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(71) Applicant: **SICAM - S.R.L.**
Societa' Italiana Costruzioni Aeromeccaniche
20141 Milano (IT)

(72) Inventors:
• **ZANARDI, Stefano Maria**
20125 MILANO (IT)
• **Tolga, KISBU**
INSTANBUL (TR)

(74) Representative: **Palladino, Saverio Massimo et al**
Notarbartolo & Gervasi S.p.A.
Viale Achille Papa, 30
20149 Milano (IT)

(54) **DEWATERING SECTION OF A HYDROENTANGLEMENT APPARATUS FOR THE PRODUCTION OF NON-WOVEN FABRICS**

(57) It is described an improved apparatus for the production of non-woven fabrics, and in particular an improved section of said apparatus dedicated to drying non-woven fabrics produced by hydroentanglement.

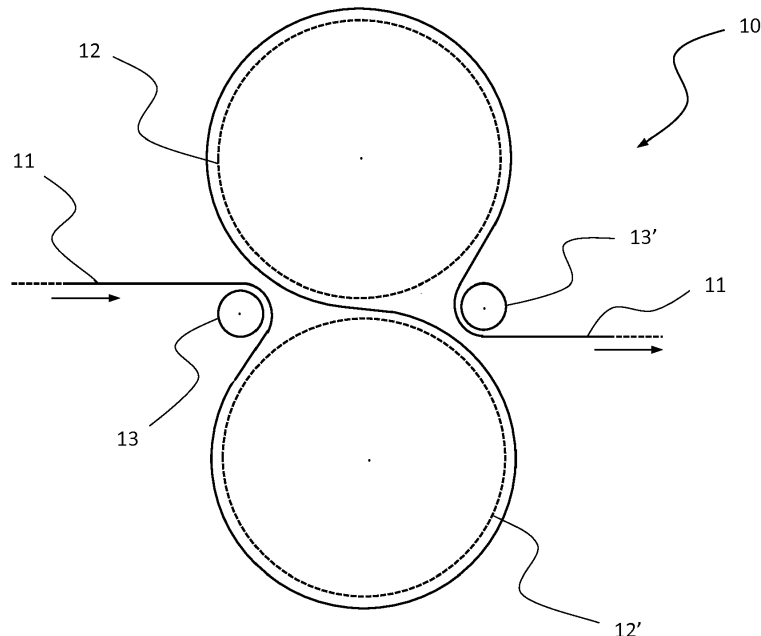


Fig. 3

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an improvement in an apparatus for the production of non-woven fabrics, and in particular in the section of the apparatus dedicated to drying non-woven fabrics produced by hydroentanglement.

STATE OF THE ART

[0002] Non-woven fabrics are fabric-like materials made from natural (e.g., cellulose) or artificial (e.g., polyester) fibers, bonded together by chemical, mechanical, heat or solvent treatment, and denote fabrics (such as felt) which are neither woven nor knitted.

[0003] Non-woven fabrics have replaced traditional fabrics in a number of applications and products, among which, to cite but a few, surgical masks and caps, disposable clothing, tea bags, vacuum bags, diapers, carpet backing and filters for gasoline, oil and air.

[0004] A widespread process for producing non-woven fabrics is by hydroentanglement. In this process, a continuous web of fibers obtained by airlaying, wet-laying or carding laid on a conveyor belt is consolidated by means of fine, high pressure jets ("needles") of water which penetrate the web, hit the conveyor belt and bounce back causing the fibers to entangle and interlace.

[0005] Non-woven fabrics produced this way are soaked with water and need to be dried before stocking or selling.

[0006] There are known several methods for drying non-woven fabrics, generally comprising multi-step processes, in which the first step(s) lead to a partial removal of water from the fabric, with drying completed in an oven. As drying in the oven is energy-intensive, all methods try to extract as much water as possible from the fabric before the treatment in oven; in the field, the steps directed to extract water from the non-woven fabric before its final drying in an oven are cumulatively referred to as "dewatering". Each method, characterized by a given sequence of steps, corresponds to a specific construction and a specific order of drying tools of the dewatering section of the apparatus.

