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(54) Moisture managing undergarment

(57) The invention relates a moisture managing undergarment (10) having an inner side (2) adapted to be towards skin of users and an outer side (3) adapted to be towards inside surface of a separate outer suit (4). The undergarment is made of a multilayer material, which comprises a textile fabric layer (5) for said inner side, a separative layer (6) of a thermally isolating material, a waterproof/breathable membrane or coating layer (7) on top of said separative layer, and an elastic, slip surface textile fabric layer (8) on top of said waterproof/breathable membrane or coating layer (7) and attached thereto for the outer side of said undergarment.

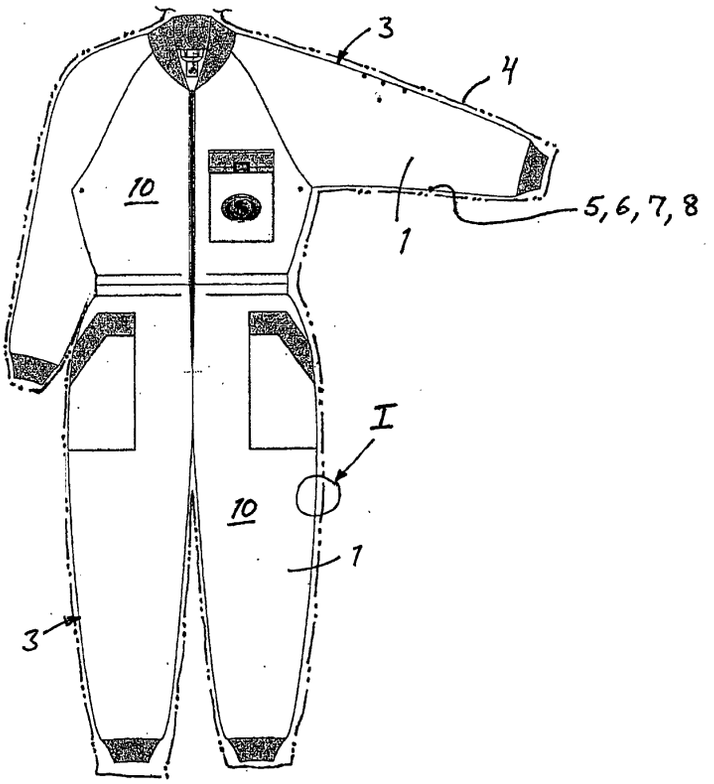

Fig. 1

EP 1 481 599 A2

Description

FIELD OF THE INVENTION

[0001] The invention relates a moisture managing undergarment, which has an inner side adapted to be towards the skin of users and an outer side adapted to be towards the inside surface of a separate outer suit. Accordingly, the undergarment is intended to be used between the body of the user persons and the outer suit, which outer suit is mainly protective or mainly responsible for protection against the environmental effects, like water, heat, cold, wind etc.

BACKGROUND OF THE INVENTION

[0002] The publication US-5 344 698 discloses a composite textile fabric comprising a first fabric layer of a material selected from the group consisting of polyester, acrylic and nylon, which has been rendered hydrophilic in order to quickly transport urine and other body fluids therethrough, a second fabric layer for absorbing said urine and other body fluids comprising at least 5% by weight of a super absorbent fiber, and a breathable barrier layer applied to the second fabric layer having a high moisture vapor transmission rate so that moisture retained by the second layer rapidly evaporates; wherein the first fabric layer and the second fabric layer are formed integrally and concurrently by knitting a plaited construction. The barrier layer provides a gating mechanism for promoting transport of urine from the first fabric layer as the water contained therein evaporates from the second fabric layer and through the barrier layer, whereupon the weight of liquid retained by the absorbent layer is slowly and continually reduced. The use of a super absorbent fiber is because the fibers will absorb many times their own weight, even when under pressure and they will retain the absorbed liquid when subjected to pressure, and they swell many times as they absorb fluids and they do it faster than super absorbent powder.

