US005636380A

United States Patent [19]

Schindler et al.

[11] Patent Number: 5,636,380

[45] Date of Patent: Jun. 10, 1997

[54] **THERMOREGULATORY APPAREL**

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[21] Appl. No.: **481,874**

[22] Filed: **Jun. 7, 1995**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 239,590, May 9, 1994, abandoned.

[51] **Int. Cl.**[6] **A41B 1/00**; A41B 11/00

[52] **U.S. Cl.** **2/69**; 2/DIG. 1

[58] **Field of Search** 428/77, 78, 102, 428/122, 233, 236, 286, 298; 2/DIG. 1, 69

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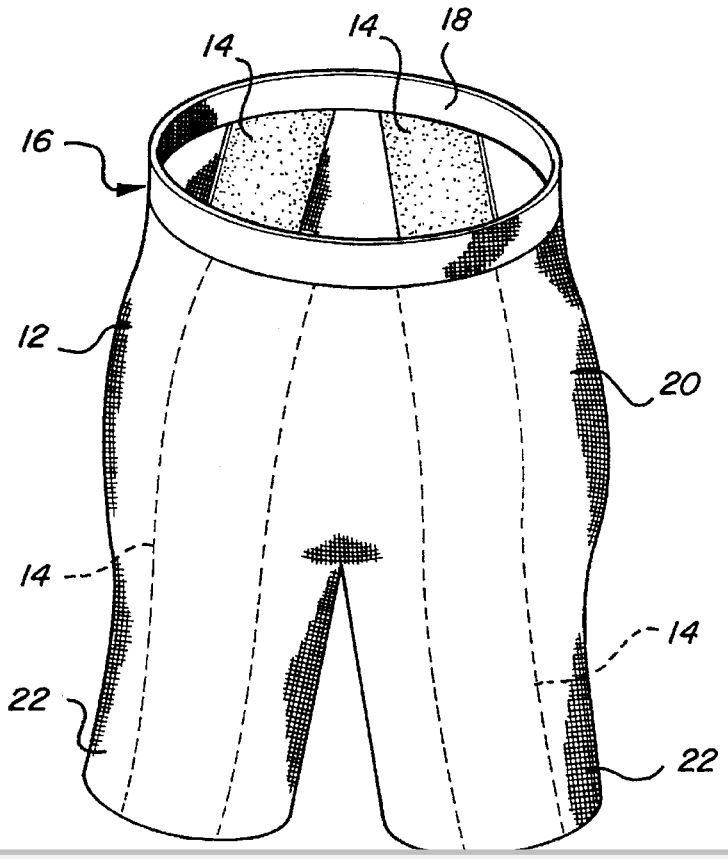
[57] **ABSTRACT**

Thermoregulatory apparel includes garments, for close-fitting skin-contacting wear having, in preferred embodiments, a base fabric of Coolmax^{cm} high moisture evaporation fabric having one or more insulating panels of Thermax^{cm} or Thermastat^{cm} hollow core fiber fabric having moisture wicking capability and applied to the inner side of the garment for skin contact at selected areas of the body where muscle protection is desired. The insulating panels maintain body heat in the protected muscles while evaporative cooling is encouraged by wicking of perspiration away from the body for evaporation from the outer Coolmax^{cm} fabric. Alternative fabric choices and various garment combinations may be utilized.

