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(54) **Method and apparatus for manufacturing artificial grass**

(57) The invention relates to a method and apparatus for manufacturing artificial grass, wherein, in a previous production step, a strand composed of loose, or substantially loose fibers is drawn through a carrier in a manner such that at a top side of this carrier loops are formed which, at some time or other in the production process, can be cut open for forming tufts, each tuft being connected to at least one other tuft via a strand part extending along an underside of the carrier, wherein the strands are manufactured from thermoplastic material and the fibers of the respective strand parts are fused together at least locally. The invention also relates to artificial grass manufactured with this method and apparatus.

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Description

[0001] The invention relates to a method for manufacturing artificial grass.

[0002] As a rule, artificial grass is manufactured by drawing strands composed of loose, or substantially loose fibers through a carrier, for instance through tufting, weaving or knitting, in a manner such that at a top side of the carrier, loops are formed. These loops are then cut open so that so-called "tufts" are obtained, each composed of a small bundle of loose, or substantially loose fibers. Here, each tuft is connected to at least one other tuft, via a strand part extending against the underside of the carrier. In order to secure the tufts to the carrier, these strand parts are usually fastened against the underside of the carrier by applying a layer of latex to this underside. In use, this latex layer can also serve as resilient, smoothening and/or damping layer.

[0003] A drawback of this known method of securing is that latex does not adhere well to all materials, which limits the choice as to the fiber and carrier materials. Moreover, the layer of latex will only adhere to the lowermost fibers in the respective strand parts. The other fibers, located closer to the carrier, are, at most, no more than clamped in between the latex layer and the carrier. As a result, these fibers can easily become detached and/or be pulled from the carrier, so that bare spots can form. This problem increases according as the number of fibers in the strand is larger. Further, relatively much latex is required which is expensive and leads to a relatively heavy product. Furthermore, latex has the property that it ages and, in the long run, pulverizes, whereby its securing effect is lost.

[0004] The object of the invention is to provide a method for manufacturing artificial grass, wherein at least a part of the drawbacks of the known method are obviated. In particular, the invention contemplates providing a method for securing the tufts of the artificial grass to a carrier without utilizing latex. To that end, a method according to the invention is characterized by the features of claim 1.

[0005] By manufacturing the fibers from a thermoplastic material, and by fusing the fibers of the respective strand parts together, the individual fibers can no longer be pulled loose. Moreover, the fused part can function as a sort of physical anchor which catches under the carrier and thus prevents an entire tuft from being pulled from the carrier from the top side. Fusing merely requires heat and some pressure, no additional auxiliary substances. As a result, a particularly light end product can be obtained.

[0006] In principle, the fibers in the respective strand parts need only be fused locally, that is, over a limited part of their lengths. In order to prevent tufts from shifting relative to the carrier, it is preferred to fuse the fibers at least adjacent the location where these tufts are drawn through the carrier for forming this physical anchor at that location. Naturally, the fibers can also be fused over the entire length of the respective strand parts.

[0007] It is noted that in this description, the term "fibers" is used as a collective term for all materials from which artificial grass can be formed in the above-mentioned manner, that is, by drawing a strand of these fibers through a carrier. Here, yarns, threads and/or (mono) filaments can for instance be considered. These "fibers" may be included loosely in the strand but can also be mutually connected, at least partly. For instance, the fibers may be formed from defibrated (partly cut loose) band material, or the strands can, at least partly, be plaited or twisted. Further, the strands can be composed of different types of fibers.

[0008] In an embodiment according to the invention, the fibers of adjoining strand parts are fused head to tail. As a result, at the underside of the carrier, rows and/or a network of fused fibers are/is obtained, so that tufts can be prevented even better from being pulled from the carrier from a top side. Furthermore, the fused rows can form projecting ridges between which, in use, when the artificial grass is placed on an underground, channels can be formed for drainage of, for instance, rainwater.

[0009] In a further embodiment according to the invention, the strand parts, at least a number of fibers thereof, are, at least locally, fused to an underside of the carrier. As a result, the tufts are secured to the carrier in all directions and pulling the tufts and/or fibers loose from an underside of the carrier is also prevented.

