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(54) **APPARATUS AND PROCESS FOR PRODUCING A SPUN BOND NONWOVEN FABRIC**

(57) Apparatus for producing a nonwoven fabric, comprising a spinneret adapted to extrude a plurality of filaments, comprising an extrusion surface equipped with extrusion holes; at least one cooling device arranged downstream of said spinneret and adapted to cool said plurality of filaments by means of cooled gas, comprising at least one delivery port to deliver said cooled gas; at least one first suction device comprising at least one suc-

tion port and adapted to suction gas below the spinneret; a drawing duct to aerodynamically draw said filaments which comprises an inlet port of said filaments; wherein said at least one suction port of said at least one first suction device is arranged downstream of said delivery port of said at least one cooling device and upstream of said drawing duct.

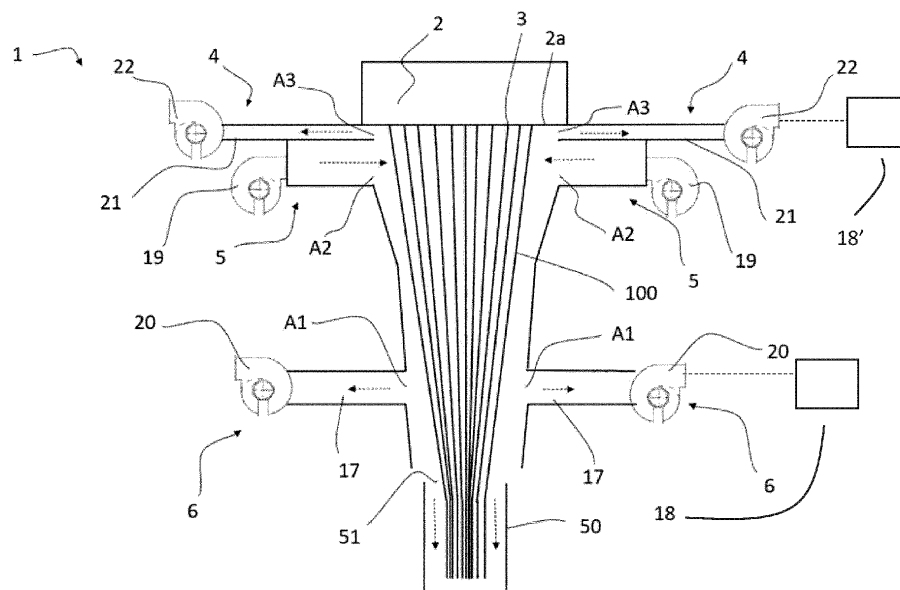


Fig. 1

Description

FIELD OF INVENTION

[0001] The present invention relates to an apparatus and process for producing a spun bond nonwoven fabric.

[0002] Typically, an apparatus for producing a spun-bond nonwoven fabric comprises a filament spinning head fed by extruders of one or more polymers, a drawing duct in which filaments are drawn by air flows which can be controlled according to the production requirements of a particular nonwoven fabric, a depositing unit for the drawn filaments which typically comprises a movable support that receives the filaments drawn by the drawing unit and in which the nonwoven fabric is formed.

[0003] It is known that, as a result of the extrusion of polymers in the spinneret, harmful gases comprising waste substances such as oligomers, antioxidant substances, dyes, anti-UV substances, anti-static waste substances and additive substances are generated below the spinneret and float below the spinneret in the form of gas or gas comprising particles of these waste substances. These harmful gases can alter the mechanical and chemical characteristics of the filaments. Therefore, in the context of spunbond nonwoven fabric production, the problem of removing harmful gases below the spinneret is felt.

STATE OF THE ART

[0004] As described, for example, in US5370833, which relates to an apparatus for producing continuous filaments by melt-spinning, a gas purification system comprises adsorbent materials such as silica gas or activated carbon, a suction duct and a suction pump. This purification system may be arranged below the spinneret in connection with a chamber in which the extruded filaments fall and/or in connection with the chamber and below a duct that provides cooling gas by a direct flow from the center of the duct to the walls of the chamber.

