

**APPARATUS AND METHOD FOR MANUFACTURING SPUNBONDED  
NONWOVEN FABRIC SIMULTANEOUSLY HAVING UNIFORM DENSITY  
DISTRIBUTION AND SIMILAR TENSILE STRENGTHS IN LONGITUDINAL AND  
TRANSVERSE DIRECTIONS**

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**BACKGROUND OF THE INVENTION**

Field of the invention

[1] The present invention relates to an apparatus and method for manufacturing spunbonded nonwoven fabric simultaneously having uniform density distribution and similar  
10 tensile strengths in longitudinal and transverse directions, and more specifically, to an apparatus and method for manufacturing spunbonded nonwoven fabric having excellent density distribution by suppressing an increase in tensile strength ratio in longitudinal and transverse directions.

15 Related Art

[2] A manufacturing technique of spunbonded nonwoven fabric has been steadily developed since a commercial manufacturing technique was introduced. An industrial large-scale spunbonded nonwoven fabric manufacturing method that has been beginning to be developed by combining techniques of spinning filaments or filament fibers is largely  
20 classified into two types of manufacturing processes, i.e., Docan and Curtain processes. General contents related to this are described in pages 203 to 224 of Introduction to Nonwoven Technology (by Subhash K. Batra, 2012, DEStech Publications Inc. North Carolina State Univ. U.S.A.).

[3] Docan process or Docan method basically uses a device that is similar to a circular  
25 pipe using compressed air as a device for stretching fibers at a high speed to increase strength

of filament fibers that is manufactured. Such a method can manufacture a high strength fiber relatively simply by enabling the fibers to be stretched at a high speed of 5,000 m/min or higher using a relatively simple device. However, since the fibers that are stretched at a high speed is bundled while the fibers are being introduced into a docan pipe, the bundled  
5 fibers should be separated from each other and uniformly diffused in order to use the fibers as a nonwoven fabric.

**[4]** Curtain process or Curtain method uses a rectangular long slit type fiber stretching device which is relatively complicated and large. Although Curtain process or Curtain method is advantageous in manufacturing of spunbonded nonwoven fabric in a large quantity,  
10 it may be difficult to uniformly supply compressed air for stretching since Curtain process or Curtain method uses a stretching device which is single along a wide width direction. Therefore, speed distributions of filaments may be locally different from one another. Further, weight distribution of the nonwoven fabric may become easily defective since stretched filaments are entangled with one another.

**[5]** Therefore, although spunbonded nonwoven fabric manufacturing methods include Docan process or Curtain process, all of the spunbonded nonwoven fabric manufacturing methods include methods for uniformly diffusing the stretched filaments without stretched filaments being roped with one another which have been devised. Further, the spunbonded nonwoven fabric manufacturing methods include various methods and techniques which have  
20 been devised such that the filaments have an equal tensile strength ratio by constantly rearranging separated and diffused filaments in longitudinal and transverse directions of the nonwoven fabric. The above-described uniformities of weight (density) distribution and tensile strength of the nonwoven fabric are common characteristics required in all nonwoven fabrics, and many techniques have been introduced by various inventors of the prior art to  
25 devise spunbonded nonwoven fabric manufacturing method satisfying all requirements.

[6] On the other hand, there is a method for manufacturing a nonwoven fabric by dispersing and diffusing the stretched fibers using Coanda device after obtaining stretched fibers by stretching filaments using divided curtain type stretching devices.

[7] Specifically, the patent provides a method by combining techniques of Docan and  
5 Curtain processes, the method which can manufacture a product having uniform weight distribution and tensile strength ratio of the nonwoven fabric by (1) introducing a plurality of curtain type stretching devices which are not an integrated form, but are a separated form, (2) arranging a plurality of separated stretching devices such that the plurality of separated stretching devices have a predetermined angle with respect to a nonwoven fabric  
10 manufacturing progress direction, and (3) developing and disposing a filament diffuser such as Coanda device in lower ends of the stretching devices, thereby simultaneously separating filaments and arranging fibers in a transverse direction.

[8] However, since the above-described techniques use Coanda device disposed in the lower ends of the stretching devices, the techniques are basically a method for diffusing an air  
15 flow, and stretched filaments are dispersed after following a direction in which air diffused by Coanda device flows. Therefore, it is difficult to manufacture a nonwoven fabric with uniform density distribution since the filaments are tangled or entangled with one another by the air flow while the air is being diffused. Such a phenomenon may be easily deteriorated as the more the number of filaments is increased, or as the lower a denier of the filaments is.  
20 That is, fine denier filaments with 3 denier or less are moved fast in the air flow. Further, many filaments should be introduced into the curtain type stretching devices to increase productivity. It is actually difficult to manufacture a fine denier product since degree of freedom (a distance between the filaments) of the filaments is further lowered, and entanglement or tanglement between fibers is further deteriorated by such a combined action.  
25 Further, defects such as twist or entanglement between the fibers are frequently observed

since separation or diffusion between the fibers is not sufficiently performed during manufacturing of a low weight product having a nonwoven fabric weight of 50 g/m<sup>2</sup> or less even in the case of manufacturing a medium-fineness product of 5 deniers or more and a thick denier product of 8 deniers or more. Therefore, products manufactured by the corresponding technique are commercially limited to products with a high weight of 60 g/m<sup>2</sup> or more practically comprised of thick filaments of 8 deniers or more.

**[9]** Coanda technique and device applied to Curtain process are illustrated in EP0224435 and US Patent No. 5,045,271. Basic principle and device structures are similar to techniques provided in the above-mentioned German and US patents.

**[10]** In order to improve such a phenomenon, a technique illustrated in US Patent Publication No. 2003-0030175 may be considered. This technique provides an air injection technique using compressed air instead of Coanda device disposed in lower ends of the separated stretching devices. Namely, this technique suggests a method for dispersing and diffusing the filaments by alternately injecting compressed air in a direction perpendicular to a directly downward progress direction of a stretched filament bundle.

**[11]** However, the present method cannot help manufacturing products with non-uniform weight distribution since a phenomenon that filaments are entangled or twisted with one another by turbulence is frequently generated, the turbulence being generated while a large amount of a high pressure air flow continuously jetted at a high speed from the stretching device and a high pressure air flow intermittently injected in a direction perpendicular to the large amount of the high pressure air flow are being collided with each other. Basically, there is not a change in the principle that dispersion or diffusion of the filaments is imparted by adjusting a flow of the air between Coanda method and high pressure air injection method. It is obviously impossible for such methods to uniformly separate or diffuse each of the filaments. Accordingly, the methods have definite limitations in manufacturing a nonwoven

fabric with uniform density distribution, i.e., a nonwoven fabric with uniform weight distribution.

**[12]** In order to overcome such technical limitations, an example of the prior art providing a method for effectively separating continuous filaments moved at a high speed is illustrated in US Patent No. 3,338,992. This technique is a method for attaching a high voltage DC static electricity to the surface of the continuous filaments moved at the high speed through friction or a corona discharge. As well known, when a high voltage static electricity is attached to the surface of a thermoplastic synthetic fiber, repulsive force generates a force of allowing the filaments to push to each other, thereby exhibiting an effect of naturally separating the filaments without generating twist or entanglement between the fibers. According to Docan method or Curtain method, although devices of methods for applying a high voltage DC static electricity to the surface of filaments moved at a high speed are different from each other, basic principles of the methods are the same.

**[13]** Namely, a DC static electricity of a level of 10 to 30 KV is generated on the surface of stretching-completed filaments such that static electricity ions in a corona state are attached on the surface of fibers. A technique and device for generating and attaching a DC static electricity by Docan method are well described in US Patent No. 5,225,018. This technique is described as follows. (1) Filaments stretched at a high speed through a pipe are collided with an inclined reflection plate to make the filaments in a flat state such that static electricity is evenly attached to the surface of each of fibers. (2) A DC static electricity in a corona state is moved and attached to the surface of the fibers from a high voltage DC static electricity imparting device disposed in a lower end of the inclined reflection plate, and (3) the fibers are pushed to each other and separated from each other to be diffused by electrostatic force attached to the surface of the fibers.

**[14]** A static electricity filament dispersion technique in Docan method is well disclosed

in US Patent No. 5,225,018. That is, the fibers are separated and diffused from each other by static electricity repulsive force between the fibers when disposing a rectangular DC static electricity application device in the lower ends of the docan type stretching devices from which stretched filaments are discharged in a downward direction and attaching corona ions to the surface of the fibers.

