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(54) NONWOVEN SPUNBOND FABRIC

(57) Nonwoven fabric (1) comprising a plurality of filaments (2) made of at least two different materials (A, B), said multicomponent filaments (2) having two sub-filaments (2a, 2b) co-extruded from said materials (A, B) in side-by-side arrangement and adhered to one another, wherein the material (A) of a first sub-filament (2a) has melting temperature (T1) different from the melting temperature (T2) of the material (B) of a second sub-filament (2b) by at least 10°C and wherein, in cross section, the contact surface between said two sub-filaments (2a, 2b) is substantially wave-shaped

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Description

[0001] The present invention concerns the field of nonwoven fabrics, and in particular of nonwoven fabrics obtained by spunbond process.

[0002] As known, spunbond fabrics are obtained by extruding, drawing and depositing a plurality of filaments of plastic material on a conveyor belt. The filaments laid down on the belt are then constrained together at a plurality of points, by different processes, such as for example by calendering, applying air or water jets, or joining, etc.

[0003] A typical plant for producing spunbond filaments comprises a spinning head fed by extruders, a drawing unit and a deposition unit for depositing the drawn filaments on a movable support (collecting surface) where the nonwoven fabric is formed.

[0004] The nonwoven fabrics of spunbond type are used in various fields, such as for example medical and sanitary ones, but also in the geotechnical field, in civil engineering, in building construction. Obviously, depending on the application, the nonwoven fabric must have different mechanical properties relating to outward finishing, resistance to particular agents, etc., so as to meet the different requirements of the areas of use.

[0005] Nonwoven fabrics are known in the art which are made from filaments formed by two or more components, so as to be able to exploit different characteristics of the employed materials.

[0006] It is known, for example, to arrange two polymer materials in side-by-side arrangement. In the side-by-side arrangement, two polymer materials are coextruded so as to form a multicomponent filament in which the two materials form two sub-filaments arranged next to each other. Typically, the multicomponent filament has circular section and the two sub-filaments have semicircular sections. In other words, the section of the contact surface between the two filaments substantially coincides with the diameter of the section of the multicomponent filament. It is also known to vary the ratio between the two components. In this case, the contact surface between the two sub-filaments coincides with a chord of the circular section of the multicomponent filament.

[0007] It is further known to select the materials of the two sub-filaments with different characteristics so as to cause the multicomponent filament to crimp. Such a configuration provides the final nonwoven fabric with increased softness and volume, among other things.

[0008] For example, the two sub-filaments may be made of materials having different coefficients of elasticity, whereby the multicomponent filament is initially extruded and drawn, thus forming a not-crimped continuous filament. When the multicomponent filament is no longer tensioned, the two sub-filaments shrink in different way, thus crimping the multicomponent filament.

[0009] Similarly, the two sub-filaments may be made of materials having different coefficients of thermal expansion and/or different shrinkage. If the multicomponent filament is subjected to thermal treatment, the two sub-filaments expand/shrink in a different way with respect to one another thus crimping the multicomponent filament.

[0010] Additionally, it is known to manufacture the two sub-filaments of materials different from one another, resulting in uneven stresses between the two sub-filaments during the extrusion and drawing steps, thereby subsequently crimping the multicomponent filament.

[0011] In these and other examples the two materials of which are made the two sub-filaments, are typically required to have good reciprocal bonding properties. In other words, when not crimped, the two sub-filaments are arranged one next to the other and adhered, i.e. attached and integral to each other. After crimping, too, the two sub-filaments remain adhered to one another. In other words, considering for example the case of sub-filaments having different coefficients of thermal expansion, the two sub-filaments remain adhered to one another, so that the sub-filament having greater thermal expansion bends the sub-filament having lower thermal expansion. However, known spunbond processes do not allow high crimping level to be obtained.

[0012] Moreover, processes are known for crimping even materials having low reciprocal bonding properties. For example, US 3458390 teaches to make side-by-side multicomponent filaments in which the contact surface between the two filaments generates a shape coupling (by means of "necked-down portions" (undercuts)), so as to mechanically constrain the sub-filaments to one another. Therefore, the two sub-filaments are bonded by such mechanical constraint and do not split during the required treatments (for example thermal treatments). It is difficult to obtain such a shape. Moreover, excessive stress may cause the undesirable splitting of the multicomponent filament. Finally, it is not known how to make a nonwoven fabric by such multicomponent filament.

[0013] It is an object of the present invention to make a spunbond nonwoven fabric having high crimping level.

[0014] It is a further object of the present invention a spunbond method allowing this nonwoven fabric to be simply and economically produced.

[0015] These and other objects are achieved by the present invention by means of a nonwoven fabric according to claim 1, a filament according to claim 12 and a method for producing such a fabric according to claim 14.

[0016] Preferred aspects are set forth in dependent claims.

[0017] According to an aspect of the present invention, a spunbond nonwoven fabric comprises a plurality of multicomponent filaments, wherein the multicomponent filaments have two sub-filaments coextruded in side-by-side arrangement. In particular they have melting temperatures different from one other by at least 10°C. In other words the melting temperature of the first filament is different from the melting temperature of the second filament by at least 10°C, preferably by at least 20°C.

[0018] The sub-filaments are "adhered" to one other so that during the preparation of the nonwoven fabric the two sub-filaments remain bonded, i.e. the sub-filaments do not split. In other words, after the co-extrusion, the materials of the two sub-filaments adhere to one other, i.e. the sub-filaments become integral to one other.

[0019] Thus, the materials of the sub-filaments have good co-adhesion properties, i.e. they are so-called "compatible" materials. Accordingly, when the two sub-filaments are co-extruded, a contact surface along which the materials are attached to each other is formed. The adhesion between the materials of the two sub-filaments is sufficiently strong to impede their separation during the normal treatments which the nonwoven fabric is subjected to.

[0020] Furthermore, in section, the contact surface between the two sub-filaments is substantially wave-shaped. In other words, the section of the contact surface (i.e. the line defined by the cross section of the contact surface) is a substantially wave-shaped line.

[0021] "Wave-shaped" or "wavy" line means a line, typically a curved continuous line, which forms at least one peak and one trough, or peaks and troughs, i.e. maxima and minima, alternate to one another.

[0022] Such an alternation of peaks and troughs typically causes the formation of at least one protrusion of a first filament within the second sub-filament.

[0023] In particular, considering the cross section of the filament, the contact surface between a first sub-filament and a second sub-filament has at least one inflection, and the first sub-filament forms at least one protrusion within the second sub-filament. Such a protrusion has a progressively decreasing width.

