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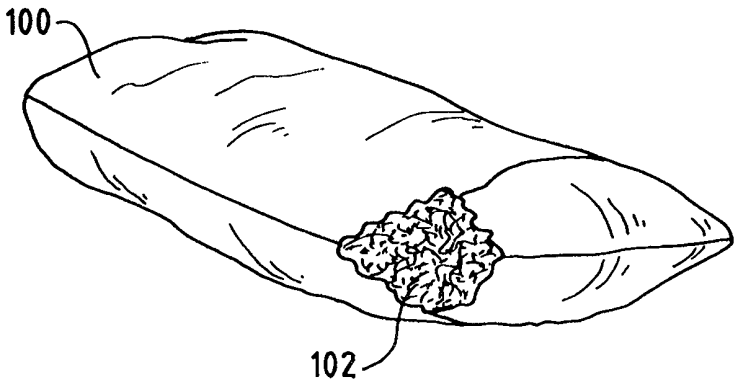

(57) Abstract

A laminate fabric like material has a hydroentangled, non-woven outer layer laminated to an apertured polymer film inner layer. The outer layer is treated for fluid resistance, flame retardancy, and with an antimicrobial. The inner film layer is apertured to impart desired air permeability. The resultant fabric like material is stain resistant, breathable, durable, and relatively inexpensive to produce. The laminate fabric of the invention may find particular utility as a cover for a pillow (100) or the like.

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BREATHABLE, STAIN-RESISTANT COVER FOR ARTICLES

Cross Reference:

The present application claims priority based on U.S. Provisional Application No. 60/093,283; filed July 27, 1998.

Field of the Invention:

This invention relates to breathable, satin-resistant covering for articles, such as covers or ticking for pillows.

Background of the Invention:

In commercial settings, such as hotels and motels, bed pillows are covered with a woven fabric of a cotton and polyester blend. The fabric is coated with a finish to discourage absorption of liquids. In practice, however, these covers are not very fluid resistant and easily become stained. While separate pillow cases are used to cover pillows and therefore camouflage the stains to some extent, stained pillows must be taken out service and discarded.

In hospitals or long term care facilities the pillowing ticking or inner case is usually made from a nonporous film for moisture repellency. Vents must be included at the sides to allow escape of air. These type of tickings are noisy and hot, and therefore disadvantageous for use.

A heretofore unresolved need therefore exists for a method for making a fabric suitable for use as a pillow ticking, as well as the fabric produced thereby.

Objects of the Invention:

It is an object of the invention to provide a method for making a breathable fabric suitable for use as a pillow ticking having moisture and stain resistance, as well as the product formed thereby.

Summary of the Invention:

In accordance with the present invention, a fabric suitable for use as a pillow cover or ticking comprises a film and fabric laminated to one another, with the film being apertured in a controlled manner to allow the air permeability of the laminate to be tailored to the type of pillow filling used, such as fiberfill or down. The laminated fabric has an air permeability of between about 25-180 ft^3/min (708-5,094 l/min), as measured using the Frazier air permeability test. The fabric is also preferably treated with a repellent to render it stain resistant and may also be treated with an antimicrobial agent.

The fabric layer of the laminate of the invention may be a conventional textile such as a woven or braided fabric. Preferably, the fabric comprises a nonwoven made from fibers or filaments. These include fabrics made from carded fibers, spunbonded fabrics of continuous filaments and composites. Most preferred are nonwoven fabrics made from a process called hydroentanglement wherein fine jets of water are used to entangle a web of fibers into a coherent sheet. The fabric layer in web form is treated with an aqueous suspension that preferably comprises an acrylic flexible binder, a fluorocarbon repellent, and an antimicrobial agent, such as Arichlorosan. The thus treated fabric is laminated to a film, and the film-fabric laminate is treated to form pores in the film layer.

The present invention further comprises a method for making the cover of the invention. The method generally comprises the steps of providing a nonwoven

web of fibers, treating the fabric with a mixture comprising a flexible binder and a liquid repellant,

and laminating an apertured film to the fabric, with the film having an air permeability of between about 25-180 ft^3/min (708-5,094 l/min). Preferably, the nonwoven layer is formed by hydroentangling polymer fibers supported on a three dimensional apertured surface to form a coherent web having an apertured, three dimensional surface. The web preferably has a basis weight between about 0.5-2.5 oz/yd^2 (16.7-83.5 gm/m^2), while the film preferably has a basis weight between about 0.2-0.75 oz/yd^2 (6.7-25.1 gm/m^2).

