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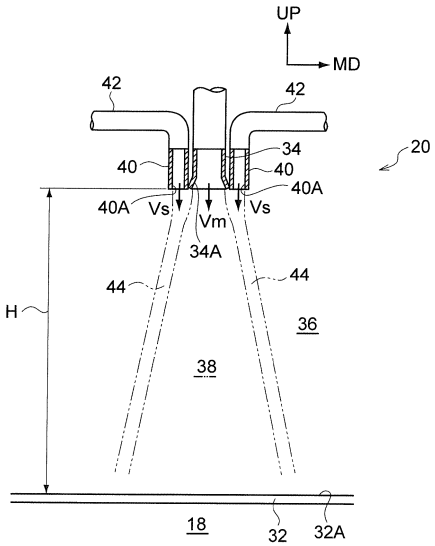
(54) NON-WOVEN FABRIC MANUFACTURING DEVICE, NON-WOVEN FABRIC MANUFACTURING METHOD, AND NON-WOVEN FABRIC

(57) A diffusing unit of an apparatus for manufacturing a non-woven fabric is provided with a diffusion space between a jet nozzle and a moving belt of a collecting unit, an opening of a sub nozzle is arranged side-by-side with an opening of the jet nozzle, and the sub nozzle jets air from the opening. The jet nozzle jets, toward the moving belt, plural filaments together with air. The air jetted from the jet nozzle forms a conveying flow that gradually spreads and flows in the diffusion space, and the plural filaments are diffused by this conveying flow and are sent toward the moving belt to be collected. The air jetted from the sub nozzle flows along the air flow around the conveying flow and suppresses air in the diffusion space from entering the conveying flow.

FIG.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to an apparatus for manufacturing a non-woven fabric, a method of manufacturing a non-woven fabric, and a non-woven fabric.

BACKGROUND ART

[0002] Non-woven fabrics such as spunbonded non-woven fabrics find widespread use in medical materials, sanitary materials, civil engineering materials, packaging materials, and the like. A spunbonded non-woven fabric is manufactured from a web obtained by subjecting filaments obtained by melt spinning a thermoplastic resin to a cooling process using cooling wind and a drawing process using drawing wind and thereafter collecting and depositing the filaments on a collecting medium while diffusing the filaments.

[0003] Patent Document 1 (Japanese Patent No. 2556953) discloses an apparatus including a cooling chamber whose cross section in the horizontal direction is rectangular, and is gradually reduced in the filament traveling direction, a drawing nozzle connected to the cooling chamber and having a stepped concave portion formed on a wall body at a discharge port, and a filament placement device connected to the drawing nozzle, the apparatus manufacturing a spun filament strip from an aerodynamically drawn synthetic resin filament. The filament placement device of Patent Document 1 has a rectangular cross section in the horizontal direction and has a form of a jet pump including a Venturi-like drainage area in the longitudinal direction and a diffuser outlet, and is configured in such a manner that the amount of air sucked from a free air intake port is adjusted by an intake pipe opposed to the diffuser outlet across a filament strip placement filter belt.

[0004] Patent Document 2 (Japanese Patent No. 3135498) discloses an apparatus for manufacturing a spun fleece web from a thermoplastic resin endless filament, comprising a nozzle plate body having a large number of nozzles, a process shaft, a conveying unit, and a conveying conveyor, wherein processing air flows into the process shaft and the conveying unit, endless filament is introduced from a nozzle hole of the nozzle plate body and flows into the process shaft by a discharge motion toward the conveying conveyor as an endless filament group in the form of a mixture of air and filament, the conveying unit includes a central introduction conduit for the endless filament group and a following diffuser conduit extending to the conveying conveyor, the discharge motion and its overlapping fleece forming motion are forcibly imparted, and the two conduits extend in a direction transverse to the direction of travel of the conveying conveyor belt. In Patent Document 2, the introduction conduit and/or the diffuser conduit are used for mixing air and a filament, and the apparatus is configured to includes an aerodynamic equidistribution device including a flow-through slit shape for additional introduction of air into the conduit extending across the direction of travel of the conveying conveyor belt across the width of the conduit and an outflow slit shape for discharging air from the conduit, whereby a flow rate to be additionally supplied and a flow rate of air to be discharged are controlled or adjusted for the purpose of additionally influencing equidistribution of the filament during mixing of air and the filament. In Patent Document 2, the apparatus is configured in such a manner that the inner surface of the introduction conduit and/or the diffuser conduit are provided with an obstruction member in the vicinity of the surface in the longitudinal section of the conduit, whereby a spiral region is formed rearwardly with respect to the flow direction.

[0005] Patent Document 3 (Japanese Patent No. 5094588) describes, as an apparatus for manufacturing a spunbonded web formed from a filament, an apparatus including: a spinneret for forming a filament; a cooling chamber for supplying processing air for cooling the filament provided downstream of the spinneret; and a drawing unit for extending the filament connected to the cooling chamber, wherein a connection area between the cooling chamber and the drawing unit is closed, the drawing unit has a drawing passage in which a passage wall is branched over at least a part of the length of the drawing passage, and in the drawing unit, at the upstream end of the branched drawing passage portion, additional air is injected into the drawing passage under a condition that a filament bundle is widely formed in the machine direction, and a deposition device for depositing a filament of a spunbonded web is provided. Patent Document 3 describes that there is a deposition unit downstream of the drawing unit, the deposition unit includes an upstream diffuser and an adjacent downstream diffuser, and an ambient air inlet slit is provided between the upstream diffuser and the downstream diffuser.

SUMMARY OF INVENTION

Technical Problem

[0006] Meanwhile, examples of important characteristics related to the quality of non-woven fabrics include uniformity and strength. For example, Patent Document 2 aims to obtain a non-woven fabric having a uniform mesh size. However, in non-woven fabrics having high uniformity, the entanglement of the filaments may be insufficient so that the strength is lowered.

[0007] The invention has been made in view of the above facts, and an object thereof is to provide an apparatus for manufacturing a non-woven fabric, a method of manufacturing a non-woven fabric, and a non-woven fabric in which the uniformity of the non-woven fabric is improved while decrease in the strength of the non-woven fabric is suppressed.

Solution to Problem

[0008] Specific means for achieving the above object include the following embodiments.

[0009] A first embodiment is an apparatus for manufacturing a non-woven fabric, the apparatus comprising:

a collecting unit that collects, on a collecting medium, filaments that are jetted toward the collecting medium;
a diffusing unit comprising a main nozzle that jets, toward the collecting medium, air that is supplied together with the filaments that are to be collected on the collecting medium, and a diffusion space that is provided between the main nozzle and the collecting medium and in which the filaments are diffused by an air flow in which the air jetted, together with the filaments, from the main nozzle is flowing while being diffused; and
an air flow generation means that generates, around the air flow of the air jetted from the main nozzle into the diffusion space, an air flow that is close to and follows the air flow.

[0010] A second embodiment is a method of manufacturing a non-woven fabric, the method comprising:

providing, between a main nozzle, from which air is jetted together with filaments, and a collecting medium, that collects the filaments jetted from the main nozzle, a diffusion space in which the filaments are diffused by an air flow in which the air jetted, together with the filaments, from the main nozzle is flowing while being diffused;
jetting, toward the collecting medium, the filaments together with the air from the main nozzle, while generating, by an air flow generation means, and around the air flow of the air jetted from the main nozzle into the diffusion space, an air flow that is close to and follows the air flow; and
collecting and depositing, on the collecting medium, the filaments that have been diffused in the diffusion space.

