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(54) **Stretchable nonwovens**

(57) A nonwoven material which can be elongated and which will partially recover. The material comprises a web of fibers comprising polymeric chains which fibers are entangled with one another. The fibers are stretched in a first direction at a temperature wherein the fibers are aligned in a first direction and the polymeric chains within the fiber are also orientated in such first direction. The fibers are then cooled and demonstrate an ability to elongate and partially recover in a second direction that is different from the first direction.

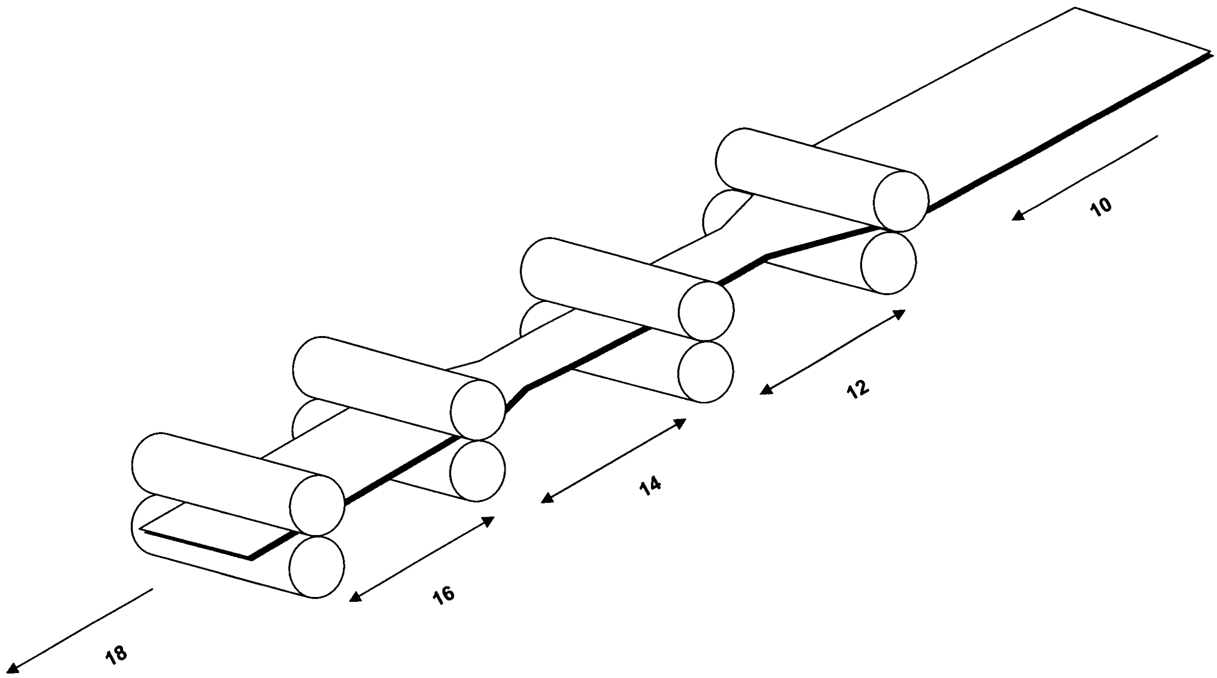


**FIGURE 1**

EP 1 657 333 A1

## Description

### Field of Invention

**[0001]** The present invention relates generally to stretchable nonwoven fabrics, and more particularly, to a method of making a nonwoven fabric the can be made to develop stretch and recovery. The methods for producing such stretchable nonwoven fabrics have particular utility as applied to continuous multicomponent filaments have a titer of 0.01 to 1.0 dtex and bonded.

### Background of the Invention

**[0002]** Nonwoven fabrics are used in a wide variety of applications such as medical products, personal care products, work garments, sports and leisure wear, shoe linings, bed linen and carpet construction. These types of fabrics differ from woven or knitted fabrics in that they are produced directly from individual fibers interlaid in an irregular pattern to form a fibrous mat, eliminating the traditional textile manufacturing processes of multi-step yam preparation, and weaving or knitting. Entanglement of the fibers or filaments of the fabric acts to provide the fabric with a substantial level of integrity.

**[0003]** The manufacture of nonwoven fabrics is a highly developed art. In general, nonwoven webs and their manufacture involve forming filaments or fibers and depositing them on a carrier in such manner so as to cause the filaments or fibers to overlap as a mat of a desired basis weight. The bonding of such a mat may be achieved by entanglement or by other means, such as adhesives, application or heat and/or pressure, or, in some cases, by pressure alone.