The preferred lamination process is described in U.S. patents 3,632,269, 4,381,326; 4,690,679; 4,806,411; and 4,859,519; incorporated herein by reference. In general, the nonwoven substrate and the film are fed into a nip between two rolls for lamination. The two rolls comprise a first coated metal roll heated to a temperature above or near the softening temperature of the film, and a second coated, surface patterned roll held at a relatively low temperature. The film softens and adheres to the fabric while under heat and pressure in the nip. In addition, the surface pattern on the heated roll imparts a pattern of apertures on the film layer only. A differential in surface speeds between the two rolls may be created and adjusted to change the degree of permeability imparted to the film layer.

The method of the invention thus provides a process for producing a final laminate fabric that is stain resistant with a desired air permeability.

The above brief description sets forth rather broadly the more important features of the present disclosure so that the detailed description that follows may be better understood, and so that the present contributions to the art may be better appreciated. There are, of course, additional features of the disclosure that will be described hereinafter

which will form the subject matter of the claims appended hereto. In this respect, before explaining embodiments of the disclosure in detail, it is to be understood that the disclosure is not limited in its application to the details of the construction and the arrangements set forth in the following description or illustrated in the drawings. The present invention is capable of other embodiments and of being practiced and carried out in various ways, as will be appreciated by those skilled in the art. Also, it is to be understood that the phraseology and terminology employed herein are for description and not limitation.

Brief Description of the Figures:

Figure 1 is a schematic of an embodiment of the process of making the non-woven substrate layer of the invention;

Figure 2 is a schematic of an embodiment of the process of making the laminate fabric material of the invention;

Figure 3 is a partial cutaway perspective view of a pillow made according to an embodiment of the method of the invention; and

Figure 4 is a partial cross section of the pillow of Fig. 3.

Description of the Invention:

Turning now to the drawings, Fig. 1 shows a preferred process of the invention for producing the preferred non-woven substrate of the invention. Fibers 2 are extruded from extruder 4 onto moving support 6, thereby forming lightly entangled web 8. Although fibers 2 are illustrated as being extruded, they may likewise comprise carded staple fibers or spunbond fibers. Most preferred fibers 2 comprise continuously extruded polyester

filaments. Lightly bonded web 2 is transferred to rotating forming drum 10 with three dimensional, apertured surface 12 (shown in exaggeration). As used herein, the term "three dimensional" refers to a condition of having raised portions with a continuous recessed portion therebetween. Web 8 supported on drum surface 12 passes under high pressure water jet stations 14 fed by high pressure water supply line 16 which impinges web 8 with a plurality of high pressure water jets 18.

Web 8 is thereby hydroentangled and imparted with a three dimensional, apertured surface. A more detailed description of the method of hydroentangling using three dimensional, apertured surfaces and the web thereby formed is provided in U.S. Patents Nos. 3,632,269; 4,381,326; 4,690,679; 4,806,411; and 4,859,519; which are incorporated herein by reference. Entangled web 20 preferably has a basis weight of between about 0.3-2.3 oz/yd^2 (10 – 73.5 gm/m^2).

Entangled web 20 is then passed through dip and squeeze station 21 which comprises aqueous bath 22 and roller squeeze 24. Bath 22 preferably comprises an acrylic binder, an anti-microbial, and a fluid resisting agent such as a fluorocarbon. The binder employed, when cured by drying, serves to maintain the integrity of the fabric and also serves to retain the repellent and the antimicrobial agent. Bath 22 may also comprise a flame retardant. Web 20 is then squeezed with rollers 24 to remove excess liquid treatment, and passed through dryer 26 for further drying. Although not illustrated in detail, drier 26 preferably comprises a tenter frame drier which serves to hold the web 20 in its original width and to prevent shrinking tent drier, as is known in the art, so that web 20 dimensions are retained during drying. Treatment is preferably provided such that web 20 collects a net amount of about 0.2 oz/yd^2 (6.7 gm/m^2) through station 21, so that final

treated web 20 has a preferred basis weight of between about 0.5-2.5 oz/yd^2 (16.7 – 83.5 gm/m^2).

