The examination is being carried out on the **following application documents**

Description, Pages

1-8 as published

Claims, Numbers

1-20 as annexed to the Int. Prel. Examination Report

Drawings, Sheets

1/2, 2/2 as published

Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure:

D1 FR 2 064 159 A (KALLE AG) 16 July 1971 (1971-07-16)

D4 US 4 583 302 A (SMITH) 22 April 1986 (1986-04-22)

D6 US 4 567 077 A (GAUTHIER) 28 January 1986 (1986-01-28)

D8* US 5 115 582 A (WESTHEAD WILLIAM T [US]) 26 May 1992 (1992-05-26)

* This document (D) is cited by the examiner (see the Guidelines, C - VI, 8.7). A copy of the document is annexed to the communication and the numbering will be adhered to in the rest of the procedure.

******

1 Clarity (Art. 84 EPC)

Claim 1 defines 1 a spiral-link fabric comprising a stuffer insert disposed within one or more spiral coils, wherein the stuffer insert is capable of being pulled through the at least one spiral coils.

The underlined feature above is however not a feature suitable for clearly define the subject-matter of claim 1 for the following reasons.

1.1 It relates to a particular step when fabricating the spiral-link fabric which does not produce any concrete technical feature of the spiral-link fabric itself, which could distinguish the claimed spiral-link fabric from a spiral-link fabric comprising stuffer inserts inserted by another fabrication step. The intended limitations are therefore not clear from this claim, contrary to the requirements of Article 84 EPC.

1.2 The documents D4, D6 and D8 disclose the concept of reducing the permeability of a spiral-link fabric by inserting filler strands through the spiral coils. In this respect the applicant submit that such filler strands are pushed or stuffed into the inner space of each spiral coil one portion at a time [cf. page 3, lines 13-19 of the present application]. The examining division is of the opinion that these stuffer inserts capable of being pushed through the spiral coils are inevitably and obviously also capable of being pulled through the spiral coils.

2 Inventive step (Art. 56 EPC)

2.1 The document D1 is considered to be the prior art closest to the subject-matter of claim 1 and shows the following features thereof

A spiral-link fabric comprising a plurality of spiral coils arranged in a predetermined manner such that adjacent ones of side-by-side spiral coils are interdigitated with each other so as to form a channel and interconnected by a pintle extending through the channel, wherein at least some of the plurality of spiral coils have a coil width of approximately 12 mm or larger as measured in machine direction of the spiral fabric (cf. claim 1 in part).

As such this spiral-link fabric is suitable for use in a papermaking machine (see Guidelines for the examination in EPO; C-III 4.13).

2.2 The subject-matter of claim 1 therefore differs from this known spiral-link fabric in that it comprises further a stuffer insert disposed within one or more spiral coils, wherein the stuffer insert is capable of being pulled through the at least one spiral coils.

2.3 The problem to be solved by the present invention may therefore be regarded to reduce the permeability of a spiral-link fabric.

2.4 The solution proposed in claim 1 of the present application cannot be considered to involve an inventive step (Articles 52(1) and 56 EPC).

Inserting filler strands through the spiral coils is described in D6 as providing the same advantages as in the present application. The skilled person would therefore regard it as a normal option to include this feature in the spiral-link fabric described in D1 in order to solve the problem posed. Furthermore with regard to the dimension of the coils of the spiral-link fabric of D1 the skilled person would select as stuffer flat strips as illustrated in figures 1 to 3 of D6, wherein these strips are obviously capable of being pulled through the spiral coils.

2.5 For the reasons explained in point 2.4 above The method proposed in claim 16 of the present application cannot be considered to involve an inventive step (Articles 52(1) and 56 EPC).

2.6 Furthermore the steps of pulling or pushing the stuffer is known as to be selected in accordance with the stiffness of the stuffer (see D8, column 9, lines 11 - 15). the skilled person would therefore regard it as a normal option to pull flat strip shaped stuffers as disclosed in D6 through the spiral coils of the spiral-link fabric described in D1, according to the stiffness of the flat strip shaped stuffers. In this respect the presence of holes in the flat strip shaped stuffers is particularly adapted to this mode of insertion.

3 Conclusion

It is not at present apparent which part of the application could serve as a basis for a new, allowable claim. Should the applicant nevertheless regard some particular matter as patentable, an independent claim should be filed taking account of Rule 43(1) EPC. In this respect the applicant is requested:

3.1 in amending the independent claim for distinguishing from the prior art,

- to keep as much as possible the present wording of independent claims;

- to add more precise wording found elsewhere in the original disclosure rather than by merely replacing the wording of the claims;

- to indicate from which original page(s), line(s) or claim(s) the more precise wording stems (Art. 123(2); see also Guidelines E-II 1);

- to insert reference signs placed between parentheses in the claims to increase their intelligibility, Rule 43(7) EPC.

3.2 to comment, in the letter of reply, the inventive step by reference to the prior art;

3.3 to revise the description,

- by mentioning D1 in the description according to Rule 42(1)(b) EPC;

- by making it consistent with the claims to be filed (Art. 84, Rule 42(1)(c) EPC).

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Application No.	Ref.	Date
05 825 090.3 - 1256	4.A471.12EP.72	23.04.2010
Applicant: ALBANY INTERNATIONAL CORP.		

Communication pursuant to Article 94(3) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(2) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 4 months

from the notification of this communication, this period being computed in accordance with Rules 126(2) and 131(2) and (4) EPC. One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (R. 50(1) EPC).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Art. 94(4) EPC).

Registered Letter

Thibaut, Emile
Primary Examiner
For the Examining Division

Enclosure(s): 3 page/s reasons (Form 2906)
Copy of US-A-5,115,582

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4.A471.12EP.72
B/TR/Sf

Geneva, August 23, 2010

RE: **European Patent Application N° 05 825 090.3 - 1256**
In the name of ALBANY INTERNATIONAL CORP.

Dear ladies and gentlemen,

With reference to the notification pursuant to Article 94(3) EPC dated 23 April 2010 concerning the above captioned European patent application, the applicant wishes to present amendments and arguments that hopefully take into account the objection raised in the communication.