[0024] The "width" of the protrusion is measured along a direction parallel to a straight line connecting the ends of the section of the contact surface, i.e. the points wherein the contact surface touches the edge of the filament section.

[0025] Thus, "protrusion" is defined as the portion of the first sub-filament between the section of the contact surface and the straight line linking the ends of the section of the contact surface.

[0026] The width is "decreasing" from the base (i.e. from the straight line connecting the ends of the section of the contact surface) to the top of the protrusion, i.e. to the farthest point of the protrusion from the straight line linking the ends of the section of the contact surface, at a crest (i.e. a peak or a trough) of the wave.

[0027] Generally, the contact surface is typically shaped so to avoid the formation of undercuts.

[0028] In an embodiment, the contact surface has a single inflection. In a preferred embodiment shown and discussed below in more detail, there are two inflections placed at opposite sides of the protrusion of the first sub-filament.

[0029] According to a possible aspect, the sub-filaments are in the multicomponent filament in a volume ratio between 1:4 e 4:1. It has been observed that, as a result of thermal treatment, such a combination of sub-filaments with the above described materials and arrangement surprisingly causes an increased crimping of the multicomponent filaments with respect to arrangements known in the art. This result is supposed to be partially caused by both the asymmetry of the section of the multicomponent filament and the large contact surface between the two sub-filaments of the multicomponent filament (i.e. the great length of the contact surface). Furthermore, it is noted that materials having melting temperatures that differ by less than 10°C do not provide results as good as those of the present invention. The 10°C difference between the melting points is detected by using the same method to measure the melting points of the two materials. A measuring method of the melting point is, for example, ASTM D 3418-03; the melting temperature can also be measured by a temperature probe.

[0030] It is noted that the filament typically has circular section, resulting in the filament section not provided with a predefined orientation. Defining a crest, oriented in one direction, "peak" instead of "trough" and a crest oriented in the opposite direction "trough" instead of peak is a purely formal choice that does not alter the effects of the present invention. In other words, a wave comprises two peaks and a trough when has three crests, two crests oriented to one side, and an opposite crest with respect the two other crests (and typically interposed therebetween).

[0031] Preferably, the length of the section of the contact surface is greater than the greatest dimension of the section of the multicomponent filament.

[0032] Such a condition particularly occurs when the volume ratio between the two sub-filaments is close to 1:1. More in general, given a filament comprising two sub-filaments having a determined volume ratio, a wave-shaped section of the contact surface has length greater than a section of the straight line shaped contact surface. According to an aspect, the period of the wave formed by the section of the contact surface is preferably between 40% and 100% of the diameter length (or the greatest dimension) of the filament section. In a preferred embodiment, the wave period is about 2/3 the value of the diameter (or the greatest dimension) of the section of the multicomponent filament.

[0033] As mentioned above, a preferred embodiment provides the presence of at least one protrusion provided with two inflections, i.e. in such an embodiment the contact surface has at least one first inflection at a first side of the protrusion, and at least one second inflection being at the side of the protrusion opposite to the first side.

[0034] In such an embodiment, the distance between the two inflections (i.e. the length of the segment that, in section, connects the two inflections) is preferably lower than 70% of the diameter length of the section, more preferably lower than 60% of the diameter, still more preferably lower than 50% of the diameter.

[0035] According to an aspect of the invention, the first sub-filament is made of a first polymer material, and the second sub-filament is made of a second polymer material. Such first and second polymeric materials are selected among PP, CoPP, PE, CoPE, PET, CoPET, PA, PLA. The two sub-filaments can be made of the same type of material, provided that the previous condition relating to different melting temperatures is met, i.e. the difference between the melting temperatures of the two materials is greater than 10°C. Such a difference is preferably greater than 20°C. According to an aspect of the invention, the materials which the first and second sub-filaments are made of have viscosities different from one other, preferably with a difference greater than 20%, when measured with the same method and in the same conditions. In other words, the value of viscosity of the material of the first sub-filament is different from the value of the viscosity of the second filament, with a difference preferably greater than 20%.

[0036] According to a further aspect, the material with lower melting temperature is also that one with the lower viscosity.

[0037] As described, the volume ratio between the filaments is between 1:4 and 4:1. Preferably, there is a lower amount of the sub-filament made of the material with a lower melting temperature than the other sub-filament. The materials A, B for the two sub-filaments are preferably selected among PP, coPP, PE, coPE, PET, coPET, PLA. Preferred combinations are: PP/PE, PP/coPP, PET/PP, PET/coPET, PET/PE, PLA/PP, PLA/PE. The terms coPP, coPE, coPET used in the present description are respectively polypropylene copolymer, polyethylene copolymer, polyethylene terephthalate copolymer. PLA, as known, denotes polylactic acid, i.e. the lactic acid polymer.

[0038] According to an aspect of the invention, the grammage of the nonwoven fabric is between 10 and 1000 g/m^2, preferably between 10 and 500 g/m^2. According to an aspect of the invention, the linear mass density of the multicomponent filaments is between 1.5 and 30 den, preferably between 3 and 15 den.

[0039] The present invention further relates to a multicomponent filament having at least two sub-filaments co-extruded from at least two materials in side-by-side arrangement and adhered to one another, wherein the material of a first sub-filament has melting temperature different from the melting temperature of the material of a second sub-filament by at least 10°C and wherein, in cross section, the contact surface between said two sub-filaments is substantially wave-shaped.

[0040] According to a preferred aspect, in cross section, the line defined by the contact surface between a first sub-filament and a second sub-filament has at least one inflection, and the first sub-filament forms at least one protrusion within the second sub-filament; such a protrusion having decreasing width. The width is decreasing when moving from the first sub-filament towards the second sub-filament, as it is visible in the figures.

[0041] The present invention further relates to a spunbond process for producing nonwoven fabric comprising a plurality of multicomponent filaments, which are drawn, deposited on a collecting surface and heated so as to crimp the filaments, wherein each multicomponent filament has two filaments adhered to one another, the sub-filaments being of materials having melting temperatures that differ from one another by at least 10°C, characterized in that said two sub-filaments are coextruded according to a side-by-side arrangement, with a volume ratio between 1:4 and 4:1, so that the section of the contact surface between said two sub-filaments is substantially wave-shaped.

[0042] According to a preferred aspect, the contact surface is shaped by varying the extrusion/spinning pressure of at least one of the sub-filaments between at least two distinct points of a section of the sub-filament of the multicomponent filament.

[0043] In an embodiment, the wave can be sinusoidal; in other embodiments, the wave is formed by circumference or ellipse portions connected to one another by points of inflexion.

