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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 (W) is treated in a treatment system (10), in particular coated by curtain coating or sized by curtain sizing, which treatment system (10) comprises at least one curtain application device (20) and two treatment rolls (30) between of which treatment rolls (30) a treatment nip (N) is formed, in which method at least one curtain (C) of a treatment substance is provided by the application device (20). In the method an application device (20), which comprises a distribution chamber (21), at least one feed opening (20F), at least one flow-through (20FT) and a lip opening (24), is used to provide the curtain (C) of the treatment substance and in the method profile of the applied treatment substance in cross direction of the fiber web (W) i.e. in longitudinal direction of the application device (20) is controlled by at least one means configured to adjust flow of the treatment substance in the distribution chamber (21). The invention also relates to a treatment system for treatment of a fiber web (W), in particular a coating system for curtain coating or a sizing system for curtain sizing, which treatment system (10) comprises at least one curtain application device (20) and two treatment rolls (30) between of which treatment rolls (30) a treatment nip (N) is formed. The application device (20) comprises a distribution chamber (21),

at least one feed opening (20F), at least one flow-through (20FT) and a lip opening (24) and the treatment system (10) further comprises at least one means configured to adjust flow of the treatment substance in the distribution chamber (21) to control the profile of the treatment substance applied in cross direction of the fiber web (W) i.e. in longitudinal direction of the application device (20).

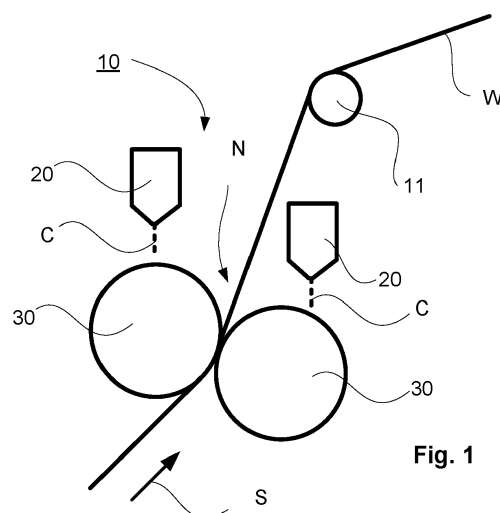


Fig. 1

Description

Technical field

[0001] In general, the present invention relates to treating of fiber webs in a fiber web production line, in particular, the present invention relates to a curtain sizing or coating method and to a curtain sizing or coating method device. 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.

Background

[0002] 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/m² and boards manufactured in multi-ply technology and having a basis weight of 150-600 g/m². 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.

[0003] 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 comprises 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 comprises at least one slitter-winder for forming customer rolls as well as a roll packaging apparatus.

[0004] 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 is used in order to improve paper web properties, in particular water resistance, water absorption properties, strength, internal strength and bending stiffness. In addition, runnability as well as dusting tendency can be affected favorably. 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, typically passing the fiber web through a sizing nip formed between two sizing rolls.

[0005] In production of fiber webs, for example in production of paper or board webs, in coating, especially in pigment coating, onto surface of the fiber web is formed

a layer of coating color at a coating station (a coater) typically followed by drying. The formation of a coating color can be divided in supplying the coating color onto the web surface, which is called the application of the coating color, as well as in the adjustment of final amount of coating color.

[0006] One important recently developed sizing and coating technique is curtain application, i.e. curtain sizing and/or curtain coating, which is suitable to size or to coat fiber webs, such as paper and board webs. By curtain sizing or coating good coverage of sizing agents or coating color on the fiber web surface to be sized or coated is achieved.

[0007] The present invention relates to treatment of the fiber web by curtain sizing and/or curtain coating.

[0008] In curtain sizing or coating two main types of curtain sizing or coating devices, curtain application devices, are used, namely curtain sizing or coating devices with slot-fed and curtain sizing or coating devices with slide-fed. In the slide fed curtain sizing or coating devices, sizing agents or coating color is fed by means of a nozzle assembly onto an inclined plane and the sizing agents or coating color flows down towards an edge of the plane constituting a nozzle lip and the curtain is formed as the sizing agents or coating color falls off the nozzle lip onto the web. In the slot-fed curtain sizing or coating devices sizing agents or coating color is pumped through a distribution chamber into a narrow vertical slot and the curtain is formed at its lip and falls onto the web.

