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(54) Title: A ROLL FOR A FIBRE WEB MACHINE

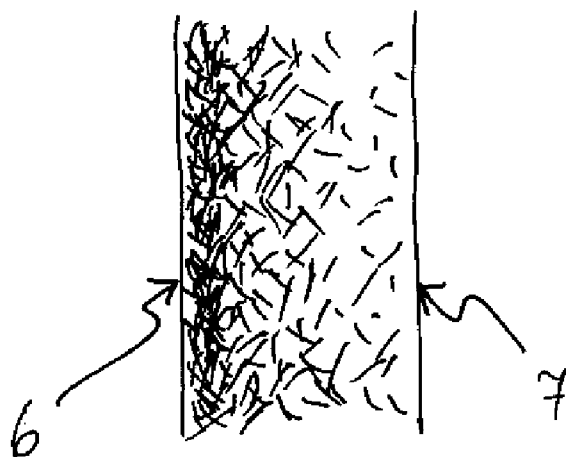


Fig. 3

(57) Abstract: The invention relates to a roll cover for a roll of a fibre web machine, said roll cover comprising fibres and a polymermatrix, wherein said fibres are in the form of a fibre tape having a length and a width, the width being the distance from a first edge to a second edge. The roll cover is characterised in that at least one characteristic of the tape varies in a predetermined manner along the width of the tape.



A ROLL FOR A FIBRE WEB MACHINE

FIELD AND BACKGROUND

The present invention relates to a roll cover for a roll of a fibre web machine, said
5 roll cover comprising fibres and a polymer matrix, wherein said fibres are in the
form of a fibre tape having a length and a width, the width being the distance from
a first edge to a second edge. The invention also relates to a roll of a fibre web
machine as well as to a method for manufacturing a roll of a fibre web machine.

Paper, board, finishing and tissue machines use several different types of rolls,
10 such as press rolls, suction rolls and calender rolls. It is known that these rolls,
which are typically made of metal, can be covered by polymers.

The role of the cover is important for the process, as the paper web or the like is
typically led to the calender unsupported, i.e. without the support of a fabric, to a
nip formed between a calender roll, covered by a polymer, and a hard-faced
15 counter roll. In such nip, the paper web is thus in direct contact with the roll
surfaces.

As stated, calender rolls and other rolls have several effects on the paper web, i.e.
on the gloss and smoothness of the finished paper, and also on the paper bulk.
The size of the calender rolls is typically 4-12 m in length and 400-1500 mm in
20 diameter. The magnitude of linear loads in these rolls can be as high as 300-600
N/mm.

In general, there is a difference in stiffness between the polymeric cover and the
metallic roll shell body, which difference under loaded state causes shear stress
on the metal-polymer interface. To minimise this stress, the polymer cover is
25 manufactured of several layers of different stiffness properties. Typically the
polymer cover is two-layered comprising a bottom layer on the metal body and a
functional layer on the bottom layer, the stiffness of the bottom layer being lower
than that of the metal body but higher than the stiffness of the functional layer.

For example, document WO 2008/116832 discloses a roll cover having several layers comprising fibre reinforcement and polymer matrix, the fibre reinforcement material being different at least in successive layers. Fibre material is selected such that coefficient of thermal expansion of the fibres of each layer is increased in
5 radial direction from the roll shell body towards the top.

Document WO 99/22066 presents a roll cover having variable hardness along its thickness. In this roll cover, the layer that is arranged on the roll shell body has a high hardness whereas the hardness gradually decreases radially outwardly. This design aims at reducing shear stresses between the roll cover and the roll shell
10 body, as well as at reducing internal heat generation due to hysteresis.

It is thus known that it is beneficial that the modulus of the cover decreases radially from the bottom layer to the functional layer. It is also known to achieve this by using several layers containing different fibres, thus creating a step-wise decrease in modulus. A problem encountered with this design is that the change
15 from one layer (and one type of fibre) to another layer (and another type of fibre) is discontinuous, thus creating weak points in the cover. The effect of such weak points is increased if the maximum stress due to the load is caused near such a discontinuous point. There exists thus a high risk that the roll needs to be re-covered prematurely, as the cover disintegrates at such weak points. Another
20 disadvantage is the laborious production with several steps due to different types of raw materials used in different layers.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to minimise or even totally eliminate the problems existing in the prior art.

