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(54) METHOD OF TREATING A FIBER WEB AND A TREATMENT SYSTEM FOR TREATMENT OF A FIBER WEB

(57) The invention relates to a method of treating a fiber web, in which method the fiber web is sized in a sizer (10), in which the sizing agent (T) is applied onto the fiber web by two hard sizing rolls (11,12) in a sizing nip (N). The fiber web (W) is sized with high solids content sizing agent (T) by indirect curtain sizing in a curtain sizer (10) and in the sizing nip (N) at substantially uniform pressure distribution and uniform speed in cross-direction of the fiber web (W). After the sizing the fiber web (W) is heat-treated in a heat-treatment zone (Z) of a heat-treatment device (20). The invention also relates to a treatment system for treatment of a fiber web, which system comprises a sizer (10) comprising sizing rolls (11,12) forming a sizing nip (N). The system further comprises a heat-treatment device (20) comprising a heat-treatment zone (Z). The sizer is a curtain sizer (10) with indirect application of sizing agent (T) in high solids content and one of which hard sizing rolls is a deflection compensated roll and a substantially straight sizing nip is formed.

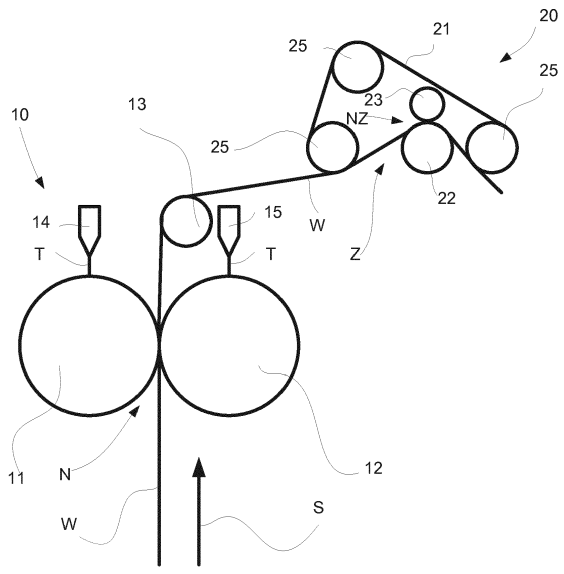

Fig. 1

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Description

[0001] In general, present invention relates to treating of fiber webs in a fiber web production line. More especially the present invention relates to a method according to preamble part of the independent method claim and to a treatment system according to preamble part of the independent treatment system claim.

[0002] In this description and the following claims by fiber webs are meant for example a paper and board webs.

[0003] Fiber webs, such as paper and board webs are available in a wide variety of types and can be divided according to basis weight in two grades: papers with a single ply and a basis weight of 25-300 g/m^2 and boards manufactured in multi-ply technology and having a basis weight of 150-600 m/m^2. It should be noted that the borderline between paper and board is flexible since board grades with lightest basis weights are lighter than the heaviest paper grades. Generally speaking, paper is used for printing and board for packaging.

[0004] The subsequent descriptions are examples of values presently applied for fiber webs, and there may be considerable fluctuations from the disclosed values. The descriptions are mainly based on the source publication Papermaking Science and Technology, section Papermaking Part 3, edited by Rautiainen, P., and published by Paper Engineers' Association, Helsinki 2009, 404 pages.

[0005] Mechanical-pulp based, i.e. wood-containing printing papers include newsprint, uncoated magazine and coated magazine paper.

[0006] Today's newsprint furnishes mostly contain between 80 and 100 % deinked pulp (DIP). The rest of the furnish is mechanical pulp (typically TMP). However, there is also newsprint made of 100 % mechanical fiber furnishes. DIP based newsprint may contain up to 20 % filler. The filler content of a virgin-fiber based newsprint furnish is about 8 %.

[0007] General values for CSWO newsprint can be regarded as follows: basis weight 40-48.8 g/m^2, PPS s10 roughness (SCAN-P 76-95) 4.0-4.5 μm, Bendtsen roughness (SCAN-P21:67) 150 ml/min, density 600-750 kg/m^3, brightness (ISO 2470:1999) 58-59 %, and opacity (ISO 2470:1998) 92-95%.

[0008] Uncoated magazine paper (SC-supercalendered) grades usually contain 50 % - 75 % mechanical pulp, 5 % - 25 % chemical pulp, and 10 % - 35 % filler. The paper may also contain DIP. Typical values for calendered SC paper (containing e.g. SC-C, SC-B, and SC-A/A+) include basis weight 40-60 g/m^2, ash content (SCAN-P 5:63) 0-35%, Hunter gloss (ISO/DIS 8254/1) <20-50%, PPS s10 roughness (SCAN-P 76:95) 1.0-2.5 μm, density 700-1250 kg/m^3, brightness (ISO 2470:1999) 62-75%, and opacity (ISO 2470:1998) 90-95%.

[0009] Coated mechanical papers include for example MFC (machine finished coated), LWC (lightweight coated), MWC (medium weight coated), and HWC (heavy weight coated) grades. Coated mechanical papers usually contain 45 % -75 % mechanical or recycled fiber and 25 % - 55 % chemical pulp. Semi chemical pulps are typical in LWC paper grades made in the Far East. The filler content is about 5 % -10 %. The grammage is typically in the range 40-80 g/m2.

[0010] General values for LWC paper can be regarded as follows: basis weight 40-70 g/m^2, Hunter gloss 50-65%, PPS S10 roughness 1.0-1.5 μm (offset) and 0.6-1.0 μm (roto), density 1100-1250 kg/m^3, brightness 70-75%, and opacity 89-94%.

[0011] General values for MFC paper (machine finished coated) can be regarded as follows: basis weight 48-70 g/m^2, Hunter gloss 25-40%, PPS S10 roughness 2.2-2.8 μm, density 900-950 kg/ m^3, brightness 70-75%, and opacity 91-95%.

[0012] General values for MWC paper (medium weight coated) can be regarded as follows: basis weight 70-90 g/ m^2, Hunter gloss 65-70%, PPS S10 roughness 0.6-1.0 μm, density 1150-1250 kg/ m^3, brightness 70-75%, and opacity 89-94%.

[0013] Wood free paper is divided into two segments: uncoated and coated. Conventionally, the furnish of wood free papers consists of bleached chemical pulp, with less than 10 % mechanical pulp.

[0014] Typical values are for uncoated WFU Copy paper: grammage 70-80 g/m^2, Bendtsen roughness 150-250 ml/min and bulk > 1.3 cm3/g; for uncoated offset paper: grammage 60-240 g/m^2, Bendtsen roughness 100-200 ml/min and bulk 1.2- 1.3 cm3/g; and for color copy paper: grammage 100 g/m^2, Bendtsen roughness < 50 ml/min and bulk 1.1 cm3/g.