**[0004]** Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, bonded carded web processes and, more recently, meltspinning processes.

**[0005]** In meltblowing, thermoplastic resin is fed into an extruder where it is melted and heated to the appropriate temperature required for fiber formation. The extruder feeds the molten resin to a special meltblowing die. The die arrangement is generally a plurality of linearally arranged small diameter capillaries. The resin emerges from the die orifices as molten threads into a high velocity stream of gas, usually air. The air attenuates the polymer into a blast of fine fibers which are collected on a moving screen placed in front of the blast. As the fibers land on the screen, they entangle to form a cohesive web so that it is generally impossible to remove one complete fiber from the mass of fibers or to trace one fiber from beginning to end.

**[0006]** The spinbonding process has also been used to produce nonwoven fabrics. Various spinbonding techniques exist, but all include the basic steps of: extruding continuous filaments, quenching the filaments, drawing or attenuating the filaments by a high velocity fluid, and collecting the filaments on a surface to form a web. Spunbonded webs can have a more pleasant feel than meltblown webs because they more closely approximate textile filament deniers and consequently textile-like drape and hand.

**[0007]** While manufacture of nonwoven fabrics from homopolymer, single component filaments or fibers is well known, use of multi-component "splittable" fibers or filaments can be advantageous for some applications. These types of splittable fibers or filaments comprise plural sub-components, typically comprising two or more different polymeric materials, with the sub-components arranged in side-by-side relationship along the length of the filaments or fibers. Various specific cross-sectional configurations are known, such as segmented-pie, islands-in-the-sea, flower-like, side-by-side arrays, as well as a variety of additional specific configurations.

**[0008]** The sub-components of splittable fibers or filaments can be separated by various chemical or mechanical processing techniques. For example, portions of the multi-component fiber or filament can be separated by heating, needlepunching, or water jet treatment. Suitable chemical treatment of some types of multi-component fibers or filaments acts to dissolve portions thereof, thus at least partially separating the sub-components of the fibers or filaments.

**[0009]** While woven and knitted fabrics provide a level of hand, drape and stretch that is preferred over most nonwoven fabrics, these benefits are somewhat offset by the cost and complexity of the textile manufacturing processes used to produce woven and knitted fabrics. There have been numerous attempts to improve the stretch and recovery characteristics of nonwoven fabrics to take advantage of the lower manufacturing costs. These include the use of more expensive elastomeric fibers in the web, as well as additional processing steps such as the lamination or coating of the web with other materials, and mechanical crimping of some of the fibers.

**[0010]** United States Patent No. 4,426,420 entitled "Spunlaced Fabric Containing Elastic Fibers" and assigned to DuPont is directed at hydraulically entangled spunlaced fabrics which are heat treated to impart improved stretch properties. Two types of fibers comprise the batt, hard fibers (polyester, polyamide, etc.) and elastomeric fibers (preferably poly (butylene terephthalate)-co-poly-(tetramethyleneoxy) terephthalate at 10-25%).

**[0011]** United States Patent No. 4,820,572 entitled "Composite Elastomeric Polyether Block Amide Nonwoven Web" assigned to Kimberly-Clark Corp. is directed at an elastomeric nonwoven web formed by meltblowing, a coherent matrix of preferably microfibers composed of a polyester blockamide copolymer.

**[0012]** United States Patent No. 5,151,320 entitled "Hydroentangled Spunbonded Composite Fabric and Process" assigned to the Dexter Corporation is directed at a hydroentangled composite fabric made by subjecting a spunbonded base web material of continuous manmade filaments to stretching in the cross direction at least

5 percent of its original dimension, but less than the cross direction elongation of the material under ambient conditions at the time of stretching. A cover layer of fluid dispersible fibers is applied to the stretched base web to form a multilayer structure, and the structure subjected to hydroentanglement to join the layers.

**[0013]** United States Patent No. 5,227,224 entitled "Stretchable Nonwoven Fabrics and Method For Making Same" assigned to Chisso Corporation is directed at a uniform web comprising 70-100% by weight polypropylene base heat bondable composite fibers and 0-30% of other organic fibers (polyamide, polyester) having a web heat shrinkage percentage of 50% or higher at 120°C. The fibers are uniformly entangled together and "shrinked" as a result of sufficient entanglement imparted through further heat treatment (not under tension), resulting in a fabric having an elastic recovery at 30% elongation of 80% or higher in both warp and weft directions.