A film is then apertured and laminated to treated collected web 20. Fig. 2 illustrates a general process for laminating and aperturing the film of the invention to web 20. Film 60 preferably comprises low density polyethylene ("LDPE"), linear low density polyethylene ("LLDPE"), polypropylene, polyvinylchloride, ethylene maleic anhhydride ("EMA"), ethylene vinyl acetate, and blends and copolymers thereof. The preferred weight of the film can vary between 0.2 to 0.75 oz/yd^2 (6.7-25 gm/m^2), provided only that the film and fabric laminate is capable of being processed to render the film porous. An example of a suitable film is 77 parts low density polyethylene, 20 parts EMA, and 3 parts titanium dioxide.

The film 60 and non-woven web are dropped into nip 71 between a heated, smooth surface roll 70 and a resilient forming roll 72. Roll 70 is preferably coated with Teflon and heated to a temperature in the range of the melting temperature of the film, which for the example film described above is in the range of about 225° F (107° C). Forming roll 72 has a resilient outer surface preferably comprised of silicone rubber which was engraved with a pattern comprising a series of discontinuous elevated lands 74 separated by a continuous recessed area 84 as shown in exaggerated cross section in Fig. 2. Roll 72 is preferably maintained by cooling at a temperature of about 45° -70° F (7° - 21° C). The film layer 60 is cast on in nip 71, where the pressure is preferably about 30-50 psi.

The shape of the apertures or holes in the apertured film corresponds generally to the shape of the land portions of the resilient forming roll 72 used. These land portions may take the shape of any desired geometrical object, such as rectangles, squares, hexagons, triangles, or the like. The size and number of lands on forming roll 72 should be

selected to provide the desired air permeability. In addition, roll 72 may advance at a faster rate than roll 70 to adjust the air permeability of the final fabric. The final film 60 layer as laminated preferably comprises about 0.5 oz/yd^2 (16.7 gm/m^2).

The porosity of the final composite is an important consideration. The porosity of the composite should be in the range of about 25 - 180 ft^3/min (708-5,094 liter/min) as measured by standard test procedures. For fiber fill pillows, the porosity can be in the upper end of the range, such as between about 80 - 110 ft^3/min (2,264 – 3,113 liter/min); and for down fill pillows between about 30-50 ft^3/min (849 – 1,415 liter/min) to resist feathers from piercing the fabric.

The apertured film / fabric laminate adheres to roll 72 as it advances and is cooled with roller 76 which is held at a relatively low temperature of between about 45° -70° F (7° - 21° C) for use with the preferred film described above. The laminate is pulled off of roll 76 with a pair of pull rolls 77 and 78, and accumulated on take-up roll 80.

A detailed description of the general film aperturing process as described above is presented in U.S. Patent No. 4,690,679; which is herein incorporated by reference.

The hydrostatic head of the finished laminate fabric is in the order of 8 to 15 cm, as measured with the hydrohead test. Stain resistance, as measured by the Alcohol Drop Test, is 9 to 10, which corresponds to hold out of a drop of 90 to 100 percent isopropyl alcohol.

In an additional preferred step of the method of the invention, the thus produced fabric is then cut to form substantially rectangular pieces, with two of the pieces joined together to make a sealed pouch with filling therebetween to form a pillow. Such an article is shown in a partial cut away perspective view in Fig. 3. The fabric of the invention 100 covers a filling 102 which may comprise, for example, synthetic fibers or

organic down. The fabric of the invention is preferably oriented with the film layer 104 facing inwards and the non-woven layer 106 facing outwards, as shown in the partial cross section of Fig. 4 of the pillow of Fig. 3. The continuous film layer 104 prevents penetration of liquids, and penetration of liquids through the pores in film 104 is impeded by the treated fabric 106 on the reverse side of the pores.

In addition to use as a pillow ticking, the laminate of the invention may also of course be used for other applications, with examples comprising a protective cover for other objects such as on a mattress, head rest, or as a furniture cover, where good stain resistance and porosity is required.

The preferred method of the invention thereby comprises a process for making a cover or ticking comprising a film and fabric laminate, with the film being apertured in a controlled manner to allow the air permeability of the laminate to be tailored to the type of pillow filling, such as fiberfill or down. The resultant fabric is also preferably treated with a repellent to render it stain resistant and may also be treated with an anti-microbial agent. A resultant article, such as a pillow tick, advantageously is highly stain resistant, breathable for comfort, durable, economical to produce, and has a patterned surface that appears fabric like.