[0003] The publication US-5 155 867 discloses a stretchable, body conformable, undergarment for the protection of the wearer from contact with external fluids, comprised of a stretchable laminated material of: a stretchable water penetration-resistant, moisture vapor permeable membrane; a hydrophilic polyurethane layer adhered to said membrane; and a stretchable knit textile fabric adhered to said hydrophilic polyurethane. The undergarment is constructed such that the knit textile, preferably of cotton or polyester-cotton blend fabric, is on the inside of the undergarment. In this undergarment the stretchable water penetration resistant, moisture vapor-permeable membrane comprises porous, expanded polytetrafluoroethylene. The undergarment provide protection to the body from accidental contact with blood and other body fluids, which protection is needed by medical personnel working in non-standard environments such as emergency rooms, accident and natural disaster sites, rescure operations and the like.

[0004] When persons are staying or especially working in environmental conditions, where they must wear such protective outer garment or suit, which is at least liquid-tight or possibly vapor-tight or even gas tight, the secreted sweat and its condensation inside the protective outer suit or garment is a problem. The condensed sweat spreads all through the underwear used, making it wet. Firstly, it is very uncomfortable to be in wet underwear. Secondly, wet underwear does not insulate from coldness or heat properly. Currently known or available materials and material combinations do not provide adequate feeling of dryness and/or thermal insulation when used under outer garment or suit, which is liquid-tight or vapor-tight or gas tight.

SUMMARY OF THE INVENTION

[0005] The undergarment of the invention utilizes a combination of materials enabling to manage the moisture secreted by a person as a sweat and at least partly preserved inside a separate outer suit or outer protective garment so that the surface, which is in contact with the skin of the user person, is kept dry enough to be comfortable for long time periods. The materials and their combination can be designed to provide dryness and/or feeling of dryness for required time periods, like time of performing individual tasks or other activities, because the amount of sweat and so the amount of water present can be calculated/evaluated for various situations. The undergarment of the invention utilizes a combination of materials also enabling to maintain the thermal insulation properties at a high level during use, i.e. the thermal insulation of the undergarment is not seriously deteriorated because of the water originating from the sweat.

[0006] According to the main aspect of the invention it is provided a moisture managing undergarment having an inner side adapted to be towards skin of users and an outer side adapted to be towards inside surface of a separate outer suit; said undergarment being made of a multilayer material, which comprises a textile fabric layer for said inner side, a separative layer, and a waterproof/breathable membrane or coating layer on top of said separative layer, the layers being attached to each other; in which undergarment said separative layer between said textile fabric layer and said waterproof/breathable membrane or coating layer is a thermally isolating material; and that said multilayer material further comprises an elastic, slip surface textile fabric layer on top of said waterproof/breathable membrane or coating layer and attached thereto for the outer side of said undergarment.

[0007] According to another aspect of the invention the thermally isolating material of the separative layer is composed of full fibers, and/or hollow fibers, and/or open cell foamed polymer, and/or closed cell foamed

polymer with breathable perforations. The water absorbability of this thermally isolating material shall be low, but water vapor permeability shall be high so that the sweat, i.e. water goes through the separative layer without accumulating in the thermally isolating material.

[0008] According to the further aspects of the invention said textile fabric layer at the inner side is a fleece fabric of synthetic fiber(s); and said surface textile fabric layer is a tricot fabric of synthetic fibers. Fleece is very comfortable material as the innermost layer against the skin of the user. The tricot fabric or the like stretchable fabric with slippery surface as the outermost layer allow gliding of the outer protective suit in respect to the undergarment and also controls the water/sweat that is conveyed from the user through the innermost layer, the thermally isolating material and the water-proof/breathable membrane or coating, and is in many applications - depending on the breathing properties of the outer suit and depending on environmental conditions like temperature - at least partly condensed on the inside of the outer suit, i.e. between the undergarment and the outer suit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The foregoing summary, and the following detailed description of the preferred embodiments of the present invention, will be better understood when read in conjunction with the accompanying drawings, in which:

FIG. 1 represents generally a typical undergarment according to the invention in frontal view; the outer suit under which the undergarment is intended is visualized with phantom lines.