7 Claims, 2 Drawing Sheets



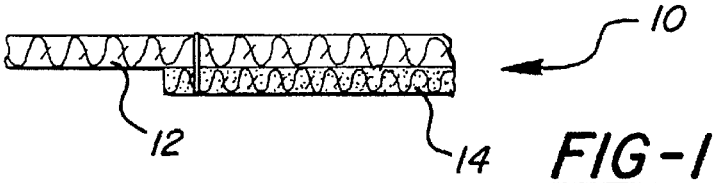


FIG-1

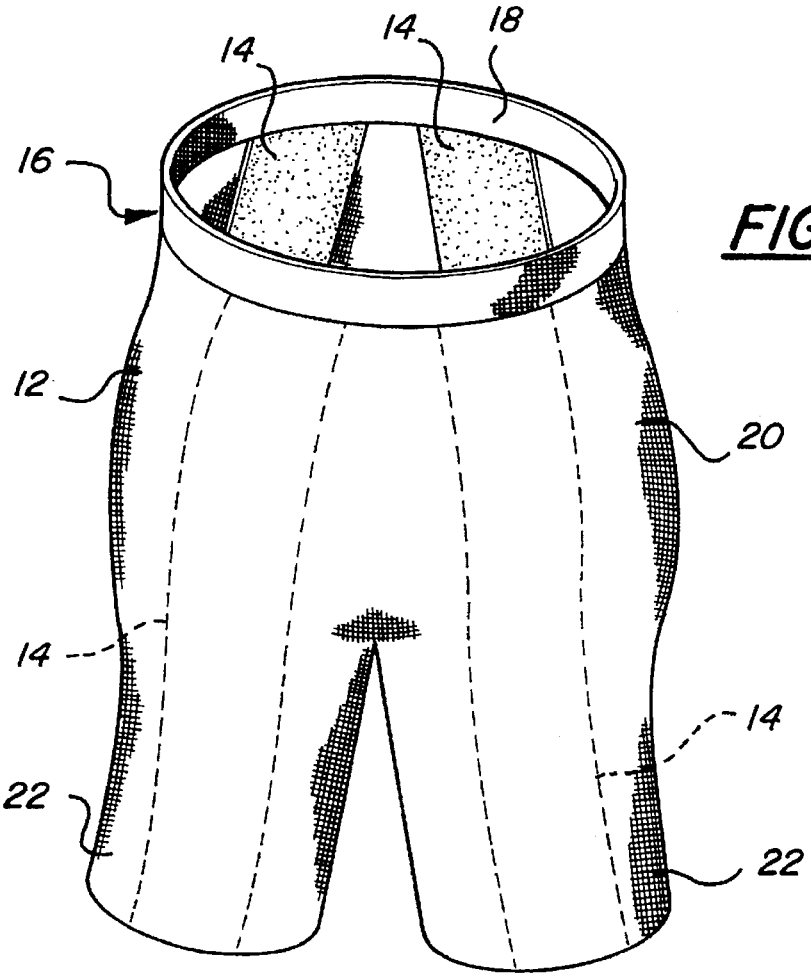


FIG-2