[0011] In a first embodiment and a second embodiment, a spinning unit (spinning step) that spins filaments from a molten resin or the like to output a plurality of filaments; a cooling unit (cooling step) that cools the plurality of filaments introduced from the spinning unit with a cooling wind; a drawing unit (drawing step) that draws the plurality of cooled filaments by a drawing wind; and a collecting unit (collecting step) that collects and deposits the plurality of drawn filaments to produce a web are included, and a non-woven fabric is manufactured from the collected web. The manufacturing apparatus includes a diffusing unit (diffusing step) in which a plurality of filaments introduced from the drawing unit is jetted toward the collecting unit while the filaments are diffused.

[0012] The diffusing unit includes: a main nozzle; and a diffusion space provided between the main nozzle and a collecting medium of the collecting unit. It is preferable that the diffusion space in the first and second embodiments is a space in which an air flow by air jetted from the main nozzle can be naturally diffused without being disturbed. The diffusion space may be surrounded by partition walls, and when the space is surrounded by partition walls, the partition walls may be provided apart from an air flow so as not to affect an air flow caused by air jetted from the main nozzle. A plurality of filaments are arranged along the machine width direction, and the main nozzle has a long slit shape along the machine width direction.

[0013] As a result, the air jetted from the main nozzle becomes an air flow (jet flow) flowing to the collecting medium while gradually spreading along the machine direction in the diffusion space. The plurality of filaments jetted, together with the air, from the main nozzle are diffused in the machine direction by the air flow formed in the diffusion space and collected on the collecting medium.

[0014] Here, in the diffusing unit, air flow generation means is provided, and around an air flow of air jetted from the main nozzle, an air flow that is close to and follows the air flow is generated by the air flow generation means, whereby air in the diffusion space is suppressed from entering the air flow of the air jetted, together with the plurality of filaments, from the main nozzle due to the air flow that is close to and follows the air flow of the main nozzle. A flow velocity fluctuation is generated inside the air flow of the air jetted from the main nozzle, and when air in the diffusion space enters the air flow, a region in which the flow velocity fluctuation is larger than the surroundings is generated. In contrast, by generating, around the air flow of air jetted from the main nozzle, an air flow that is close to and follows the air flow, air in the diffusion space is suppressed from entering into the air flow of the air jetted from the main nozzle, whereby a region in which the flow velocity fluctuation is larger than the surroundings is narrowed or the magnitude of the flow velocity fluctuation in a region in which the flow velocity fluctuation is larger than the surroundings is reduced.

[0015] When a region in which flow velocity fluctuation is larger than the surroundings is generated, the larger the flow velocity fluctuation in the region is, the more entanglement between filaments is generated, and a bundle of filaments is generated, which impairs the uniformity, but when the magnitude of the flow velocity fluctuation is reduced, generation of a bundle of filaments is suppressed and the uniformity is improved.

[0016] In a third embodiment, it is preferable that the air flow generation means includes a sub nozzle for jetting air into the diffusion space. In a fourth embodiment, the air flow generation means includes a sub nozzle that has an opening portion arranged side-by-side with the opening portion of the main nozzle, and that jets air into the

diffusion space.

[0017] In the third and fourth embodiments, a sub nozzle that has an opening portion arranged side-by-side with the opening portion of the main nozzle is provided, and air jetted from the sub nozzle generates, around the air flow of the air jetted from the main nozzle, an air flow that is close to and follows the air flow.

[0018] As a result, air in the diffusion space is suppressed from entering the air flow of the air jetted from the main nozzle, whereby the uniformity of a non-woven fabric can be easily improved.

[0019] In a fifth embodiment, the sub nozzle in the third and fourth embodiments is provided at the machine direction side of the main nozzle and at the opposite side of the main nozzle from the machine direction side.

[0020] In the fifth embodiment, the sub nozzle is provided both at the machine direction side of the main nozzle and at the opposite side of the main nozzle from the machine direction side. As a result, air in the diffusion space is suppressed from entering, from the machine direction side and from the side opposite from the machine direction side, into an air flow of the air jetted from the main nozzle, whereby increase in the flow velocity fluctuation of the air jetted from the main nozzle is effectively suppressed.

[0021] In a sixth embodiment, the flow velocity of the air jetted from the sub nozzle may be equal to or lower than the flow velocity of the air jetted from the main nozzle, in any of the third embodiment to the fifth embodiment. In a seventh embodiment, it is more preferable that the flow velocity of the air jetted from the sub nozzle is no lower than 1/10 of the flow velocity of the air jetted from the main nozzle, in the sixth embodiment.

[0022] Each of the first to seventh embodiments is suitable for obtaining a non-woven fabric in which the ratio of the strength at 5% elongation in the machine direction to the strength at 5% elongation in a direction perpendicular to the machine direction is 2.0 or less as a non-woven fabric in which uniformity is improved while suppressing strength degradation.

[0023] Each of the first to seventh embodiments is suitable for manufacturing a non-woven fabric having a maximum strength of 35.0 (N/25 mm) or more at a time of elongation in the machine direction. In each of the first to seventh embodiments, the maximum strength at a time of elongation in the machine direction of a non-woven fabric to be manufactured is more preferably 37.5 (N/25 mm) or more, further more preferably 40.0 (N/25 mm), and most preferably 42.5 (N/25 mm).

[0024] Further, each of the first to seventh embodiments is suitable for manufacturing a non-woven fabric having a basis weight variation (%) of preferably 3.0% or less, and more preferably 2.5% or less.

Advantageous Effects of Invention

[0025] According to embodiments of the specification, there is an effect that a non-woven fabric with improved uniformity is obtained while suppressing strength deterioration.

BRIEF DESCRIPTION OF DRAWINGS

[0026]

Fig. 1 is a schematic configuration diagram of a manufacturing apparatus according to the embodiment.
Fig. 2 is a schematic configuration diagram showing a diffusing unit.
Fig. 3A is a distribution diagram showing an example of simulation results of flow velocity fluctuation in the embodiment.
Fig. 3B is a distribution diagram showing an example of simulation results of flow velocity fluctuation in Comparative Example.
Fig. 4 is a table showing a comparison of manufacturing conditions and physical properties according to Example.

DESCRIPTION OF EMBODIMENTS

[0027] Hereinafter, an embodiment of the invention will be described in detail with reference to the drawings. Fig. 1 shows a main part of apparatus 10 for manufacturing a non-woven fabric according to the embodiment. The manufacturing apparatus 10 according to the embodiment is used for manufacturing a spunbonded non-woven fabric. In the following description, MD (machine direction) direction indicates the machine direction (machine flow direction), and UP direction indicates upward direction in the vertical direction. In the following description, a direction (a direction perpendicular to the machine direction) orthogonal to each of the MD direction and the UP direction is expressed as CD (cross machine direction) direction (machine width direction: not shown).

[0028] The manufacturing apparatus 10 includes: a spinning unit 12 for spinning a molten resin obtained by melting a thermoplastic resin used for a spunbonded non-woven fabric to produce filaments; a cooling unit 14 that performs a cooling process on the spun filaments; and a drawing unit 16 that performs a drawing process on the filaments. The manufacturing apparatus 10 includes: a collecting unit 18 for collecting the cooled and drawn filaments to obtain a web to be a non-woven fabric; and a diffusing unit 20 that jets a plurality of filaments so as to diffuse toward the collecting unit 18.

