(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 645 683 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.04.2006 Bulletin 2006/15

(21) Application number: **05108476.2**

(22) Date of filing: **15.09.2005**

(51) Int Cl.:
D21F 1/00 *(2006.01)* ***D21F 7/08*** *(2006.01)*
D01D 5/253 *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **05.10.2004 DE 102004048432**

(71) Applicant: **Voith Fabrics Patent GmbH**
89522 Heidenheim (DE)

(72) Inventors:
- **Hay, Stewart Lister**
  Ramsbottom, Lancashire BL0 9EH (GB)
- **Patel, Sanjay**
  Summerville, SC South Carolina 29485 (US)

(54) Yarn having a bi-nodal cross-section and papermaking fabric comprising such a yarn

(57) The present invention relates to a monofilament yarn for use in an industrial textile, wherein said yarn has a bi-nodal cross section. The present invention further relates to an industrial fabric, preferably a paper making clothing, which comprise at least one monofilament yarn with a bi-nodal cross section. In addition the present invention relates to a method of making an industrial fabric comprising a monofilament yarn with a bi-nodal cross section.

EP 1 645 683 A1

Description

FIELD OF INVENTION

[0001] The present invention relates to industrial fabrics, and in particular, but not exclusively, to industrial fabrics such as paper maker's forming fabric.

DESCRIPTION OF PRIOR ART

[0002] The structure of forming fabric for use in paper making machines effects the web formation from the wet pulp and Therefore has a bearing on the quality of the paper produced. Conventionally, forming fabrics are manufactured from fabrics' produced by weaving single, cylindrical monofilament strands of polymer material or metal wires. The knuckles formed at the cross-over points of such woven fabrics however, impart a mark onto the paper surface, causing a reduction in smoothness. Also, such fabrics have been shown to demonstrate a poor sheet release.

[0003] In order to alleviate the above described drawbacks fabrics have been developed in which at least some of the individual yarns within the structure of the fabric are composed of a plurality of individual, joined, monofilament polymeric strands.

[0004] In US 4,636,426 (Huyck Corporation) two adjacent, monofilament strands are glued together using a heat activated polymeric adhesive. The joined strands are utilised in either the machine direction (MD), the cross direction (CD) or both the MD and the CD of the fabric. The adhesive is also used to adhere the MD and CD yarns at their cross-over points. By this means the overall height of the knuckle is reduced.

[0005] In US 5.591,525 (Shakespeare) and divisional thereof US 5,597,646 (Shakespeare) the fabric is formed using yams which have been formed by extruding, through a die, at least two individual filaments of polymer around a single axis, the swell of the material at the die fusing the filaments together. The single axis forms a central axis which can be either a filament or a void.

[0006] Fabrics formed using joined yarns however have the disadvantage that they are not particularly stable and are susceptible to separation of the so-called joined (glued or fused) yarns.

[0007] In US 5,944,062 (Christini Forming Fabrics GmbH), the weave pattern of the fabric is such that adjacent MD or CD yarns are woven in, in side by side pairs so as to be mutually contacting. This has the drawback that the problem of separation of the yarns remains, together with the fact that two insertions of the loom are required during formation of the fabric in order to insert such pairs.

[0008] In US 5,366,798 (Wangner Systems Corporation) a single system of warp yarns is woven with stacked triple weft yarns. The middle yarn of the triple weft has a cross-section which is of H-shaped, star-shaped, or X" shaped configuration; which shaped cross-section forms upper and lower channels in which respective upper and lower wefts of the stack are received and supported. This helps prevent lateral shifting of the yarns within the stacked structure, which would lead to an alteration in the knuckle pattern presented on the support surface of the fabric and an alteration of the drainage properties;

[0009] US 4,705,601 (Chiu-Kai) describes a three layer forming fabric in which warp yarns having an ovate cross-section are incorporated into the lowermost, that is machine-side layer. Ovate warp yarns have a greater tensile strength than the cylindrical yams used in The uppermost, that is pulp side layer, which allows comparatively a fewer number of such ovate yarns than cylindrical yarns to be used. This gives rise to a lower density in the lowermost layer, which enables a greater water extraction because it is possible to apply a greater suction pressure to the lowermost layer. The ovate yarns however have the same vertical height as the cylindrical yarns, in order that the overall thickness of the fabric is not altered by using such yarns and in order that the surface of the uppermost layer is not changed.

SUMMARY OF THE INVENTION

[0010] It is an object of the present invention to provide a fabric in which the effect that the knuckle has on the product transported thereon is reduced and which overcomes or alleviates the above described drawbacks.