**[0014]** United States Patent No. 5,540,976 entitled "Nonwoven Laminate With Cross Directional Stretch" assigned to Kimberly-Clark Corporation is directed at a laminate comprising three layers. The outer layers of spunbond non-woven fiber webs are made of crimped or crimpable fibers and the inner layer is an elastomeric polymer layer. The layers are preferably bonded together by hydroentanglement.

**[0015]** United States Patent No. 5,549,964 entitled "Stretchable Nonwoven Fabric and Method of Manufactoring the Same" assigned to Asahi Kasei Kogyo Kabushiki Kaisha is directed at a stretchable nonwoven fabric manufactured by using a hydrogenated block copolymer. The copolymer preferably comprises a vinyl aromatic compound, a conjugated diene compound and a polyolefm and is melt blown.

**[0016]** United States Patent No. 5,534,335 entitled "Nonwoven Fabric Formed From Alloy Fibers" assigned to Kimberly-Clark Corporation is directed at a nonwoven fabric comprising at least two thermoplastic polymers and a compatabilizer. One of the thermoplastics is present in a dominant continuous phase, (say a polypropylene) the other present as a non-continuous phase (say, a polyamide or a polyester). The melt temperature of the non-continuous phase polymer preferably is at least 30°C less than the melt temperature of the continuous phase polymer. The fiber may be melt blown or spunbonded.

**[0017]** United States Patent No. 5,814,390 entitled "Creased Nonwoven Web With Stretch and Recovery" is assigned to Kimberly-Clark Worldwide and is directed at nonwoven fabrics produced by creasing a precursor using interdigitated rolls and heat setting the creases. The fabric preferably comprises a non-elastic olefm polymer-based thermoplastic fiber-comprising precursor web.

**[0018]** United States Patent No. 5,910,224, entitled "Method for Forming An Elastic Necked-Bonded Material" is also assigned to Kimberly-Clark Worldwide and is directed at a method of making a stretchable composite by applying an elastomeric precursor to a neckable material, neck-stretching the neckable material and heating the elastomeric precursor while the neckable material is in a necked condition. The precursor may comprise a latex or thermoset elastomer. The neckable material may be formed by spunbonding or melt blowing preferably comprising, microfibers for instance polyester, polyamide and polyolefin.

**[0019]** United States Patent No. 5,997,989 entitled "Elastic Nonwoven Webs and Method of Making Same" assigned to BBA Nonwovens Simpsonville, Inc. is directed at a spunbonded elastic nonwoven fabric, (and a process for making such) comprising a web of bonded thermoplastic filaments of a thermoplastic elastomer. A slot draw spunbonding process_provides a web having an RMS recoverable elongation of at least 75% (MD and CD) after 30% elongation of the fabric and one pull.

**[0020]** United States Patent No. 6,689,703 entitled "Elastically Stretchable Nonwoven Fabric and Fabric For Making the Same" assigned to Uni-Charm Corp. is directed at an elastically stretchable nonwoven fabric including thermoplastic elastomer filaments, the filaments being heat sealed and/or mechanically interwined together to form a nonwoven fabric that has crimped and non-crimped regions. The crimps are at a rate of 50/cm or higher. The crimps are formed by blowing hot air against an extrudate followed by blowing a warm or cold blast of air (at least 20°C less than the melting point of the filaments) against the filaments so that the filaments are stretched and reduced in diameter and are unevenly cooled, becoming at least partially crimped. The filaments are then heat sealed or mechanically intertwined to obtain the stretchable nonwoven fabric.

**[0021]** United States Patent No. 6,692,541 entitled "Method of Making Nonwoven Fabric Comprising Splittable Fibers" assigned to Polymer Group, Inc is directed at a method where fabrics are formed from splittable filaments or staple length fibers having a plurality of subcomponents which are at least partially separable into their sub-components by hydroentanglement. A three dimensional image transfer device having a foraminous forming surface is used to impart a distinct surface pattern or image to the precursor web during hydroentanglement. The web is preferably carded and cross-lapped prior to imaging and patterning.

**[0022]** United States Patent Application 2003/0064650 entitled "Stretchable Multiple Component Spunbond Web And A Process For Making" assigned to DuPont is directed at providing high levels of three dimensional helical crimp utilizing draw rolls to provide a high degree of orientation. Filaments are mechanically drawn under conditions where the polymeric components remain substantially amorphous. The method comprises melt spinning continuous filaments comprising at least first and second distinct melt-spinnable polymers wherein the polymers are arranged in distinct substantially constantly positioned zones across the cross-section of the filaments in an eccentric relationship and extending substantially continuously along the length of the filaments. The filaments are quenched, passed over a series of rolls to anneal them (from amorphous to semicrystalline), tensioned and released to form helical crimps.

