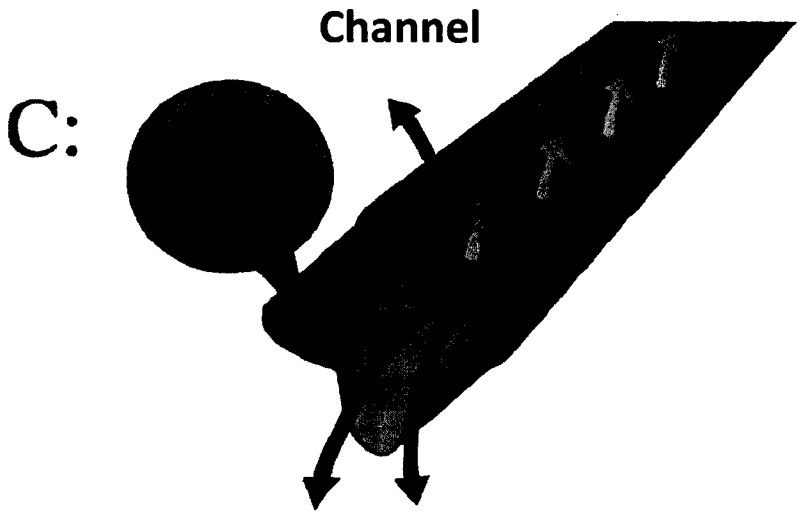


Fig. 6

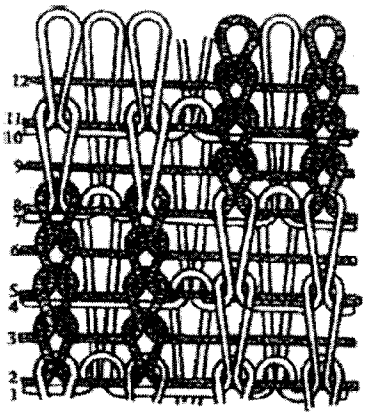


Fig. 7

E:

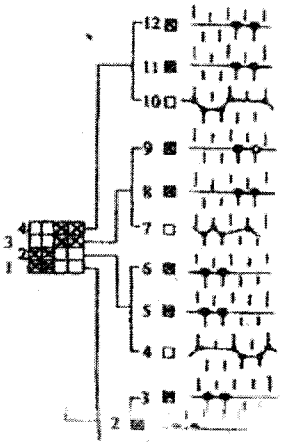


Fig. 8

ILLUSTRATION 9:

F:

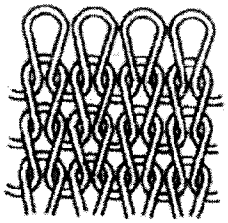


Fig. 9

ILLUSTRATION 10:

G:

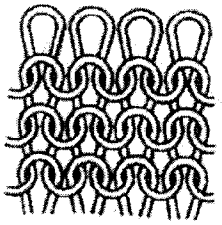


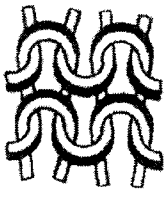
Fig. 10

ILLUSTRATION 11:

(a)

Fig. 11

ILLUSTRATION 12:



(b)

Fig. 12

ILLUSTRATION 13:

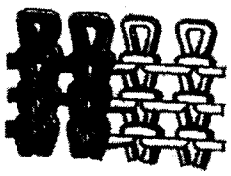


Fig. 13

ILLUSTRATION 14:

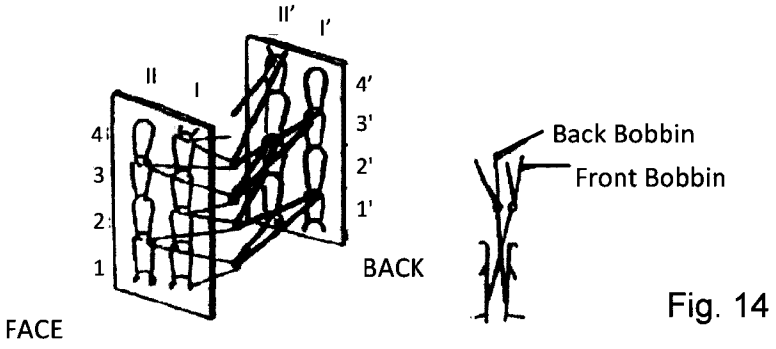


Fig. 14

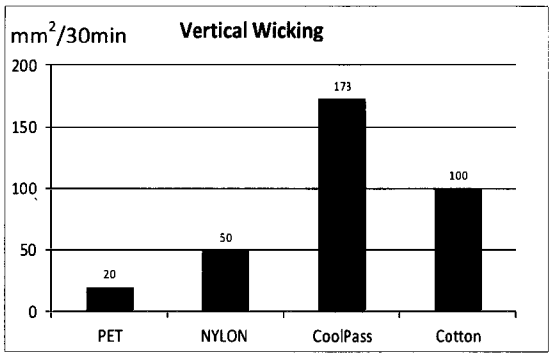


Fig. 15

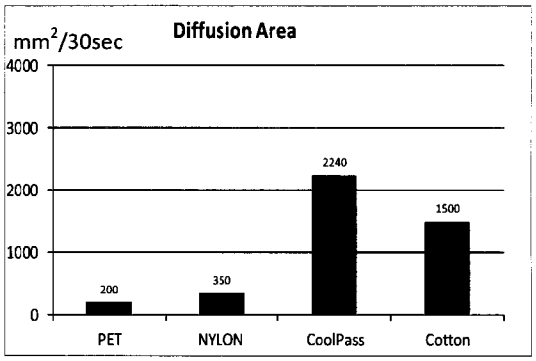
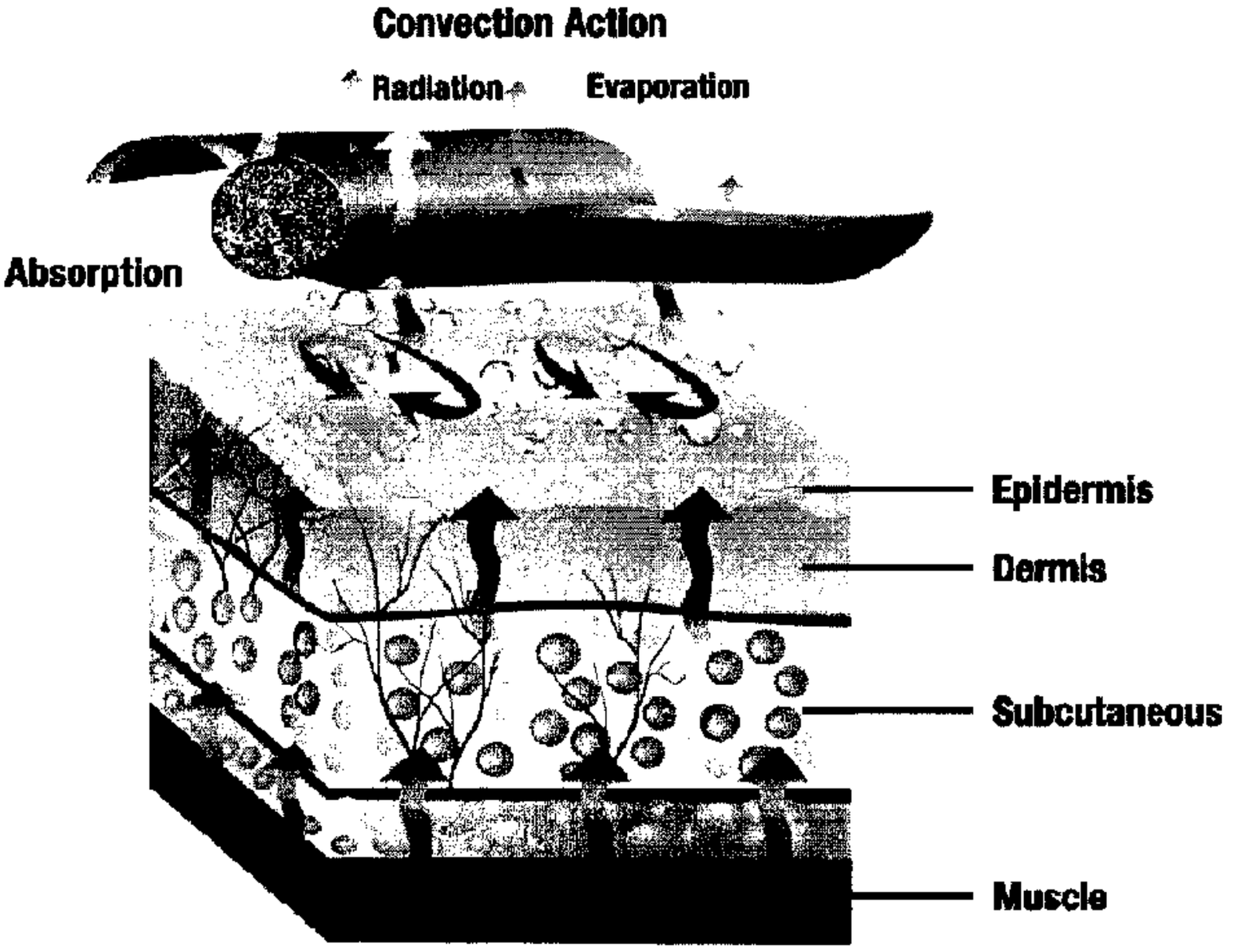


Fig. 16

Specifications

Cross-sec	Dull	Spec	Denier	Count
+	半光 (half bright)	DTY	50	48 72
			75	48 72 96
			100	48 72 144
			150	96 144
			200	96
W		FDY	50	36
			75	36
		DTY	50	36
			75	36

Fig. 17


Convection Action
Radiation
Evaporation
Absorption
Epidermis
Dermis
Subcutaneous
Muscle