25 An object of the present invention is to create a cover of a roll that has a continuous change of modulus through at least part of the thickness of the cover.

Another object of the invention is to provide a cover and a method for manufacturing a cover of a roll in a single step or in only a few steps instead of

several steps as in the prior art, and yet to obtain a cover having in its thickness direction zones with different properties.

The invention relates to a roll cover for a roll of a fibre web machine, said roll cover comprising fibres and a polymer matrix, wherein said fibres are in the form of a fibre tape having a length and a width, the width being the distance from a first edge to a second edge. In a typical roll cover according to the invention, at least one characteristic of the tape varies in a predetermined manner along the width of the tape.

The invention also relates to a roll of a fibre web machine comprising a roll cover according to the present invention, as well as to a method for manufacturing a roll according to this invention.

DETAILED DESCRIPTION OF THE INVENTION

Now it has been surprisingly found out that it is possible to manufacture a cover of a roll that has a continuous change of modulus through at least part of the thickness of the cover, in a single step. An advantage of the present invention is thus that the manufacturing time can be significantly reduced, for example from typical eight hours in the prior art to only four hours. This naturally leads to a significant reduction in manufacturing costs.

Some further advantages of a cover according to the present invention are for example a better resistance to deformation, a better thermal conductivity, a continuous change of modulus and thus a better wear resistance. The modulus of the finished cover is a result of the nature of the fibres, the type of matrix material and the amount and type of fillers.

According to the present invention, at least one characteristic of the tape varies in a predetermined manner along the width of the tape, as the fibres are in the form of a fibre tape having a length and a width, the width being the distance from a first edge to a second edge, and being considerably smaller than the length of the fibre tape. The fibre tape also has a thickness that is considerably smaller than the width of the tape.

- In this context, by calender roll is meant a roll having a polymeric cover or layer covering its main surface that is in contact with the web during the calendaring. It is clear that the cover according to the invention is suitable for other rolls employed in the machines for making and/or treating paper or board webs. Such machines are paper and board machines as such, including their drying sections and on-line calenders, as well as off-line calenders for cellulosic webs, such as supercalenders. Moreover, when paper web is mentioned in this text, it is clear that also webs of board, tissue and other webs comprising mainly cellulosic fibres are covered by this expression, which is only used for simplicity of wording. By single pass wrapping is meant a method of manufacturing in which the entire cover is obtained by a single step winding from one end of the roll to the other end of the roll but not returning back or repeating, i.e. the different layers are manufactured at the same time. Multiple pass wrapping means a method in which different layers of the cover are manufactured separately.
- It is also to be noted that a typical roll for a fibre web machine such as paper, board, finishing or tissue machine comprises a cylindrical roll shell body. The roll shell body is typically made of metal, such as cast iron. The thickness of a finished roll cover is about 5-15 mm, preferably 8-10 mm, while the tape can have a thickness of about 2-5 mm and a width of 100-200 mm, preferably about 150 mm.
- According to an embodiment of the invention, the characteristic is selected from the group consisting of the type of fibres and the amount of fibres.

According to another embodiment of the invention, the tape comprises

- a first edge zone extending from the first edge towards the second edge to a distance that is 5 - 50 % of the width of the tape,
- a second edge zone extending from the second edge towards the first edge to a distance that is 5 - 50 % of the width of the tape, and
- optionally a core zone between the first edge zone and the second edge zone, each of these zones having different characteristics.

- The tape may thus comprise, in its width direction, at least two zones having in majority different fibres and possibly also different amounts of fibres. The transition

from one zone to another can occur either continuously, i.e. there are one or more intermediate zones comprising both types of fibres in different amounts, or it can occur sharply, i.e. the change of type of fibres occurs along a clear line. Most often there will be at least some overlap in the type of fibres from one zone to another, 5 due to on one hand the manufacturing process of the tape and on the other hand in order to avoid too sharp transitions in properties in the finished cover. Preferably the tape comprises two zones that are each about 36 – 65 %, for example 50 % of the whole width of the tape.