[15] Such a method for dispersing the fibers by electrostatic force has an advantage that microscopic defects such as twist and entanglement are not well displayed since separation between each of the fibers is certainly acted in the method. Therefore, the method is an advantageous manufacturing method since the method can improve the generation of minute defects due to twist or roping of the filaments that may be shown in a product when manufacturing a low weight nonwoven fabric of 60 g/m<sup>2</sup> or less, particularly a ultra-low weight nonwoven fabric of 20 g/m<sup>2</sup> or less. Further, the static electricity separation technique is often used since it does not greatly display performance expression according to thickness of the fibers.

[16] However, such a static electricity separation technique does not provide a method for uniformly adjusting tensile strengths in longitudinal and transverse directions of a final nonwoven fabric by forcibly moving filament fibers in a weft direction. Namely, since repulsive force due to electrostatic force is a weak force, the repulsive force sufficiently provides separation force in the level of the filaments, but cannot exhibit a greater force level of allowing the filaments to move further distances in a transverse direction. Therefore, such a static electricity imparting technique is usefully used in manufacturing a low weight nonwoven fabric with excellent density distribution, but lacks in manufacturing a high quality spunbonded nonwoven fabric having an equal tensile strength ratio in longitudinal and transverse directions.

[17] A prior art of providing a method which can improve strength ratios in longitudinal

and transverse directions in Docan method is disclosed in JP3106681. This technique provides a method for arranging filaments in a transverse direction as far as possible by adjusting a distance between docan jet pipes which are arranged in a vertical (transverse) direction with respect to a nonwoven fabric manufacturing length direction (longitudinal direction). That is, this technique is a method for uniformly maintaining tensile strengths in longitudinal and transverse directions of the nonwoven fabric by increasing tensile strength of a nonwoven fabric in a transverse direction and suppressing improvement in tensile strength of the nonwoven fabric in a longitudinal direction.

**[18]** The method relating to improvement in nonwoven fabric weight distribution of JP3106681 is disclosed in JP2988052 and JP3269542. The above-described JP3106681, JP2988052 and JP3269542, which are all as methods for separating fibers using static electricity, are methods using the generation of forced friction type static electricity without using a high voltage DC static electricity generator. Namely, JP3106681, JP2988052 and JP3269542 are a method for continuously manufacturing a nonwoven fabric with uniform density distribution by rubbing filaments discharged at a high speed from stretching pipes of Docan method against collision plates disposed at a lower side to generate static electricity, and simultaneously preventing twist or entanglement between fibers using the static electricity and dispersing the fibers.

**[19]** These methods can be usefully used since the methods can use simpler devices than methods for charging the surface of the filaments with electricity by directly generating a DC high voltage. However, (1) the methods may be harmful to human body and environment by using a main component of lead (Pb) as a frictional body such that a nonwoven fabric as a product contains a small amount of fine lead (Pb) powder produced by rubbing the frictional body against fibers, thereby wearing down the frictional body, and (2) the methods cannot effectively charge the fibers with electricity as electro-static discharge lacks since the

methods are a method which does not directly apply a high voltage to the fibers by generating a corona discharge using a DC high voltage generator (HVG). Therefore, since, when a large amount of multiple fibers are rubbed and charged with electricity, frictional force between the frictional body and the fibers cannot be uniformly maintained such that electro-  
static discharge quantity cannot be sufficiently secured due to non-uniformity of charge  
electrified repulsive force and lack in overall frictional force, separation between the fibers  
may not be sufficiently performed.

[20] That is, when the number of fiber filaments is increased to improve productivity, phenomena such as non-uniformity of static discharge and lack in discharge quantity may be  
generated. Further, conventional techniques also have a disadvantage that it is difficult to  
access a market having a high demand in for hygienic, medical and filter applications and  
high growth and earnings rate since lead (Pb) is used as a main component of the frictional  
body.

[21] As results of examining and analyzing such conventional techniques in detail, it has  
not been possible to find out an excellent technique which satisfies both uniform weight  
distribution and the same strength in longitudinal and transverse directions of the spunbonded  
nonwoven fabric. Particularly, a manufacturing technique of spunbonded nonwoven fabric  
having excellent weight distribution and strength ratios in longitudinal and transverse  
directions even in a low weight product of 60 g/m<sup>2</sup> or less is nonexistent . In addition, a  
new method considering all factors such as productivity, toxicity and environmental aspect  
should be taken into account.

[Related art document]

[Patent document]

Korean Patent Registration No. 10-0680373

## SUMMARY OF THE INVENTION

[22] An apparatus for manufacturing spunbonded nonwoven fabric according to the present invention for achieving the objective includes: a plurality of nozzles which are each connected to a plurality of stretching pipes to discharge filaments stretched through the plurality of stretching pipes; and a conveyor which collects the filaments to transfer the collected filaments in a first direction, wherein the plurality of nozzles are arranged at a slope that is not 0 degree with respect to a direction that is perpendicular from the first direction.

[23] Here, the apparatus may include a stretching unit which includes the plurality of stretching pipes and stretches a filament bundle spun from spinning blocks through the plurality of stretching pipes.

[24] Further, the plurality of nozzles are connected to lower portions of the plurality of stretching pipes.

[25] Additionally, the apparatus includes at least one spinning block which is interlocked with the plurality of stretching pipes and melts a thermoplastic synthetic fiber at high temperatures to spin the filament bundle to the plurality of stretching pipes.

[26] Further, the spinning block is arranged at a slope that is not 0 degree with respect to the direction that is perpendicular from the first direction.

[27] Further, an angle at which the spinning block is arranged at a slope that is not 0 is between 20 degrees of an angle and 80 degrees of an angle.

[28] Further, the spinning block is provided in a plural number, and the spinning blocks are arranged at a distance between 0.5 M and 2.0 M.

[29] In addition, an interval at which the plurality of nozzles are arranged with each other is a horizontal distance between 40 mm and 150 mm.

[30] Moreover, the interval at which the plurality of nozzles are arranged with each other is a vertical distance of at least 30 mm.

[31] Further, an angle at which the plurality of nozzles are arranged at a slope that is not 0 is between 20 degrees of an angle and 80 degrees of an angle.

[32] Further, an angle at which the plurality of nozzles are arranged at a slope that is not 0 is between 30 degrees of an angle and 45 degrees of an angle.

5 [33] Additionally, the apparatus includes a corona discharge unit which is provided in an upper end or a lower end of the plurality of nozzles to flow compressed air into the plurality of stretching pipes, and separates and diffuses the filaments by attaching ions to the surface of the filaments, thereby charging the filaments with electricity.

[34] Additionally, the apparatus includes a plurality of air current interference preventing  
10 plates which are formed to be separated at a predetermined distance from each of the plurality of nozzles correspondingly to each of the plurality of nozzles and block a flow of air applied to the filaments.

[35] Further, a width of one of the plurality of air current interference preventing plates is a numerical value obtained by adding a value of 20 to 100 mm to a horizontal distance of one  
15 of the plurality of nozzles, and a vertical length of one of the plurality of air current interference preventing plates is 50 to 150 mm.

[36] Moreover, a separated distance between one of the plurality of air current interference preventing plates and one of the plurality of nozzles is between 6 mm and 30 mm.

[37] Further, an angle at which one of the plurality of air current interference preventing  
20 plates is inclined is between 0 degree of an angle and 30 degrees of an angle based on a state that is perpendicular from the ground.

[38] Meanwhile, an apparatus for manufacturing spunbonded nonwoven fabric according to the present invention for achieving the another objective includes: a plurality of nozzles which are each connected to a plurality of stretching pipes to discharge filaments that have  
25 been stretched through the plurality of stretching pipes; and a conveyor which collects the

filaments to transfer the collected filaments, wherein points at which the filaments are brought into contact with the conveyor and collected with respect to the direction that is perpendicular from the first direction are different from one another.

**[39]** On the other hand, a method for manufacturing spunbonded nonwoven fabric according to the present invention for achieving the objective comprises the steps of: spinning the thermoplastic synthetic fiber into a filament bundle by allowing spinning blocks to melt a thermoplastic synthetic fiber at high temperatures; stretching the spun filaments through a plurality of stretching pipes; allowing a plurality of nozzles connected to each of the plurality of stretching pipes to discharge the filaments; allowing air current interference preventing plates to block a flow of air applied to the filaments; collecting the filaments from the plurality of nozzles to arrange the collected filaments on a conveyor; and transferring the arranged filaments in a first direction to bond the filaments, wherein the plurality of nozzles are arranged at a slope that is not 0 with respect to the direction that is perpendicular from the first direction.

