(54) Title: APPARATUS AND METHOD FOR TREATING A COATED OR UNCOATED FIBROUS WEB

(57) Abstract: The invention relates to an apparatus and a method for treating a coated or uncoated fibrous web, comprising at least one belt circle (2a), outside which is provided at least one counter-element (5) establishing a contact surface with the belt, such that the belt (2a) and the counter-element (5) develop therebetween a treatment zone for a web (W1), the web to be treated being passed therethrough. The apparatus comprises at least one additional belt circle (2b), such that the additional belt (2b) and the counter-element (5) develop therebetween a second treatment zone for a fibrous web, a second web (W2) to be treated being passed therethrough, whereby a single apparatus is capable of treating simultaneously at least two separate fibrous webs (W1, W2).
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Apparatus and method for treating a coated or uncoated fibrous web

The invention relates to an apparatus for treating a coated or uncoated fibrous web, comprising at least one belt circle, outside which is provided at least one counter-element establishing a contact surface with the belt, such that the belt and the counter-element develop therebetween a treatment zone for a web, the web to be treated being passed therethrough.

The Applicant's prior applications, e.g. FI 20020159, PCT/FI03/00066, PCT/FI03/00067 and PCT/FI03/00068, describe a so-called metal-belt calender and its various applications and embodiments. However, all these solutions involve concepts, wherein just one fibrous web is treated at a time. In practice, this represents a somewhat limited capacity for a single treatment apparatus. Especially, if the treatment apparatus is used as an on-line unit, it will be necessary to have more than one treatment apparatus per one paper machine line, for example. The apparatus is likely to have a running speed which is lower than that of a paper machine. Likewise, if the web to be treated is slitted for rolls narrower than the web width of a paper machine, for example if the width of the treatment apparatus must be dimensioned to be smaller than the machine width, the number of treatment units required for a single paper machine line will be even higher. In practice, this represents expensive investments in equipment for performing a finishing treatment for a fibrous web.

Applications regarding the inventive apparatus and method include processes described in conjunction with the above-cited applications for manufacturing and finishing a fibrous web, especially so-called metal belt calendering. Other treatment processes will be relevant as well, such as pressing, drying, condensation drying, application of a dry coating, sizer coating.

One important objective of the present invention is to provide a treatment apparatus for a fibrous web, improved in terms of the above applications,
which has a substantially increased treatment capacity for fibrous webs. It has now been discovered that the belt circles and counter-elements of an apparatus as described above can be arranged in such a way that a single apparatus is capable of treating simultaneously more than one fibrous webs.

In order to fulfil this objective, a treatment apparatus of the invention in its first embodiment is characterized in that the apparatus is provided with at least two belt circles, such that said belt circles and an external counter-element develop therebetween the number of fibrous-web treatment zones matching the number of belt circles, the webs to be treated being passed therethrough.

According to a second preferred embodiment of the invention, it is an alternative option that outside one belt circle is provided at least two counter-surfaces, for example thermal rolls. Hence, using just one belt circle it is possible to provide several different treatment zones for a fibrous web, one against each separate counter-element.

The invention enables a considerable increase in overall treatment capacity for fibrous webs per one apparatus. For example, a treatment apparatus, which has two separate treatment zones established by means of a counter-element and two belt circles, enables treating two fibrous webs at the same speed and, thus, it has basically a double treatment capacity with respect to a conventional treatment apparatus provided with a single treatment zone. It is also possible that a treatment apparatus of the invention be sized narrower than a fibrous web making machine, such as a paper machine, being for example half of its width. By treating two slitted narrower webs, it is thus possible to further process the entire output of a paper machine without compromising the overall capacity of the line, while still maintaining a fairly high running speed in the treatment apparatus. Thus, the invention makes it possible to increase the end product output capacity of an entire paper machine line and, on the other hand, to reduce expensive investments.
The invention will now be described in more detail with reference to the accompanying drawings, in which:

Fig. 1 shows in a schematic side view one exemplary implementation of the invention for an apparatus, wherein the apparatus is provided with two separate treatment zones against one counter-element on its opposite sides by means of two separate belt circles.

Fig. 2 shows in a schematic side view a second exemplary implementation of the invention for an apparatus, wherein against one counter-element is provided three separate treatment zones by means of three belt circles.