The tape may also comprise, along its width, a continuous profile of fibres, i.e. at 10 the first edge zone, there are at least 90 % of the first type of fibres, such as glass fibres, then the amount of the second type of fibres, such as aramide fibres, continuously increases and the amount of the first type of fibres decreases until at the second edge zone there are at least 90 % of the second type of fibres. Another possibility is that at the area of the first edge, which is located closest to the roll 15 shell body and forms the bottom layer of the roll cover, the fibres consist mainly of glass fiber or mixture of glass and carbon fibers. At the area of the second edge, which is located at the top surface of the covered roll and forms a wear layer of the cover, the fibers comprise mainly aramide fibers or a mixture of aramide and carbon fibers, the content of glass fibers being preferably 0 % at the second edge.

20 Inorganic fibres applicable in the invention are for example glass or boron fibres. Organic fibres applicable in the invention are for example polyacrylonitriles, polyamides, aromatic polyamides and carbon fibre. Type of the fibre can be woven, non-woven or roving fibre.

One typical material for the matrix is epoxy resin, but also polyester can be used. 25 The ratio of polymer matrix to fiber may be and preferably is greater in the outermost surface of the cover, so that all fibers on the surface are fully embedded and secured in the matrix.

According to an embodiment of the invention, the first edge zone comprises fibres selected from the group consisting of glass fibres, carbon fibres, aramide fibres, 30 polyamide fibres, basalt fibres and mixtures thereof.

The second edge zone preferably comprises fibres selected from the group consisting of aramide fibres, including para-aramide fibres, carbon fibres, polyamide fibres, basalt fibres and mixtures thereof.

Furthermore, the tape may also comprise, in its width direction, thermally
5 conductive fibres extending from the first edge zone to the second edge zone. These thermally conductive fibres are intended for conducting the heat out of the bottom layer of the finished cover to the functional layer, both during the curing of the cover at the manufacturing and during operation in the fibre web machine.

These thermally conductive fibres can be for example carbon fibres. Moreover, the
10 thermally conductive fibres are preferably continuous fibres having a length that is at least 50 % of the width of the tape.

Preferably, the cover is manufactured by a single pass-method, i.e. it is a single coiled cover. In this embodiment, the fibre tape may be either in direct contact with the roll shell body, or there may be a layer of primer between the roll shell body
15 and the cover. The primer layer may be used for example to enhance the adhesion of the cover to the roll shell body, depending on the cover materials used.

The cover of the present invention may contain fillers that are admixed with the matrix material. With the fillers, properties of the cover can be improved or its cost
20 can be cut. Typically, fillers are used to improve wear resistance and to adjust matrix stiffness and hardness. Fillers applicable in the invention are inorganic fillers, such as metal, ceramic and mineral fillers, for example aluminium oxide, silicon oxide, carbides, nitrides, glass, silicates and mica in many different particle forms like powder, balls, pearls, fibres etc., and synthetic organic fillers, such as
25 synthetic polymers, for example ultra high molecular weight polyethylene (UHMWPE), synthetic fibres such as short fibres, chopped fibres, powdered fibres, aliphatic or aromatic polyamide as an example.

The cover of the invention may also contain other additives and processing aid agents such as polymerization initiators, activators and accelerators, hardeners,
30 plasticizers, thermal stabilators, antioxidants, antiozonates, pigments etc. for

promoting the process and improving physical properties of the cover. These agents are mixed with the matrix before bringing into contact with the fibre material.

During the winding, the consecutive cycles of the felt can be overlapped to an extent, which depends on the width of the tape and the desired thickness of the cover. The wound tape preferably forms an angle α with the surface of the roll shell body. The angle α can be selected to be in a range of $\pm 5-60^\circ$ depending on the specific embodiment and structure of the tape. With angles less than 5° the benefits of the invention relating to the desired layered structure are not properly achieved and steep angles over 60° would increase the risk of cover failure especially in nip roll applications where radial loads are exerted to the cover but to some extent also in other roll positions since the cohesion and homogeneity between two fiber winding may be impaired. A preferable range would be around 45° or less, more preferably 30° or less.