**[40]** Meanwhile, a method for manufacturing spunbonded nonwoven fabric according to the present invention for achieving the another objective comprises the steps of: spinning the thermoplastic synthetic fiber into a filament bundle by allowing spinning blocks to melt a thermoplastic synthetic fiber at high temperatures; stretching the spun filaments through a plurality of stretching pipes; allowing a plurality of nozzles connected to each of the plurality of stretching pipes to discharge the filaments; allowing air current interference preventing plates to block a flow of air applied to the filaments; allowing the filaments to be collected and arranged on a conveyor from the plurality of nozzles; and transferring the arranged filaments in a first direction to bond the filaments, wherein the plurality of nozzles are arranged at a slope that is not 0 with respect to the direction that is perpendicular from the first direction.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[41] FIG. 1 is a schematic diagram of a conventional apparatus for manufacturing spunbonded nonwoven fabric.

5 [42] FIG. 2 is a side view schematically showing an apparatus for manufacturing spunbonded nonwoven fabric according to an exemplary embodiment of the present invention.

[43] FIG. 3 is a plane figure schematically showing the apparatus for manufacturing the spunbonded nonwoven fabric illustrated in FIG. 2.

10 [44] FIG. 4 is a drawing schematically showing an arrangement of spinning blocks or nozzles illustrated in FIG. 3.

[45] FIG. 5 is a drawing schematically showing the enlarged structure by enlarging a structure of charging with electricity filaments that have been stretched in and discharged from the apparatus for manufacturing the spunbonded nonwoven fabric illustrated in FIG. 2.

15 [46] FIG. 6 is a drawing schematically showing other embodiment of the structure of charging the filaments with electricity illustrated in FIG. 5.

[47] FIG. 7 is a drawing schematically showing another embodiment of the structure of charging the filaments with electricity illustrated in FIG. 5.

## **DESCRIPTION OF EXEMPLARY EMBODIMENTS**

20 [48] Hereinafter, preferred embodiments of the present invention are described with reference to the accompanying drawings. However, although some configurations which are irrelevant to a subject matter of the present invention are omitted or summarized, omitted configurations are not necessarily configurations which are not needed in the present  
25 invention, but may be combined and used by those skilled in the art to which the present

invention pertains.

[49] The present invention has invented a method which supplements drawbacks of the foregoing conventional techniques, is perfect in quality and defect improvements, simultaneously considers productivity and an environmental aspect, and can continuously produce an excellent product regardless of diameter of fibers composing spunbonded nonwoven fabric and weight of the nonwoven fabric manufactured.

[50] Drawings are exemplified to aid in an explanation of the present invention, and the present invention will be described in detail using the drawings.

[51] FIG. 1 is a schematic diagram of a conventional apparatus for manufacturing spunbonded nonwoven fabric, FIG. 2 is a side view schematically showing an apparatus for manufacturing spunbonded nonwoven fabric according to an exemplary embodiment of the present invention, FIG. 3 is a plane figure schematically showing the apparatus for manufacturing the spunbonded nonwoven fabric illustrated in FIG. 2, and FIG. 4 is a drawing schematically showing an arrangement of spinning blocks or nozzles illustrated in FIG. 3.

[52] As illustrated in FIG. 1 to FIG. 4, an apparatus for manufacturing spunbonded nonwoven fabric simultaneously having uniform density distribution and similar tensile strengths in longitudinal and transverse directions (hereinafter, referred to as “an apparatus for manufacturing spunbonded nonwoven fabric”) may include a raw material storage and supply tank 110, an extrusion unit 120, spinning blocks 130, an exhaust unit 140, a filament cooling unit 150, a stretching unit 160, a corona discharge unit 170, a high voltage generator 180, nozzles 190, air current interference preventing plates 200, a conveyor 210, a suction unit 220, a calender roll 230, a cooling roll 240, and a winder 250.

[53] The raw material storage and supply tank 110 is a configuration which has raw material for the thermoplastic synthetic fiber stored therein and supplies the raw material for the thermoplastic synthetic fiber to the extrusion unit 120.

[54] The extrusion unit 120 is a configuration which is formed in a horizontal shape to melt the supplied raw material for the thermoplastic synthetic fiber and extrude a melted raw material for the thermoplastic synthetic fiber by the spinning blocks 130.

[55] The spinning blocks 130 are a configuration of manufacturing filament fibers by spinning the raw material for the thermoplastic synthetic fiber that has been melted at high temperatures through spinning nozzles. Such spinning blocks 130 may be arranged at a slope which is not 0 with respect to a direction that is perpendicular from a progress direction(machine direction=MD) in which the conveyor 210 transfers the filaments. A plurality of spinning blocks 130 are provided such that the plurality of spinning blocks 130 may be arranged in a direction perpendicular to the conveyor 210, and the plurality of spinning blocks 130 may be arranged to be separated from each other at predetermined distance.

[56] The exhaust unit 140 is a configuration of exhausting to the outside gases generated when melting the raw material for the thermoplastic synthetic fiber at high temperatures.

[57] The filament cooling unit 150 is a configuration of cooling a filament bundle 1 manufactured of spunbonds by the spinning blocks 130. The filament bundle 1 manufactured through such spinning blocks 130 is maintained at high temperatures since the filament bundle 1 is in a state that heat is applied to the filament bundle 1. At this time, since the filament bundle 1 which is maintained at high temperatures has a form that is very weak at a high temperature state, there may be break of fiber in the form of the filament bundle 1 during stretch of the filament bundle 1. Therefore, the filament cooling unit 150 maintains the form of the filaments by providing cooling air to the filament bundle 1 that has been manufactured and spun of the filaments, thereby reducing temperature of the filament bundle 1.

[58] The stretching unit 160 is a configuration which is provided under the spinning

blocks 130 to stretch the filament bundle 1 that has been spun. Such a stretching unit 160 may include stretching pipes 160', and may stretch filament bundle 1 at a high speed to obtain stretched filaments. The stretched filaments do not lose intrinsic physical properties in spite of high tensions and high temperatures continuously applied in subsequent processes by having a high tensile strength and a low thermal shrinkage rate. After stretching is completed, the filaments are moved to the nozzles 190 through the stretching pipes 160'. The stretching unit 160 may be interlocked with the spinning blocks 130, and may include a plurality of stretching pipes 160' which are arranged at the same inclination angle along an inclination angle at which the spinning blocks 130 are arranged at a slope which is not 0 with respect to a direction that is perpendicular from a progress direction in which the conveyor 210 transfers the filaments. For example, when forming an inclination angle at which the spinning blocks 130 are arranged at 30 degrees of an angle with respect to the direction that is perpendicular from the progress direction in which the conveyor 210 transfers the filaments, the inclination angle at which the plurality of stretching pipes 160' are also arranged at 30 degrees of an angle with respect to the direction that is perpendicular from the progress direction in which the conveyor 210 transfers the filaments.

**[59]** The corona discharge unit 170 is a configuration which is provided in upper ends or lower ends of the nozzles 190 to separate and diffuse stretched filaments by attaching ions to the surface of the filaments. Such a corona discharge unit 170 is provided with a plurality of discharge needles 172, and the discharge needles 172 are charged with electricity by a discharge electrode 171 such that the filaments can be charged with electricity. Further, the discharge electrode 171 has a plurality of holes formed in the surface thereof, and compressed air is flown in from one side of the corona discharge unit 170 such that the compressed air can be jetted to the filaments through the holes formed in the surface of the discharge electrode 171. In addition, a protective cover 173 can protect the discharge needles 172

from the outside. Moreover, a ground electrode 174 and the discharge electrode 171 form a ground. For instance, the corona discharge unit 170 may be positioned in the vicinity where the filaments are moved from the stretching pipes 160' when the filaments stretched through the stretching pipes 160' are moved to a lower part by gravity. Accordingly, the corona  
5 discharge unit 170 allows all of the filaments to have one polarity of a positive (+) pole or a negative (-) pole by injecting ions into the filaments using the discharge needles 172. Filaments charge electrified with one polarity generate repulsive force to each other, and the filaments maintain a stretched state by repulsive force such that the filaments can be discharged from the nozzles 190 without being bundled to each other.

10 **[60]** The high voltage generator 180 is a configuration of charge electrifying the discharge needles 172 of the corona discharge unit 170 into the positive (+) pole or the negative (-) pole by applying a voltage to the corona discharge unit 170.

**[61]** The nozzles 190 are a configuration in which the nozzles 190 are each connected to lower portions of the stretching pipes 160' to discharge stretched filaments to the outside.

15 Such nozzles 190 may be arranged by forming an inclination angle at a slope which is not 0 with respect to the direction that is perpendicular from the progress direction in which the conveyor 210 transfers the filaments in the same manner as in the stretching pipes 160' to which the nozzles 190 are connected. Therefore, the filaments discharged from the nozzles 190 may be collected in a state that the filaments are inclined to the conveyor 210 as  
20 illustrated in FIG. 2, and positions of the conveyor 210 at which the filaments are each collected may be different from each other accordingly. Namely, distances between any one point that is perpendicular from the progress direction of the conveyor 210 to points of the conveyor 210 at which the filaments are each collected are all different from one another. For instance, if a plurality of nozzles 190 are arranged at 30 degrees of an angle with respect  
25 to the direction that is perpendicular from the progress direction in which the conveyor 210

transfers the filaments, it means that, when discharged filaments are also collected in the conveyor 210, a straight line formed by points at which the filaments are collected is formed at 30 degrees of an angle with respect to a horizontal direction of the conveyor 210.