[0010] In further elaboration, the fibers are fused by heating and subsequently pressing them together. Here, the heating temperature is preferably relatively high, in particular approximately 10° to 50° higher than a melting temperature of the fibers, so that these fibers can fuse under relatively limited pressure. The carrier can be guided along, successively, an infrared station or a heated surface and then be guided along a pair of rollers. If desired, a roller contacting the underside of the carrier can be heated so that it can simultaneously serve as heating means. In addition, a roller contacting the top side of the carrier can be cooled, in order to cool the tufts and thus minimize the deforming effect of a pressure applied by this roller to the tufts.

[0011] In a further embodiment, heating and pressing-on the fibers takes place mainly at the underside of the carrier. To that end, the carrier can be guided by an underside along a heat source, for instance a heated roller, and be pressed against this heat source with the aid of counter pressure means, these counter pressure rollers preferably engaging a part of the carrier which is substantially unheated or has already cooled. To that end, the counter pressure means can be arranged at a distance from the heat source, viewed in travelling direction of the carrier. In addition or alternatively, the counter pressure means can be provided with cooling means. As a result, the deforming influence of this counter pressure on the carrier can be minimized so that formation of nap can be prevented. Nap formation is the phenomenon whereby, under the influence of heat, pressure and in-

ternal stresses, tufts assume a preferential direction. This process is irreversible.

[0012] In a further embodiment, a supporting layer can be provided against the underside of the carrier, which layer can be manufactured from, for instance, a resilient, damping material, for instance, foamed plastic. This supporting layer and the carrier can be glued or melted together, while fusion of the supporting layer can take place in a manner comparable to the fusion of the fibers, or even, at least partly, simultaneously therewith. Further, against an underside of the carrier, fastening means can be provided such as for instance Velcro tape, adhesive tape, press studs or the like, preferably detachable fastening means. With these, the artificial grass can be fastened to an underground in a simple manner. The artificial grass can for instance be supplied in strips (on the roll) or as tiles, and can be suited for use indoors as well as outdoors.

[0013] The invention further relates to an apparatus for manufacturing artificial grass, formed from strands of thermoplastic fibers drawn through a carrier. The apparatus is then provided with heating means for heating fibers extending at an underside of the carrier, and pressure means for pressing these heated fibers together. As a result, the fibers will fuse in situ and individual fibers are thus prevented from being pulled from the carrier. Moreover, the greater the set pressure is, the more the fibers will deform, in particular be flattened, so that at the location of the fusion, physical anchors will be formed (at the underside of the carrier) preventing entire strands from being pulled from the carrier from the top side. These flattened parts furthermore have a relatively large surface so that they can adhere well to the carrier.

[0014] In an advantageous embodiment, the heating means and pressure means are at least partly combined in the form of a heated pressure roller along which the carrier can be guided by an underside. Here, a number of guiding rollers or counter pressure rollers can be provided for having the carrier lie at a particular pressure against this pressure roller. It is preferred that these counter pressure rollers are arranged, viewed in travelling direction of the carrier, in front of and behind the pressure roller, at such a distance from this pressure roller that they engage a substantially unheated carrier part.

[0015] The invention further relates to artificial grass, provided with a carrier and strands of thermoplastic fibers drawn therethrough, which fibers are fused together, at least locally, at an underside of the carrier in a manner such that the individual fibers are secured against pulling loose from a top side of the carrier.

[0016] Against the underside of the carrier, further, one or more supporting layers can be provided, in order to give the artificial grass the desired properties, for instance in the field of damping, resilience, weight, insulation, watertightness et cetera. Thus, depending on the intended field of use and associated requirements for use, different supporting layers can be provided under the carrier.

[0017] In the further subclaims, further advantageous embodiments are described of a method and apparatus according to the invention, as well as artificial grass manufactured therewith. In clarification, exemplary embodiments of a method, apparatus and artificial grass according to the invention will be further elucidated with reference to the drawing. In the drawing:

Fig. 1A shows, in cross-sectional view, a first embodiment of a piece of artificial grass according to the invention;
Fig. 1B shows, in bottom view, the artificial grass according to Fig. 1A, with removed supporting layer;
Figs. 2A,B show, in cross-sectional view and bottom view, respectively, an alternative embodiment of a piece of artificial grass according to the invention;
Fig. 3 schematically shows, in side view, an apparatus for manufacturing artificial grass according to the invention; and
Figs. 4A, B show two exemplary embodiments of a securing unit according to the invention, for fusing the fibers together, resulting in artificial grass according to Figs. 1A, B and artificial grass according to Figs. 2A,B, respectively.