[0015] In coated pulp-based printing papers (WFC), the amounts of coating vary widely in accordance with requirements and intended application. The following are typical values for once- and twice-coated, pulp-based printing paper: once-coated basis weight 90 g/ m^2, Hunter gloss 65-80%, PPS s10 roughness 0.75-1.1 μm, brightness 80-88%, and opacity 91-94%, and twice-coated basis weight 130 g/ m^2, Hunter gloss 70-80%, PPS S10 roughness 0.65-0.95 μm, brightness 83-90%, and opacity 95-97%.

[0016] Containerboard includes both linerboard and corrugating medium. Liners are divided according to their furnish base into Kraft liner, recycled liner and white top liner. Liners are typically 1- to 3-ply boards with grammage varying in the range 100-300 g/m^2.

[0017] Linerboards are generally uncoated, but the production of coated white-top liner is increasing to meet higher demands for printability.

[0018] The main cartonboard grades are folding boxboard (FBB), white-lined chipboard (WLC), solid bleached board (SBS) and liquid packaging board (LPB). In general, these grades are typically used for different kinds of packaging of consumer goods. Carton board grades vary from one- up to five-ply boards (150-400 g/m^2). The top side is usually coated with from one to

three layers (20-40 g/m^2); the back side has less coating or no coating at all. There is a wide range of different quality data for the same board grade. FBB has the highest bulk thanks to the mechanical or chemi mechanical pulp used in the middle layer of the base board. The middle layer of WLC consists mainly of recycled fiber, whereas SBS is made from chemical pulp, exclusively.

[0019] FBB's bulk typically is between 1.1-1.9 cm^3/g whereas WLC is on range 1.1-1.6 cm^3/g and SBS 0.95-1.3 cm^3/g. The PPS-s10-smoothess is respectively for FBB between 0.8 - 2.1 μm, for WLC 1.3- 4.5 μm and for SBS 0.7 - 2.1 μm.

[0020] Release paper is used in label base paper in various end-use applications, such as food packaging and office labels. The most common release paper in Europe is supercalendered glassine paper coated with silicone to provide good release properties.

[0021] Typical values for supercalendered release papers are basis weight 60 - 95 g/m^2, caliper 55-79 μm, IGT 12-15 cm, Cobb Unger for dense side 0.9-1.6 g/m^2 and for open side 1.2-2.5 g/m^2.

[0022] Coated label paper is used as face paper for release, but also for coated backing paper and flexible packings. Coated label paper has a grammage of 60-120 g/m^2 and is typically sized or pre-coated with a sizer and single-blade coated on one side.

[0023] Some typical paper properties for coated and calendered label paper are basis weight 50-100 g/m^2, Hunter gloss 70-85%, PPS s10 roughness 0.6-1.0 μm, Bekk smoothness 1500-2000 s and caliper 45-90 μm.

[0024] The fiber webs are produced in a fiber web producing process. As known from the prior art in fiber web producing processes typically comprise an assembly formed by a number of apparatus arranged consecutively in the process line. A typical production and treatment line comprise a head box, a wire section and a press section as well as a subsequent drying section and a reel-up. The production and treatment line can further comprise other devices and/or sections for finishing the fiber web, for example, a pre-calender, a sizer, a final-calender, a coating section. The production and treatment line also typically comprise at least one slitter-winder for forming customer rolls as well as a roll packaging apparatus.

[0025] In production of fiber webs, for example in production of paper or board webs, sizing is used to alter the properties of a fiber web by adding sizing agents, for example starch or other sizing agents. Sizing can be divided to internal sizing and surface sizing. In internal sizing the sizing agent is added to pulp in the wet end of the fiber web machine before forming. In surface sizing the sizing agent is added onto the surface of the fiber web typically at the dry end of the fiber web machine. Surface sizing is used in production of many fiber web grades, for example of uncoated fine papers and of several board grades. Sizing is used in order to improve paper web properties, in particular water resistance, water absorption properties, strength, internal strength, surface strength and bending stiffness, as well as to improve adherence of coating color to the surface of the fiber web. In addition, runnability as well as dusting tendency can be affected favorably.

[0026] An object of the invention is to create a method of treating a fiber web and a treatment system for treatment of a fiber web, in which the above problems and disadvantages are eliminated or at least minimized.

[0027] A particular object of the invention is to create a method and a system to treat the fiber web to improve the surface strength and/or the forming closed fiber web surface.

[0028] A particular object is to create a method and a system to treat the fiber web to improve the strength and/or stiffness of the fiber web.

[0029] To achieve the objects mentioned above and later the method according to the invention is mainly characterized by the features of the characterizing part of the independent method claim.

[0030] The treatment system for treatment of a fiber web according to the invention is mainly characterized by the features of the characterizing part of the independent treatment system claim.

[0031] Advantageous features and embodiments of the invention are defined in the dependent claims.

[0032] According to the invention in the method of treating a fiber web, the fiber web is sized in a sizer, in which the sizing agent is applied onto the fiber web by two hard sizing rolls in a sizing nip, wherein the fiber web is sized with high solids content sizing agent by indirect curtain sizing in a curtain sizer and in the sizing nip at substantially uniform pressure distribution and uniform speed in cross-direction of the fiber web and after the sizing the fiber web is heat-treated in a heat-treatment zone of a heat-treatment device.

[0033] According to the invention in the treatment system for treatment of a fiber web, which system comprises a sizer comprising two hard sizing rolls forming a sizing nip, wherein the system further comprises a heat-treatment device comprising a heat-treatment zone and the sizer is a curtain sizer with indirect application of sizing agent in high solids content and one of the hard sizing rolls is a deflection compensated roll and a substantially straight sizing nip is formed.

[0034] According to one advantageous aspect of the invention the method and the system the fiber web is sized in the curtain sizer and the sizing agent is applied to the fiber web indirectly, i.e. first applying the sizing agent onto a surface of a roll forming a sizing nip, i.e. onto a surface of a sizing roll, and then applying the sizing agent to the fiber web by the sizing roll.

[0035] According to an advantageous feature of the invention the curtain sizer comprises a slot or a slide nozzle.

[0036] According to an advantageous feature of the invention the sizing agent is applied in high solids content, preferably in solids content 10 - 60%, more preferably 20 - 40 %.

[0037] According to an advantageous feature of the invention the fiber web is sized with sizing agent having viscosity of 100 cP (centipoise) or over, preferably 100 cP - 2000 cP, more preferably 100 - 1500 cP.