I/ Amendments

You will find enclosed to this letter a set of amended claims 1-19 which replace claims 1-20 filed upon entry into the European phase on 21 June 2006.

- Claim 1 is amended to define:

  "A spiral-link fabric for use in a papermaking machine comprising:
  a plurality of spiral coils arranged in a predetermined manner such that adjacent ones of side-by-side spiral coils are interdigitated with each other so as to form a channel and interconnected by a pintle extending through the channel, wherein at least some of the plurality of spiral coils have a coil width of approximately 12 mm or larger as measured in machine direction of the spiral-link fabric, and
  a <u>flexible</u> stuffer insert disposed within one or more spiral coils, wherein the <u>flexible</u> stuffer insert is capable of being pulled through the one or more spiral coils."

  This amendment is based on the description (p.6, l.21-25) as originally filed.

- Claim 16 is amended to define:

  "A method of forming a spiral-link fabric for use in a papermaking machine comprising the steps of:

arranging a plurality of spiral coils in a predetermined manner such that adjacent ones of side-by-side spiral coils are interdigitated with each other so as to form a channel; extending a pintle through each said channel formed from the interdigitated spiral coils; wherein at least some of the plurality of spiral coils have a coil width of approximately 12 mm or larger as measured in machine direction of the spiral-link fabric, and
inserting a flexible stuffer insert through at least one spiral coil, wherein the flexible stuffer insert is capable of being pulled through the one or more spiral coils."

This amendment is based on the description as originally filed (p.6, l.21-25).

The subject-matter of the new claims 1-19 does not extend beyond the content of the application as originally filed and the amendments are thus in conformity with article 123(2) EPC.

II/ Patentability

Instant claim 1 recites, inter alia:

"A spiral-link fabric...
wherein at least some of the plurality of spiral coils have a
coil width of approximately 12 mm or larger as measured in
machine direction of the spiral-link fabric, and
a flexible stuffer insert disposed within one or more spiral
coils, wherein the flexible stuffer insert is capable of being pulled through the one or more spiral coils."

Accordingly, one embodiment of the instant invention relates to a spiral-link fabric wherein at least some of the spiral coils have a coil width of approximately 12 mm or larger as measured in machine direction of the spiral-link fabric, and a flexible stuffer insert is disposed within one or more of the spiral coils.

It should be noted that the use of spiral coils having a coil width of 12mm or larger produced unexpected results, and examples of such unexpected results are disclosed throughout the specification as originally filed. The specification also discusses the shortcomings or drawbacks of the prior art spiral-link fabrics. For example, it is initially addressed in the Instant Application that the large number of pintles in prior art fabrics substantially covers the fabric, resulting in a fabric that is diagonally stiff during operation.

It should be noted here that spiral-link fabrics are usually heat stabilized, and when a heat stabilized spiral fabric is applied as a transport belt, it exhibits excellent resistance to stretching, bowing and narrowing. However, because of this high resistance to dimensional changes plus the relatively high level of surface smoothness characteristic of these fabrics, spiral-link fabrics guide poorly on a paper machine section. Exhibit A titled "Spiral Fabrics as Dryer Fabrics" is produced herewith as evidence to illustrate this problem (See Product Features on page 2 and figure showing spiral fabric with stiff stuffers on page 3, for example).

Additionally in fast production machines or papermaking machines, all rolls should ideally be aligned perfectly parallel to one other. However, this ideal setting is seldom achieved, and many times the rolls are out of line and/or the individual rolls vary in diameter along their length due to wear or abrasion. Exhibit B titled "Analysis of dryer felt alignment — Key to effective paper machine production" is produced herewith as evidence to illustrate this problem (See Front-to- back misalignment on page 2, for example).

In either case, the fabric reacts by showing a buckling effect in the initial start-up phase, guides poorly on the machine during the run, and may eventually run off the machine due to the high resistance to dimensional changes plus the relatively high level of surface smoothness previously discussed. To say in other words, where a fabric encounters a misaligned roll, the edge that has the shortest distance to travel will begin to move ahead -- causing a misalignment bow in the fabric, and the fabric eventually running off the machine. This is caused because of the use of relatively short spiral coils and stiff stuffers within these coils, which make the fabric relatively inflexible and rigid.

However, the instant fabric overcomes these problems and provides a solution to an unsolved problem. For example, it is disclosed (p.8, l.8-12) of the Application as published that:

"Further, the stuffer inserts of the present invention may be formed of softer, more flexible and less expensive materials than prior art stuffers because the stuffer insert may now be pulled though the fabric instead of pushed through. As a result, the present fabric may be more flexible and less diagonally stiff than prior art spiral- link fabrics, improving the guiding and tracking of the fabric."

Accordingly, one advantage of using spiral coils having a coil width of approximately 12 mm or larger, and flexible stuffer inserts within the spiral coils is <u>increased flexibility</u> and <u>less stiffness</u> in diagonal direction, which prior art spiral-link fabrics have failed to achieve. These properties allow the fabric to conform better to any misalignment in the fabric run on the paper machine than their smaller prior art counterparts, and thereby improve the guiding and tracking of the fabric on the papermaking machine.

It should be noted here that spiral-link fabrics have been in use since mid 1970s (See page 1 of Exhibit A). They were originally developed in Europe during the mid 1970s, and papermaking fabrics as spiral structures started to appear in the U.S. in 1978. An example of one of the early spiral-link fabrics is disclosed in U.S. Patent No. 4,346,138 to Lefferts. However, none of the prior art spiral-link fabric designs have overcome this common problem encountered in the papermaking industry. Therefore, there was a long-felt unsolved need to produce a spiral-link fabric which would not pose the guiding or tracking problems, which would not run off the machine, and which would be relatively inexpensive to produce.

Applicant respectfully submits that the instant fabric and method overcome the shortcomings or drawbacks of the prior art spiral-link fabrics and methods by incorporating <u>spiral coils having a coil width of 12 mm or larger</u>, and incorporating <u>a flexible stuffer insert within the spiral coils</u>, which make the fabric more flexible and less diagonally stiff than prior art spiral-link fabrics, improving the guiding and tracking of the fabric.

