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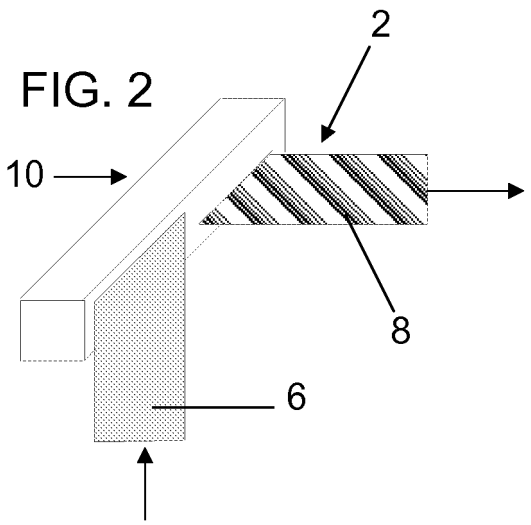
(54) Method for forming a continuous paper web extensible in the longitudinal direction and in the transverse direction

(57) A method for forming a continuous paper web extensible in the longitudinal direction and in the transverse direction, characterised by passing a paper web (2), having a water content of between 20% and 80%, into contact with at least one deviation roller (4), the axis of which forms an angle between 30° and 60° to the longitudinal axis of the web, and subjecting the web, at the contact surface between said paper web and said roller, to a compaction which is prevalent in one of the two directions parallel to and perpendicular to the roller axis.

FIG. 2



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Description

[0001] The present invention relates to a method for forming a continuous paper web extensible in the longitudinal direction and in the transverse direction.

[0002] Extensible papers are known, these having the property of being extensible in one or more directions if subjected to stretching.

[0003] Various methods for forming these extensible papers are also known, based essentially on the principle of compacting the constituent fibres of the paper when this has a high water content and hence a pasty and pliable constituency, i.e. during the paper forming process and following its steeping. Depending on the method by which this compaction is obtained, an extensibility can be achieved which is prevalent in the longitudinal direction or in the transverse direction.

[0004] In FR 1 242 857, the paper web under formation is caused to undergo a path comprising a first portion curved in a certain direction, followed by a portion curved in the opposite direction. This method makes use of the thickness of the paper web under formation, which along the first curved portion causes longitudinal compaction of those fibres located internally, with reference to the thickness of the paper web, whereas along the second curved portion it causes longitudinal compaction of those fibres which, although located in the interior of this second portion, correspond in fact to the external part of the previous portion.

[0005] The final result consists of an overall compaction of the fibres of the paper web in the longitudinal direction, and hence of a longitudinal extensibility of the web.

[0006] In US 6 024 832, the paper web under formation is caused to pass between two rollers, of which one is made of steel and the other is made of rubber, this latter rotating in the opposite direction but with lesser peripheral velocity, such as to cause the fibres to undergo longitudinal compaction.

[0007] In Italian Patent Application VE2008A000066 of 7 August 2008 of the same Applicant the paper web under formation is positioned on a transversely prestretched elastic web, such that the return to the original configuration causes transverse compaction of the paper web, to give it transverse extensibility properties.

[0008] The two treatments can also be effected in sequence, to finally obtain a paper web provided with extensibility characteristics both in the longitudinal direction and in the transverse direction, however with fairly complex and costly equipment which inter alia reduces the normal productivity of a traditional continuous paper machine.

[0009] In GB 1 194 252 a paper sheet under formation is positioned between two prestretched membranes of plastic material, such that their subsequent elastic return to their rest configuration causes the sheet to be compacted in all directions by entrainment, to give it extensibility characteristics in all directions.

[0010] This method results in extremely slow operability and moreover is applicable only to paper sheets and not to the webs leaving a continuous paper machine.

[0011] An object of the invention is to overcome all the drawbacks jointly and separately found in known methods for making extensible papers by proposing a new method which enables paper webs extensible in all directions to be formed, using a very simple apparatus applicable virtually to all continuous paper machines, without substantially reducing their productivity.