[0038] According to an advantageous feature of the invention the fiber web is sized with sizing agent comprising fiber suspension.

[0039] According to an advantageous feature of the invention the fiber web is sized with sizing agent comprising natural fibers and/or synthetic fibers. Advantageously, the sizing agent comprises for example pulp and/or cotton and/or nylon and/or polyester and/or aramid fibers.

[0040] According to an advantageous feature of the invention the fiber web is sized with sizing agent comprising fiber suspension with 0,5 % or less fiber consistency.

[0041] The fibers can be nanoscale fibers and/or microscale fibers, advantageously, length of a fiber in the sizing agent is 0,1 μm - 10 mm and width of a fiber in the sizing agent is 0.01 - 30 μm.

[0042] Advantageously, surface tension of the sizing agent is 50 mN/m or less.

[0043] According to an advantageous feature of the invention the fiber web is treated by first adding the high solids sizing agent in the sizer to the fiber web and by thereafter activating the sizing agent by pressure and heat of the heat-treatment in the heat-treatment zone and thus increasing the Young's modulus of at least surface parts of the fiber web. By this the strength of the fiber web, especially the surface strength of the fiber web, is improved as the Young's modulus of at least the surface parts of the fiber web with the heat-treated sizing agent increases due to increased and/or enhanced bonding of fibers. The strength of the fiber web after the heat-treatment is improved 10 - 70%. Advantageously, schematical form of the strength variation in thickness direction of the fiber web corresponds to the form of an I-beam cross section form. Accordingly, also the bending stiffness of the fiber web is improved.

[0044] According to an advantageous feature of the invention the fiber web is treated by first adding the high solids sizing agent comprising fiber suspension in the sizer to the fiber web and by thereafter activating the sizing agent by pressure and heat of the heat-treatment in the heat-treatment zone and thus improving binding of the fiber suspension to the fiber web. Especially, the pressure and the heat of the heat-treatment improves the adherence of the fibers of the fiber suspension of the sizing agent onto the surface of the fiber web and thus a very good surface sized fiber web is achieved for application of coating color or other surface finishing substances onto the fiber web. By this the strength of the fiber web, especially the surface strength of the fiber web, is improved as the Young's modulus of at least the surface parts of the fiber web with the heat-treated sizing agent increases due to increased and/or enhanced bonding of fibers. The strength of the fiber web after the heat-treatment is improved 10 - 70%. Advantageously, schematical form of the strength variation in thickness direction of the fiber web corresponds to the form of an I-beam cross section form.

[0045] According to an advantageous feature of the invention linear load in the sizing nip is 5 - 450 kN/m, more preferably the linear load in the sizing nip is 5 - 200 kN/m.

[0046] According to one aspect of the invention the method and the system the fiber web after the sizing in the curtain sizer the fiber web is heat-treated in a heat-treatment zone, which is advantageously formed between a heated belt loop, in particularly metal belt loop, and a roll, advantageously a hard roll.

[0047] According to one aspect of the invention the method and the system the fiber web after the sizing in the curtain sizer the fiber web is heat-treated in a heat-treatment zone, which is advantageously formed between two belt loops, in particularly metal belt loops, at least one of which is advantageously heated.

[0048] According to an advantageous feature of the invention the length of the heat-treatment zone is 0,2 - 15 m, advantageously 0,2 - 5 m.

[0049] According to an advantageous feature of the invention the surface temperature in the heat-treatment zone is 100 - 250 °C.

[0050] According to an advantageous feature of the invention the pressure in the heat-treatment zone is 0,1 MPa - 30 MPa, advantageously 0,1 - 5 MPa. The pressure comprises at least a low basic pressure in the heat-treatment zone but in addition thereto the pressure during the heat-treatment zone can vary, for example at least one high pressure pulse created by at least one additional roll-nip, a heat-treatment nip, placed at a location in the heat-treatment zone can be used. Also, instead a loading sector formed by a loading element located in the heat-treatment zone can be used to variate the pressure in the heat-treatment zone.

[0051] According to an advantageous feature of the invention the dwell time of the fiber web in the heat-treatment zone is at least 20 ms, advantageously 100 - 10 000 ms.

[0052] According to the invention in the treatment system one of the hard sizing rolls is a deflection compensated roll by which the pressure distribution and speed of the sizing nip can be adjusted in cross-direction of the fiber web and thus substantially uniform speed and uniform pressure distribution in the sizing nip in cross-direction of the fiber web is achieved.

[0053] According to the invention the sizing nip is formed between two hard rolls. Advantageously as the hard roll is used a roll produced of hard material or provided with a hard coating or cover. Advantageously, as the hard roll is used a ceramic or metallic roll or advantageously, a roll with a hard-polymeric roll cover (rubber, polyurethane or composite) having surface hardness 60 - 100 shoreD, advantageously 80 - 95 shoreD. The hard nip enhances the strength increase.

[0054] According to an advantageous feature of the invention in the sizing nip of the sizer and thus during the sizing the run of the fiber web is substantially vertical.

[0055] According to the invention in the treatment system the sizing nip is formed between two hard rolls, one of which is a deflection compensated roll and due to the effect provided by the deflection compensated roll the sizing nip is substantially straight, by which the runnability of the fiber web is improved.

[0056] According to one in particularly advantageous aspect of the invention the method and the system in accordance with the invention are used in production of a fiber web for folding box board or liner fiber web grade.

[0057] According to one aspect of invention the system in accordance with the invention are to be by configurating an existing fiber web production line, for example by adding the system to a fiber production line without a sizing section at a location after the drying section, as the sizing section with the heat-treatment zone or by amending an existing sizing section to be in accordance with the treatment system comprising the hard nip sizer with high solids sizing agent and the heat-treatment zone in accordance with the invention.

[0058] In the method and in the system according to the invention either one or both sides of the fiber web are treated.

[0059] The method and the system according to an advantageous aspect of the invention are also well applicable in sizing with two-component sizing agent as in this type of curtain sizing there is no return circulation of sizing substance. In other types of sizing methods and systems with return circulation the two-component sizing agent may harden in the return circulation and thus cause problems in the return circulation.

[0060] The method and the system according to an advantageous aspect of the invention also sizing agents with platy particle shaped substance suspensions, for example kaolin, can be used as in curtain sizing no metering rods are needed for applicating the sizing substance. In types of sizing methods and systems, where metering rods are used, grooves of the metering rods would block if platy particle shaped substance suspensions would be used.