[0005] WO9625539 describes a melt-spinning apparatus for producing filaments, comprising a cooling duct below the spinneret which comprises three porous tubes, wherein the first porous tube and the third porous tube receive air from outside the apparatus while at the second porous tube, which is interposed between the first and third porous tubes, air is suctioned to allow gases harmful to health to be removed.

[0006] At present, in the context of production of spun-bond nonwoven fabric, harmful gases are at least partially diluted or at least partially removed by means of cooling elements which, by delivering cooling gases, allow the harmful gases to be at least partially cooled and conveyed to the drawing channel and then dispersed outside the apparatus. However, harmful gases cooled and floating in the vicinity of the extruded filaments have the drawback of altering the mechanical and chemical characteristics of the filaments extruded from the spinneret.

In addition, these harmful gases can deposit on the walls of the apparatus, thus forming an oily coating that can alter the mechanical or chemical characteristics of the filaments, thereby altering the proper formation of the desired nonwoven fabric after the drawing step in the drawing duct. If an oily coating is formed, it is then necessary to remove it by interrupting the nonwoven fabric production process in order to carry out the cleaning operation at considerable cost, both in terms of production time of the nonwoven fabric and in terms of the amount of nonwoven fabric that can be produced.

[0007] An object of the present invention is to solve the above-mentioned drawbacks by providing a process and apparatus for producing a nonwoven fabric that allows harmful gases comprising waste substances to be effectively removed, while limiting possible interruptions in the production process and limiting alterations in the mechanical and chemical properties of the filaments forming the non-woven fabric.

DESCRIPTION OF THE INVENTION

[0008] These and other objects are achieved by the present invention as discussed in one or more of the appended claims.

[0009] Specifically, an aspect of the present invention relates to an apparatus according to claim 1, and a different aspect concerns a related process according to claim 8. Preferred aspects are set forth in the dependent claims.

[0010] More specifically, an aspect of the present invention relates to an apparatus for producing a nonwoven fabric, comprising: a spinneret adapted to extrude a plurality of filaments and comprising an extrusion surface equipped with extrusion holes; at least one cooling device arranged downstream of the spinneret and adapted to cool said plurality of filaments by means of cooled gas, comprising at least one delivery port to deliver the cooled gas; at least one first suction device comprising at least one first suction port and adapted to suction gas below the spinneret; a drawing duct to aerodynamically draw said filaments which comprises at least one inlet port of said filaments and wherein said at least one first suction port of said at least one first suction device is arranged downstream of said at least one delivery port of said at least one cooling device and upstream of said drawing duct.

[0011] Thus, the apparatus has a suction device downstream of a cooling device. The cooling device allows the plurality of filaments extruded by the spinneret to be cooled and, at the same time, allows waste substances, such as oligomers, antioxidant substances, dyes, anti-UV substances, anti-static waste substances and additive substances which float below the spinneret in the form of gas or gas comprising particles of these waste substances, to be cooled. The subsequent suction device allows these waste substances to be suctioned, preventing them from being in the drawing channel. As a matter

of fact, this presence could worsen the mechanical and chemical characteristics of the filaments before the formation of the nonwoven fabric.

[0012] More generally, the first suction device (with its special position) prevents (or at least limits) the waste substances from depositing on the walls of the apparatus, thus avoiding or reducing the need to clean the same apparatus, in fact, the first suction device acts downstream of the cooling device, that is, at a region where the filaments and the waste substances are significantly cooled compared to a region located at the spinneret.

[0013] As a matter of fact, the first suction device can suction at least part of the waste substances before they contact the walls of the apparatus, or otherwise prevent them from depositing in the event of contact, by forcing their movement (and subsequent removal) toward the suction port. According to a possible aspect, the suction device can exert enough suction force to remove (at least partially) any deposit of the waste substances on the walls of the device.