[0012] This and other objects which will be apparent from the ensuing description are attained, according to the invention, by a method for forming a continuous paper web extensible in the longitudinal direction and in the transverse direction, as described in claim 1.

[0013] The present invention is further clarified hereinafter with reference to the accompanying drawings, in which:

- Figure 1 is a schematic plan view illustrating the principle on which the method of the invention is based,
- Figure 2 is a schematic view illustrating the same principle applied to a paper web under formation subjected to a generic arrangement for both longitudinal and transverse compaction,
- Figure 3 is a perspective schematic view thereof subjected to a unit for its longitudinal compaction,
- Figure 4 is a perspective schematic view thereof subjected to a different unit for its longitudinal compaction,
- Figure 5 is a perspective schematic view thereof subjected to a unit for its transverse compaction,
- Figure 6 is a schematic plan view thereof subjected to two generic units for its compaction,
- Figure 7 shows it in the same view as Figure 4, but as a first modified embodiment thereof,
- Figure 8 shows it in the same view as Figure 4, but as a second modified embodiment thereof.

[0014] As can be seen from the figures, the method of the invention consists essentially of using a known method for compacting a paper web of high water content, in particular a paper web under formation, in a manner different from that used in the traditional art. More particularly, all the known methods for compacting a paper web consist of passing the web under formation through compaction units which, while operating on the basis of different compaction techniques and using methods related to said techniques, always use rollers having their axes perpendicular to the web advancement direction. It follows that on termination of the treatment, the web leaves in the same direction as the entry direction or at most at an angle along the longitudinal plane, but always perpendicular to the roller axes.

[0015] In contrast, in the method of the invention, compaction is achieved while maintaining the rollers of the

compaction unit inclined to the direction from which the paper web to be treated originates, and in particular disposed with their axes forming an angle between 30° and 60°, preferably 45°, such that compaction takes place in all cases both with a component parallel to the longitudinal axis of the paper web and with a component perpendicular thereto.

[0016] Moreover, as compaction of the paper web under formation generally takes place with a component prevalently parallel or perpendicular to the web longitudinal axis, but also with a component more or less large percentage-wise in the other direction, i.e. in the direction perpendicular or parallel to the web advancement direction, it will always be possible to choose for the rollers of the compaction unit a suitable angle of inclination to the longitudinal axis of the paper web, such as to choose the desired ratio between the two extents of extensibility of the web in the two perpendicular directions, in accordance with the desired result and independently of the compaction method used.

[0017] Figure 1 schematically shows a paper web, which is diverted in passing about a roller 4. The paper web has a high water content of between 20% and 80%, and is thus highly pliable; it could be a web under formation in any continuous paper machine, or an already formed web subjected to a prior steeping treatment.

[0018] In the drawing it can be seen that the entering portion 6 of the web 2, i.e. the web portion upstream of the roller 4, advances in a certain direction, with the axis of the roller 4 inclined to the advancement direction of the web 2 by an angle between 30° and 60°, preferably 45°; it can also be seen that the exiting portion 8 of the web 2, i.e. the web portion downstream of the roller 4, is inclined to the direction of the upstream portion 6 by an angle between 60° and 120°, in this particular case it being 90°.

[0019] Figure 2 shows schematically, as a parallelepiped box, the unit which compacts the fibres of the web 2. Specifically, this unit comprises the roller 4 and all that which traditionally cooperates with it to achieve compaction of the web fibres both in the longitudinal direction and in the transverse direction or, as found in practice, prevalently in one of the two directions but also with a small component in the other direction.

[0020] Hence with reference to Figure 2, the paper web portion 6 which enters the compaction unit, indicated overall by 10, has substantially no extensibility characteristics, whereas when it leaves that unit it has high extensibility characteristics. Moreover, as the web, in passing through the unit 10, is subjected to compaction treatment in a direction inclined to the web longitudinal axis, it is clear that independently of whether the compaction applied to that band of the web 2 in contact with the deviation roller 4 is transverse or longitudinal, in reality it presents both a transverse component and a longitudinal component, the extensibility ratio in one and the other direction evidently being linked both to the inclination of the roller 4 to the longitudinal axis of the entering web, and to the compaction method used.

