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(54) **PLANT FOR PRODUCING NON-WOVEN FABRIC**

(57) Plant for producing non-woven fabric, which comprises a descent path (3) along a vertical axis (Y) between an upper inlet (4) and a lower outlet (5), an extrusion unit (29) in order to introduce filaments for forming non-woven fabric into the descent path (3), a cooling unit (6) in order to cool the filaments, and a stretching unit (7) placed below the cooling unit (6). The stretching unit (7) comprises a stretching duct (70), which is extended with seal continuity between an upper mouth (71), having a specific first transverse section (S1), and a lower mouth (72), having a specific second transverse section (S2). The stretching duct (70) comprises an adjustment section (74) which is extended being narrowed, with a given convergence angle ($\alpha 1$), from the upper mouth (71) to a narrow section (73) having a specific third transverse section (S3). In addition, the stretching duct (70) comprises a diffusion section (75) which is extended being widened from the narrow section (73) to the lower mouth (72) with a specific divergence angle ($\alpha 2$). The plant also comprises ventilator means (8), adapted to generate a flow of gas traversing the stretching duct (70).

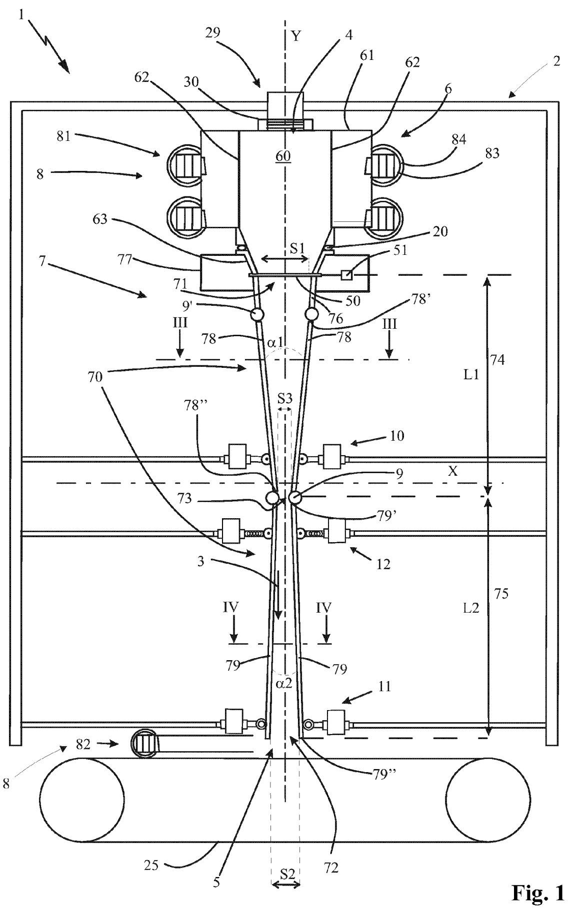

Fig. 1

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Description

Field of application

[0001] The present invention regards a plant for producing nonwoven fabric, in particular made of plastic material, according to the preamble of the independent claim number 1.

[0002] The present plant for producing nonwoven fabric is intended to be advantageously employed in the field of production of fiber webs adapted to form a nonwoven fabric, which is also normally web-like.

[0003] In particular, the plant, object of the present invention, is advantageously employable for producing a continuous web of semifinished nonwoven fabric, intended to undergo subsequent transformations in order to obtain a finished product.

[0004] Such webs are normally used in particular for producing sanitary products, such as caps, masks and gloves or in the agriculture field for producing nonwoven fabric intended to be set on the ground to be cultivated, in order to remedy the formation of weeds and/or to protect seeds.

[0005] The invention is therefore inserted in the industrial field of production of web-like material of nonwoven fibers, or more generally in the field of production of nonwoven fabric.

State of the art

[0006] It has been known for some time, in the field of production of fiber webs made of plastic material, to produce nonwoven fabric, such as for example spunbond of polypropylene, polyester, polyethylene and/or other polymers, in particular for producing bandages, gauzes, caps, masks and other sanitary products, or for example for producing nonwoven fabric intended to be used in the agriculture field for covering ground to be cultivated.

[0007] More generally, the nonwoven fabric is a semifinished product intended to sustain successive working steps for producing products of various type, normally made of plastic material and with web form or with web superimposition. Such webs are formed by filaments placed in a random manner in layers and usually joined in a mechanical manner, or by means of adhesives or at least partially melted by means of heat.

[0008] In the aforesaid technical field of production of nonwoven fabric, plants for producing nonwoven fabric have been known for some time, which normally provide for forming a plurality of filaments of plastic material, which are stretched, laid on a conveyor belt and then pressed on each other in a random manner, in order to form the aforesaid nonwoven fabric webs.

[0009] On example of a plant for producing non-woven fabric is described in the document US 4,692,106. The plant described therein is vertically extended along a main channel, along which different operating stations are vertically provided for producing the aforesaid filaments of plastic material.

[0010] On the upper part, a unit is provided for extruding a plurality of filaments of plastic material at high temperature, which are introduced within the main channel through an upper inlet mouth, at which an extrusion head is placed, from which the filaments exit on the lower part. As is known, such extrusion head is provided on the lower part with a plurality of holes facing the upper inlet opening, from which a mass of melted plastic material exits in the form of filaments.

[0011] The filaments are normally extruded in the form of pasty plastic material, at high temperature, normally comprised between 150°C and 280°C.

[0012] On the lower part, a cooling unit is provided (known with the term "quenching" in the technical jargon of the field), in which an air flow is forcibly introduced within the main channel, by means of at least one fan placed outside the latter.

[0013] The air flow introduced into the cooling station cools the filaments that have formed upon exiting the extrusion head of the extrusion unit.

[0014] In addition, the air introduced into the main channel at the cooling unit elongates the filaments of plastic material within a segment with reduced section of the main channel, up to making them reach the desired size, for example up to making them reach a linear density of about 1 - 10 dtex.

[0015] In order to obtain the desired weave (i.e. a substantially random and uniform arrangement of the filaments) for producing the non-woven fabric, it is necessary to randomly weave together the filaments, forming a dense weave that is substantially without interruption.

[0016] For such purpose, the plant of known type is provided with an ejection station unit which defines, along one section of the main channel, a diffuser which terminates on the lower part with an outlet opening opposite the inlet opening.

[0017] More in detail, the air that flows within the diffuser is moved in a manner such to confer a turbulent motion thereto. In this manner, the filaments are thrust by the air and are weaved together in a substantially random manner in order to form the desired weave of the non-woven fabric.

[0018] In particular, the diffuser is extended downward, and in particular towards the outlet opening, with substantially hourglass shape, and is provided with an upper section which is extended, starting from the cooling unit, narrowing up to an intermediate narrow section, and a lower section which is extended starting from such intermediate narrow section, widening up to the outlet opening. In this manner, the air that flows within the diffuser encounters the aforesaid narrow section followed by an increase of the section in the lower section of the diffuser and takes on a turbulent motion, mixing and weaving the filaments.

[0019] In particular, the diffuser has lateral walls made of flexible material and multiple actuators connected to such lateral walls that are actuatable for deforming the latter so as to modify the section of the diffuser itself, in order to obtain a different distribution of filaments in the final product.

[0020] The plant of known type, below the ejection unit, provides for a conveyor belt placed below the outlet opening with which the diffuser terminates in order to receive the filaments.

[0021] The conveyor belt is moved in order to advance the filaments thus set along a substantially horizontal movement direction, in order to form the web of non-woven fabric.

[0022] Subsequently, the web of non-woven fabric thus obtained undergoes further working steps such as for example a pressing, and is then moved towards a winding station in which web is wound around a support core in order to form reels of non-woven fabric, allowing a quick storage and transport thereof.

[0023] The plant for producing non-woven fabric of known type described briefly above has shown in practice that it does not lack drawbacks.

[0024] The main drawback lies in the fact that the plant of known type does not allow an optimal adjustment of the turbulence level in proximity to the deposition station during the production operations, therefore it is not possible to optimize the distribution of the filaments on the conveyor belt as a function of the thickness of the filaments themselves.

