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(54) A process of producing soft and absorbent non woven fabric

(57) Soft and absorbent nonwovens are obtained by means of bi-oriented stretching of a nonwoven of filaments comprising two or more polymers (A, B), such as to provide a final filament (3) wherein said two or more polymers are not unitary with one another, the stretching imparting different elongation deformations to said two or more polymers.

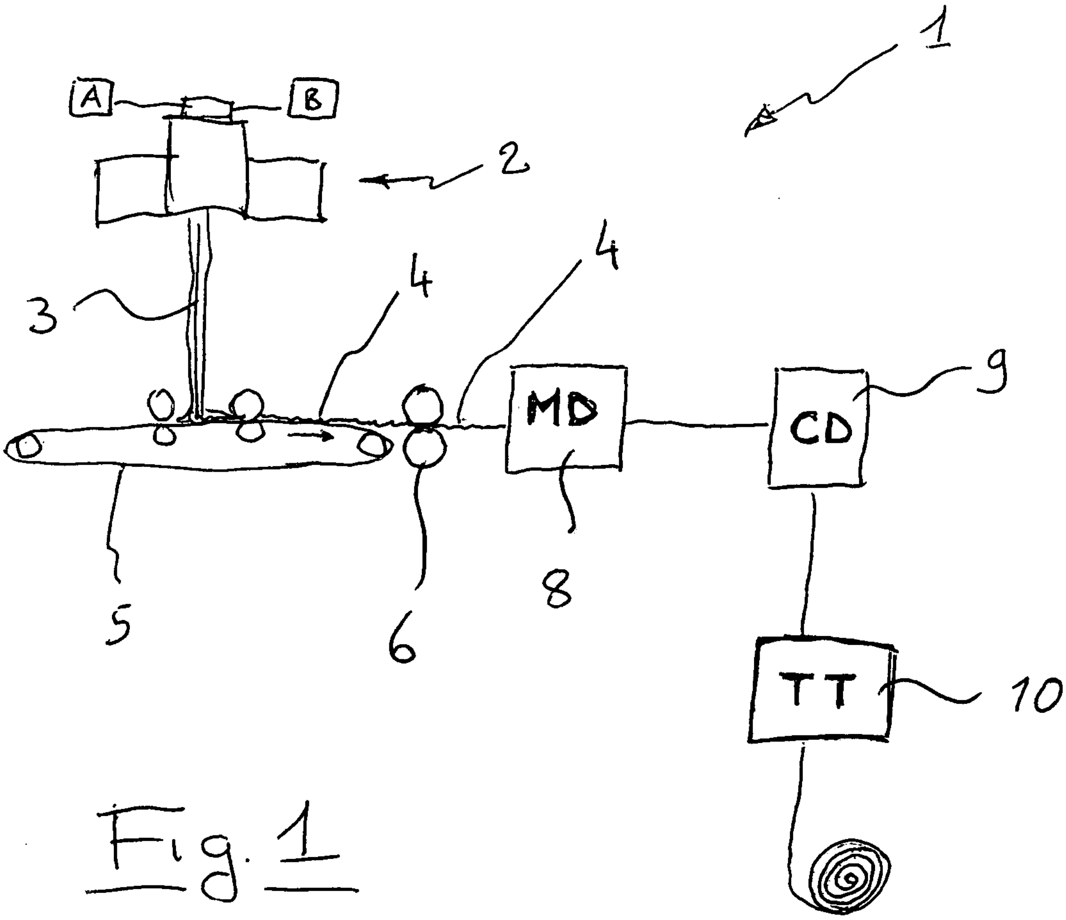

Fig. 1

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Description

[0001] The present invention relates to a process for the production of soft and absorbent nonwovens.

[0002] More in particular, the present invention relates to a nonwoven of the spunbond type treated by stretching in such a manner as to reduce the weight thereof and make it softer, absorbent and voluminous.

[0003] Spunbond nonwovens are obtained by extrusion, stretching and depositing a plurality of filaments made of plastic material on a conveyer belt. The filaments deposited on the belt are then constrained to one another in a plurality of points, generally by bonding.

[0004] The process of stretching spunbond nonwovens to obtain the aforesaid increased softness of the product has been known for some time. A problem of prior art is that of loss of the mechanical properties of the fibres and of the nonwoven due to the breakage of the fibres in the bonding points.