FIGS. 2A and 2B represent two alternative structures of the multilayer material according to the invention for making the undergarment, on top of a person and under an outer suit, in a cross-sectional view along a plane perpendicular to the surfaces of the material, from an area I in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] A moisture managing undergarment 10 has an inner side 2 adapted to be towards skin 20 of the users, and an outer side 3 adapted to be towards inside surface of a separate outer suit 4. It is suggested that persons using the undergarment of this invention does not wear additional underclothes between their skin 20 and the undergarment 10, but such underclothes, if thin material and without special isolation or absorption properties, can be used if wanted. E.g. underclothes of thin synthetic fabrics typical in everyday use hardly cause adverse effects on the function of moisture managing undergarment 10 of this invention. The moisture managing undergarment 10 is intended and designed to be used under an outer garment or suit 4, which is at least liquid-tight or possibly vapor-tight or even gas tight, but nothing prohibits using it under any other type of outer suit 4, or alone without any outer garment. When using under said other type of outer suit 4 or alone all designed advantages are not attained, but the undergarment 10 is very comfortable and practical under these circumstances, too. The undergarment 10 is preferably either an one part garment, like that shown in Fig. 1, or a two part garment like trousers and blouse, and it can have shorter legs and/or sleeves, instead of normal long legs and sleeves, if especially wanted, whereupon some of the properties may be lost. It shall be noted that in this description the definition "fiber" is also used to mean "thread" and "yarn" and "filament", because it is evident that materials disclosed can be prepared utilizing any of these.

[0011] The undergarment 10 is made of a multilayer material, which comprises a textile fabric layer 5 for the inner side 2, which should be in contact with the skin 20 of the person wearing or using the undergarment, as explained above. The multilayer material also comprises a separative layer 6, which is explained later in detail, and a waterproof/breathable membrane or coating layer 7 on top of said separative layer. The different layers are attached to each other, whereupon they form the multilayer material. The waterproof/breathable membrane or coating layer 7 is either a microporous membrane, or an intermolecular permeable membrane, or alternatively a microporous or an intermolecular permeable film resulting from the coating. Many types of waterproof/breathable membranes and coating materials for attaining the films, respectively, are commercially available from many manufacturers, and so they are not explained in detail. The idea of these membranes and coated films is the same, to have so small-sized ways in the material that water vapor passes therethrough but water droplets not. Microporous membranes are typically made of expanded polytetrafluorethylene (PTFE) with very small physical pores for permeability of water vapor and non-permeability of liquid water, whereas the intermolecular permeable membranes are made of e.g. a type of polyester providing molecular level structure for non-permeability of liquid water and permeability of water vapor. Membranes or coated films can be also made from polyurethane and other polymers. Membranes or films with these non-permeability and permeability qualities having hydrophilic properties in one embodiment, or polar and hydrophobic properties in another embodiment are considered to belong to the group of intermolecular permeable membranes or films. The important physical properties of these membranes and films are Water Vapor Diffusion Resistance or Water vapor Flux (g/m^2·24h), and Water Proof Rate (mm H_2O) or Waterproofness (kN/m^2). The thickness of the membranes and films are typically in the order of 0.01 mm to 0.05 mm, but the above mentioned important physical prop-

erties are decisive not the thickness. These materials are available under e.g. the registered trademarks Gore-Tex®, Sympatex®, Triplepoint Ceramic®, Sili-Tex®, Xalt®, and X-Tex By Ursuit®, and many others. The moisture managing undergarment 10 of the invention has been tested using X-Tex By Ursuit® as the waterproof/breathable membrane 7. The Water Proof Rate shall be over 800 mm H_2O, or preferably at least 1500 mm H_2O, or typically at least 2500 mm H_2O. At the same time Water vapor Flux shall be at least 200 g/m^2·24h, or preferably at least 400 g/m^2·24h, or typically at least 600 g/m^2·24h. Coatings that increase solely the contact angle of the water on textile are not believed to be effective because of low Water Proof Rate, but contact angle increasing treatment can be added to membranes or films described above, if it does not worsen their other properties.