**[0023]** What is therefore needed is a nonwoven fabric capable of elongation and recovery and which improves upon the prior art and which can be readily manufactured in accordance with the invention herein.

**[0024]** It is thus one object of the present invention to provide a nonwoven fabric, which may be manufactured from spunbond material, and which may be elongated, and which has, e.g. elongation values in the range of about 5 to 70%.

**[0025]** It is a more specific object of the present invention to provide any thermoplastic filamentous nonwoven (spunbonded or a composite thereof) that is hydroentangled such that it can be stereched and can be made to develop stretch and recovery.

**[0026]** It is still further object of the present invention to provide a spun bonded nonwoven fabric comprising a web of filaments wherein one exposes a filament web that contains filaments that may be entangled and/or interlocked with one another, which is then stretched in a first selected direction at a selected temperature that provides stretching characteristics in a second direction other than the first direction.

## Summary of the Invention

**[0027]** In one embodiment, the present invention is directed at a nonwoven material which can be elongated in a selected direction, comprising a web of fibers comprising polymeric chains which fibers are entangled with one another characterized in that the fibers have been stretched in a first direction at a temperature wherein the fibers are aligned in said first direction and said polymeric chains in said fiber are orientated in said first direction. The fibers are then cooled below said temperature wherein the web of fibers demonstrate an ability to elongate in a second direction that is different from said first direction and wherein said fibers can also partially recover from said elongation in said second direction.

**[0028]** In a second alternative embodiment the present invention is directed at a process for providing a nonwoven material with stretchable characteristics, comprising the steps of forming a web of polymeric filaments that are entangled with one another, wherein said polymeric filaments have a Tm. This may then be followed by stretching the web in a first direction at a temperature wherein said temperature is below Tm to align said fibers in said first direction and to orient said polymeric chains in said fiber in said first direction. This may then be followed by cooling said fibers below said temperature wherein said nonwoven material can elongate in a second direction that is different from said first direction and partially recover from said elongation in said second direction. Optionally, this process may include the additional step wherein said web is further stretched across said width of said web, and wherein said nonwoven material can still elongate in a second direction across said width of said web and partially recover from said elongation.

## Brief Description of the Drawings

**[0029]** The above and other objects, features and advantages of the invention will become further apparent upon consideration of the written description and the appended drawings in which,

> **FIG. 1** is an illustration of a one-step process for producing the stretchable material of the present invention.
>
> **FIG. 2** is an illustration of a two-step process for producing the stretchable material of the present invention.
>
> **FIG. 3** is a graph of fiber orientation v. orientation angle prior to stretching.
>
> **FIG. 4** is a graph of fiber orientation v. orientation angle after stretching.

## Detailed Description of the Preferred Embodiments

**[0030]** In a first preferred embodiment, the present invention stands directed at a nonwoven material which can be elongated in a selected direction, comprising a web of fibers comprising polymeric chains which fibers are entangled with one another.

**[0031]** Preferably, the web of fibers comprise a microfilament nonwoven fabric having a weight of 30 to 150 g/m$^2$ and a tear strength of >40 N/5 cm, the nonwoven fabric being made of continuous multicomponent filaments having a titer of 1.5 to 5 dtex which are melt-spun, stretched, and directly laid down to form a nonwoven fabric, wherein the continuous multicomponent filaments are split, at least to the extent of 80%, to form continuous microfilaments having a titer of 0.01 to 1.0 dtex and bonded.

**[0032]** More preferably, the continuous multicomponent filaments may comprise a continuous bicomponent filament comprising two polymers. The two polymers may comprise a first polymer such as a polyester polymers, and a second polymer may comprise a polymer selected from the group consisting of polyamides, polyolefins, and mixtures thereof.

**[0033]** In one particularly preferred embodiment, the nonwoven fabric herein may be manufactured from a material manufactured and sold by Freudenberg Nonwovens under the trademark Evolon™, which is identified as a textile made of microfilaments. It is reportedly manufactured in one continuous process, from polymer granulate to finished textile during which the spinning and laying down of the filaments in the web form are preferably combined with one another. Water jet bonding then provides the Evolon™ material which is constructed of endless microfilaments.