[0014] According to a possible aspect, the apparatus comprises at least one second suction device comprising at least one second suction port arranged downstream of the spinneret and upstream of the at least one delivery port of the cooling device. Thanks to the present solution, there are two different regions of removal of waste substances, specifically a region upstream of the cooling device (thanks to the second suction device) and a region downstream of the cooling device (thanks to the first suction device). Thanks to a second suction device, it is possible to reduce the amount of waste substances that would otherwise have to be removed entirely by the first suction device. This increases the efficiency of suction of the waste substances and consequently prevents any alteration of the mechanical and chemical characteristics of the filaments extruded from the spinneret.

[0015] According to a possible aspect, the first suction device comprises purification elements to purify the gas suctioned through the first suction port. Purification elements adapted to this purpose are known in art and may comprise, for example, electrostatic cleaning filters, activated carbon filters, or devices using a water wash.

[0016] In general, purification elements retain harmful elements that could be harmful to the health of operators if released into the surrounding environment.

[0017] According to a possible aspect, the first suction port is fluidically connected to at least one first suction channel and at least one aspirator. According to a possible aspect, the second suction port, if present, is also fluidically connected to at least one second suction duct and at least one second aspirator.

[0018] According to a possible aspect, the section of the second suction port is smaller than the section of the first suction port. Preferably, the section of the first suction port (and typically also the related first suction channel connected thereto) is greater than 150% of the section of the second suction port (and typically also of the second suction channel connected to it). In possible embod-

iments it is more than 200% of the section of the second suction port, or more than 300% of the section of the second suction port. This allows the suction flow rate of the first suction port to be high even if the suction speed is lowered. This reduces the effect of the air suction on the filaments, which would otherwise come into contact with each other or anyhow with the walls of the following drawing channel, thus worsening their characteristics.

[0019] According to a possible aspect, the distance between the first suction port and the spinneret is greater than the distance between the first suction port and the drawing channel.

[0020] The field technician can quantitatively compare these two distances, without the need for precise measurement. In any case, these distances can be measured in the direction perpendicular to the extrusion surface, which typically corresponds, in use, to the vertical direction. Specifically, the distance between the first suction port and the drawing channel can be measured as the distance between the center of the geometric shape defined by the first suction port and the inlet port of the drawing channel; the distance between the first suction port and the extrusion surface can be measured as the distance between the center of the geometric shape defined by the first suction port and the extrusion surface of the spinneret. In general, as discussed, because the difference between the two distances can be assessed with the naked eye, the field technician is generally able to identify that the first suction port is closer to the drawing channel than the spinneret.

[0021] The position of the second suction port, which is arranged at a distance from the spinneret and closer to the inlet of the drawing channel, is particularly effective in preventing (or at least limiting) the waste substances from flowing into the drawing channel.

[0022] Specifically, the first suction port is placed near the inlet port of the drawing duct so as to ensure that during the aerodynamic drawing step, the filaments are not subject to chemical or mechanical alteration due to the presence of waste substances, i.e., harmful substances. In addition, this prevents waste substances from flowing through the drawing duct and subsequently being released into the surrounding environment. According to a possible aspect, said at least one delivery port of cooled gas is fluidically connected to at least one blowing element.

[0023] A further aspect of the invention further comprises a process for producing a nonwoven fabric by means of an apparatus according to what described above, comprising the steps of: i) extruding a plurality of filaments from said spinneret; ii) cooling said plurality of filaments below said spinneret by means of cooling gas delivered by said at least one cooling device; iii) drawing said filaments by means of a drawing duct; further comprising a step of suctioning gases by means of at least one first suction device downstream of said at least one delivery port of said at least one cooling device and upstream of said drawing duct.

[0024] According to a possible aspect, the process comprises a step of suctioning gas by means of at least one second suction device downstream of the spinneret and upstream of said at least one delivery port of said at least one cooling device.