[0029] The spinning unit 12 includes a spinneret 22 including a plurality of spinning nozzles arranged therein, and a molten resin introduction pipe 24 is connected to the spinneret 22. In the spinning unit 12, a molten resin introduced into the spinneret 22 through the molten resin introduction pipe 24 is spun by spinning nozzles to produce filaments. In the spinning unit 12, the spinneret 22 includes a plurality of spinning nozzles, thereby outputting a plurality of filaments arranged in the CD direction. The cooling unit 14 includes a cooling chamber 26 into

which a plurality of spun filaments are introduced, and a cooling wind supply duct 28 is connected to the cooling chamber 26. The cooling unit 14 uses air supplied from the cooling wind supply duct 28 as cooling wind and cools the plurality of filaments introduced into the cooling chamber 26 by cooling wind.

[0030] The drawing unit 16 is provided with a drawing shaft 30 whose opening section is elongated in the CD direction (in Fig. 1, a direction perpendicular to the page) and short in the MD direction, and which extends in the vertical direction. In the drawing unit 16, the drawing shaft 30 is connected to the cooling chamber 26, and a plurality of filaments are introduced from the cooling chamber 26 to the drawing shaft 30. The drawing unit 16 uses cooling wind introduced together with the plurality of filaments or air supplied into the drawing shaft 30 separately from the cooling wind as drawing wind, and outputs the filaments introduced from the cooling unit 14 while drawing the filaments by drawing wind.

[0031] The collecting unit 18 includes a moving belt 32 as a collecting medium formed of mesh, punching metal, or the like, and suction means (not shown) provided below the moving belt 32. The diffusing unit 20 jets a drawing wind introduced from the drawing shaft 30 or air introduced separately from the drawing wind toward the moving belt 32 of the collecting unit 18. The collecting unit 18 collects the jetted plurality of filaments on the collection surface 32A of the moving belt 32 while sucking the filaments by suction means to generate a web to be a non-woven fabric. The spinning unit 12, the cooling unit 14, the drawing unit 16, and the collecting unit 18 of the manufacturing apparatus 10 may apply known configurations for generating a plurality of filaments by spinning a molten resin, cooling and drawing the plurality of filaments generated, and collecting a plurality of filaments.

[0032] Fig. 2 shows a schematic configuration of the diffusing unit 20 according to the embodiment. The diffusing unit 20 includes a jet nozzle 34 as a main nozzle. In the jet nozzle 34, an opening 34A at the tip as an opening portion serving as a jetting port is formed in a slit shape long in the CD direction and is directed onto the moving belt 32 of the collecting unit 18. The jet nozzle 34 is connected to the drawing shaft 30 of the drawing unit 16, and a plurality of cooled and drawn filaments are introduced. In the diffusing unit 20, air of a drawing wind or air separate from drawing wind is introduced into the jet nozzle 34.

[0033] The diffusing unit 20 jets air and a plurality of filaments introduced into the jet nozzle 34 from the opening 34A onto the moving belt 32 of the collecting unit 18. The diffusing unit 20 sends a plurality of filaments jetted from the jet nozzle 34 toward the collecting unit 18 by the air flow of air jetted from the jet nozzle 34. Hereinafter, an air flow generated by the air jetted together with the plurality of filaments from the jet nozzle 34 is referred to as a conveying flow.

[0034] In the diffusing unit 20, a diffusion space 36 is provided between the jet nozzle 34 and the collection surface 32A of the moving belt 32 of the collecting unit 18, and the conveying flow flows in the diffusion space 36 towards the moving belt 32. The diffusion space 36 is a space that is not provided with a wall surface or the like for regulating the flow of the conveying flow by air jetted from the jet nozzle 34. That is, the diffusion space 36 is a space in which the conveying flow jetted from the jet nozzle 34 is not influenced by a structure such as a wall surface other than the collecting unit 18. This diffusion space may be partitioned by a partition wall as long as the partition wall is provided in such a manner not to interfere with the flow of the air flow.

[0035] As a result, in the diffusing unit 20, in the diffusion space 36, the conveying flow of the air jetted from the jet nozzle 34 flows while gradually (naturally) spreading in the MD direction and in the direction opposite to the MD direction. As the conveying flow approaches the moving belt 32, the flow velocity of the conveying flow gradually decreases. As the conveying flow spreads in the diffusion space 36, the plurality of filaments jetted from the jet nozzle 34 are diffused in the MD direction and in the direction opposite to the MD direction. As a result, in the manufacturing apparatus 10, the filaments are diffused and collected in a predetermined collection region on the collection surface 32A of the moving belt 32.

[0036] In the manufacturing apparatus 10, the opening width and the opening length of the jet nozzle 34, the moving speed of the moving belt 32, the distance between the jet nozzle 34 and the collection surface 32A of the moving belt 32, and the like are determined according to a non-woven fabric to be produced, the production speed of a non-woven fabric, the width in the CD direction of a web produced by collecting the filaments in the collecting unit 18, and the like. In the diffusing unit 20, the distance (height H) between the tip of the jet nozzle 34 and the surface of the moving belt 32 of the collecting unit 18 is determined to be from 0.1 m to less than 1 m, and the distance H is the height of the diffusion space 36.

[0037] In the manufacturing apparatus 10, the flow velocity of air jetted from the jet nozzle 34 or the air volume per unit time of jetted air is defined, and in the following, the flow velocity of air at the opening of the jet nozzle 34 is referred to as a flow velocity Vm of the conveying flow. In the diffusing unit 20, the spread of the conveying flow in the diffusion space 36 changes according to the flow velocity Vm, and when the flow velocity Vm is high, the spread of the conveying flow becomes smaller than when the flow velocity Vm is low.

[0038] In the diffusing unit 20, since the diffusion space 36 is provided, the conveying flow jetted from the jet nozzle 34 reaches the moving belt 32 while gradually spreading along mainly the MD direction. In the following description, the region of the conveying flow in the diffusion space 36 is referred to as a conveying flow region 38. Fig. 2 virtually shows the conveying flow region 38.

[0039] As shown in Fig. 1 and Fig. 2, the diffusing unit 20 is provided with a sub nozzle 40 as air flow generation

means. The sub nozzle 40 is provided with a slit shape opening 40A long in the CD direction as an opening portion. In the diffusing unit 20, the sub nozzle 40 is arranged at the MD direction side of the jet nozzle 34 and at the opposite side of the jet nozzle 34 from the MD direction side, and the opening 40A of the sub nozzle 40 is aligned with the opening 34A of the jet nozzle 34.

[0040] An air supply pipe 42 is connected to the sub nozzle 40, and air supplied through the air supply pipe 42 is jetted from the opening 40A. In the diffusing unit 20, air supplied to the sub nozzle 40 through the air supply pipe 42 is controlled in such a manner that an air flow of air jetted from the sub nozzle 40 has a flow velocity Vs determined in accordance with the flow velocity Vm of the conveying flow jetted from the jet nozzle 34. In the diffusing unit 20, the sub nozzle 40 is provided in such a manner that the jetting direction of air is substantially parallel to the jetting direction of air from the jet nozzle 34. Here, the flow velocity Vs is preferably equal to or less than the flow velocity Vm ($Vs \leq Vm$), and more preferably no lower than 1/10 of the flow velocity Vm ($Vs \geq Vm/10$). For this reason, the diffusing unit 20 is controlled to supply air to the sub nozzle 40 in such a manner that the flow velocity Vs is 1/2 of the flow velocity Vm ($Vs = Vm/2$).