Fig. 3 shows in a schematic side view an apparatus of the invention in a second embodiment, wherein two separate treatment zones for a fibrous web are established by means of two counter-elements and one belt circle, and the treatment zones are further formed with extra nips by means of a shoe roll.

Fig. 4 shows in a schematic side view one concept of the invention, wherein the inventive apparatus is used as an off-line unit.

Fig. 5 shows in a schematic side view another concept of the invention, wherein the inventive apparatus is also used as an off-line unit.

Fig. 6 shows in a schematic side view an arrangement of the invention, wherein two apparatus units of the invention, provided with soft and hard calendering surfaces, are connected in series.

Fig. 7 shows in a schematic side view another arrangement of the invention, wherein the units of figs. 1 and 3 are connected in series.
Fig. 1 illustrates one highly preferred embodiment of the invention, wherein two treatment zones for a fibrous web W1, W2 are established on the opposite sides of a counter-element 5 by means of two separate belts 2a, 2b circling around guide rolls 3.

At least some of the guide rolls are made displaceable for adjusting tightness and running of the belts 2a and 2b as desired. The belts 2a and 2b travel around the roll 5 arranged outside the same as a counter-element, such that the belts and the roll develop therebetween two separate web treating zones X1, X2. Fibrous webs W1 and W2 to be treated travel each through one treatment zone, being thus subjected to a desired pressure impulse and thermal effect as a function of time.

The roll 5, like also a nip roll 6 inside the belt circle to establish a possible extra nip against the roll 5, may or may not be a deflection compensated roll and it is selected from a group consisting of: an elastic-surface roll, such as a polymer-coated roll, a rubber-coated roll or an elastomer-surface roll, a shoe roll, a thermal roll and a fiber roll.

The apparatus shown in fig. 1 can be used for treating two different webs W1, W2 concurrently. It is also conceivable that the apparatus be used for treating just one fibrous web, for example in such a way that the web W1 is only passed either through the zone X1 or optionally through the zones X1 and X2 sequentially without rolling it up in between.

The apparatus shown in fig. 2 has three fibrous web treating zones X1, X2, X3 established against the surface of a counter-element 5 on the opposite sides of the counter-element by means of three separate belt circles 2a, 2b, 2a. Thus, the apparatus of fig. 2 provides a possibility of treating simultaneously as many as three different fibrous webs W1, W2 and W3. It is also conceivable that the apparatus of fig. 2 be likewise used for treating just one web in more than one or even in each of the three treatment zones of
the apparatus by passing the web sequentially through said treatment zones. According to the principle shown in fig. 2, it is possible to arrange even more than three belt circles against the surface of the counter-element 5. It is further conceivable that at least one nip roll 6 inside a belt circle be included as an extra loading element.

Fig. 3 depicts a second preferred implementation for an apparatus of the invention, wherein two separate treatment zones are established by one belt circle 2 with two different counter-elements 5a and 5b disposed outside the same, the fibrous web W1, W2 being passed therethrough. In addition to the belt 2 and the roll 5, inside the belt circle is provided a nip roll 4 for applying extra press force to the presently treated web. In the embodiment shown in fig. 3, the nip roll comprises a shoe roll. The nip roll can be adapted both to press against just one of the counter-elements and against both counter-elements as illustrated in fig. 3. It is further conceivable to provide between the counter-elements 5a and 5b at least one extra nip roll 6 inside the belt circle. The extra roll or rolls can be adapted to press against both counter-elements 5a and 5b or against just one of the counter-elements.

The apparatus of fig. 3 can also be used for treating just one web by organising a passage of the web sequentially through several zones.

It is characteristic of the invention that the press zones X1, X2 and X3 included in the configurations of figs. 1, 2 and 3 can be controlled independently of each other. By adjusting independently process parameters acting within various treatment zones, particularly the condition of a belt circle and a counter-element, it is possible to achieve a precise control over process consequences resulting on either side of the web (especially one-sidedness). Respectively, in a sequential treatment, the parameters of each treatment zone can be used for selecting preferred treatment conditions exactly as desired and required by this particular treatment process of a fibrous web.
It is further characteristic of the invention that the apparatus units of figs. 1, 2 and 3, especially if used as off-line units, can be configured in a particularly convenient manner for the simultaneous treatment of several fibrous webs, thus providing a considerable increase in production output. Thus, the inventive solution is capable of reducing the number of necessary off-line calenders. For example, if the normal requirement is 3-4 off-line processing units for one high-speed paper machine, one or two units will be sufficient in the inventive solution. The on-line solution is also possible, in which case a web coming from two different paper machines will be treated concurrently in a single treatment apparatus.