[0012] The textile fabric layer 5 at the inner side 2 is a fleece fabric 5' of synthetic fiber(s). Fleece is an established definition and means a fabric with at least one deep, soft, napped surface, i.e. pile textured surface. The difference between fleece, velour and velvet is somewhat vague, many times depending only on person(s) utilizing the word. In general the fleece has lowest cut pile and the velvet longest cut pile, but this is not very important though a shorter cut is preferred. The fuzzy ends of the pile fibers in fleece, attained e.g. by brushing, makes that the fleece fabric 5' is the preferred variant for textile fabric layer 5. It is anyway possible to use velour or velvet as well for textile fabric layer 5 instead of fleece, but with a slightly lower comfort to the users. As known these fabrics can be either woven or knit construction. There are two types of fleeces. In the first type both of its opposite surfaces has the pile texture, i.e. the fleece is symmetrical. In the second type only one of the opposite surface has the pile texture, i. e. the fleece is unsymmetrical. According to the preferred embodiment of the invention the first surface 5.1 of the fleece fabric 5', which surface 5.1 is to be formed the inner side 2 of the undergarment and against the skin 20, is the pile-textured surface or pile-textured side. In this embodiment the second surface 5.2 of said two opposite surfaces of said fleece fabric 5' is a smooth finished surface to be attached to the separative layer 6. As can be understood, fleece with two opposite piled textured surfaces can be used, but at the moment it is believed that the attaching to the separative layer 6 may cause difficulties. The synthetic fiber(s) for the fleece fabric are typically and preferably polyester. It is also possible to use fleece manufactured from polyamide or mixture of polyester and polyamide (= nylon) fibers, or other synthetic fibers known as such or new. The surface weight of textile fabric layer 5, i.e. fleece fabric 5' is at minimum 15 g/m^2 and at maximum 150 g/m^2, and preferably between 25 g/m^2 and 100 g/m^2.

[0013] According to the invention the separative layer 6 between the waterproof/breathable membrane or coating layer 7 and the textile fabric layer 5, as described above, is a thermally isolating material 6', i.e. a material with low thermal conductivity. For this purpose the thermally isolating material 6' of the separative layer 6 is a porous and flexible material, where the porosity means spaces between the fibers or walls of the cells. The thermally isolating material 6' has a total volume V_M defined by the outlines of the separative layer 6 and a porosity volume V_P constituted by said spaces between the fibers or walls of the cells. In order to attain good thermal isolation capability the porosity volume V_P shall be approaching the total volume V_M, whereupon the porosity volume V_P should be at least 80% of the total volume V_M, or the porosity volume V_P should be typically at least 90% of the total volume V_M. The thermally isolating material 6' of the separative layer 6 is composed of full fibers, and/or hollow fibers, and/or open cell foamed polymer, and/or closed cell foamed polymer with breathable perforations.

[0014] When made of the full and or hollow fibers mentioned above, the material thereof is typically polyester. These kinds of fibers as such and different sheets of these fibers are commercially available, and accordingly, their materials are not explained in detail. The fibers are arranged in different configurations in respect to each other, either in woven fashion, or non-woven fashion, or partly woven partly non-woven fashion. Various additional means like adhesives can be used so that the fibers are permanently attached to each other. Independent of the layout and attaching of the fibers they form e.g. sheet material with the total volume V_M and the porosity volume Vp, which sheet material being the thermally isolating material 6' for attaining the separative layer 6. These fiber materials are available under e. g. the registered trademarks Hollofil®, Primaloft®, Quallofil®, Thermax®, Thinsulate®, Finnfill®, and many others. The moisture managing undergarment 10 of the invention has been tested using Finnfill® as the thermally isolating material 6', in which mentioned material fibers - i.e. filling - are arranged to form a two sided pile structure and an about centrally positioned carrier structure for said pile structure. The thermally isolating material 6' has a mean density at maximum 200 kg/m^3, but preferably a mean density at maximum 100 kg/m^3, when measured in a non-compressed state. The Finnfill® material that was included in the moisture managing undergarment 10 has an area weight of 150 g/m^2 and thickness in the order of 5 mm and the thermal insulation was in the order of 2 clo. "Clo" is the established unit for relative thermal insulation, and 1 clo is 0.155 m·m^2·K/W. This material does not lose its properties during repeated washings of the undergarment, which is also very important property, making this mentioned thermally isolating material 6' part of the preferred embodiment of the invention. The separative layer 6 has a thickness S at minimum 3 mm, and at maximum 20 mm, and typically the thickness S is between 4 - 10 mm, all values in a non-compressed state.

