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(54) **Paper machine clothing with auxetic fibers and/or yarns**

(57) A paper machine includes a clothing carried by a plurality of rolls. At least one of the rolls is movable to exert a selected tension load on the clothing. The clothing

includes auxetic fibers. By moving one of the rolls to exert a selected tension and/or press load on the clothing, a thickness of the auxetic fibers is modified to become thinner under a lesser load or thicker under a greater load.

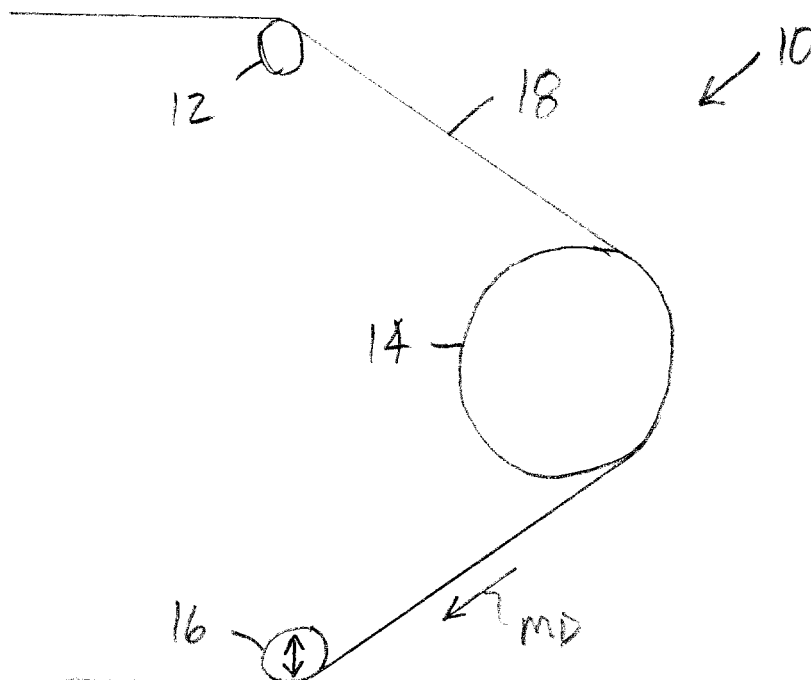


Fig. 1

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Description

1. Field of the Invention

[0001] The present invention relates to paper machines, and, more particularly, to clothing used in such paper machines.

2. Description of the Related Art

[0002] A paper machine includes clothing of various types which is carried by a plurality of rolls throughout the length of the machine. Examples of paper machine clothing include a press fabric, forming fabric, drying fabric and belt, each with its own unique construction and characteristics specific to that portion of the paper machine and the type of fiber web being produced. Each separate clothing is configured in an endless manner to be carried by a corresponding plurality of rolls, and the fiber web is transferred from one clothing to the next throughout the length of the machine. It is known to provide one or more tension rolls within each loop of clothing to keep the clothing under a desired amount of tension.

[0003] Press fabrics are typically constructed from a combination of one or more base layers and batt fiber which is physically and/or chemically interlocked with the base layers, such as by needling. An issue with this type of press fabric that is under subsequent mechanical action during operation, i.e., during running on the press section of a paper machine, is that the batt fiber is exposed to "pulling" or tension forces. In some cases, this may lead to a degree of batt fiber removal, also known as fiber shedding. This fiber shedding is destructive to the performance and subsequent life of the press fabric and also may cause quality problems within the paper sheet due to the presence of unwanted fibers.

[0004] What is needed in the art is a paper machine clothing which is less resistant to shedding during operation.

SUMMARY OF THE INVENTION

[0005] The present invention provides a paper machine clothing with natural and/or artificial auxetic fibers, yarns and/or particles.

[0006] The invention in one form is directed to a paper machine, including a clothing carried by a plurality of rolls. At least one of the rolls is movable to exert a selected tension and/or press load on the clothing. The clothing includes auxetic fibers, yarns and/or particles which become thicker in cross section as the tension and/or press load increases.