[0044] It should be noted that, due to the small size of the filament section, the waveform can actually have a shape approximating one of the ideal patterns described above. For example, in a possible embodiment, a first sub-filament forms a protrusion (thus forming a "peak") protruding within the second sub-filament, and typically arranged substantially in the middle of the filament section.

[0045] Opposite sides of the protrusion are provided with an inflection. In such an embodiment, the shape of the section of the contact surface thus approximates a sinusoidal pattern. According to an aspect, in such an embodiment, the first sub-filament has melting temperature lower than the second filament.

[0046] The invention is now described in greater detail referring to the following figures showing exemplary and non-limiting embodiments, in which:

- figure 1 is a schematic view of a plant for producing a nonwoven fabric according to the present invention;
- figures 2A and 2B are sectional views of possible filaments to form a nonwoven fabric according to the present invention;
- figures 3A - 3B are enlarged views of the fabric, showing in particular the filaments before and after the thermal treatment causing the crimping thereof;
- figures 4A - 4B are enlarged views of individual filaments before and after the thermal treatment causing the crimping thereof.

[0047] Referring to the figures, a nonwoven fabric 1 comprises a plurality of multicomponent filaments 2. The multicomponent filaments comprise two sub-filaments 2a, 2b made by co-extruding two materials A, B, that typically are polymeric materials. The sub-filaments 2a, 2b are in side-by-side arrangement.

[0048] The materials A, B for the two sub-filaments 2a, 2b are preferably selected among PP, coPP (coPP means PP copolymer), PE, coPE, PET, coPET, PA, PLA. Preferred combinations are: PP/PE, PP/coPP, PET/PP, PET/coPET, PLA/PP, PLA/PE, PET/PE. In particular, the PP/PE and PET/coPET couplings proved to be particularly suitable for the present invention.

[0049] According to a further aspect, the materials are oriented, i.e. non-amorphous, to favor (during a thermal treatment) the dimension variation of the sub-filaments in one direction, so that to allow an increased crimping of the filament and thus the increase of volume of the nonwoven fabric

[0050] Generally, the materials of the sub-filaments 2a, 2b are selected so that the melting temperature T1 of the first sub-filament 2a is different by at least 10°C to the melting temperature T2 of the second filament, more preferably by at least 20°C. In some embodiments, as mentioned above, it is possible to use two different types (i.e. two different "grades") of the same material (for example two different types of PP), provided that the above mentioned condition relating to the difference between the melting temperatures is met.

[0051] Preferably, the two materials also have different viscosity from one another, a difference by at least 20% between the two values when they are measured with the same method. In other words, the difference between the viscosity $\mu 1$ of the first sub-filament 2a and the viscosity $\mu 2$ of the second filament is greater than 20%.

[0052] As described above, the two materials (i.e. the materials the two sub-filaments 2a, 2b are made of) can be tested with the same viscometer (for example a rotational or capillary one) or, more in general, the viscosity can be determined by a common method defined in a recognized standard (for example ASTM D3835).

[0053] Generally, the sub-filament made of the material having lower melting temperature also has lower viscosity.

[0054] As mentioned above, the side-by-side arrangement provides that the two sub-filaments 2a, 2b are arranged next to one another, so that the section of the multicomponent filament 2 has two areas separate from one another. In other words the two sub-filaments 2a, 2b, in section, are separated by a line representing the contact surface 3.

[0055] The materials A, B of the two sub-filaments 2a, 2b are such that, at the contact surface 3, the sub-filaments 2a, 2b are adhered ("bonded") to one another, that is to say the materials are "co-adhesive". Such adherence between the two sub-filaments does not occur only after coextrusion, but also in the final nonwoven fabric. In other words, the treatments carried out on multicomponent filaments 2 and nonwoven fabric 1 do not cause the sub-filaments 2a, 2b to split, i.e. the sub-filaments 2a, 2b are kept adhered to one another.

[0056] According to the invention, the contact surface 3 is wave-shaped. In other words, the shape of the section of the contact surface shows peaks 31, 32 alternating with troughs 33. As known, "peaks" and "troughs" are the crests 31, 32, 33 formed by the wave. The peaks 31, 32 are directed in the opposite direction with respect to the troughs 33. It should be noted that, typically, the difference between troughs 33 and peaks 31, 32 is given only by the orientation chosen for the section of the filament. Referring to figures, crests pointing to the right are denoted as peaks and crests pointing to the left are denoted as troughs. For example, in figure 2A two peaks 31, 32 and one trough 33 can be seen.

[0057] According to a possible aspect of the present invention, the contact surface can form, in section, a wave with at least three crests 31, 32, 33. In view of the above, choosing the orientation opposite to that used herein, the three crests 31, 32, 33 can be alternatively considered as two troughs and one peak.

[0058] A wave shape typically defines at least one protrusion P1 of the first sub-filament 2a within the second sub-filament 2b. As discussed above, a protrusion P1 will be defined as that portion of the first sub-filament 2a between the section of the contact surface 3 (i.e. the line defined by the contact surface viewed in cross section) and the straight line R passing at the two ends 3a, 3b of the section of the contact surface 3, i.e. the points where the section of the contact surface 3 meets the edge of the filament section 2.

[0059] The second sub-filament 2b, too, can form further protrusions P2, P3, i.e. portions of the second filament 2b between the straight line R and the section of the contact surface 3. The protrusions P2, P3 are thus arranged in opposite way (i.e. they are arranged on the other side with respect to the straight line R) with respect to the protrusion P1. In a possible embodiment, the protrusions P1, P2, P3 formed by the troughs 33 and peaks 31, 32 can be specular to one other. In other words, the protrusions P1, P2, P3 formed by the troughs 33 and peaks 31, 32 can have the same length L and the same height H or length and height similar to one other.

[0060] As previously specified, the width L of the protrusions is measured in a direction parallel to the straight line R passing at the two ends 3a, 3b of the section of the contact surface 3, whereas the height H is measured in a direction perpendicular to the width L.

[0061] However, as it is better discussed below, embodiments wherein only a first sub-filament 2a forms a protrusion P1 within the second sub-filament 2b are possible. Typically, in such embodiments, the straight line R intersects the section of the contact surface 3 only at the ends 3a, 3b thereof.

[0062] According to an aspect, the wave period is between 40% and 100% of the diameter length of the multicomponent filament 2. It should be noted that, for convenience sake, reference will be made to the "diameter" of the multicomponent filament 2. However, the following description can be applied also to the case of a not-circular filament section. In this case, the "diameter" should be considered as the greatest dimension of the section.