[0061] Thus, the sizing agent can also comprise two-component sizing agent, for example lignin with acidic activator, and/or polymers, for example polyethene and/or polypropylene, and/or mineral fillers and/or particles, for example kaolin in platy particle shape. Also, sizing agents comprising cross-linking substances can be used.

[0062] By the invention and its advantageous aspects and features many advantages are achieved, in particular the strength, especially the surface strength, of the fiber web is significantly improved. Additionally, the fiber web with high solids content sizing agent, advantageously with fiber suspension, has a stiff structure as the sizing agent tends to remain more in the surface parts of the fiber web and the surface pores close and thus need of calendering is decreased. Additionally, the fiber web sized with sizing agent comprising according to the advantageous feature of the invention fiber suspension improves the adherence of coating color to the surface of the fiber web. Further, sizing in the nip between two hard sizing rolls does not roughen the surface smoothness of the fiber web as is typical when the sizing nip has a soft sizing roll but instead the surface smoothness increases.

[0063] Even though in the method and treatment system in accordance with the invention sizing is conducted in a hard sizing nip i.e. in a nip formed between hard sizing rolls, one skilled in the art understand that the inventive idea and its features are also applicable, when a soft sizing nip is used i.e. the sizing nip has at least one soft sizing roll.

[0064] In the following the invention is further explained in detail with reference to the accompanying drawing in which:

In figures 1-6 is very schematically shown examples of the treatment system according to the invention.

[0065] In the following description same reference signs designate for respective components etc. unless otherwise mentioned and it should be understood that the examples are susceptible of modification in order to adapt to different usages and conditions.

[0066] In the examples of figures 1-6 is very schematically shown examples of the treatment system in accordance with the invention. In these advantageous examples the fiber web running in direction S substantially upwards is sized in a curtain sizer 10 comprising a sizing nip N formed between two hard sizing rolls 11, 12 with high solids content sizing agent, comprising advantageously fiber suspension, preferably 10-60 % solids content, more preferably 20 - 40 % solids content. Viscosity of the sizing agent is 100 cP or over, preferably 100 cP - 2000 cP, more preferably 100 cP - 1500 cP and surface tension of the sizing agent is advantageously 50 mN/m, One of the hard sizing rolls 11;12 is a deflection compensated roll and thus a straight sizing nip is be formed. The sizing rolls 11,12 are hard rolls. Advantageously, as the hard roll is used a ceramic or metallic roll or advantageously with a hard-polymeric roll cover (rubber, polyurethane or composite) having surface hardness 60 - 100 shoreD, advantageously 80 - 95 shoreD. Advantageously, linear load in the sizing nip is 5 - 450 kN/m, more preferably the linear load in the sizing nip is 5 - 200 kN/m. A curtain device 14, 15 is located in connection for each sizing roll 11, 12 for applying sizing agent T onto the surface of the sizing roll 11,12 and the fiber web W is sized by indirect sizing. The sizing agent T is then via the surface of the sizing roll 11, 12 guided onto the surfaces of the fiber web W such that in the sizing nip N the sizing agent is pressed to the fiber web surfaces. After the sizing in the curtain sizer 10 the fiber web W has a short run and via a guide roll 13 is guided to a heat-treatment zone Z of a heat-treatment device 20, where the fiber web W is heat-treated. The heat-treatment zone Z is formed between a belt run of a belt-loop 21 and a roll 22 or between a belt-

run of a belt-loop 21 and another belt-run of another belt-loop 24. The length of the heat-treatment zone Z is 0,2 - 15 m, advantageously 0,2 - 5 m, and the surface temperature in the heat-treatment zone is 100 - 250 °C and the pressure in the heat-treatment zone is 0,1 MPa - 30 MPa, advantageously 0,1 - 5 MPa. The dwell time of the fiber web in the heat-treatment zone Z is at least 20 ms, advantageously 100 - 10 000 ms.

[0067] In the example of figure 1 the heat-treatment device 20 comprises a belt-loop 21 running and supported by guide rolls 25 and a roll 22 and the heat-treatment zone Z is formed between the run of the belt-loop 21 and the roll 22 on the run of the belt 21 on the roll 22. The fiber web W is guided to run between the belt 21 and the roll 22. Additionally, a heat-treatment nip NZ is formed between the roll 22 and another roll 23 to further press the fiber web W in the heat-treatment zone. In the heat-treatment zone Z the belt 21 is heated.

[0068] In the example of figure 2 the heat-treatment device 20 comprises two belt-loops 21, 24 running and supported by guide rolls 25, 26 and the heat-treatment zone Z is formed between the runs of the belt-loops 21, 24. The fiber web W is guided to run between the belts 21, 24. In the heat-treatment zone Z at least one of the belts 21 is heated.

[0069] In the example of figure 3 the heat-treatment device 20 comprises a belt-loop 21 running and supported by guide rolls 25 and a roll 22 and the heat-treatment zone Z is formed between the run of the belt-loop 21 and the roll 22 on the run of the belt 21 on the roll 22. The fiber web W is guided to run between the belt 21 and the roll 22. Additionally, heat-treatment nips NZ are formed between the roll 22 and the guide rolls 25 to further press the fiber web W during its run in the heat-treatment zone. In the heat-treatment zone Z the belt 21 is heated.

[0070] In the example of figure 4 the heat-treatment device 20 comprises a belt-loop 21 running and supported by guide rolls 25 and a roll 22 and the heat-treatment zone Z is formed between the run of the belt-loop 21 and the roll 22 on the run of the belt 21 on the roll 22. The fiber web W is guided to run between the belt 21 and the roll 22. Additionally, a heat-treatment nip NZ is formed between the roll 22 and the guide rolls 25 to further press the fiber web W during its run in the heat-treatment zone. In the heat-treatment zone Z the belt 21 is heated.

[0071] In the example of figure 5 the heat-treatment device 20 comprises a belt-loop 21 running and supported by guide rolls 25 and a roll 22 and the heat-treatment zone Z is formed between the run of the belt-loop 21 and the roll 22 on the run of the belt 21 on the roll 22. The fiber web W is guided to run between the belt 21 and the roll 22. In the heat-treatment zone Z the belt 21 is heated.

[0072] In the example of figure 6 the heat-treatment device 20 comprises a belt-loop 21 running and supported by guide rolls 25 and a roll 22 and the heat-treatment zone Z is formed between the run of the belt-loop 21 and the roll 22 on the run of the belt 21 on the roll 22. The fiber web W is guided to run between the belt 21 and the roll 22. Additionally, a loading element 29 is located in the heat-treatment zone Z to further press in a loading sector LS the fiber web W during its run in the heat-treatment zone. In the heat-treatment zone Z the belt 21 is heated.

