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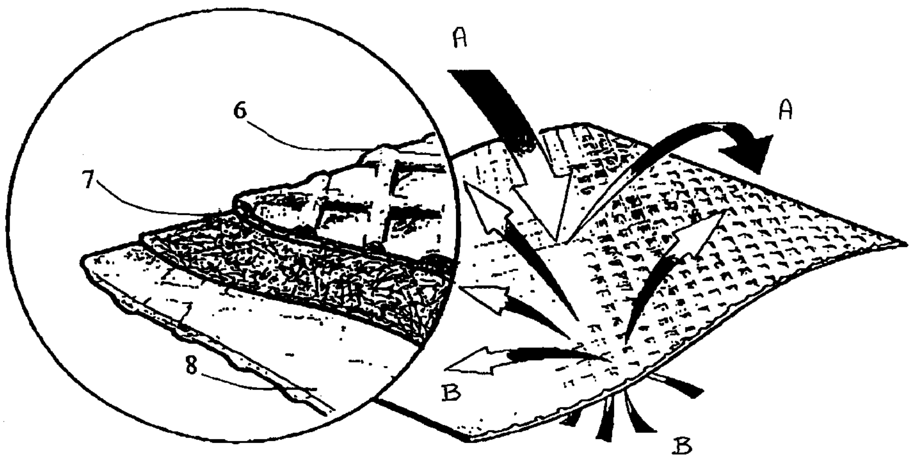
## (54) Permeable fabrics

(57) The invention relates to a laminated fabric which is permeable to gas and/or vapour but possesses water droplet and solid particle barrier properties. The fabric comprises at least two layers of non-woven material, one layer (1; 4; 7) being a compressed fibrous melt-blown material and the other(s) provided by a support layer having an open porous structure. In the examples, the support layers (2; 3,5; 6,8) have a spun-bonded structure. The melt-blown layer (1; 4; 7) of the fabric may be compressed prior to lamination from an average pore size diameter greater than 8μm to a diameter approaching or entering a range of pore diameter sizes from 8μm down to about 1μm preferably between 3-7μm and most preferably about 4μm. After a point-bonding or calendering technique, the pore diameter of the melt-blown layer (1; 4; 7) will be within the range 1-8μm, preferably 2-7μm and most preferably between 2-4μm. Advantageously, both the melt-blown layers and the spun-bonded layers may comprise polymers of polypropylene and/or polyethylene. The finished fabric may advantageously be useful in a wide range of applications from bedding materials and sportswear to tarpaulins, camping equipment such as tents, and roofing underlays.

Figure 3

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## Description

The present invention relates to gas and/or vapour permeable materials, and production methods therefor. Particularly, but not exclusively the invention relates to air and/or water vapour permeable fabrics for use in various industries such as in building construction, textile manufacture, bedding manufacture and the like.

Gas and/or vapour permeable fabrics known in the art as possessing good barrier properties to water droplets and/or solid particles generally comprise co-extruded or monolayer films comprising a plurality of micropores or monolithic films which permit the passage of vapour, and/or gases through them. Typically, in such fabrics the passage of vapour and/or gas occurs via molecular diffusion. Fabrics of this kind act as barriers to liquid droplets, such as water droplets, and to solid particulates, yet retain a vapour permeability, (e.g. water vapour permeability) and/or a gas permeability which permits the fabric to "breathe". Hitherto, such fabrics incorporating fibrous materials have not been found to possess sufficiently good barrier properties relative to fabrics which do not include a fibrous barrier component. Furthermore, fabrics of the prior art comprising fibrous materials lack strength and robustness and have been found to be inadequate for use in demanding applications, for example, when used in roofing tile underlays.