[0025] Advantageously, this allows a first suction of heated gas below the spinneret. This allows, for example, the gas containing waste substances to be at least partially removed. This removal of waste substances by the second suction device reduces the amount of waste substances that would otherwise have to be removed entirely by the first suction device placed downstream of the cooling device and upstream of the drawing channel.

[0026] According to a possible aspect, the gas suctioned by means of said at least one first suction device has a flow rate between 6000 m³/h and 9000 m³/h, preferably it is about 7500 m³/h.

[0027] According to a possible aspect, the gas suctioned by means of said at least one second suction device has a flow rate in the range between 1000 m³/h and 3000 m³/h, preferably it is about 2000 m³/h.

[0028] According to a possible aspect, the cooling gas delivered by said at least one cooling device has a flow rate in the range between 10000 m³/h and 20000 m³/h, preferably it is about 15000 m³/h.

[0029] Adjusting the flow rate of the cooling gas delivered by the cooling device can be particularly advantageous, depending on the polymers used for filament extrusion in the spinneret.

[0030] According to a possible aspect, the cooling gas delivered by said at least one cooling device has a temperature in the range between 10 °C and 40 °C, preferably in the range between 14 °C and 30 °C.

[0031] According to a possible aspect, the gas suctioned through said at least one suction port has a temperature in the range between 50 °C and 70 °C.

[0032] According to a possible aspect, the flow rate of the gas in the drawing duct is between 40000 and 50000 m³/h, preferably it is 45000 m³/h.

[0033] According to a possible aspect, during the step i) the filaments are extruded from the spinneret at a temperature preferably between 190 °C and 290 °C.

BRIEF DESCRIPTION OF THE FIGURES

[0034] The invention will now be described in more detail with reference to the drawings included for illustrative and non-limiting purposes, where:

- Figure 1 is a schematic representation of an apparatus for producing nonwoven fabric according to an embodiment of the present invention.
- Figure 2 is a schematic representation of the apparatus in figure 1 in which the distances of the at least one suction port of the suction device from the extrusion surface of the spinneret and from the inlet port of the drawing duct are shown.

DETAILED DESCRIPTION OF THE INVENTION

[0035] An apparatus 1 for producing a nonwoven fabric comprising a spinneret 2 adapted to extrude a plurality of filaments 100, comprising an extrusion surface 2a equipped with extrusion holes 3.

[0036] The apparatus 1 further comprises at least one cooling device 5 arranged downstream of the spinneret 2 and adapted to cool the filaments 100 by cooled gas. The cooling device 5 comprises at least one delivery port A2 to deliver cooled gas. Specifically, the delivery port A2 allows cooled air to be delivered to the filaments 100 extruded from the spinneret 2 so as to decrease the temperature of the extruded filaments. According to an embodiment, as shown for example in Figure 1, the presence of at least one cooling device 5 allows cooled gas to be delivered so as to ensure that the cooled gas can flow between the filaments 100 below the spinneret 2.

[0037] Preferably, the delivery port A2 of cooled gas is fluidically connected to at least one blowing element 19.

[0038] The apparatus 1 further comprises at least one first suction device 6 comprising at least one first suction port A1 and adapted to suction gas below the spinneret 2.

[0039] The first suction device 6 allows gas floating below the spinneret to be suctioned and, in particular, allows waste substances, i.e., elements that are undesired during the formation of the filaments 100, such as oligomers, antioxidant substances, dyes, anti-UV substances, anti-static waste substances and additive substances, to be suctioned. The operation of the first suction device 6 prevents waste substances from adhering to the outer surface of the extruded filaments or from being incorporated into the extruded filaments.

[0040] The first suction device 6 prevents waste substances from depositing on the walls of the apparatus 1. This deposit could form an oily layer which would worsen the mechanical properties of the filaments and, as a result, the properties of the nonwoven fabric. Moreover, the presence of this oily layer would not only lead to a deterioration of the nonwoven fabric being produced but also to the interruption of the production process for cleaning the apparatus 1, so as not to affect also the properties of the nonwoven fabric subsequently produced, resulting in undeniable waste of time and money.