[0025] Another drawback is given by the fact that the plant of known type does not allow easily disconnecting the diffuser from the cooling unit in order to allow normal cleaning and maintenance operations of the plant itself.

[0026] The patent application US 2003/0178742 A1 describes a plant for producing non-woven fabric, which comprises an ejection station provided with an upper diffuser and a lower diffuser separated from each other by an interspace for the introduction of secondary air. In particular, the upper diffuser is provided with converging upper walls and diverging lower walls, having tilt angle (with respect to the vertical) comprised between 0.5 and 3°.

[0027] Also the latter solution of known type, nevertheless, do not allow optimizing the distribution of the filaments on the conveyor belt as a function of the thickness of the filaments themselves.

Presentation of the invention

[0028] In this situation, the problem underlying the present invention is therefore that of overcoming the drawbacks manifested by the plants for producing non-woven fabric of known type, by providing a plant and a process for producing non-woven fabric, which allow adjusting the distribution of filaments within the main channel.

[0029] A further object of the present invention is to provide a plant for producing non-woven fabric which allows quickly carrying out operations of cleaning and maintenance of the extrusion unit and of the ejection unit.

[0030] A further object of the present invention is to provide a plant for producing non-woven fabric which is structurally and operatively simple, entirely reliable and capable of operating in any operating condition.

[0031] A further object of the present invention is to provide a plant for producing non-woven fabric which is simple to use by operations.

Brief description of the drawings

[0032] The technical characteristics of the invention, according to the aforesaid objects, can be clearly seen in the contents of the below-reported claims and the advantages thereof will be more evident in the following detailed description, made with reference to the enclosed drawings, which represent a merely exemplifying and non-limiting embodiment of the invention, in which:

- figure 1 illustrates a schematic sectional view of a plant for producing non-woven fabric, object of the present invention;
- figure 2 shows a detail of the plant for producing non-woven fabric illustrated in figure 1, regarding the connection between a first and second wall of a stretching unit;
- figure 3 shows a sectional view of the present plant according to the trace III-III of figure 1;
- figure 4 shows a sectional view of the present plant according to the trace IV-IV of figure 1.

Detailed description of a preferred embodiment

[0033] With reference to the enclosed drawings, reference number 1 overall indicates a plant for producing nonwoven fabric, according to the present invention.

[0034] This is intended to be employed for producing nonwoven fabric of different type and material, such as in particular spunbond made of plastic material, e.g. polypropylene and/or polyethylene, and in particular polyethylene terephthalate (PET in the technical jargon of the field).

[0035] Hereinbelow, reference will be made to a plant 1 for producing nonwoven fabric made of plastic material, in accordance with the preferred embodiment illustrated in the enclosed figures. Nevertheless, the plant 1 of the present invention can also be advantageously employed for producing nonwoven fabric of another type, per se well known to the man skilled in the art and therefore not described in detail hereinbelow. Therefore, hereinbelow with the term "nonwoven fabric", it must be intended a substantially web-like material composed of a plurality of filaments compressed on each other in a substantially random manner.

[0036] In particular, the nonwoven fabric is normally composed of a plurality of filaments of plastic material joined together by means of a mechanical action, e.g. by means of crushing.

[0037] With reference to the example of figure 1, the plant 1 for producing non-woven fabric according to the invention comprises a support structure 2 (illustrated schematically in figure 1) provided with a descent path 3 extended along a vertical axis Y between an upper inlet 4 and a lower outlet 5.

[0038] The plant 1 also comprises an extrusion unit 29, mounted on the support structure 2 and arranged for introducing filaments for forming a non-woven fabric in the descent path 3 through the inlet 4 of the latter.

[0039] Advantageously, the extrusion unit 29 comprises an extrusion head 30, mounted on the support structure 2 and positioned at the inlet 4 of the descent path 3. In particular, the extrusion head 30 is provided with multiple wire drawing holes directed downward and adapted to dispense filaments of molten material in order to form non-woven fabric. Advantageously, the plant 1 comprises feed means (not illustrated in the figures) connected to the extrusion head 30 and arranged for providing to the latter a continuous flow of molten plastic material intended to pass through the wire drawing holes in order to form the aforesaid filaments.

[0040] According to the invention, the plant 1 comprises a cooling unit 6 placed below the extrusion unit 29 and comprising a cooling chamber 60 placed along the descent path 3 and susceptible of being traversed by the filaments in order to cool them.

[0041] The plant 1 also comprises a stretching unit 7 placed below the cooling unit 6 and comprising a stretching duct 70, which is extended along the descent path 3 between an upper mouth 71, sealingly connected to the cooling chamber 60, and a lower mouth 72 placed at the outlet 5 of the descent path 3 itself.

[0042] In this manner, in operation, the filaments coming from the cooling chamber 60 are susceptible of entering into the stretching duct 70 through the aforesaid upper mouth 71 of the latter and are susceptible of exiting from the stretching duct 70 itself through the aforesaid lower mouth 72.

[0043] Advantageously, the plant 1 comprises deposit means 25 (in particular a deposit belt), which are placed below the lower mouth 72 of the stretching channel 70 in order to receive the filaments exiting from the latter and transport them towards a station downstream of the plant 1.

[0044] The stretching duct 70 comprises an adjustment section 74, which is extended, along the vertical axis Y, between the upper mouth 71 and a narrow section 73, narrowing towards such narrow section 73 with a specific convergence angle $\alpha 1$.

[0045] In addition, the stretching duct 70 comprises a diffusion section 75, which is extended, along the vertical axis Y, between the narrow section 73 and the lower mouth 72, broadening towards the lower mouth 72 itself with a specific divergence angle $\alpha 2$.

[0046] In addition, the plant 1 comprises ventilator means 8, mounted on the support structure 2 and arranged for generating a flow of gas (e.g. air) adapted to traverse the stretching duct 70 and advantageously the cooling chamber 60, as described in detail hereinbelow. Advantageously, the decreasing width of the adjustment section 74 of the stretching duct 70 (with the aforesaid convergence angle $\alpha 1$) allows, due to the known Bernoulli laws, an acceleration and therefore an increase of the speed of the gas that flows therein. In particular, the air that accelerates along the adjustment section 74 simultaneously drives the filaments, bringing them to the desired thickness, comprised for example between 1 and 10 dtex.

[0047] The increasing width of the diffusion section 75 of the stretching duct 70 (with the aforesaid divergence angle $\alpha 2$) ensures that the air that flows therein encounters an increase of the section and slows up to taking on a turbulent motion, mixing and weaving the filaments that slide within the diffusion section 75 itself. In this manner, the filaments are thrust by the air and are woven with each other in a substantially random manner in order to form the aforesaid desired weave of the non-woven fabric. According to the invention, the upper mouth 71 of the stretching duct 70 is sealingly connected to the cooling chamber 60 and, in addition, the stretching duct 70 is extended from the upper mouth 71 to the lower mouth 72 with seal continuity, in a manner such that the gas flow generated by the ventilator means 8 is susceptible of entering into the stretching duct 70 only through the upper mouth 71 and of exiting from the same stretching duct 70 only through the lower mouth 72.

[0048] In this manner, along the extension of the stretching duct 70 from the upper mouth 71 to the lower mouth 72, there is no further entrance or exit of air into or from the stretching duct 70 itself.

[0049] In this manner, in particular, the air flow entering the upper mouth 71 of the stretching duct 70 is equal to the air flow exiting from the lower mouth 72 of the stretching duct 70 itself.

[0050] Advantageously, the ventilator means 8 are adapted to introduce the gas flow into the cooling chamber 60 from which the gas flow passes into the stretching duct 70 through the upper mouth 71 of the latter. In particular, since the stretching duct 70 is sealingly connected to the cooling chamber 60, the air flow that traverses the cooling chamber is the same entering the upper mouth 71 of the stretching duct 70.

[0051] With reference to the example of figure 1, the upper mouth 71 of the stretching duct 70 has a first transverse section S1 thereof, the lower mouth 72 from the stretching duct 70 has a second transverse section S2 thereof, and the narrow section 73 has a third transverse section S3 thereof.