[0009] The treatment substance is fed to the distribution chamber through a feed opening, which is typically located in the middle of the distribution chamber in respect of the longitudinal direction of the distribution chamber or at one of longitudinal ends of the distribution chamber. From the distribution chamber the treatment substance is applied through openings of the nozzle assembly in the slot-fed application or through the narrow vertical slot in longitudinal direction of the distribution chamber in the slide-fed application.

[0010] In the curtain application often occurs that distribution of the applied treatment substance on the fiber web in the longitudinal direction of the distribution chamber, i.e. in cross-direction of the fiber web i.e. in perpendicular direction in respect of the main running direction of the fiber web is at least partially inclined, for example inclined from the feed opening towards the end/ends of the distribution i.e. towards the edges of the fiber web or vice versa. In arrangements known from prior art with the feed opening at the middle of the distribution chamber this has been tried to solve by feeding more treatment substance and via several feed openings. In arrangements known from prior art with the feed opening at one of the ends of the distribution chamber inclination of the profile has been tried to decrease by making the slot opening of the distribution chamber narrower and/or longer (higher) in flow direction of the curtain but this leads to expensive, difficult to clean and easily clogging slot opening. Additionally, these solutions are typically

suitable for improving the situation only for one certain treatment substance and for treatment substances with substantially same properties.

[0011] Sizing agents or coating color can be applied in one or more curtain layers. The sizing or the coating can be direct sizing, in which the treatment substance (the sizing agent or the coating color) is directly applied onto the surface of the fiber web before the treatment nip, or indirect sizing or coating in which the treatment substance at first is applied onto a surface of a roll or like moving surface, via which the sizing agent or the coating color is transferred onto the surface of the fiber web in the treatment nip.

[0012] Typically, two different methods are used to control width of the curtain and the edges of the curtain. One is to feed the curtain wider than width of the fiber web to be coated/sized and then the width is allowed freely narrow in cross direction of the web as the curtain falls downwards towards the fiber web. This method is called as out-board method. The other, called as in-board method, is to feed the curtain narrower than the width of the fiber web to be coated, and the width is required to maintain uniform as the curtain falls downwards towards the fiber web. The curtain is maintained at required width by means of edge guides which are located along each edge of the feeding slot / the nozzle lip.

[0013] One disadvantage in connection with treatment systems known from prior art is that the treatment system is suitable for only one kind of treatment substance or for treatment substances with substantially same properties, especially in respect of the viscosity and surface tension of the treatment substance, or for a narrow flow range. Thus, in case a treatment substance is to be changed for a different type of treatment substance or to treatment substance with substantially different properties the whole treatment system is needed to be replaced.

Summary

[0014] 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 particular a curtain sizing or coating method and device, in which the disadvantages of the prior art are eliminated or at least minimized.

[0015] A particular object is to create a method of treating a fiber web and a treatment system for treatment of a fiber web, in particular a curtain sizing or coating method and device, in which the disadvantages and problems relating to the at least partially inclined cross-directional application profile of the treatment substance in the curtain application, explained above, are eliminated or at least minimized.

[0016] A particular, non-binding 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 particular a curtain sizing or coating method and device, in which the disadvantages and problems relating to the control of edges of the treatment substance curtain in the curtain

application, explained above, are eliminated or at least minimized.

[0017] A particular, non-binding object of the invention a method of treating a fiber web and a treatment system for treatment of a fiber web, in particular a curtain sizing or coating method and device, which is suitable for different types of treatment substances or for treatment substances with substantially different properties without need to replace the whole system.

[0018] To achieve the objects mentioned above and those that will be discussed later the method according to the invention is mainly characterized by the features of the characterizing part of the independent method claim. The treatment system according to the invention, in turn, is mainly characterized by the features of the characterizing part of the independent treatment system claim.