[0021] Figure 3 shows schematically the compaction method of FR 1 242 857, in which the web 2 is passed between rollers, one of which is the deviation roller 4 and the other rollers, and in particular the rollers 12 and 14, are associated with a continuous web 16, which causes a first portion of the web 2 to adhere to a portion of the cylindrical surface of the deviation roller 4, and a subsequent portion of the web 2 to adhere to a portion of the cylindrical surface of the web 14.

[0022] In the first portion the web 2, which has a certain thickness and is curved in one direction, causes longitudinal compaction of the fibres on the inner (concave) side of the web, i.e. on that side of the web which adheres to the roller 14, whereas in the next portion the web 2 is curved in the opposite direction and causes longitudinal compaction of the fibres on the opposite side of the web 2, which adheres to the roller 14.

[0023] According to the teaching of FR 1 242 857 the compaction unit is arranged perpendicular to the longitudinal axis of the web 2 and causes fibre compaction prevalently in the longitudinal direction, to give the web a certain extensibility prevalently in a longitudinal direction, whereas in the present case because the compaction unit 10 is inclined to the web advancement direction, this unit gives the web 2 extensibility both in the longitudinal direction and in the transverse direction.

[0024] Figure 4 shows an example of the paper web longitudinal compaction method according to US 6 024 832. The compaction unit 10 essentially comprises the deviation roller 4, made of rubber, and a backing roller 18, which is made of steel and rotates in the opposite direction to the roller 4 but at a greater peripheral velocity. The result is that in the contact region between the rollers 4 and 18 the paper web 2 is subjected to a force which tends to cause it to advance and also to a counteracting force which tends to brake it. The combined effect of these two contrasting forces results in compaction of the fibres of the web 2, this compaction taking place both in the longitudinal direction and in the transverse direction because of the arrangement of the unit 10 inclined to the web advancement direction.

[0025] Figure 5 shows an example of the paper web transverse compaction method according to Italian Patent Application VE2008A000066. The compaction unit 10 comprises the roller 4, which in this case is provided with a large circumferential cavity closed by an elastic sleeve, and a further pair of rollers 20, which interfere with the roller 4 and temporarily cause said elastic sleeve to locally retract into the circumferential cavity of the roller, to thus stretch the sleeve axially.

[0026] When the sleeve emerges from the interference by the rollers 20 and regains its original configuration, it causes the paper web under formation to undergo compaction parallel to the axis of the roller 4. However again in this case, the arrangement of the compaction unit 10 inclined to the longitudinal axis of the web 2 means that the compaction, which would otherwise be essentially

transverse, in reality is also longitudinal with the result that the paper web obtained is extensible in all directions, with prevalence in the transverse direction or in the longitudinal direction depending on the angle of inclination of the compaction unit 10.

[0027] In this embodiment of the method, the paper web instead of being simply rested on the sleeve, which has been prestretched, could possibly be pressed against this by another sleeve or by a belt or by a roller.

[0028] As stated, in all the illustrated embodiments the method of the invention enables the treated paper web to leave the compaction unit inclined to the entering web and, if the axes of the rollers of said compaction unit are disposed at 45° to the longitudinal axis of the entering web, the exit web will lie at an angle of 90° to the entering web. This means that by using two compaction passes, a choice can be made between restoring the original web advancement direction (see Figure 6), or inverting its advancement direction; this can be particularly advantageous if compaction is undergone during the process of forming the paper web in a continuous paper machine, which in this case instead of being arranged in a single line, which can even exceed one hundred metres in length, it can be arranged in two lines folded back on themselves, with a considerable reduction in the longitudinal dimension of the machine.

[0029] Because of the fact that during treatment of the paper web 2 this could be subjected to translation along the surface of the deviation roller 4, the invention provides for counteracting this translation by forming said roller with at least one spiral-shaped element 22, disposed such that as the roller rotates, this urges the paper web in the direction to oppose this translation.

[0030] This spiral-shaped element can involve the deviation roller 4 as stated, but could evidently involve the roller 18 cooperating with the roller 4, or even both the rollers, and in general at least one of the two surfaces involved in carrying out the compaction of the paper web 2.