Melt-blown fabrics comprising microfilaments, i.e. filaments of typically 1 to 5μm diameter are known in the art. Melt-blown sheet material comprising hydrophobic polymers, such as polyolefins, possesses a degree of resistance to water droplets and to solid particulates while retaining gas permeability and vapour permeability properties. However, such structures typically having an average pore size of about 15μm do not have sufficiently good barrier properties enabling them to be used in demanding applications. Such materials, when exposed to extreme conditions such as wind-driven rain and the like, are prone to leakage which is thought to be caused by continuous flexing of the porous structure permitting the invasion of water droplets and so-called water micro-droplets into the material.

It has been found that typical meltblown materials, having an average pore size of about 15μm and a basis weight of about 40g/m$^2$, when incorporated into a structure intended for use as a roofing underlay, exhibit poor barrier properties when exposed to water spray. The barrier properties of the meltblown layer may be enhanced by the use of hydrophobic additives, such as organic fluorocarbon derivatives, which further increase the hydrophobic character of the surface of the fibres. Such additives are known in the art and may be added to the fibre surface by a topical application or may be added as a melt additive. However, even with the advantage conferred by the use of such hydrophobic additives, it has been found that meltblown fabrics with an average pore size of about 15μm and a base weight of less than about 40g/m$_2$ do not possess adequate barrier properties when exposed to water spray.

It is an object of this invention to provide gas permeable and/or vapour permeable non-woven fabrics incorporating fibrous materials so arranged as to provide water droplet and solid particle barrier properties to such fabrics.

The present invention provides a laminated fabric comprising at least two layers of non-woven sheet material, said fabric comprising (i) a first layer of compressed melt-blown material having an average pore size diameter in the range of from 1μm to about 8μm, laminated to (ii) a second layer of a material having an open porous structure.

Advantageously, said second layer is of a material having a spun-bonded structure.

Preferably, the compressed melt-blown material may have average pore size diameter of from about 3μm to about 7μm in its unlaminated state and from about 2μm to about 7μm in its laminated state. Advantageously, the compressed melt-blown material may have an average pore size diameter of about 4μm in its unlaminated state and from about 2μm to 4μm in its laminated state.

By compressing the melt-blown layer by any conventional compressing means, the porous structure thereof may be at least partially collapsed providing the compressed sheet with properties more usually associated with a film while maintaining its desirable fibrous characteristics.

Whilst compression of the unlaminated melt-blown material to give an average pore size within the preferred range, below the average pore size of uncompressed meltblown sheets, is advantageous, further compression to yield meltblown materials with an even smaller average pore size may be disadvantageous. Compression to yield melt-blown material with an average pore size at the lower end of the above mentioned ranges or beyond can cause embrittlement of the melt-blown material. Such embrittlement of the meltblown material would cause problems when the material is subsequently processed due to the ease with which the material might be torn. The water vapour permeability and air permeability of such very highly compressed materials also could be reduced to levels which are less advantageous in their intended applications.

It has been found that the average pore size of the meltblown sheet can be reduced during lamination to a second (or third) layer of a sheet material having an open porous structure. Lamination of meltblown sheets to such supportive, open layers may be effected by passing the sheet materials simultaneously through, for example, a point bonding calendering process. In this process, which is known in the art, a combination of heat and pressure is applied in an intermittent pattern known as point bonding. The area of such bond points is typically 7% to 40% of the total area of the bonded materials and may preferably be in the range 19% to 25%. It has been found that, although the compression due to such lamination is intermittent, a significant decrease in the average pore size of the meltblown sheet is achieved. The extent of the reduction in average pore size of the meltblown sheet is typically about 20% to about 32% when the meltblown sheet is processed to form the intermediate layer of a three-layer structure, the two outer layers being spun-bonded layers, the structure being conveniently referred to an SMS (Spun-bonded/melt-blown/spun-bonded) structure.