The present invention further comprises the fabric like cover material made through the method of the invention. This fabric of the invention comprises a film and fabric laminated to one another, with the film being apertured in a controlled manner to allow the air permeability of the laminate to be tailored to the type of pillow filling used, such as fiberfill or down. The laminated fabric has an air permeability of between about 25-180 ft^3/min (708-5,094 l/min), as measured using the Frazier air permeability test, as is

well known in the art. The fabric is also preferably treated with a repellent to render it stain resistant and may also be treated with an antimicrobial agent.

The fabric layer of the laminate of the invention may be a conventional textile such as a woven or braided fabric. Preferably, the fabric comprises a nonwoven made from fibers or filaments. These include fabrics made from carded fibers, spunbonded fabrics of continuous filaments and composites. Most preferred are nonwoven fabrics made from a process called hydroentanglement wherein fine jets of water are used to entangle a web of fibers into a coherent sheet. A suitable process is described in U.S. Patent No. 4,379,797, incorporated herein by reference. Modern processes are available wherein the web is consolidated on a porous roll having a three dimensional surface to provide additional depth and pattern to the fabric and to simulate woven or knitted fabrics.

The fabric layer may comprise natural or synthetic fibers or filaments or combinations thereof. In the preferred case of hydroentangled or other nonwoven fabrics, the fibers preferably include polyester, although others such as nylon, rayon, cotton, polyolefin and others, as well as mixtures thereof, may be employed. Polyester and polyester blends are preferred in many cases, since these are the materials currently used in the relevant industry. The preferred fabric layer weight range is between about 0.5 to 2.5 oz/yd^2 (16.7-83.5 gm/m^2), with about 1.6-2.5 oz/yd^2 (53.4-83.5 gm/m^2) most preferred. Preferably, the nonwoven has a three dimensional, apertured surface, as results from hydroentangling fibers supported on a three dimensional, apertured forming surface, to provide aesthetic and breathability advantages to the final laminate fabric. A process for making a suitable non-woven as well as the non-woven described therein are described in U.S. Patent Nos. 3,632,269, 4,381,326; 4,690,679; 4,806,411; and 4,859,519; incorporated herein by reference.

The fabric layer in web form is treated with an aqueous suspension that preferably comprises an acrylic flexible binder, a fluorocarbon repellent, and an antimicrobial agent, such as Arichlorosan. A flame retardant may also be comprised. The excess liquid is squeezed from the fabric, and the fabric is dried. With the preferred fluid resistance treatment of the fabric substrate, the resulting laminate fabric advantageously has a stain resistance rating of 9-10 as measured by the Alcohol Drop Test, as is known in the art. In addition, the laminate fabric supports a hydrostatic head of 10-15 cm, as measured by the hydrohead test, as is also known in the art. Also, the preferred fabric of the invention has a flame retardancy rating of at least 9 seconds, as measured using standard tests known in the art.

The thus treated fabric is laminated to a film, and the film-fabric laminate is treated to form pores in the film layer. The film preferably is comprised of a member chosen from the group consisting of polyethylene, polypropylene, polyvinylchloride, ethylene maleic anhhydride, ethylene vinyl acetate, and combinations thereof. The film preferably has a basis weight of between about 0.2 – 0.75 oz/yd^2 (6.7-25.1 gm/m^2), and most preferably has a basis weight of about 0.5 oz/yd^2 (16.7 gm/m^2).

When using the preferred laminate fabric of the invention as a pillow tick, apertures are formed to provide the laminate fabric with an air permeability of preferably between about 30-50 ft^3/min (849-1415 l/min), as measured by the Frazier air permeability test, when it is to be used with down filling. If fiber fill is to be used, an air permeability of between about 80-110 ft^3/min (849-1415 l/min) is preferred.

To form a pillow, the apertured laminated film and fabric, furnished in roll form, may be cut into sheets of suitable size, formed into pouches by joining two sheets together

about their periphery, filled with the desired resilient filler, and sealed. The film layer preferably faces inward and the fabric layer outward for aesthetic and comfort advantages.

Accordingly, a preferred embodiment of the present invention comprises a pillow formed from the laminate fabric cover of the invention, as is shown in a partial cut away perspective view in Fig. 3. The fabric of the invention 100 covers a filling 102 which may comprise, for example, synthetic fibers or organic down. The fabric of the invention is preferably oriented with the film layer 104 facing inwards and the non-woven layer 106 facing outwards, as shown in the partial cross section of Fig. 4 of the pillow of Fig. 3. Such an orientation provides aesthetic advantages, as well as advantages for user comfort. The continuous film layer 104 prevents penetration of liquids, and penetration of liquids through the pores in film 104 is impeded by the treated fabric 106 on the reverse side of the pores.