[0007] One commonly adopted construction of the dewatering section comprises i) a first stage in which a continuous belt of non-woven fabric is caused to pass over a sucking slot; and ii) a second stage in which a compression is applied to the fabric belt. In detail, the sucking slot generally extends about 8 to 15 mm in the moving direction of the fabric belt, and across the whole width of the fabric belt; it is positioned under the conveyor belt that supports the web to be dewatered, and that is air-permeable. A vacuum is applied to a chamber beneath the slot, which is purposely designed no longer than about 15 mm, in order to have a little area where the low pressure is concentrated; the extremely violent sucking

action thus produced causes room air to pass through the web; the airflow passage forces water to follow the air stream, and a certain percentage of water is removed from the non-woven fabric as a result. After the passage through the web, air is generally first passed in a water separator to have water recycled in the plant, and then exhausted outside by means of a ventilator. In the second stage of this common dewatering arrangement, the compression between pressing rolls squeezes out from the fabric another portion of water.

[0008] Some machinery producers further install a small hood over the path of the fabric web, where hot air recovered from the ventilator motor cooling fan is blown.

[0009] This very common arrangement is shown, for instance, in patent application US 2007/068645 A1: this document discloses several embodiments of dewatering sections of non-woven fabric production plants, in each of which the suction stage (referred to in the document as "suction box 38") is positioned upstream the compression stage ("pressing zone 14" in the document).

[0010] Dewatering methods and apparatuses comprising a suction step (or stage) followed by a compression step (or stage) are however not satisfactory. One of the problems noted by the present inventors is that the dewatering efficiency is not optimal, and a relevant portion of water still needs to be evaporated in the final drying operation in the oven, with a relatively high energy consumption.

[0011] The object of the present invention is to provide a novel construction of the dewatering section of an apparatus for the production of non-woven fabrics, which improves the overall amount of energy required for drying non-woven fabrics produced by hydroentanglement.

SUMMARY OF THE INVENTION

[0012] These objects are achieved with the present invention, which relates to a dewatering section of a plant of production of non-woven fabrics by hydroentanglement, which comprises:

- a) a compression station of a wet non-woven fabric coming from the hydroentanglement step; and
- b) downstream the compression station, a suction station in which the non-woven fabric is exposed to reduced pressure for a time of at least 0.3 seconds.

BRIEF DESCRIPTION OF THE FIGURES

[0013] The invention will be described in the following with reference to the Figures, in which:

- Fig. 1 shows a flow chart outlining a prior art production process of non-woven fabrics including a hydroentanglement step;
- Fig. 2 shows a flow chart outlining a production process of non-woven fabrics including a hydroentanglement step according to the invention;

- Fig. 3 represents a preferred structure of the sucking tool of the dewatering station of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] The inventors have observed that, surprisingly, reversing the order in which the suction and compression steps are carried out compared to the arrangement that is usual in the field, gives rise to an enhanced effectiveness of dewatering of a non-woven fabric produced by hydroentanglement, with a consequent marked energy saving in the overall drying process.

[0015] Fig. 1 schematically represents, in the form of a flow chart, a process or an apparatus for the production of non-woven fabrics according to the prior art: A' is the process step (or apparatus section) in which a web of loose fibers is formed; B' is the step (or station) in which the fibers are interlaced by hydroentanglement; C' is the first step (or station) of dewatering, in which a first portion of the water soaking the fabric is extracted by an airflow forced to pass through the fabric by a pressure drop across the same due to the presence of a suction slot; D' is the second step (or station) of dewatering, in which a second portion of the water present in the fabric is extracted by squeezing it; and E' is the step (or station) of final drying of the fabric in an oven. Fig. 2 schematically represents, in the form of a flow chart, a process or an apparatus for the production of non-woven fabrics according to the invention. Steps (or stations) A, B and E are the same as A', B' and E' in Fig. 1; step (or station) C of the invention corresponds to step (or station) D' of the prior art; and step (or station) D of the invention corresponds to step (or station) C' of the prior art.

[0016] After the hydroentanglement step B, the non-woven fabric has already achieved its final mechanical strength, and there is no need any more of transporting it on a conveyor belt; the fabric travels in the dewatering/drying sections of the apparatus as a stand-alone product.

[0017] The tool used in the dewatering station by compression of the invention, C, may be of any known kind. Typically, compression is achieved by means of two counter-rotating cylinders, having the axis perpendicular to the moving direction of the non-woven fabric in the apparatus, at least one of which is pre-tensioned in order to exert a preset pressure on the fabric. Compression tools of this kind are widely known in the art, are commercially available, and generally referred to as squeezing padders. The surface of the cylinders is generally covered with a layer of rubber.