[0052] The aforesaid first, second and third transverse sections S1, S2, S3 are defined on a plane orthogonal to the vertical axis Y of the descent path 3.

[0053] According to the idea underlying present invention, the following ratios are provided:

- the ratio between the first transverse section S1 of the upper mouth 71 of the stretching duct 70 and the third transverse section S3 of the narrow section 73 is comprised between 2 and 10, and preferably between 2 and 4;

- the ratio between the second transverse section S2 of said lower mouth 72 of the stretching duct 70 and the third transverse section S3 of said narrow section 73 is greater than 1 and lower than or equal to 10, and preferably is greater than 1 and lower than or equal to 4;
- the convergence angle $\alpha 1$ of the adjustment section 74 stretching duct 70 is greater than or equal to 1° and lower than or equal to 6°, and preferably between 1.8° and 2.3°;
- the divergence angle $\alpha 2$ of the diffusion section 75 of the stretching duct 70 is greater than 0° and lower than or equal to 4°, and preferably between 1.2° and 1.6°.

[0054] It was surprisingly and experimentally indicated that, in the configuration of the stretching duct 70 with seal continuity, the aforesaid ratios between the above-reported sizes allow obtaining an optimal distribution of the filaments of non-woven fabric, in relation to their thickness.

[0055] It is underlined that, in the schematic example of figure 1, the widths of the transverse sections S1, S2, S3 and of the convergence and divergence angle $\alpha 1$ and $\alpha 2$ are indicated not in scale (with increased dimensions) for representative clarity. Advantageously, the support structure 2 is extended according to a first direction X substantially orthogonal to the vertical axis Y and according to a second direction Z orthogonal to the vertical axis Y and to the aforesaid first direction X.

[0056] Preferably, the stretching duct 70 (and therefore its adjustment and diffusion sections 74, 75) is extended width-wise according to the aforesaid first direction X and is extended depth-wise according to the aforesaid second direction Z.

[0057] In particular, the adjustment section 74 of the stretching duct 70 has width (defined along the aforesaid first direction X) which decreases from the upper mouth 71 towards the narrow section 73 (according to the aforesaid convergence angle $\alpha 1$), and the diffusion section 75 of the stretching duct 70 has width (defined along the aforesaid first direction X) which increases from the narrow section 73 towards the lower mouth 72 (according to the aforesaid divergence angle $\alpha 2$).

[0058] In this manner, advantageously, the width of the first, second and third transverse sections S1, S2 and S3 are defined by the width of the stretching duct 70 at, respectively, the upper mouth 71, the lower mouth 72 and the narrow section 73. Preferably, in accordance with a particular embodiment, the stretching duct 70 (and therefore the adjustment and diffusion sections 74, 75) is extended depth-wise with constant width along the second direction Z.

[0059] In such case in particular, the widths of the first, second and third transverse section S1, S2 and S3 have the same above-indicated ratios between the transverse sections S1, S2 and S3 themselves.

[0060] For example, the width of the first transverse section S1 is comprised between 50 mm and 150 mm, the width of the second transverse section S2 is comprised between 30 mm and 100 mm, and the width of the third transverse section S3 is comprised between 10 mm and 30 mm (as long as the above-indicated ratios are respected). Advantageously, the adjustment section 74 of the stretching duct 70 is extended from the upper mouth 71 to the narrow section 73 (along the vertical axis Y) with a first length L1, and the diffusion section 75 is extended from the narrow section 73 to the lower mouth 72 (along the vertical axis Y) for a second length L2.

[0061] The ratio L2/L1 between the aforesaid second length L2 and the aforesaid first length L1 is comprised between 0.8 and 1.0.

[0062] For example, the first length L1 is comprised between 1100 mm and 1800 mm and the second length L2 is comprised between 1000 mm and 1800 mm (as long as the above-indicated ratios are respected).

[0063] Advantageously, the adjustment section 74 of the stretching duct 70 comprises two first walls 78 facing each other, each of which is extended along the vertical axis Y between an upper first edge 78', placed at the upper mouth 71 of the stretching duct 70, and a first lower edge 78" placed at the narrow section 73.

[0064] In addition, the diffusion section 75 of the stretching duct 70 comprises two second walls 79 facing each other, each of which is extended along the vertical axis Y between a second upper edge 79', which is placed at the narrow section 73, and a second lower edge 79" placed at the lower mouth 72 of the stretching duct 70.

[0065] In particular, the two first walls 78 are positioned on opposite sides with respect to the second direction Z and are each extended depth-wise along such second direction Z (preferably parallel to the latter) between two first lateral edges 78‴ placed as a perimeter connection of the upper and lower first edges 78', 78".

[0066] Analogously, the two second walls 79 are positioned on opposite sides with respect to the second direction Z and are each extended depth-wise along such second direction Z (preferably parallel to the latter) between two second lateral edges 79‴ placed as a perimeter connection of the second upper and lower edges 79', 79".

[0067] In this manner, in particular, the first walls 78 and the second walls 79 define the width of the stretching duct 70, and in particular the first walls 78 define the width of the adjustment section 74 of the stretching duct 70 and the second walls 79 define the width of the diffusion section 75 of the stretching duct 70 itself.

[0068] In particular, the first walls 78 are obtained with separate components with respect to the second walls 79, in which each first wall 78 is connected to the corresponding second wall 79 at, respectively, the first lower edge 78" and the second upper edge 79'. Preferably, the first walls 78 and the second walls 79 of the stretching duct 70 are substantially rigid. In particular, the first and second walls 78, 79 are made with plates of metal material, e.g. steel of stainless type, and are provided with a thickness preferably comprised between 20 and 40 mm, and still more preferably is 30 mm. Preferably, the first walls 78 are tilted with respect to each other and are extended mutually approached towards the narrow section 73, between them defining the convergence angle $\alpha 1$ of the adjustment section 74. Preferably, the second walls 79 are tilted with respect to each other and are extended mutually away towards the lower mouth 72, between them defining the divergence angle $\alpha 2$ of the diffusion section 75. In particular, each first wall 78 is provided with a first internal face 16 directed towards the first internal face 16 of the other first wall 78 (delimiting between them the volume of the adjustment section 74 of the stretching duct 70), and with an opposite first external face 17. Analogously, each second wall 79 is provided with a second internal face 18 directed towards the second internal face 18 of the other second wall 79 (delimiting between them the volume of the diffusion section 75 of the stretching duct 70), and with an opposite second external face 19.

[0069] Advantageously, the third transverse section S3 of the narrow section 73 and the second transverse section S2 of the lower mouth 72 are defined by the mutual tilt, respectively, of the first walls 78 and of the second walls 79.

[0070] Preferably, the stretching unit 7 comprises first sealing means 9 interposed between the first lower edges 78" of the first walls 78 and the second upper edges 79' of the second walls 79, sealingly connecting the first lower edge 78" to the corresponding the second upper edge 79'.

[0071] In this manner, advantageously, the aforesaid sealing means 9 determine a sealing connection of the adjustment section 74 with the diffusion section 75, ensuring the aforesaid seal continuity of the stretching duct 70 (which does not have any further entrance or exit of air along its extension between its upper mouth 71 and its lower mouth 72).

[0072] In particular, the first sealing means 9 prevent a fluid communication between the closed volume enclosed between the first and second walls 78, 79 of the stretching duct 70 and the outside environment.

[0073] Advantageously, the stretching unit 70 comprises first actuator means 10 mechanically connected to the first walls 78 or to the second walls 79 at the narrow section 73, and arranged for moving, respectively, the first walls 78 or the second walls 79, transverse to vertical axis Y in order to adjust the third transverse section S3 (and in particular the width of the latter) of the narrow section 73.

[0074] In accordance with the embodiment illustrated in the enclosed figures, the first actuator means 10 are mechanically connected to the first walls 78 at the narrow section 73, and are arranged for moving such first walls 78 transverse to the vertical axis Y in order to adjust the third transverse section S3 of the narrow section 73.