The laminate is also advantageously suited for use as a protective cover for other objects such as on a mattress, head rest, or as a furniture cover, where good stain resistance and porosity is required.

The advantages of the disclosed invention are thus attained in an economical, practical, and facile manner. While preferred embodiments and example configurations have been shown and described, it is to be understood that various further modifications and additional configurations will be apparent to those skilled in the art. It is intended that the specific embodiments and configurations herein disclosed are illustrative of the preferred and best modes for practicing the invention, and should not be interpreted as limitations on the scope of the invention as defined by the appended claims.

Claims

1. A cover for a flexible article comprising a fabric substrate, a layer of apertured film laminated to the substrate, the laminate having a porosity of about 25 to 180 ft^3/min (708 – 5,094 liter/min) as measured using the Frazier Air permeability test.

2. The cover of Claim 1 wherein said fabric additionally comprises a binder for the fabric.

3. The cover of Claim 2 wherein said binder contains a liquid repellent.

4. The cover of Claim 2 wherein said binder contains an antimicrobial agent.

5. The cover of Claim 1 wherein said fabric is a hydroentangled fabric of fibers.

6. The cover of Claim 5 wherein said fibers comprise polyester fibers.

7. The cover of claim 5 wherein said hydroentangled fabric having a three dimensional, apertured surface.

8. The cover of Claim 1 wherein said apertured film consists of a member chosen from the group polyethylene, polypropylene, polyvinylchloride, ethylene maleic anhhydride, ethylene vinyl acetate, and blends and copolymers thereof.

9. The cover of Claim 1, wherein said film layer has a final laminated basis weight between about 0.2 –0.75 oz/yd^2 (6.7 – 25.1 gm/m^2).

10. The cover of Claim 1, wherein said film layer has a final laminated basis weight of about 0.5 oz/yd^2 (16.7 gm/m^2).

11. The cover of Claim 1, wherein said fabric substrate has a basis weight between about 0.5-2.5 oz/yd^2 (16.7 – 83.5 gm/m^2).

12. The cover of Claim 1, wherein said laminate can support a hydrostatic head of 10-15 cm.

13. The cover of Claim 1, wherein said laminate has a stain resistance as measured by the Alcohol Drop Test of 9-10.

14. The cover of claim 1, wherein the fabric has an air permeability of about 30-50 ft^3/min (849 – 1,415 liter/min) as measured using the Frazier Air permeability test.

15. The cover of claim 1, wherein the fabric has an air permeability of about 80-110 ft^3/min (2,264 – 3,113 liter/min) as measured using the Frazier Air permeability test.

16. A pillow comprising:

a) a filling material; and

b) a cover surrounding and encasing said filling, said cover comprising:

i) an outwardly facing layer comprising a hydroentangled non-woven fabric treated with a binder and a liquid repellent, said fabric having a basis weight of between about 0.5-2.5 oz/yd^2 (16.7 – 83.5 gm/m^2), and

ii) an inwardly facing layer laminated to one side of said non-woven fabric; said inwardly facing layer comprising an apertured film consisting of a member of the group polyethylene, polypropylene, polyvinylchloride, ethylene maleic anhydride, ethylene vinyl acetate, and combinations thereof; said film having a basis weight of between about 0.2 –0.75 oz/yd^2 (6.7 – 25.1 gm/m^2), the fabric and film laminate having a porosity of between about 25 to 180 ft^3/min (708 – 5,094 liter/min) as measured using the Frazier Air permeability test, a hydrostatic head rating of 10-15 cm, and a stain resistance as measured using the Alcohol Drop test of 9-10.

17. A method for making a porous stain resistant laminate fabric-like cover for an article, said method comprising the steps of :

a) providing a non-woven web of fibers, treating the fabric with a mixture comprising a flexible binder and a liquid repellent, and

b) laminating an apertured film to the fabric, said film having a porosity of between about 25 to 180 ft^3/min (708 – 5,094 liter/min) as measured using the Frazier Air permeability test.