[0018] The device used in the dewatering station by suction of the invention, D, may have any geometry or configuration that assures an exposure of any point of the non-woven fabric to an airflow crossing the fabric of at least 0.3 seconds. This may be a slot in fluid communication with an evacuated chamber, with a length in the travelling direction of the non-woven fabric such to satisfy said condition with the usual travelling speed values of

fabrics in these systems (typically in the order of hundreds of meters per minute), or one or more perforated rolls over which the non-woven fabric, already entangled in the hydroentanglement machine passes and the inside of which is evacuated by pumping systems.

[0019] With this condition, at the same level of pumping by vacuum pumps (that is, with the same energy consumption of the pumping system), the quantity of air flowing through the non-woven fabric is the same as in the traditional slot system; the greater surface crossed by the same amount of air implies a less intense airflow across the fabric; yet, the inventors have observed that this does not lead to a reduced dewatering effect, and that the reduction of airflow speed across the fabric is more than compensated by the longer exposure time to said airflow.

[0020] Preferably, the suction device of the invention is a rotating perforated roll, or better a pair of rotating perforated rolls, the inner space of which is connected to a vacuum pump; the non-woven fabric is exposed to the suction action and consequent air crossing along the whole part of its transport path across the system.

[0021] The perforated roll(s) may consist of a cylindrical surface made of a metal foil of sufficient mechanical strength (for instance, a stainless steel foil of thickness 3 mm) with a series of evenly distributed through holes. Typically, the through holes have size between about 1.5 and 5 mm, and the total area of the perforations is between about 25 and 50% of the area of their cylindrical surface.

[0022] Alternatively, the perforated rolls may be built juxtaposing and fixing to each other at their sides (for instance, by means of nuts and bolts) a series of metal profiles with a "U" or a "H" profile, such that the lower parts of the "U" metal profiles, or the horizontal tracts of the "H" profiles, define a cylindrical surface; these lower parts or horizontal tracts have a series of perforations, which put the inner part of the cylinder in communication with the outside. The arms of the "U" or "H" metal profiles extending outward from this cylindrical surface support a metal net tightly wrapped around the metal profiles; this way, the surface the non-woven fabric contacts has a much higher void-to-solid ratio, for instance of about 95%, and thus a higher area of the non-woven fabric is directly exposed to vacuum.

[0023] The nonwoven fabric travels in the non-woven fabric production plants typically at a speed of about 200 m/min: with this speed, the time a point in the fabric takes to cross a slot of the prior art systems is between about 1/400 of second (for a slot of length 8 mm) and about 1/200 of second (for a slot of length 15 mm); in the present invention, with two perforated rolls of diameter 300 mm, the length of the path exposed to low pressure is of at least (depending on the convolution of the path around the rolls) about 1 m, which means an exposure time to low pressure of each point of the fabric of about 0.3 seconds.

[0024] An even more preferred configuration of the

suction device of the invention is represented in Fig. 3. The device comprises two main, perforated rolls 12 and 12' (the perforations are schematically represented by the dashed lines), and two idle rolls 13 and 13'; all rolls in this embodiment are rotating. The axes of perforated rolls 12 and 12', and of idle rolls 13 and 13', are all parallel, and in a transversal view said axes are positioned at the vertices of a rhombus. The perforated rolls 12 and 12' and idle rolls 13 and 13' may be made of stainless steel. For clarity of representation, the non-woven fabric 11 is shown in the drawing spaced apart from perforated rolls 12 and 12' and from idle rolls 13 and 13', but of course in operation the fabric is taut against these perforated and idle rolls. In this suction device, the fabric is caused to slide around idle roll 13, then around perforated roll 12', then around perforated roll 12, and finally around idle roll 13', in the direction indicated by the arrows, in a 8-shaped path. Rolls 12 and 12' are perforated and a vacuum is produced in their inner part by vacuum pumps; the fabric is exposed to an airflow across it during all its travel around the perforated rolls, that is, for a length that is essentially the sum of the circumferences of the two perforated rolls. In the typical conditions indicated above, rolls of 300 mm diameter and a travelling speed of the belt in the plant of 200 m/min, it can be calculated that the fabric is subjected to an airflow crossing it during about 0.5 s, that is, a period at least 100 times longer than in the suction systems of the prior art.