Applicant respectfully submits that these results were unexpected in light of the fact that prior art designs had not attempted to use spiral coils having a coil width of 12 mm or larger with a flexible stuffer insert disposed within the spiral coils. In the instant case, there is clear evidence that the claimed fabric indeed resulted in a better performance that prior art fabrics. Specifically, the incorporation of <u>spiral coils having a coil width of 12 mm or larger</u>, and <u>flexible stuffer insert within the spiral coils</u>, has resulted in, inter alia, making the fabric more flexible and less diagonally stiff than prior art spiral-link fabrics, thereby improving the guiding and tracking of the fabric.

For at least the foregoing reasons, independent claim 1 patentably distinguishes over D1, D6, and D8, considered either alone or in combination, and is therefore allowable. Independent claim 16 is similar, or somewhat similar, in scope to claim 1, and is therefore allowable for similar, or somewhat similar, reasons. Further, claims 2-15, which depend from claim 1, and claims 17-19, which depend from claim 16, are allowable as well.

III/ Requests

In summary, it is believed on this side that the amendments in the application and the above explanations adequately take into account the objections raised in the pending notification. The presently claimed subject matter is thus considered to be patentable and we await your confirmation in this matter.

Therefore, continuation of the grant procedure under consideration of the above mentioned amendments and explanations is duly requested.

In case of further questions, the Examining Division is welcome to contact the representative of the applicant by telephone. Shall it be considered by the examining division to reject the application in its present shape, an opportunity for further comments, eventually by way of oral proceedings according to Art.116 EPC, is requested.

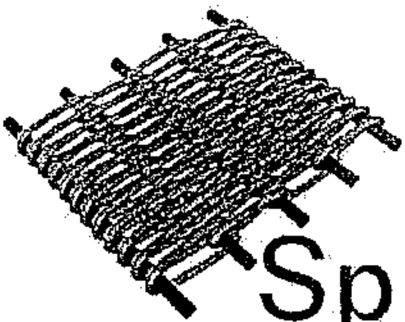
Yours faithfully,

Constantin Kiliaridis
Bugnion Genève
Association Nr 255

Attachments:

- amended set of claims
- amended set of claims showing the amendments
- Exhibit A
- Exhibit B

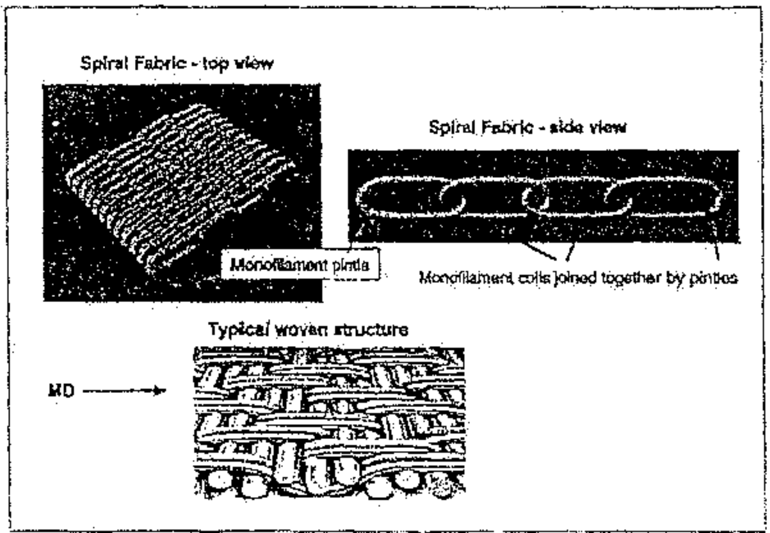
EXHIBIT A



Spiral Fabrics as Dryer Fabrics

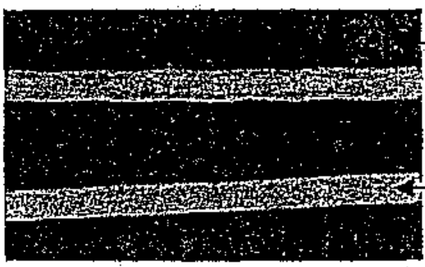
By Mike Di Ruscio

Spiral fabrics are defined as non-woven structures formed by assembly rather than using yarns that interlace together in a loom. Dryer fabrics as spiral structures started to appear in the US in 1978 and with subsequent product improvements they have evolved to the product that is known today worldwide as Spiral Fabrics. These structures were originally developed in Europe during the mid 1970's and still prevail today as an alternative to a woven dryer fabric.



Specially designed equipment was developed to manufacture the helical shaped coil yarns. These coil yarns are then joined together using uniquely designed coil assembly machines. The term fabric is somewhat of a misnomer since one would identify a fabric structure as a woven composition that has been produced using traditional weaving equipment known as looms. Spiral fabrics are not made on traditional fabrication equipment. Instead the spiral fabric is produced using a forming technique called assembly, therefore the term non-woven fits the category.

These helically coiled yarns are joined together with straight monofilaments called pintles. These pintles are mechanically inserted through the "eye" openings created when a left and right handed spiral coiled yarn is joined together as shown below. Once joined together as an endless belt the seam join area is undetectable and essentially seamless.



Spiral coils are assembled together to a predetermined width and length to form a fabric structure. This spiral yarn structure has to then be subjected to a high-tension heat setting process. This heating step imparts dimensional stability to the structure. The heat setting process allows the coil yarns to elongate thereby resulting in an increased stretch resistance. The high tension stretching in combination with the high exposure temperature imparts diagonal direction stability to the structure via pintle surface crimping or deformation. This pintle deformation actual acts to lock together the completely assembled structure.

Materials

Spiral fabrics today are produced mainly from monofilaments of polyester (PET) materials. These materials can be modified during processing to improve heat, moisture resistance as well as contaminant resistance. All major clothing suppliers offer these type spiral products.

Another material that is used today to manufacture spiral fabrics for dryer fabrics is ryton (PPS) monofilaments. These PPS spiral fabrics are usually applied on high temperature hydrolysis prone dryer sections. Because of the high cost of ryton material the ryton spiral fabric is prudently applied. The market price of ryton has recently seen some softening. If this market trend continues we may see more of these ryton material spirals being applied.