[0075] Preferably, the first actuator means 10 comprise two first actuators 10', each of which mechanically connected to the corresponding first wall 78, in particular at the first external face 17 of the latter.

[0076] In particular, each first actuator 10' is an actuator of linear type (e.g. electric or hydraulic), advantageously with movement axis transverse to the vertical axis Y, and is preferably hinged to the corresponding first wall 78.

[0077] Preferably, the first actuator means 10 are adapted to move mutually close to or away from the first lower edges 78" of the two first walls 78 so as to modify the width of the stretching duct 70 at the narrow section 73 and, therefore, the third transverse section S3 of the latter.

[0078] In particular, the first actuator means 10 are adapted to vary the tilt of the first walls 78, in a manner such to vary the convergence angle $\alpha 1$ of the adjustment section 74, for example by rotating the first walls 78 around their first upper edges 78'. For such purpose, preferably, the first upper edges 78' are arranged rotatably (as described in detail hereinbelow).

[0079] Preferably, the stretching unit 7 comprises second actuator means 11 mechanically connected to the second walls 79 at the lower mouth 72 of the stretching duct 70, and arranged for moving the second walls 79 transverse to the vertical axis Y in order to adjust the second transverse section S2 (and in particular the width of the latter) of the lower mouth 72 and, advantageously, the divergence angle $\alpha 2$ of the diffusion section 75 of the stretching duct 70.

[0080] In this manner, in particular, the plant 1, object of the present invention, allows varying the form of the stretching duct 70 and setting the convergence angle $\alpha 1$ of the adjustment section 74 and the divergence angle $\alpha 2$ of the diffusion section 75, so as to adjust the distribution of the filaments along the descent path 3.

[0081] Preferably, the second actuator means 11 comprise two second actuators 11', each of which mechanically connected to the corresponding second wall 79, in particular at the second external face 19 of the latter.

[0082] In particular, each second actuator 11' is an actuator of linear type (e.g. electric or hydraulic), advantageously with movement axis transverse to the vertical axis Y, and is preferably hinged to the corresponding second wall 79.

[0083] Advantageously, the plant 1 comprises a logic control unit (e.g. a PLC) which is operatively connected to the actuator means 10, 11 (and in particular to the first and to the second actuators 10', 11') and is operatively connected to a control panel actuatable by a user in order to drive the logic control unit to actuate the actuator means 10, 11. Preferably, the second actuator means 11 are adapted to mutually move closer or away the second lower edges 79" of the two second walls 79 so as to modify the width of the stretching duct 70 at the lower mouth 72 and, therefore, the second transverse section

S2 of the latter.

[0084] In particular, the second actuator means 11 are adapted to vary the tilt of the second walls 79, in a manner such to vary the divergence angle $\alpha 2$, by rotating the second walls 79 around the second upper edges 79'.

[0085] For such purpose, advantageously, the first lower edge 78" of each first wall 78 is rotatably constrained to the second upper edge 79' of the corresponding second wall 79, in a manner such to allow the rotation of the second walls 79 with to the first walls 78. In particular, with reference to figure 2, each first wall 78 is provided, at the first lower edge 78", with a first abutment portion 13, and each second wall 79 is provided, at the second upper edge 79', with a second abutment portion 14 which abuts against the first abutment portion 13 according to an engagement direction U substantially transverse to the vertical axis Y (and in particular substantially parallel to the first direction X).

[0086] In addition, the stretching unit 7 comprises elastic means 12 mechanically connected to each second wall 79 and arranged for forcing the second abutment portion 14 against the first abutment portion 13.

[0087] In operation, the elastic means 12, following the movement of the first walls 78 and/or of the second walls 79, exert an elastic reaction on the second wall 79 which maintains in abutment the first and the second abutment portion 13, 14 even if the first and second walls 78, 79 modify their position.

[0088] In this manner, following the movement of the first walls 78 and/or of the second walls 79, the second upper edges 79' of the second walls 79 are free to rotate with respect to the first lower edges 78" of the first walls 78 (and vice versa), maintaining such second upper edges 79' connected to such first upper edges 78', so as to maintain the first walls 78 connected to the second walls 79.

[0089] Advantageously, the elastic means 12 comprise two pneumatic pistons 121, each of which connected to the corresponding second wall 79 (in particular to the second external face 19 of the latter) by means of a respective rotatable coupling element 101. In accordance with the particular embodiment illustrated in figure 2, the first abutment portion 13 of the first wall 78 is made on the first internal face 16 of the latter and the second abutment portion 14 is made on the second external face 19 of the second wall 79, in a manner such that the second wall 79 abuts against the first internal face 16 of the first wall 78. In such configuration, the elastic means 12 are arranged for pulling the second wall 79 towards the outside (i.e. towards the first internal face 16 of the first wall 78) in order to maintain the second abutment portion 14 of the second wall 79 in abutment against the first abutment portion 13 of the first wall 78.

[0090] Of course, it is possible to configure the abutment portions 13, 14 with opposite orientation (i.e. with the first abutment portion 13 made on the first external face 17 of the first wall 78 and the second abutment portion 14 made on the second external face 19 of the second wall 79, arranging the elastic means 12 in order to push the second wall 79 towards the interior (i.e. towards the first external face 17 of the first wall 78). Advantageously, one between the first abutment portion 13 and the second abutment portion 14 comprises a projecting tooth 15, and the other between the two abutment portions 13, 14 is provided with a recess 15' in which such projecting tooth 15 is engaged.

[0091] In accordance with the particular embodiment represented in figure 2, the projecting tooth 15 beings to the second abutment portion 14 of the second wall 79 and is placed at the second upper edge 79' of the latter, and the recess 15' belongs the first abutment portion 13 of the first wall 78 and is placed at the upper first edge 78' of the latter.

[0092] In particular, the recess 15' has a substantially step-like form and the projecting tooth 15 is projectingly extended (for example from the second upper edge 79' of the second wall 79) in order to be inserted in the recess 15' itself.

[0093] Advantageously, the first sealing means 9 are interposed between the first abutment portion 13 of the first wall 78 and the second abutment portion 14 of the second wall 79, in particular in the recess 15'.

[0094] Advantageously, with reference to the example of figure 2, on the internal side of the stretching duct 70, the second upper edge 79' of each second wall 79 is placed flush or recessed with respect to the first lower edge 78" of the corresponding first wall 78. More in detail, the second upper edge 79' of each second wall 79, at the second internal face 18 of the latter, is placed flush or recessed with respect to the first lower edge 78" of the corresponding first wall 78 at the first internal face 16 of the latter.

[0095] In particular, the margin of the second internal face 18 along the second upper edge 79' of each second wall 79 is placed flush or recessing with respect to the margin along the first lower edge 78" of the first internal face 16 of the corresponding first wall 78, preferably by a recess measurement comprised between about 0.0 mm (in the event in which the margins are flush) and 5 mm, and preferably between 0.2 mm and 1.5 mm.

[0096] In this manner, advantageously, in the transition between the adjustment section 74 and the diffusion section 75, the filaments, along the internal faces 16, 18 of the first and second walls 78, 79, do not encounter obstacles that prevent their correct descent towards the lower mouth 72 of the stretching duct 70.

[0097] Preferably, the stretching unit 7 comprises at least two abutment elements 90, each of which acts on the corresponding first and second walls 78, 79 in order to define the aforesaid recess measurement of the second upper edge 79' of the second wall 79 with respect to the first lower edge 78" of the first wall 78.

[0098] In particular, each adjustment element 90 comprises a support body 91 fixed to the first wall 78 or to the second wall 79, and an abutment body 92 which is mounted on the support body 91 in a movable manner along the engagement direction U and receives in abutment the other walls 78, 79, by exerting a blocking action opposite the force exerted by the elastic means 12.

[0099] In this manner, the position of the second upper edge 79' of the second wall 79 with respect to the first lower edge 78" of the first wall 78 is defined by the position of the abutment body 92, which in this manner allows defining the recess measurement of the second wall 79 with respect to the first wall 78.