[0031] This spiral-shaped element 22 can be formed in the most varied ways, in the sense that it can be formed integrally with the roller 4 and/or 18 to which it pertains, or can be applied to it, in which case it can be made of the same or different material. In this latter case the spiral-shaped element can be in relief relative to the surface of the roller 4 and/or 18 or can be coplanar therewith and perform its function by utilizing the greater friction which it presents compared with the remaining part of the roller surface.

[0032] The spiralled roller 4 and/or 18 can be formed specifically for this function or can consist of a traditional loom temple, i.e. a roller used in weaving to transversely stretch the fabric, with which it is in contact.

Claims

1. A method for forming a continuous paper web extensible in the longitudinal direction and in the transverse direction, **characterised by** passing a paper web (2), having a water content of between 20% and 80%, into contact with at least one deviation roller (4), the axis of which forms an angle between 30° and 60° to the longitudinal axis of the web, and subjecting the web, at the contact surface between said paper web and said roller, to a compaction which is prevalent in one of the two directions parallel to and perpendicular to the roller axis.

2. A method as claimed in claim 1, **characterised by** counteracting any tendency of the paper web (2) to translate parallel to the axis of deviation roller (4), by maintaining said paper web in contact with a spiral-shaped element (22) wound in the direction coherent with said counteracting action.

3. A method as claimed in claim 1, **characterised by** using at least one roller (4, 18) provided on its lateral surface with said spiral-shaped element (22).

4. A method as claimed in one or more of the preceding claims, **characterised by** using at least one roller (4, 18) on which said spiral-shaped element (22) is provided in relief relative to the remaining surface of said roller.

5. A method as claimed in one or more of the preceding claims, **characterised by** using at least one roller (4, 18) on which said spiral-shaped element (22) is formed of material with a higher friction coefficient than that of the remaining surface of the roller.

6. A method as claimed in one or more of the preceding claims, **characterised by** using a paper web during its formation process.

7. A method as claimed in one or more of the preceding claims, **characterised by** using a paper web which has been already formed and subjected to a prior steeping treatment.

8. A method as claimed in one or more of the preceding claims, **characterised by** effecting compaction of the web in a direction perpendicular to the axis of said roller, while subjecting the web to deviation in the opposite direction.

9. A method as claimed in one or more of the preceding claims, **characterised by** effecting compaction of the web (2) in a direction perpendicular to the axis of said roller (4) by passing the web between two rollers which are made of materials having friction coefficients different from that of the web and are rotated at different peripheral velocities such that the roller of greater friction coefficient rotates at the lesser peripheral velocity.

10. A method as claimed in one or more of the preceding claims, **characterised by** effecting compaction of the web in a direction parallel to the axis of said roller (4) by using a roller presenting at least one circumferential cavity covered by an elastic sleeve, to cause temporary localized stretching of said sleeve by virtue of its forced entry into said circumferential cavity before it is brought into contact with said web, then finally causing its subsequent release, with its resultant axial contraction and consequent transverse compaction of the fibres of the web, which meanwhile has been brought into contact with the roller.

11. A method as claimed claim 10, **characterised by** maintaining the paper web pressed against said sleeve during its axial contraction.

12. A method as claimed in one or more of the preceding claims, **characterised by** effecting compaction of the web in a direction parallel to the axis of said roller (4) by passing the web between two rollers, at least one of which is provided with helical grooves which as the roller rotates extend towards its central region.

13. A method as claimed in one or more of the preceding claims, **characterised by** subjecting to compaction a paper web under formation having a water content of between 35% and 65%.

14. A method as claimed in one or more of the preceding claims, **characterised by** subjecting to compaction a paper web under formation by arranging the roller, at which said compaction takes place, at an angle of about 45° to the advancement direction of said web.

15. A method as claimed in one or more of the preceding claims, **characterised by** varying the inclination of the roller (4), at which said compaction takes place, to the advancement direction of said web, on the basis of the compaction method used and the desired ratio between the extensibility values of said web in the transverse direction and in the longitudinal direction.