[0019] Advantageous features and embodiments of the invention are defined in the dependent claims.

[0020] According to the invention in the method of treating a fiber web, in which method the fiber web is treated in a treatment system, in particular coated by curtain coating or sized by curtain sizing, which treatment system comprises at least one curtain application device and two treatment rolls between of which treatment rolls a treatment nip is formed, at least one curtain of a treatment substance is provided by the application device, wherein the method the application device, which comprises a distribution chamber, at least one feed opening at least one flow-through and a lip opening, is used to provide the curtain of the treatment substance and in the method profile of the applied treatment substance in cross direction of the fiber web i.e. in longitudinal direction of the application device is controlled by at least one means configured to adjust flow of the treatment substance in the distribution chamber.

[0021] According to an advantageous feature of the method in accordance with the invention in the method the means adjust flow of the treatment substance in the distribution chamber to control the profile of the applied treatment substance in cross direction of the fiber web i.e. in longitudinal direction of the application device without altering outer shape of the distribution chamber. Thus, the walls or wall structure of the distribution chamber are not altered.

[0022] According to an advantageous feature of the method in accordance with the invention the means configured to adjust flow of the treatment substance in the distribution chamber can be configured to form a by-pass flow and/or the means configured to adjust flow of the treatment substance in the distribution chamber can be formed of replaceable elements which are changed to the application device for adjusting the flow of the treatment substance.

[0023] According to an advantageous feature of the method in accordance with the invention the profile is controlled by adjusting at least one by-pass flow in at least one by-pass line, which is connected to a feed line

connected to one of the feed openings and to one of the flow-throughs.

[0024] According to an advantageous feature of the method in accordance with the invention the profile is controlled by adjusting the lip opening shape formed between two lip elements of the application device by changing to the application device a lip element/-s dimensioned such, that a desired lip opening shape is provided.

[0025] According to an advantageous feature of the method in accordance with the invention the treatment substance is applied to both sides of the fiber web, the curtain application devices are provided for the treatment rolls for respective sides of the fiber web such that their respective ends in view of the location of the feed opening/-s are at opposite cross-directional edges of the fiber web.

[0026] According to an advantageous feature of the method in accordance with the invention the treatment substance is applied indirectly via the treatment rolls to the fiber web.

[0027] According to an advantageous feature of the method in accordance with the invention the profile is controlled by adjusting the flow of the treatment substance in a distribution chamber of the curtain application device by a replaceable insert to be placed in the distribution chamber by altering its inner dimensions and inner form by the replaceable insert.

[0028] According to an advantageous feature of the method in accordance with the invention the method is used for applying different treatment substances and/or treatment substances with substantially different properties.

[0029] According to the invention the treatment substance system the treatment system for treatment of a fiber web, in particular a coating system for curtain coating or a sizing system for curtain sizing, comprises at least one curtain application device and two treatment rolls between of which treatment rolls a treatment nip is formed, wherein the application device comprises a distribution chamber, at least one feed opening, at least one flow-through and a lip opening and the treatment system further comprises at least one means configured to adjust flow of the treatment substance in the distribution chamber to control the profile of the treatment substance applied in cross direction of the fiber web i.e. in longitudinal direction of the application device.

[0030] According to an advantageous feature of the treatment system in accordance with the invention the means configured to adjust flow of the treatment substance in the distribution chamber to control the profile of the applied treatment substance in cross direction of the fiber web i.e. in longitudinal direction of the application device is/are configured to adjust the flow of the treatment substance in the distribution chamber without altering outer shape of the distribution chamber.

[0031] According to an advantageous feature of the treatment system in accordance with the invention the

means configured to adjust flow of the treatment substance in the distribution chamber can be configured to form a by-pass flow and/or the means configured to adjust flow of the treatment substance in the distribution chamber can be formed of replaceable elements which are changed to the application device for adjusting the flow of the treatment substance.