[0025] Another advantage of the preferred 8-shaped configuration of the suction device of the invention is that, different from what happens with the suction slots of prior art, the side of the fabric facing the perforated rolls (the suction tools of this embodiment of the invention) changes passing from one roll to the other one; for instance, in the drawing in Fig. 3, one face of the fabric will be in direct contact with the surface of perforated roll 12', then the other face of the fabric will be exposed to perforated roll 12; this way, the fabric will be crossed by an airflow in the two opposite directions in the two halves of the 8-path, improving the dewatering efficiency of the system. With this system, the inventors have observed that it is possible to achieve a 30% improvement in the dewatering effect with same energy consumption, and a 20% reduction of gas consumption in the final drying stage in an oven.

[0026] The energy efficiency of the dewatering system of the invention may be further improved adopting measures of energy recovery, as discussed below.

[0027] A first possible measure consists in operating the system in a closed-loop configuration, in which the air of the airflow crossing the non-woven fabric is continuously separated from water and recirculated to the suction station of the dewatering system of the invention. In this way, the circulating air continuously increases its temperature because the heat generated by the recirculating ventilator is not exhausted outside the system, but rather is taken up by the air itself. The inventors have observed that, adopting this simple measure, the recir-

culating air heats up until reaching a steady state temperature of about 70-80 °C.

[0028] A second possible measure consists in the recovery of heat from the oven used for the final drying of the fabric, and again using this heat to increase the temperature of the recirculating air. The recovery of heat from the oven and its transfer to the air recirculating in the system can be achieved for instance by means of air ducts (with air/air heat exchangers) or by hot oil flow (with double air/oil heat exchangers).

[0029] These two measures are completely free of charge and can be (and are preferably) adopted together, maximizing the energy recovery from the system and the efficiency of the dewatering section, so that a lower amount of water needs to be evaporated from the fabric in the final drying stage in oven, again leading to an energy saving in the overall drying process of the fabric.

Claims

1. Dewatering section of a plant of production of non-woven fabrics by hydroentanglement, which comprises:
 - a) a compression station of a wet non-woven fabric coming from the hydroentanglement step; and
 - b) downstream the compression station, a suction station in which the non-woven fabric is exposed to reduced pressure for a time of at least 0.3 seconds.
2. Dewatering section according to claim 1, in which the compression station consists two counter-rotating cylinders, having the axis perpendicular to the moving direction of the conveyor belt transporting the non-woven fabric, at least one of which is pretensioned in order to exert a preset pressure on the fabric.
3. Dewatering section according to claim 1 or 2, in which the suction station consists in a slot in fluid communication with an evacuated chamber or one or more perforated rolls over which the non-woven fabric passes and the inside of which is evacuated by pumping systems.
4. Dewatering section according to claim 3, in which said perforated rolls consist of a cylindrical surface made of a metal foil with a series of evenly distributed through holes, in which the through holes have size between about 1.5 and 5 mm, and the total area of the perforations is between about 25 and 50% of the area of their cylindrical surface.
5. Dewatering section according to claim 3, in which said perforated rolls are made by juxtaposing and

fixing to each other at their sides a series of metal profiles with a "U" or a "H" profile, wherein the lower parts of the "U" metal profiles or the horizontal tracts of the "H" profiles, define a cylindrical surface, said lower parts or horizontal tracts having a series of perforations which put the inner part of the cylinder in communication with the outside, and wherein the arms of the "U" or "H" metal profiles extend outward from this cylindrical surface and support a metal net wrapped around the metal profiles.

6. Dewatering section according to claim 4 or 5, in which:

- the suction station (10) comprises two perforated rolls (12, 12') and two idle rolls (13, 13'), all having parallel axes, said axes being positioned in a transversal view at the vertices of a rhombus;
- said perforated rolls and idle rolls defining a 8-shaped path of the non-woven fabric (11) to be dewatered; and
- the inside of said perforated rolls is evacuated by a pumping system.

7. Dewatering section according to claim 6, in which said idle rolls (13, 13') are made of stainless steel.

8. Dewatering section according to any one of the preceding claims, further comprising a closed-loop system recirculating air of the suction station to the same suction station through a ventilator.

9. Dewatering section according to any one of the preceding claims, further comprising air/air heat exchangers or air/oil heat exchangers that contact hot air of a drying over downside the dewatering system with the air crossing the non-woven fabric in the suction station.