The present invention also relates to a method for manufacturing a roll cover for a roll of a fibre web machine, said roll cover comprising fibres and a polymer matrix, wherein said fibres are in the form of a fibre tape having a length and a width, the width being the distance from a first edge to a second edge, in which method the tape is wound helically around the roll shell body continuously in a single pass wrapping. In a typical method according to the invention, at least one characteristic of the tape varies in a predetermined manner along the width of the tape, and the first edge of the tape is in contact with the roll shell body or with a layer void of fibres arranged on the roll shell body.

In the method according to the present invention, the fibre tape is preferably applied to the roll shell body by means of a fibre tape guiding member that guides the tape in a right position and in such an angle that an optimal lead length with desired cover thickness is achieved. The guiding member can be optionally followed by a resin supply member by which means the matrix polymer resin is applied to the fibre tape layer wound on the roll shell body in an amount capable of impregnating and encapsulating the fibre layer properly. Instead or in addition to this resin supply, impregnation of the fibre tape can be performed in an

impregnation bath through which the fibre tape is lead from a tape supply before being guided over the roll shell body. It is also possible to apply the resin over the fibre covered roll in a separate step after the winding step is finished. For shorter pass-through time it is however preferable to bring the resin on the roll during the
5 winding step.

The present invention further relates to a cover of a roll of a fibre web machine obtainable by the method as described above.

The invention yet further relates to a roll of a fibre web machine comprising a cover as described above.

10 The invention also relates to a use of a tape as described above in the manufacture of a cover of a roll of a fibre web machine.

The present invention also relates to a calender for a fibre web machine comprising a roll according to the present invention. Typical multinip calenders comprise a number of rolls, arranged on top of each other. All or some of the
15 calender rolls may comprise a cover according to the present invention. Especially the first and/or the last roll of a multinip calender may have a cover according to the present invention. The invention also relates to a machine for manufacturing or treating a cellulosic web comprising at least one roll according to the present invention. Possible machines for manufacturing or treating a cellulosic are, for
20 example, paper machines, board machines, tissue machines, on-line calenders, off-line calenders, etc.

The present invention yet further relates to a fibre web machine comprising at least one roll cover or a roll according to this invention.

All the embodiments and characteristics disclosed in this specification apply to all
25 the different aspects of the invention, i.e. the embodiments listed for the cover apply *mutatis mutandis* to the tape, roll, calender, machine, use and method.

In this context, the term “comprising” is to be construed as an open term, i.e. that other features may be included in addition to those listed. Moreover, the reference numbers are not to be construed as limiting the scope of protection of the claims.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 schematically presents a fibre tape to be used in a roll cover according to a first embodiment of the invention.

Figure 2 schematically presents a fibre tape to be used in a roll cover according to
5 a second embodiment of the invention.

Figure 3 schematically presents a fibre tape to be used in a roll cover according to a third embodiment of the invention.

Figure 4 schematically presents a fibre tape to be used in a roll cover according to a fourth embodiment of the invention.

10 Figure 5 schematically presents a roll cover according to a fifth embodiment of the invention.

Figure 6 schematically presents a manufacturing method for a cover according to the present invention.

DETAILED DESCRIPTION OF THE DRAWING

15 Figure 1 schematically presents a fibre tape to be used in a roll cover according to a first embodiment of the invention. In this embodiment, the tape comprises, in its width direction W, two separate zones, a first zone 1 comprising glass fibres and a second zone 2 comprising aramide fibers. The first zone 1 includes the first edge zone 3 and the second zone 2 includes the second edge zone 4, which are not
20 represented here in proportion for sake of clarity. The length direction L is also shown in Figure 1.

Figure 2 schematically presents a fibre tape to be used in a roll cover according to a second embodiment of the invention. The tape according to this embodiment comprises in addition to the first and second zones carbon fibres 5 extending from
25 the first zone to the second zone.

Figure 3 schematically presents a fibre tape to be used in a roll cover according to a third embodiment of the invention. In this embodiment the two zones are not

clearly separated but the amount of fibres is different from the first edge 6 to the second edge 7.

Figure 4 schematically presents a fibre tape to be used in a roll cover according to a fourth embodiment of the invention. The first edge 6 comprises mainly a first
5 type of fibres 8, and the second edge 7 comprises mainly a second type of fibres 9. In the middle of the tape, both types of fibres are mixed and the transition from the first type to the second type of fibres is continuous, i.e. the fibre composition changes gradually.