[0007] The invention in another form is directed to a paper machine clothing, including at least one layer of fibers, with at least some of the fibers being auxetic fibers.

[0008] The invention in yet another form is directed to a method of operating a paper machine, including the steps of: carrying a clothing with a plurality of rolls, the

clothing including auxetic fibers; and moving one of the rolls to exert a selected tension and/or press loading on the clothing, thereby modifying a thickness of the auxetic fibers to become thinner under a lesser load or thicker under a greater load.

[0009] An advantage of the present invention is that the fibers and/or yarns can be made thicker during operation of the paper machine by applying a higher tension and/or press load to the clothing.

[0010] Another advantage is that when the clothing includes a base layer, the auxetic fibers and/or yarns which are needled to the base layer can be made resistant to shedding because of the auxetic properties.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic view of a portion of a paper machine, including an embodiment of a clothing of the present invention;
 Fig. 2 is a fragmentary, sectional view of an embodiment of the clothing of the present invention in the form of a press fabric;
 Fig. 3A is a schematic representation showing the auxetic properties of the auxetic fibers shown in Fig. 2 when under a compression load;
 Fig. 3B is a schematic representation showing the auxetic properties of the auxetic fibers shown in Fig. 2 when under a tension load; and
 Fig. 4 is a fragmentary, sectional view of another embodiment of the clothing of the present invention.

[0012] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate embodiments of the invention, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

[0013] Referring now to the drawings, and more particularly to Fig. 1, there is shown an embodiment of a paper machine 10 of the present invention, which generally includes rolls 12, 14 and 16 which carry a paper machine clothing 18. Roll 16 is a tension roll which is adjustable as indicated by the double-headed arrow to provide a desired degree of tension on clothing 18. Clothing 18 may be differently configured, depending upon the type of fiber web being produced and the location of clothing 18 along the length of the paper machine, as will be

more apparent from the description hereinafter.

[0014] Referring to Fig. 2, a clothing in the form of a press fabric 20 will be described in greater detail. Press fabric 20 generally includes a first base layer 22, a second base layer 24 and batt fiber 26 which is physically and/or chemically coupled, e.g., via needling with at least one of first base layer 22 and second base layer 24. With a conventional press fabric 20, batt fiber 26 includes a plurality of fibers 28 which exhibit a typical Poisson's Ratio when exposed to a tensile or compression load. More particularly, when the plurality of fibers 28 are subjected to tension loading, the fibers become longer and thinner, whereas when the fibers are subjected to compression loading, the fibers become shorter and thicker.

[0015] In contrast, press fabric 20 also includes a batt fiber 26 with a plurality of auxetic fibers 30 which exhibit a negative Poisson's Ratio when exposed to tension or compression loading. Referring to Fig. 3A, a schematic illustration of an elongate fiber 30 is shown in phantom lines prior to compression loading. As a result of the compression loading, the fiber 30 becomes shorter and thinner. Conversely, referring to Fig. 3B, an elongate fiber 30 is shown in phantom lines prior to tension loading indicated by the double-headed outward arrows. As a result of the tension loading, the elongate fiber 30 becomes longer and thicker. The expansion and contraction properties of auxetic fibers 30 shown in Figs. 3A and 3B are opposite to that typically expected for a body placed under compression or tension loading, and not intuitively apparent. These auxetic properties of fibers 30 can be designed to advantage within batt fiber 26 of press fabric 20. The composition of auxetic fibers 30 relative to conventional fibers 28 can vary, depending upon the application. Moreover, the orientation, length and diameter of auxetic fibers 30 when at rest can vary depending upon the application. Further, auxetic fibers 30 can be designed within batt fiber 26 to have a higher concentration adjacent first base layer 22, second base layer 24 and/or a middle portion between first and second base layers 22 and 24.