Fig. 1

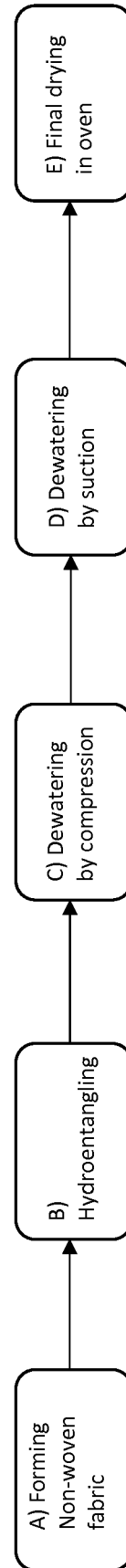


Fig. 2

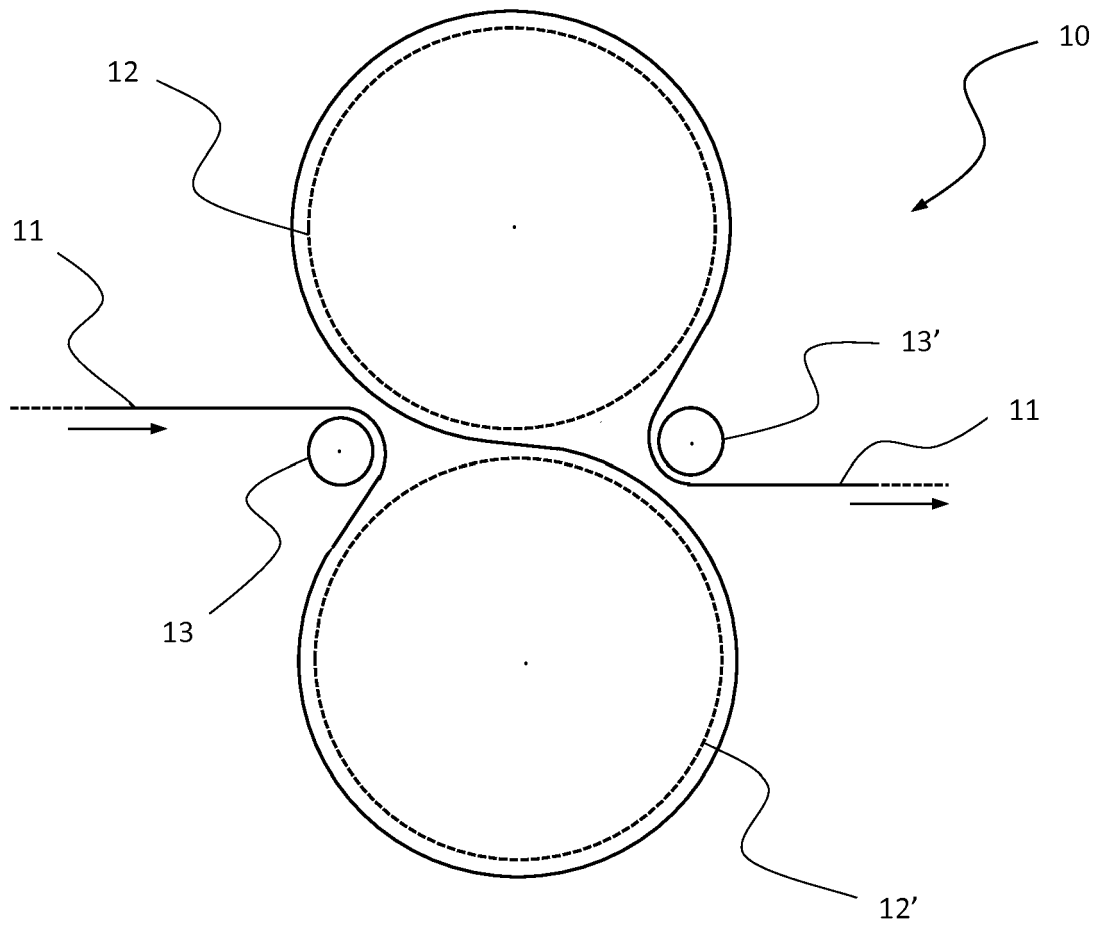


Fig. 3



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EP 19 18 0826

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Place of search Munich		Date of completion of the search 21 October 2019	Examiner Beckert, Audrey
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