[0063] As known the "period" of the wave can be measured as the distance between two subsequent peaks (or two troughs).

[0064] Therefore, in light of the above definitions, the contact surface 3 changes at least once its own curvature, i.e. has at least one inflection. Preferably, the contact surface 3 (in section) has at least two inflections (or inflection points) f1, f2.

[0065] According to an aspect, the inflection points f1, f2 (and more in general the shape of the section of the contact surface 3) are configured so that to avoid the presence of undercuts.

[0066] A section of the contact surface 3 provided with undercuts is in fact complex to be made and is not effective during the crimping step of the filament 2 when, as in the present solution, the two sub-filaments 2a, 2b are adhered to one another.

[0067] Typically, the section of the contact surface 3 covers at least one period of the waveform. More preferably, the contact surface has at least two peaks and one trough, thus covering at least 1.5 periods of the waveform.

[0068] Furthermore, in possible embodiments, the waveform meets the edge of the filament section at the middle point between trough and peak, i.e. far from troughs and peaks. The height H of the protrusions P1, P2, P3 (measured starting from the straight line R) is preferably between 5% and 40% of the value of the diameter, more preferably between 5 and 15%. In possible embodiments, the height H is about 10% of the diameter of the section of the multicomponent filament 2.

[0069] In a possible embodiment shown in figure 2A, the wave shape is substantially sinusoidal. In further possible embodiments, the section of the contact surface 3 can be non-regular, therefore in a possible embodiment the section of the contact surface 3 approximates a sinusoid, without respecting all the geometrical parameters thereof. In the embodiment shown in figure 2A, the volume ratio between the two sub-filaments 2a, 2b is about 1:1. However, preferably, in the filament 2, there is a lower amount of the sub-filament having the material with melting temperature lower than the melting temperature of the material of the other sub-filament,. Thus a preferred volume ratio is about 40% - 60%. However, generally, good crimping levels are obtained when the volume ratio between the two sub-filaments 2a, 2b is between 1:4 and 4:1. In other words, the percentage by volume of each of the two sub filaments can be varied between 20% and 80% of the volume of the multicomponent filament. The embodiment of figure 2A depicts a possible shape of the section of the contact surface 3.

[0070] As mentioned, it is possible that the contact surface 3 has (in section) some irregularities, thus approximating a sinusoidal shape, without respecting all the geometrical parameters thereof. The section of a possible filament according to such an embodiment is depicted for example in figure 2B. Generally, according to a possible aspect, the section of the contact surface 3 between the two sub-filaments 2a, 2b of a filament approximates a sinusoid, whereby a first sub-filament 2a has a protrusion P1 protruding within the second sub-filament 2b.

[0071] According to an aspect depicted in figure 2B, the section of the contact surface 3 has two inflections f1, f2, a first inflection f1 being at one of the two sides of the protrusion P1, and a second inflection f2 being at the other side of the protrusion P1. As discussed above, the section of the contact surface 3 is such to avoid the formation of undercuts.

[0072] The protrusion P1 is preferably arranged in a substantially central position with respect to the filament section 2.

[0073] The first sub-filament 2a (having a protrusion P2 provided with two inflections f1, f2) is typically made of material A having melting temperature T1 (and preferably also viscosity $\mu 1$) lower than the temperature T2 (and preferably also than the viscosity $\mu 2$) of the material B of the other sub-filament.

[0074] The section of the contact surface 3 can further be predominantly (o entirely) arranged on one side of the straight line R, therefore there cannot be one or more of the protrusions P2, P3 of the second filament. In particular, in the embodiment of figure 2B, there is only one protrusion P2 of the second sub-filament 2b, having very small dimensions compared to the ones of the protrusion P1 of the first sub-filament 2b.

[0075] Preferably, the multicomponent filament 2 has linear mass density between 3 and 15 den.

[0076] A plant 10 for producing nonwoven fabric according to an aspect of the present invention, schematically shown in Figure 1, comprises a source 11a of a first material A and a source 11b of a second material B, a spinneret or spinning head 12, drawing means 13, a collecting surface 14 and heating means 15.

[0077] For producing a non-woven fabric according to the present invention, two polymer materials A, B are provided by the sources 11a, 11b to the spinning head 12. Such polymer materials A, B are the materials the two filaments 2a, 2b are made of.

[0078] The two materials A, B are coextruded within the spinneret 12 so as to form a plurality of multicomponent filaments 2. As mentioned, the multicomponent filaments 2 have two sub-filaments 2a, 2b arranged side-by-side and bonded by a contact surface 3. The contact surface 3 is substantially wave-shaped in section. Preferably, such a shape is obtained by locally varying the extrusion pressure at different areas of the section of at least one of the sub-filaments 2a, 2b.

[0079] Referring to figure 2, the method for obtaining a wave shape is now described in detail. In particular, the first sub-filament 2a is extruded under a constant pressure $p\beta$. The extrusion pressure, i.e. the spinning pressure, of the second sub-filament varies, for example in sinusoidal way, between two values $p\alpha$ e $p\gamma$. $p\alpha$ is lower than $p\beta$, whereas $p\gamma$ is higher than $p\beta$. The second sub-filament 2b forms a protrusion P2, P3 within the first sub-filament 2a where the second sub-filament is extruded at pressure $p\gamma$ (i.e. at a pressure higher than the pressure of the first sub-filament 2a). Conversely, the first sub-filament forms a protrusion P1 within the second sub-filament 2b where the second sub-filament 2b is extruded under a pressure pα (i.e. a pressure lower than the pressure of the first sub-filament).

[0080] For the sake of simplicity, an embodiment in which only the pressure of one of the two sub-filaments 2a is varied, has been described. However, in order to obtain a desired shape (e.g. wavy), the extrusion pressure can be varied at different areas of both the sub-filaments 2a, 2b.

[0081] Generally, the second sub-filament forms a protrusion within the first sub-filament and vice versa, where the pressure of the second sub-filament 2b is greater than the pressure of the first sub-filament 2a.

[0082] The shape and size of such a protrusion are a function of the pressure variation. For example, if the pressure varies linearly between two limits, an area of the section of the contact surface that is substantially a segment can be obtained.

[0083] Then, the multicomponent filaments are deposited on a collecting surface 14, for example a movable conveyor belt. The filaments arrange themselves and overlap substantially randomly on the surface 14 to form a layer 20 of filaments, which are typically overlapped to each other.