[0032] According to an advantageous feature of the treatment system in accordance with the invention the treatment system comprises at least one by-pass line, which is connected to a feed line connected to one of the feed openings and to one of the flow-throughs, a control means in the by-pass line and the profile of the applied treatment substance is configured to be controlled by adjusting the by-pass flow in the by-pass line by the control means.

[0033] According to an advantageous feature of the treatment system in accordance with the invention in the treatment system the lip opening is formed between lip elements, at least one of the lip elements is replaceable and the profile is controlled by adjusting the lip opening shape formed between the lip elements of the application device by changing to the application device a lip element/-s dimensioned such, that a desired lip opening shape is provided.

[0034] According to an advantageous feature of the treatment system in accordance with the invention the treatment system comprises two curtain application devices, one for each of the treatment rolls for respective sides of the fiber web and the application devices are located such that their respective ends in view of the location of the feed opening/-s are at opposite cross-directional sides of the fiber web.

[0035] According to an advantageous feature of the treatment system in accordance with the invention the treatment system comprises a replaceable insert to be placed in the distribution chamber to alter its inner dimensions and inner shape .

[0036] According to an advantageous feature of the treatment system in accordance with the invention the treatment system is configured to be utilized for different treatment substances and/or for treatment substances with substantially different properties. By the invention and its advantageous features and aspect many advantages and benefits are achieved: One of the most important advantage is that the invention provides for the same treatment system and its curtain application device to be used for different types of treatment substances, such as sizing agents, coating colors, pigmented sizing agents, micro fibrillated cellulose substances, chemical substances etc., and for treatment substances with different properties, for example viscosity in the range of 30-1000 mPa s, advantageously 50-400 mPa-s (Brookfield viscosity, 100 rpm), surface tension in the range of 20-70 mN/m, due to the configuration of cross-directional profile adjustment of the treatment substance to be applied. Also importantly, the cross-directional inclination of the profile of the applied treatment substance can be

eliminated or at least minimized and thus, an even cross-directional profile of the applied treatment substance is achieved.

[0037] According to an advantageous aspect of the invention the curtain application device has a feed opening for the treatment substance only at one end of the distribution chamber of the curtain application device. By this a simpler, cost effective, maintenance friendly and robust curtain application device is achieved. In order to avoid the disadvantage known from corresponding solutions of prior art i.e. to avoid the at least partially inclined profile of the applied treatment substance in the cross-direction of the fiber web, which profile is for example decreasing from the end of the feed of the distribution chamber towards the other end i.e. the end of the flow-through or vice versa, the treatment system comprises an adjustable by-pass flow from the flow-through to the feed line and by adjusting the by-pass flow the flow in the distribution chamber is controlled such that the profile of the applied treatment substance is as desired, advantageously even. The by-pass flow is provided with control means to adjust the flow of the by-pass flow. At the minimum the by-pass flow is 0%, when all treatment substance fed to the curtain application device to its distribution chamber is fed to the fiber web. At maximum the by-pass flow is 90% of the total amount of the treatment substance fed to the curtain application device. Advantageously, the by-pass flow is 0%-60% of the total amount of the treatment substance fed to the curtain application device.

[0038] According to an advantageous aspect of the invention the curtain application device has a feed opening for the treatment substance only at one end of the distribution chamber of the curtain application device. By this a simpler, cost effective, maintenance friendly and robust curtain application device is achieved. In order to avoid the disadvantage known from corresponding solutions of prior art i.e. to avoid the at least partially inclined profile of the applied treatment substance in the cross-direction of the fiber web, which profile is for example decreasing from the end of the feed of the distribution chamber towards the other end i.e. the end of the flow-through or vice versa, in treatment systems, where the treatment substance is applied to both sides of the fiber web, the curtain application devices are provided for the treatment substance for the respective sides of the fiber web such that their feed ends are at opposite cross-directional sides of the fiber web. Thus, the possible inclination of the applied layers on the opposite sides of the fiber web compensate each other and the cross-directional profile of the applied treatment substance in total is substantially even.