[0011] In accordance with one aspect of the present invention there is provided a monofilament yarn having a bi-nodal cross section.

[0012] The binodal monofilament yarn may comprise two nodes, which are immediately adjacent, or the nodes may be separated by an integral linking bridge.

[0013] The bi-nodal yarns preferably have an aspect ratio of maximum width to maximum height ranging from 1,1 to 1,7, preferably from 1,3 to 1,6 and most preferably around 1,4.

[0014] The bi-nodal yams may be symmetrical or non-symmetrical in respect to their longitudinal axis.

[0015] According to a further embodiment of the invention the nodes may be flat at one side of the yarn.

[0016] The bi-nodal yarns preferably are made of a polymeric material. The polymeric material preferably comprising alone or in combination PA, PE, PET.

[0017] In accordance with a second aspect of the invention there is provided an industrial fabric comprising at least some monofilament yarns having bi-nodal cross section.

[0018] By providing a yarn produced from a single filament the yarn has more structural integrity and is thereby more stable and less susceptible to separation when compared to a fused yarn, yarns joined during die swell or yarns simply laid side by side. The increase in stability further allows the use of thinner (when viewed vertically) yarns, thereby further reducing fabric thickness whilst maintaining or decreasing void volume. For example, a bi-nodal yarn could replace a yarn of thicker diameter,

but with the same mass in order to reduce the fabric thickness.

[0019] As the mass remains the same, the void volume decreases. A decrease in void volume results in less water carry and so therefore reduces the likelihood of re-wet. This is particularly beneficial for forming fabrics. In terms of production this leads to a dryer sheet, which would mean energy savings or an ability to speed the paper machine up.

[0020] The consequential reduction in knuckle height leads to improved paper smoothness and easier sheet release. The channel between the nodes leads to improved water drainage. The nodes also provide point contacts with the product conveyed on the fabric, resulting in much finer wire marks. There is also a reduction in the time taken to weave the fabric, since the bi-nodal yarn takes the place of two separate yarns.

[0021] A fabric constructed with bi-nodal yarns also has improved stiffness which is beneficial on high speed gap formers with their enclosed forming zones. Stiffness equates to good sheet macro-formation due to reduction in streaks (density variations), caused by fabric with low stiffness not being able to withstand the hydraulic pressures.

[0022] According to a preferred embodiment of the invention the bi-nodal yarns are warp yarns and / or weft yarns of the fabric.

[0023] According to a further embodiment of the invention the fabric is a multi layer fabric comprising bi-nodal yarns on the paper side layer and / or wear side layer and / or on a middle layer of the fabric.

[0024] Bi-nodal yarns used on the paper side of the fabric lead to a reduction of knuckle height resulting in a smoother paper contacting surface with less tendency of wire marking. Bi-nodal yarns used on the wear side of the fabric preferably but not exclusively as CD yarns has the advantage that they enhance the scraping action of fibres from elements and reduce friction/drive load by trapping water, leading to an increase in the longevity of the fabric. Bi-nodal yarns when added to the middle or top layers of for example a triple-weft fabric can provide good stiffness, giving additional fibre support in the top layer.

[0025] Favourably all paper side layer warp yarns are provided with bi-nodal cross section.

[0026] Further it is advantageous if all wear side warp yarns are provided with bi-nodal cross section.

[0027] To increase the flatness of the paper side layer at least some of the bi- nodal yarns provided on the paper side layer having a flat side facing to the paper side.

[0028] To increase wear resistance of the wear side layer at least some of the bi - nodal yarns provided on the wear side layer having a flat side facing to the wear side.

[0029] According to a further aspect of the invention the bi-nodal yarns provided on the paper side layer having the same aspect ratio like the bi-nodal yarns provided on the wear side layer.

[0030] To get a fine and smooth paper side and a wear resistant wear side preferably at least some bi-nodal yarns provided on the paper side layer having a smaller total cross sectional area than the bi-nodal yarns provided on the wear side layer.

[0031] In accordance with a third aspect of the present invention there is provided a method of making an industrial fabric comprising the step of extrusion of a single filament yarn through a die to produce a monofilament bi-nodal yarn.