[0041] Preferably, the first suction device 6 comprises purification elements 18 to purify the gas suctioned through the first suction port A1.

[0042] Preferably, the purification elements 18 comprise electrostatic cleaning filters or activated carbon filters or devices using a water wash.

[0043] The purification elements allow waste substances suctioned by the suction port A1 to be retained, so that they are not dispersed into the environment.

[0044] Preferably, the first suction port A1 is fluidically connected to at least one first suction channel 17 and to at least one first aspirator 20.

[0045] According to a possible embodiment, the purification elements 18 are arranged downstream of the first

aspirator 20. This allows any waste substances to be separated from the suctioned gas and then the purified gas can be treated, according to procedures known in the art, in further apparatuses that can allow the gas separated from the harmful gases to be reused.

[0046] The apparatus further comprises a drawing duct 50 to aerodynamically draw the filaments 100, which comprises at least one inlet port 51 of the filaments 100.

[0047] The first suction port A1 of the first suction device 6 is arranged downstream of the delivery port A2 of the cooling device 5 and upstream of the drawing duct 50.

[0048] As discussed, by positioning the first suction port A1 (downstream of the delivery port A2), gas comprising waste substances can be removed before the drawing step of the filaments 100 in the drawing duct 50.

[0049] Moreover, according to a preferred aspect, the distance D1 between the first suction port A1 and the spinneret 2 is greater than the distance D2 between the first suction port A1 and the drawing channel 50. In preferred embodiments, the first suction device 6 is therefore configured to remove waste substances near the inlet port 51 of the drawing channel, or in any case at a distance from the spinneret 2.

[0050] This allows waste substances to be removed before the filaments are subjected to aerodynamic drawing in the drawing duct 50, thus preventing (or reducing) waste substances from depositing onto the walls of the drawing duct 50 and onto the filaments 100.

[0051] According to a possible aspect, the apparatus 1 further comprises at least one second suction device 4 which comprises a second suction port A3 arranged downstream of the spinneret 2 and upstream of the cooling device 5.

[0052] The second suction device 4 allows waste substances below the spinneret 2 to be suctioned.

[0053] Preferably, the second suction port A3 is fluidically connected to at least one second channel 21 and one second aspirator 22.

[0054] Preferably, the second suction device 4 also has purification elements 18', typically downstream of the second aspirator 22. These purification elements are preferably independent of those connected to the first suction device, so that their suction speed can be adjusted independently. However, it is still possible to connect the two suction devices to the same purification elements. It is further possible that only one of the two suction devices 4, 6 is connected to purification elements 18, 18'.

[0055] According to a possible aspect, the section of the second suction port A3 is smaller than the section of the first suction port A1. Typically, the section of the first channel 17 also is smaller than that of the second channel 21.

[0056] Typically, the ratio of the section of the first suction port A1 to the section of the second suction port A3 is more than 150%, preferably more than 200%, more preferably more than 300%. These values also typically apply to the ratio of the section of the first channel 17 to

the section of the second channel 21. Furthermore, the suction speed at the first suction port is typically lower than the suction speed at the second suction port, so that the effect of the first suction device 6 on the path of the filaments 100 is reduced. In other words, the suction speed, at the first suction port A1, is adjusted to a value that does not change the path of the filaments 100 at the first suction port A1.

[0057] The term "path of the filaments" refers to the direction followed by the extruded filaments before entering the drawing duct 50.

[0058] Adjusting the suction speed at the first suction port A1 prevents (or reduces), for example, the filaments 100 from coming into contact with each other or with the walls of the apparatus or adjacent to the first suction port A1.

[0059] During use, filaments 100 are extruded from the spinneret 2. The extrusion temperature of the filaments is typically between 190 °C and 290 °C.