18. The method for making a cover as in claim 17, wherein said mixture further comprises an antimicrobial agent.

19.The method for making a cover as in claim 17, wherein said non-woven fabric is a hydroentangled fabric of fibers, and said method further comprises hydroentangling fibers into a non-woven web.

20. The method for making a cover as in claim 19, further comprising the step of hydroentangling said fibers on a support with a three dimensional surface to impart a three dimensional, apertured surface to said web.

21. The method for making a cover as in Claim 17 wherein said fibers comprise polyester fibers.

22. The method for making a cover as in claim 17, wherein said apertured film consists of a member chosen from the group of polyethylene, polypropylene, polyvinylchloride, ethylene maleic anhhydride, ethylene vinyl acetate, and combinations and copolymers thereof.

23. The method for making a cover as in claim 17, wherein said film has a basis weight between about 0.2 –0.75 oz/yd^2 (6.7 – 25.1 gm/m^2).

24. The method for making a cover as in claim 17, wherein said film has a basis weight of about 0.5 oz/yd^2 (16.7 gm/m^2).

25. The method for making a cover as in claim 17, wherein said nonwoven fabric has a basis weight between about 0.5-2.5 oz/yd^2 (16.7 – 83.5 gm/m^2).

26. The method for making a cover as in claim 17, wherein the stain resistant laminate supports a hydrostatic head of about 10-15 cm as measured by the hydrohead test.

27. The method for making a cover as in claim 17, wherein the stain resistant laminate has a stain resistance as measured by the Alcohol Drop Test of 9-10.

28. The method for making a cover as in claim 17, wherein the stain resistant laminate has an air permeability of about 30-50 ft^3/min (849 – 1415 liter/min) as measured using the Frazier Air permeability test.

29. The method for making a cover as in claim 17, wherein the stain resistant laminate has an air permeability of about 80-110 ft^3/min (2,264 – 3,113 liter/min) as measured using the Frazier Air permeability test.

30. The method for making a cover as in claim 17, further comprising the steps of cutting the stain resistant laminate fabric in substantially rectangular sections and attaching two of said sections to one another to form a pouch with filling therebetween to thereby form a pillow, with said film layer facing inward.

31. The method for making a cover as in claim 17, wherein said step of laminating said film to said nonwoven fabric comprises feeding said web and said film into a nip between a first and a second roller, said first roller heated to a temperature in the melting range of said film, said second roll cooled to a temperature substantially lower than the melting temperature of said film and having a three dimensional patterned surface, said first roll patterned surface imparting a three dimensional, apertured pattern in said film, and cooling the resultant laminate fabric on a third roll.

32. A method of making a stain resistant covered pillow, comprising the steps of:

a) hydroentangling fibers on a three dimensional, apertured support surface to form a coherent entangled web having a three dimensional, apertured surface, said web having a basis weight between about 0.5-2.5 oz/yd^2 (16.7 – 83.5 gm/m^2), treating said web in an aqueous bath comprising a binder and a liquid repellant, drying said web;

b) laminating a polymer film to said web by feeding said web and said film into a nip between a first and a second roller, said film having a basis weight of between about 0.2 –0.75 oz/yd^2 (6.7 – 25.1 gm/m^2), said first roller heated to a temperature in the melting range of said film and having a three dimensional patterned surface, said second roll cooled to a temperature substantially lower than the melting temperature of said film, said first roll patterned surface imparting a pattern of apertures in said film; cooling the resultant laminate fabric on a third roll; wherein said resultant laminate having a porosity of between about 25 to 180 ft^3/min (708 – 5,094 liter/min) as measured using the Frazier Air permeability test, and a stain resistance as measured by the Alcohol Drop Test of 9-10; and

c) cutting said laminate fabric into substantially rectangular sections, and joining said sections to one another about their periphery with said film layer facing inward and with filling therebetween to form a pillow.