[0032] By way of example only specific embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1	is a diagrammatic representation of four different bi-nodal yarns, each constructed in accordance with the present invention;
Figs. 2a and 2b	are sectional side views of a single layer fabric woven with non-symmetrical bi-nodal yarns;
Fig. 3a	is a sectional side view of a known single layer fabric employing mono-filament MD yarns:
Fig. 3b	is a view similar to Fig. 3a but comparing the same fabric constructed with bi-nodal yarns instead of known mono-filament MD yarns and illustrating the overall reduction in thickness for a fabric constructed in accordance with the present invention;
Fig. 4	is a sectional side view of a double-layer fabric employing bi-nodal MD yarns;
Fig. 5	is a sectional side view of a double-layer fabric comprising paperside and wearside CD bi-nodal yarns
Fig. 6	is a sectional side view illustrating a triple-weft structure employing MD bi-nodal yarns
Fig. 7	is a sectional side view illustrating a triple-weft structure employing CD binodal yarns;
Fig. 8	is a sectional side view illustrating a triple-weft fabric employing MD bi-nodal yarns; and
Fig. 9	is a sectional side view illustrating a triple-weft fabric employing CD bi-nodal yarns.

[0033] The bi-nodal yarns of the present invention are prepared by extrusion a single filament to form a bi-nodal yarn. Examples of the shapes of such bi-nodal yarns are shown in Fig. 1, in which yarns (a) and (b) are symmetrical about its X-axis and yarns (c) and (d) are non-symmetrical about their X-axis. In the yarn of Figs 1 (a) and 1 (d) the two nodes 10, 12 are integrally formed and are immediately adjacent to each other, whilst in the yarn of Figs. I (b) and I (c) the two nodes 10,12 are spaced apart by an integrally formed connecting bridge 14.

[0034] Figs. 2a and 2b illustrate the use of the non-symmetrical bi-nodal yarns (c) and (d) in a single layer fabric 34 and 36. It is to be understood that the yarns can lie in either the MD or CD directions or both the MD and CD directions. Also, the yarns can be woven in position either way round with their flatter side facing (such as in Fig. 2a) or facing away (such as in Fig. 2b) from the yarns woven in the opposite direction. The orientation of the yarns is selected depending on the required machine conditions.

[0035] It is also to be understood that other types of bi-nodal yarns, such as (a) and (b) could be used in such a single layer weave. For example in Figure 3b yarn of the cross section shown in 1(a) is illustrated as a MD yarn in a single-layer structure 38. In Fig. 3a a conventional fabric is illustrated woven with the same pattern as that of Fig. 3b but with conventional cylindrical yarns rather than bi-nodal yarns. Measurement of the thickness A of the conventional fabric (Fig. 3a) when compared to the thickness B of the fabric constructed with bi-nodal yarns (Figure 3b) reveals that the overall thickness of binodal fabric B is less that the thickness A of the conventional fabric, thereby the overall height of the knuckle is reduced with a subsequent reduction in the tendency to mark when used, for example as a papermaker's forming fabric.

[0036] Furthermore, by forming the bi-nodal yarn from a single yarn it is possible to produce a yam of increased structural integrity when compared to a paired, joined or 'fused yarn. The increased stability allows the use of thinner yarns to reduce fabric thickness whilst maintaining or decreasing void volume. For example, a bi-nodal yarn could replace a cylindrical yarn of thicker diameter, but having the same mass to reduce the fabric thickness. As the mass remains the same, the void volume decreases. A decrease in void volume results in less water carry and so therefore reduces the likelihood of re-wet. This is particularly beneficial in forming fabrics leading to the production of a dryer sheet, which would mean energy savings or an ability to speed the paper machine up.

[0037] Furthermore, a channel for water drainage is provided between the two nodes, unlike a flat yarn, which has no ability to drain water. The nodes of the bi-nodal yarn also only present a point contact producing thereby a much finer wiremark, when compared to the broader contact provided by a flat yarn.

[0038] Fig. 4 illustrates the use of the bi-nodal yarns as a machine-direction yarn 16 in a double-layer fabric 22. Whilst Fig. 5 illustrates the use of bi-nodal yarns 16, 18 in both the machine and cross direction of a fabric 24. Reference numeral 18 representing bi-nodal cross-section yarns and numeral 20 binder yarns.

[0039] Fig. 6 illustrates a triple-weft structure 26 where the bi-nodal yarn is utilised as a machine-direction yarn 16, whilst in the embodiment of Fig. 7 the bi-nodal yarn is used as a cross-direction yarn 18 in a triple-weft structure 28. In the embodiment of Fig. 8 the bi-nodal yam is utilised as a machine- direction yarn 16 at only the machine-side of a triple-weft structure 30 whilst Fig. 9 illustrates a similar structure 32 with the bi-nodal yarn as the cross- direction yarn 18.