It is further conceivable that, in the process of treating a fibrous web in one or more zones X1, X2 or X3, the zones are provided in the vicinity thereof with an agent applicator, such as a coater, a size press or a water moistening device. Especially, in the process of treating one and the same web sequentially without intermediate winding in any of the zones X1, X2 or X3, the applicator can be provided upstream of, between, or downstream of the zones in a preferred fashion. The applicator may also perform a profiling function.

In the cases of figs. 1-3, the treatment of a fibrous web can be further accompanied by some other process applied to the fibrous web, such as moistening, drying, heating or cooling of the fibrous web.

Fig. 4 displays one exemplary embodiment of the invention, wherein a single apparatus of the invention is used as an on-line unit. From a paper machine the wound-up rolls are conveyed to a treatment apparatus. It is also possible that at this point the rolls have already been slitted to a narrower width. The fibrous webs are unrolled from unwinders AR1, AR2, from which each web is carried through one treatment zone in the treatment apparatus and then the webs are rolled up with rewinders KR1, KR2.
Hence, in this example, the treatment of two fibrous webs proceeds concurrently, and only once and totally independently of a paper machine. In a particularly preferred case, both the belt circles and the roll are both heated to enable treatment of both surfaces of a web in one zone. Especially, when used as an off-line unit, a single apparatus of the invention is readily adaptable for the concurrent treatment of several fibrous webs, thus resulting in a considerable increase in production volume. Especially in modernization processes for paper and board machines, this may prove to be a particularly beneficial solution.

It is also possible to use the single processing apparatus of fig. 4 in this embodiment of the invention for just one fibrous web, whereby the web is run through both treatment zones sequentially, or also in such a way that the web is only passed through one treatment zone. Furthermore, the fibrous web can be first unrolled from an unwinder AR1 and carried through a first treatment zone of the apparatus to a rewinder KR2. The completely wound-up roll can be transferred further to the position of an unwinder AR2, from which the web is conveyed further to a second treatment zone of the apparatus and on to a rewinder KR1, while the next roll of fibrous web is already in the process of being unwound from the unwinder AR1 for processing the same in the first treatment zone of the apparatus. This processing sequence is particularly advantageous when the belt circles and the roll are made of materials of different types (hard and soft) and/or have different temperatures, and yet a symmetrical treatment is desired for the web. Hence, the effect of a single treatment zone is one-sided in nature, yet both surfaces of a web can be subjected to an equal treatment with said arrangement. Thus, the treatment of a paper web proceeds continuously on a throughput principle in sequences AR1 → KR2 → AR2 → KR1.

In the inventive concept shown in fig. 5, the inventive apparatus is likewise used as an off-line unit. Here, the fibrous webs are also unloaded from
unwinders AR1, AR2 to a treatment apparatus and rolled up after the
treatment onto rewinders KR1, KR2. There, the winders are further disposed
in such a way that the rolls can be conveyed for the treatment and after the
treatment onwards from the processing unit along the processing line of a
paper mill. This is visualised schematically by means of arrows.

In the cases of figs. 4 and 5, as well, it is conceivable to accompany the
treatment of a fibrous web by some other treatment process, such as
coating, moistening, drying, heating or cooling of the fibrous web. Said
treatment is performed downstream of the unwinders AR1, AR2 and/or
upstream of the rewinders KR1, KR2.

The press zones in an apparatus of the invention can be of the type hard-
hard (i.e. metal belt-hard roll) or hard-soft (hard belt-soft roll or vice versa).
In addition, units of the invention can also be arranged in series, as desired.
The concept of fig. 6 comprises two units as shown in fig. 1 connected in
series. There, the units are optionally provided with soft and hard
calendering surfaces, for example such that the first unit has a hard roll and
a soft belt and the second unit has a soft roll and a hard belt. On the other
hand, the arrangement of fig. 7 comprises units as shown in figs. 1 and 3
connected in series, for example such that the first unit has soft rolls (5a, 5b;
on the right in fig. 7) and a hard belt (2c) and the second unit has also a soft
roll (5c) and hard belts (2a and 2b). In the cases of 6 and 7, upstream of,
between, or downstream of the units can be provided other web treating
actuators (moistening, drying, heating or cooling).