Spiral fabrics can also be produced with another heat resistant material that has a much higher melting point compared with PET or PPS. This material is known as PEEK. It has a supplier cost that is very prohibitive to use for dryer fabric applications. It is currently only being produced in limited quantities for very special high temperature drying applications. Until the price comes down to a practical level, spiral fabrics produced with PEEK monofilaments will be applied on a very limited basis.

Spiral Construction

Any of the above monofilament materials can be supplied with coils made using round or flat rectangular shaped monofilaments. Round yarn type spirals usually dominate but the flat shaped yarns are chosen for the structure whenever caliper and contact surface area factors are a major requirement for the application.

Spiral fabrics can be purchased in different mesh counts and thicknesses just like woven fabrics. Finer mesh products are generally applied on publication and writing grades while course mesh products are applied on kraft grades.

Diagram 1 shows an end view of two spiral coils linking together to form two coil courses or rows can explain the difference between a fine mesh versus a course mesh spiral product.

Based on above criteria a spiral structure can be described using the following three dimensional criteria;

1. **Coil dimension** (major x minor measurement); example, 6.8 x 3.8mm coil size.
2. **Coil yarn dimension** (diameter of round yarn or minor x major axis if flat yarn); example, .70mm or .35 x.70mm yarn size.
3. **Connecting pintle dimension** (diameter of round yarn); example, .90mm yarn size.

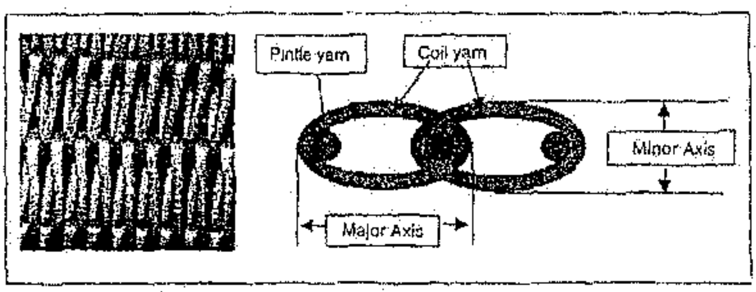


Diagram 1

Coil Size, mm	Monofil Size, mm	Pintle Size, mm	Mesh Type
[illegible]	0.85	[illegible]	course
[illegible]	0.57 x 0.88	[illegible]	course
[illegible]	0.70	[illegible]	medium
[illegible]	0.70	[illegible]	medium
[illegible]	0.60	[illegible]	fine
[illegible]	0.60	[illegible]	fine
[illegible]	0.44 X .70	[illegible]	fine
[illegible]	0.35 X .70	[illegible]	fine

Chart 1: Several standard spiral fabric dimensions produced by suppliers today.

In the spiral-making process the major and minor axis of the coil yarn can be varied in dimension using a mandrel-forming device that the coil wraps around during the coil formation process. Varying these two dimensions affects both courses per inch and caliper thickness of the construction. The minor and major axis can also be varied by changes in dimension of either the monofilament yarn that forms the coil or the diameter of the pintle yarn that joins the coils together. Changing the coil yarn dimension changes the CD direction coil frequency as well as caliper. A change in joining pintle dimension affects fabric caliper as well as dimensional stability.

Today's spiral fabric have evolved and matured into a classification system based on fineness of structure that can be characterized by the above three dimensions into fine, medium and course mesh spiral fabrics (See chart 1).

Product Features

When a heat stabilized spiral fabric is applied as a transport belt, it will exhibit excellent resistance to stretching, bowing and narrowing. Because of this high resistance to dimensional changes plus the relatively high level of surface smoothness characteristic of these fabrics, at times these two positive features will cause spiral fabrics to guide poorly on a paper machine section during the start-up phase. For this reason special attention must be taken during the start-up phase. Also the machine elements must have good alignment to compensate for these two inherent features. To prove this concept one need to only look at the diagonal stress-strain values generated for spiral fabric compared to woven fabrics. Normal % diagonal elongation at a 50 PLI load for woven products are 9-13% while spiral fabrics exhibit much lower values in the range of 6-8%. (See chart 2).

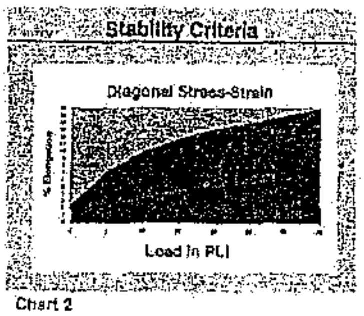
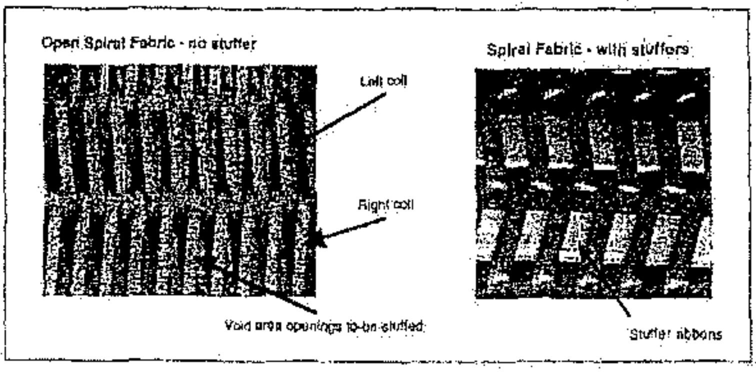


Chart 2

The high open area (greater void volumes) and greater dimensional stability are advantageous properties for spiral fabrics over traditional woven structures. Spiral fabrics can achieve permeabilities as high as 1000 CFM and still retain excellent dimensional stability

Very low to medium permeabilities are also achievable with spiral fabrics. Lower permeabilities in spiral fabrics can be achieved by filling the CD direction cavities with stuffer or insertion materials. Several different materials have been used in the past to fill these openings including fibrous yarns, ribbons, foams, shoestring, etc. Most of the lower permeability spiral fabrics produced today use rectangular shaped monofilament ribbons to close off the openings as shown by the following images.