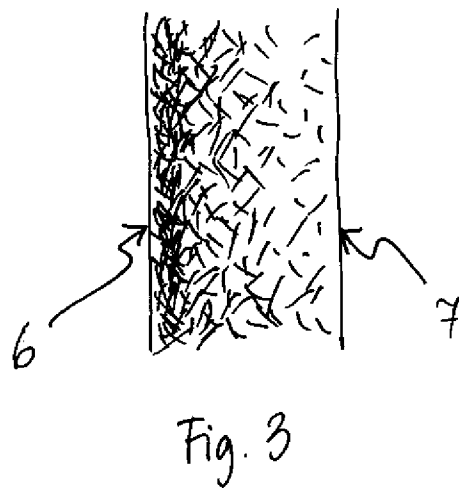
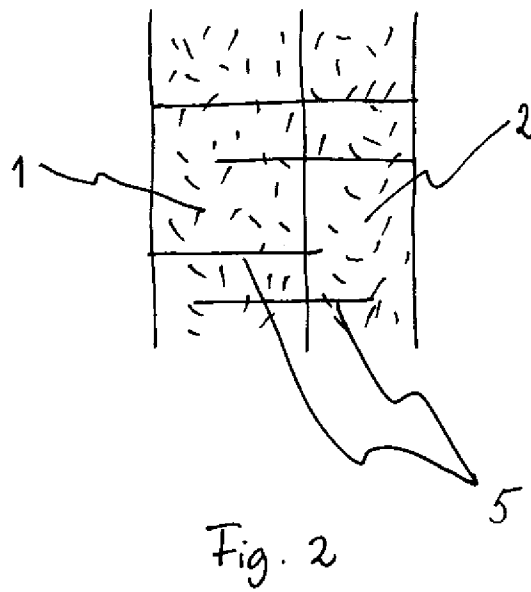
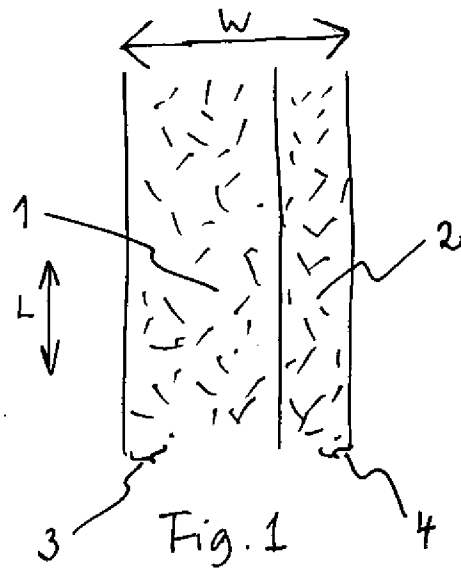
Figure 5 schematically presents a portion of a roll cover according to a fifth
10 embodiment of the invention, shown as a cross-section cut along the rotational axis of the roll. A roll cover 12 is provided on the surface of the roll shell body 10. The cover comprises fibres and a polymer matrix. The fibres, in the form of a fibre tape (having a width W), are wound helically around the roll shell body 10. The
15 tape is wound in such a way that its first edge zone 6 is in contact with the roll shell body 10, while its second edge zone 7 forms the outer surface of the roll cover. The winding angle α in Figure 5 is only for sake of clarity depicted to be higher than is practical or preferable. With each rotation of the roll shell body 10 the fibre tape is wound with a lead t depending on the tape's dimensions and in
20 such a manner as to provide the final roll cover without a need for other covering layers.

Figure 6 schematically presents a manufacturing method for a cover according to the present invention. The fibre tape 13 from the tape supply 14 is wound around the roll shell body 10 which is rotated by the motor 15. Fibre tape guiding member 11 guides the tape 13 in a right position and in such a winding angle that an
25 optimal lead length with desired cover thickness is achieved. The guiding member 11 travels forward along a beam 16 by the force of a second motor 17 (along the directions shown with reference number 18) and is here followed by a resin supply member 19 by which means the matrix polymer resin is applied to the fibre tape layer wound on the roll shell body 10 in an amount capable of impregnating and
30 encapsulating the fibre layer properly. The motors are driven by a power supply 20.