[0016] As indicated above, conventional fibers 28 and auxetic fibers 30 are physically and/or chemically bonded with at least one of first base layer 22 and second base layer 24 via a needling process of conventional design. The needling process inserts a portion of conventional fibers 28 and auxetic fibers 30 into corresponding puncture holes formed in first base layer 22 and/or second base layer 24. Because of the auxetic properties associated with auxetic fibers 30, tension loading on batt fibers 26 results in an increase in the thickness or "swelling" of auxetic fibers 30, thereby reducing the onset threshold and tendency for fiber shedding during operation. More particularly, because of the swelling of auxetic fibers 30, the internal friction between the periphery of the auxetic fibers 30 and the needled hole increases to inhibit removal of the auxetic fibers.

[0017] As a result of the better resistance of auxetic fibers 30 to the tension forces experienced on a paper

machine press section during operation, it is possible to decrease the severity of the needling regime for physical bonding between batt fiber 26 and base layers 22 and/or 24. This in turn would ensure minimal damage to first base layer 22 and second base layer 24 and a higher overall strength of press fabric 20.

[0018] In the embodiment shown in Fig. 2, auxetic fibers 30 have a circular cross-section, but could also be formed with other suitable shaped cross sections, such as a flattened or polyhedral shape cross-section, etc. The auxetic fibers 30 could also be designed with a flattened cross-section which expands either along the major or minor axis of the flattened cross-section when exposed to a tension force. The auxetic fibers can have a negative Poisson's Ratio of between 1:2 to 1:5, or possibly even higher for some applications. The fibers and/or yarns can be formed from auxetic polymers such as liquid crystalline polymers, micro-porous polymers or other compositions providing such auxetic properties.

[0019] Referring now to Fig. 4, another embodiment of a paper machine clothing 40 of the present invention is shown in schematic form. Clothing 40 is a multi-layer clothing with a first layer 42 and a second layer 44. A plurality of yarns 46 (only one of which is shown in Fig. 4; and having a length longer than fibers 28 or 30) is woven between first layer 42 and second layer 44. The length, diameter, orientation and weave pattern for yarns 46 may vary, depending upon the application. In the embodiment shown, the single yarn 46 is shown extending generally parallel to machine direction MD indicated by the directional arrow above clothing 40. Similar to press fabric 20, clothing 40 includes a selected number of yarns 46 which are auxetic yarns providing auxetic properties when under compression or tension loading. In the event that yarn 46 is needled at certain locations to first layer 42 and/or second layer 44, the pullout strength because of the auxetic properties is increased.

[0020] The use of combinations of auxetic fibers and auxetic yarns increases the fiber anchoring even more and a balanced mixture of fibers and yarns may cope for the negative aspects like the higher needling damage to the yarns. Primarily the CD oriented yarns are damaged by the needling process and therefore the use of auxetic yarns in the MD direction does not cause severe needling damage to the yarns.

[0021] The auxetic properties of fibers, yarns and/or particles can be used to influence the permeability of the clothing as the behavior of the clothing under stress will change and the widening will affect the running properties. The auxetic affect can also be used in approximate mixtures of fibers, yarns and/or particles with and without the auxetic behavior to build dimensionally stable press felts beyond what can be achieved with conventional technology. This has influence on the lengthening and widening issues at various locations along the length of the paper machine involving the belt (e.g., transfer, centering and smoothening).

[0022] As a result of the use of auxetic fibers, it is also

possible to use finer fibers in the manufacturing process which will behave under tensile and/or press load as coarse fibers. The widening can also lead to buildup of a smoother surface as the surface becomes more dense upon thickening of the fibers. The density of the surface can be advantageously affected when using auxetic yarns and/or fibers with particular shaped cross sections.

[0023] A multiple component yarn/fiber with at least one auxetic component and one non-auxetic component can provide new physical properties for the paper machine clothing not previously obtainable, such as self crimping under stress/tension. Depending upon the shape of the fibers, the press behavior of a felt with auxetic fibers on the surface will change, a flat fiber with the ratio 1:2 likely changes the properties/shape the same way and the influence on flat fibers with even higher ratios like 1:3 or 1:5, or even higher. A paper machine clothing with auxetic behavior as described above, if configured to be reversible, also allows the paper machine to be run under different conditions, like normal running: high tension = dense felt; cleaning procedure: low tension = easy cleaning.