[0084] In alternative embodiments, the plant 1 may comprise one or more spinning heads arranged in parallel with respect to the shown spinning head 12, so that a further layer of multicomponent filaments is laid upon the layer 20 shown in figures. This or these spinning heads can produce filaments made with other arrangements and/or different materials with respect to the filaments 2. Furthermore, one or more layers of filaments made according to the known technique can be overlapped on the layer 20, so that the resulting nonwoven fabric has only one layer made according to the present invention. Moreover, in further embodiments, the layer 20 made according to the present invention (instead of being placed below) may be overlapped on, or interposed between, the layers of filaments made according to the known art.

[0085] Before deposition, the filaments 2 (or the layer 20 of filaments) are drawn by proper means 13 known in the art. The plant 10 may further comprise means 16, known in the art, for constraining the filaments 2 of the layer 20 to each other at several joining points. For example, in the embodiment shown, there are calenders 16 which can be properly shaped and/or heated in order to facilitate the filaments 2 to constrain to each other. In any case, alternative means 16 for constraining the filaments 2 are known, for example through needle punching. Subsequently, the layer 20 is subjected to thermal treatment, typically in an oven or other similar heating means 15.

[0086] Preferably, the layer 20 is heated to a temperature between 100 and 250°C, preferably for a time period between 5 and 120 seconds.

[0087] Thanks to the thermal treatment, the multicomponent filaments 2 crimp, so that a particularly voluminous nonwoven fabric 1 is obtained. Therefore, the filaments 2 crimp only after being deposited on the collecting surface 14. As above mentioned, the difference between the melting temperatures of the two elements and the particular shape of the contact surface between the two elements specially promote this crimping.

[0088] In particular, thanks to the thermal treatment within the means 5, an increase of the volume of the nonwoven fabric between 2 and 5 times the volume of the nonwoven fabric before the thermal treatment, can be obtained. In fact, typically during such a step a first sub-filament 2a (generally that one having lower melting temperature) shrinks more than the other sub-filament 2b. As the two sub-filaments are adhered one another, the first sub-filament 2a bends the second sub-filament 2b, causing the crimping of the second sub-filament 2b and, accordingly, a volume increase of the nonwoven fabric.

[0089] In an alternative embodiment, the filaments of the layer 20 can be simultaneously crimped and constrained to each other by thermal treatment, for example in an oven. In this case, a mechanical constraint caused by crimping and a thermal bond at contact points caused by high temperature, are formed among the filaments.

[0090] As above mentioned, during the steps of the above described process, the sub-filaments 2a, 2b remain adhered to one another, so that the filaments 2 are kept intact. In other words, the sub-filaments 2a, 2b of the filaments 2 do not separate (i.e. they do not split) and are held together in the nonwoven fabric 1.

[0091] Therefore, the nonwoven fabric according to the present invention has low density, and thus is soft and voluminous. Such a nonwoven fabric further has high liquid-absorption capacity.

[0092] Preferably, the grammage of the nonwoven fabric 1 according to the present invention is between 10 and 500 g/m^2.

Claims

1. Nonwoven fabric (1) comprising a plurality of filaments (2) made of at least two different materials (A, B), said multicomponent filaments (2) having at least two sub-filaments (2a, 2b) co-extruded from said materials (A, B) in side-by-side arrangement and adhered to one another, wherein the material (A) of a first sub-filament (2a) has melting temperature (T1) different from the melting temperature (T2) of the material (B) of a second sub-filament (2b) by at least 10°C and wherein, in cross section, the contact surface (3) between said two sub-filaments (2a, 2b) is substantially wave-shaped.

2. Nonwoven fabric (1) according to claim 1 wherein, in cross section, the contact surface (3) between a first sub-filament (2a) and a second sub-filament (2b) has at least one inflection (f1, f2), and wherein the

first sub-filament (2a) forms at least one protrusion (P1) within the second sub-filament (2b), said protrusion (P1) having decreasing width (L).

3. Nonwoven fabric (1) according to claim 1, wherein in said filament there are two of said materials (A, B) whose volume ratio is between 1:4 and 4:1.

4. Nonwoven fabric (1) according to claim 1 o 2, wherein the value of viscosity (μ1, μ2) of the material (A, B) of one of the two sub-filaments (2a, 2b) is lower, preferably by at least 20%, than the value of viscosity (μ2, μ1) of the material (B, A) of the other sub-filament (2b, 2a).

5. Nonwoven fabric (1) according to any one of the preceding claims, wherein the first sub-filament (2a) is made of a material (A) having viscosity (μ1) and melting temperature (T1) respectively lower than the viscosity (μ2) and the melting temperature (T2) of the material (B) of the second sub-filament (2b).

6. Nonwoven fabric (1) according to any one of the preceding claims, wherein the percentage by volume of the first sub-filament (2a) is lower than the percentage by volume of the second filament (2b) within the filament 2, and wherein the melting temperature (T1) of the material (A) of the first sub-filament (2a) is lower than the melting temperature (T2) of the material (B) of the second sub-filament (2b).

7. Nonwoven fabric (1) according to any one of the preceding claims, wherein the first sub-filament (2a) forms a protrusion (PI) protruding within the second sub-filament (2b), wherein the contact surface (3) between the two sub-filaments (2a, 2b), in section, has a first and second inflection (f1, f2) placed on opposite sides of said protrusion (PI).

8. Nonwoven fabric (1) according to one of the preceding claims, wherein, in section, the contact surface (3) between said two sub-filaments (2a, 2b) has length greater than the greatest dimension of the section of said multicomponent filament (2).

9. Nonwoven fabric (1) according to one of the preceding claims, wherein said first and second materials (A, B) are selected among PE, coPE, PET, coPET, PP, coPP, PA, PLA.

10. Nonwoven fabric (1) according to one of the preceding claims, having grammage between 10 and 1000 g/m^2.

11. Nonwoven fabric (1) according to one of the preceding claims, wherein the linear mass density of said multicomponent filaments is between 1.5 and 30 den.

12. Multicomponent filament (2) having at least two sub-filaments (2a, 2b) co-extruded from at least two materials (A, B) in side-by-side arrangement and adhered to one another, wherein the material (A) of a first sub-filament (2a) has melting temperature (T1) different from the melting temperature (T2) of the material (B) of a second sub-filament (2b) by at least 10°C and wherein, in cross section, the contact surface between said two sub-filaments (2a, 2b) is substantially wave-shaped.