The open area characteristic of spiral fabrics gives the structure a relative high air carrying (air pumping action) capability compared to woven fabric. The spiral's ability to move high volumes of air is a characteristic of these high void volume structures. This feature makes course type spiral fabrics highly desirable for kraft grade, slower-speed (2500'/min or less) machines. This air carrying ability is well suited for dryer sections that have not been optimized with modern air handling or air evacuation systems. This is certainly a positive factor when considering dryer limited paper machines, which can use spiral fabrics to provide the extra boost needed to speed up the drying process.

Besides excellent dimensional stability and air carrying potential, other strong features offered by spiral fabrics are:

1. High wear resistant surfaces because of the high material surface-support and caliper retention. Based on internal testing, a spiral fabric produced with .70mm size monofilament yarns has 4 times better wear resistance when compared to woven structures using .44x.88mm MD yarns (See chart 3).
2. Can be cleaned very easily and maintains clean for the life of the fabric. This is supported by Albany's worldwide field results experience and would be particularly apparent for open spiral fabrics without ribbon stuffers.
3. Excellent tear resistance in both MD and CD direction which makes spiral fabric very resistant to wad damage. The relatively seamless construction makes it even more advantageous for strength retention and as a result, wreck prone paper machines could have less risk when damage to dryer fabrics occurs.
4. Contact area measurements show excellent results for the medium-dimension spiral coil products. For this particular spiral structure, contact area value of 27.3% is averaging almost 2 times greater contact surface compared to several common Albany and competitive products (See chart 4).

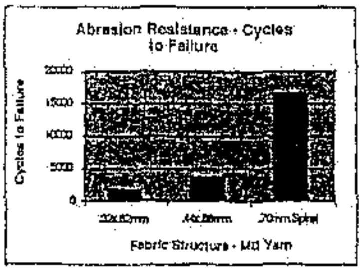


Chart 3

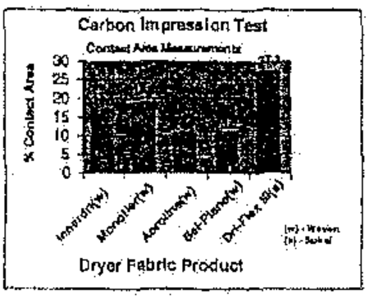


Chart 4

Finer mesh spiral products will show even higher values for contact area measurements. The long floating yarns that characterize the surface of spiral fabrics achieve these high contact area values.

Applications

As stated earlier spiral fabrics are especially suited for kraft and containerboard applications. It has a strong presence in these two grade structures in the US market, especially when recycle stock is also considered on these papermachines. A spiral fabric can be very competitive in this grade structure because of the positive features of strength, high open area, and easy cleaning.

Recent spiral fabric development has led to the ability of achieving permeabilities of less than 150 cfm, and there have been many cases where these spirals have been applied successfully on printing and writing grades. This situation is prevalent in the European market where spiral fabrics hold a much larger market share when compared to the US market. The lower permeabilities are also simultaneously combined with recent ability to produce spiral fabrics with caliper thickness as low as .058", and because of this, we are beginning to see run references for 1st section Unirun and even Bel-Run section runs. Again, these are application references being experienced in Europe. We have seen very limited runs on these types of applications in the US market.

In addition to dryer fabric applications, spiral fabrics have been largely applied on non-paper machine type applications such as pulp and sludge presses, board machines, nonwoven, food processing, coal washing, tobacco processing, etc. As in the case for kraft paper grades, spiral fabrics are ideal products for industrial transport belt applications.

The Market

The total spiral fabric market for dryer fabrics in the US is 1.8 million square feet. This represents about 8-9% of the total dryer fabric market. The European market share for spiral fabrics is slightly higher in the 15% range with Germany having the largest market in the range of 30%.

The European market is somewhat more open-minded when it concerns spiral fabrics. In fact some references quote European market share in the range of 20%, but it is believed that this also includes non-paper machine applications.

In the manufacture of spiral fabrics a clothing supplier benefits economically in two ways; expensing less in capital requirements and relatively high productivity compared to woven production.

Field running problems during the early years of development and a general misunderstanding on how these products should be applied has hampered the market growth of spiral fabrics. Most of these problems were product related and caused significant setback for the product's growth. Problems such as slack or floppy edges, pintle migration, edge fraying, and surface flatness has now been addressed by the clothing industry. In order to eliminate these product problems dryer fabric suppliers had to address process and material related inconsistencies. The application questions still continues but the market is beginning to notice and sales are ebbing up. At times the demand for these products has been actually dictated by customer requests instead of supplier intent. For whatever reason, spiral fabrics continue to be manufactured as an alternative dryer fabric based on options of choice as well as functionality. ■

About the Author

Mike Di Ruscio is Product Development Manager, Albany Mount Vernon Dryer Fabrics, Albany International Corp.

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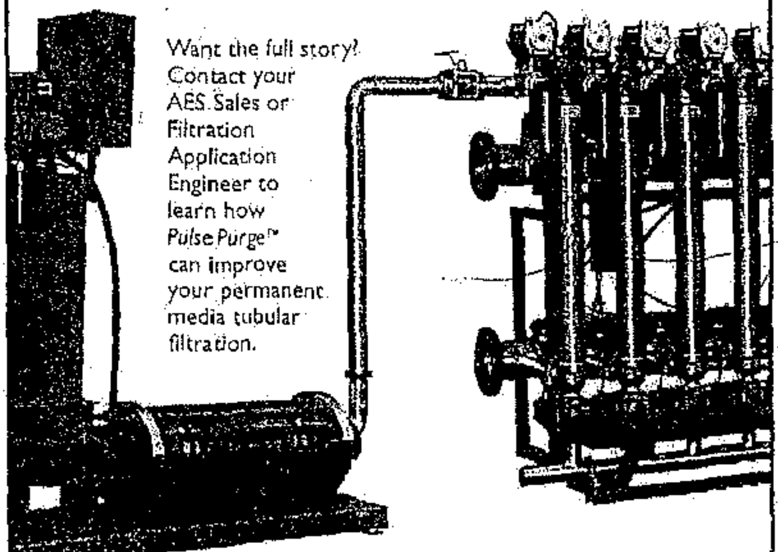

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EXHIBIT B

PAPERMAKER GUIDELINES:

Analysis of dryer felt alignment—key to effective paper machine production

BY THOMAS A. BUTLER

If all conditions on a paper machine were perfect, the dryer fabric seam would run straight throughout its life. In reality, this seldom happens because of a number of factors. Analysis of the causes and effects of seam bows is a key step to getting the most from a dryer fabric and the paper machine on which it runs.