[0005] US 5.296.289 (1994) describes a process for stretching a spunbond nonwoven in MD (Machine Direction) and/or CD (Cross-Machine Direction), wherein the nonwoven is first calendered to form a plurality shaped "spot bonds" between the filaments, in the absence of complete bonding thereof, and then stretched. The filaments are, according to this patent, releasable from the spot bonds and allow the nonwoven to be stretched without causing breakage of these filaments. The main disadvantage of this embodiment is that the nonwoven must be shaped, with consequent loss of hand properties thereof.

[0006] US 5.626.571 (1997) attempts to solve the aforesaid problems by using a particular type of polyethylene yarn; stretching provides a nonwoven with apertures having increased dimensions for improved transfer of body liquids and secretions to an absorbent layer below. The stretched nonwoven is softer than the unstretched base.

[0007] W02004104285 (2004) describes a process for biaxial stretching of nonwovens to obtain a product with improved softness, open pore ratio and flexibility. Nonwovens that can be utilized are described as being principally those made of PP, both spun-bonded and melt-blown, nonwovens made of polyethylene/polypropylene bicomponents, formed by laminates of PP nonwovens and PE nonwovens bonded together, and PE, nylon, viscose and polyester nonwovens.

[0008] The products obtainable with the aforesaid techniques, even if softer than the initial product, still have relatively low absorption properties and a large number of fibres are broken during biaxial stretching. On the other hand, nonwovens currently produced with heat-bonding using a calender are somewhat stiff and flat (not voluminous) even if obtained with filaments with a titer between 0.8 and 3 dtex.

[0009] The object of the present invention is to improve the production processes of stretched nonwovens and to improve the quality and technical properties of stretched nonwovens, in particular their liquid absorption capacities.

[0010] This object is achieved by means of the present invention which relates to a process for the production of nonwovens by means of bi-oriented stretching of a nonwoven, characterized by comprising the steps of extruding filaments comprising two or more polymer components, formed of a first and of a second thermoplastic material differing from one another and such as to provide a final filament wherein said first and second material are not unitary with one another, and stretching the nonwoven thus obtained in at least one direction to impart different elongation deformations to said first and said second polymer material.

[0011] According to an aspect of the invention, the polymers are incompatible with one another.

[0012] According to another aspect of the invention, the bicomponent filament (or yarn) is of the skin/core type, the polymer with higher melting point forming the core.

[0013] According to a further embodiment, the bicomponent filament is of the "side-by-side" and/or splittable type.

[0014] In a preferred aspect of the invention, the stretch ratio is between 1:1.1 and 1:4; the stretching step is followed by a shrinking step of the stretched filaments that leads to a different configuration of the polymers In an embodiment, the stretching step is followed by a heat stabilization step, which allows controlled shrinkage of the filaments.

[0015] The nonwoven thus obtained and the system for obtaining it are also included in the invention.

[0016] The present invention presents numerous advantages with respect to prior art. Increased softness, volume and drapability of the nonwoven is obtained through mechanical reduction of the titer.

[0017] Moreover, there is a considerable increase in both the production speed and the width of the nonwoven. Production is extremely easy, as a higher titer is produced, which is then mechanically stretched eliminating the difficulty of producing low titer directly, i.e. during spinning, said linear densities remaining in any case stiff even after calendering.

[0018] Other advantages are given by the fact that the calender to bond the filaments before they are stretched can operate at a lower speed than that required to produce nonwovens with the same titer but which are not stretched. By operating at a lower speed and with a higher thickness of nonwoven, the calender will require less maintenance and its performance will be improved.

[0019] More in general, by operating at lower speeds, the efficiency and yield of machinery for producing spunbond nonwoven are increased as machine downtime and the production of waste are decreased.

[0020] The production capacity is higher, as machines that support the speed without any great problems and with modest power consumption are required downstream of the calender.

[0021] Decrease of the titer with mechanical tension, rather than pneumatically, translates into an energy saving of approximately 20% with respect to the same result obtained using pneumatic drawing.

[0022] The invention will now be described in greater detail with reference to the accompanying drawings, provided by way of non limiting example, wherein:

- fig. 1 show a schematic view of a system for the production of nonwovens according to the present invention;
- figs. 2 and 3 show schematic plan views of a portion of nonwoven before and during the stretching step;
- figs. 4, 5 and 6 show sections of filaments suitable for the present invention;
- figs 7 and 8 show partially sectional perspective views of bicomponent filaments before and after the stretching step;
- fig. 9 shows a schematic view of the nonwoven during stretching and after shrinking;
- fig. 10 shows an enlarged schematic view of two filaments of a nonwoven after stretching and after shrinking, as can be obtained according to the invention.