[0015] In the second embodiment of the invention the

thermally isolating material 6' of the separative layer 6 is composed of a flexible open-cell foamed polymer, also called cellular plastic. These polymers can be flexible polyurethane foam, latex foam rubber, cellular rubber or flexible cellular polyvinyl chloride, which are also commercially available under different brands and trademarks. Accordingly, they are not described in detail. When the Fraction Open Cells has a high value meaning that a large portion of the cells are interconnected by gas phase, i.e. air, the isolating material 6' behaves like those based on fibers. In the third embodiment of the invention the thermally isolating material 6' is a flexible closed-cell foamed polymer with low value of Fraction Open Cells, in which case this separative layer 6 must have separately provided with breathable perforations. These perforations can be small holes or slits extending through the separative layer 6. For the second and third embodiment the thermally isolating material 6' of the separative layer 6 has also a mean density at maximum 200 kg/m^3, or preferably at maximum 100 kg/m^3, in a non-compressed state. Also here the separative layer 6 has a thickness S at minimum 3 mm, and at maximum 20 mm, and typically the thickness S is between 4 - 10 mm, all values in a non-compressed state.

[0016] The thermally isolating material 6' is especially without super absorbent material(s). This is because materials containing super absorbents loose their thermal isolation properties when they absorb water. Super absorbents absorb water more than their initial volume and weight. Contrary to super absorbents the thermally isolating material 6' used in the moisture managing undergarment 10 has a water absorption at maximum equal to said total volume V_M, or typically at maximum equal to said porosity volume V_P, or preferably smaller than said porosity volume V_P. This amount of absorption is reality for the thermally isolating materials 6' described above only if totally immersed in water. Under other circumstances the water absorption is substantially smaller, perhaps at maximum 5%, or at maximum 10%, or smaller than 20% of the initial weight of thermally isolating material 6'. It is also possible to mix or otherwise combine the above disclosed fiber type material and the above disclosed cell type polymer.

[0017] According to the invention the multilayer material further comprises stretchable or elastic, slip surface textile fabric layer 8 on top of the waterproof/breathable membrane or coating layer 7 and attached thereto for the outer side 3 of the undergarment 10. This surface textile fabric layer 8 is preferably a tricot fabric 8' of synthetic fibers. The tricot is a warp knit fabric with the fiber loops connected vertically in respect to the fabric sheet, and the opposite sides are different. Warp knit fabrics with other names as tricot can be utilized as well. It is easy to get the one of the tricot fabric surfaces a smooth finish, which is slippery, i.e. have a low friction in respect to at least to the underside 21 of the intended separate outer suit 4. As generally known tricot is also elastic, i. e. it can be stretched in directions parallel to the fabric sheet. It is also possible to use jersey or other weft knit fabrics, which generally are more stretchable than tricot and other warp knit fabrics, but typically have, in spite of smooth finished surface, higher friction in respect to other fabrics used for the underside 21 of the separate outer suit 4. The tricot, or other respective fabric 8' of the surface textile fabric layer 8 has a surface weight at minimum 80 g/m^2 to attain necessary strength. The surface weight of the tricot, or other respective fabric 8' is at maximum 300 g/m^2 for avoiding excessive weight of the undergarment 10. It may be practical to use a heavier and thicker tricot for applications, in which the wearing time of the undergarment 10 is known to be very long, e.g. several hours or the whole days, and lighter and thinner tricot for applications, in which the wearing time of the undergarment 10 is known to be shorter, e. g. only a few hours. It is believed now that the tricot or other respective fabric 8' controls the movement of the water possibly condensed between the waterproof/breathable membrane or coating layer 7 and the underside 21 of the separate outer suit 4, while allowing mutual gliding of the undergarment 10 and outer suit 4. To maximize the slipperiness of the surface textile fabric layer 8 the synthetic fibers/yarns of the fabric 8' has smooth or even surface without any brushing or the like. The synthetic fibers or yarns used for preparation of the tricot, or the respective fabric 8' is preferably polyester or nylon. Other synthetic fibers known as such or new may also be useful.