[0060] Below the spinneret 2, waste substances produced by the extrusion of the filaments 100 are preferably suctioned by means of the second suction device 4 arranged downstream of the spinneret 2. Preferably, the gas suctioned by means of the second suction device 4 has a flow rate in the range between 1000 m³/h and 3000 m³/h, preferably it is about 2000 m³/h.

[0061] The filaments 100 are cooled by means of the cooling device 5 after the extrusion step and, if present, after the suction step by means of the second suction device 4. The cooling device 5 comprises a delivery port A2 that directs cooled gas in the direction of the filaments 100 and allows the cooling of the waste substances. The temperature of the gas delivered by the cooling device 5 is typically in the range of 10°C to 40°C, preferably in the range of 14°C to 30°C. In preferred embodiments, the delivering flow rate of gas cooled by the cooling device 5 is in the range of 10000 m³/h to 20000 m³/h, preferably it is about 15000 m³/h.

[0062] After the cooling step, the waste substances are suctioned by the first suction device 6 through the suction port A1.

[0063] Preferably, the gas suctioned by means of the first suction device 6 has a flow rate in the range between 6000 m³/h and 9000 m³/h, preferably it is about 7500 m³/h. According to an embodiment, the suction device 6 comprises a purification device 18 which allows the waste substances suctioned by the suction port A1 to be retained, so that they are not dispersed into the environment.

[0064] Next, the filaments are aerodynamically drawn in the drawing duct 50 located downstream of the first suction device 6. Preferably, the flow rate of the gas in the drawing duct is between 40000 m³/h and 50000 m³/h, preferably it is 45000 m³/h.

[0065] In a known way, the filaments are usually laid on a suitable surface so as to form a nonwoven fabric.

Claims

1. Apparatus (1) for producing a nonwoven fabric, comprising:

- a. a spinneret (2) adapted to extrude a plurality of filaments (100) and comprising an extrusion surface (2a) equipped with extrusion holes (3);
- b. at least one cooling device (5) arranged downstream of said spinneret (2) and adapted to cool said plurality of filaments (100) by means of cooled gas, comprising at least one delivery port (A2) to deliver said cooled gas;
- c. at least one first suction device (6) comprising at least one first suction port (A1) and adapted to suction gas below the spinneret (2);
- d. a drawing duct (50) to aerodynamically draw said filaments (100) which comprises at least one inlet port (51) of said filaments (100);

wherein said at least one first suction port (A1) of said at least one first suction device (6) is arranged downstream of said at least one delivery port (A2) of said at least one cooling device (5) and upstream of said drawing duct (50).

- 2. Apparatus according to claim 1, comprising at least one second suction device (4) comprising at least one second suction port (A3) arranged downstream of said spinneret (2) and upstream of said at least one delivery port (A2) of said at least one cooling device (5).
- 3. Apparatus according to claim 1 or 2, wherein said at least one first suction device (6) and/or said second suction device (4) comprises purification elements (18, 18') for purifying the gas suctioned through the at least one first suction port (A1), preferably said purification elements (18, 18') comprise electrostatic cleaning filters or activated-carbon filters or devices using a water wash.
- 4. Apparatus according to one of the preceding claims, wherein said at least one first suction port (A1) is fluidically connected to at least one first suction channel (17) and to at least one first aspirator (20).
- 5. Apparatus according to one of the preceding claims, wherein the distance (D1) between said at least one first suction port (A1) and said spinneret (2) is greater than the distance (D2) between said at least one first suction port (A1) and said drawing channel (50).
- 6. Apparatus according to one of the preceding claims, wherein said at least one delivery port (A2) is fluidically connected to at least one blowing element (19).
- 7. Apparatus according to one of the preceding claims,

wherein said second suction port (A3) is fluidically connected to at least one second channel (21) and to a second aspirator (22).