With typical, uncompressed meltblown materials, the degree of compression afforded by the lamination process is insufficient to yield a fabric having a meltblown layer with an average pore size within the range of this invention. The following data is given by way of example. A commercially available meltblown sheet of basis weight 18g/m$^2$ had a mean flow pore size of 14.7μm. After processing to an SMS structure using conditions known in the art, the mean flow pore size was 11.9μm, a reduction of 19%. In a second example, a meltblown sheet of 20g/m$^2$ had a mean flow pore size of 13.6μm. After processing to an SMS structure, the mean flow pore size was 9.5μm, a reduction of 30%. In a third example, a meltblown sheet of 13g/m$^2$ had a mean flow pore size of 20.3μm. After processing to an SMS structure, the mean flow pore size was 14.4μm, a reduction of 29%. In a further example, a meltblown sheet of basis weight 20g/m$^2$ had a mean flow pore size of 13.0μm. After processing to an SMS structure, the mean flow pore size was 9.2μm, a reduction of 29%. All of the examples were point bonded using a 19% bond area. Thus, in the above examples, although the average pore size was reduced by the lamination process, none of the laminated meltblown sheets achieved an average pore size within the pore size range according to this invention.

However, in carrying out the method in accordance with the present invention it has been found that compression of the meltblown sheet during the lamination process may be achieved even with meltblown sheets which have already been compressed to within the preferred range prior to lamination. Thus, an unlaminated, but compressed, melt-blown sheet of basis weight 25g/m$^2$ had a mean flow pore size of 3.4μm. After processing to an SMS structure using a point bond pattern of 19%, the mean flow pore size was 2.3μm, a reduction of 32%. This is a significant reduction within the range of the present invention. It has been found that an SMS structure, as defined in this example, has excellent water barrier properties when exposed to water spray.

Typically, the material having an open porous structure may be a spun-bonded polymer as described below.

In an example according to the invention, the layer of compressed melt-blown material may contain additives, such as hydrophobic melt additives and the like, for example an organic fluorocarbon derivative. Such additives are known in the art and may be added to polymers from which melt-blown materials are made to improve their barrier properties. Examples of polymers from which compressed melt-blown materials may be made include polyolefinic polymers such as polyethylene and polypropylene homopolymers and co-polymers thereof and of mixtures of homopolymers and co-polymers. Other additives, such as UV absorbing additives may be advantageously added to the melt polymer so as to inhibit the polymer degradation due to, for example, exposure to ultraviolet light.

Other polymeric materials may also be found suitable as will be apparent to the skilled reader.

Examples of other additives which may be added to the melt-blown material include conventional additives such as flame retardants, pigments and plasticisers, and the like. The fabrics of the invention may typically take the form of sheeting, strips and the like.

It has been found in tests, that while the particle barrier properties of the pre-compressed melt-blown material are improved if the pore size of the material is, on average, of from 1μm to about 8μm in accordance with the invention, preferably from 3μm to about 7μm, the preferred average pore size is about 4μm.

In certain applications, such as in bedding covers for allergy relief, the particle barrier properties of the finished bedding covers, tested under simulated use conditions, can exceed those of similar covers made from materials which are totally impermeable to air. While not intending to be bound by theory, it is believed that the high air permeability of the fibrous laminate structures of the present invention permits air to flow substantially through the large surface area of the bedding cover material rather than through the seams and closure devices. Materials which are substantially impermeable to air, when subjected to typical "in use" pressures, cause the internal air to be expelled predominantly through the seams and/or closure devices. The expelled air from conventional materials in such circumstances can carry solid particles, such as house dust mite faeces and other particulate material which may be allergenic matter thus rendering the protective cover inefficient. The materials according to the present invention are believed to have a good filtration efficiency due to the smaller average size of the pores of the meltblown material forming the barrier layer, such that the efficiency of the bedding cover in decreasing the amount of contact with the user of allergenic particulates is greater with materials of the present invention relative to those materials of the prior art.