13. Filament according to claim 12, comprising the features of one or more of claims 2 to 9.

14. Process for producing a nonwoven fabric (1) comprising a plurality of multicomponent filaments (2), **characterized in that** each multicomponent filament (2) is coextruded from at least two different materials (A, B) thus providing a filament (2) having at least two sub-filaments (2a, 2b) adhered to one another, wherein the material (A) of a first sub-filament (2a) has melting temperature (T1) different from the melting temperature (T2) of the material (B) of a second sub-filament (2b) by at least 10°C, and **in that** said at least two sub-filaments (2a, 2b) are coextruded according to a side-by-side arrangement, thus providing that, in the cross-section of the filament (2), a contact surface (3) between two sub-filaments (2a, 2b), is substantially wave-shaped.

15. Process according to claim 14, wherein the configuration of said contact surface (3) is provided by varying the extrusion pressure, i.e. the spinning pressure, of at least one of the sub-filaments (2a) between at least two distinct points of a section of said sub-filament (2a) of the multicomponent filament (2).

16. Process according to one of claims 14 or 15, further comprising the step of heating said nonwoven fabric (1).

17. Process according to one of claims 14 a 16 wherein, after the treatments carried out on said nonwoven fabric (1), the sub-filaments (2a, 2b) remain adhered to one another.