Types of seam bows. Over the years, the paper industry has come up with a lot of different names for various types of seam bows. For the purposes of this dicussion, however, they may be classified into two general types:

(1) The *symmetrical bow* is shown in Fig. 1. In this case, the front and back edges run about even and the center runs ahead. The amount of this type bow is determined by the distance from the center of the seam to an imaginary line connecting the two edges.

(2) *Front-to-back misalignment bows* are shown in Figs. 2 and 3. In this type bow, one edge leads the other. This distortion may take various shapes depending on various conditions in the dryer section. The amount of this type of bow is determined by the distance that one edge leads the other.

Effects of seam bows. Seam bows have a variety of effects on dryer fabric and paper machine performance, and most of these effects are undesirable. The most notable results are:

(1) *Loss in width* of the fabric is the inevitable result of any type of bow. A severe bow can cause so much width loss that the edges of the sheet will be unfelted. This, in turn, leads to a host of paper machine problems and also to premature fabric removal. Table I shows the amount of width loss for bowed fabrics. For example, a 240-inch wide fabric with a 30-inch long bow will regain 9.8 inches of width when the fabric seam is straightened.

(2) *Variations in fabric tension and drying* are also caused by seam distortion of the fabric. The tension profile and amount of variation change with the type and length of seam bow. A fabric with a symmetrical bow runs tight on the edges and relatively slack in the middle. This tension profile tends to add to overdrying of the edges of the sheet and high moisture in the middle. Moreover, this condition places unduly high stress on the edges of the seam. The edges of the seam carry most of the tension load of the entire fabric. If left uncorrected, a symmetrical seam bow can contribute to early seam failure at the fabric edge. A fabric with a front-to-back seam bow has lower tension on the edge that is running ahead. The greatest amount of stress is being applied to the edge of the seam that trails. A seam running with a front-to-back bow leads to uneven moisture profiles in the front and back sides of the sheet.

(3) *Variations in permeability* are characteristic of bowed fabrics. A distorted fabric will not pass air or water vapor at the same rate as an undistorted fabric. When woven, a dryer fabric is "square," and the openings in it are uniform in size. This produces a fabric with uniform permeability. If this fabric is distorted as it runs on the machine, the openings change shape and may restrict the

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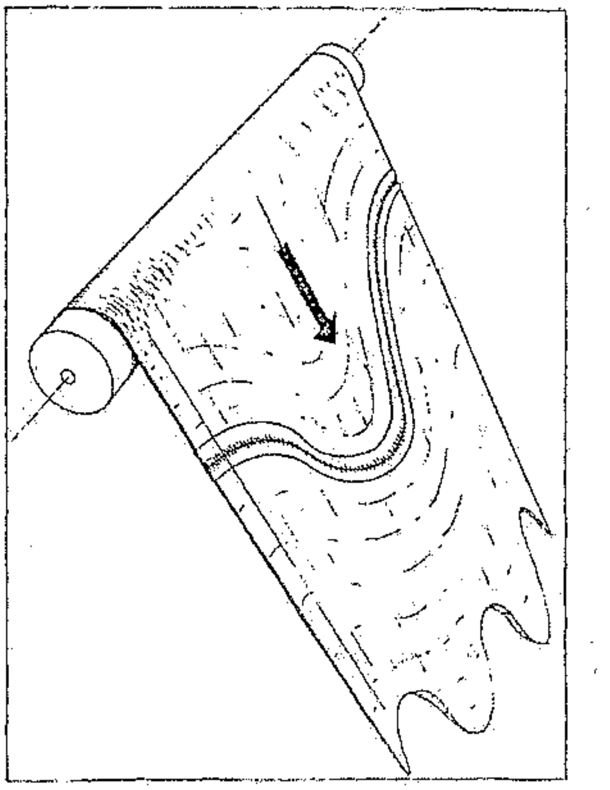

Fig. 1. Symmetrical bow is illustrated in this drawing.

About the author: Butler is a service engineer with Asten-Hill Co. This article is the last of three which relate to getting the most out of dryer felts. Previous articles ran in the April 15 and May 30 issues of *Paper Trade Journal*.

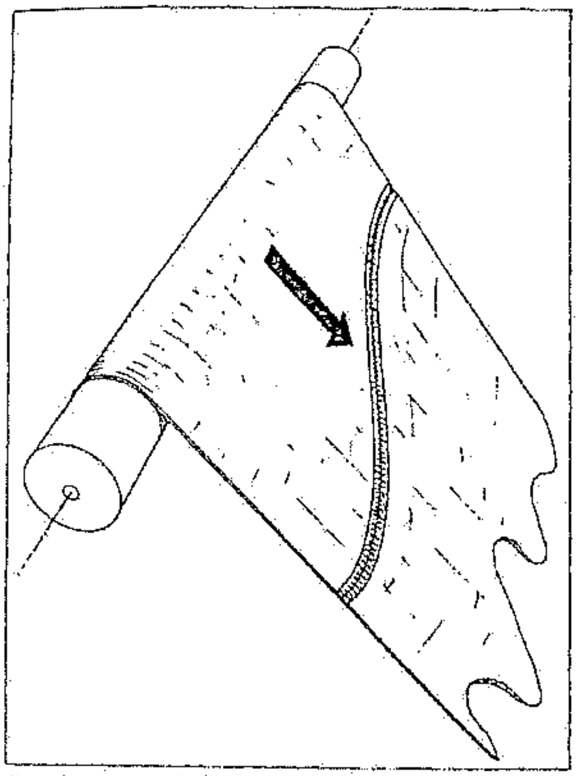

Fig. 2. Front-to-back misalignment bow.