The material of the second layer may comprise a fabric which may or may not possess the barrier qualities of the melt-blown material but which acts as a strengthening support therefor. It will be appreciated that any suitable second material, in providing improved supporting strength to the said non-woven laminated fabric, should not substantially reduce the gas and/or vapour permeability of the melt-blown material. Furthermore, it will be appreciated that any second material should be compatible with the compressed melt-blown material. Preferably, such a fabric may also possess the barrier properties of the compressed melt-blown material may be secured in contact therewith so as to provide a supporting substrate providing backing strength to the said non-woven laminated fabric.

The second layer of spun-bonded material may be thermally point bonded to the said first layer by conventional means, such as by calendering or ultrasonic welding.

In a preferred example according to the invention the non-woven laminated fabric may comprise at least three layers, in which the layer consisting of a compressed melt-blown material having an average pore size of from 1μm to about 8μm in its unlaminated state is placed between upper and lower spun-bonded polymer supporting layers.

The polymer used in the outer and inner spun-bonded polymer layers may be any suitable polymer which is capable of providing strengthening support to the non-woven laminated fabric without substantial deleterious effect to the gas permeability and/or vapour permeability thereof. The spun-bonded polymer may have an open porous structure and is selected at least on the basis that it has sufficient barrier and/or strengthening properties for its intended use. Suitable spun-bonded polymers can be selected from homopolymers such as polypropylene or polyethylene or can be selected from co-polymers, for example, polyethylene/polypropylene co-polymers or from mixtures of homopolymers and co- polymers depending on the intended application of the laminated fabric. For example, where a tri-laminate structure is to be used for untiled or unslated roofing underlay it has been found that if the outer spun-bonded polymer layer is comprised of filaments of for example 20μm to 25μm per filament, when positioned in use as a roofing underlay at a surface coverage of at least 50g/m$^2$, water droplet barrier properties of the laminate structure are further improved.

It will also be appreciated that additives may also be included in the outer spun-bonded polymer supporting layer. Examples of suitable additives include hydrophobic additives, such as organic fluorocarbon derivatives, ultraviolet light absorbing additives to inhibit polymer degradation, flame retardants and the like.

The invention further provides a method of producing a non-woven fabric as described above, involving the application of compressive force to a sheet portion of said melt-blown material having an average pore size diameter greater than a predetermined size, and carrying out a bonding step to point-bond said layers together to provide the laminated fabric, said melt-blown material of the fabric when the lamination step is complete having an average pore diameter of said predetermined size lying in the range of from 1μm to about 8μm.

Preferably, the melt-blown fabric of the first layer may be compressed to an average pore size in the range of from 1μm up to 8μm in its unlaminated state. Preferably, the average pore size may be from about 3μm to about 7μm. Most preferably the average pore size is about 4μm.

Typically, the melt-blown fabric of the first layer and the second layer(s) are bonded together in a laminated or layered structure, such as a sheet or strip.

The material having an open porous structure may be a spun-bonded polymer as herein described.

In an example according to the invention in order to provide, for example a roofing underlay fabric, two sheets of material having an open porous structure may be point bonded one to each side of a compressed melt-blown sheet fabric having an average pore size of between 1μm and 8μm thereby forming a tri-laminate sheet material in which the pore size of the melt blown sheet is further reduced within the range of 1μm to 7μm.

The invention finds particular use in articles comprising non-woven laminated fabrics of the invention such as roofing underlays, bedding fabrics such as mattress covers, tarpaulins, camping equipment e.g. tents, anoraks and the like, sportswear such as sailing smocks, leggings, ski-jackets and the like, building covers such as scaffolding covers and the like.

There will now be described several further embodiments of the invention. The description which is intended to be read with reference to the drawings is given by way of example only and not by way of limitation.

In the drawings:

Figure 1 shows a schematic representation of a two component laminate consisting of a compressed melt-blown barrier layer 1 and the supporting open porous structure 2;

Figure 2 shows a schematic representation of a three component laminate, and

Figure 3 shows an illustration of a three component laminate for use, for example, as a bedding cover for allergy relief.

The laminate of Figure 2 comprises an upper supporting open porous layer 3, a compressed melt-blown layer 4 and a lower supporting open porous layer 5.