[0024] It is also possible to use auxetic yarn in a pintel area of seam felts and link fabrics for manipulating the permeability in the seam area or the link fabric itself.

[0025] While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

Claims

1. A paper machine clothing, comprising at least one layer of fibers, at least some of said fibers being auxetic fibers.
2. The paper machine clothing of claim 1, wherein said clothing comprises one of a press fabric, a forming fabric, a drying fabric and a belt.
3. The paper machine clothing of claim 2, wherein said clothing comprises a press fabric including at least one base layer, and batt fiber coupled with said base layer, said batt fiber including at least one of auxetic particles and said auxetic fibers.
4. The paper machine clothing of claim 3, wherein said batt fiber is at least one of physically and chemically coupled with said base layer.
5. The paper machine clothing of claim 4, wherein said

batt fiber is physically coupled with said base layer via needling.

6. The paper machine clothing of claim 1, wherein said auxetic fibers have one of a circular and flattened cross section.
7. The paper machine clothing of claim 1, wherein said auxetic fibers have a Poisson's ratio of between 1:2 to 1:5 when subjected to tensile loading.
8. The paper machine clothing of claim 1, further including a plurality of yarns, at least some of said yarns being auxetic yarns.
9. The paper machine clothing of claim 8, wherein said clothing includes a base layer, and at least some of said yarns are physically coupled with said base layer.
10. The paper machine clothing of claim 9, wherein said yarns extend in a machine direction of said clothing and are needled to said base layer.
11. The paper machine clothing of claim 1, wherein said auxetic fibers are comprised of an auxetic polymeric material.
12. A paper machine, comprising a clothing carried by a plurality of rolls, at least one of said rolls being movable to exert a selected load on said clothing, said clothing including auxetic fibers which become thicker in cross section as said load increases.
13. The paper machine clothing of claim 12, wherein said clothing comprises one of a press fabric, a forming fabric, a drying fabric and a belt.
14. The paper machine clothing of claim 13, wherein said clothing comprises a press fabric including at least one base layer, and batt fiber coupled with said base layer, said batt fiber including said auxetic fibers.
15. The paper machine clothing of claim 14, wherein said batt fiber is physically coupled with said base layer.
16. The paper machine clothing of claim 15, wherein said batt fiber is physically coupled with said base layer via needling.
17. The paper machine clothing of claim 12, wherein said auxetic fibers have one of a circular and flattened cross section.
18. The paper machine clothing of claim 12, wherein said auxetic fibers have a Poisson's ratio of between 1:2 to 1:5 when subjected to tensile loading.

19. The paper machine clothing of claim 12, further including a plurality of yarns, at least some of said yarns being auxetic yarns.
20. The paper machine clothing of claim 19, wherein said clothing includes a base layer, and at least some of said yarns are physically coupled with said base layer. 5
21. The paper machine clothing of claim 20, wherein said yarns extend in a machine direction of said clothing and are needed to said base layer. 10
22. The paper machine clothing of claim 12, wherein said auxetic fibers are comprised of an auxetic polymeric material. 15
23. A method of operating a paper machine, comprising the steps of: 20
- carrying a clothing with a plurality of rolls, said clothing including auxetic fibers; and
moving one of said rolls to exert a selected load on said clothing, thereby modifying a thickness of said auxetic fibers to become one of thinner 25
under a lesser load and thicker under a greater load.
24. The method of operating a paper machine clothing of claim 23, wherein said clothing comprises one of a press fabric, a forming fabric, a drying fabric and a belt. 30
25. The paper machine clothing of claim 23, wherein said clothing includes a plurality of yarns, at least some of said yarns being auxetic yarns. 35
26. The paper machine clothing of claim 25, wherein said clothing includes a base layer, said yarns extending in a machine direction of said clothing, at least some of said yarns being needed to said base layer. 40