**[0034]** With reference to **FIG. 1** herein, the web of fibers may be unwound and fed at **10** to opposing rollers and preheated and stretched at **12** and **14** which provides a lengthwise stretch and an unconstrained widthwise shrinkage. Preferably, the heating is such that the web of fibers comprising polymer chains are identified to have a melting point **Tm** and the temperature of preheating as noted above is at a temperature that is below **Tm,** and most preferably, about 0.1 - 20.0 °C below **Tm.** In addition, the temperature of preheating may be set to a temperature that is above **Tg** and below **Tm,** with respect to those polymers that may exhibit a glass transition temperature or **Tg.** Preferably the fibers, as illustrated, are aligned in the lengthwise direction and the polymeric chains are also oriented in such direction.

**[0035]** In addition, with reference to **FIG. 3** herein, the fiber orientation (% frequency) has been plotted v. the orientation angle, prior to stretching, which therefore provides a view of the fiber orientation distribution (FOD). Turning to **FIG. 4** herein, the fiber orientation (% frequency) has been plotted against orientation angle after stretching. Upon comparison of **FIGS. 3** and **4** it should be apparent that the fiber orientation is, subsequent to stretching, shifted towards the direction that the fabric is being stretched. Prior to stretching, the structure is relatively isotropic and after stretching the more anisotropic character can be seen.

**[0036]** Returning then to **FIG. 1,** it can then be seen that at **16** one may optionally impose a widthwise stretch wherein the width may be set to a desired size, by the use, e.g., of a tenter frame. Those of skill in the art will recognize that a tenter frame allows one to stretch the fabric back to its original width. In any event, the result of the preferred methodology illustrated in **FIG. 1** is that upon quenching and winding at **18** it has been found that one produces a web of fibers that demonstrate an ability to elongate in a second direction that is different from the first (lengthwise) direction and wherein the fibers can partially recover from such elongation. Along such lines it has been found that the ability to elongate in the second direction may reach levels up to about 70 %, along with partial recovery.

**[0037]** With attention now focused to **FIG. 2,** illustrated therein is a two-step process for producing the stretchable material of the present invention. It can be seen at **20** the step of unwinding and feeding is followed by preheating and stretching in a lengthwise direction at locations **22** and **24** facilitated by the use of rollers and heating via the use of said rollers to the desired temperatures, as herein described. In such manner at **26** the stretched fabric is quenched and wound and may be utilized in such form. Optionally, as shown, the output at **26,** after being quenched and wound may then again be unwound and fed at **28** such that upon travel between the rollers a widthwise stretch is imposed to a selected width at **30** followed by quenching and winding at **32.**

**[0038]** In accordance with the present invention it therefore has been found that one can uniquely prepare a stretchable nonwoven material which would allow for utility in a number of applications where the advantages of the nonwoven material can be utilized, and now, along with the ability of such nonwoven to provide stretch and recovery characteristics.

**[0039]** While the present invention has therefore been described in connection with certain preferred embodiments, it is understood that the subject matter ecnompased by way of the present invention is not to be limited to those specific embodiments. It is therefore intended that the subject matter of the present invention include all equivalents that may fall within the scope of the following claims.

## Claims

1. A nonwoven material which can be elongated in a selected direction, comprising

   (a) a web of fibers comprising polymeric chains which fibers are entangled with one another **characterized in that**:

   (i) said fibers have been stretched in a first direction at a temperature
   wherein said fibers are aligned in said first direction and said polymeric chains in said fiber are orientated in said first direction; and
   (ii) said fibers have been cooled below said temperature;

   wherein said web of fibers demonstrate an ability to elongate in a second direction that is different from said first direction and wherein said fibers can also partially recover from said elongation in said second direction.

2. The nonwoven fabric of claim 1 wherein said polymeric chains have a melting point **Tm,** and said temperature is below **Tm.**

3. The nonwoven fabric of claim 2 wherein temperature below **Tm** is about 0.1- 20 °C below **Tm.**

4. The nonwoven fabric of claim 1 wherein said polymer chains have a **Tg** and **Tm,** and said temperature is at or above **Tg** and below **Tm.**

5. The nonwoven fabric of claim 1 wherein said fibers elongate in said second direction up to about 70% and partially recover.

6. The nonwoven fabric of claim 1 wherein said second direction is substantially perpendicular to said first direction.

7. The nonwoven fabric of claim 1 wherein said web of

fibers comprises a microfilament nonwoven fabric having a weight of 30 to 150 g/m$^2$ and a tear strength of >40 N/5 cm, the nonwoven fabric being made of continuous multicomponent filaments having a titer of 1.5 to 5 dtex which are melt-spun, stretched, and directly laid down to form a nonwoven fabric, wherein the continuous multicomponent filaments are split, at least to the extent of 80%, to form continuous microfilaments having a titer of 0.01 to 1.0 dtex and bonded.