[0041] In the embodiment, the opening 34A of the jet nozzle 34 and the opening 40A of the sub nozzle 40 are arranged side-by-side, but the invention is not limited thereto, and the opening 34A of the jet nozzle 34 and the opening 40A of the sub nozzle 40 may be arranged with a step in such a manner that one of them is farther from the collection surface 32A of the moving belt 32 than the other.

[0042] As a result, as shown in Fig. 2, in the diffusing unit 20, an air flow that is close to and follows the conveying flow is generated around the conveying flow (conveying flow region 38) in the diffusion space 36 by air jetted from the sub nozzle 40. Fig. 2 virtually shows the air flow generated by air jetted from the sub nozzle 40 as an air flow layer 44.

[0043] In the thus configured manufacturing apparatus 10, the plurality of filaments spun from the molten resin and subjected to cooling treatment and drawing treatment are introduced into the jet nozzle 34 of the diffusing unit 20. Air (air of a drawing wind or air supplied separately from the drawing wind) for generating a conveying flow is introduced into the jet nozzle 34.

[0044] In the diffusing unit 20, a diffusion space 36 is provided between the jet nozzle 34 and the moving belt 32 of the collecting unit 18, and the air and the plurality of filaments introduced into the jet nozzle 34 are jetted from the opening 34A of the jet nozzle 34 toward the diffusion space 36. As a result, the plurality of filaments are blown onto the moving belt 32 of the collecting unit 18 while being diffused by the conveying flow by air jetted from the jet nozzle 34, and are collected on the collection surface 32A.

[0045] Incidentally, the sub nozzle 40 is provided together with the jet nozzle 34 in the diffusing unit 20, and the sub nozzle 40 jets air supplied through the air supply pipe 42 to the diffusion space 36. As a result, in the diffusion space 36, an air flow that is close to and follows the conveying flow is generated around the conveying flow, and air in the diffusion space 36 is suppressed from entering into the conveying flow (into the conveying flow region 38).

[0046] The flow velocity of a plurality of filaments which are conveyed in the diffusion space 36 by the conveying flow fluctuates inside the conveying flow, and in a region in which the flow velocity fluctuation is larger than the surroundings, the larger the flow velocity fluctuation is, the more entanglement of the filaments is generated. As a result, a non-woven fabric obtained from a web produced by collecting the filaments has high tensile strength. However, when the entanglement of the filaments increases in the collected web, the uniformity of the non-woven fabric is deteriorated.

[0047] On the other hand, in the diffusing unit 20 provided with the sub nozzle 40, an air flow that is close to and follows the conveying flow is formed around the conveying flow by air jetted from the sub nozzle 40, and the magnitude of the flow velocity fluctuation is suppressed in a region, generated inside the conveying flow, in which the flow velocity fluctuation is large. As a result, in a web collected in the collecting unit 18, increase in entanglement of the filaments is suppressed, and a non-woven fabric in which uniformity is improved can be obtained.

[0048] Here, Figs. 3A and 3B show simulation results of the flow velocity fluctuation (velocity fluctuation) of the air flow in the diffusion space 36 by the distribution of the flow velocity fluctuation. Fig. 3A corresponds to the diffusing unit 20 of the embodiment (Example 1 below) provided with the jet nozzle 34 and the sub nozzle 40, and Fig. 3B shows as Comparative Example (Comparative Example 1 below) a diffusing unit 20A in which the sub nozzle 40 is not provided and only the jet nozzle 34 is provided.

[0049] In the simulation of the flow velocity fluctuation, in the diffusing units 20 and 20A, the flow velocity of air jetted from the jetting nozzle 34 is set to the same flow velocity Vm, and in the diffusing unit 20, the flow velocity Vs of air jetted from the sub nozzle 40 is set to 1/2 of the flow velocity Vm ($Vs = Vm/2$), and air is jetted in parallel with the jetting direction of air from the jet nozzle 34. Regarding the flow velocity fluctuation, a velocity difference of the flow velocity at each sampling time is obtained from the flow velocity at each preset sampling time, and the value of the root mean square (RMS) of the obtained speed difference is used.

[0050] In the diffusing unit 20A of Comparative Example shown in Fig. 3B, a region in which the flow velocity fluctuation is extremely large compared to the surroundings is generated in the air flow jetted from the jet nozzle 34. When such a region in which the flow velocity fluctuation is extremely large is generated, the tensile strength of a non-woven fabric is improved but the uniformity of the mesh formed by filaments is deteriorated.

[0051] In contrast, in the diffusing unit 20 of Example 1 shown in Fig. 3A, the magnitude of the flow velocity fluctuation is suppressed in a region in which the flow velocity fluctuation is large in the air flow jetted from the jet nozzle 34, as compared with the diffusing unit 20A. As a result, in the diffusing unit 20, entanglement of the filaments in a web collected in the collecting unit 18 is more suppressed than in the diffusing unit 20A.

[0052] Therefore, in the manufacturing apparatus 10 provided with the sub nozzle 40 of the diffusing unit 20, a non-woven fabric with improved uniformity is obtained as compared with a case in which the sub nozzle 40 is not provided. In the diffusing unit 20 of the Example, a region having a larger flow velocity fluctuation than the surroundings remains in the conveying flow, whereby a reduction in the tensile strength of a non-woven fabric is suppressed.

[0053] In the embodiment described above, the flow velocity Vs of the sub nozzle 40 is set to 1/2 of the flow velocity Vm of the jet nozzle 34, but the flow velocity Vs is not limited thereto. The flow velocity Vs of the sub nozzle 40 may be equal to or less than the flow velocity Vm of the jet nozzle 34, whereby the flow velocity fluctuation is suppressed in the conveying flow without restricting the spread of the conveying flow in the diffusion space 36.

[0054] The flow velocity Vs of the sub nozzle 40 may be larger than the flow velocity Vm of the jet nozzle 34 (Vs > Vm). In this case, when the jetting direction of air from the sub nozzle 40 is made substantially parallel to the jetting direction of air from the jetting nozzle 34, air jetted from the sub nozzle 40 may regulate the spread of the conveying flow in the diffusion space 36. For this reason, when the flow velocity Vs of the sub nozzle 40 is made larger than the flow velocity Vm of the jet nozzle 34 (Vs > Vm), in the sub nozzle 40, the direction of the opening 40A or the jetting direction of air may be a direction along the conveying flow around the conveying flow of air jetted from the jet nozzle 34, that is, a direction of flowing in contact with the flow of the conveying flow.

[0055] In the embodiment, the sub nozzle 40 is provided at the MD direction side and at the side opposite from the MD direction side with respect to the jet nozzle 34, but the sub nozzle 40 may be provided at the MD direction side or at the side opposite from the MD direction side with respect to the jet nozzle 34. In other words, the sub nozzle 40 may be provided at at least one of the MD direction side or the side opposite from the MD direction side with respect to the jet nozzle 34.

[0056] Furthermore, in the embodiment, the sub nozzle 40 is provided as the air flow generation means, but the air flow generation means is not limited to the sub nozzle 40, and may be any means as long as the means generates around the conveying flow a flow of an air flow that is close to and follows the conveying flow.

EXAMPLES

[0057] Hereinafter, the invention will be described more specifically with reference to the Example. The invention is not limited to the Example.

[0058] Physical properties in the embodiment (hereinafter referred to as Example 1) and Comparative Example to the embodiment (hereinafter referred to as Comparative Example 1) were measured by the following methods.