[0040] Other variations on the use of binodal monofilament yarns will readily occur to those skilled in the art.

Claims

1. Monofilament yarn for use in an industrial textile, wherein said yarn having a binodal cross section.

2. Monofilament yarn according to claim 1, **characterized in** **that** said bi-nodal yarn comprise two nodes which are immediately adjacent.

3. Monofilament yarn according to claim 1, **characterized in** **that** said bi-nodal yarn comprise two nodes which are separated by an integral linking bridge.

4. Monofilament yarn according to one of the claims 1 to 3, **characterized in** **that** said bi-nodal yarn has an aspect ratio of maximum width to maximum height greater than 1, preferably ranging from 1,1 to 1,7, more preferably from 1,3 to 1,6 and most preferably around 1,4.

5. Monofilament yarn according to one of the claims 1 to 4, **characterized in** **that** said bi-nodal yam is symmetrical or non-symmetrical in respect to its longitudinal axis.

6. Monofilament yarn according to one of the claims 1 to 5, **characterized in** **that** said nodes are flat at one side of the yarn.

7. Monofilament yarn according to one of the claims 1 to 6, **characterized in** **that** said bi-nodal yarn is made of a polymeric material, wherein the polymeric material preferably comprise alone or in combination PA, PE, PET.

8. Industrial fabric, preferably a paper making clothing, comprising at least one monofilament yarn according to one of the claims 1 to 7.

9. Industrial fabric according to claim 8,
characterized in
that said bi-nodal yarns are warp yarns and / or weft yarns of the fabric.

10. Industrial fabric according to one of the claims 8 to 9,
characterized in
that said fabric is a multi layer fabric comprising bi-nodal yarns on the paper side layer and / or wear side layer and / or on a middle layer of the fabric.

11. Industrial fabric according to one of the claims 8 to 10,
characterized in
that all paper side layer warp yarns are provided with bi-nodal cross section.

12. Industrial fabric according to one of the claims 8 to 11,
characterized in
that all wear side warp yarns are provided with bi-nodal cross section.

13. Industrial fabric according to one of the claims 8 to 12,
characterized in
that at least some of the bi- nodal yarns provided on the paper side layer
having a flat side facing to the paper side.

14. Industrial fabric according to one of the claims 8 to 13,
characterized in
that at least some of the bi- nodal yarns provided on the wear side layer having a flat side facing to the wear side.

15. Industrial fabric according to one of the claims 8 to 14,
characterized in
that the bi-nodal yarns provided on the paper side layer have the same aspect ratio like the bi-nodal yarns provided on the wear side layer.

16. Industrial fabric according to one of the claims 8 to 15,
characterized in
that at least some bi-nodal yarns provided on the paper side layer having a smaller total cross sectional area than the bi-nodal yarns provided on the wear side layer.

17. Industrial fabric according to one of the claims 8 to 16,
characterized in
that the fabric is a forming fabric or a dryer fabric or a base cloth of a press felt or smoothing belt or transfer belt.

18. Method of making an industrial fabric comprising the step of extrusion of a single filament yarn through a die to produce a monofilament yarn having a binodal cross section.