It is also essential to appreciate that the fibrous webs to be treated need not
be exactly alike, but one and the same apparatus of the invention or
combinations thereof arranged in series can be used for concurrently treating
fibrous webs of dissimilar types.
Claims

1. An apparatus for treating a coated or uncoated fibrous web, comprising at least one belt circle (2a), outside which is provided at least one counter-element (5) establishing a contact surface with the belt, such that the belt (2a) and the counter-element (5) develop therebetween a treatment zone for a web (W1), the web to be treated being passed therethrough, characterized in that the apparatus comprises at least one additional belt circle (2b), such that the additional belt (2b) and the counter-element (5) develop therebetween a second treatment zone for a fibrous web, a second web (W2) to be treated being passed therethrough, whereby a single apparatus is capable of treating simultaneously at least two separate fibrous webs (W1, W2).

2. An apparatus as set forth in claim 1 for treating a coated or uncoated fibrous web, characterized in that the apparatus is further provided with a third belt circle (2c), such that the belts (2a, 2b, 2c) and the counter-element (5) develop therebetween three treatment zones, one of three webs (W1, W2, W3) to be treated being passed through each zone, whereby a single apparatus is capable of treating simultaneously three separate fibrous webs (W1, W2, W3).

3. An apparatus as set forth in claim 1 or 2 for treating a coated or uncoated fibrous web, characterized in that inside at least one of the belt circles (2a, 2b, 2c) is provided at least one press member (4) for pressing the belt (2a, 2b, 2c) against the counter-element (5).

4. An apparatus as set forth in claim 3, characterized in that the press member comprises at least one roll (4), which may or may not be deflection compensated and which roll is selected from a group consisting of: an elastic-surface roll, such as a polymer-coated roll, a rubber-coated roll or an elastomer-surface roll, a shoe roll, a thermal roll, a metal roll and a fiber roll.
5. An apparatus as set forth in any of claims 1-4 for treating a coated or uncoated fibrous web, characterized in that the surface of the counter-element (5) and/or one or more belts (2a, 2b, 2c) is made hard.

6. An apparatus as set forth in any of claims 1-4 for treating a coated or uncoated fibrous web, characterized in that the surface of the counter-element (5) and/or one or more belts (2a, 2b, 2c) is made soft.

7. An apparatus for treating a coated or uncoated fibrous web, comprising a belt circle (2), outside which is provided a counter-element (5a) establishing a contact surface with the belt, such that the belt (2) and the counter-element (5a) develop therebetween a treatment zone for a web (W1), the web to be treated being passed therethrough, characterized in that the apparatus is provided with at least one additional counter-element (5b), such that the belt (2) develops, together with the counter-elements (5a, 5b), separate fibrous web treating zones (X1, X2) for passing a different fibrous web therethrough, the apparatus being adapted for treating at least two fibrous web.

8. An apparatus as set forth in claim 7 for treating a coated or uncoated fibrous web, characterized in that inside at least one belt circle (2a, 2b, 2c) is provided at least one press member (4) for pressing the belt (2a, 2b, 2c) against the counter-element (5).

9. An apparatus as set forth in claim 8, characterized in that the press member comprises at least one roll (4), which may or may not be deflection compensated and which roll is selected from a group consisting of: an elastic-surface roll, such as a polymer-coated roll, a rubber-coated roll or an elastomer-surface roll, a shoe roll, a thermal roll, a metal roll and a fiber roll.
10. An apparatus as set forth in any of claims 7-9 for treating a coated or uncoated fibrous web, characterized in that the surface of one or more counter-elements (5a, 5b)) and/or the belt (2) is made hard.

11. An apparatus as set forth in any of claims 7-9 for treating a coated or uncoated fibrous web, characterized in that the surface of one or more counter-elements (5a, 5b)) and/or the belt (2) is made soft.