[0018] Fig. 1A shows, in cross-sectional view, a piece of artificial grass 1 according to the invention, provided with a relatively thin, flexible carrier 3 and a series of fibers 4, projecting from the carrier 3 in bunches, or "tufts" 5. In the exemplary embodiment shown, the fibers 4 have a flat, elongated form, in order to resemble real grass, but can, naturally, have many other forms. The fibers 4 are manufactured from a thermoplastic material, such as, for instance, polyester, polyamide, polypropylene, polyethylene or combinations thereof. The tufts 5 are formed by bundling a number of fibers 4 into a strand 6, and to then draw this strand through the carrier 3 by means of techniques known per se such as, for instance, tufting, weaving or knitting. At a top side of the carrier 3, loops L are then formed which, subsequently, can be cut open as schematically shown in Fig. 1A, at the right hand side in interrupted lines and with cutting lines S.

[0019] Alternatively, strands 6 can be weaved through two carriers 3 placed one at a distance above the other (this is known as so-called two-layer weaving), wherein between the carriers 3, "loops" L are formed, which can then be cut through halfway so that two carriers 3 with tufts 5 are obtained.

[0020] In all cases, each tuft 5 will each time be connected to at least one other tuft 5, via a strand part 8, which strand part 8 extends at the underside of the carrier 3, between the respective tufts 5 (see also Fig. 1B). With artificial grass 1 according to the invention, the fibers 4 of these strand part 8 are fused together at least locally, in a manner to be further described.

[0021] The carrier 3 can be a non-woven material, for instance felt or a synthetic plastic, but can also be a woven, knitted or foamed material. The carrier 3 can further

be manufactured from natural or synthetic material. In the case of synthetic material, preferably, a thermoplastic material is chosen, for instance polyethylene or polyester. As a result, the fibers can be fused well to the underside of the carrier 3.

[0022] Against the underside of the carrier 3, a supporting layer 7 can be provided (as shown in Fig. 1A, but, for the sake of clarity, omitted in Fig. 1B). This supporting layer 7 can for instance be manufactured from a relatively thick, resilient material such as for instance felt, rubber or latex. In an advantageous embodiment, the supporting layer 7 is manufactured from a foamed plastic, for instance polyethylene foam. Such a foamed layer 7 has good damping and insulating properties. When the artificial grass is intended for outdoor use, the foam preferably has a closed cell structure, in order to prevent sponge action and damage through freezing.

[0023] Depending on the material from which the carrier 3 and the supporting layer 7 are manufactured, the supporting layer 7 can for instance be connected to the carrier 3 through gluing or fusing, in particular flame laminating. If desired, the supporting layer 7 and carrier 3 can be provided with openings for draining (rain)water. In an alternative embodiment, the carrier 3 and supporting layer 7 can be replaced by one single layer, in which the strand fibers 4 are provided and secured in the abovementioned manner. Naturally, the supporting layer 7 can also be omitted so that a very thin, light product is obtained. In that case, the supporting layer 7 can be supplied additionally, as loose underlying layer.

[0024] The artificial grass 1 can be furnished in strips (on a roll) or in tile-form. Against an underside of the artificial grass 1, fastening means 9 can be provided such, as for instance, Velcro tape, tape, press studs or magnet strips, for anchoring the artificial grass to an underground. If desired, this underground can be provided with complementary fastening means. In addition or alternatively, ballast or filler means can be used in the form of, for instance, sand or synthetic granules, which can be scattered over the artificial grass 1 in order to weight the artificial grass and thus keep it in place. Such filler means offer as additional advantage that it helps the "blades of grass", at least the tufts 5 and the separate fibers 4 therein, to stay upright.