Fig.1

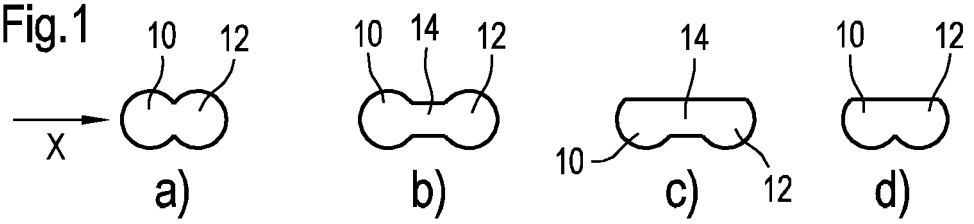


Fig.2A

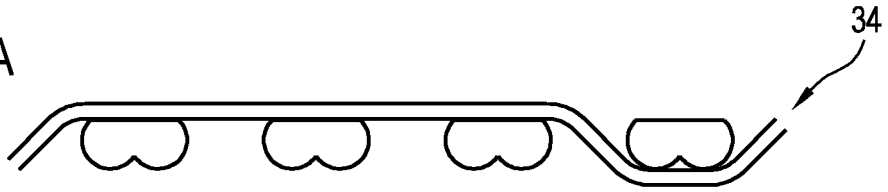


Fig.2B

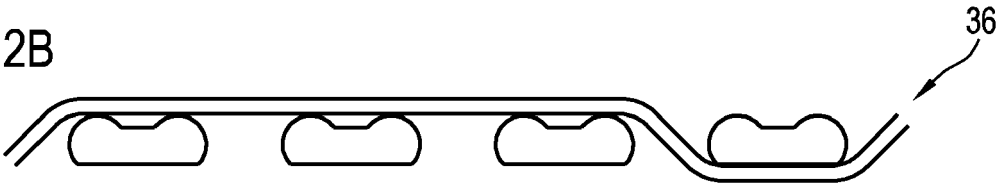
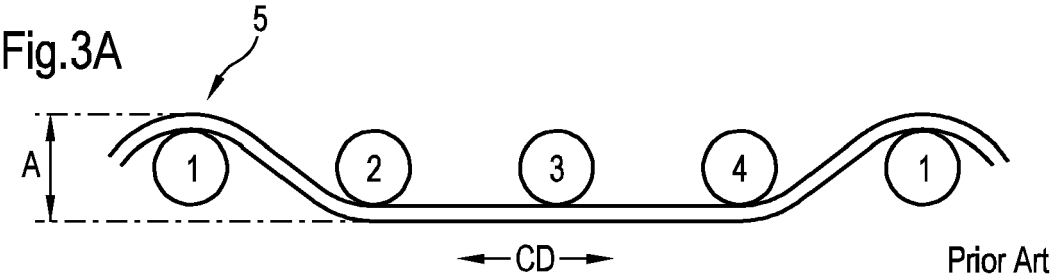
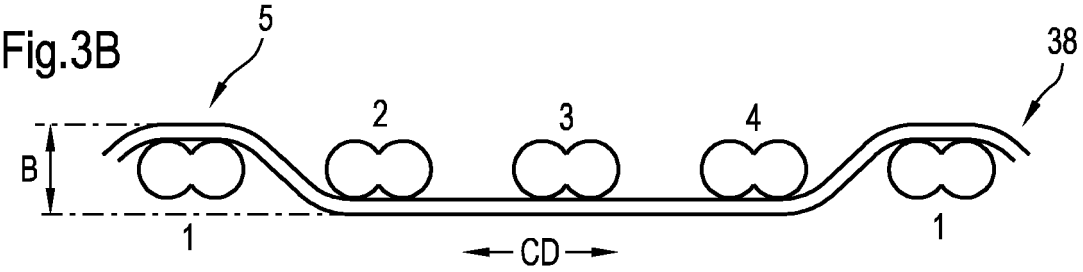