FIG. 1

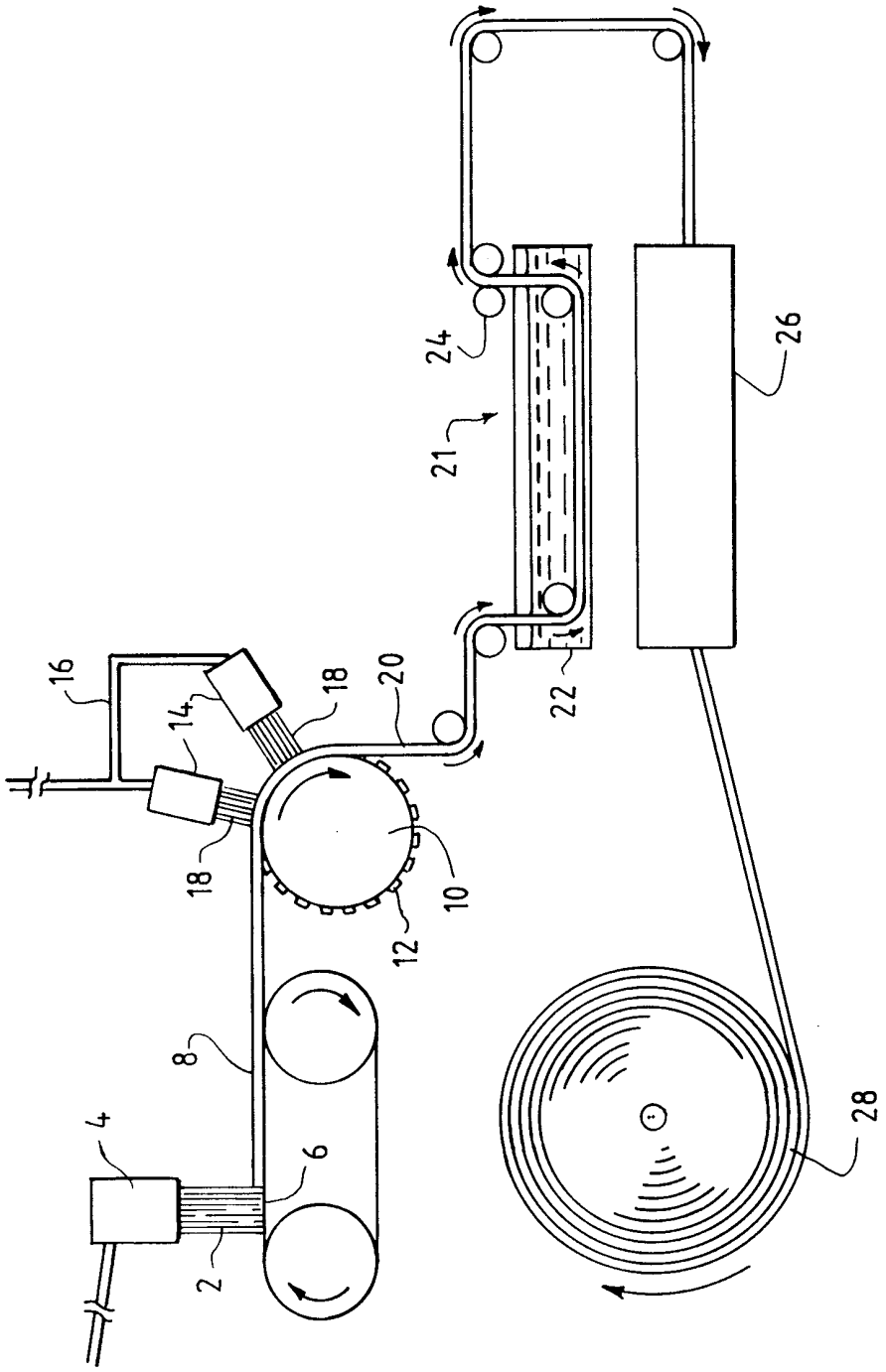


FIG. 2

2/2

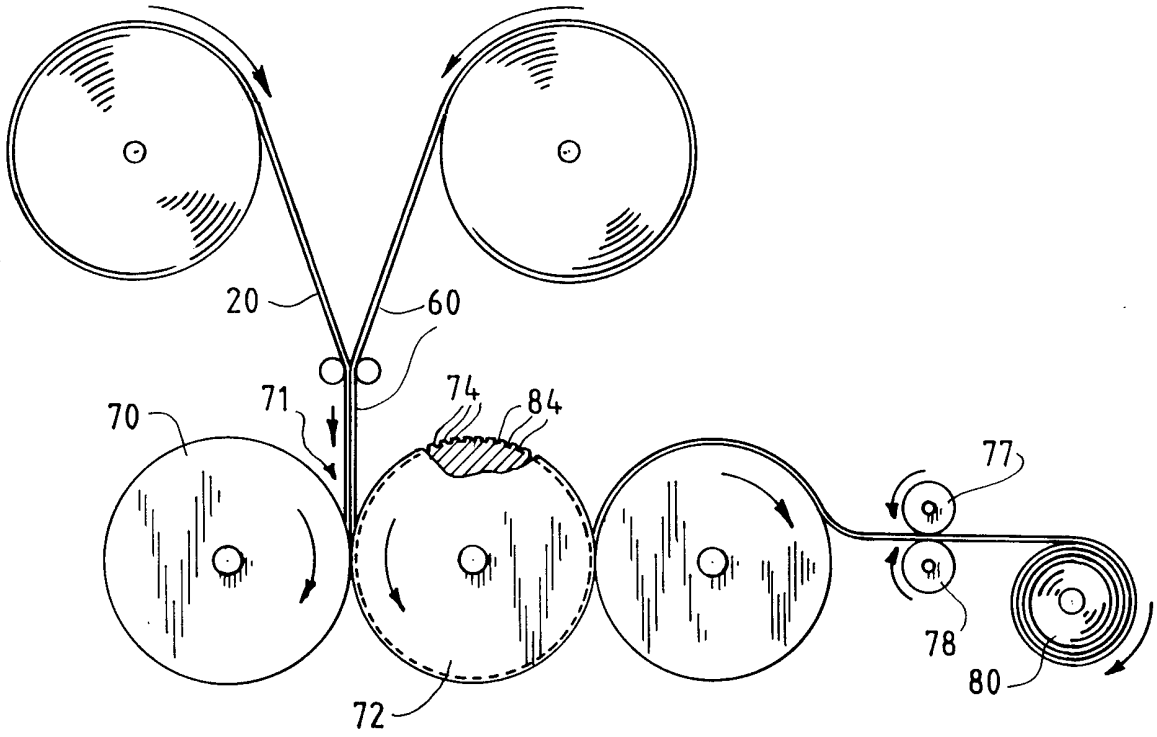


FIG. 3

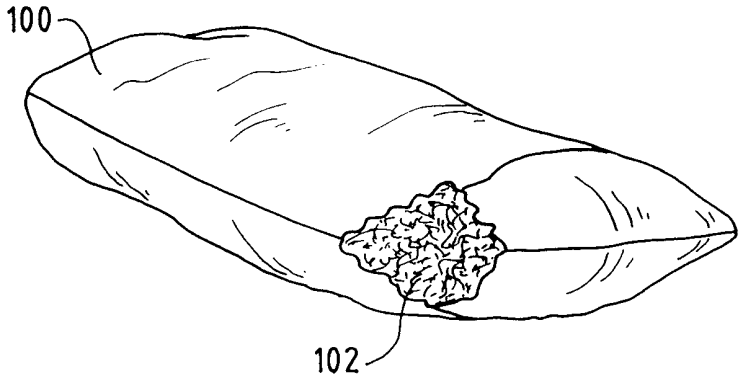
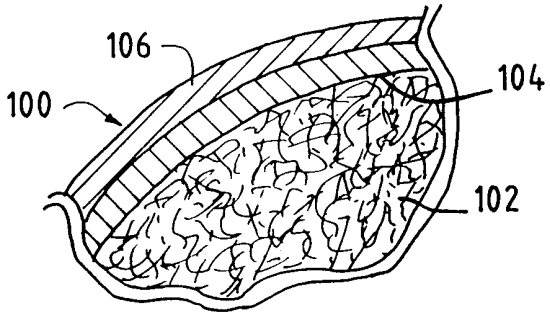


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/16933

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B32B 1/04, 3/02, 3/10, 5/00, 29/02, 31/00, 31/20; A47G 9/02
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U S. : 428/74, 137, 138, 219; 442/396, 398, 408; 156/176, 290, 308.2, 308.4, 309.9; 5/490

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS
search terms: frazier, porosity, aperture, pillow cover

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,290,628 A (LIM ET AL) 01 March 1994.	
A, P	US 5,919,177 A (GEORGER ET AL) 06 July 1999.	
A	US 4,781,962 A (ZAMARRIPA ET AL) 01 November 1988.	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 29 OCTOBER 1999	Date of mailing of the international search report 09 NOV 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer CHRISTOPHER W. RAIMUND Telephone No. (703) 308-0651

Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/16933

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

428/74, 137, 138, 219; 442/396, 398, 408; 156/176, 290, 308.2, 308.4, 309.9; 5/490