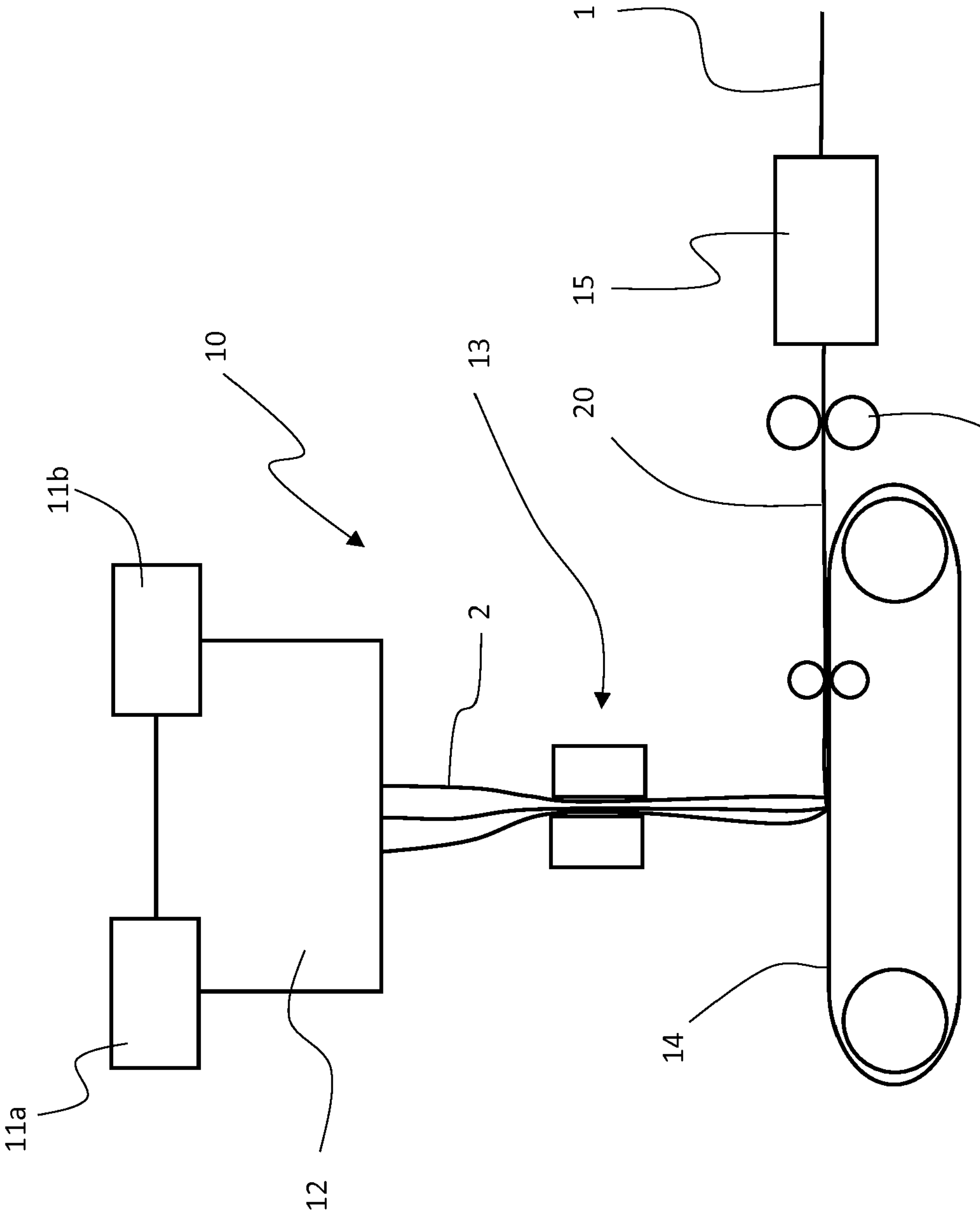

Fig. 1

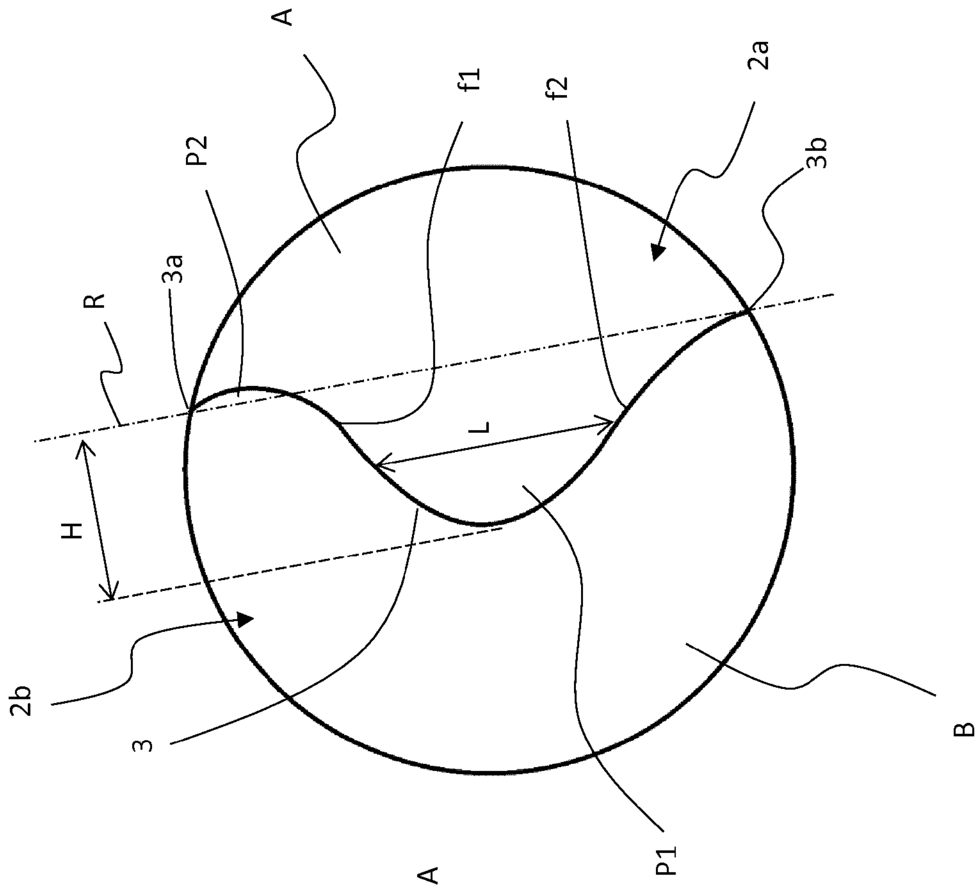
A
f1
f2
2a
P2
3b
3a
R
L
H
2b
3
B
P1

Fig. 2B

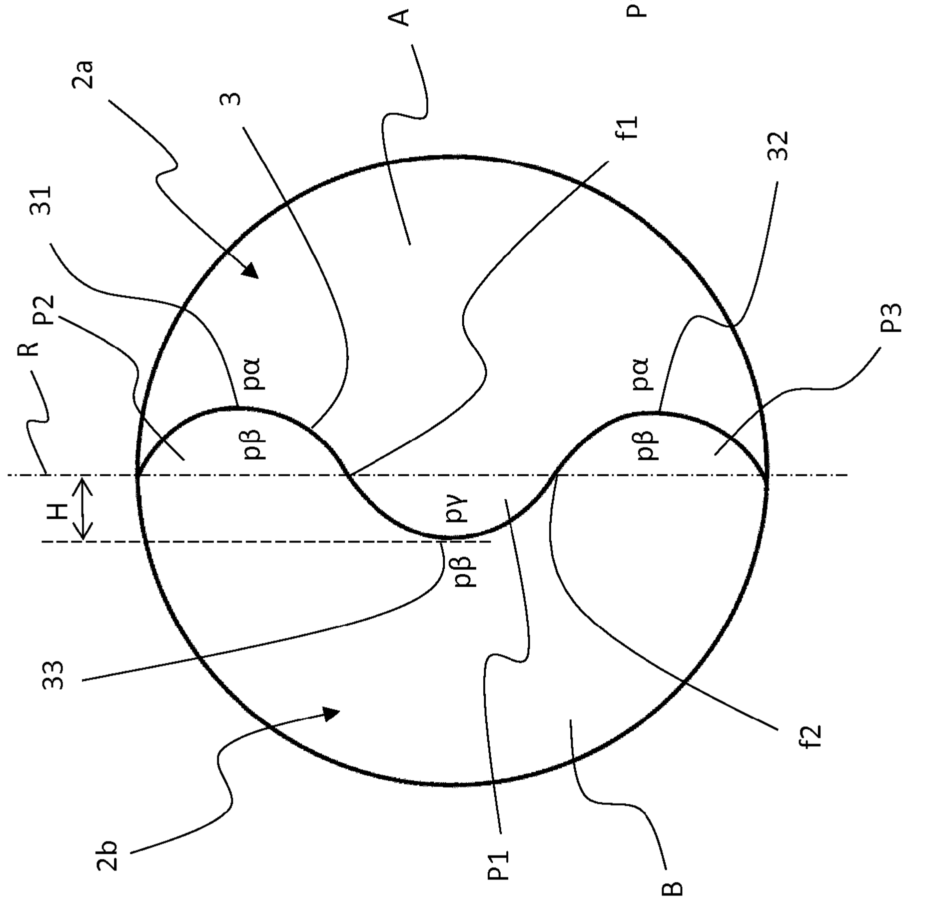
A
2a
3
f1
32
31
P2
R
P3
pα
pβ
pα
pβ
H
pγ
pβ
33
f2
2b
P1
B