[0023] Firstly with reference to fig. 1, the process for the production of nonwovens by means of bi-oriented stretching of a nonwoven, comprises the steps of coextruding from a spunbond device 2 a plurality of filaments 3 comprising two or more polymers A, B, such as to provide a final filament 3 wherein said two or more polymers are not unitary with one another, forming a nonwoven 4 by collecting said filaments on known means, such as a belt 5, constraining said filaments of said nonwoven to one another in a plurality of points, and stretching the nonwoven thus obtained in at least one direction to impart different elongation deformations to said first and said second polymer material. The object is to make the nonwoven drapable, soft and voluminous; suitable nonwovens preferably have a weight between 8 g/m^2 and 350 g/m^2.

[0024] The polymers A and B are coextruded by the device 2 in a manner known per se in the art and form, for example, skin/core filaments or side-by-side filaments (in which the polymers A and B are side-by-side) or also splittable filaments (with section in segments), or a mixture of these three types; figs. 4-6 schematically show the three types of filaments discussed above. For this purpose, the device 2 comprises a polymer source A, a polymer source B and so on for each polymer to be used. The polymers are sent to one or more dies from which they are extruded in bicomponent or multicomponent form.

[0025] Continuous bicomponent filaments, preferably composed of core and skin, are then extruded.

[0026] Suitable polymers for the core portion of the filament are in particular: PET, PA, PP, PE, PLA. Polymers suitable for the skin portion are, for example: PP, PE, LLDPE, HDPE, PET, PA, PLA also low melt polymers. Preferably, combinations core PET 95% - skin PE 5% or core PET 50% - skin PE 50% or PET-PP in the same or other proportions are used; the aforesaid ratios are in weight.

[0027] As mentioned above, the polymers are joined in such a manner as to be different from one another, preferably incompatible with one another and in any case are such as to produce a filament that is not unitary; in other words, the filament obtained is composed of polymers A and B which present a contact surface 11. At this surface 11 the polymers adhere to one another but are not unitary, i.e. they behave substantially as a unitary filament, or as if they were cohered although they are not bonded on the surface 11, until the moment in which they are subjected to tensile stress during stretching.

[0028] The filaments collected on the belt 5 are conveyed to means for constraining, or "consolidating", the nonwoven. These means are preferably composed of a calender 6 where the outer layers of skin of a plurality of filaments 3 are heat bonded to one another, in a plurality of constraining points 7 (fig. 2). Alternatively, other means to constrain the filaments are possible, such as water jets. The nonwoven thus obtained therefore presents areas 7 in which the filaments are bonded and cannot be moved away from one another while the rest of the nonwoven is formed of filaments that move with respect to one another. The bonding points 7 thus act as constraints with respect to movement of the fibres and, also during the stretching step, the filaments are not subject to dimensional variations at these bonding points 7.

[0029] The nonwoven thus obtained is then subjected to a stretching step, preferably in both directions MD and CD (Machine Direction and Cross Machine Direction). Nonwovens of this type can be cold or hot stretched on rolls or in specific ovens or also with chains or with other apparatus that implies elongation of the nonwoven in CD and MD. Fig. 1 schematically shows two different devices 8 and 9 that perform stretching of the bicomponent filament nonwoven. Suitable stretching means are hot rolls, chain ovens and are known in the art, for example from the aforesaid documents to which express reference is made for the stretching means.

[0030] Stretching is preferably followed by a heat treatment step (TT, ref. 10) to dimensionally stabilize the stretched nonwoven; in any case, it is preferable to subject the stretched nonwoven to a shrinking step, i.e. partial shrinkage of said filaments toward the initial conformation thereof; this shrinkage is controlled and can also be performed during the heat treatment of the nonwoven.

[0031] The stretch ratio, both in MD and CD, is between 1:1.1 and 1:4, more preferably between 1:1-1 and 1:2.