(1. Basis Weight [g/m^2])

[0059] Five test pieces of 100 mm (MD) x 100 mm (CD) were taken from a non-woven fabric. The sampling locations (sampling positions) of the test pieces were set to 5 arbitrary locations.

[0060] Next, the mass of each test piece was measured for each sampled test piece using an electronic even balance (manufactured by Kansei Co., LTD.), and the average value of the mass of the test pieces was obtained. The value obtained by converting the obtained average value into the mass [g] per 1 m^2 was rounded off to the first decimal place to obtain the basis weight [g/m^2] of each test piece sample.

(2. Basis Weight Variation [%])

[0061] 100 test pieces of 50 mm (MD) $\times$ 50 mm (CD) were taken from a non-woven fabric. Sampling was carried out at 10 locations in the width direction (CD) of the non-woven fabric and ten times in the flow direction (MD).

[0062] Subsequently, for each test piece taken, the mass [g] of each test piece was measured using an electronic even balance (manufactured by Kansei Co., LTD.), and the average value and the standard deviation of the mass of the test pieces were obtained. The value obtained by dividing the standard deviation by the average value was taken as the basis weight variation [%] of each non-woven fabric sample.

(3. Filament Diameter [μm])

[0063] Five test pieces of 10 mm (MD) $\times$ 10 mm (CD) were taken from a non-woven fabric. Sampling was carried out at one arbitrary location.

[0064] Subsequently, the test piece was photographed with an optical microscope at a magnification of 200 times, and the photographed image was analyzed with image size measurement software (manufactured by INNOTECH CORPORATION: Pixs 2000 Version 2.0). Ten filament diameters were measured for each test piece, the average value of the filament diameters of each test piece was obtained, rounded off to the first decimal place, and the rounded value was taken as the filament diameter (μm) of each non-woven fabric sample.

(4. Yarn Bundle of Non-woven Fabric [Points])

[0065] One test piece of 250 mm (MD) $\times$ 200 mm (CD) was taken from a non-woven fabric. Sampling was car-

ried out at one arbitrary location.

[0066] Next, the non-woven fabric was visually checked, and the number of spots (yarn bundles) where two or more filaments were entangled in a bundle was counted, and evaluated according to the following criteria.

A: The number of yarn bundles is 0
B: The number of yarn bundles is from one to less than 20
C: The number of yarn bundles is 20 or more

(5. MD 5% Strength and MD Strength [N/25 mm])

[0067] Five MD test pieces of 25 mm (CD) x 200 mm (MD) were taken from a non-woven fabric. Sampling was carried out at arbitrary 5 locations.

[0068] Subsequently, each sampled test piece was pulled and elongated under the conditions of chuck distance: 100 mm and tensile speed: 100 mm/min using a universal tensile tester (manufactured by INTESCO Co. Ltd., IM-201 type), and the load [N] at the time when the distance between the chucks was 105 mm, and the maximum load [N] were measured. Average values of each of the test pieces were determined, they were rounded off to the first decimal place, and the rounded values were defined as the MD 5% strength [N/25 mm] and the MD strength [N/25 mm] of each non-woven fabric sample. The MD 5% strength corresponds to the strength at 5% elongation in the machine direction, and the MD strength corresponds to the maximum strength at a time of elongation in the machine direction.

(6. CD 5% Strength and CD Strength [N/25 mm])

[0069] Five CD test pieces of 25 mm (MD) x 200 mm (CD) were taken from a non-woven fabric. Sampling was carried out at arbitrary 5 locations.

[0070] Subsequently, each sampled test piece was pulled and elongated under the conditions of chuck distance: 100 mm and tensile speed: 100 mm/min using a universal tensile tester (manufactured by Intesco, IM-201 type), and the load [N] at the time when the distance between the chucks was 105 mm, and the maximum load [N] were measured. Average values of each of the test pieces were determined, they were rounded off to the first decimal place, and the rounded values were defined as the CD 5% strength [N/25 mm] and the CD strength [N/25 mm] of each non-woven fabric sample. The CD 5% strength corresponds to the strength at 5% elongation in a direction perpendicular to the machine direction, and the CD strength corresponds to the maximum strength at a time of elongation in a direction perpendicular to the machine direction.

(Example 1)

[0071] As a first propylene polymer, a propylene homopolymer having a melting point of 162°C and an MFR (measured at 230°C under a load of 2.16 kg, according to ASTM D 1238, the same applies hereinafter) of 60 g/10 min was used. As a second propylene-based polymer, a propylene/ethylene random copolymer having a melting point of 142°C, an MFR of 60 g/10 min, and an ethylene unit component content of 4.0% by mole was used. Using the first propylene polymer and the second propylene-based polymer, composite melt spinning was performed by a spunbonding method to obtain eccentric sheath-core type composite long filaments having a core portion of propylene homopolymer and a sheath portion of propylene/ethylene random copolymer (core portion/sheath portion = 20/80 (weight ratio)) as filaments.

[0072] The obtained filaments were dispersed from the main nozzle (jet nozzle 34) shown in Fig. 1 and was deposited on the collecting medium (moving belt 32). At this time, the velocity of air jetted from the jet nozzle 34 (main nozzle) was 107.3 m/sec, and air jetted from the sub nozzle 40 (jet width 12 mm) provided at a position 38 mm horizontally away from the jetting port (opening 34A) of the jet nozzle 34 was set to 1/4 (26.8 m/sec) with respect to the velocity of air jetted from the jet nozzle 34.

[0073] Thereafter, the filaments were peeled from the collecting medium and thermally adhered by heating embossing with an area ratio of the emboss pattern of 6.7%, an emboss area of 0.19 m^2, a heating temperature of 130°C, and a linear pressure of 60 kg/cm to obtain a spunbonded non-woven fabric. The basis weight of the obtained spunbonded non-woven fabric was 20.0 g/m^2. The obtained spunbonded non-woven fabric was evaluated by the methods described above. The evaluation results are shown in Fig. 4.

(Comparative Example 1)

[0074] A spunbonded non-woven fabric was obtained in the same manner as in Example 1 except that air jetted from the sub nozzle 40 was set to 0 (speed 0 m/sec). The basis weight of the obtained spunbonded non-woven fabric was 20.2 g/m^2. The obtained spunbonded non-woven fabric was evaluated by the methods described above. The evaluation results are shown in Fig. 4.

[0075] Here, the basis weight variation was 3.5 [%] in Comparative Example 1, whereas the basis weight variation in Example 1 was 2.0 [%]. In Example 1, the evaluation of the yarn bundle [points] in the non-woven fabric was B, whereas the evaluation in Comparative Example 1 was C. At this time, the MD 5% strength was 4.3 N/25 mm in Example 1 and 5.2 N/25 mm in Comparative Example 1, and the CD 5% strength was 2.7 N/25 mm in Example 1 and 1.2 N/25 mm in Comparative Example 1. The MD 5% strength/CD 5% strength in Example 1 was 1.6, whereas the ratio in Comparative Example 1 was 4.3. From this, it is understood that in Example 1, compared with Comparative Example 1, strength reduction is suppressed and uniformity is improved.