[0025] Fig. 3 schematically shows an apparatus 10 according to the invention for manufacturing artificial grass 1 as described hereinabove. To that end, the apparatus 10 shown comprises, from left to right, a first reel 12 for the supply of carrier material 3, a series of second reels 13_{a-n} for the supply of loose fibers 4 (alternatively, the fibres 4 can be supplied as strand 6, from a single reel, not shown), a tufting station 14 for drawing the strand 6 through the carrier 3 and, subsequently, cutting open S the formed loops L, and a securing unit 15 for securing the tufts 5 in or to the carrier 3. In the exemplary embodiment shown, further, a laminating station 16 is provided for applying a supporting layer 7 to the carrier 3. To that end, the laminating station 16 is provided with a third reel 17 for the supply of supporting material 7, heating means 18 for heating the supporting material 7, and pressure means 19 in the form of a pair of rollers with which the heated supporting layer 7 can be pressed against the carrier 3 (which process, in jargon, is called 'flame laminating'). Naturally the supporting layer 7 can be fastened to the carrier 3 in other manners, for instance through gluing. The laminating station 16 can thereto be adjusted accordingly. The supporting layer 7 can also be provided in a later stage or be completely omitted. The apparatus 10 can further comprise a station (not shown) for applying fastening means 9 to an underside of the artificial grass 1, for instance Velcro tape or tape as shown in Fig. 1A. Further, a fourth reel can be provided (not shown) for storing the produced artificial grass 1 on a roll, or a cutting and stacking station (not shown either) for cutting the artificial grass to size, for instance into tiles, and then stacking it.

[0026] The tufting station 14 is provided with means, in particular one or more needles 20, for drawing the supplied strand of fibers 6 through the carrier 3, for instance through tufting, weaving, knitting or in other manners (known per se). Further, diverting means can be provided (not shown) around which the strands 6 can be guided in order to thus form loops L. The tufting station 14 further comprises cutting means 22 to cut the formed loops L open or through, so that tufts 5 are obtained.

[0027] Further, between the different stations mentioned, naturally, drive means, guiding means, buffers and/or storing reels (none shown) can be provided in order to lead the carrier 3 and the fibers 6 along these stations at a desired pace. The stations can also be designed as autonomous stations, along which the artificial grass can be guided in successive steps, separated in place and time.

[0028] The securing unit 15 comprises heating means 24 for heating, at least locally, the fibers 4 in the strand part 8 at the underside of the carrier 3, and pressure means 25 for pressing the heated fibers 4 together so that they fuse together. Hereinbelow, two possible embodiments of a securing unit 15 according to the invention will be described with reference to Figs. 4A and B, with which an artificial grass 1 according to Figs 1A,B and an artificial grass to be further described according to Figs. 2A,B, respectively, can be manufactured.

[0029] In the embodiment according to Fig. 4A, the pressure means 25 comprise a pressure roller 26, arranged under the carrier 3, and two counter pressure rollers 28, arranged above the carrier 3, on both sides of the pressure roller 26 or, viewed in travelling direction V of the carrier 3, in front of and behind the pressure roller 26. By means of the pressure roller 26, a force F_D can be applied to the underside of the carrier 3, while with the pressure rollers 26, two counterforces Fc can be applied to the top side of the carrier 3 which, together, are as great as the force F_D mentioned, but opposite in direction. The pressure roller 26 is provided with a heated shell, so that the pressure roller 26 can also function as

heating means 24.

[0030] In this embodiment, the underside of carrier 3 is simultaneously heated and pressed-on by pressure roller 26. As a result, the fibers 4 in the strand parts 8 will fuse in a manner as shown in Fig. 1B, that is, without appreciable (plastic) deformation. An advantage of this embodiment is that a very limited pressure can suffice. Furthermore, a counter pressure applied by the counter pressure rollers 28 acts on a "cold" part of the carrier 3, so that this counter pressure (which is already small) will not occasion appreciable deformation at the tufts 5. The virtually undeformed, fused fibers 4 can form projecting ridges at the underside of the carrier 3, (provided that the tufts 5 are arranged in rows) between which, in use, channels can be formed for draining rainwater.

[0031] In an alternative embodiment, the securing unit 15 can be designed as shown in Fig. 4B, while parts corresponding to Fig. 4A are indicated with corresponding reference numerals, increased by 100. In this embodiment, the pressure means 125 comprise a pair of rollers disposed one above the other, with which two equally great, but opposing forces F_D, Fc can be applied to an underside or top side, respectively, of the carrier 103. The heating means 124 are arranged in front of the pressure means 125, and can comprise, for instance, an infrared station or a heated roller.

[0032] In this embodiment, the carrier 103 is guided by an underside along the heating means 124 so that fibers extending against this underside are heated to above their melting temperature. Thereupon, the carrier 103 is guided along the pair of rollers 125, so that the heated fibers 104 are pressed against each other and against the carrier 103. The fibers 104 can then, if desired, be flattened, as shown in Figs. 2A, B (by setting a sufficiently high roller pressure). The fusing together ensures that no individual fibers 104 can be pulled loose, while the flattened form ensures that the tufts 105 cannot be pulled through the carrier 103 from a top side of this carrier 103.