**8.** The nonwoven fabric of claim 7 wherein said continuous multicomponent filaments comprise a continuous bicomponent filament comprising two polymers.

**9.** The nonwoven fabric of claim 8 wherein one of said polymers comprises a polyester polymers, and one of said polymers comprise a polymer selected from the group consisting of polyamides, polyolefins, and mixtures thereof.

**10.** A process for providing a nonwoven material with stretchable characteristics, comprising the steps of:

(a) forming a web of polymeric filaments that are entangled with one another,
wherein said polymeric filaments have a **Tm;**
(b) stretching said web in a first direction at a temperature wherein said temperature is below **Tm** to align said fibers in said first direction and to orient said polymeric chains in said fiber in said first direction;
(c) cooling said fibers below said temperature wherein said nonwoven material can elongate in a second direction that is different from said first direction and partially recover from said elongation in said second direction.

**11.** The process of claim 10 wherein said temperature below Tm is about 0.1-20 °C below **Tm.**

**12.** The process of claim 10 wherein said fibers elongate in said second direction up to about 70% and partially recover.

**13.** A process for providing a nonwoven material with stretchable characteristics, comprising the steps of:

(a) forming a web of polymeric filaments that are entangled with one another, wherein said polymeric filaments have a **Tm** and said web has a length and a width;
(b) stretching said web in a first direction coinciding with said web length at a temperature wherein said temperature is below **Tm** to align said fibers in said first direction and to orient said polymeric chains in said fiber in said first direction and
wherein said width of said web is reduced;
(c) cooling said fibers below said temperature wherein said nonwoven material can elongate in a second direction across said width of said web and partially recover from said elongation.

**14.** The process of claim 13 wherein including the additional step wherein said web is further stretched across said width of said web, and wherein said nonwoven material can still elongate in a second direction across said width of said web and partially recover from said elongation.

**15.** The process of claim 13 wherein said step of stretching across said width of said web comprises placing said web on a tenter frame.