[0076] Therefore, the manufacturing apparatus and

the manufacturing method of a non-woven fabric according to the embodiment are suitable for manufacturing a non-woven fabric in which strength reduction is suppressed and uniformity is improved. The manufacturing apparatus and manufacturing method of a non-woven fabric according to the embodiment are suitable for manufacturing a non-woven fabric having a ratio of 5% elongation strength (MD 5% strength) in the machine direction (MD direction) to 5% elongation strength (CD 5% strength) in a direction perpendicular to the machine direction (CD direction) (MD 5% strength/CD 5% strength) of 2.0 or less.

[0077] Further, the manufacturing apparatus and manufacturing method of a non-woven fabric according to the embodiment are suitable for manufacturing a non-woven fabric having a basis weight variation of preferably 3.0% or less, and more preferably 2.5% or less.

[0078] The manufacturing apparatus and manufacturing method of a non-woven fabric in the embodiment are suitable for manufacturing a non-woven fabric having a maximum strength (MD strength) at a time of elongation in the machine direction of more preferably 37.5 [N/25 mm] or more, still more preferably 40.0 [N/25 mm] or more, and most preferably 42.5 [N/25 mm] or more.

[0079] The disclosure of Japanese Patent Application No. 2016-020144 is herein incorporated by reference in its entirety.

[0080] All documents, patent applications, and technical standards described in this specification are incorporated herein by reference to the same extent as if each individual document, patent application, or technical standard was specifically and individually indicated to be incorporated by reference.

Claims

1. An apparatus for manufacturing a non-woven fabric, the apparatus comprising:

   a collecting unit that collects, on a collecting medium, filaments that are jetted toward the collecting medium;
   a diffusing unit comprising a main nozzle that jets, toward the collecting medium, air that is supplied together with the filaments that are to be collected on the collecting medium, and a diffusion space that is provided between the main nozzle and the collecting medium and in which the filaments are diffused by an air flow in which the air jetted, together with the filaments, from the main nozzle is flowing while being diffused; and
   an air flow generation means that generates, around the air flow of the air jetted from the main nozzle into the diffusion space, an air flow that is close to and follows the air flow.

2. The apparatus for manufacturing a non-woven fabric according to claim 1, wherein the air flow generation means comprises a sub nozzle that jets air into the diffusion space.

3. The apparatus for manufacturing a non-woven fabric according to claim 1 or 2, wherein the air flow generation means comprises a sub nozzle that has an opening portion arranged side-by-side with an opening portion of the main nozzle, and that jets air into the diffusion space.

4. The apparatus for manufacturing a non-woven fabric according to claim 2 or 3, wherein the sub nozzle is provided at a machine direction side of the main nozzle and at an opposite side of the main nozzle from the machine direction side.

5. The apparatus for manufacturing a non-woven fabric according to any one of claims 2 to 4, wherein a flow velocity of the air jetted from the sub nozzle is equal to or lower than a flow velocity of the air jetted from the main nozzle.

6. The apparatus for manufacturing a non-woven fabric according to claim 5, wherein the flow velocity of the air jetted from the sub nozzle is no lower than 1/10 of the flow velocity of the air jetted from the main nozzle.

7. A method of manufacturing a non-woven fabric, the method comprising:

   providing, between a main nozzle, from which air is jetted together with filaments, and a collecting medium, that collects the filaments jetted from the main nozzle, a diffusion space in which the filaments are diffused by an air flow in which the air jetted, together with the filaments, from the main nozzle is flowing while being diffused;
   jetting, toward the collecting medium, the filaments together with the air from the main nozzle, while generating, by an air flow generation means, and around the air flow of the air jetted from the main nozzle into the diffusion space, an air flow that is close to and follows the air flow; and
   collecting and depositing, on the collecting medium, the filaments that have been diffused in the diffusion space.

8. The method of manufacturing a non-woven fabric according to claim 7, further comprising jetting, into the diffusion space, air from a sub nozzle that has an opening portion arranged side-by-side with an opening portion of the main nozzle, to generate, around the air flow of the air jetted from the main nozzle into the diffusion space, an air flow that is

close to and follows the air flow.

9. The method of manufacturing a non-woven fabric according to claim 8, wherein the sub nozzle is provided at a machine direction side of the main nozzle and at an opposite side of the main nozzle from the machine direction side.

10. The method of manufacturing a non-woven fabric according to claim 8 or 9, wherein a flow velocity of the air jetted from the sub nozzle is equal to or lower than a flow velocity of the air jetted from the main nozzle.

11. The method of manufacturing a non-woven fabric according to claim 10, wherein the flow velocity of the air jetted from the sub nozzle is no lower than 1/10 of the flow velocity of the air jetted from the main nozzle.

12. A non-woven fabric, wherein a ratio of a strength at 5% elongation in a machine direction to a strength at 5% elongation in a direction perpendicular to the machine direction, is 2.0 or less.

13. The non-woven fabric according to claim 12, wherein a maximum strength at a time of elongation in the machine direction is 35.0 (N/25 mm) or more.