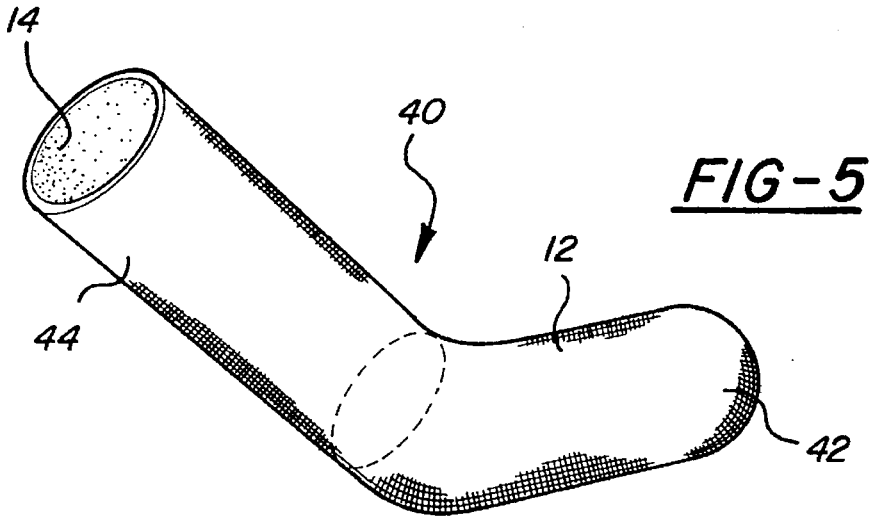


FIG-5

FIG - 3

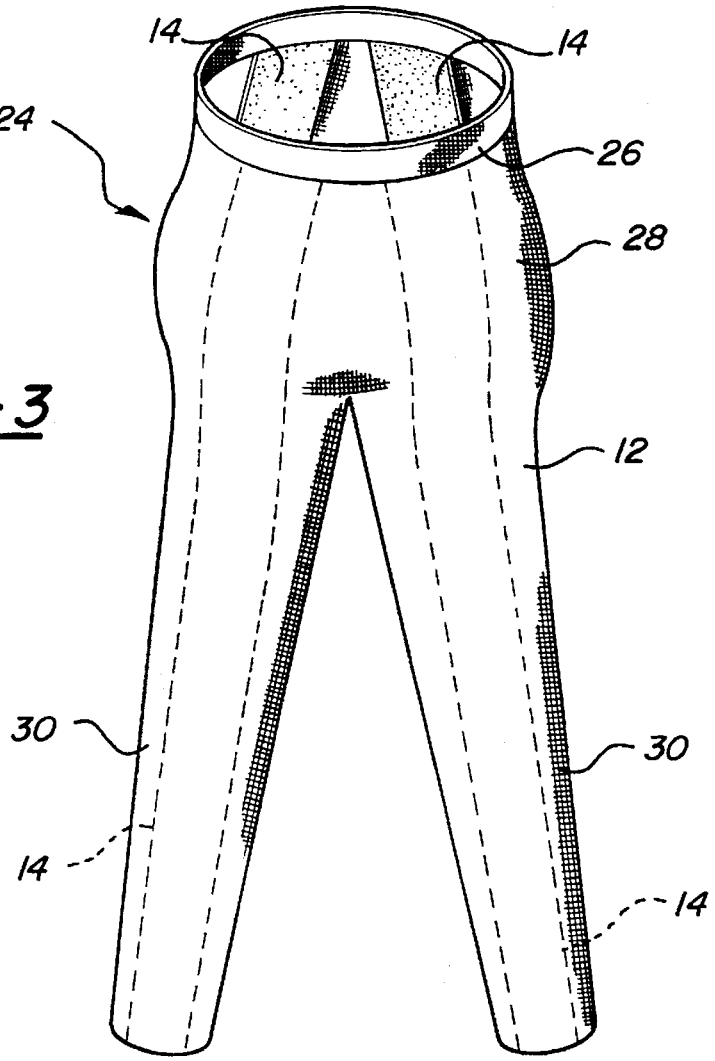
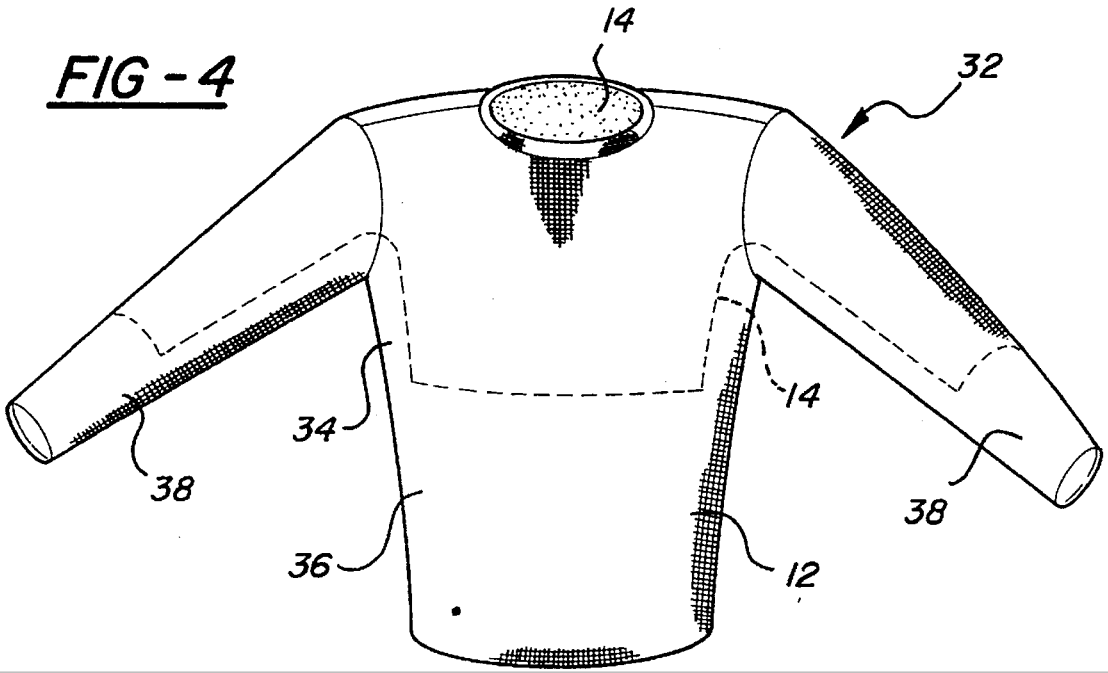