8. Process for producing a nonwoven fabric by means of an apparatus (1) according to one or more of the preceding claims, comprising the steps of:

- i. extruding a plurality of filaments (100) from said spinneret (2);
- ii. cooling said plurality of filaments (100) below said spinneret (2) by means of cooling gas delivered by said at least one cooling device (5);
- iii. drawing said filaments (100) by means of a drawing duct (50);

further comprising a step of suctioning gases by means of said at least one suction device (6) downstream of at least one delivery port (A2) of said at least one cooling device (5) and upstream of said drawing duct (50).

- 9. Process according to claim 8, comprising a step of suctioning gas by means of at least one second suction device (4) downstream of said spinneret (2) and upstream of said at least one delivery port (A2) of said at least one cooling device (5).
- 10. Process according to claim 8 or 9, wherein the cooling gas delivered by said at least one cooling device (5) has a temperature in the range between 10 °C and 40 °C, preferably in the range between 14 °C and 30 °C.
- 11. Process according to any one of claims 8-10, wherein the gas suctioned through said at least one first suction port (A1) has a temperature in the range between 50 °C and 70 °C.
- 12. Process according to one of claims 8-11, wherein during the step i) the filaments (100) are extruded from the spinneret (2) at a temperature between 190 °C and 290 °C.
- 13. Process according to any one of claims 8-12, wherein the suction speed, at said first suction port (A1), is adjusted to a value that does not change the filament path (100) at the first suction port (A1).
- 14. Process according to any one of claims 8-13, wherein the gas suctioned by means of the first suction device 6 has a flow rate in the range between 6000 m³/h and 9000 m³/h, preferably it is about 7500 m³/h.
- 15. Process according to any one of claims 8-14, wherein the gas suctioned by means of the second suction device 4 has a flow rate in the range between 1000 m³/h and 3000 m³/h, preferably it is about 2000 m³/h.