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passage of air or water vapor. These variations in permeability can cause non-uniform drying and moisture profile problems.

Causes of seam bows. Understanding the causes of seam bows is the key to deciding what corrective action is necessary. The major causes are:

(1) *Symmetrical bows* are usually caused by roll deflection. The most common causes of roll deflection are excessive fabric tension and/or old rolls that merely sag or deflect. The recommended tension for a dryer fabric is 5 pli to 7 pli. Tensions above this level do not appreciably improve either drying rate or fabric guiding, but they can cause seam failure, high fabric wear rate, increased likelihood of accidental damage, and bearing failure—in addition to roll deflection. Roll diameter differences—due to buildup of stock, rust, or other foreign materials on the roll face—can also be a cause of a symmetrical bow.

(2) *Front-to-back misalignment bows* result from rolls that are out of line and/or differences in roll diameter. All the rolls in a dryer fabric run, including all the return rolls and all the pocket rolls, should be parallel to one another and to the dryer cylinders. If any roll is out of line, the seam will react by showing a front-to-back misalignment. The magnitude of the effect of a single out-of-line roll is dependent on the amount of wrap on that roll. Thus, pocket, hitch, corner, and stretch rolls are potential problem points.

Where a fabric encounters a misaligned roll, the edge ahead—causing a misalignment bow. Changes in roll diameter can also be the culprit. Rolls may be reduced in diameter by wear or abrasion. Increase in diameter can result from buildup of stock, rust, or other foreign materials. If one side decreases or increases diameter more than the other, a front-to-back misalignment bow will result.

Correction of symmetrical bows. Replacement of deflecting rolls with either stronger rolls or rolls of larger diameter will normally solve a symmetrical bow problem. However, this can be a costly operation. Old rolls can also be removed from the machine and fiberglassed or rubber covered to add enough stability to prevent sagging or deflection.

It may be more practical to install concave rolls. The installation of one or two concave rolls will usually eliminate even an extreme symmetrical bow. In a concave roll, the center has a smaller diameter than the edges. At any given RPM, the surface speed of any point on the roll varies with the circumference at that point. Thus, the middle has the lowest speed and the edges higher speeds. This causes the edges of the fabric to run ahead to correct the symmetrical bow.

Proper placement of a concave roll and the amount of negative crown required are dependent on a complex set of factors—beyond the scope of this discussion. Any mill considering the use of concave rolls would be well advised to consult with a dryer fabric supplier whose applications

Troubleshooting Alignment Problems

(1) Symmetrical bows, where the edges run even and the center runs ahead, are usually caused by roll deflection.

(2) Roll deflection may be caused by excessive fabric tension; dryer fabrics should be operated at 5 pli to 7 pli.

(3) Deflection resulting from weakening of aged rolls may need to be corrected by replacing or recovering the rolls.

(4) A concave roll, which runs at higher surface speed at its edges, may be used to correct a symmetrical bow.

(5) Either type of bow may be caused by increased roll diameters from accumulation of stock, rust, or contaminants on the roll face; the rolls should be scraped or otherwise cleaned.

(6) If roll diameter differences are caused by wear or abrasion, roll replacement or recovering may be necessary.

(7) Front-to-back misalignment seam bows usually indicate misalignment of one or more rolls in the section.

(8) The magnitude of effect of a single out-of-line roll varies directly with the amount of wrap on the roll.

(9) The taping method, utilizing a 100-ft steel tape and the Asten Align-All tool, is a quick and inexpensive alternative to optical alignment for the purpose of correcting dryer fabric seam distortion.

engineers can make the necessary computations and recommendations.

Correcting front-to-back misalignment bows. If buildup of stock or contaminants on roll surfaces are causing misalignment, the rolls should be scraped or cleaned as required. If roll diameter differences are caused by wear or abrasion, roll replacement or recovering may be necessary.

If all rolls in the section are in good condition, they may need to be realigned. Theoretically, the ideal solution is optical alignment. Since most mills do not have either equipment or personnel with the required training, the services of a consulting engineer are often required. In most cases, optical alignment is time-consuming and expensive. In many cases, a less complex and time-consuming technique can provide the necessary corrections.

The *taping method* is one such technique which can be carried out by mill personnel. A description of the application of this method to an actual machine illustrates its use.

The first step was to make a side evaluation sketch shown in Fig. 3. The rolls with the greatest amount of wrap in the return run were labeled A, B, C, D, E, F, and G. The pocket rolls, including the tail roll, were numbered 1 through 7.

The rolls indicated as a guide roll and hand guide roll were not considered. These rolls are moved constantly during day-to-day machine operation and they do not distort the seam even when cocked to one side or the other. The same holds true for fixed rolls with little wrap; they are seldom the source of significant misaligment problems.

After the drawing was completed, one of the rolls in the return run needed to be established as parallel to the dryers. This roll then became the reference roll for other rolls in the run. The reference roll is established by taping around one of the dryers and a felt roll at the front and back to ascertain that they were parallel. This can also be accomplished through the use of a plumb bob if it is not possible to tape.

With the reference roll established, the systematic check could proceed. In the side evaluation shown in **Fig. 3**, Roll B was established as the reference roll parallel to the dryer. The next step was to check Roll B vs. Roll A—the stretch roll. The stretch roll is a good place to start the procedure, as it travels in a movable carriage and often becomes misaligned.

A 100-ft steel tape measure was used to check roll alignments in the return run. The procedure was to tape around both roll faces an equal distance in from the front side. This figure was then recorded on the chart, as in the case of Rolls A to B front, 17 ft-3$^{1}/_{16}$ inches.

The same procedure was repeated on the back side of the machine, and the dimension entered on the chart, Rolls A to B back, 17 ft-3$^{3}/_{16}$ inches. The difference between the two dimensions, ⅛ inch, is entered in the difference column.

Since the difference was determined by taping around two rolls, the actual misalignment, $^{1}/_{16}$ inch, was half the difference between front and back dimensions. This $^{1}/_{16}$ inch was the distance the roll would need to be moved to bring it back into perfect alignment. On the machine in this example, the stretch roll misalignment was in the proper direction to help cause some seam distortion. Nevertheless, the amount of misalignment was so small that it could be considered insignificant. It was necessary to look further for the cause of alignment.