<u>Example 1</u>

A compressed polypropylene melt-blown layer 1 of basis weight 17 g/m$^2$ and having an average pore size of 7μm was thermally laminated to a polypropylene spun-bonded non-woven fabric 2 of basis weight 33 g/m$^2$.

<u>Example 2</u>

The layers 1 and 2 of Example 1 were then point bonded in a laminating step which used sufficient pressure further to reduce the average pore size of the melt-blown layer to 5μm. The fabric may be used for the manufacture of industrial protective apparel.

Example 3

The material comprised of an upper layer 3 of UV stabilised polypropylene spun-bonded non-woven fabric of basis weight 70 g/m$^2$, a pre-compressed polypropylene melt-blown layer 4 of basis weight 20 g/m$^2$, having an average pore size of 4μm and containing a hydrophobic additive and a lower layer 5 of UV stabilised polypropylene spun-bonded non-woven fabric, the layers 3, 4 and 5 being thermally bonded. This material is suitable for application as a roofing underlay.

Example 4

The material comprised an upper layer 6 of polypropylene spun-bonded non-woven fabric of basis weight 20 g/m$^2$, a compressed polypropylene melt-blown layer 7 of basis weight 20 g/m$^2$ having an average pore size of 4μm and a lower layer 8 of polypropylene spun-bonded non-woven fabric of basis weight 20 g/m$^2$.

It will be found that this material provides a more efficient barrier (see arrows A) to particulate allergens when used as a bedding cover for allergy relief, while permitting the passage of air (arrows B).

Various modifications may be made within the scope of the invention.

## Claims

1. A laminated fabric comprising at least two layers of non-woven sheet material, said fabric comprising:

   (i) a first layer of compressed melt-blown material having an average pore size diameter in the range from 1μm to about 8μm, and
   (ii) a second layer of a material having an open porous structure.

2. A laminated fabric as claimed in claim 1, wherein the second layer of material is of a spun-bonded structure.

3. A laminated fabric as claimed in either one of claims 1 and 2, wherein the average pore size diameter of the first layer material is in the range of about 2μm to 7μm.

4. A laminated fabric as claimed in claim 3, wherein the average pore size of the first layer material is in the region of 2μm to 4μm.

5. A laminated fabric as claimed in any one of the preceding claims wherein the first layer material is a homopolymer of polyethylene or polypropylene or a co-polymer thereof.

6. A laminated fabric as claimed in any one of the preceding claims, wherein additives are added to the material of the first layer, which additives comprise hydrophobic additives, UV absorbing additives, flame retardants, pigments and/or plasticisers.

7. A laminated fabric as claimed in any one of the preceding claims wherein the second layer is bonded to one side of the first layer and a third layer having an open pore structure is bonded to the opposite side of the first layer.

8. A laminated fabric as claimed in claim 7, wherein the third layer has identical or closely similar composition and structure to that of the second layer.

9. A laminated fabric as claimed in any one of the preceding claims in which the layers comprising the fabric are bonded by a point-bonding technique.

10. A laminated fabric as claimed in claim 9, wherein the point bonding technique comprises ultrasonic spot welding.

11. A laminated fabric as claimed in claim 9, wherein the point bonding technique comprises a calendering treatment.

12. A laminated fabric as claimed in any one of claim 9 to 11, wherein the total area of said points is between 7 and 40% of the fabric area and preferably between about 19% and 25%.

13. A laminated fabric as claimed in any one of the preceding claims wherein the compressed melt-blown material is rendered into a compressed condition during lamination of the layers.

14. A laminated fabric as claimed in any one of claims 1 to 12 wherein the melt-blown material is precompressed to reduce the average pore size diameter thereof and is further compressed to the required average pore size diameter during lamination of the layers.