16. A method as claimed in one or more of the preceding claims, **characterised by** subjecting the paper web under formation to more than one compaction treatment in sequence.

17. A method as claimed in claim 16, **characterised by** subjecting the paper web under formation to several mutually different compaction treatments.

FIG. 1

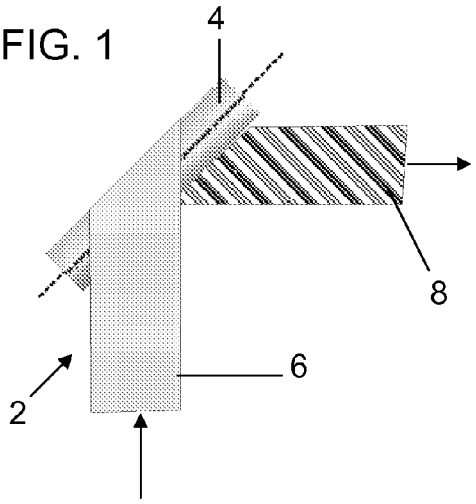


FIG. 2

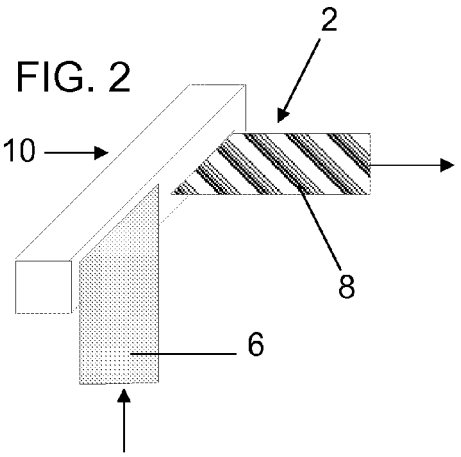


FIG. 3

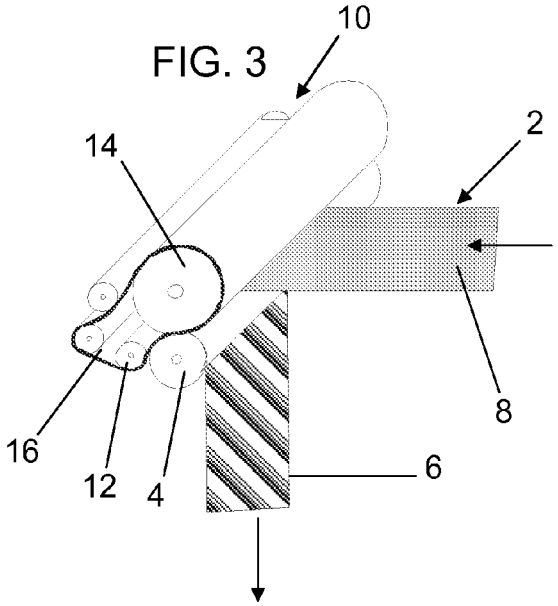