[0032] As seen above, the polymers are chosen in such a manner as to form filaments that are initially cohered but not unitary: the skin polymer, during the bi-oriented stretch step, separates from the core polymer as the reciprocal adhesion forces between the polymers on the polymer-polymer interface 11 are insufficient to maintain the portions A and B of the filament adherent to one another. Consequently, the polymer A, for example the skin (fig.4) is detached from the core and is able to "slide" or slip on the surface of the core polymer B. The latter is also subjected to tension, allowing the two polymers both to decrease in section between the heat bonded points 7 obtained in the calender, as can be seen in figs. 7 and 8, which show the filament 3 as initially extruded (fig.7) and during stretching (fig. 8).

[0033] In other words, during the bi-orientation step, or stretching or drawing step, the filaments will have a smaller section than the initial section and will no longer be cohered as in the spinning step, as they are two different polymers and each has a different behaviour under tension and when tension is released.

[0034] The stretching process allows the titer of the yarn to be decreased in proportion to the stretch; for example, with a stretch ratio of 1:2 the titer of the portions of yarn between bonding or consolidation points 7, decreases by 50%. The weight of the nonwoven does not decrease by 50% as the calendered bonding points 7 remain unstretched. If the filaments 3 being spun have a titer of 2 dtex and are stretched with a ratio of 1:2, the final titer of at least part thereof is 1 dtex. The filaments composed of A/B (skin A 50% / core B 50%) will have a titer of the skin = 0.5 dtex and a titer of the core = 0.5 dtex. This process allows them to enter the microfiber sector which, as is known, have linear densities equal to or less than 1 dtex.

[0035] In the release step, after the mechanical orientation step of the filaments and subsequent heat stabilization, the two polymers A and B have different shrinkage, being composed of two different polymers with different behaviours under tension and create an increase in the volume of the nonwoven 4 as the filaments are no longer rectilinear, as schematized in figs. 9 and 10. These figures schematically show the behaviour of a filament 3 that is extended between two constraining, or bonding, points 7; the representation with dashed lines shows the condition of the bicomponent filament during tension, in the stretching step of the nonwoven, while the representation below with solid lines shows the same filament after shrinkage. As stated, the polymers A and B are different, behave in different ways and being no longer cohered, as the stresses in the stretching step have released them from one another (see fig. 8), they move separately from one another and tend to form a nonwoven with a "three-dimensional" structure.

[0036] The amount of increase in volume of the nonwoven is partly dependent on the amount of shrinkage.

[0037] The amount of shrinkage is adjustable by varying the treatment temperature and the tension of the nonwoven. The stretched nonwoven, left free (i.e. not subjected to tension) at ambient temperature presents a crimp effect, i.e. of basic or initial increase in volume, which can be increased and controlled by means of temperature and tension.

[0038] For example, controlled shrinkage can be performed as follows.

[0039] After the stretching step of the nonwoven, it is fed, still in stretched condition and proceeding at a speed of 400 m/min, to a group of rolls heated to the temperature of 120°C. The feed roll or rolls present a speed of 400 m/min, while the delivery roll or rolls present a speed of 360 meters per minute.

[0040] Alternatively to the heated cylinders, heating ovens, such as the one indicated with the reference 10 in fig. 1, can be utilized.

[0041] This different speed allows controlled shrinkage of the nonwoven aided by the temperature.

[0042] Shrinkage is mostly absorbed by the oriented (stretched) filaments of which the nonwoven is composed, which given their bicomponent structure shrink differently producing a three-dimensional crimp that determines the increase in volume. This crimp effect, i.e. increase in volume, is enhanced by the fact that the core B is not always perfectly positioned in the centre of the filament, often being moved to one side thereof. The same thing occurs for side-by-side and splittable yarns.

[0043] This makes the nonwoven thus obtained strong but very flexible, as the filament loses resilience, a factor that gives the nonwoven drapability, softness and volume, while maintaining strength in MD and CD.

[0044] In an embodiment of the invention, the process includes for the use of a stretch ratio that is such as to produce a plurality of filaments having a lacerated skin portion A and an integral core portion B. The nonwoven thus obtained presents an improved softness and volume and above all a greater liquid absorption capacity.

[0045] A further embodiment of the invention also includes a step of applying means to the nonwoven to control the dimensions of the apertures between filaments. These means are, for example, chosen from melt-blown fibres, cellulose fibres and breathable films laminated to the stretched nonwoven in order to increase permeability and/or absorption power.

[0046] These applications are in fact used to close, in a controlled manner, the spaces between the fibres in such a manner as to obtain a microporosity or absorption required of the final product without prejudicing the properties of softness and volume obtained by means of the invention.

[0047] As already shown, this invention translates into numerous advantages.