[0033] With this embodiment, the carrier 103 is preferably manufactured from heat-insulating material or provided, at a top side, with a layer of heat insulating material, so that the tufts 105 are not heated, or only to a limited extent (through heat conduction from the underside of the carrier 103). It is further preferred that the set pressure force $F_{D,C}$ is kept as low as possible so that the tufts 105 are not deformed by this pressure force. Also, the top roller can be cooled in order to cool the tufts 5, should they nevertheless have heated to a limited extent.

[0034] By profiling the pressure means in a suitable manner, it can be ensured that, at some locations, the fibers 4, 104 are pressed-on more and, at other locations less or not at all, so that these fibers 4, 104 fuse together only locally.

[0035] The invention is not limited in any manner to the exemplary embodiments represented in the description and the drawing. All combinations of (parts of) embodiments described and/or shown are understood to fall within the inventive concept. Furthermore, many variations thereon are possible within the framework of the invention as set forth in the following claims.

Claims

1. A method for manufacturing artificial grass, wherein in a previous production step a strand composed of loose, or substantially loose fibers is drawn through a carrier in a manner such that at the top side of this carrier, loops are formed which at some moment or other in the production process can be cut open for forming tufts, each tuft being connected to at least one other tuft via a strand part extending along an underside of the carrier, **characterized in that** the strands are manufactured from thermoplastic material and the fibers of the respective strand parts are fused together, at least locally.

2. A method according to claim 1, wherein the fibers of adjoining strand parts are fused head to tail.

3. A method according to claim 1 or 2, wherein the strand parts are fused to an underside of the carrier.

4. A method according to any one of the preceding claims, wherein the fusing of the fibers is done by heat and pressure.

5. A method according to claim 4, wherein pressure is applied to heated fibers, and wherein a counter pressure or reaction pressure to be applied to the carrier is applied to a part of the carrier that is substantially unheated or has already cooled.

6. A method according to any one of the preceding claims, wherein the carrier is guided by an underside along heating means and pressure means.

7. A method according to claim 6, wherein the carrier is guided by a top side along counter pressure means, which are arranged directly above the pressure means.

8. A method according to claim 6, wherein the carrier is guided by a top side along counter pressure means, which, viewed in travelling direction of the carrier, are arranged at a considerable distance in front of and behind the heating means, so that a counter pressure applied by these counter pressure means to the carrier acts on a substantially unheated carrier part.

9. A method according to any one of claims 6 - 8, wherein the pressure means are heated and thus, simultaneously, function as heating means.

10. A method according to any one of the preceding claims, wherein, to the underside of the carrier, a supporting layer is applied which is preferably manufactured from a resilient material, and which is fastened to the carrier by, for instance, gluing or fusion, in particular flame laminating.

11. An apparatus for manufacturing artificial grass that is formed from strands of thermoplastic fibers drawn through a carrier, wherein the apparatus is provided with heating means for heating fibers extending at an underside of the carrier and pressure means for pressing these heated fibers against each other so that, at that location, these fibers fuse together.

12. An apparatus according to claim 11, wherein the heating means comprise a heated roller.

13. An apparatus according to claim 11 or 12, wherein the heating means are designed for heating the fibers to a temperature which is higher than a melting point of these fibers.

14. An apparatus according to any one of claims 11- 13, wherein the pressure means comprise at least one pressure roller and at least one counter pressure roller, designed for applying pressure to an underside and a top side of the carrier.

15. An apparatus according to claim 14, wherein one pressure roller and two counter pressure rollers are provided, while the counter pressure rollers are arranged, viewed in travelling direction of the carrier, in front of and behind the pressure roller and are designed for forcing the carrier against the pressure roller.

16. Artificial grass comprising a carrier, provided with tufts, formed from strands of thermoplastic fibers drawn through the carrier, wherein each tuft is connected to at least one other tuft, via a strand part extending under the carrier, while the fibers of the respective strand part are fused together at least locally.

17. Artificial grass according to claim 16, wherein the fibers are fused together such that the fused parts form physical anchors, preventing the fibers and/or tufts from being pulled loose from a top side of the carrier.

18. Artificial grass according to claim 16 or 17, wherein against the underside of the carrier a supporting layer is provided, preferably manufactured from a relatively resilient material.