**[62]** In an embodiment of the present invention, at least two points among the points at which the filaments are collected may be positioned at distances that are different from each other from an area of the direction that is perpendicular from the progress direction of the conveyor 210. For instance, a unit including the two or three points among the points at which the filaments are collected may have a predetermined slope with respect to the perpendicular direction.

**[63]** The air current interference preventing plates 200 are a configuration in which the air current interference preventing plates 200 are provided at positions separated from each of the nozzles 190 at predetermined intervals to block a flow of air that may be applied to the filaments. Such air current interference preventing plates 200 are provided in a direction that is perpendicular from the ground, and can be inclined at a predetermined angle. For example, the air current interference preventing plates 200 may be collided with the filaments discharged from the nozzles 190 in a state that the air current interference preventing plates 200 are inclined at 30 degrees of an angle from the direction that is perpendicular to the ground.

**[64]** The conveyor 210 is a configuration which is provided under the air current interference preventing plates 200 and the nozzles 190 to collect the filaments discharged from the nozzles 190 and transfer arranged filaments.

**[65]** The suction unit 220 is a configuration which exhausts compressed air remained in the suction unit 220 to the outside.

**[66]** The calender roll 230 is a configuration of manufacturing a nonwoven fabric by pressing and bonding the filaments arranged on the conveyor 210.

[67] The cooling roll 240 is a configuration of cooling a manufactured nonwoven fabric.

[68] The winder 250 is a configuration of winding a manufacturing completed nonwoven fabric to a predetermined length.

[69] Hereinafter, structure of the present invention together with drawings will be described in detail. A manufacturing process of a spunbonded nonwoven fabric may be largely divided into three processes.

[70] A first process, as a spinning process of manufacturing filament fibers through spinning nozzles by melting a thermoplastic synthetic fiber at high temperatures, is similar to a general filament fiber manufacturing method.

[71] A second process comprises uniformly arranging the separated filaments on a conveyor 210 after separating each of the filaments using a configuration of stretching spun thermoplastic filaments at a high speed to manufacture a high strength fiber and then dispersing the filaments. The second process is also referred to as a web manufacturing process.

[72] Finally, a third process is a process of bonding a web comprised of a plurality of filaments to impart physical properties including tensile strength to the web. Although various techniques may be used in such a bonding process, a calender roll 230 is frequently used in a thermal bonding process that is generally the most universal device. Therefore, it is described also in the present invention that nonwoven fabrics are bonded using the calender roll 230.

[73] Here, the filament, as a word obtained by simply abbreviating a filament fiber, has the same meaning as the filament fiber.

[74] The web manufacturing process, i.e., the second process among such processes is used by developing various techniques and devices since the web manufacturing process is a core process of determining performance of a spunbonded nonwoven fabric.

[75] A core web manufacturing and arranging method of a divided and inclined arrangement method through inclined arrangement of the spinning blocks 130, the stretching pipes and the nozzles 190 is shown in FIG. 3 to manufacture a spunbonded nonwoven fabric of which a designed weight distribution of the present invention is uniform, and which has the same tensile strength in longitudinal and transverse directions.

[76] Further, a conventional arrangement method compared with the divided and inclined arrangement method of the present invention can be seen from FIG. 1.

[77] Referring to FIG. 1, a conventional apparatus for manufacturing spunbonded nonwoven fabric includes: spinning blocks 40 which are arranged and installed in a direction that is perpendicular to a web manufacturing progress direction; a stretching unit including a plurality of stretching pipes 30 which are installed parallel to one another under the spinning blocks 40; a plurality of nozzles 20 which are installed parallel to one another under the spinning blocks 40; and collision plates 10 which are installed to maintain a predetermined distance from the plurality of nozzles 20 and are integrally arranged parallel to one another.

In such arrangements, a distance between the nozzles 20 plays a very important role in the expression of weight distribution of a nonwoven fabric and tensile strengths of the nonwoven fabric in longitudinal and transverse directions.

[78] A method has conventionally been suggested based on a concept as illustrated in FIG. 1, wherein the method uniformly maintains tensile strengths of the nonwoven fabric in the longitudinal and transverse directions by adopting a structure of widely dispersing filaments in a transverse direction by widely adjusting a distance between the nozzles 20.

[79] However, such a structure has a disadvantage that the number of the nozzles 20 installed is decreased since the distance between the nozzles 20 is relatively wide. That is, productivity may be lowered. Further, although a tensile strength ratio is improved since the distance between the nozzles 20 is wide, weight distribution of the nonwoven fabric may be

deteriorated since area of the filaments to be dispersed by the nozzles 20 is also widen.

**[80]** As can be seen from FIG. 3 of the present invention, the present invention forms an inclination angle by arranging spinning blocks 130 at a slope which is not 0 with respect to a direction that is perpendicular from a web progress direction, i.e., a direction in which a conveyor 210 is progressed. Here, the spinning blocks 130 are interlocked with a plurality of stretching pipes 160' and a plurality of nozzles 190. The plurality of nozzles 190 in the present invention each maintain a predetermined distance therebetween, thereby generating an effect described in the present invention. Namely, it is important to constantly maintain a horizontal distance  $l_1$  and a vertical distance  $l_2$  between the nozzles 190. As a result, an inclination angle of the spinning blocks 130 interlocked with the plurality of nozzles 190 is formed to maintain the horizontal distance  $l_1$  and the vertical distance  $l_2$  between the nozzles 190 within predetermined ranges in the present invention. Accordingly, the plurality of stretching pipes 160' and the plurality of nozzles 190 are also interlocked with the spinning blocks 130 and arranged at a slope which is not 0 with respect to the direction that is perpendicular from the direction in which the conveyor 210 is progressed, thereby forming a inclination angle thereof.

**[81]** Therefore, it is preferable to maintain an inclination angle of the spinning blocks 130 at 20 degrees of an angle with respect to a direction that is perpendicular from a web or filament progress direction, i.e., a progress direction of the conveyor 210 in the present invention. Further, it is preferable to a maximum angle at 80 degrees of an angle or less, more preferably 25 to 50 degrees of an angle level, and most preferably 30 to 45 degrees of an angle level. In the present invention, a nozzle distance  $l_0$  is divided into the horizontal distance  $l_1$  and the vertical distance  $l_2$ , and the nozzles 190 each maintain a predetermined distance therebetween, thereby generating an effect described in the present invention.

**[82]** Therefore, the nozzles 190 in the present invention preferably maintain a horizontal

distance  $l_1$  of 40 mm or more. More preferably, the nozzles 190 preferably maintain a horizontal distance  $l_1$  of 70 mm or more, and it is not preferable that the nozzles 190 maintain a horizontal distance  $l_1$  of more than 150 mm. Most preferably, the nozzles 190 preferably maintain a horizontal distance  $l_1$  ranging from 70 mm to 120 mm.

5    **[83]**    Here, since a distance between the nozzles 190 is a short distance when the nozzles 190 maintain a horizontal distance  $l_1$  of less than 40 mm, interference between filaments may be easily generated by a large amount of an air flow jetted from adjacent nozzles 190. Moreover, since the nozzle distance  $l_0$  is far away when the horizontal distance  $l_1$  is more than 150 mm, weight distribution of the nonwoven fabric may be deteriorated. Accordingly, the  
10   horizontal distance  $l_1$  should be maintained at a distance that is suggested in the present invention.

**[84]**    The vertical distance  $l_2$  is also an important variable. The vertical distance  $l_2$  should maintain at 30 mm or more, and a wide vertical distance  $l_2$  is preferable since the wider the vertical distance  $l_2$  is, the less interference between adjacent nozzles 190 is.

15   **[85]**    However, much effort is required in manufacturing and operation maintenance since dimensions of the conveyor 210 is also increased to be more than necessary if a separated distance between the nozzles 190 becomes widen from each other, i.e., an inclination angle of the spinning blocks 130 is too large. Therefore, it is preferable to maintain the vertical distance  $l_2$  within a stably operable range without being lowered to a predetermined distance  
20   or less.

**[86]**    There are advantages that the output can be increased, and a nonwoven fabric having more uniform density distribution and excellent tensile strengths in longitudinal and transverse directions can be manufactured at the same time since more nozzles 190 can be installed when a nonwoven fabric to be manufactured has a predetermined width if the  
25   inclination angle of the spinning blocks 130 is more than 60 degrees of an angle.