[0100] Advantageously, the stretching unit 7 comprises third actuator means (not illustrated in the enclosed figures) which are connected to the abutment body 92 of the adjustment element 90 and are actuatable, in particular by means of the control unit of the plant 1, in order to set the position of the abutment body 92 along the engagement direction U. For example, the abutment body 92 is mounted on the support body 91 by means of a screw-nut screw coupling and is actuatable, in particular by the third actuator means, in rotation in order to be moved along the coupling direction U.

[0101] With reference to the embodiment illustrated in figure 2, the support body 91 of the adjustment element 90 is fixed to the first external face 17 of the first wall 78, and the abutment body receives the second wall 79 in abutment, in particular the second external face 19 of the latter.

[0102] In accordance with a non-illustrated embodiment of the present invention, in which the first actuator means 10 are connected to the second walls 79, the elastic means 12 are connected to the first walls 78, carrying out a function analogous to that set forth above. Advantageously, with reference to figure 1, the cooling unit 6 comprises a containment body 61 which at its interior delimits the cooling chamber 60 and is provided with two lateral walls 62 facing each other, between which the cooling chamber 60 is extended, transverse to the vertical axis Y. In particular, the two lateral walls 62 delimit between them the width of the cooling chamber 60 according to the first direction X.

[0103] In particular, the containment body 61 of the cooling unit 6 is sealingly connected to the stretching duct 70 by means of a connector cone 63 placed to connect between the cooling chamber 60 and the adjustment section 74 of the stretching duct 70. Preferably, the connector cone 63 is sealingly connected to the containment body 61 of the cooling unit 6 by means of suitable sealing gaskets 20.

[0104] Advantageously, the adjustment section 74 of the stretching duct 70 comprises two fixed walls 76 placed to connect between the cooling chamber 60 and the first walls 78 of the stretching duct 70 itself. More in detail, the two fixed walls 76, placed facing each other, are extended, along the descent path 3, between the upper mouth 71 of the stretching duct 70 and the upper first edge 78' of the first walls 78.

[0105] More in detail, the fixed walls 76 are interposed between the containment body 61 (and in particular the connector cone 63) and the first walls 78 of the adjustment section 74 of the stretching duct 70.

[0106] In particular, the fixed walls 76 are placed on the same sides of the respective first walls 78 with respect to the descent path 3 and, suitably, they are extended depth-wise along the second direction Z.

[0107] Advantageously, the stretching unit 7 comprises second sealing means 9' placed between each fixed wall 76 and the upper first edge 78' of the corresponding first wall 78, so as to ensure the seal continuity of the stretching duct 70.

[0108] Preferably, the upper first edge 78' of each first wall 78 is rotatably constrained (e.g. by means of abutment) to the corresponding fixed wall 76 in order to allow the first actuator means 10 to vary the tilt of the first walls 78 and, thus, the convergence angle $\alpha 1$ of the adjustment section 74.

[0109] Advantageously, with reference to figure 3, the stretching duct 70 comprises two opposite first lateral walls 40 placed transverse to the first walls 78 and positioned orthogonally to the second direction Z in order to delimit depth-wise the adjustment section 74 of the stretching duct 70.

[0110] More in detail, each first lateral wall 40 is extended between the two first walls 78 and is connected to the corresponding first lateral edge 78‴ of each first wall 78 itself.

[0111] Advantageously, the stretching unit 7 comprises third sealing means 9" placed between each first lateral wall 40 and the corresponding first lateral edge 78‴ of the first wall 78, in a manner such to ensure a sealing closure of the stretching duct 70 also with respect to the first lateral walls 40.

[0112] Preferably the first, second and third sealing means 9, 9', 9" comprise two perimeter gaskets, each of which placed perimetrically along the upper 78', lower 78" and lateral 78‴ edges of the corresponding first wall 78.

[0113] In particular, each perimeter gasket defines, along the first lower edge 78" the first sealing means 9, along the upper first edge 78' the second sealing means 9', and along the first lateral edges 78‴ the third sealing means 9".

[0114] Advantageously, the aforesaid perimeter gaskets are inflatable gaskets.

[0115] Suitably, each first wall 78 is provided with a perimeter groove 41 in which the corresponding perimeter gasket is housed.

[0116] Preferably, along the first lower edge 78" of the first wall 78, the aforesaid perimeter groove 41 defines the recess 15' of the second abutment portion 14.

[0117] Advantageously, with reference to figure 4, the stretching duct 70 comprises two opposite second lateral walls 42 placed transverse to the second walls 79 and positioned orthogonally to the second direction Z in order to delimit depth-wise the diffusion section 75 of the stretching duct 70.

[0118] More in detail, each second lateral wall 42 is extended at least between the two second walls 79 and is connected to the corresponding second lateral edge 79‴ of each second wall 79 itself.

[0119] Advantageously, the stretching unit 7 comprises fourth sealing means 43 placed to connect between each second lateral wall 42 and the corresponding second lateral edge 79‴ of the second wall 79, in a manner such to ensure a sealing closure of the stretching duct 70 with respect to the second lateral walls 42.

[0120] Preferably, the aforesaid fourth sealing means 43 are provided with suitable gaskets placed along the second lateral edges 79‴ and, for example, comprise gaskets of O-ring type 43' and/or lip gaskets 43".

[0121] Advantageously, the configuration of the present invention also allows an easy disassembly of the first and second walls 78, 79 of the stretching duct 70 if it is necessary to execute operations of maintenance on the extrusion head 30 or execute a cleaning of the first and second walls 78, 79 themselves.

[0122] Preferably, with reference to the example of figure 1, the ventilator means 8 comprise a first ventilation group 81 fluid-connected with the cooling chamber 60 and arranged for introducing, into the cooling chamber 60, the gas flow adapted to intercept the filaments in order to cool them.

[0123] Suitably, the lateral walls 62 of the containment body 61 of the cooling unit 6 are provided with respective openings in fluid communication with the aforesaid first ventilation group 81, so as to allow the entrance of the gas flow into the cooling chamber 60.

[0124] Preferably, the first ventilation group 81 comprises one or more first ventilators (not illustrated) adapted to generate a flow of gas and one or more heat exchangers (also not illustrated) adapted to intercept the gas flow generated by the first ventilators in order to bring it to a specific temperature.

[0125] Advantageously, the first ventilators are fluid-connected with the cooling chamber 60 by means of one or more feed ducts 83. Preferably, the latter are sealingly connected to the containment body 61 of the cooling unit 6 by means of fifth sealing means 84, comprising advantageously inflatable gaskets.

[0126] Advantageously, the ventilator means 8 comprise a second ventilation group 82 fluid-connected with the lower mouth 72 of the stretching duct 70 and arranged for suctioning the gas flow from the stretching duct 70 itself through the lower mouth 72 of the latter. Preferably, the second ventilation group 82 comprises one or more second ventilators, placed for example in proximity to the lower mouth 72 of the stretching duct 70. Advantageously, the second ventilation group 82 allows preventing the deposit of oily compounds deriving from the filament polymerization reaction residue, suctioning such compounds together with the gas flow.

[0127] Advantageously, the ventilator means 8 are arranged for generating the gas flow (e.g. air) adapted to traverse the stretching duct 70 and advantageously the cooling chamber 60, with a flow comprised between 1000 and 5000 m^3/h per linear meter of depth of the stretching duct 70 (and advantageously of the cooling chamber 60) along the second direction Z.

[0128] Advantageously, the control unit is operatively connected to the ventilator means 8 (and in particular to the first ventilators of the first ventilation group 81 and/or to the second ventilators of the second ventilation group 82) in order to drive the latter such to obtain the aforesaid flow, in particular with a pressure preferably comprised between 1500 and 15000 Pa.

[0129] Advantageously, the plant 1 comprises a shutter 50 interposed between the cooling chamber 60 and the stretching duct 70, preferably at the upper mouth 71 of the stretching duct 70 itself, and in particular between the connector cone 63 and the fixed walls 76.

[0130] In operation, the shutter 50 is actuatable to close at the start of the plant 1 in order to obstruct the inlet mouth 71 of the stretching duct 70, so as to prevent the first sections of produced filaments - which have unsuitable size and/or physical characteristics - from entering into the stretching duct 70 itself and subsequently falling on the deposit belt 25, ruining the stratification of the non-woven fabric.