CLAIMS

- 1 A roll cover for a roll of a fibre web machine, said roll cover comprising fibres and a polymer matrix, wherein said fibres are in the form of a fibre tape having a length and a width, the width being the distance from a first edge to a second edge,
5 **characterised** in that at least one characteristic of the tape varies in a predetermined manner along the width of the tape.
2. A roll cover according to claim 1, **characterised** in that said characteristic is selected from the group consisting of the type of fibres and the amount of fibres.
3. A roll cover according to claim 1 or 2, **characterised** in that the tape comprises
10 - a first edge zone extending from the first edge towards the second edge to a distance that is 5 - 50 % of the width of the tape,
- a second edge zone extending from the second edge towards the first edge to a distance that is 5 - 50 % of the width of the tape, and
- optionally a core zone between the first edge zone and the second edge zone,
15 each of these zones having different characteristics.
4. A roll cover according to any of the preceding claims, **characterised** in that the first edge zone comprises fibres selected from the group consisting of glass fibres, carbon fibres, aramide fibres, polyamide fibres, basalt fibres and mixtures thereof.
5. A roll cover according to any of the preceding claims, **characterised** in that the
20 second edge zone comprises fibres selected from the group consisting of aramide fibres, carbon fibres, polyamide fibres, basalt fibres and mixtures thereof.
6. A roll cover according to any of the preceding claims, **characterised** in that the tape comprises, in its width direction, thermally conductive fibres extending from the first edge zone to the second edge zone.
- 25 7. A roll cover according to claim 6, **characterised** in that the thermally conductive fibres are carbon fibres.

8. A roll cover according to claim 6 or 7, **characterised** in that the thermally conductive fibres are continuous fibres having a length that is at least 50 % of the width of the tape.
9. A roll of a fibre web machine comprising a roll cover according to claim 1.
- 5 10. A method for manufacturing a roll cover for a roll of a fibre web machine, said roll cover comprising fibres and a polymer matrix, wherein said fibres are in the form of a fibre tape having a length and a width, the width being the distance from a first edge to a second edge, in which method the tape is wound helically around the roll shell body continuously in a single pass wrapping, **characterised** in that
- 10 - at least one characteristic of the tape varies in a predetermined manner along the width of the tape, and that
- the first edge zone of the tape is in contact with the roll shell body or with a layer void of fibres arranged on the roll shell body.