[0018] The synthetic fibers described above for layer materials of the invention has the advantage that the fiber material itself does not substantially soak up water, contrary to natural fibers. The textile fabric layer 5 for said inner side 2, the separative layer 6 being of thermally isolating material, the waterproof/breathable membrane or coating layer 7, and the stretchable, slip surface textile fabric layer 8 for said outer side 3 are attached to each other forming a uniform multilayer laminate 1. This attaching of said layers 5 and 6 and 7 and 8 of the laminate 1 is made by adhesives 11, 12, 13 spread between material sheets of said layers prior to preparing said undergarment 10. There are several various adhesives and lamination methods, which are used in factories, specialized in production of the textile laminates. The adhesives and lamination methods for producing moisture managing undergarment 10 of the invention shall be selected so that the layers 5 and 6 and 7 and 8 of the laminate 1 are securely attached also during the use of the undergarment, but the transportation of water vapor therethrough the laminate is not prohibited. Accordingly, any known or new lamination material and/or lamination method suitable for the purpose can be utilized. The undergarment 10 of the invention is made from a ready made laminated multilayer material 1 with the layers 5 and 6 and 7 and 8 using any practical production technology.

Claims

1. A moisture managing undergarment having an inner side (2) adapted to be towards skin of users and an outer side (3) adapted to be towards inside surface of a separate outer suit (4); said undergarment (10) being made of a multilayer material, which comprises a textile fabric layer (5) for said inner side, a separative layer (6), and a waterproof/breathable membrane or coating layer (7) on top of said separative layer, the layers being attached to each other, **characterized in that** said separative layer (6) between said textile fabric layer (5) and said waterproof/breathable membrane or coating layer (7) is a thermally isolating material (6'); and that said multilayer material further comprises an stretchable, slip surface textile fabric layer (8) on top of said waterproof/breathable membrane or coating layer (7) and attached thereto for the outer side of said undergarment (10).

2. A moisture managing undergarment according to claim 1, **characterized in that** said thermally isolating material (6') of the separative layer (6) is a porous material without super absorbent material (s).

3. A moisture managing undergarment according to claim 1, **characterized in that** said thermally isolating material (6') of the separative layer (6) has a total volume (V_M) and a porosity volume (V_P); and that said thermally isolating material (6') has a water absorption at maximum equal to said total volume (V_M), or at maximum equal to said porosity volume (V_P), or smaller than said porosity volume (V_P).

4. A moisture managing undergarment according to any of the preceding claims, **characterized in that** said thermally isolating material (6') of the separative layer (6) is composed of: full fibers, and/or hollow fibers, and/or open-cell foamed elastomer, and/or closed-cell foamed elastomer with breathable perforations; and that the space between the fibers or walls of the cells constitutes porosity volume (V_P).

5. A moisture managing undergarment according to claim 4, **characterized in that** said fibers in said thermally isolating material (6') are arranged to form a two sided pile structure and a carrier structure for said pile structure.

6. A moisture managing undergarment according to any of the preceding claims, **characterized in that** said separative layer (6) has a thickness at minimum 3 mm, and at maximum 20 mm; or between 4 - 10 mm, in a non-compressed state.