[0131] When the plant 1 is in the conditions for generating the filaments according to the requested specifications, the shutter 50 is opened in order to allow the production in normal operation conditions of the non-woven fabric.

[0132] Advantageously, the plant 1 comprises fourth actuator means 51 mechanically connected to the shutter 50 and operatively connected to the control unit, which is arranged for actuating such fourth actuator means 51 in order to open and close the shutter 50 in an automated manner.

[0133] Preferably, the plant 1 comprises a seal chamber 77, hermetically closed, which houses the shutter 70 (and preferably the fourth actuator means 51) at its interior and is extended along the descent path 3 astride the inlet mouth 71 of the stretching duct 70, in a manner such to sealingly connect the stretching duct 70 with the cooling chamber 60, (in particular also in the presence of a discontinuity determined by the shutter 70). Preferably, the seal chamber 77 is extended, along the vertical axis Y, between an upper wall thereof placed above the upper mouth 71 of the stretching duct 70 and a lower wall thereof placed below the upper mouth 71 itself.

[0134] In particular, the upper wall of the seal chamber 77 is sealingly fixed to the containment body 61 of the cooling unit 6 or to the connector cone 63, and the lower wall of the seal chamber 77 is sealingly fixed to the fixed walls 76 of the stretching duct 70.

[0135] The invention thus conceived therefore attains the pre-established objects.

Claims

1. Plant (1) for producing non-woven fabric, which comprises:

- a support structure (2) provided with a descent path (3) extended along a vertical axis (Y) between an upper inlet (4) and a lower outlet (5);
- an extrusion unit (29) mounted on said support structure (2) and arranged for introducing filaments for forming a non-woven fabric in said descent path (3) through said inlet (4);
- a cooling unit (6), placed below said extrusion unit (29) and comprising a cooling chamber (60) placed along said descent path (3) and susceptible of being traversed by said filaments in order to cool said filaments;
- a stretching unit (7) placed below said cooling unit (6) and comprising a stretching duct (70), which is extended along said descent path (3) between an upper mouth (71), through which said filaments are susceptible of entering into said stretching duct (70), and a lower mouth (72) placed at said outlet (5) and through which said filaments are susceptible of exiting from said stretching duct (70);

said stretching duct (70) comprising:

- an adjustment section (74), which is extended, along said vertical axis (Y), between said upper mouth (71) and a narrow section (73), narrowing towards said narrow section (73) with a given convergence angle ($\alpha 1$); and
- a diffusion section (75), which is extended, along said vertical axis (Y), between said narrow section (73) and said lower mouth (72), broadening towards said lower mouth (72) with a given divergence angle ($\alpha 2$);
- ventilator means (8), which are mounted on said support structure (2) and are arranged for generating a flow of gas adapted to traverse at least said stretching duct (70) from said upper mouth (71) to said lower mouth (72);

wherein the adjustment section (74) of said stretching duct (70) comprises two first walls (78) facing each other, each of which is extended along said vertical axis (Y) between an upper first edge (78') and a first lower edge (78") placed at said narrow section (73); wherein said first walls (78) are tilted with respect to each other and are extended mutually approached towards said narrow section (73), between them defining said convergence angle ($\alpha 1$);

wherein the diffusion section (75) of said stretching duct (70) comprises two second walls (79) facing each other, each of which is extended along said vertical axis (Y) between a second upper edge (79'), which is placed at said narrow section (73), and a second lower edge (79") placed at said lower mouth (72); wherein said second walls (79) are tilted with respect to each other and are extended mutually away towards said lower mouth (72), between them defining said divergence angle ($\alpha 2$);

wherein said upper mouth (71) has a first transverse section (SI), said lower mouth (72) has a second transverse section (S2), and said narrow section (73) has a third transverse section (S3);

said plant (1) being **characterized in that** the upper mouth (71) of said stretching duct (70) is sealingly connected to said cooling chamber (60) and said stretching duct (70) is extended from said upper mouth (71) to said lower mouth (72) with seal continuity in a manner such that said gas flow is susceptible of entering into said stretching duct (70) only through said upper mouth (71);

wherein:

- the ratio between the first transverse section (S1) of said upper mouth (71) and the third transverse section (S3) of said narrow section (73) is comprised between 2 and 10;
- the ratio between the second transverse section (S2) of said lower mouth (72) and the third transverse section (S3) of said narrow section (73) is greater than 1 and lower than or equal to 10;
- the convergence angle ($\alpha 1$) of the adjustment section (74) of said stretching duct (70) is greater than or equal to 1° and smaller than or equal to 6°;
- the divergence angle ($\alpha 2$) of the diffusion section (75) of said stretching duct (70) is greater than 0° and smaller than or equal to 5°;

said plant (1) comprising first sealing means (9) which are interposed between the first lower edges (78") of said first walls (78) and the second upper edges (79') of said second walls (79), sealingly connecting said adjustment section (74) to said diffusion section (75);

said stretching unit (7) comprising first actuator means (10) mechanically connected to said first walls (78) or to second walls (79) at said narrow section (73), and arranged for moving, respectively, said first walls (78) or said second walls (79), transverse to said vertical axis (Y) in order to adjust the third transverse section (S3) of said narrow section (73).

2. Plant (1) according to claim 1, **characterized in that** the adjustment section (74) has a first length (L1) from said upper mouth (71) to said narrow section (73), and said diffusion section (75) has a second length (L2) from said narrow section (73) to said lower mouth (72); wherein the ratio (L2/L1) between said second length (L2) and said first length (L1) is comprised between 0.8 and 1.0.

3. Plant (1) according to claim 1 or 2, **characterized in that** said first actuator means (10) are mechanically connected to said first walls (78) at said narrow section (73), and are arranged for moving said first walls (78) transverse to said vertical axis (Y) in order to adjust the third transverse section (S3) of said narrow section (73).

4. Plant (1) according to any one of the preceding claims, **characterized in that** said stretching unit (7) comprises second actuator means (11) mechanically connected to said second walls (79) at said lower mouth (72), and arranged for moving said second walls (79) transverse to said vertical axis (Y) in order to adjust the second transverse section (S2) of said lower mouth (72).

5. Plant (1) according to any one of the preceding claims, **characterized in that** the first lower edge (78") of each said first wall (78) is rotatably constrained to the second upper edge (79') of the corresponding said second wall (79").

6. Plant (1) according to claims 3 and 5, **characterized in that** each said first wall (78) is provided, at said first lower edge (78"), with a first abutment portion (13), and each said second wall (79) is provided, at said second upper edge (79'), with a second abutment portion (14) which abuts against said first abutment portion (13) according to an engagement direction (U) substantially transverse to said vertical axis (Y); wherein said stretching unit (7) comprises elastic means (12) mechanically connected to each said second wall (79) and arranged for forcing said second abutment portion (14) against said first abutment portion (13).

7. Plant (1) according to claim 6, **characterized in that** said elastic means (12) comprise at least two pneumatic pistons.

8. Plant (1) according to any one of the preceding claims, **characterized in that** the adjustment section (74) of said stretching duct (70) comprises two fixed walls (76) facing each other, which are extended, along said descent path (3), between said upper mouth (71) and the first upper edges (78') of said first walls (78);
wherein said stretching unit (7) comprises second sealing means (9') placed between each said fixed wall (76) and the first upper edge (78') of the corresponding said first wall (78).

9. Plant (1) according to any one of the preceding claims, **characterized in that** each said first wall (78) comprises two opposite first lateral edges (78‴) placed as a perimeter connection of said first upper edge (78') with said first lower edge (78");

wherein said stretching duct (70) comprises two opposite first lateral walls (40) placed transverse to said first walls (78) and each connected to a corresponding said first lateral edge (78‴) of each said first wall (78);
wherein said stretching unit (7) comprises third sealing means (9") placed between each said first lateral wall (40) and the corresponding said first lateral edge (78‴) of said first wall (78).