Fig.3A



Prior Art

Fig.3B



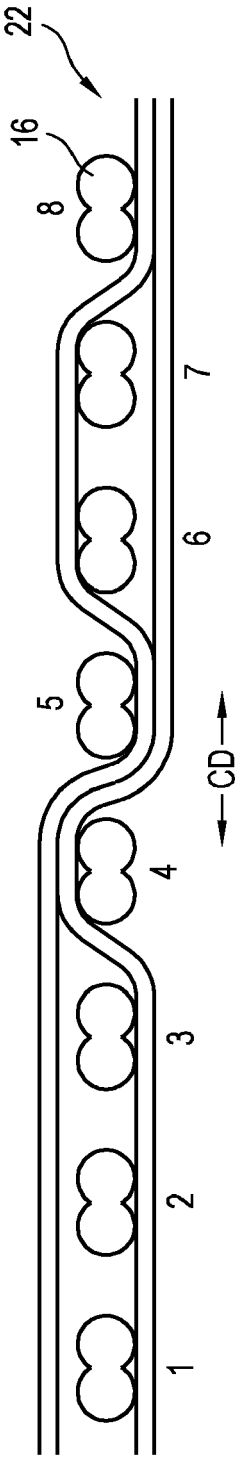


Fig.4

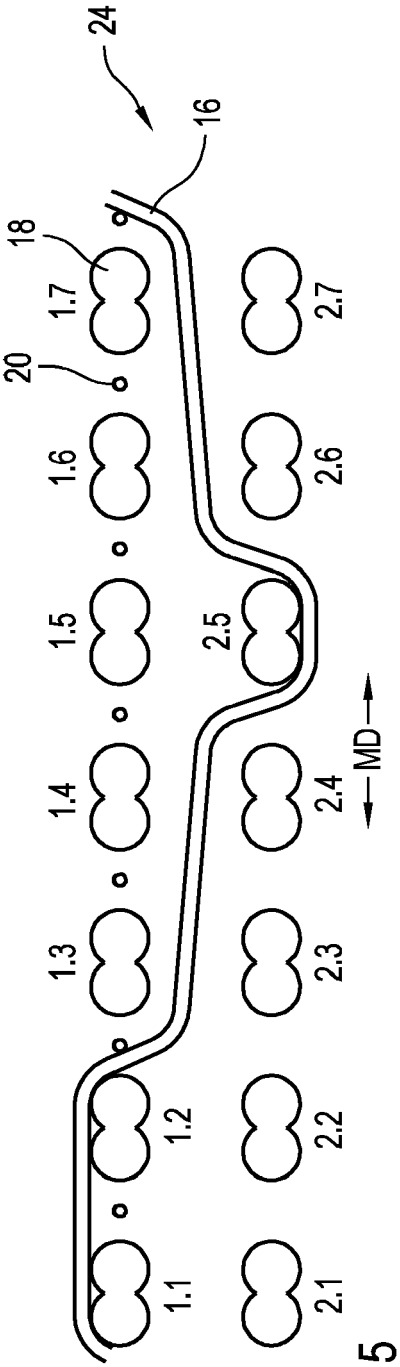


Fig.5

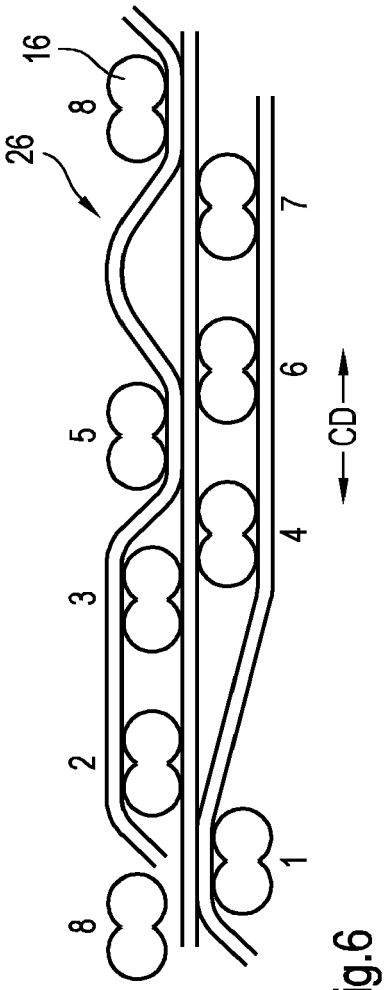


Fig.6

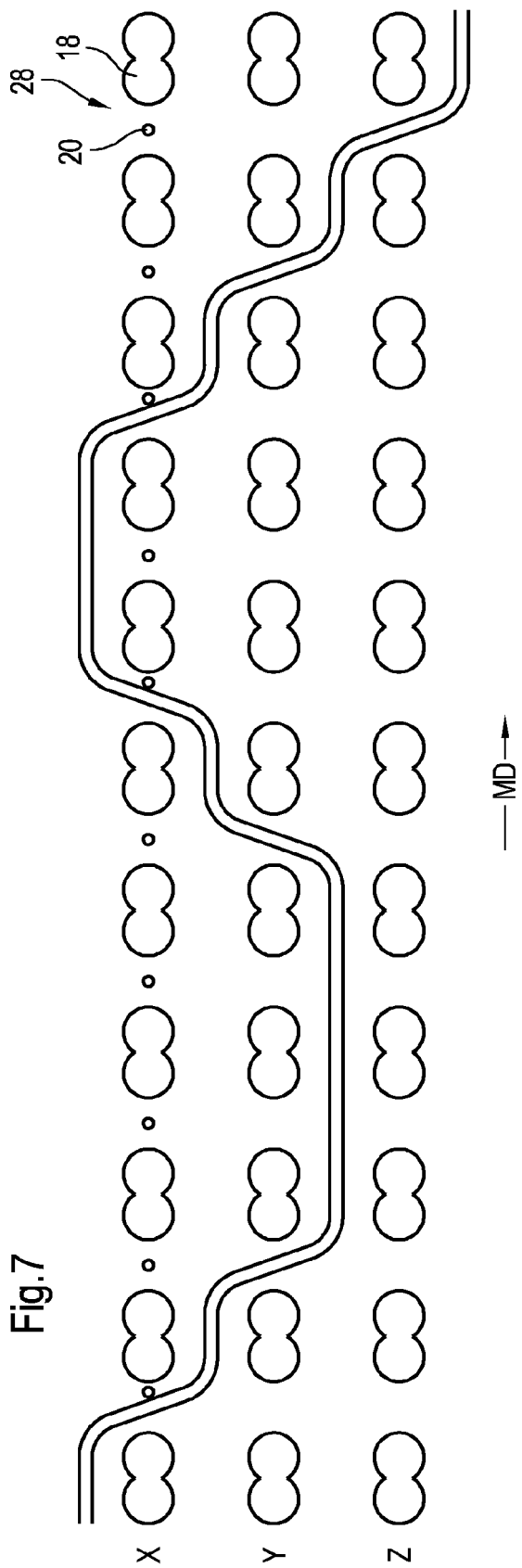


Fig.7

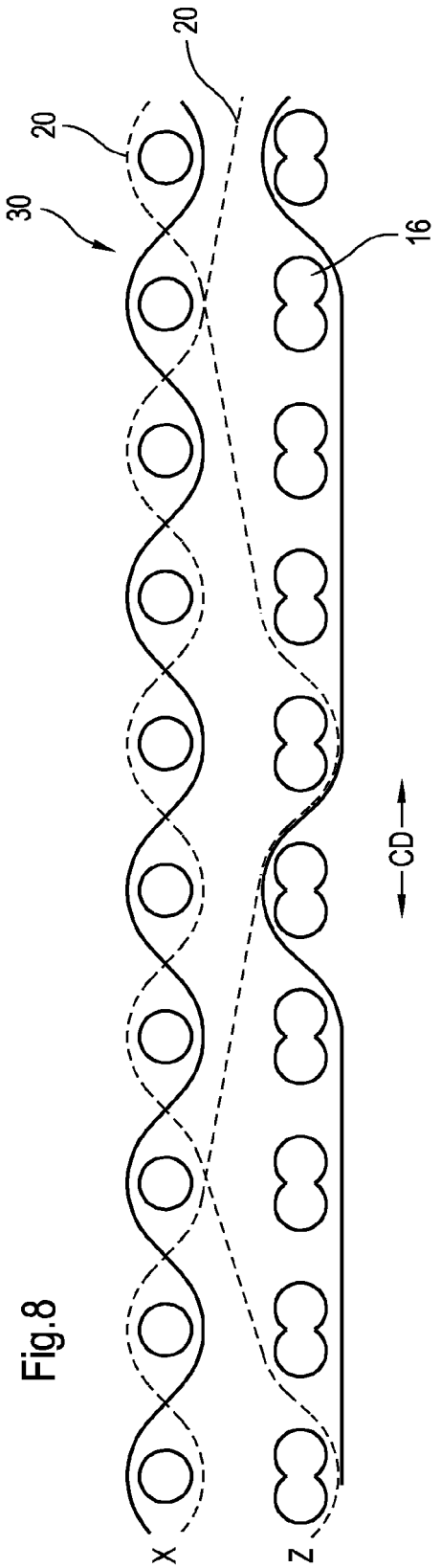


Fig.8

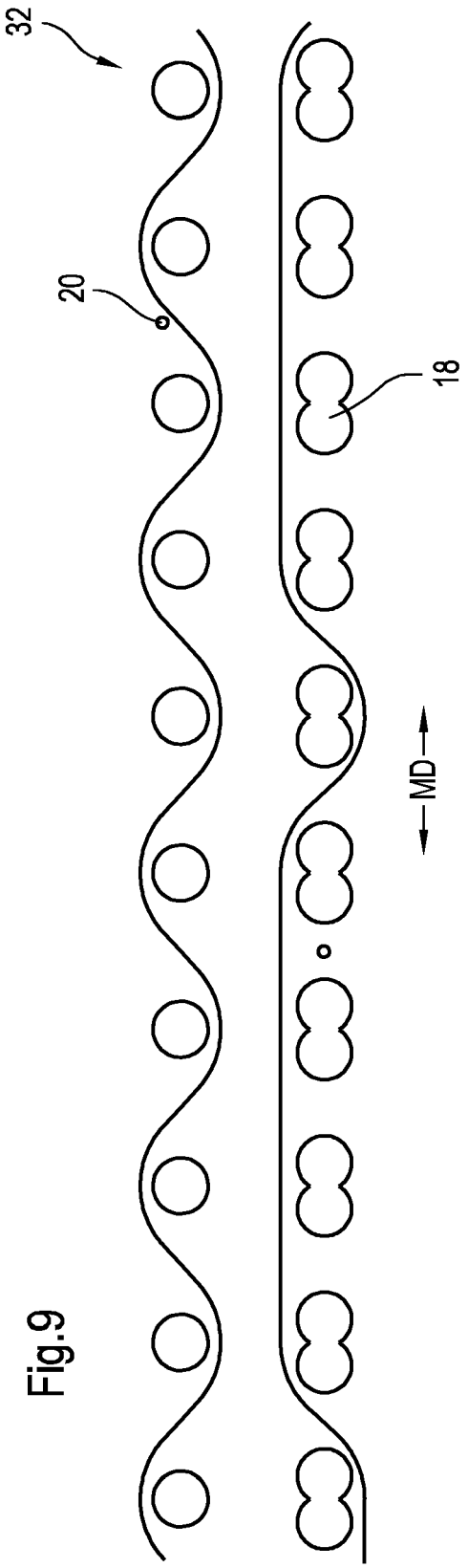


Fig.9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 10 8476

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 2004/079089 A (VOITH FABRICS PATENT GMBH; HAY, STEWART LISTER) 16 September 2004 (2004-09-16) * page 4, lines 14-26 * * page 5, lines 14-19 * * page 10, line 14 - page 11, line 6 *	1-5, 8-12,17, 18	D21F1/00 D21F7/08 D01D5/253
Y		13-16	

X	EP 1 054 097 A (THOMAS JOSEF HEIMBACH GMBH & CO) 22 November 2000 (2000-11-22) * paragraphs [0001], [0013] - [0017], [0023], [0024] * * figure 3 *	1,3-9, 17,18	
Y		13,14	

X	US 6 179 013 B1 (GULYA THOMAS G) 30 January 2001 (2001-01-30) * column 1, lines 36-61 * * column 5, line 62 - column 6, line 48 * * column 20, lines 28-59 * * figure 16D *	1,2,4,5, 7-10,12, 17	
Y		15,16	