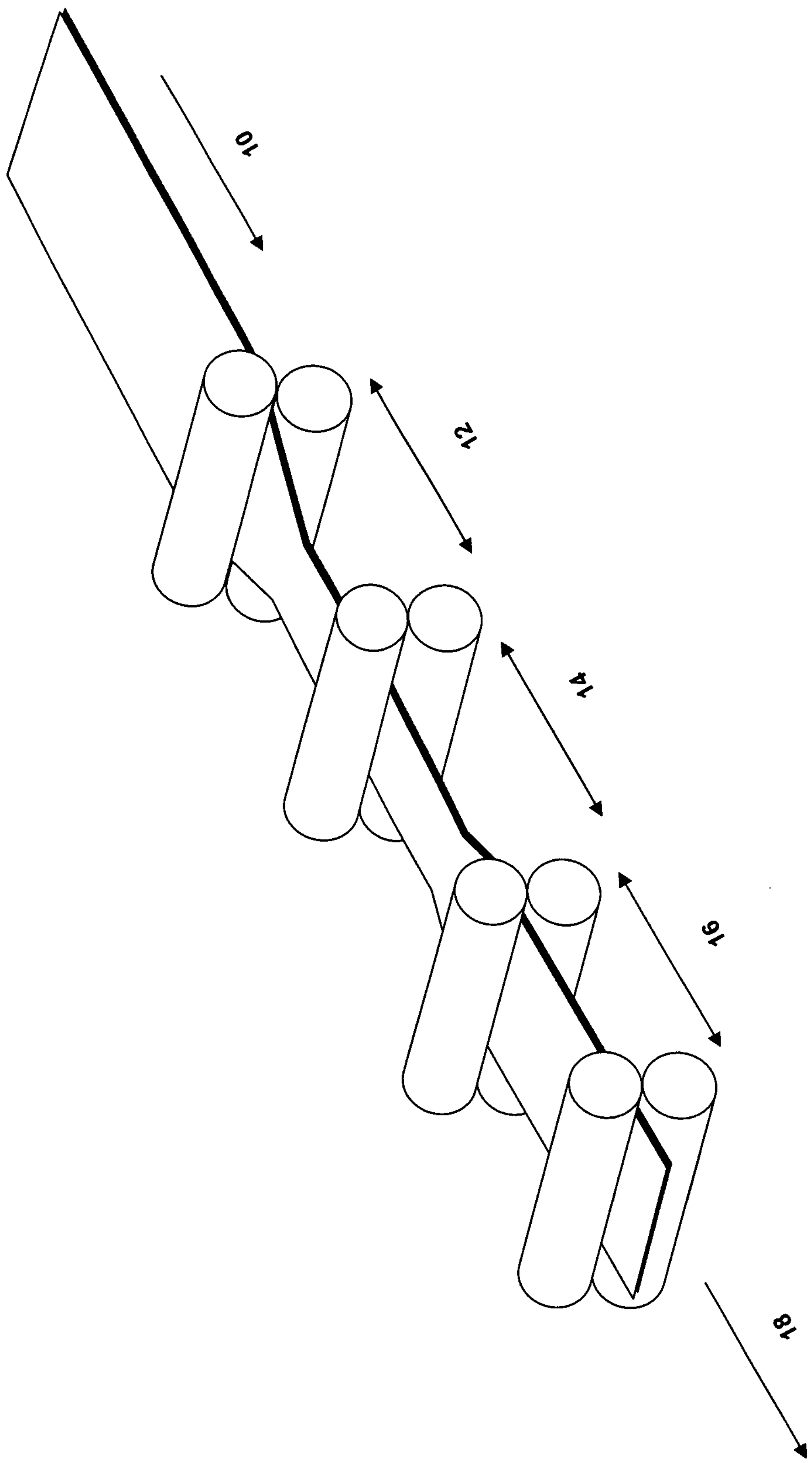


FIGURE 1

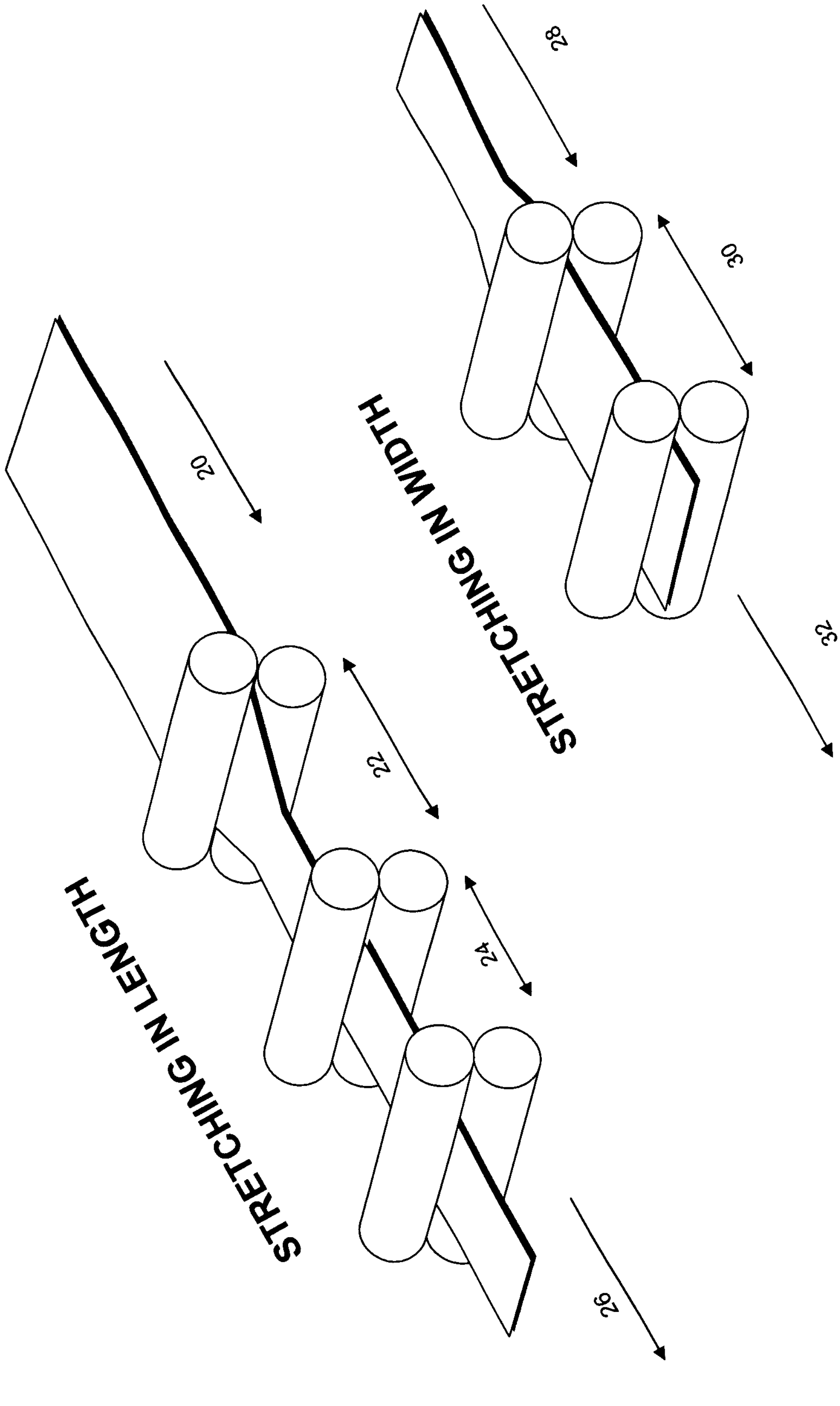


FIGURE 2

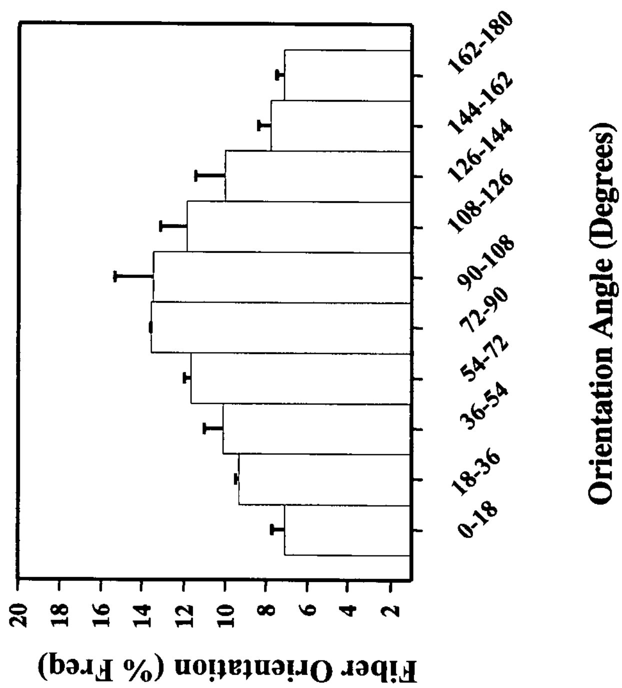
Fiber Orientation (% Freq)
20
18
16
14
12
10
8
6
4
2
0-18
18-36
36-54
54-72
72-90
90-108
108-126
126-144
144-162
162-180
Orientation Angle (Degrees)

FIGURE 3

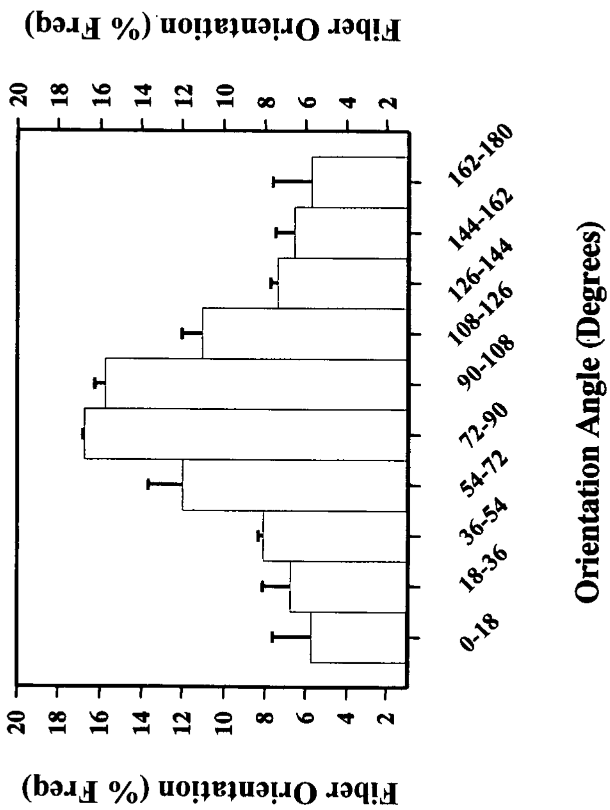
Fiber Orientation (% Freq)
20
18
16
14
12
10
8
6
4
2
0-18
18-36
36-54
54-72
72-90
90-108
108-126
126-144
144-162
162-180
Orientation Angle (Degrees)

FIGURE 4

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# EUROPEAN SEARCH REPORT

Application Number
EP 05 02 4281

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The present search report has been drawn up for all claims

3

| Place of search | Date of completion of the search | Examiner |
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| Munich | 21 February 2006 | Demay, S |

CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 02 4281

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