10. Plant (1) according to claim 8 and 9, **characterized in that** said first, second and third sealing means (9, 9', 9") comprise two perimeter gaskets, each of which is placed perimetrically along the upper, lower and lateral edges (78', 78", 78‴) of the corresponding said first wall (78).

11. Plant (1) according to any one of the preceding claims, **characterized in that** each said first wall (78) is provided with a first internal face (16) facing the first internal face (16) of the other said first wall (78), and each said second wall (79) is provided with a second internal face (18) facing the second internal face (18) of the other said second wall (79);
wherein the second upper edge (79') of each said second wall (79), at said second internal face (18), is placed flush or recessed with respect to the first lower edge (78") of the corresponding said first wall (78) at said first internal face (16).

12. Plant (1) according to any one of the preceding claims, **characterized in that** said first walls (78) and said second walls (79) are substantially rigid.

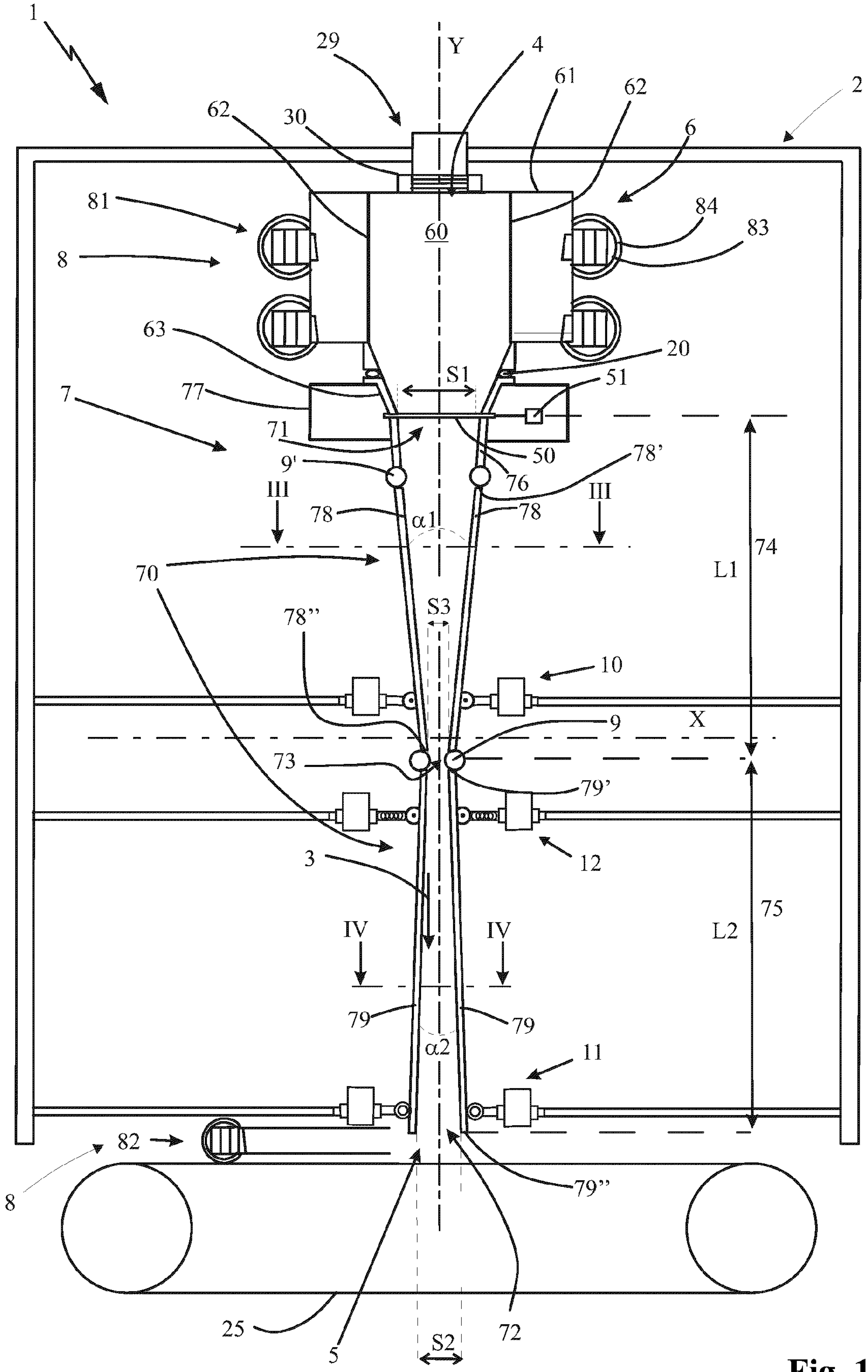
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Fig. 1