[0073] In the description in the foregoing, although some functions and elements have been described with reference to certain features, those functions and elements may be performable by other features whether described or not. Although features have been described with reference to certain embodiments or examples, those features may also be present in other embodiments or examples whether described or not. Above the invention has been described by referring to some advantageous examples only, to which the invention is not to be narrowly limited. Many modifications and alterations are possible within the inventive idea.

[0074] Reference signs used in the drawing:

10 sizer
11 sizing roll
12 sizing roll
13 guide roll
14 curtain sizer
15 curtain sizer
20 heat-treatment device
21, 24 belt loop
22 roll
25, 26 guide roll
29 loading element
LS loading sector
N size nip
NZ heat-treatment nip
S running direction of the fiber web
T sizing agent
W fiber web
Z heat-treatment zone

Claims

1. Method of treating a fiber web, in which method the fiber web is sized in a sizer (10), in which the sizing agent (T) is applied onto the fiber web by two hard sizing rolls (11,12) in a sizing nip (N), **characterized in that** the fiber web (W) is sized with high solids content sizing agent (T)by indirect curtain sizing in a curtain sizer (10) and in the sizing nip (N) at substantially uniform pressure distribution and uniform speed in cross-direction of the fiber web (W), and that after the sizing the fiber web (W) is heat-treated in a heat-treatment zone (Z) of a heat-treatment device (20).

2. Method according to claim 1, **characterized in that** in the method the fiber web (W) is sized with high solids sizing agent (T) having solids content of 10 - 60 %, preferably 20 - 40 %.

3. Method according to claim 1 or 2, **characterized in that** in the method the fiber web (W) is sized with sizing agent (T) having viscosity of 100 cP or over, preferably 100 cP- 2000 cP, more preferably 100 cP - 1500 cP.

4. Method according to any of claims 1 - 3, **characterized in that** in the method the fiber web (W) is sized with sizing agent (T) comprising fiber suspension, advantageously natural fibers and/or synthetic fibers and that in the method the fiber web (W) is sized with sizing agent (T) comprising fiber suspension with 0,5% or less fiber consistency.

5. Method according to any of claims 1 - 4, **characterized in that** in the method the sizing agent (T) is activated by pressure and heat in the heat-treatment zone (Z) for increasing Young's modulus of at least surface parts of the fiber web (W).

6. Method according to any claims 1 - 5, **characterized in that** in the heat-treatment zone (Z) the fiber web (W) is pressed by a pressure of 0,1 MPa - 30 MPa, advantageously of 0,1 - 5 MPa and that in the heat-treatment zone (Z) the surface temperature is 100 - 250 °C.

7. Method according to any of claims 1 - 6, **characterized in that** dwell time of the fiber web (W) in the heat-treatment zone (Z) is at least 20 ms, advantageously 100 - 10 000 ms.

8. Method according to any of claims 1 - 7, **characterized in that** in the heat-treatment zone (Z) the fiber web (W) is further pressed in at least one heat-treatment nip (NZ) or in at least one loading sector (LS).

9. Treatment system for treatment of a fiber web, which system comprises a sizer (10) comprising two hard sizing rolls (11,12) forming a sizing nip (N), **characterized in that** the system further comprises a heat-treatment device (20) comprising a heat-treatment zone (Z), that the sizer is a curtain sizer (10) with indirect application of sizing agent (T) in high solids content and that one of the hard sizing rolls (11;12) is a deflection compensated roll and a substantially straight sizing nip (N) is formed.

10. Treatment system according to claim 9, **characterized in that** the heat-treatment device (20) comprises at least one belt-loop (21), advantageously a heated belt-loop, supported by guide rolls (25), and a roll (22), between of which at least one belt-loop (21) and roll (22) the heat-treatment zone (Z) of the heat-treatment device (20) is formed.

11. Treatment system according to any of claim 9 or 10, **characterized in that** the heat-treatment device (20) comprises two belt-loops (21, 24) supported by guide rolls (25, 26), between or which belt-loops (21, 24) the heat-treatment zone (Z) is formed.

12. Treatment system according to any of claims 9 - 11, **characterized in that** the heat-treatment zone (Z) comprises at least one heat-treatment nip (NZ) or at least one loading sector (LS).

13. Treatment system according to any of claims 9 - 12, **characterized in that** length of the heat-treatment zone (Z) is 0,2 - 15 m, advantageously 0,2 - 5 m.

14. Treatment system according to any of claims 9 - 13, **characterized in that** surface temperature in the heat-treatment zone is 100 - 250 °C.

15. Treatment system according to any of claims 9 - 14, **characterized in that** pressure in the heat-treatment zone is 0,1 MPa - 30 MPa, advantageously of 0,1 - 5 MPa.