FIG - 4



THERMOREGULATORY APPAREL

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. patent application Ser. No. 08/239,590 filed May 9, 1994, now abandoned.

FIELD OF THE INVENTION

This invention relates to thermoregulatory apparel and in particular to close fitting skin contacting garments for the regulation of body temperature.

BACKGROUND OF THE INVENTION

It is known in the art that human performance, in work or athletic competition, is dependent upon maximal muscle efficiency. Muscles function most efficiently in an optimized cellular environment which is defined as:

1) Homeothermic temperature—37° C.±1° C.
2) Homeostatic Ph range—7.4±.2
3) Adequate/Abundant Energy Sources (glycogen/glucose)
4) Adequate/Abundant Oxygen Sources
5) Maximized Blood Circulation (to bring in nutrients, oxygen; and remove waste products-lactic acids and CO_2)

During human work (or athletic performance) muscle metabolism creates a tremendous heat load which must be dissipated by the human thermoregulatory system.

The skin, through the production and evaporation of perspiration, dissipates this heat load. Radiation, conduction, and convection contribute to this heat dissipation. However, in the active athlete, 80% of this heat dissipation is accomplished by the evaporation, at the skin level, of perspiration.

Humans (and their muscles) function best in a homeothermic state, (37° C.±1° C.). Thus the proper management of this "heat load of metabolism" assumes a high priority in the circulatory physiologic response of athletes in competition (or in high-intensity workers).

The circulation (blood flow) eventually finds itself with two high demand requirements:

1) Carry blood flow to the skin to dissipate excess heat of muscle metabolism.
2) Carry blood flow to the muscle to replenish glycogen/glucose stores, oxygen, and remove acidic waste products (Lactic acid and CO_2).

A competition then develops between the skin and muscle for blood flow in the high performance athlete or intense worker.

SUMMARY OF THE INVENTION

The present invention provides thermoregulatory apparel in the form of garments including diverse panels which enhance the skins ability to dissipate or retain heat as necessary to maintain a body temperature or homeothermic muscle environment of 37° C.±1° C. The garments may include various apparel items applicable for use on different parts of the body and include, but are not limited to, pants, shorts, stockings, body suits, wraps, braces, pads, supports, socks, leggings, sleeves, shirts, hats, gloves and the like.

Each garment includes a combination of heat dissipation panels and heat retention panels which are to be worn in contact with the skin. The heat dissipation panels increase moisture from the skin to an outer portion of the garment. In preferred embodiments, the evaporation of perspiration, and thus cooling, is enhanced by increasing the fiber surface area which is available in the garment for exposure of the perspiration to the air so that evaporation occurs more quickly. Thus the garment does not become soaked and prevent the circulation of air through its fibers.