12. An apparatus as set forth in any of claims 1-11, characterized in that in engagement therewith is provided a further actuator, which is used for moistening, drying or profiling.

13. An arrangement for treating a coated or uncoated fibrous web, characterized in that the arrangement comprises one or more apparatus units as set forth in any of claims 1-12 arranged on a single line.

14. Use of an apparatus as set forth in any of claims 1-12 for the simultaneous treatment of two or more coated or uncoated fibrous webs.

15. A method for treating a coated or uncoated fibrous web with an apparatus, comprising at least one belt (2) adapted to circle around a guide element (3a), outside which belt is provided at least one counter-element (5) establishing a contact surface with the belt, such that the belt (2) and the counter-element (5) develop therebetween a treatment zone for a web (W1), the web to be treated being passed therethrough, characterized in that the method involves the use of a second belt (2b) adapted to circle around a different guide element (3b), such that the belt (2) and the counter-element (5) develop therebetween a second treatment zone for a fibrous web, a second fibrous web (W1) being passed therethrough, whereby a single apparatus is capable of treating simultaneously two separate fibrous webs (W1, W2).
16. A method as set forth in claim 15, characterized in that the method further comprises the use of a third belt (2c) adapted to circle around a guide element (3c), such that the belts and the counter-element (5) develop therebetween a third treatment zone for a fibrous web, a third web to be treated being passed therethrough, whereby a single apparatus is capable of treating simultaneously three separate fibrous webs (W1, W2, W3).

17. A method as set forth in claim 15 or 16 for treating a coated or uncoated fibrous web, characterized in that the method comprises the use of at least one press member (4) provided inside one or more belt circles (2a, 2b, 2c) for pressing the belt (2a, 2b, 2c) against the counter-element (5).

18. A method as set forth in claim 15 for treating a coated or uncoated fibrous web, characterized in that, as a press member, the method comprises the use of at least one roll (4), which may or may not be deflection compensated and which roll is selected from a group consisting of: an elastic-surface roll, such as a polymer-coated roll, a rubber-coated roll or an elastomer-surface roll, a shoe roll, a thermal roll, a metal roll and a fiber roll.

19. A method as set forth in any of claims 15-18, characterized in that the method comprises the use of one or more counter-elements (5), whose surface is made hard or soft, and/or one or more belts (2), whose surface is made hard or soft.

20. A method as set forth in any of claims 15-19, characterized in that the apparatus used in the method for treating a fibrous web comprises an on-line or off-line unit.
### A. CLASSIFICATION OF SUBJECT MATTER

**IPC7:** D21G 1/00, D21F 3/04

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)

**IPC7:** D21F, D21G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

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

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>X</td>
<td>GB 190716653 A (WILLIAM MORGAN WALLACE ET AL), 28 November 1907 (28.11.1907), page 2, line 12 - line 32, figure 7</td>
<td>1-6,15-20</td>
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<td>A</td>
<td>EP 1318236 A2 (VOITH PAPER PATENT GMBH), 11 June 2003 (11.06.2003), abstract</td>
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<td>A</td>
<td>DE 10019474 A1 (VALMET CORP.), 4 January 2001 (04.01.2001), abstract</td>
<td>1-20</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents
  - "A" - 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
  - "B" - earlier application or patent but published on or after the international filing date
  - "L" - document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  - "O" - document referring to an oral disclosing use, exhibition or other means
  - "P" - document published prior to the international filing date but later than the priority date claimed

Date of the actual completion of the international search: 27 October 2004

Date of mailing of the international search report: 01-11-2004

Name and mailing address of the ISA/Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM

Authorized officer
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Form PCT/ISA/210 (second sheet) (January 2004)
International Search Report

Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

   see next page

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. X As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest □ The additional search fees were accompanied by the applicant’s protest.

□ No protest accompanied the payment of additional search fees.
Invention I: (claims 1-6 and 15-20) The invention according to claims 1-6 and 15-20 concerns an apparatus and a method for treating at least two separate fibrous webs simultaneously. The apparatus comprises a number of belts and a counter element.

Invention II: (claims 7-14) The invention according to claims 7-14 concerns an apparatus for treating at least two separate fibrous webs simultaneously. The apparatus comprises a number of counter elements and a belt.
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