15. A method of producing laminated fabric according to claim 1 and comprising at least two layers of non-woven sheet material comprising a first layer of compressed melt-blown material at least one side of which is point-bonded to a second layer of material having a porous structure, said method involving the application of compressive force to a sheet portion of said melt-blown material having an average pore size diameter greater than a predetermined size, and carrying out a bonding step to point-bond said layers together to provide the laminated fabric, said melt-blown material of the fabric when the lamination step is complete having an average pore diameter of said predetermined size lying in the range of from 1μm to about 8μm.

**16.** A method as claimed in claim 15, wherein the compression step is carried out in a plurality of stages comprising a first step in which the melt-blown material is compressed until the average pore size diameter is reduced so as to approach or enter said range and a second step in which further compression is carried out during the bonding step so as to reduce the pore size diameter still further to achieve the predetermined size within said range.

**17.** A method as claimed in either one of claims 15 and 16, wherein the average pore diameter size of the first layer prior to the lamination step is between 3μm and 7μm.

**18.** A method as claimed in either one of claims 15 or 16, wherein the predetermined average pore diameter size of the first layer prior to the lamination step is in the region of 4μm.

**19.** A method as claimed in either one of claims 16 to 18 wherein the average pore diameter after the to 3μm.

**20.** A method as claimed in any one of claims 15 to 18, wherein the bonding step is carried out by calendering.

**21.** A method as claimed in any one of claims 15 to 18, wherein the bonding step is carried out by an ultrasonic welding technique.

**22.** A method as claimed in any one of claims 16 to 21, wherein the reduction in average pore size diameter in the first layer resulting from the bonding step is in the region of about 20% to 32%.

Figure 1

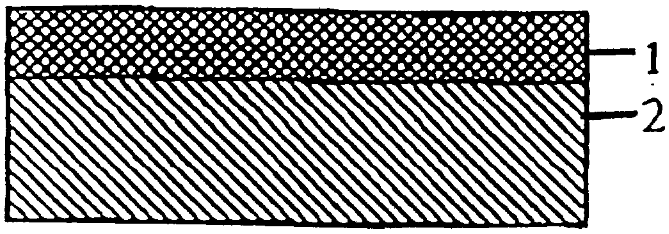
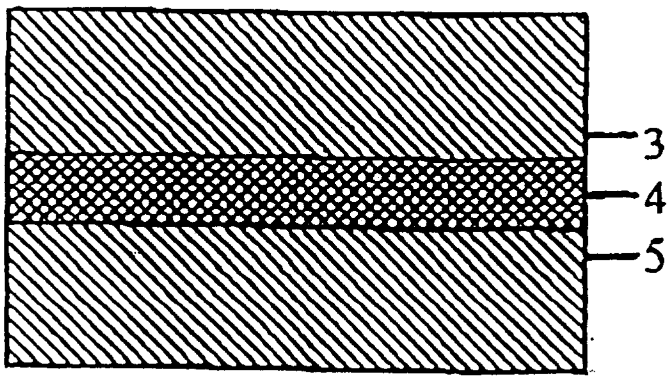