Fig. 2A

2

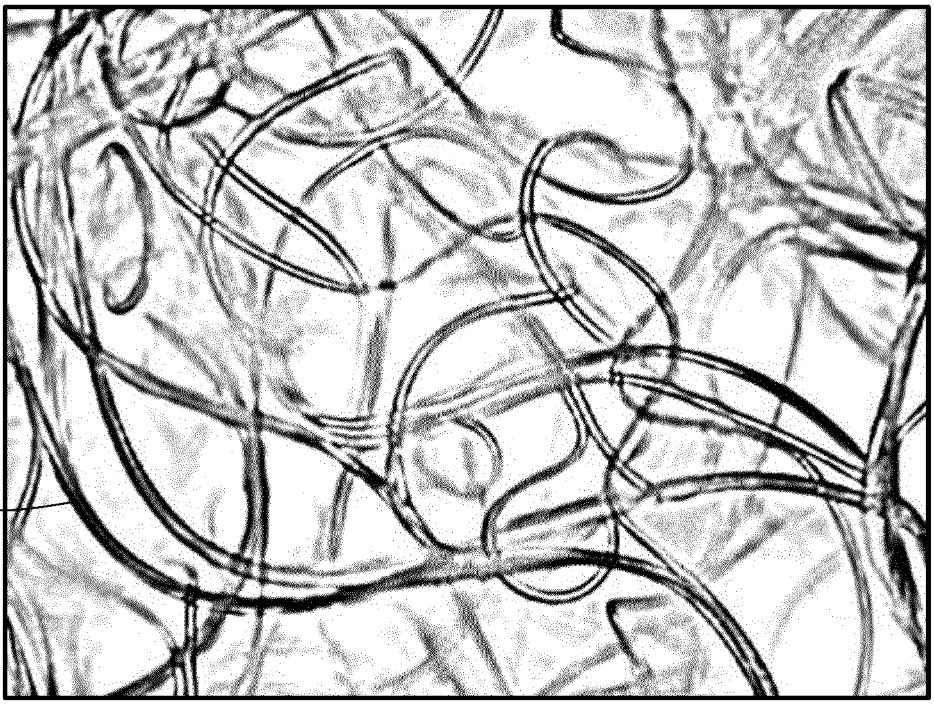

Fig. 3B

2

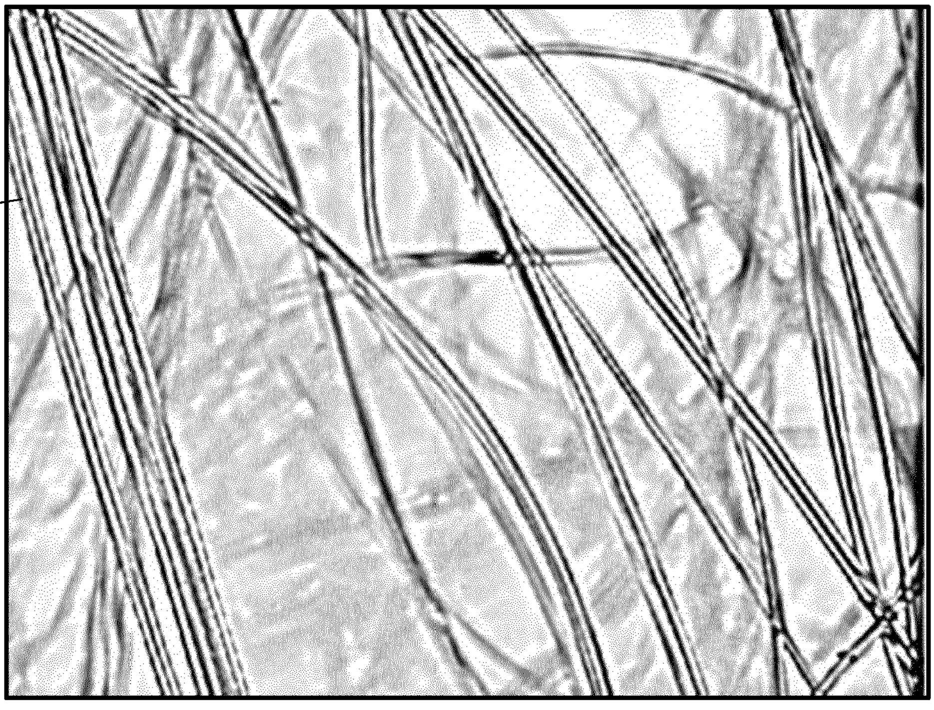

Fig. 3A

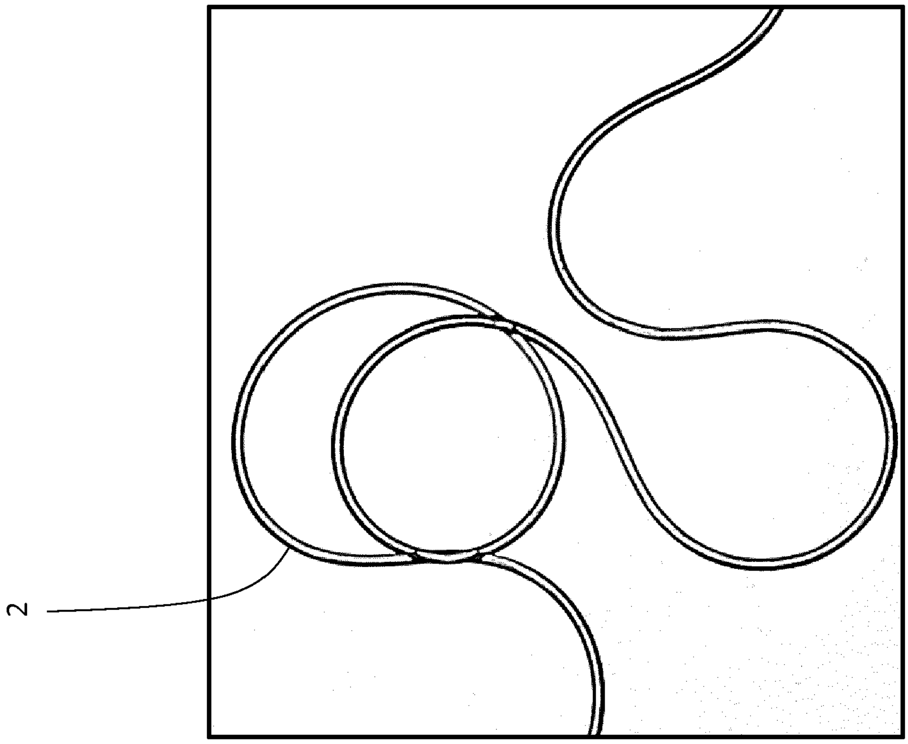

Fig. 4B

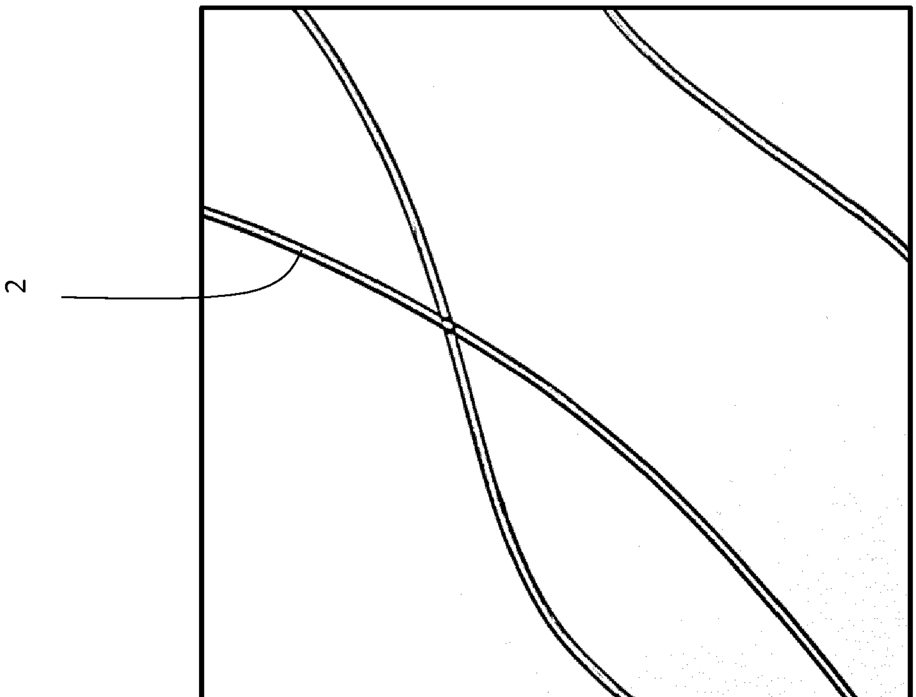

Fig. 4A

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 1684

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1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 February 2018	Billet, Aina

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