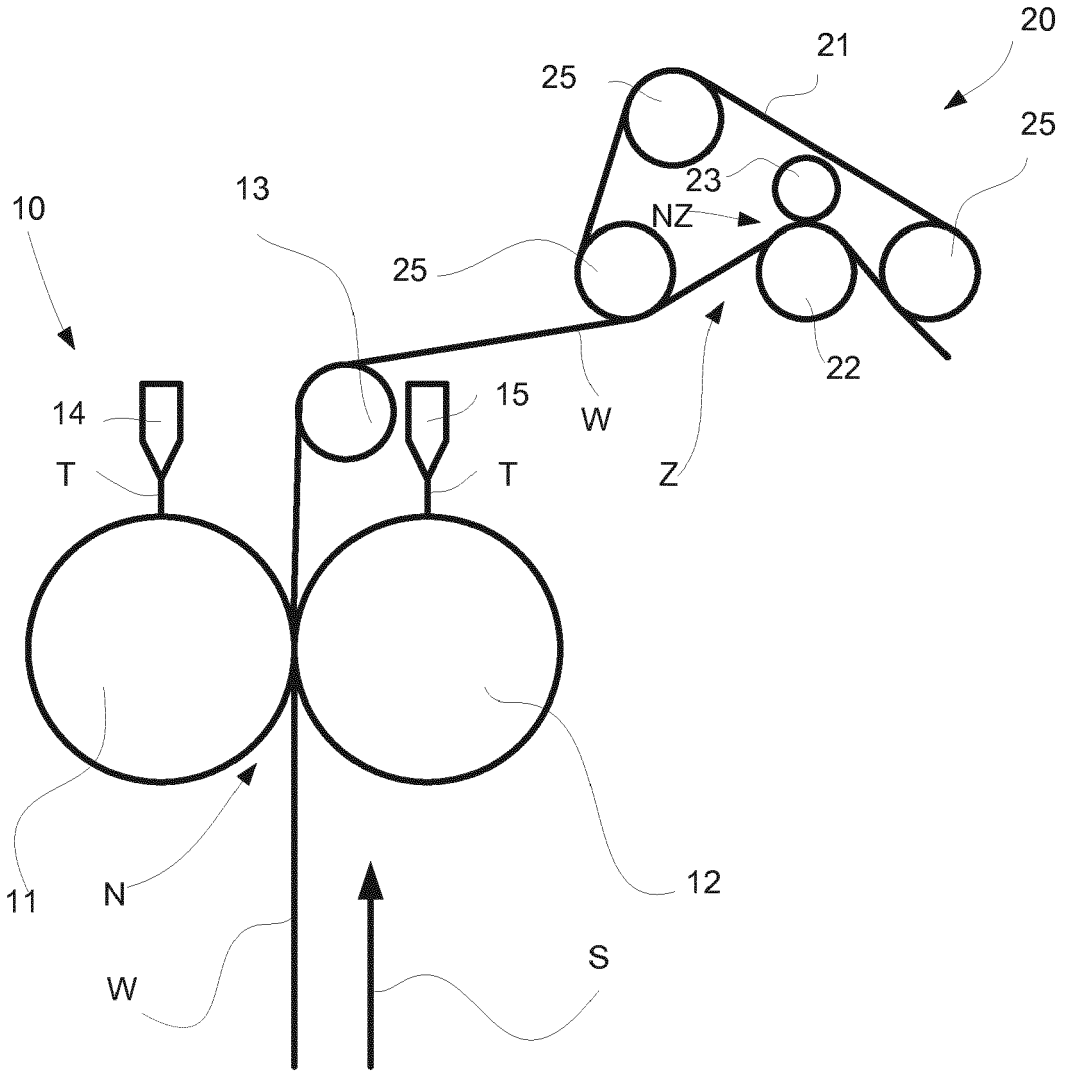

Fig. 1

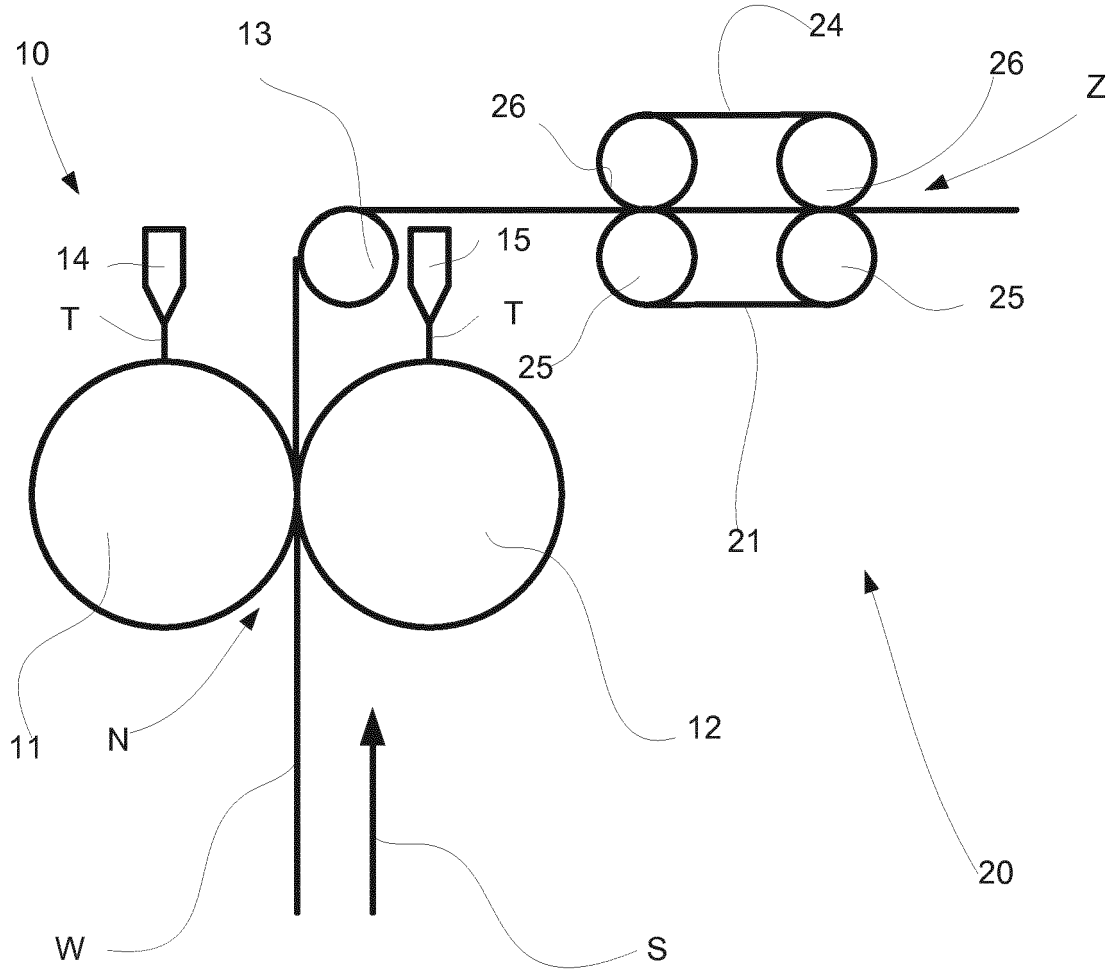

Fig. 2

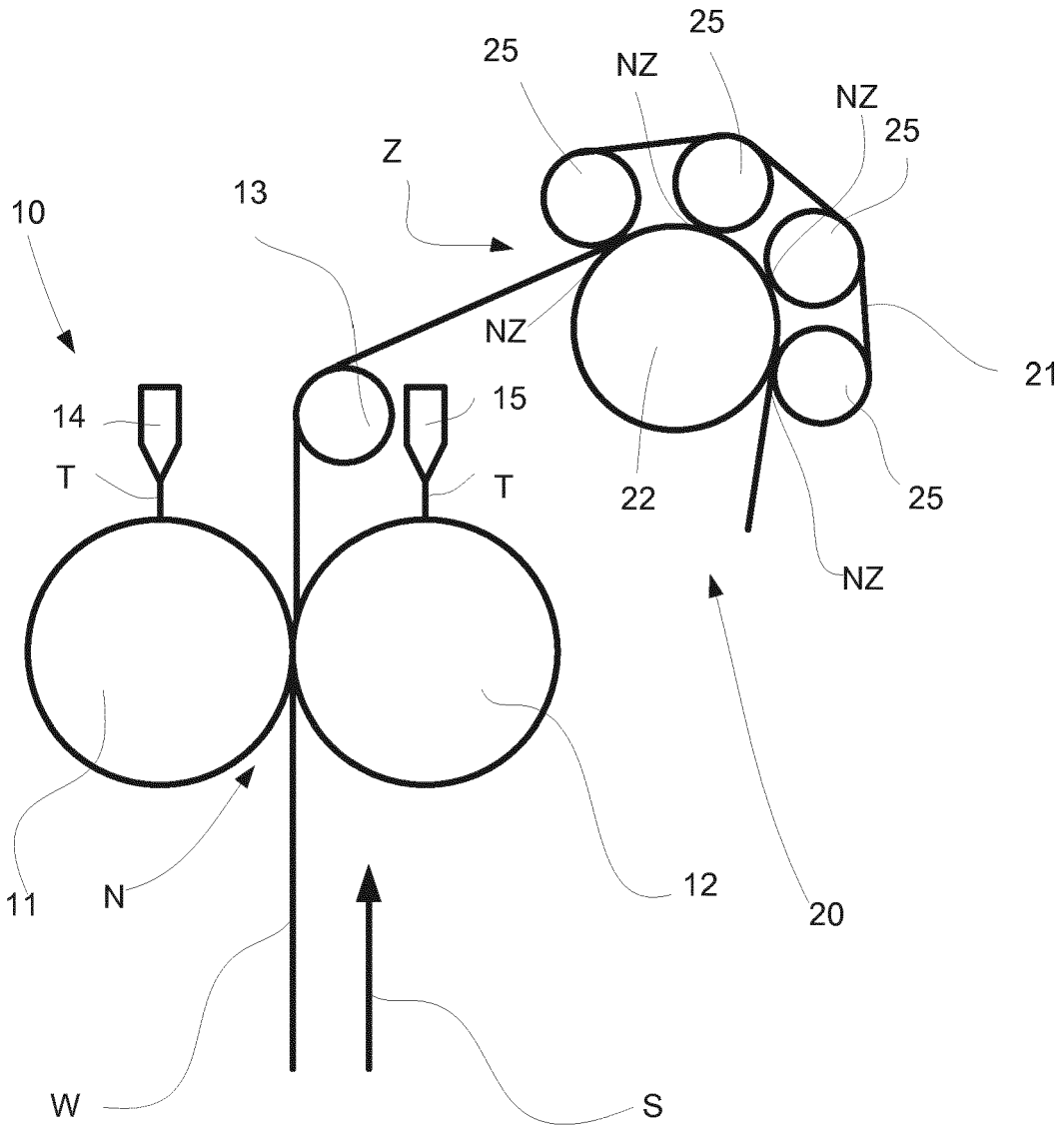

Fig. 3

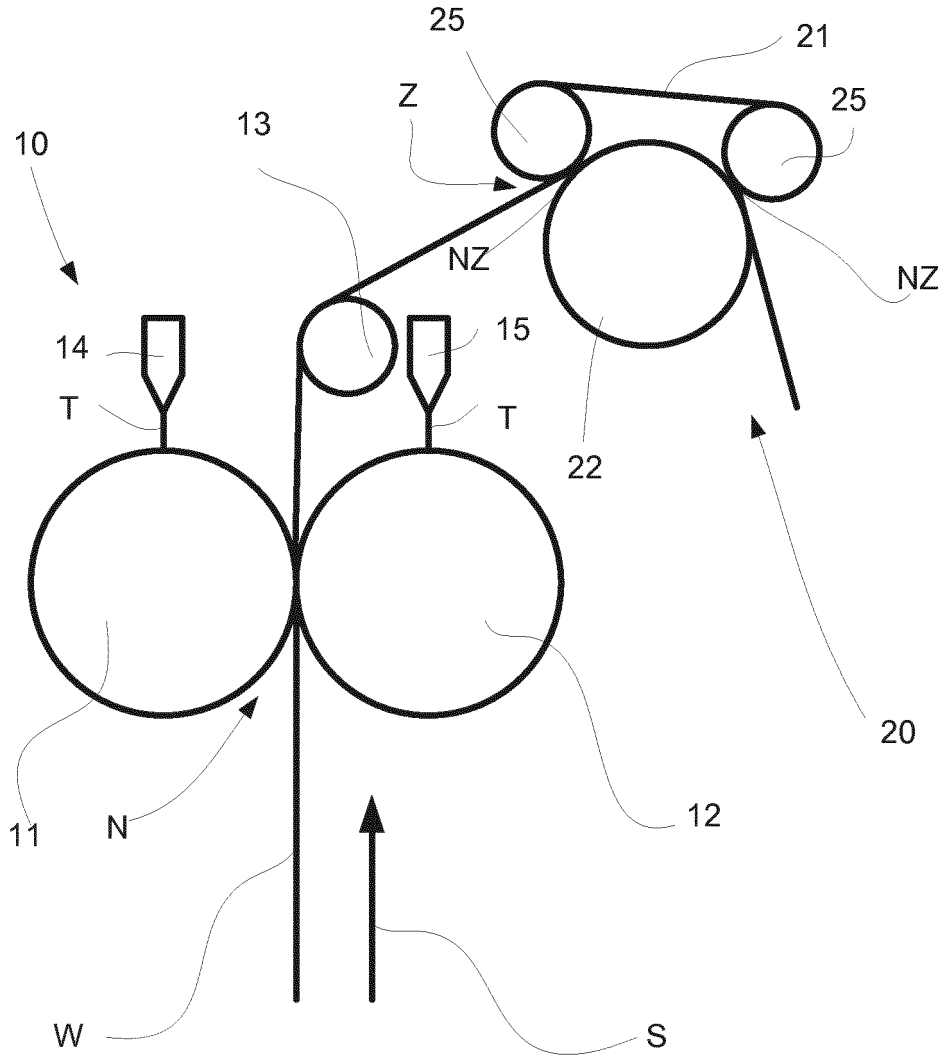

Fig. 4

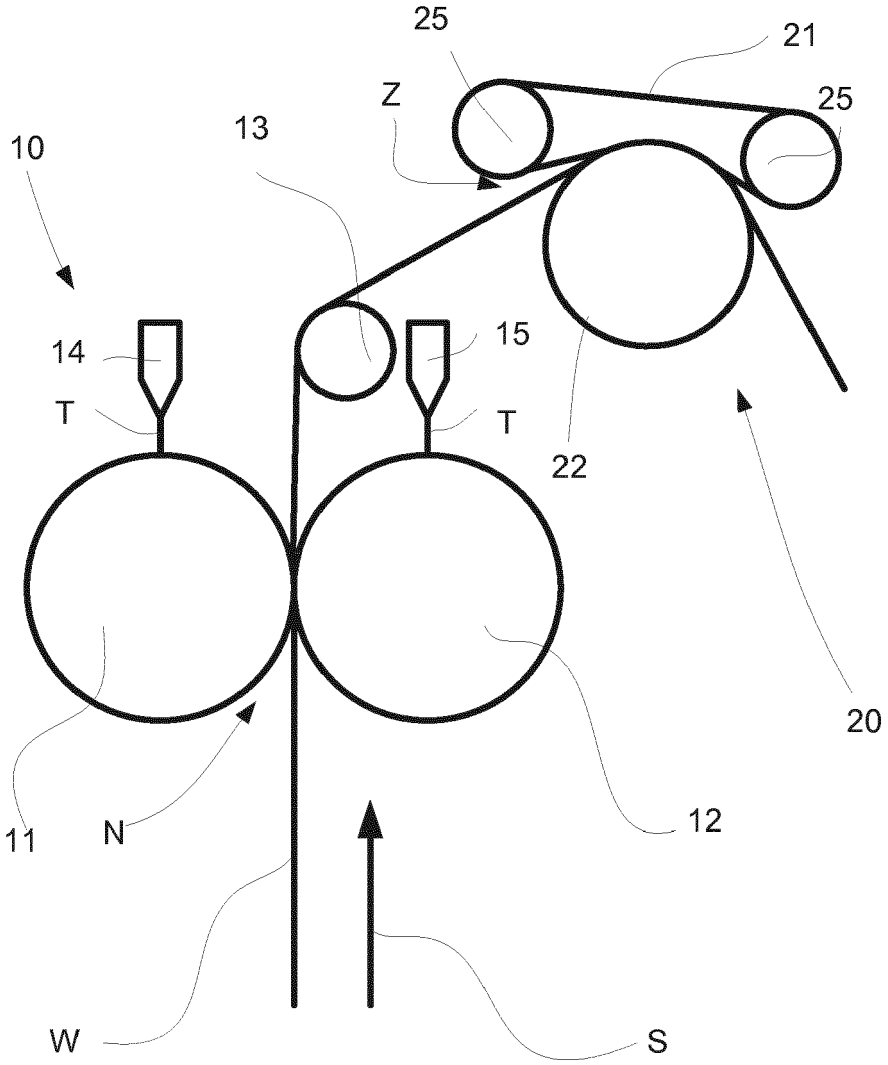

Fig. 5

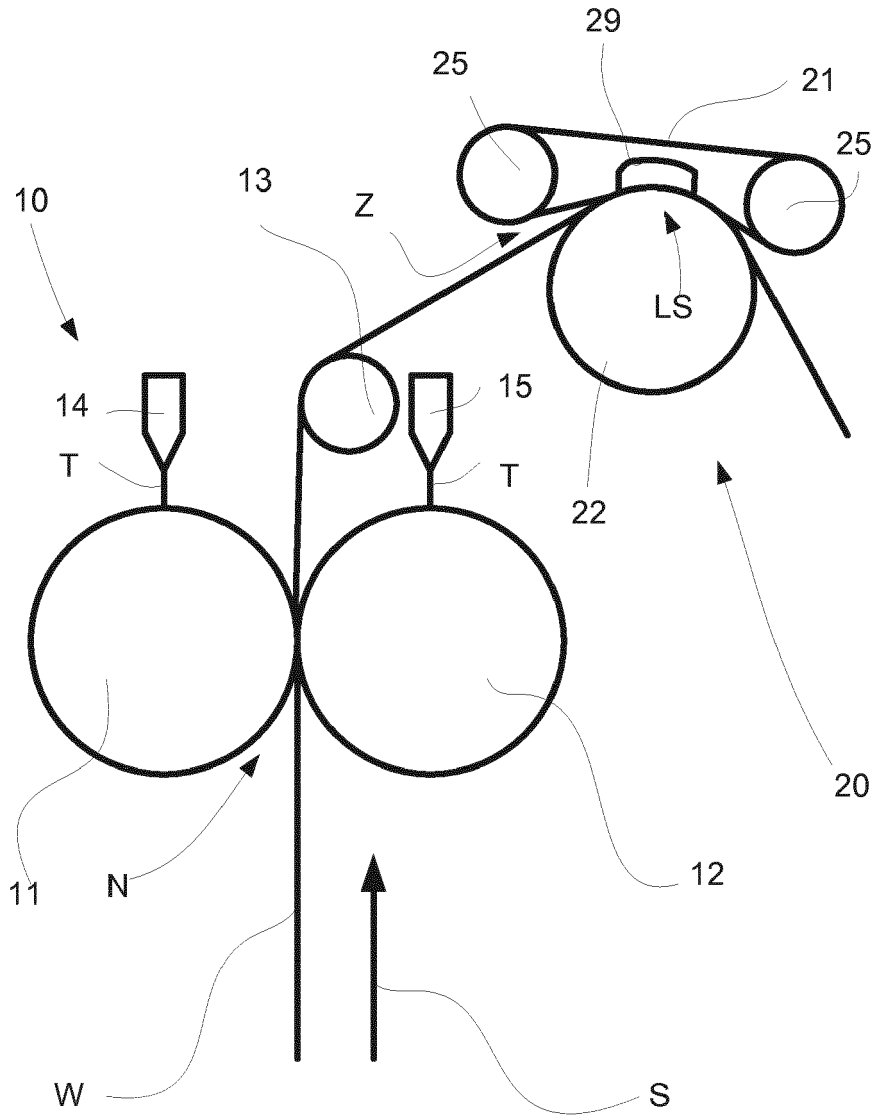

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 19 18 4856

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 100 12 344 A1 (VOITH PAPER PATENT GMBH [DE]) 20 September 2001 (2001-09-20) * paragraphs [0055] - [0057]; figure 6 * -----	1-15	INV. D21H23/48 D21H23/62 D21H25/06
X	US 5 378 497 A (JOHNSON DEAN R [US] ET AL) 3 January 1995 (1995-01-03) * column 4, line 61 - column 5, line 26 * * figure 1 * * claims 11,12,14 * -----	1-15	D21H23/32 D21H23/42 B05C1/08 B05C3/12 B05D1/30
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TECHNICAL FIELDS SEARCHED (IPC)

D21H
B05C
B05D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2019	Ponsaud, Philippe

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18-09-2019

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