19. Artificial grass according to any one of claims 16 - 18, wherein the carrier and the optional supporting layer are provided with drainage openings for water.

20. Artificial grass according to any one of claims 16 - 19, wherein fastening means are provided for fastening the artificial grass to an underground.

21. Artificial grass according to any one of claims 16 - 20, wherein the artificial grass is strip-shaped or tile-shaped.

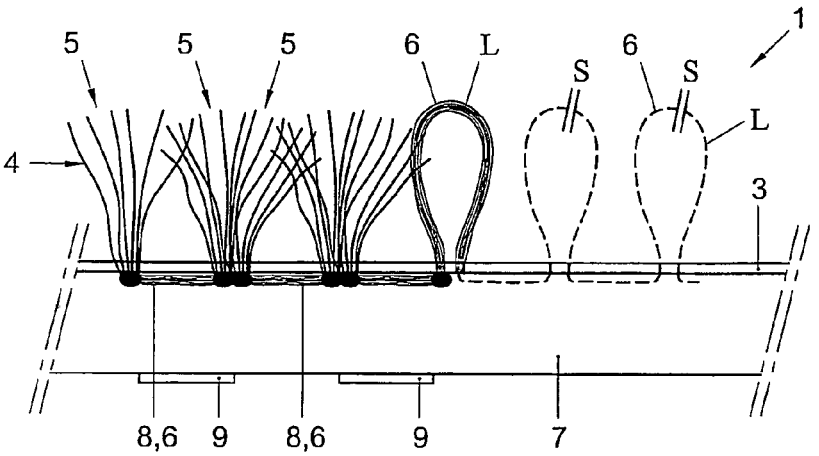

Fig. 1A

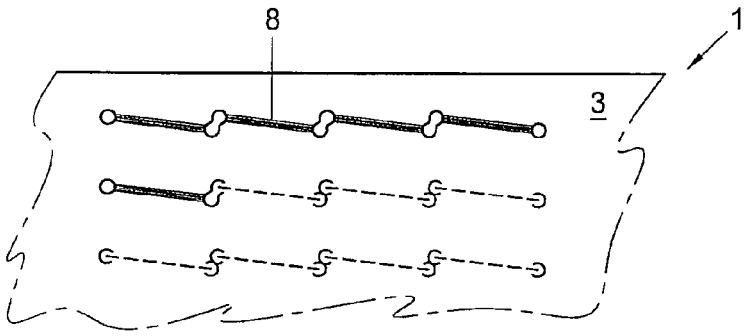

Fig. 1B

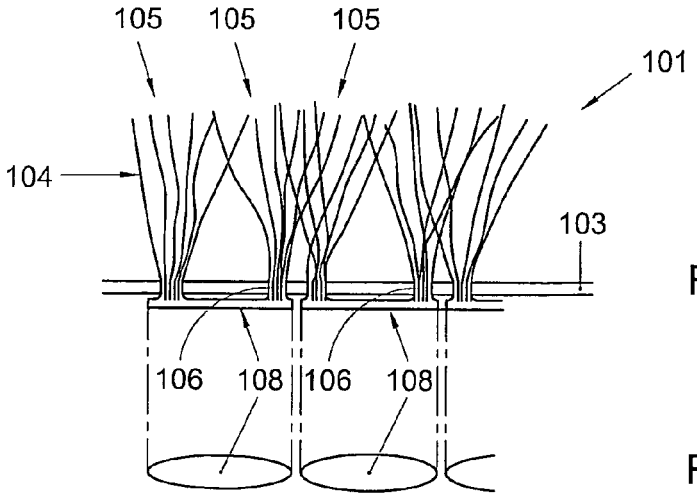

Fig. 2A

Fig. 2B

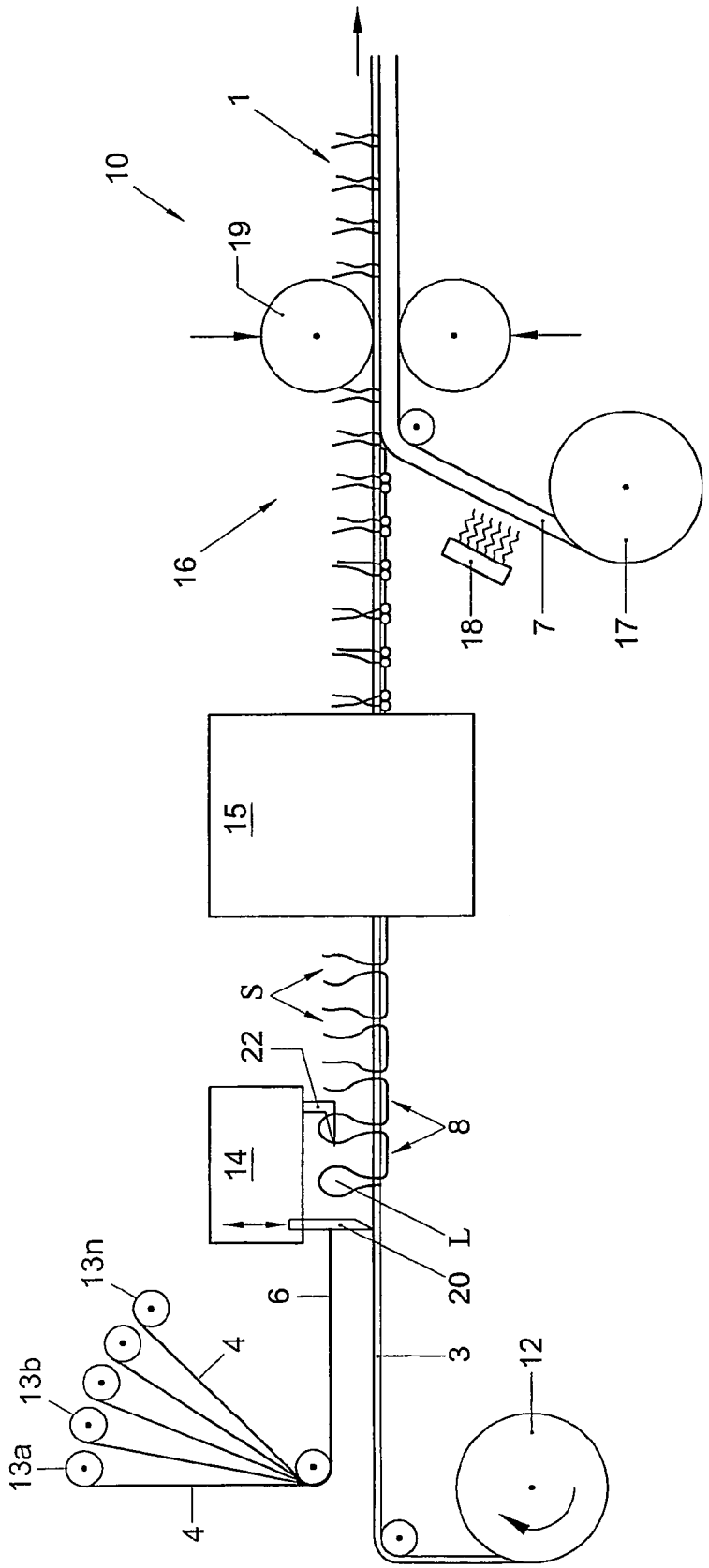

Fig. 3

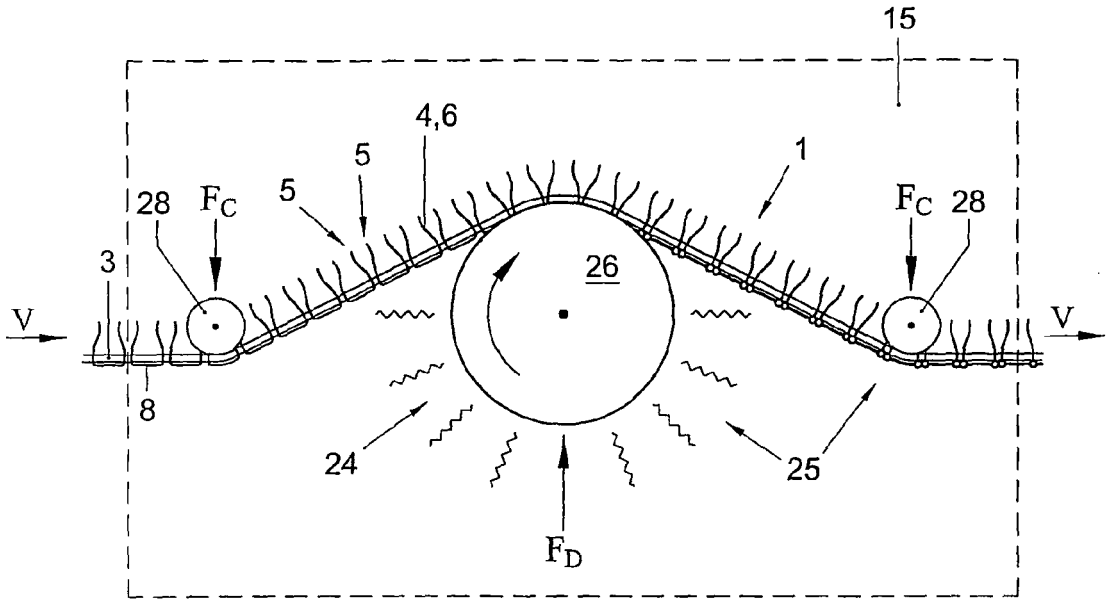
15
4,6
5
5
1
28
F_C
F_C
28
3
26
V
V
8
24
25
F_D