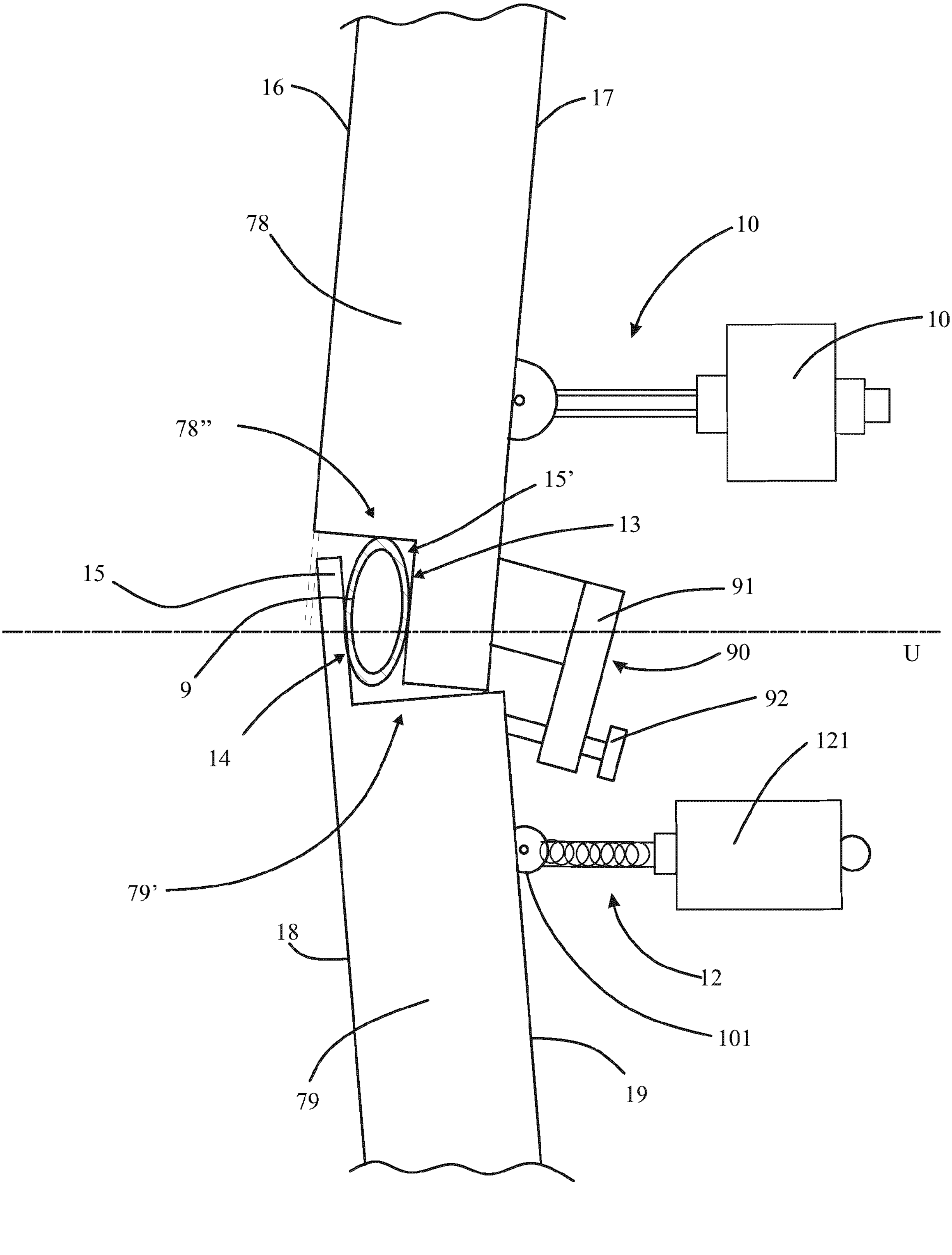

Fig. 2

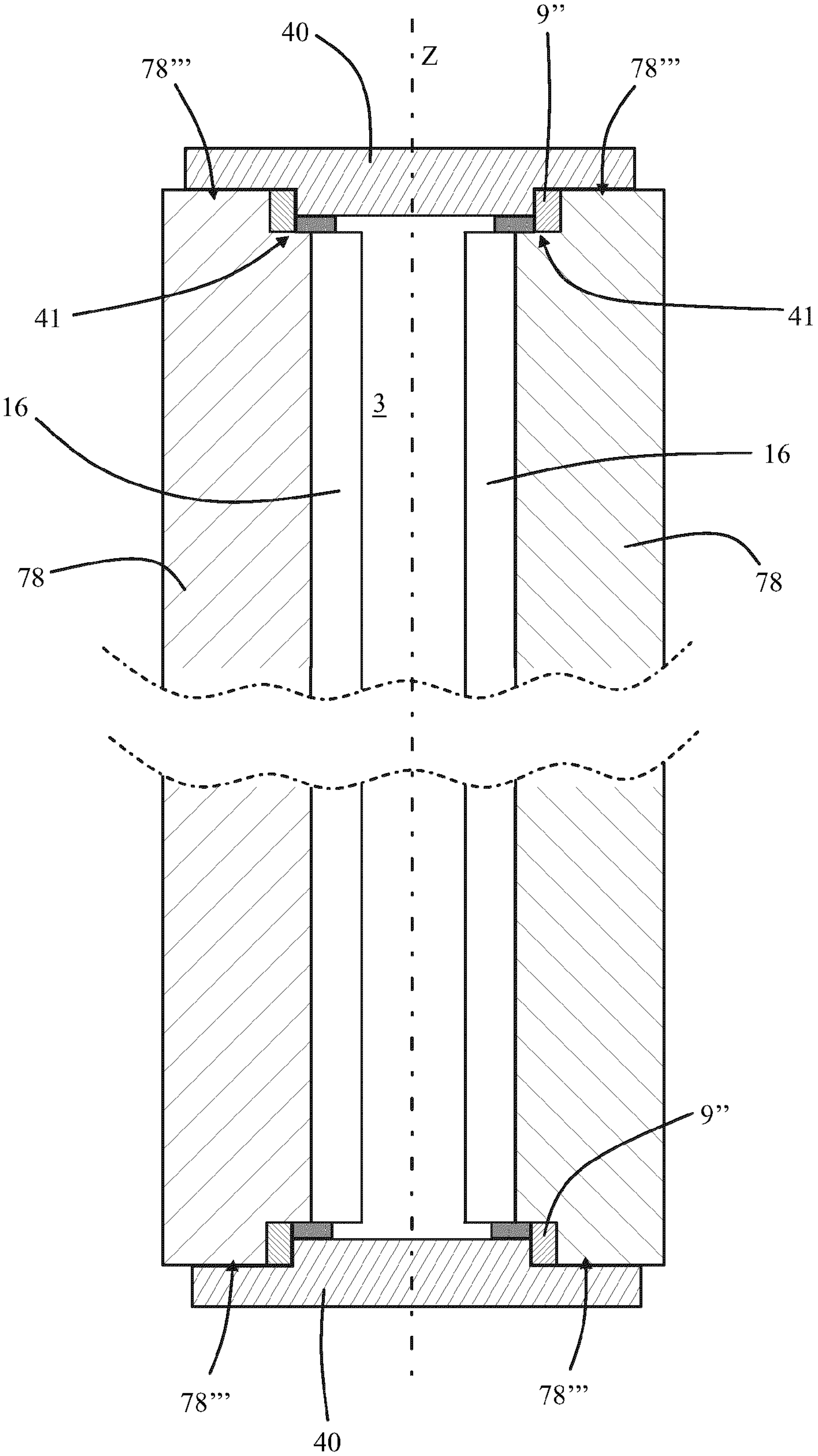

Fig. 3

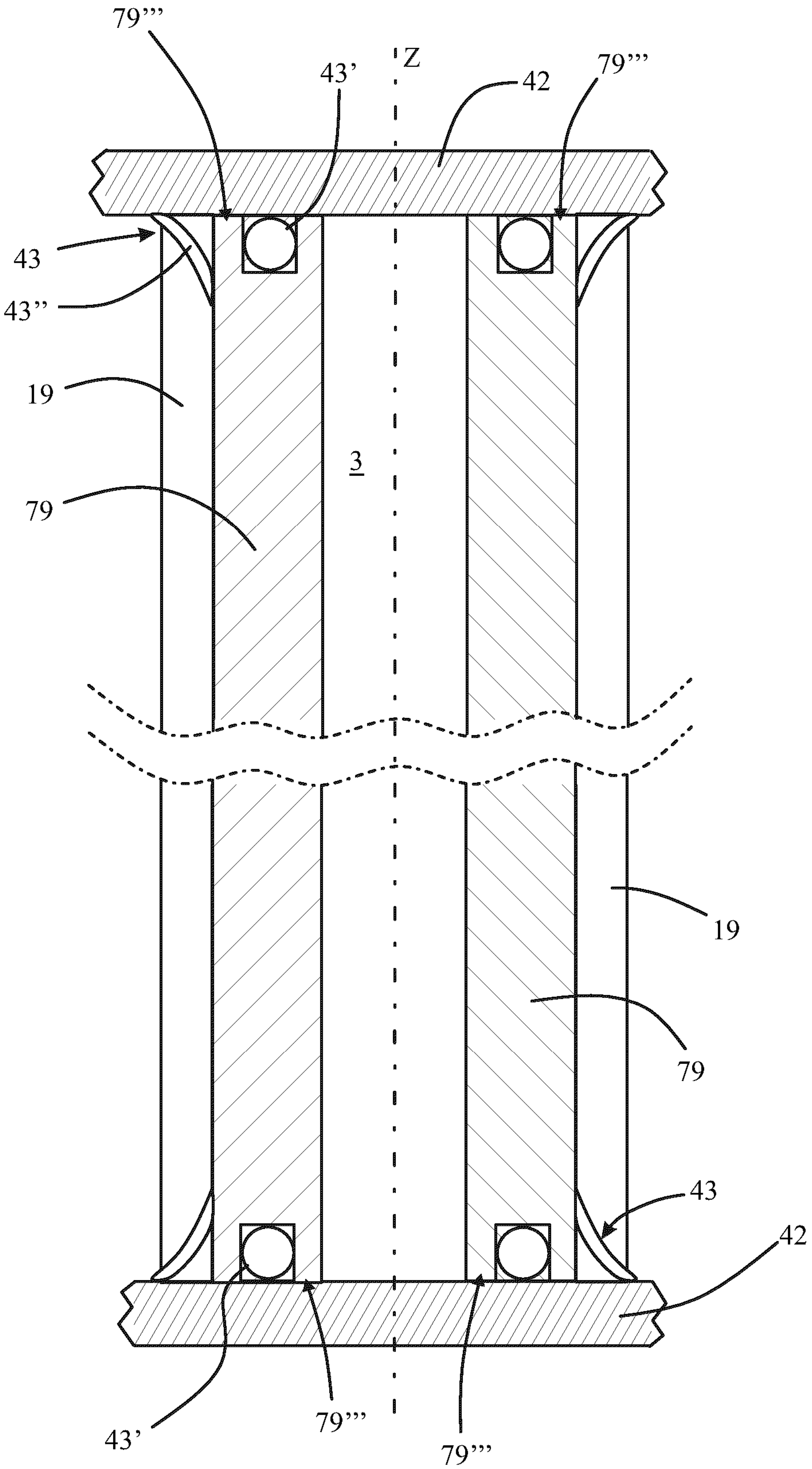

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
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