7. A moisture managing undergarment according to any of the preceding claims, **characterized in that** said thermally isolating material (6') of the separative layer (6) has a mean density at maximum 200 kg/m^3, or at maximum 100 kg/m^3, in a non-compressed state.

8. A moisture managing undergarment according to claim 1, **characterized in that** said textile fabric layer (5) at the inner side is a fleece fabric (5') of synthetic fiber(s).

9. A moisture managing undergarment according to claim 8, **characterized in that** said fleece fabric (5') has two opposite surfaces, at least a first surface (5.1) of which has a pile texture positioned to form said inner side (2) of the undergarment.

10. A moisture managing undergarment according to claim 8 or 9, **characterized in that** a second surface (5.2) of said two opposite surfaces of said fleece fabric (5') has a smooth finishing to be attached to said separative layer (6).

11. A moisture managing undergarment according to claim 1, **characterized in that** said waterproof/breathable membrane or coating layer (7) is: a microporous membrane; or an intermolecularly permeable membrane; or a microporous or an intermolecularly permeable film.

12. A moisture managing undergarment according to claim 1, **characterized in that** said surface textile fabric layer (8) is a tricot fabric (8') of synthetic fibers having a surface weight at minimum 80 g/m^2.

13. A moisture managing undergarment according to claim 12, **characterized in that** said tricot fabric (8') of the surface textile fabric layer (8) has a surface weight at maximum 300 g/m^2.

14. A moisture managing undergarment according to claim 12 or 13, **characterized in that** said synthetic fibers of the tricot fabric (8') has smooth texture providing a low friction in respect to at least to the underside of the intended separate outer suit (4).

15. A moisture managing undergarment according to any of the preceding claims, **characterized in that** said textile fabric layer (5) for said inner side (2), said separative layer (6) being of thermally isolating material, said waterproof/breathable membrane or coating layer (7), and said stretchable, slip surface textile fabric layer (8) for said outer side (3) are attached to each other forming a uniform multilayer laminate (1).

16. A moisture managing undergarment according to

claim 15, **characterized in that** said attaching of said layers (5 and 6 and 7 and 8) of the laminate (1) is made by adhesives (11, 12, 13) spread between material sheets of said layers prior to preparing said undergarment (10).