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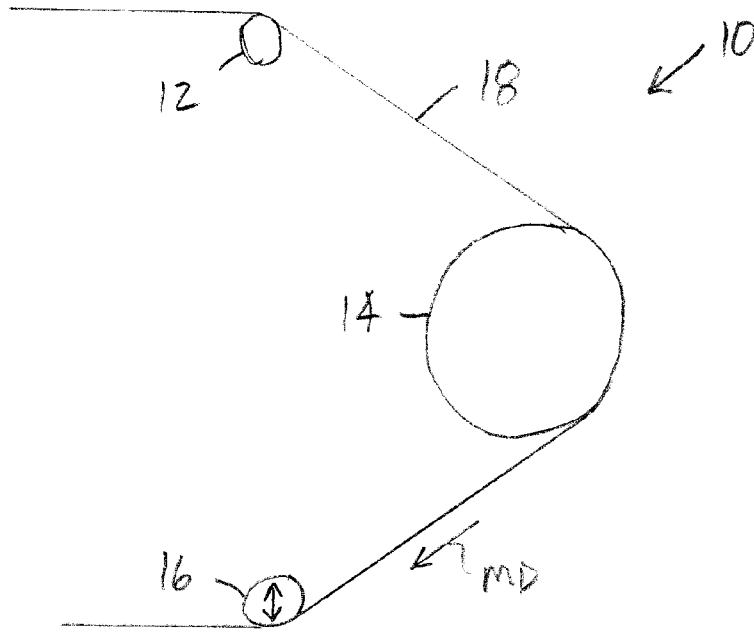


Fig. 1

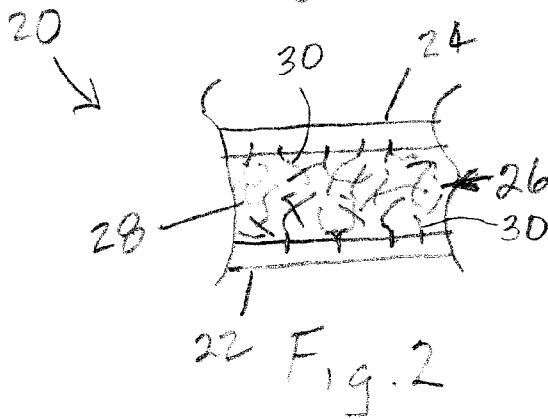


Fig. 2

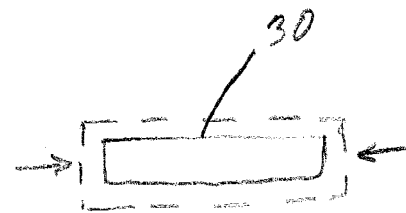


Fig. 3A



Fig. 3B

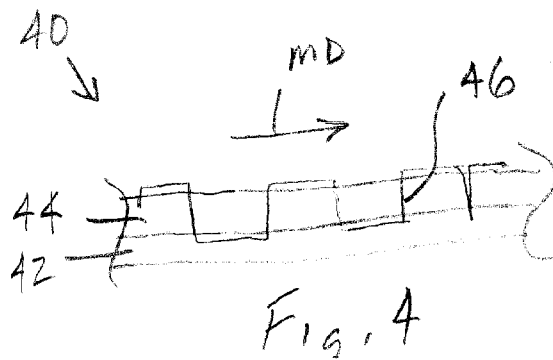


Fig. 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 15 0947

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2005/181694 A1 (CROOK ROBERT L [US] ET AL) 18 August 2005 (2005-08-18) * paragraphs [0018] - [0020] * -----	1,12,23	INV. D21F7/08 D21F1/00
			TECHNICAL FIELDS SEARCHED (IPC)
			D21F D21G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 May 2008	Examiner Maisonnier, Claire
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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