The heat retention panels in each garment increase the skin's ability to maintain and develop heat in major muscle groups of the body. These heat retention panels reflect heat, or lessen heat loss, and are placed to cover superficial major muscle groups prone to injury. Preferably, these heat retaining panels utilize fibers of hollow construction which trap air within each fiber for insulation of the heat retaining panel. These fibers are, preferably, also configured to wick moisture to the exterior of the insulating panels and, in some cases, to adjacent cooling panels for rapid moisture elimination.

The unique interaction of cooling panels and heat retaining panels in the same garment is the essence of Thermoregulatory Apparel. By design, such a garment enhances the skin's efforts to:

1) Evaporate perspiration and cool the body and/or
2) Retain heat from selected body portions and wick moisture away for rapid evaporation, thus keeping the garment dry and warm.

Thermoregulatory Apparel potentiates and improves the skin's efforts to maintain a steady thermoregulatory, homeothermic muscle environment of 37° C.±1° C. Either cooling or heat retention is improved, depending on the variation from the desired 37° C. As a result, the human thermoregulatory system becomes more efficient in managing environmental temperature changes. Greater temperature variances (hot or cold) can be managed with less stress on the thermoregulatory system, less skin blood flow, and less perspiration production. This decreases dehydration, allows more blood flow to be directed to active muscle groups, and enhances performance. Injury rates are lessened and post-activity recovery times are shortened. Thermoregulatory Apparel has positively affected the competition between skin and muscle for blood flow in the maximally stressed athlete or worker. In addition, areas prone to injury can be cooled or heated, as required, to lessen soft tissue injury rates.

The invention herein drastically reduces muscle injury and encourages the healing process through the material composition which is used to make apparel which causes the heat generated by the muscle to retain and to be reflected back (vasodilation) into the muscle to maintain an optimal level of heat and oxygenation and to reduce the rapid cooling (vasoconstriction-which restricts the capillaries and reduces the oxygen causing the spindles and fibers to shorten which results in the damaging effects mentioned above) and reheating which may lead to muscle injury.

An added benefit relates to the energy producing results of this effect. Depending upon the type and intensity of physical exertion, one will observe different levels of heat production. The body will transfer the energy caused via the cellular metabolism to the skeleton, making movement possible. During, the aforementioned, elevation of body core temperature occurs. This resulting increase of body core temperature and the maintenance of the higher body core temperature also causes a condition which will improve the kinetic output due to a faster rate of metabolism. This effect is a result of the thermoregulatory apparel. The biochemical response at the cellular level of the muscle unit will thus

result of the thermoregulatory apparel and is completely unique from any other product available. This in turn will allow for reduction in resistance and improvement in the muscle's ability to contract along with the increased temperature. The benefits described herein are uniquely attributable to the thermoregulatory apparel which is the subject of this patent application.

The thermoregulatory apparel isolates the long musculatendon units in a state of vasodilation which by its properties cause an increase in oxygen delivery. The capillaries will not be cut off due to vasoconstriction caused via the sweat response. More oxygen is emitted from hemoglobin and delivered into the cellular level of the muscle. There will exist less constriction of the spindles and fibers of the muscle and greater elasticity. This unique result is the performance enhancement property of the thermoregulatory apparel.

The result is: a reduction in muscle injuries such as sprains, strains, and pulls; an improved environment for the healing process; and greater efficiency of performance output.

In referring to the drawings, it should be understood that the broad concept involves use of a dual fabric garment to control body temperature. Such garments may be of any useful type, including shirts, compression shorts, socks, leggings, hats, gloves, pants and so forth, which may be useful in accomplishing the purpose of retaining controlled heat in commonly injured or stressed areas, such as hamstrings and gluteal muscles and quadriceps, and providing maximum cooling for other areas of the body. The drawings therefore illustrate only examples of such garments which are subject to changes in their details and configurations of the various panels to accomplish the desired purposes.