**[87]** However, there is a difficulty in manufacturing and operation since length of the conveyor 210 is increased if the inclination angle is too large as described above. Therefore, it is preferable to maintain a slope angle of the spinning blocks 130 within a range of 25 to 50 degrees of an angle considering an operating environment. However, it is also possible to manufacture the nonwoven fabric in a state that the angle is changed to a level of 60 to 80 degrees of an angle according to a manufacturing environment.

**[88]** Here, it has been described that an inclination angle is formed by arranging a plurality of spinning blocks 130, a plurality of stretching pipes 160' and a plurality of nozzles 190 at a slope which is not 0 from a progress direction of the conveyor 210. However, although the spinning blocks 130 are arranged at a slope of 0 with respect to the progress direction of the conveyor 210 as in the conventional technique according as arrangement of the spinning blocks 130 is carried out, an inclination angle may be formed by arranging the plurality of stretching pipes 160' and the plurality of nozzles 190 at a slope which is not 0 with respect to a direction that is perpendicular from the progress direction of the conveyor 210.

**[89]** As described above, the present invention has suggested a method which can manufacture a nonwoven fabric having excellent quality by reducing a distance of the nozzle distance  $l_0$  to 150 mm or less. The method according to the present invention increases productivity and can manufacture a product having more uniform density distribution by enabling a greater number of nozzles 190 to be installed. Namely, although a nonwoven fabric according to a conventional technique exhibits a still high tensile strength in a longitudinal direction by having a tensile strength ratio of 1.2 or more in longitudinal and transverse directions, a nonwoven fabric according to the method according to the present invention may achieve a tensile strength ratio of 1.0 in the longitudinal and transverse directions.

[90] Here,  $L_1$  is a total sum of the horizontal distance  $l_1$  of the nozzles 190, and  $L_0$  is a total sum of the nozzle distance  $l_0$  of the nozzles 190. Therefore, an angle formed by  $L_0$  and  $L_1$  is also the same as an angle  $\alpha$  formed by  $l_0$  and  $l_1$ .

[91] Further, a spunbonded nonwoven fabric having uniform density distribution can be manufactured by the air current interference preventing plates 200 installed under the nozzles 190 in the present invention.

[92] The conventional technique has allowed frictional electricity to be generated by preparing collision plates 10 to generate static electricity by friction, thereby colliding filaments with the collision plates 10. Therefore, the amount of compressed air supplied to the stretching pipes 30 cannot help being increased to generate more static electricity, and a heavy metal material such as lead (Pb) having a high discharge sequence with the synthetic fiber has been used a material for the collision plates 10 to effectively generate friction in the conventional technique. Further, the conventional technique has had a limitation in that the manufactured collision plates 10 are used after manufacturing the collision plates 10 in a long integrated form in front of the nozzles 10 in a state that the nozzles 20 are arranged in a line when arranging the nozzles 20.

[93] However, an inclination angle is formed by arranging the spinning blocks 130 or the plurality of stretching pipes 160' and the plurality of nozzles 190 at a slope which is not 0 with respect to a direction that is perpendicular from the progress direction of the conveyor 210 in the present invention. Therefore, air current interference preventing plates 200 which are divided such that the air current interference preventing plates 200 have a shorter width than the collision plates instead of long integrated collision plates 10 are provided in the lower part in front of each of the nozzles 190 to minimize air current interference between adjacent nozzles 190. The air current interference preventing plates 200 block an air flow and prevent a vortex of air generated due to diffusion of a large amount of air current

discharged from the adjacent nozzles 190.

**[94]** It is impossible to prevent a phenomenon that air currents interfere with each other between the nozzles 20 since air currents can be scattered in both directions of width of the collision plates 10 when the long integrated collision plates 10 adopted in the conventional technique are used. When the air currents interfere each other, it is apprehended that interference of the air currents not only interrupt progress of filaments moved in both directions of the width, but also generates a vortex such that a nonwoven fabric may also have poor weight distribution and tensile strength ratio in longitudinal and transverse directions. Accordingly, the present invention prevents a vortex of air from being generated and blocks an air flow by including air current interference preventing plates 200 which are divided for each of the nozzles 190 and have a short width to solve such problems.

**[95]** Width  $l_a$  of the air current interference preventing plates 200 of the present invention preferably has a numerical value of about the horizontal distance  $l_1$  of the nozzles 190 + (20 to 100 mm), and more preferably a numerical value level of the horizontal distance  $l_1$  of the nozzles 190 + (20 to 60 mm).

**[96]** Here, when the width  $l_a$  is too short, an air current moved in a transverse direction may be flown out in a web progress direction, and circumstances that weight distribution and tensile strength in a longitudinal direction are increased may be generated accordingly. In contrast, when the width  $l_a$  is too long, there is a problem that installation and operation are difficult.

**[97]** Although examples of a material for the air current interference preventing plates 200 may preferably include non-conductive materials including ceramics, it is fine to use an earthed conductive metals as the material for the air current interference preventing plates 200. Further, the examples of a material for the air current interference preventing plates 200 may include materials which are electrically charged with the same polarity such as

electrically charged filaments. As a result, it is fine to use any materials as the material for the air current interference preventing plates 200 if the electrically charged filaments are not adhered to the air current interference preventing plates 200.

**[98]** A vertical length  $l_b$  of the air current interference preventing plates 200 is preferably a level of 50 to 150 mm. Here, if the vertical length  $l_b$  of the air current interference preventing plates 200 is too short, an air current moved in a lower direction may be flown out in a web progress direction, i.e., a direction in which the conveyor 210 transfers filaments, and weight distribution and tensile strength in a longitudinal direction of the spunbonded nonwoven fabric may be increased accordingly. Further, a problem that fibers are adhered to the air current interference preventing plates 200 may be generated since a speed of the filaments discharged from the nozzles 190 is lowered if the vertical length  $l_b$  of the air current interference preventing plates 200 is too long. Accordingly, the width  $l_a$  and the vertical length  $l_b$  of the air current interference preventing plates 200 are preferably maintained as described above.

**[99]** Although it is preferable to vertically maintain the air current interference preventing plates 200, the air current interference preventing plates 200 may be formed by allowing the air current interference preventing plates 200 to maintain a predetermined angle to prevent adhesion of the filaments discharged from the nozzles 190. Namely, since an air current is discharged in a web progress direction, i.e., a direction in which the conveyor 210 transfers filaments when an angle  $\beta$  at which the air current interference preventing plates 200 are inclined in a direction that is perpendicular from the ground is too large, weight distribution of the spunbonded nonwoven fabric may be deteriorated, and tensile strength in a longitudinal direction of the spunbonded nonwoven fabric may be increased. Therefore, the angle  $\beta$  is maintained to 30 degrees of an angle or less, and more preferably 20 degrees of an angle or less.

**[100]** It is necessary that a distance  $d$  between the air current interference preventing plates 200 and the nozzles 190 also maintains a predetermined distance. If the distance  $d$  is narrow, a case that the nozzles 190 are clogged by a phenomenon such as filament fibers break or drop exhibited by an intermittent spinnability fault is generated. Further, if the distance  $d$  is wide, a running speed of the filaments discharged from the nozzles 190 is dropped, thereby generating a case that the filaments are adhered to the air current interference preventing plates 200. Therefore, it is preferable that the distance between the air current interference preventing plates 200 and the nozzles 190 is maintained to a level of 6 to 30 mm.

**[101]** As illustrated in FIG. 3, two or more of plural spinning blocks 130 may be provided in a web progress direction to further increase productivity in the present invention. In this case, a distance  $W$  between the spinning blocks 130 arranged in a plural number is important. That is, there is a possibility that density distribution of filaments becomes non-uniform since air flows jetted from front and rear rows of the spinning blocks 130 are interfered with each other if the distance  $W$  between the spinning blocks 130 is narrow. In contrast, although possibility of air interference is reduced if the distance  $W$  is widened, manufacturing may be difficult, and a lot of costs may be required since dimensions of the conveyor 210 is increased more than necessary. Accordingly, it is necessary to maintain an appropriate distance  $W$ , and the distance  $W$  is preferably maintained to a level of 0.5 M to 2.0 M.

**[102]** As illustrated in a drawing, a DC corona discharge unit 170 may be provided in the present invention. This will be described through FIG. 5.

**[103]** FIG. 5 is a drawing schematically showing the enlarged structure by enlarging a structure of charging with electricity filaments that have been stretched in and discharged from the apparatus for manufacturing the spunbonded nonwoven fabric illustrated in FIG. 2.

**[104]** As illustrated in FIG. 5, the corona discharge unit 170 discharges a corona which emits an ion beam by connecting a DC high voltage generated from a high voltage generator

(HVG) 180 to discharge needles 172. While DC ions generated from the discharge needles 172 are being attached to and electrically charged on the surface of filaments continuously moved, fibers can be separated and diffused by repulsive force of the ions electrically charged with the same polarity.