[0048] The process is more economically profitable, as approximately 20% less power is required with respect to production processes currently used in the market.

[0049] The step to form the web is easier, as a higher titer of the filaments is sufficient and this results in a decrease in the use of power during the spinning and forming step of the nonwoven.

[0050] Moreover, the nonwoven increases in volume and greatly increases its liquid absorption power.

[0051] The draw ratios, pneumatic orientation, web formation, calendering, mechanical stretch and heat stabilization of the filaments can naturally be modified according to the end product required. The invention will now be further described with reference to the following non-limiting examples.

Example 1.

[0052]

SYSTEM WITH TWO 3200 mm HEADS WITH PRODUCTION 1500 KG/H
Required product: 14 grams/m^2
Required product width: 4200 mm
Extruded polymers: PET - PE
Type of bicomponent filament: core, skin
Initial product: 24.5 grams/m^2
Initial width: 3200 mm
Speed at the bonding calender 320 m/min
Stretch ratio 1:1.35 (3200x1.35=4200mm)
14 grams/ m^2 are thus obtained.
Controlled stretch and shrinkage are performed with group of rolls having a speed of the initial roll equal to 320 m/min, a stretch delivery speed equal to 480 m/min and a final speed, i.e. of the roll that controls shrinkage, equal to 430 m/min.
Energy consumption per kg of product = 0.72 kW
Filaments with initial linear density: 2 dtex
Filaments with final linear density: 1.4 dtex
The energy consumption of the process currently used in the market to produce an equivalent nonwoven with weight of 14 g/m^2 is on average greater than 0.90 kW.

Example 2.

[0053]

HYGROSCOPICITY
Absorption power.
A nonwoven was prepared in the following way:

A portion of this nonwoven according to the invention, type Spunbond Bicomponent PET-PE, was stretched in MD and CD as follows:

MD stretching: 1 to 1.4; CD stretching with ratio 1 to 1.4.
Controlled stretching and shrinkage with group of rolls in analogy with the specifications above.
Samples of nonwoven were subjected to absorption test as follows:

Sample A, 10x10 cm of nonwoven 30 g/m^2 (normal)
Sample B, 10x10 cm of skin/core nonwoven stretched and treated according to the invention and weight of 30 g/m^2.
Sample C, 10x10 cm of splittable nonwoven stretched and treated according to the invention and weight of 30 g/m^2.

[0054] The same type of hydrophilic additive is added to the surface of each of the samples A, B and C, in the quantity of 0.4% in weight.

- after immersion in water for 10 seconds, there is a threefold increase in the weight of sample A of nonwoven 30 g/m^2 with hydrophilic additive applied to the surface at 0.4%.
- after immersion in water for 10 seconds, there is a twelvefold increase in the weight of sample B of HCS nonwoven 30 g/m^2 with hydrophilic additive applied to the surface at 0.4%.
- after immersion in water for 10 seconds, there is a twentyfold increase in the weight of sample C of HCS nonwoven 30 g/m^2 with hydrophilic additive applied to the surface at 0.4%.

[0055] Products obtained with the present invention can be used in:

- Hygiene-healthcare sector: top sheets and back sheets, Adl - acquisition dry layer; wet wipes; medicals.

As PET-PE products can be sterilized with gamma rays, the products of the invention can be used where this characteristic is required.
The products do not emit fine dust and can be also be used in industrial and household applications, such as for: table linen; bed linen; cleaning cloths; insulation; roofing, geotextiles, packaging.

[0056] Flame retardant, anti dust mite, hydrophilic and UV-blocking additives can be applied to the skin of the filaments without being applied to the core of the filaments.

Claims

1. Process for the production of nonwovens by means of bi-oriented stretching of a nonwoven, **characterized by** comprising the steps of coextruding filaments comprising two or more polymers (A, B), such as to provide a final filament (3) wherein said two or more polymers are not unitary with one another, forming a nonwoven with these filaments, constraining the filaments of said nonwoven to one another in a plurality of points (7), and stretching the nonwoven (4) thus obtained in at least one direction to impart different elongation deformations to said first and said second polymer material.

2. Process according to claim 1, also comprising the step of permitting partial shrinkage of said filaments toward their initial conformation.

3. Process according to claim 1 or 2, wherein said polymers (A, B) are incompatible polymers.

4. Process according to one of the preceding claims, also comprising a heat treatment step of the stretched nonwoven (4).