FIG.1

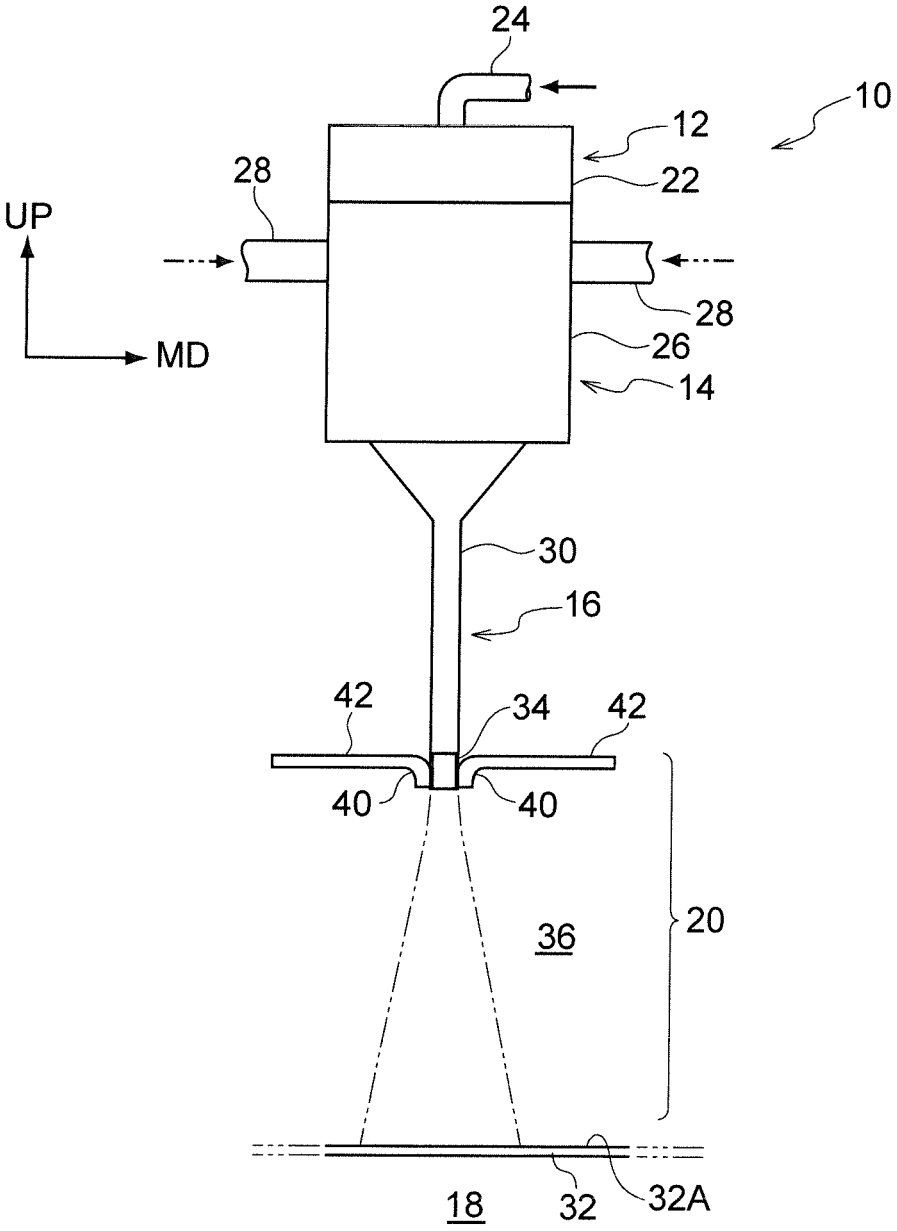

FIG.2

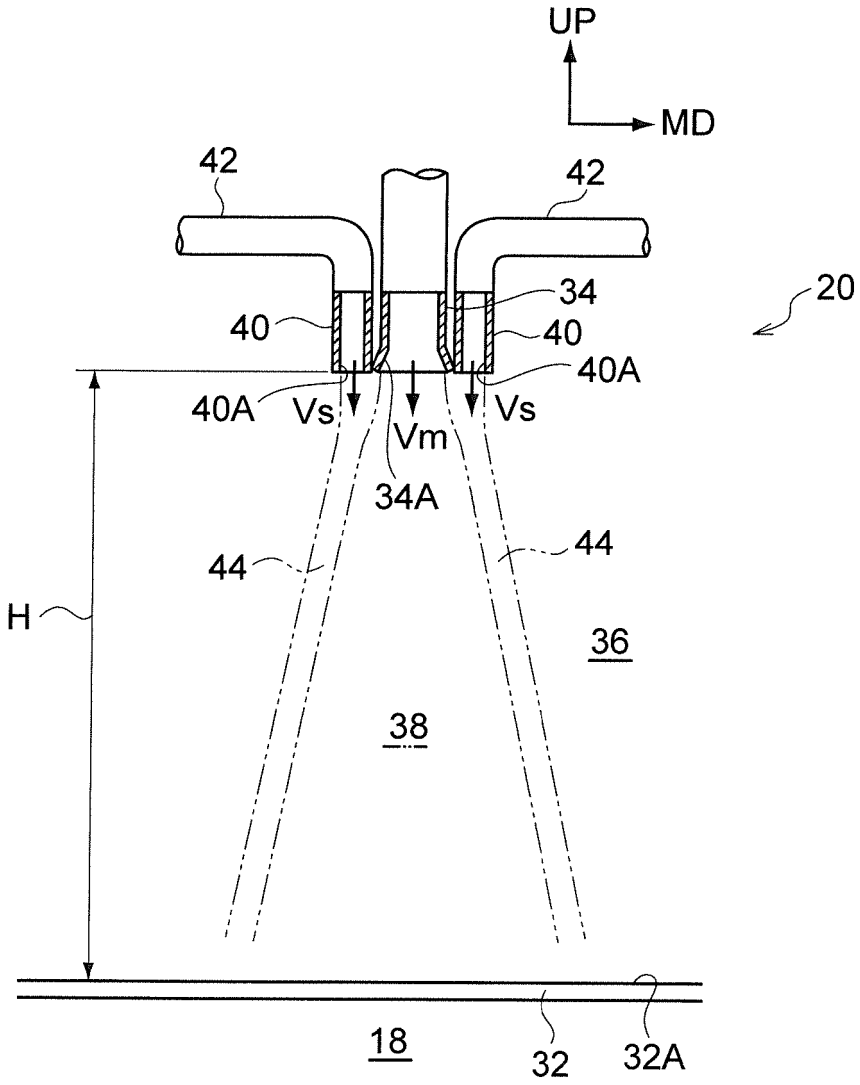

FIG.3A

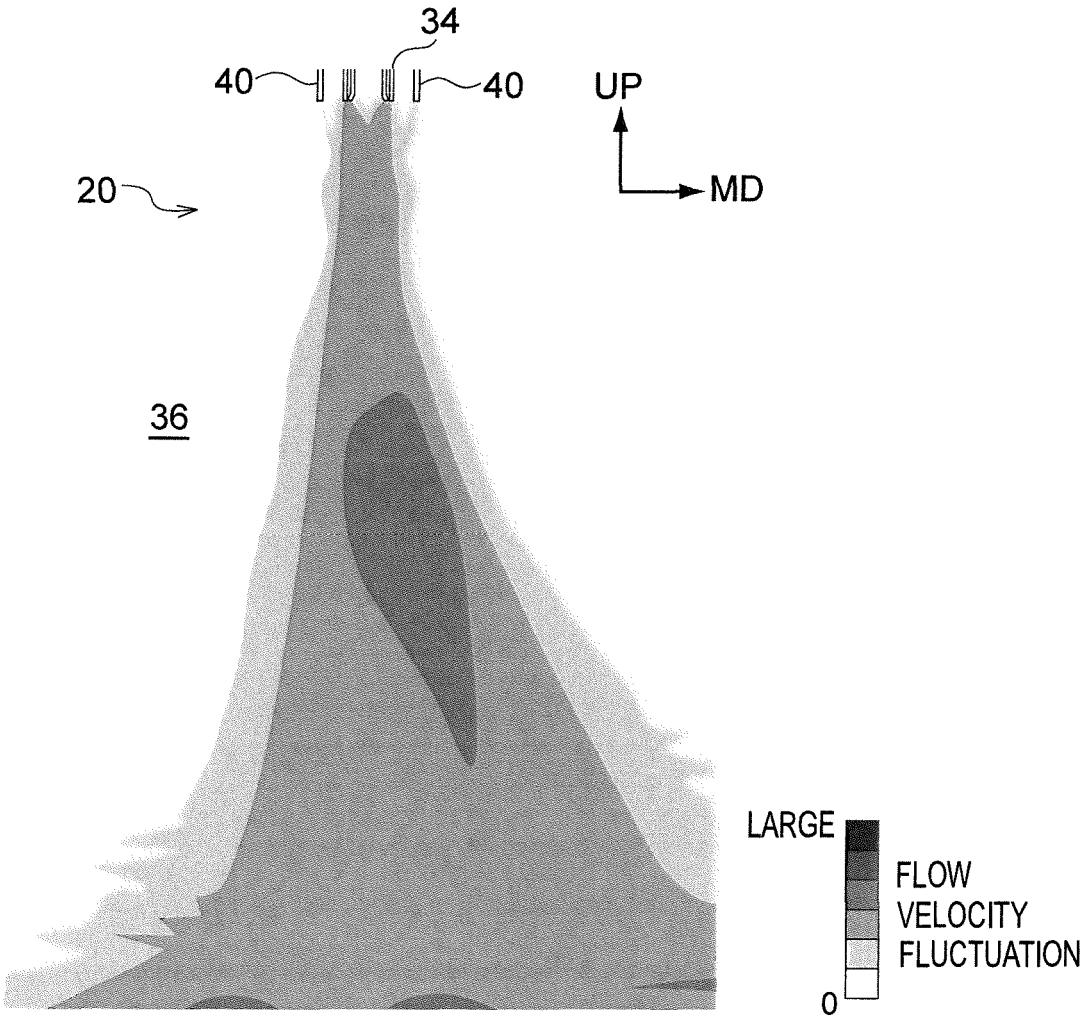

FIG.3B

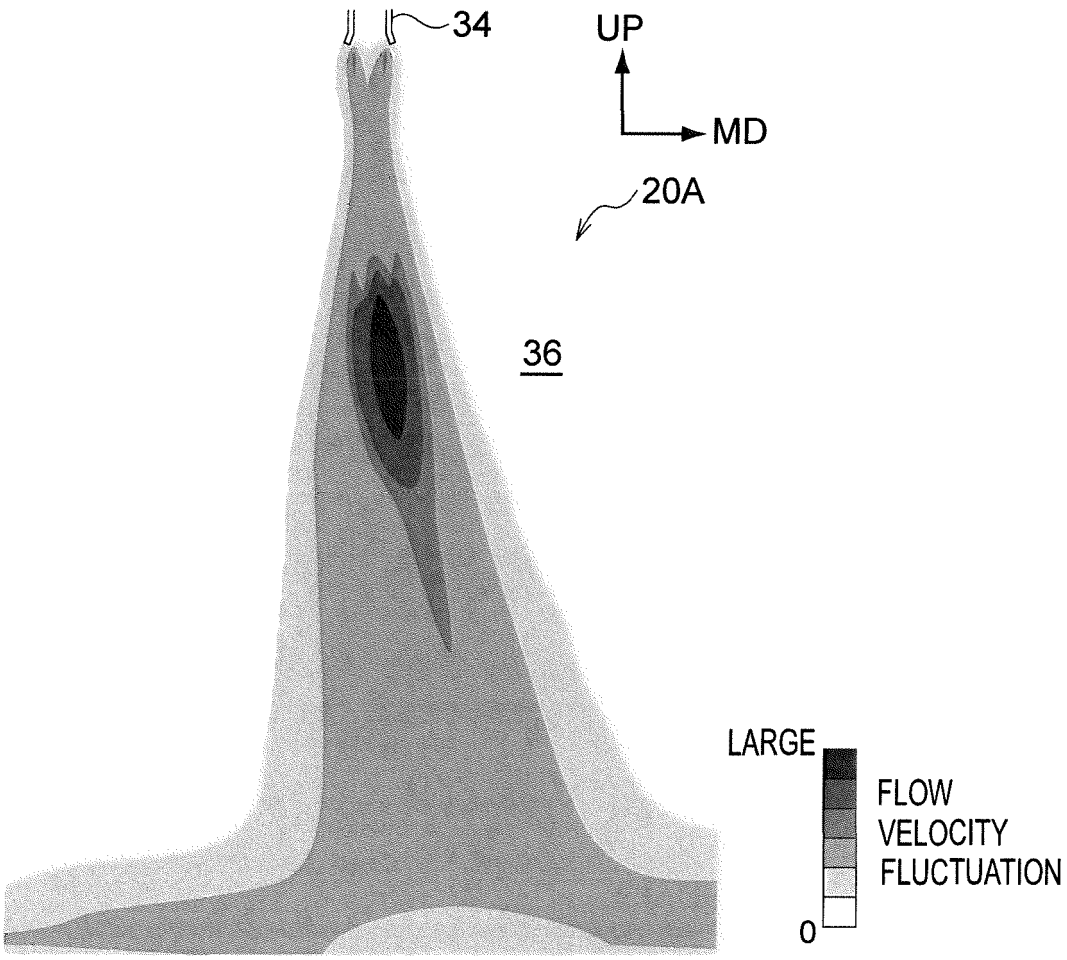

FIG.4

			EXAMPLE 1	COMPARATIVE EXAMPLE 1
MAIN NOZZLE AIR VELOCITY		[m/sec]	107. 3	107. 3
SUB NOZZLE POSITION	VERTICAL POSITION	(WITH RESPECT TO MAIN NOZZLE) [mm]	±0	±0
	HORIZONTAL POSITION	(WITH RESPECT TO CENTER OF MAIN NOZZLE)[mm]	38	38
SUB NOZZLE WIDTH		[mm]	12	12
SUB NOZZLE AIR VELOCITY		[m/sec]	26. 8	(0)
BASIS WEIGHT		[g/m^2]	20. 0	20. 2
BASIS WEIGHT VARIATION		[%]	2. 0	3. 5
FILAMENT DIAMETER		[μm]	18	18
YARN BUNDLE IN NON-WOVEN FABRIC		[POINT]	B	C
MD 5% STRENGTH		[N/25mm]	4. 3	5. 2
CD 5% STRENGTH		[N/25mm]	2. 7	1. 2
MD 5% STRENGTH/CD 5% STRENGTH		[−]	1. 6	4. 3
MD STRENGTH		[N/25mm]	43. 8	41. 6
CD STRENGTH		[N/25mm]	24. 7	16. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/012062

A. CLASSIFICATION OF SUBJECT MATTER
D04H3/16(2006.01)i, *D01D5/08*(2006.01)i, *D04H1/736*(2012.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04H1/00-18/04, D01D1/00-13/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2011-241510 A (Toyota Boshoku Corp.), 01 December 2011 (01.12.2011), claims; paragraphs [0018] to [0024]; fig. 1 & US 2011/0285053 A1 claims; paragraphs [0014] to [0021]; fig. 1 & CN 102251296 A	1-13
X	JP 2013-087412 A (Oerlikon Textile GmbH & Co. KG.), 13 May 2013 (13.05.2013), claims; paragraphs [0048] to [0051]; fig. 1 & US 2013/0099409 A1 claims; paragraphs [0051] to [0054]; fig. 1 & EP 2584076 A1 & CN 103061044 A & KR 10-2013-0044179 A	1,7,12,13

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2017 (30.05.17)	06 June 2017 (06.06.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/012062