5 **[105]** In the present invention, compressed air is flown into the corona discharge unit 170 such that the corona discharge unit 170 increases the amount of ions attached to the surface of the fibers. Clean air which does not contain moisture or impurities should be used as the compressed air (Instrument Air, IA). If air containing moisture or impurities is used, there may be problems that spark may be generated or an insulated portion may be destroyed, and  
10 the discharge needles 172 are contaminated when performing discharge at a high voltage. An discharge electrode 171 is made of a copper or brass material which is easily electrically conductive, the discharge needles 172 comprise a stainless steel material having excellent strength and toughness, and the discharge electrode 171 has a hole having a diameter level of 0.3 to 1.0 mm formed in the surface thereof. Although a supply amount of the compressed  
15 air is not determined, the supply amount of the compressed air is adjusted such that compressed air supplied to a rear end of the discharge electrode 171 has a pressure level of 0.05 to 1.0 Kg/cm<sup>2</sup>G.

**[106]** Compressed air flown into the corona discharge unit 170 may be jetted to the circumference of the discharge needles 172 through the hole formed in the discharge  
20 electrode 171. The jetted compressed air increases the amount of ions generated from front end portions of the discharge needles 172, and allows the electrically charged ions of air to be more easily in contact with filaments, thereby increasing the amount of ions attached to the filaments and enabling the ions to be uniformly attached to the filaments at the same time. Further, the jetted compressed air may also play a role of increasing lifetime of the discharge  
25 needles 172 by preventing contaminants from being attached to the surface of the discharge

needles 172.

**[107]** In addition, a protective cover 173 is provided in front of the discharge needles 172 to protect the discharge needles 172 such that the filaments or other alien substances are not directly brought into contact with the discharge needles 172. The protective cover 173 is made of an insulating material which is not electrically conductive.

**[108]** Pressure of air can be adjusted by forming size of a passage through which compressed air flows into the discharge electrode 171 such that air can be always flown into front ends of the discharge needles 172. A vortex may be generated since an air flow comes into contact with filaments discharged in a vertically downward direction when the compressed air has a high supply pressure. Therefore, it is preferable to use the compressed air in a state that compressed air flown in maintains a low pressure.

**[109]** Further, a corona discharge unit 170 and a structure may be diversely implemented through FIG. 6 and FIG. 7 in the present invention.

**[110]** FIG. 6 is a drawing schematically showing other embodiment of the structure of charging the filaments with electricity illustrated in FIG. 5, and FIG. 7 is a drawing schematically showing another embodiment of the structure of charging the filaments with electricity illustrated in FIG. 5.

**[111]** As illustrated in FIG. 6 to FIG. 7, it is also possible in the present invention that position of the corona discharge unit 170 is positioned under the nozzles 190. Namely, FIG. 6 illustrates that the filaments are electrically charged by the corona discharge unit 170 after the filaments are first collided with the air current interference preventing plates 200 when filaments that have been stretched through the stretching pipes 160' are discharged from the nozzles 190. Accordingly, the filaments can be electrically charged by the corona discharge unit 170 after the filaments are discharged although the filaments are not electrically charged when the filaments are discharged from the nozzles 190, the amount of ions generated from

front end portions of the discharge needles 172 is increased by allowing the compressed air flown into the corona discharge unit 170 to be jetted to the circumference of the discharge needles 172 through the hole formed in the discharge electrode 171, and the amount of ions attached to the filaments is increased, and the ions can be uniformly attached to the filaments at the same time by enabling the electrically charged ions of air to be more easily in contact with the filaments.

**[112]** Further, the corona discharge unit 170 may be formed in a state that a side surface of the corona discharge unit 170 is also inclined as much as an angle  $\beta$  at which the air current interference preventing plates 200 are inclined from a direction that is perpendicular from the ground in FIG. 7. Accordingly, since the discharge needles 172 are also lengthened identically to the side surface of the corona discharge unit 170 as it goes to lower portions of the discharge needles 172 provided within the corona discharge unit 170, the air current interference preventing plates 200 can maintain an electrically charged position at the angle  $\beta$  at which the air current interference preventing plates 200 are inclined from a direction that is perpendicular from the ground.

**[113]** As a result, a spunbonded nonwoven fabric can be manufactured in the present invention by allowing the spinning blocks 130 to melt a thermoplastic synthetic fiber at high temperatures to spin the thermoplastic synthetic fiber into filament bundle 1, stretching spun filaments through a plurality of stretching pipes 160', allowing the nozzles 190 connected to each of the plurality of stretching pipes 160' to discharge the filaments, allowing the air current interference preventing plates 200 to block a flow of air applied to the filaments, collecting and arranging the filaments on the conveyor 210, and transferring the filaments in a first direction, thereby bonding the filaments. The first direction is the conveying direction of the conveyor 210 or longitudinal direction or progress direction or machine direction.

**[114]** Using the corona discharge unit 170 in the present invention is a method which is

particularly useful when increasing the number of filament strands to enhance productivity of a low weight nonwoven fabric of 60 g/m<sup>2</sup> or fine, or thin filaments with a diameter of 3 deniers or less. For example, since speed of the conveyor 210 is fast in the case of a low weight nonwoven fabric of 20 g/m<sup>2</sup> or less, density distribution of the low weight nonwoven fabric becomes non-uniform, and spunbonded filaments composing the nonwoven fabric may be easily arranged in a longitudinal direction in which the nonwoven fabric is manufactured. However, when the corona discharge unit 170 is used, or compressed air is flown into the corona discharge unit 170 as in the present invention, a nonwoven fabric with excellent weight distribution can be manufactured by allowing filaments to be easily electrically charged, separated and dispersed, and decreasing a probability of generating problems such as twist and entanglement between the filaments. Further, the present invention can disperse the fibers by sufficiently electrically charging the surface of fibers regardless of diameter or number of the filaments.

**[115]** This is an effect that is impossible in a conventional frictional discharge method, and the present invention easily electrically charges the discharge needles 172 and can improve service life of the discharge needles 172 by flowing compressed air into the discharge needles 172. Therefore, the present invention not only can improve both productivity and quality by including the corona discharge unit 170, but also can provide the corona discharge unit 170 such that various product groups are produced at the same facilities.

**[116]** As described above, the present invention provides an excellent technique which satisfies both weight distribution and strength ratio in longitudinal and transverse directions of spunbonded nonwoven fabric. Particularly, the present invention provides a new manufacturing technique of spunbonded nonwoven fabric having excellent weight distribution and equal strength ratio in longitudinal and transverse directions even in a low weight product of 60 g/m<sup>2</sup> or less and a ultra-low weight product of 20 g/m<sup>2</sup> or less. Further,

the present invention can improve productivity regardless of diameter of filaments manufactured, and is human body friendly and environmentally friendly at the same time even when spunbonded nonwoven fabric products are manufactured and used.

**[117]** Hereinafter, Examples of the present invention will be described. Effects and results of the present invention are not limited to the following Examples. Physical performances of nonwoven fabrics manufactured in the present Examples and Comparative Examples were evaluated using JIS L 1906 (an evaluation method of a spunbonded nonwoven fabric). The present Examples were implemented based on structures and above descriptions of apparatuses illustrated in FIG. 2 to FIG. 7.

**[118]** [Examples 1 to 3, and Comparative Examples 1 to 2]

**[119]** Filaments were manufactured through spinning nozzles by melting a polyester chip having an intrinsic viscosity (IV) of 0.655 at a spinning temperature of 296 °C. At this time, pressure of compressed air flown into stretching pipes 160' was adjusted to set a discharge amount of the filaments such that a spinning speed of the filaments became 5,200 m/min, and the filaments were manufactured to a diameter of 9 deniers. While adjusting the number of filaments introduced into the stretching pipes 160' to 20 to 40 filaments, weight distributions, tensile strengths in longitudinal and transverse directions and tensile strength ratios in the longitudinal and transverse directions of nonwoven fabrics along with production capacity variations were each examined.

**[120]** Moreover, an inclination angle of the spinning blocks 130 was fixed to 35 degrees of an angle, and the nozzle distance  $l_0$  was fixed to 80 mm. The width  $l_a$  and vertical length  $l_b$  of the air current interference preventing plates 200 were fixed to 120 mm, the distance  $d$  between the nozzles 190 and the air current interference preventing plates 200 was fixed to 15 mm, and the angle formed by the nozzles 190 and the air current interference preventing plates 200 was fixed to a vertical angle. An discharge voltage of a DC high voltage

generator 180 introduced into the corona discharge unit 170 was fixed to 22 KV, and air with a pressure of 0.25 Kg/cm<sup>2</sup>G was constantly supplied.