5. Process according to one of the preceding claims, also comprising a step of applying to said nonwoven means for controlling the dimensions of the aperture between the filaments (3).

6. Process according to one of the preceding claims, wherein the stretch ratio in said at least one direction is between 1:1.1 and 1:2.

7. Process according to one of the preceding claims, wherein the stretch ratio is such as to produce a plurality of filaments having a lacerated skin portion (A) and an integral core portion (B).

8. Nonwoven (4) as obtainable according to one of the preceding claims, **characterized by** comprising a plurality of filaments (3) each of which formed by two or more polymers (A, B) such as to form a filament wherein said two or more polymers are not unitary with one another, said two or more polymers (A,B) presenting different deformations when subjected to elongation.

9. Nonwoven according to claim 8, wherein said two or more polymers (A, B) are incompatible polymers.

10. Nonwoven according to claim 8 or 9, wherein said filaments comprise a portion of skin (A) and a portion of core (B), and wherein at least part of the filaments subjected to elongation present a lacerated skin portion and an integral core portion.

11. Nonwoven according to one of claims 8 to 10, wherein said two or more polymers are chosen from PP, PE, LLDPE, HDPE, PET, PA, PLA.

12. Nonwoven according to one of claims 8 to 11, also comprising means to control the dimensions of the apertures between filaments.

13. Nonwoven according to claim 12, wherein said means are chosen from melt-blown fibres, cellulose fibres and breathable films.

14. System for the production of nonwovens according to one of claims 8 to 13, comprising an extrusion device to form a spunbond nonwoven (4), means (6) to constrain the filaments of the nonwoven to one another in a plurality of points (7), and means (8, 9) to stretch said nonwoven in at least one direction, **characterized in that** said extrusion device comprises means (2) to coextrude two or more polymers (A, B) such as to form a filament (3) wherein said two or more polymers (A, B) are not unitary with one another, said two or more polymers presenting different deformations when subjected to elongation.

15. System according to claim 14, also comprising means (10) to perform a heat treatment and/or a controlled shrinkage of the stretched nonwoven.