X	EP 0 506 983 A (TORAY INDUSTRIES, INC) 7 October 1992 (1992-10-07) * page 3, lines 3-6 * * page 4, lines 4-6 * * page 7, lines 36-40 * * page 7, line 47 - page 8, line 14 * * figure 2 *	1-5,7-9, 17,18	

X	DE 40 31 608 A1 (TAMFELT OY AB, TAMPERE, FI) 11 April 1991 (1991-04-11) * column 1, lines 3-7 * * column 2, line 44 - column 3, line 45 * * column 3, line 68 - column 4, line 5 * * figure 1 *	1,3,5-9, 17	

	-/--		

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

D21F
D01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 October 2005	Maisonnier, C

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

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 10 8476

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 633 596 A (JOSEF ET AL) 6 January 1987 (1987-01-06) * column 1, lines 6-12 * * column 2, lines 54-64 * * column 3, lines 41-46,53-58 * * figures 2,4 *	1,3-9, 17,18	
X,D	US 5 366 798 A (OSTERMAYER ET AL) 22 November 1994 (1994-11-22) * column 1, line 56 - column 2, line 41 * * column 4, lines 10-16 * * figures 3,3A *	1,3, 5-10,17	
X	US 4 481 079 A (DAWES ET AL) 6 November 1984 (1984-11-06) * column 4, line 10 - column 5, line 28 * * figure 6 *	1,3-5,7, 8,17	
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) -& JP 2004 190177 A (SHIKIBO LTD), 8 July 2004 (2004-07-08) * abstract * * figure 1 *	1,2,4,5, 8,9,17, 18	TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 October 2005	Maisonnier, C

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 10 8476

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-10-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004079089 A	16-09-2004	NONE	
EP 1054097 A	22-11-2000	CA 2308883 A1	20-11-2000
		DE 19923088 C1	12-10-2000
		ES 2177491 T3	16-12-2002
		US 6332480 B1	25-12-2001
US 6179013 B1	30-01-2001	NONE	
EP 0506983 A	07-10-1992	DE 69131343 D1	22-07-1999
		DE 69131343 T2	13-01-2000
		WO 9207126 A1	30-04-1992
		US 5378537 A	03-01-1995
DE 4031608 A1	11-04-1991	AT 195990 A	15-04-1996
		CA 2026750 A1	10-04-1991
		FI 83673 B	30-04-1991
		SE 9002855 A	10-04-1991
US 4633596 A	06-01-1987	NONE	
US 5366798 A	22-11-1994	NONE	
US 4481079 A	06-11-1984	NONE	
JP 2004190177 A	08-07-2004	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82