These and other features and advantages of the invention will be more fully understood from the following description of certain exemplary embodiments of the invention taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a cross-sectional view of a cloth panel assembly including cooling and insulating fabrics according to the invention;

FIG. **2** is a pictorial view of a compression shorts garment for athletes according to the invention;

FIG. **3** is a pictorial view of a compression slacks garment with insulating panels according to the invention;

FIG. **4** is a pictorial view of a close fitting shirt formed with an insulating panel according to the invention; and

FIG. **5** is a pictorial view illustrating one of a pair of socks having an insulating panel in the leg portion according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. **1** of the drawings in detail, numeral **10** generally indicates a thermoregulatory cloth material which includes a base layer of fabric **12** made of a polyester fiber blend which enhances evaporation of perspiration and wicking. Examples of polyester fiber are found in clothing made with fabric certified with the name Coolmax^{cm} by the Dupont Company. Cloth **10** additionally includes at least one insulating panel **14**, made from a heat retaining polyester fiber blend and internally applied in a garment over the areas where controlled heat retention is desired. Examples of fiber certified by the Dupont Company with the names Thermax^{cm} and Thermastat^{cm}. Such fibers have hollow cores which provide insulating air space within the fibers. The Thermastat^{cm} fiber is additionally configured to form linearly extending groove-like passages that promote wicking of perspiration along the fiber away from the body. The insulating panel **14** is preferably sewn onto the base fabric layer **12** on the inner side so that it contacts the skin of the body directly. However, if desired, an insulating panel could be edge-attached to a base layer without forming a double cloth layer as in the preferred embodiment.

While the materials mentioned above are preferred for thermoregulatory cloth according to the invention, it would be possible, if desired, to make the base fabric and insulating panel from other materials. For example, the base cloth could in addition to polyester be formed of cotton, lycra, spandex, rayon or even nylon, although these are not as effective in removing heat from the body as the Coolmax^{cm} polyester material. In like manner, other materials might be used for the insulating panels, although with less effective results. Obviously, if improved fibers or manners of making the cloth for the base layer and insulating panels are developed, these improved materials and weaves could be substituted for those disclosed in the preferred embodiment of this invention.

Referring now to FIG. **2**, there is shown an example of compression shorts for athletes, and the like, generally indicated by numeral **16**. The shorts are formed with a waistband **18** sewn to a garment having the base fabric layer **12** formed with a lower body enclosing portion **20** and a pair of legs **22**. Preferably the legs will be long enough to extend down to just above the knee of the wearer in order to obtain the most effective results from the garment. However, shorter length compression shorts may be of value and are to be included within the scope of the invention. The shorts **16** further include insulating panels **14** sewn, or otherwise attached, to the interior of the base fabric **12**. Panels **14** extend generally from the waistband **18** to the lower ends of the legs **22** and along the rear portions of the body and legs. Optionally, similar panels can be applied to the front portions of the legs and lower body. The shapes of the panels may be varied as desired to cause controlled heat retention on those portions of the body where muscles and related stressed structure are located which it is desired to protect by allowing faster warmup and increased blood flow to these areas during exercise or activity and thereafter while cooling off.

Referring to FIG. **3**, there is shown a pair of slacks or pants **24** having a waistband **26** attached to a lower body enclosing portion **28** connected with fulllength legs **30**, the portions **28** and **30** being formed completely from Coolmax^{cm} polyester fabric **12**. Within this garment fabric are formed insulating panels **14** extending from the waistband **26** to the bottom of the full-length legs in a manner similar to that described for the compression shorts of FIG. **2**.

FIG. **4** illustrates a close fitting shirt **32** which is again formed fully of Coolmax^{cm} fabric **12** and includes upper and lower body portions **34**, **36** connected with arms **38**. Within this garment shell, an insulating panel **14** is sewn which extends over the front and rear portions of the upper body portion of the garment and the upper portions of the arms down to about the elbows. The lower portions of the arms are left free of the insulating panel **14** to allow rapid cooling and evaporation of perspiration in the under arm area as well as along the sides of the upper body portion.

Referring now to FIG. **5**, there is shown a sock **40** having

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