FIG. 4

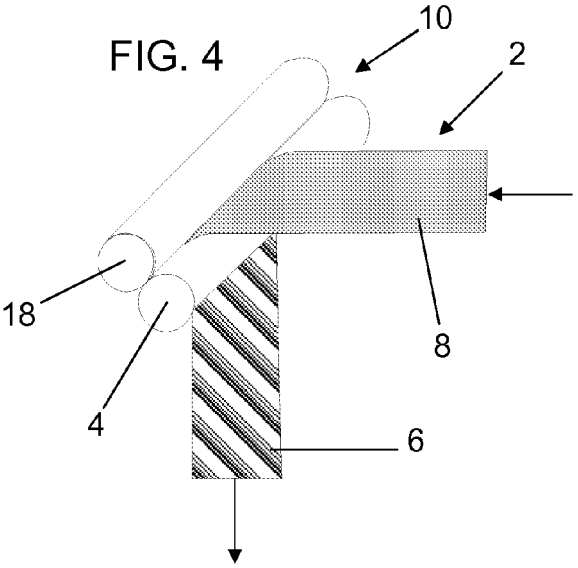


FIG. 5

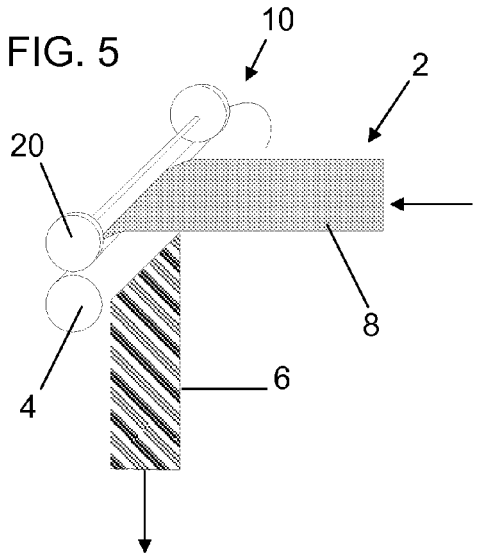
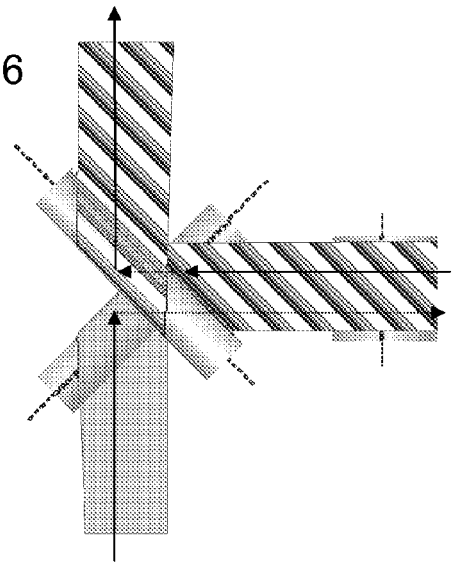


FIG. 6



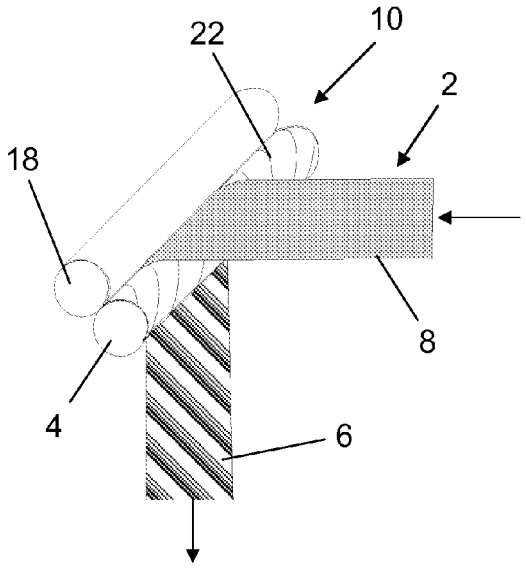


FIG. 7

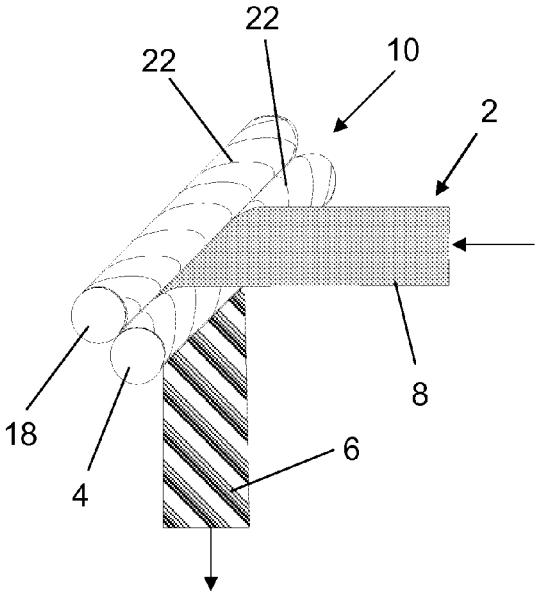


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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- US 6024832 A **[0006] [0024]**
- IT VE20080066 A **[0007] [0025]**
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