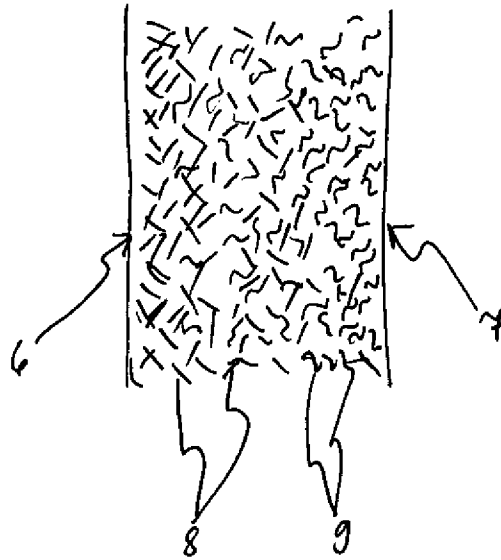


Fig. 4

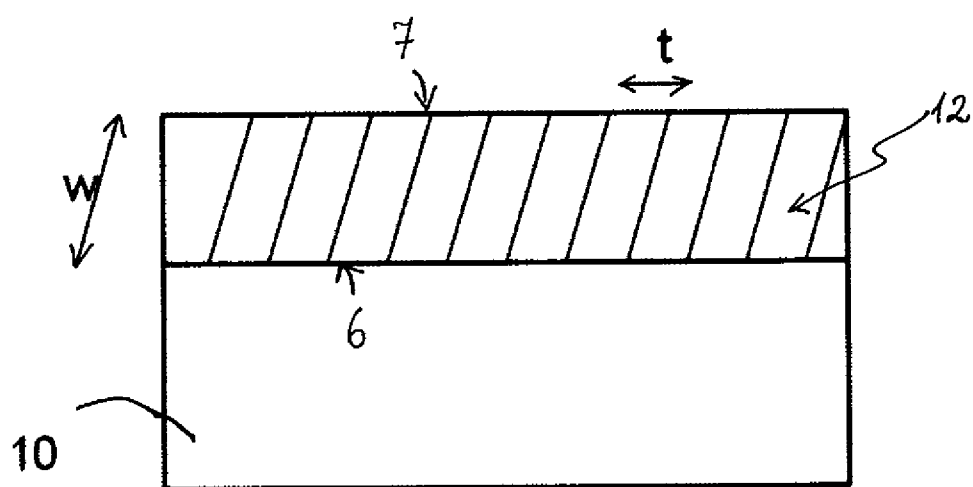


Fig. 5

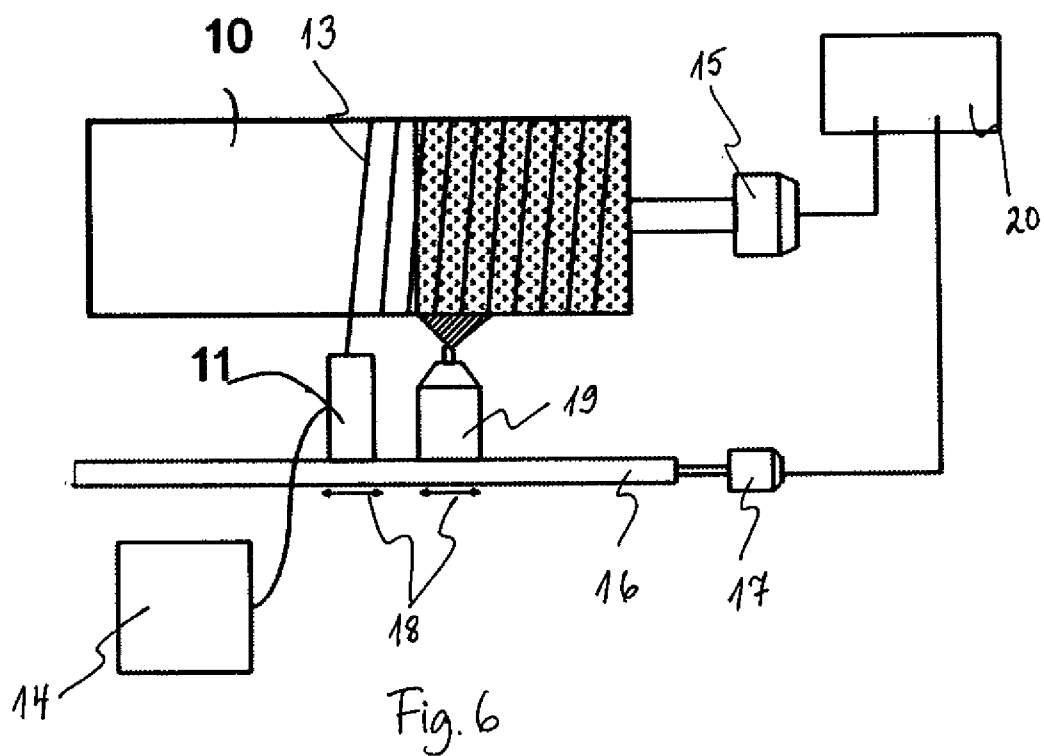


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2009/050156

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F16C, D21G, D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI, COMPDX, INSPEC, XPESP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6338706 B1 (SOHL CARSTEN) 15 January 2002 (15.01.2002) column 1, lines 14-34; column 5, line 55-column 6, line 7; column 6, line 53-column 7, line 67; Figs. 1-6	1-5, 9, 10
Y		6-8
Y	WO 2008155442 A1 (METSO PAPER INC et al.) 24 December 2008 (24.12.2008), page 7, line 28-page 9, line 10; page 10, lines 10-28; Figs. 3a-5b	6-8

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

22 October 2009 (22.10.2009)

Date of mailing of the international search report

03 November 2009 (03.11.2009)

Name and mailing address of the ISA/FI

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2009/050156

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 6338706 B1	15/01/2002	EP 1041197 A1 DE 19914709 A1	04/10/2000 05/10/2000
.....			
WO 2008155442 A1	24/12/2008	None	
.....			

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2009/050156

CLASSIFICATION OF SUBJECT MATTER

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