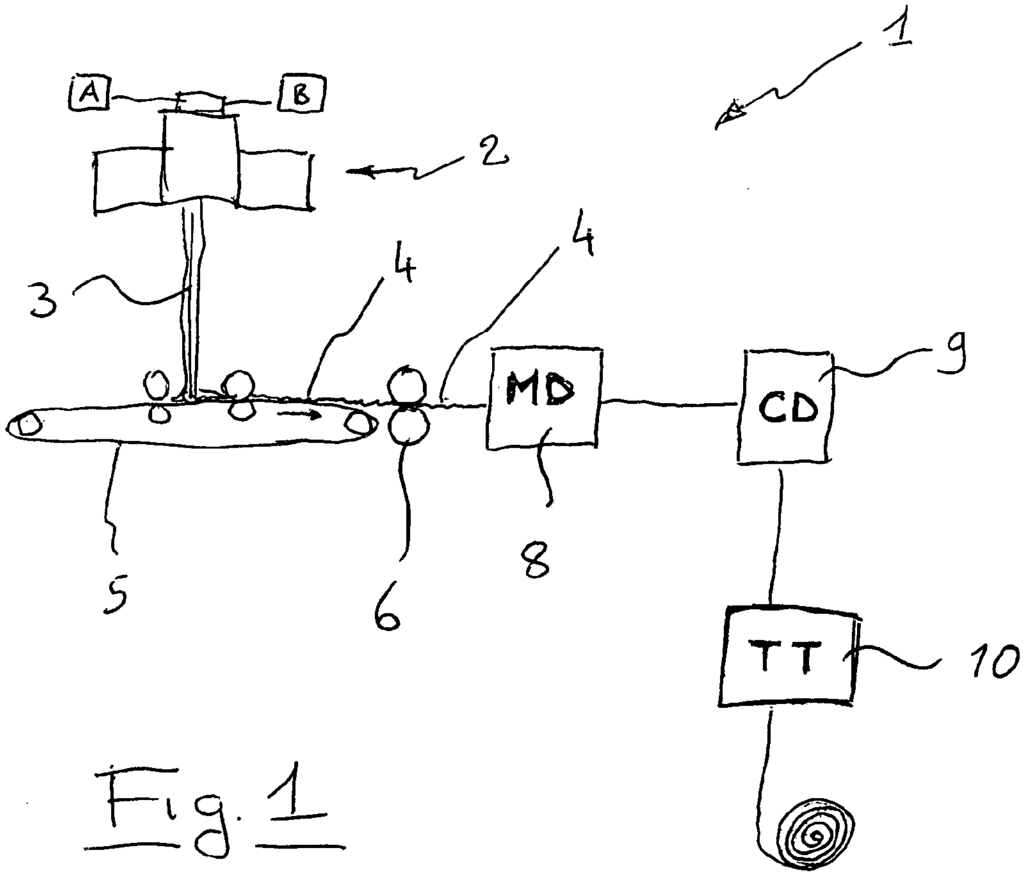

Fig. 1

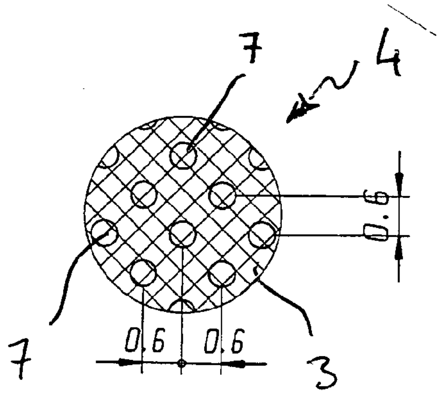

Fig. 2

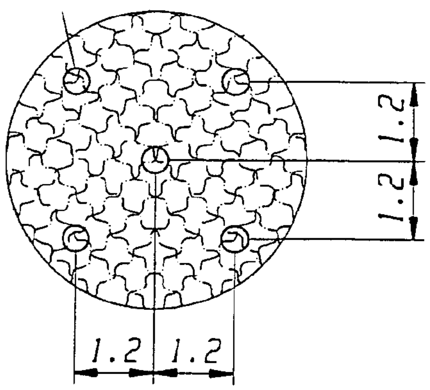

Fig. 3

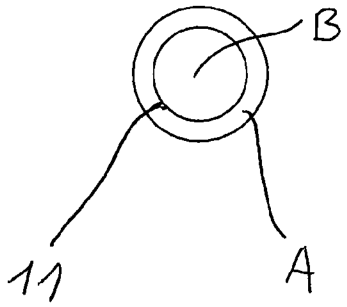

Fig. 4

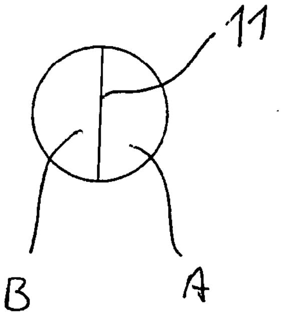

Fig. 5

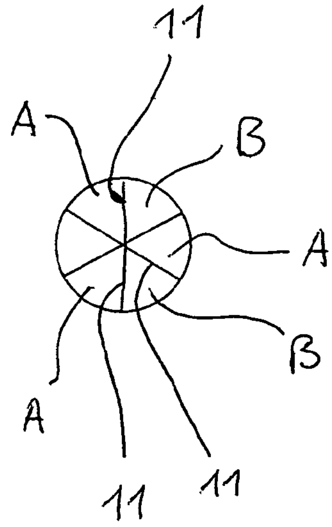

Fig. 6

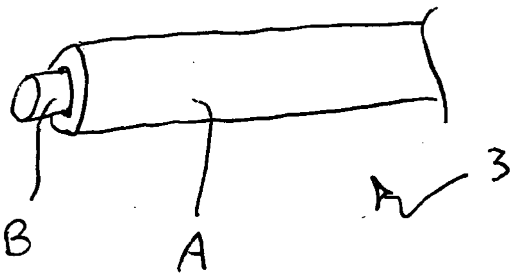

Fig. 7

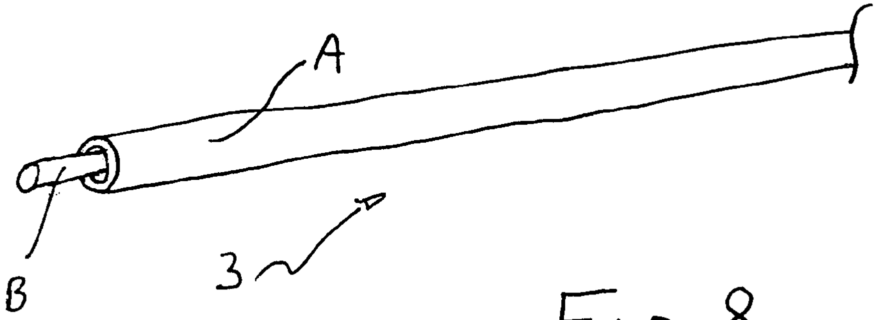

Fig. 8

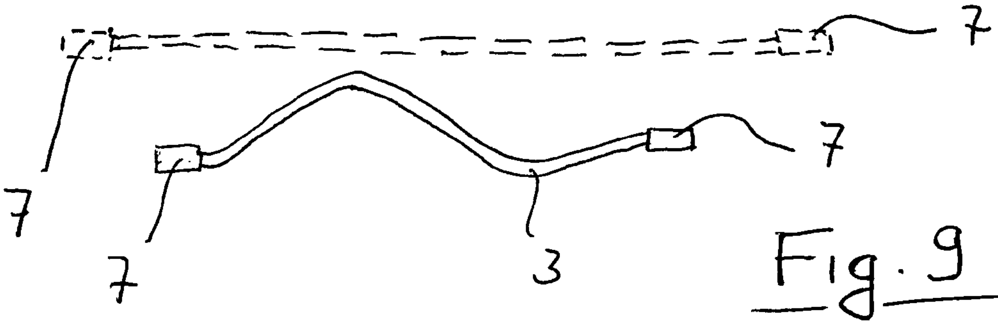

Fig. 9

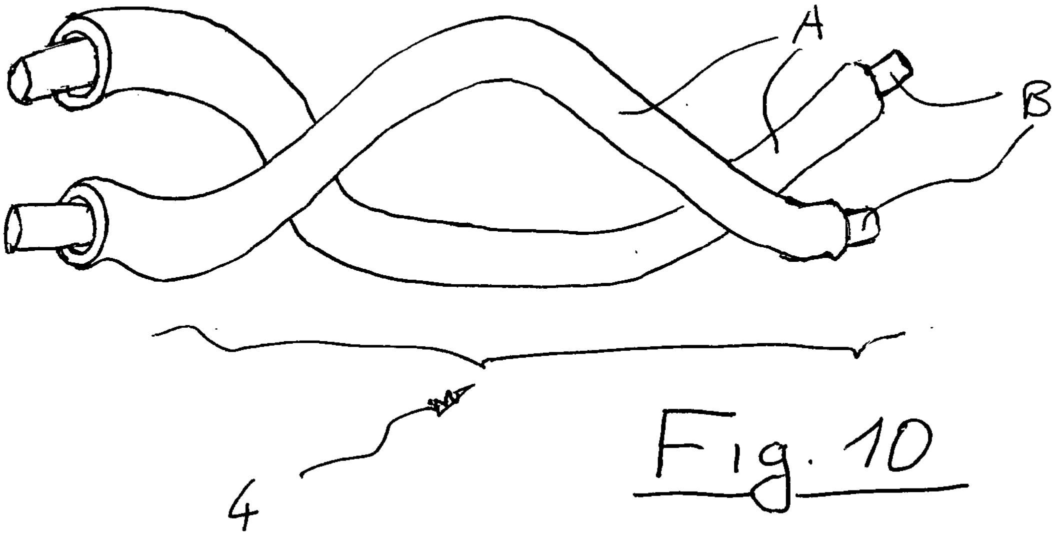

Fig. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 01 1164

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 1 559 822 A (UNI CHARM CORP [JP]) 3 August 2005 (2005-08-03) * figures 1,3,4,9 * * paragraphs [0018] - [0031] *	1-10,14, 15 11	INV. D04H3/03 D04H3/14 D01F8/06 D01F8/14 D04H3/16
Y	JP 05 186946 A (UNITIKA LTD) 27 July 1993 (1993-07-27) * abstract * * paragraphs [0009], [0036] *	11	
A	JP 2007 100274 A (CHISSO CORP; CHISSO POLYPRO SENI KK) 19 April 2007 (2007-04-19) * paragraphs [0013], [0014], [0024] - [0029], [0047]; figures 1-5; table 1 *	1	
A	EP 1 443 132 A (BBA NONWOVENS SIMPSONVILLE INC [US]) 4 August 2004 (2004-08-04) * claims 1,22-24; figures *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			D04H D01F D01D

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	30 September 2008	Barathe, Rainier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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