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-008713 A (Unitika Ltd.), 16 January 2001 (16.01.2001), examples (Family: none)	12,13
A	JP 2000-336517 A (Yugen Kaisha Suetomi Engineering), 05 December 2000 (05.12.2000), entire text & US 2001/0026815 A1	1-13
A	JP 2015-183308 A (Japan Vilene Co., Ltd.), 22 October 2015 (22.10.2015), entire text (Family: none)	1-13
A	JP 2006-083511 A (Reifenhaeuser GmbH & Co. KG Maschinenfabrik), 30 March 2006 (30.03.2006), entire text & US 2006/0061006 A1 & EP 1637632 A1 & KR 10-2006-0051299 A & CN 1757800 A	1-13

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/012062

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

(Invention 1) claims 1-11

Although claims 1-5 have no special technical feature since said claims lack novelty in the light of the document 1 (JP 2011-241510 A), claim 6 has a special technical feature, and accordingly, claims 1-11 in addition to claims 7-10 corresponding to these claims are classified into Invention 1.

(Invention 2) claims 12 and 13

(Continued to extra sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/012062

Continuation of Box No.III of continuation of first sheet(2)

Claims 12 and 13 are an invention of typical nonwoven fabric having a predetermined strength with no manufacturing method specified, and cannot be said to have the same technical feature as or a technical feature corresponding to that of claims 1 to 11 classified into Invention 1.

Consequently, claims 12 and 13 cannot be classified into Invention 1.

Form PCT/ISA/210 (extra sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2556953 B **[0003]**
- JP 3135498 B **[0004]**
- JP 5094588 B **[0005]**
- JP 2016020144 A **[0079]**