Fig. 4A

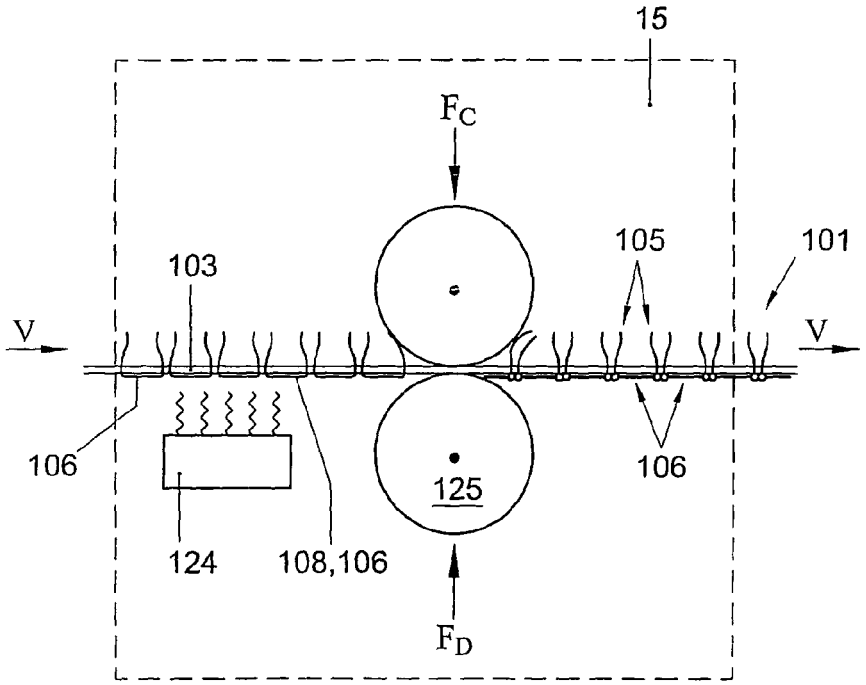
15
F_C
105
101
103
V
V
106
106
125
124
108,106
F_D

Fig. 4B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 07 5692

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X	US 4 389 434 A (H. A. POLMAN) 21 June 1983 (1983-06-21) * column 2, line 11 - line 19; claims 1,3,7,9; figures * * column 5, line 65 - column 6, line 10 *	1-21	INV. E01C13/08 D06N7/00
X	US 5 876 827 A (W. E. FINK ET AL.) 2 March 1999 (1999-03-02) * column 4, line 1 - line 50; figures 4a,4b * * column 6, line 39 - line 44 * * column 7, line 10 - line 17 * * column 7, line 50 - column 8, line 19 * * column 8, line 49 - line 53 * * column 14, line 54 - line 60 *	1-21	
X	US 4 705 706 A (G. S. AVERY) 10 November 1987 (1987-11-10) * column 3, line 45 - line 50; claims 1,3,4,6,7,15,18,19; figure 1 * * column 3, last line - column 4, line 1 *	1-3, 16-21	TECHNICAL FIELDS SEARCHED (IPC) E01C A41G D05C D06N D04H
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 July 2006	Pamies Olle, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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EUROPEAN SEARCH REPORT

Application Number
EP 06 07 5692

DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 July 2006	Pamies Olle, S

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