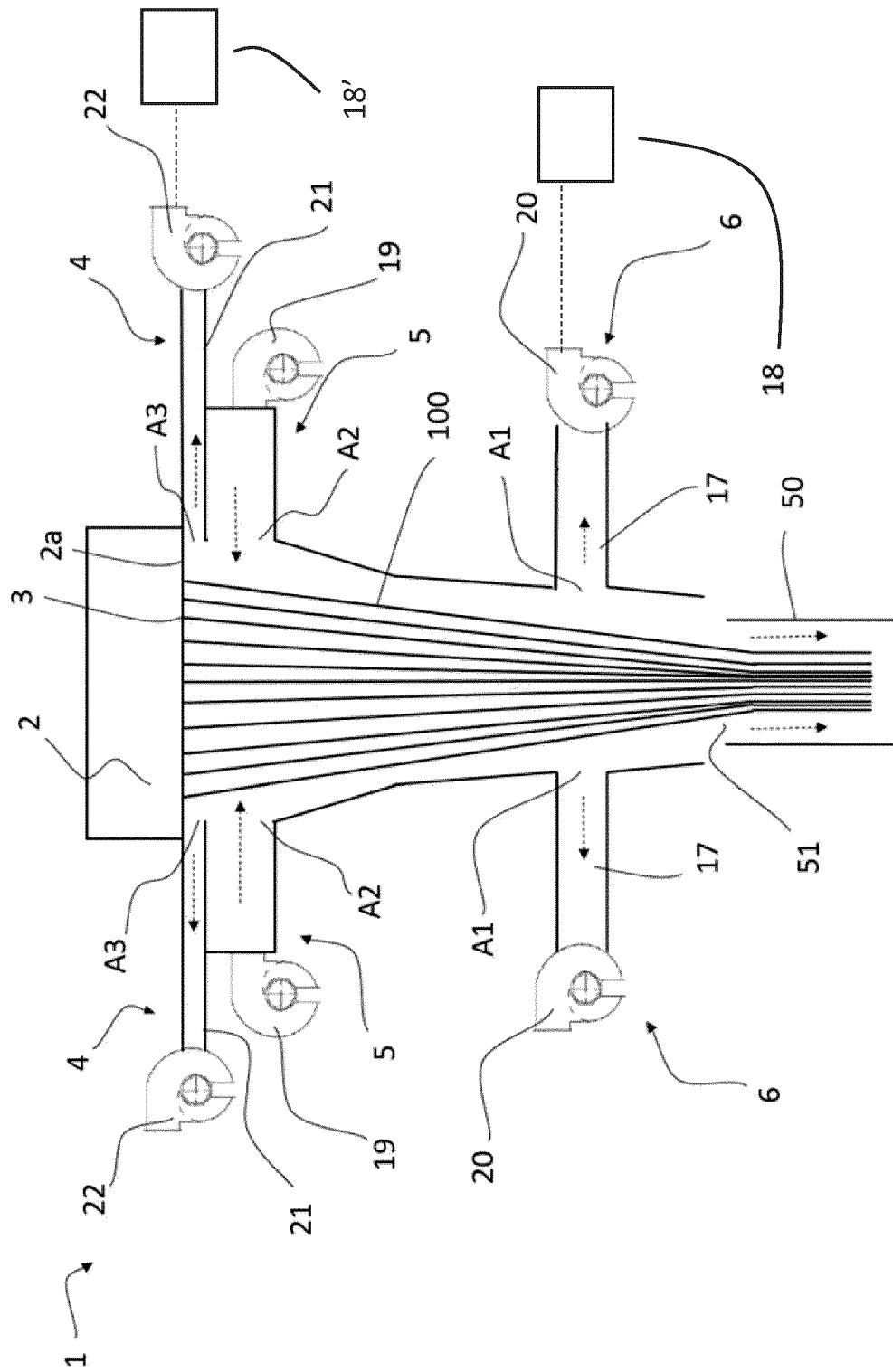


Fig. 1

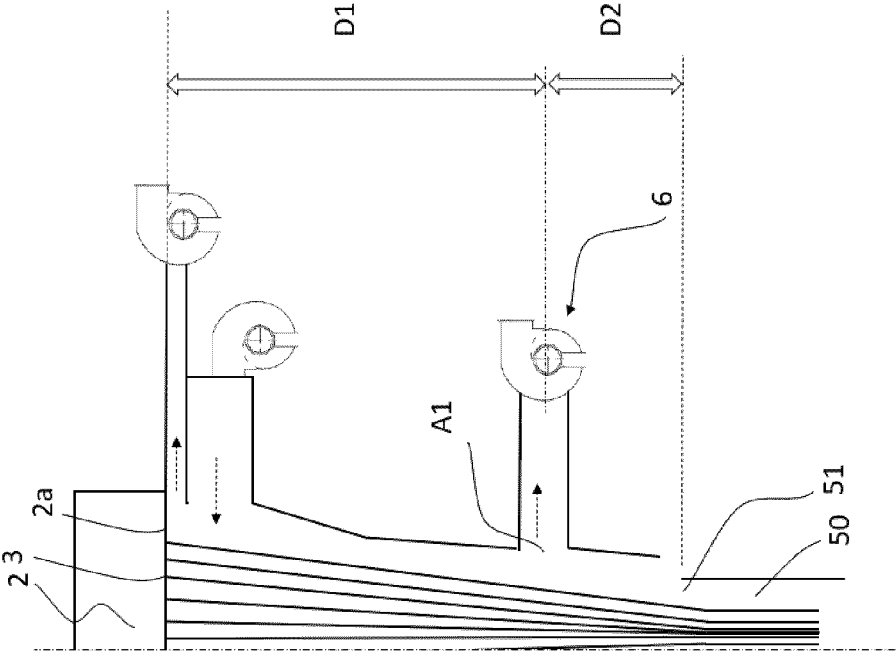


Fig. 2



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Application Number

EP 24 18 1575

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 5 November 2024	Examiner Verschuren, Jo
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT
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