Rolls B to C were checked and no misalignment was found.

The next area checked was that surrounding the felt dryers and the felt rolls over the top of them. The Asten

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WIDTH REGAINED BY STRAIGHTENING BOWED FELTS*

	Felt Width (Measured in Bowed Condition)								
Bow	80"	120"	160"	200"	240"	280"	320"	360"	400"
3"	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
6"	1.1	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2
9"	2.8	1.7	1.3	1.0	0.8	0.7	0.6	0.5	0.5
12"	4.7	3.1	2.3	1.9	1.5	1.3	1.1	1.0	0.9
15"	7.3	4.9	3.7	2.9	2.4	2.1	1.8	1.6	1.4
18"	10.3	7.0	5.3	4.2	3.5	3.0	2.6	2.3	2.1
21"	13.9	9.5	7.2	5.8	4.8	4.1	3.6	3.2	2.9
24"	17.9	12.4	9.4	7.5	6.3	5.4	4.7	4.2	3.8
27"	22.4	15.5	11.8	9.5	8.0	6.8	6.0	5.3	4.8
30"		19.0	14.6	11.7	9.8	8.4	7.4	6.6	5.9
33"		22.8	17.5	14.2	11.9	10.2	8.9	8.0	7.2
36"		26.9	20.7	16.8	14.1	12.1	10.6	9.5	8.5
39"		31.3	24.2	19.7	16.5	14.2	12.5	11.1	10.0
42"		35.9	27.9	22.7	19.1	16.5	14.5	12.9	11.6
45"		40.8	31.8	25.9	21.9	18.9	16.6	14.8	13.3
48"		45.9	35.9	29.4	24.8	21.4	18.8	16.8	15.1
51"			40.3	33.0	27.9	24.1	21.2	18.9	17.1
54"			44.8	36.8	31.1	26.9	23.7	21.2	19.1
57"			49.5	40.8	34.6	29.9	26.4	23.6	21.3
60"			54.5	44.9	38.1	33.1	29.2	26.1	23.5
63"							32.1	28.7	25.9
66"							35.1	31.4	28.4
69"							38.3	34.2	31.0
72"							41.5	37.2	33.7

*Table entries are in inches. Chart is from "Effects of Roll Deflection on Bowing and Narrowing of Dryer Felts and Fabrics," by C. B. Edgar Jr.

IN THE CLAIMS:

1. A spiral-link fabric for use in a papermaking machine comprising:

a plurality of spiral coils arranged in a predetermined manner such that adjacent ones of side-by-side spiral coils are interdigitated with each other so as to form a channel and interconnected by a pintle extending through the channel, wherein at least some of the plurality of spiral coils have a coil width of approximately 12 mm or larger as measured in machine direction of the spiral-link fabric, and

a flexible stuffer insert disposed within one or more spiral coils, wherein the flexible stuffer insert is capable of being pulled through the one or more spiral coils.

2. The spiral-link fabric of claim 1, wherein each spiral coil has a coil thickness associated therewith, and wherein a ratio of the coil thickness to coil width as measured in machine direction of the spiral-link fabric is approximately 0.5 or less.

3. The spiral-link fabric of claim 1, wherein the spiral coils are formed from monofilaments or multifilaments which are coated.

4. The spiral-link fabric of claim 3, wherein the monofilaments are round, rectangular, oval, flattened or other noncircular shape.

5. The spiral-link fabric of claim 1, wherein the pintle is selected from the group consisting of: round pintles, non-round pintles, pre-crimped pintles, and stepped diameter pintles.

6. The spiral-link fabric of claim 1, wherein the flexible stuffer insert comprises a material which is woven, knitted, or molded, or formed from extruded sheets of polymeric material or films.

7. The spiral-link fabric of claim 1, wherein the flexible stuffer insert is non-uniform in at least one dimension along its length.

8. The spiral-link fabric of claim 7, wherein the flexible stuffer insert has a varying effective diameter along its length.

9. The spiral-link fabric of claim 7, wherein the flexible stuffer insert has crimps, folds, and/or perforations distributed in a non-uniform manner throughout the length and/or diameter thereof.

10. The spiral-link fabric of claim 1, ~~further comprising a stuffer insert disposed within one or more spiral coils and,~~ wherein the fabric has a variable permeability along its width.

11. The spiral-link fabric of claim 1, wherein the spiral coils have a circular, oval or other noncircular shape.

12. The spiral-link fabric of claim 1, wherein the plurality of spiral coils have a coil width as measured in machine direction of the spiral-link fabric in the range of approximately 12 mm to 150 mm.

13. The spiral-link fabric of claim 1, wherein the flexible stuffer insert includes edges having grooves or ridges.

14. The spiral-link fabric of claim 1, wherein the flexible stuffer insert is attached or fixed to the respective spiral coil.

15. The spiral-link fabric of claim 1, wherein the flexible stuffer insert is continuous or discontinuous.

16. A method of forming a spiral-link fabric for use in a papermaking machine comprising the steps of:

arranging a plurality of spiral coils in a predetermined manner such that adjacent ones of side-by-side spiral coils are interdigitated with each other so as to form a channel;

extending a pintle through each said channel formed from the interdigitated spiral coils; wherein at least some of the plurality of spiral coils have a coil width of approximately 12 mm or larger as measured in machine direction of the spiral-link fabric, and

inserting a flexible stuffer insert through at least one spiral coil, wherein the flexible stuffer insert is capable of being pulled through the one or more spiral coils.

17. The method of claim 16, wherein each spiral coil has a coil thickness associated therewith, and wherein a ratio of the coil thickness to coil width as measured in machine direction of the spiral-link fabric is approximately 0.5 or less.

~~18. The method of claim 16, wherein the stuffer insert is pulled through the at least one spiral coil.~~

~~19~~18. The method of claim 16, wherein the spiral coils are formed from monofilaments or multifilaments which are coated.

~~20~~19. The method of claim ~~19~~8, wherein the monofilaments are round, rectangular, oval, flattened or other noncircular shape.