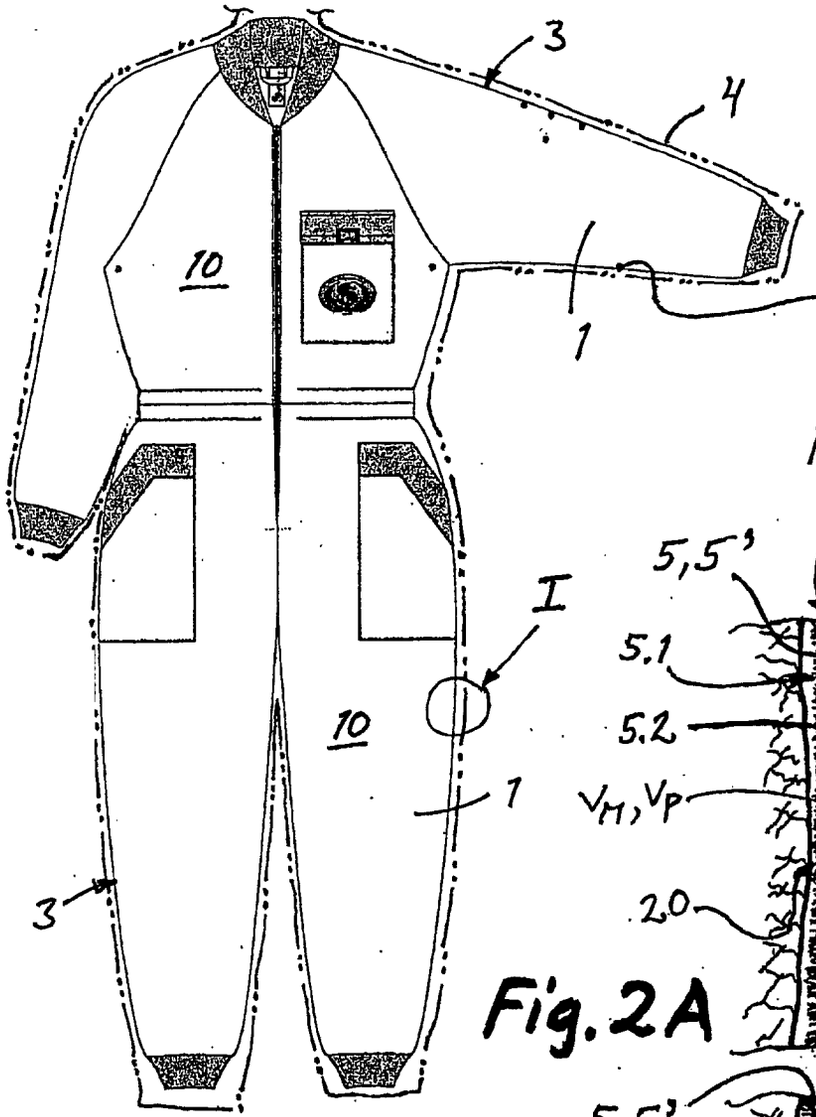

Fig. 1

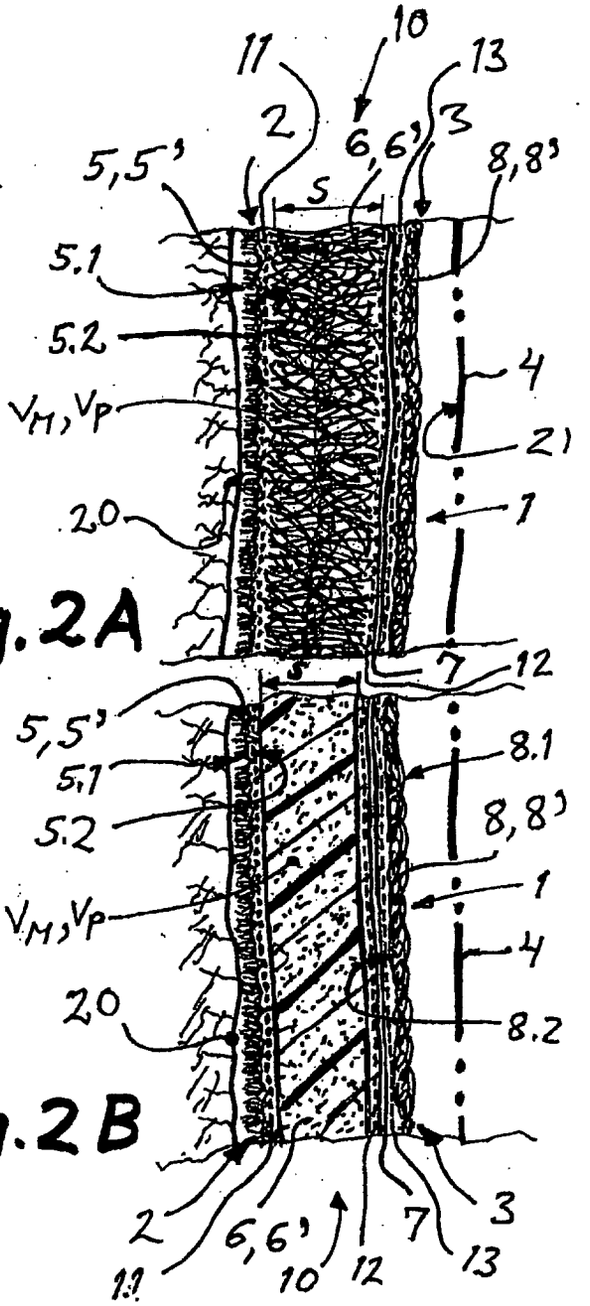

Fig. 2A

Fig. 2B