**[121]** In Comparative Examples, the apparatus of FIG. 1 was used, the horizontal distance  $l_1$  of the nozzles 190 was fixed to 80 mm, and the collision plates 10 were made of lead (Pb) which was favorable to frictional discharge.

**[122]** Widths of the manufactured nonwoven fabrics were 1.0 m, a surface temperature of a calender roll for thermal bonding 230 was fixed to 254 °C, and a pressure of the calender roll for thermal bonding 230 was fixed to 47 Kg/cm. Weights of the nonwoven fabrics finally wound on the winder 250 were 80 g/m<sup>2</sup>.

**[123]** The process of examining weight distributions of the manufactured nonwoven fabrics was performed by collecting width-wise samples and evaluating CV% of the collected width directional samples. Nonwoven fabric samples for weight evaluation were each fixed to a length of 10 cm in a machine direction (MD) and a cross direction (CD), 10 of the samples were collected in a width direction to primarily examine CV% of the collected width directional samples, and then 10 of the samples were again collected in a longitudinal direction after 10 m to examine CV% of the collected longitudinal directional samples in the same method as in the primary examination process. Twice evaluation results were put together and recorded in the following table 1. After observing defects such as twist, roping and entanglement of filaments shown in the surface of the nonwoven fabrics with the naked eyes of three evaluators using these samples, the defects were divided into five grades and recorded (1: very poor, 2: poor, 3: fair, 4: good, 5: excellent).

**[124]** [Table 1]

**[125]** Tensile strength, tear strength=MD/CD

| Classification | Example 1 | Example 2 | Example 3 | Comparative | Comparative |
|----------------|-----------|-----------|-----------|-------------|-------------|
|----------------|-----------|-----------|-----------|-------------|-------------|

|                                                  |                                      |           |           |           | Example 1 | Example 2 |
|--------------------------------------------------|--------------------------------------|-----------|-----------|-----------|-----------|-----------|
| Number of filaments<br>(stretching pipe)         |                                      | 30        | 35        | 40        | 20        | 30        |
| Through-put<br>(g/min/stretching pipe)           |                                      | 156       | 182       | 208       | 104       | 156       |
| Physical<br>properties of<br>nonwoven<br>fabrics | Weight<br>distribution<br>(CV%)      | 4.1       | 4.6       | 4.8       | 6.2       | 7.5       |
|                                                  | Tensile<br>strength<br>(Kg/5 cm)     | 13.7/13.8 | 13.3/13.9 | 13.2/13.3 | 16.5/8.2  | 16.1/7.9  |
|                                                  | Tensile<br>strength ratio<br>(MD/CD) | 1.0       | 1.0       | 1.0       | 2.0       | 2.0       |
|                                                  | Tear strength<br>(Kgf)               | 1.1/1.3   | 1.2/1.2   | 1.2/1.1   | 0.8/1.4   | 0.7/1.2   |
|                                                  | Defect<br>evaluation<br>grade        | 5         | 5         | 4         | 2         | 1         |

**[126]** [Examples 4 to 7, and Comparative Examples 3 to 4]

**[127]** Filaments were manufactured at a spinning temperature of 220 °C using a polypropylene chip with a melt index (MI) of 26. At this time, the filaments were adjusted to a thickness of 2.2 deniers at a spinning speed of 3,600 m/min. The number of filaments introduced into the stretching pipes 160' was fixed to 200 strands, and a DC high voltage

electricity of 24 KV and an air pressure of 0.40 Kg/m<sup>2</sup> were constantly supplied to the corona discharge unit 170. Speed of the conveyor 210 was adjusted such that weights of finally manufactured nonwoven fabrics became 24 g/m<sup>2</sup>. A temperature of a calender roll for thermal bonding 230 was fixed to 164 °C, and a pressure of the calender roll for thermal bonding 230 was fixed to 35 Kg/cm. At this time, the nozzle distance  $l_0$  was fixed to 85 mm, and physical properties of the nonwoven fabrics were examined while changing an inclination angle of the spinning blocks 130 to 0 to 80 degrees of an angle. Other manufacturing apparatuses and conditions were the same as in Example 1, and physical properties of the manufactured nonwoven fabrics were also examined in the same manner as in Example 1 to obtain examination results. The examination results are shown in the following table 2. The same apparatus as in Comparative Example 1 was used in Comparative Example 4, and the number of the filaments introduced into the stretching pipes 160' was fixed to 100 strands.

**[128]** [Table 2]

**[129]** Tensile strength, tear strength=MD/CD

| Classification                                     |        | Example 4 | Example 5 | Example 6 | Example 7 | Comparative<br>Example 3 | Comparative<br>Example 4 |
|----------------------------------------------------|--------|-----------|-----------|-----------|-----------|--------------------------|--------------------------|
| Spinning block angle<br>(degrees)                  |        | 20        | 35        | 45        | 60        | 15                       | 0                        |
| Vertical distance between<br>nozzles ( $l_2$ mm)   |        | 30        | 49        | 60        | 74        | 22                       | 0                        |
| Horizontal distance between<br>nozzles ( $l_1$ mm) |        | 80        | 70        | 60        | 43        | 82                       | 80                       |
|                                                    | Weight |           |           |           |           |                          |                          |

|                                         |                                |         |         |         |         |         |         |
|-----------------------------------------|--------------------------------|---------|---------|---------|---------|---------|---------|
| Physical properties of nonwoven fabrics | distribution (CV%)             | 4.8     | 4.1     | 3.6     | 3.5     | 6.9     | 7.3     |
|                                         | Tensile strength (Kg/5 cm)     | 6.6/5.6 | 5.9/5.7 | 5.8/5.9 | 5.4/6.1 | 6.4/3.9 | 7.8/2.6 |
|                                         | Tensile strength ratio (MD/CD) | 1.2     | 1.0     | 1.0     | 0.9     | 1.6     | 2.8     |
|                                         | Tear strength (Kgf)            | 0.2/0.2 | 0.2/0.2 | 0.2/0.3 | 0.2/0.2 | 0.1/0.3 | 0.1/0.3 |
|                                         | Defect evaluation grade        | 4       | 5       | 5       | 5       | 2       | 1       |

**[130]** [Examples 8 to 12, and Comparative Example 5]

**[131]** After setting the same conditions as in Example 5, trials were conducted. An inclination angle of the spinning blocks 130 was fixed to 38 degrees of an angle. At this time, while continuously changing the nozzle distance  $l_0$  to 30 to 200 mm, the trials were conducted to obtain test results. The test results are examined and shown in the following table 3.

**[132]** [Table 3]

**[133]** Tensile strength, tear strength=MD/CD

|                |           |           |            |            |            |             |
|----------------|-----------|-----------|------------|------------|------------|-------------|
| Classification | Example 8 | Example 9 | Example 10 | Example 11 | Example 12 | Comparative |
|----------------|-----------|-----------|------------|------------|------------|-------------|

|                                                    |                                         |         |         |         |         |         |           |
|----------------------------------------------------|-----------------------------------------|---------|---------|---------|---------|---------|-----------|
|                                                    |                                         |         |         |         |         |         | Example 5 |
| Vertical distance between<br>nozzles ( $l_2$ mm)   |                                         | 30      | 40      | 80      | 120     | 150     | 200       |
| Horizontal distance between<br>nozzles ( $l_1$ mm) |                                         | 23      | 31      | 63      | 94      | 117     | 156       |
| Physical<br>properties of<br>nonwoven<br>fabrics   | Weight<br>distribution<br>(CV%)         | 3.8     | 4.0     | 4.3     | 4.8     | 4.9     | 6.8       |
|                                                    | Tensile<br>strength<br>(Kg/5 cm)        | 6.4/5.6 | 6.4/5.8 | 6.2/6.1 | 5.9/6.3 | 5.6/5.7 | 4.7/5.4   |
|                                                    | Tensile<br>strength<br>ratio<br>(MD/CD) | 1.1     | 1.1     | 1.0     | 0.9     | 1.0     | 0.9       |
|                                                    | Tear<br>strength<br>(Kgf)               | 0.1/0.2 | 0.2/0.2 | 0.2/0.2 | 0.2/0.2 | 0.3/0.2 | 0.3/0.1   |
|                                                    | Defect<br>evaluation<br>grade           | 4       | 5       | 5       | 4       | 3.5     | 1         |

**[134]** [Examples 13 to 15, and Comparative Examples 6 to 8]

**[135]** After setting the same conditions as in Example 5, trials were conducted. While changing DC high voltage electricity and air pressure of the corona discharge unit 170, the tests were conducted to obtain test results. At this time, manufactured nonwoven fabrics

were manufactured to a weight of 18 g/m<sup>2</sup>. While adjusting the high voltage generator 180 to have a working current of 6 mA or less, the high voltage generator 180 was adjusted to generate a maximum voltage. The test results are examined and shown in the following table 4.