Figure 2



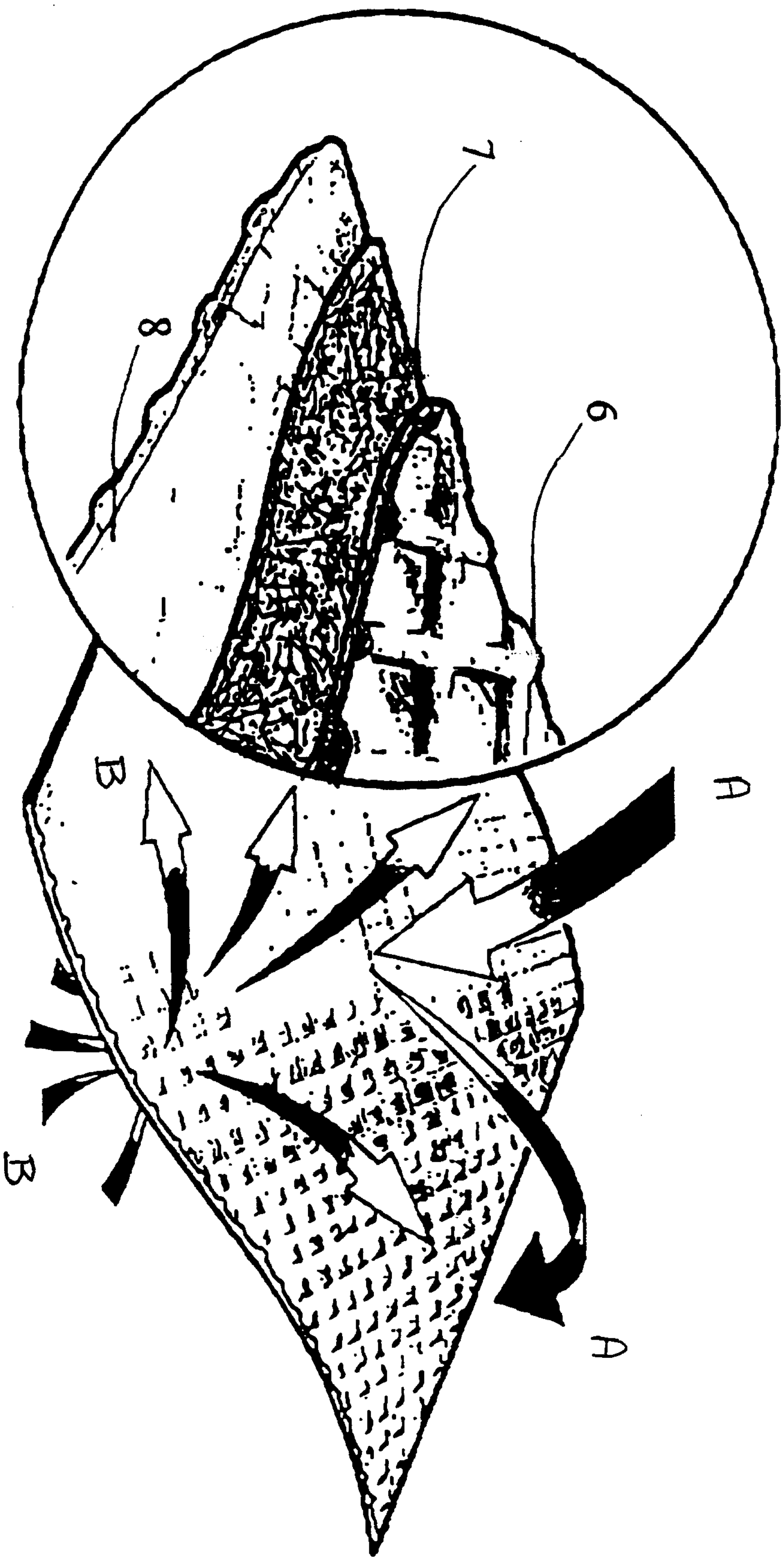



Figure 3

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# EUROPEAN SEARCH REPORT

Application Number
EP 96 30 3164

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X | EP-A-0 462 574 (KIMBERLY CLARK CO) 27 December 1991<br>* whole document * | 1-3,5, 7-11,13, 15,17, 20,21 | D04H13/00 |
| A | US-A-4 766 029 (BROCK ROBERT J ET AL) 23 August 1988<br>* column 1, line 28 - column 4, line 29 * | 1,2,5,7, 8,11 | |
| A | WO-A-95 09261 (KIMBERLY CLARK CO) 6 April 1995<br>* page 3, line 28 - page 4, line 2 * | 12 | |
| P,A | CA-A-2 138 195 (KIMBERLY CLARK CO) 9 December 1995<br>* page 6, line 1, paragraph 3 - page 12, line 8, paragraph 8 * | 1,2,5,6 | |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D04H

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 27 August 1996 | V Beurden-Hopkins, S |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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