5 [136] [Table 4]

[137] Tensile strength, tear strength=MD/CD

| Classification                                                                     |                                  | Example 13 | Example 14 | Example 15 | Comparative<br>Example 6                                                             | Comparative<br>Example 7 | Comparative<br>Example 8                                                            |
|------------------------------------------------------------------------------------|----------------------------------|------------|------------|------------|--------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------|
| HVG voltage (KV)                                                                   |                                  | 15         | 20         | 24         | 30                                                                                   | 22                       | 0                                                                                   |
| Pressure of air supplied to<br>the corona discharge unit<br>(Kg/cm <sup>2</sup> G) |                                  | 0.15       | 0.15       | 0.15       | 0.15                                                                                 | 0                        | 0                                                                                   |
| Physical<br>properties of<br>nonwoven<br>fabrics                                   | Weight<br>distribution<br>(CV%)  | 4.9        | 4.3        | 4.2        | Generation<br>of spark<br>discharge /<br>Impossible<br>to<br>manufacture<br>a sample | 5.8                      | Poor weight<br>distribution /<br>Impossible<br>to measure<br>physical<br>properties |
|                                                                                    | Tensile<br>strength<br>(Kg/5 cm) | 4.6/4.3    | 4.7/4.5    | 4.6/4.5    |                                                                                      | 4.1/3.8                  |                                                                                     |
|                                                                                    | Tensile                          |            |            |            |                                                                                      |                          |                                                                                     |

|  |                               |         |         |         |  |         |  |
|--|-------------------------------|---------|---------|---------|--|---------|--|
|  | strength<br>ratio<br>(MD/CD)  | 1.0     | 1.0     | 1.0     |  | 1.0     |  |
|  | Tear<br>strength<br>(Kgf)     | 0.1/0.1 | 0.1/0.1 | 0.1/0.1 |  | 0.1/0.2 |  |
|  | Defect<br>evaluation<br>grade | 4       | 5       | 5       |  | 3       |  |

**[138]** [Example 16 and Comparative Examples 9 to 11]

**[139]** Trials were conducted in the same manner as in Example 2. The tests were conducted while adjusting the distance  $d$  between the air current interference preventing plates 200 and the nozzles 190, the vertical directional angle  $\beta$  of the air current interference preventing plates 200, and the width  $l_a$  and vertical length  $l_b$  of the air current interference preventing plates 200. Nonwoven fabrics were manufactured to a weight of 30 g/m<sup>2</sup>. After evaluating test results to obtain a test evaluation results, the obtained test evaluation results are examined and shown in the following table 5.

10 **[140]** [Table 5]

**[141]** Tensile strength, tear strength=MD/CD

| Classification              | Example 16 | Comparative<br>Example 9 | Comparative<br>Example 10 | Comparative<br>Example 11 |
|-----------------------------|------------|--------------------------|---------------------------|---------------------------|
| Distance ( $d$ mm)          | 15         | 15                       | 15                        | 30                        |
| Width ( $l_a$ mm)           | 120        | 120                      | 120                       | 120                       |
| Vertical length ( $l_b$ mm) | 100        | 100                      | 50                        | 120                       |

| Angle (degrees)                         |                                | 20      | 30      | 20      | 10                                                                                                                                     |
|-----------------------------------------|--------------------------------|---------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------|
| Physical properties of nonwoven fabrics | Weight distribution (CV%)      | 4.0     | 4.6     | 5.3     | Generating a phenomenon that fibers are adhered to the air current interference preventing plates / Impossible to manufacture a sample |
|                                         | Tensile strength (Kg/5 cm)     | 7.3/7.5 | 8.6/6.1 | 7.9/6.3 |                                                                                                                                        |
|                                         | Tensile strength ratio (MD/CD) | 1.0     | 1.4     | 1.3     |                                                                                                                                        |
|                                         | Tear strength (Kgf)            | 0.3/0.2 | 0.2/0.3 | 0.3/0.3 |                                                                                                                                        |
|                                         | Defect evaluation grade        | 5       | 4       | 3       |                                                                                                                                        |

**[142]** Although the present invention has been described along with the accompanying drawings, this is only one of various examples including the gist of the present invention and has an object of enabling a person having ordinary skill in the art to easily practice the invention. Accordingly, it is evident that the present invention is not limited to the  
5    aforementioned examples. Accordingly, the range of protection of the present invention should be interpreted based on the following claims, and all of technological spirits within the equivalents of the present invention may fall within the range of right of the present invention by changes, substitutions and replacements without departing from the gist of the present  
10    invention. Furthermore, it is evident that the configurations of some drawings have been provided to more clearly describe configurations and have been more exaggerated or reduced than actual configurations.

**[143]** [Description of marks]

1: Filament fiber bundle

110: Raw material storage and supply tank

5 120: Extrusion unit

130: Spinning blocks

140: Exhaust unit

150: Filament cooling unit

160: Stretching unit

10 160': Stretching pipes

170: Corona discharge unit

171: Discharge electrode

172: Discharge needles

173: Protective cover

15 174: Ground electrode

180: High voltage generator

190: Nozzles

200: Air current interference preventing plates

210: Conveyor

20 220: Suction unit

230: Calender roll

240: Cooling roll

250: Winder

25 <Conventional Technique>

|   |                      |
|---|----------------------|
|   | 10: Collision plates |
|   | 20: Nozzles          |
|   | 30: Stretching pipes |
|   | 40: Spinning blocks  |
| 5 | 50: Conveyor         |

**What is claimed is:**

1. An apparatus for manufacturing spunbonded nonwoven fabric, the apparatus including:

5 a plurality of nozzles which are each connected to a plurality of stretching pipes to discharge filaments stretched through the plurality of stretching pipes; and

a conveyor which collects the filaments to transfer the collected filaments in a first direction,

10 wherein the plurality of nozzles are arranged at a slope that is not 0 with respect to a direction that is perpendicular from the first direction.

2. The apparatus of claim 1, wherein an angle at which the plurality of nozzles are arranged at a slope that is not 0 is between 20 degrees of an angle and 80 degrees of an angle.

15 3. The apparatus of claim 2, wherein an angle at which the plurality of nozzles are arranged at a slope that is not 0 is between 30 degrees of an angle and 45 degrees of an angle.

4. The apparatus of claim 1, additionally including:

20 at least one spinning block which is interlocked with the plurality of stretching pipes and melts a thermoplastic synthetic fiber at high temperatures to spin a filament bundle to the plurality of stretching pipes; and

a stretching unit which includes the plurality of stretching pipes and stretches the filament bundle spun from the spinning blocks through the plurality of stretching pipes, wherein the plurality of nozzles are connected to lower portions of the plurality of stretching  
25 pipes.

5. The apparatus of claim 1, wherein an interval at which the plurality of nozzles are arranged with each other is a horizontal distance between 40 mm and 150 mm, and a vertical distance of at least 30 mm.

30 6. The apparatus of claim 1, including a plurality of air current interference preventing

plates which are formed to be separated at a predetermined distance from each of the plurality of nozzles correspondingly to each of the plurality of nozzles and block a flow of air applied to the filaments.

5           7. The apparatus of claim 6, wherein an angle at which one of the plurality of air current interference preventing plates is inclined is between 0 degree of an angle and 30 degrees of an angle based on a state that is perpendicular from the ground.

10           8. The apparatus of claim 6, wherein a separated distance between one of the plurality of air current interference preventing plates and one of the plurality of nozzles is between 6 mm and 30 mm.

15           9. An apparatus for manufacturing spunbonded nonwoven fabric, the apparatus including: a plurality of nozzles which are each connected to a plurality of stretching pipes to discharge filaments that have been stretched through the plurality of stretching pipes; and a conveyor which collects the filaments to transfer the collected filaments in a first direction, wherein points at which the filaments are brought into contact with the conveyor and collected with respect to the direction that is perpendicular from the first direction are different from one another.

20           10. A method for manufacturing spunbonded nonwoven fabric, the method comprising the steps of:

              spinning the thermoplastic synthetic fiber into a filament bundle by allowing spinning blocks to melt a thermoplastic synthetic fiber at high temperatures;

25           stretching the spun filaments through a plurality of stretching pipes;

              allowing a plurality of nozzles connected to each of the plurality of stretching pipes to discharge the filaments;

              allowing air current interference preventing plates to block a flow of air applied to the filaments;

30           collecting the filaments from the plurality of nozzles to arrange the collected filaments on a conveyor; and

transferring the arranged filaments in a first direction to bond the filaments,  
wherein the plurality of nozzles are arranged at a slope that is not 0 with respect to the  
direction that is perpendicular from the first direction.