[0039] According to another advantageous aspect of the invention in order to avoid the disadvantage known from corresponding solutions of prior art i.e. to avoid the at least partially inclined profile of the applied treatment substance in the cross-direction of the fiber web, which profile is for example decreasing from the end of the feed

of the distribution chamber towards the other end i.e. the end of the flow-through or vice versa, the curtain application device comprises at least one replaceable lip element, advantageously replaceable lip elements. In curtain application devices the lip opening from the distribution chamber, which forms the curtain, is formed by two lip elements, between of which the lip opening is provided. The different replaceable lip element/-s is/are advantageously designed such, that the width of the lip opening in the cross-direction of the fiber web alters such, that the flow profile and thus, the profile of the applied treatment substance is desired and as needed for each type of treatment substance application. The replaceable lip element/-s can advantageously be configured to alter the length and the width of the lip opening in flow direction of the curtain in cross-direction of the fiber web. The upper end part of the replaceable lip element/-s advantageously can be configured to alter the characteristics of the distribution chamber in view of the flow of the treatment substance by altering the inner shape of the distribution chamber respectively. Thus the replaceable lip element/-s provide for the possibility of using the same curtain application device for different types of treatment substances, i.e. only the lip elements are changed, when the treatment substance type is changed. The replaceable lip elements provide for the possibility of defining the profile of the treatment substance to be applied and the flow of the treatment substance in the distribution chamber. Additionally, in cases of a breakage of a lip element the maintenance is fast and easy. Further replaceable lip element/-s provide for the possibility of using lip element/-s of different materials, for example in view of costs, or of lifetime or of treatment substance etc.

[0040] According to an advantageous aspect in order to avoid the disadvantage known from corresponding solutions of prior art i.e. to avoid the at least partially inclined profile of the applied treatment substance in the cross-direction of the fiber web, which profile is for example decreasing from the end of the feed of the distribution chamber towards the other end i.e. the end of the flow-through or vice versa, the curtain application device comprises a replaceable insert to be placed in the distribution chamber to adjust the flow of the treatment substance in the distribution chamber by altering its inner dimensions and inner form such, that the profile of the treatment substance to be applied is as desired. For example the insert may have a tapered form to adjust the cross-directional dimensions and flow area of the distribution chamber to compensate the at least partially inclined profile of the applied treatment substance.

[0041] According to an advantageous aspect of the invention the curtain application device of the treatment system comprises edge guides which are located along each edge of the feeding slot / the nozzle lip and are substantially short. The length of the edge guides advantageously 50-300 mm, more advantageously 100-200 mm. The treatment system also comprises collection trays for the edge guides that are not connected to the

application device but fixedly to another part, for example a frame part, of the treatment system. The distance between the lower surface of the collecting tray and the surface of the treatment roll is short 0,1-10 mm, advantageously 1-4 mm. Thus, the edge taper will not cause problems. The collected treatment substance from the collecting tray is further guided to another collecting tray of the treatment system or to the machine circulation of the treatment system. The treatment system can also comprise a shield plate for each of the collecting trays for the edge guides to prevent splashing. This configuration makes edge suction in edge guiding unnecessary as well as provides a functional way of width control of the curtain. Additionally, the structure is simple and no movable parts are needed as well as edge doctoring devices may be omitted.

[0042] According to an advantageous aspect of the invention in the treatment method the fiber web is treated in in treatment nip formed between two hard rolls and the treatment system comprises a treatment nip is formed between two hard surface rolls and that one or both of the hard surface rolls is/are a metal roll/-s having hardness of at least 300 HV and/or one or both of the hard surface rolls is/are a roll/-s having a composite cover with reinforcements and hardness of at least 80 Shore D. In the treatment system and method the running direction of the fiber web is substantially upwards. In the treatment system the height of the application device is adjusted by at least one actuator, advantageously by at least one screw jack, which has advantageously a power source advantageously a hydraulic motor or an electric motor, for example a servo motor, or is manually/mechanically operated. In the treatment system the height of the application device can also be adjusted by at least one hydraulic cylinder or by at least one pneumatic cylinder. In case a hydraulic motor is used movement speed can be ramp controlled by a proportional valve. A control device connected to the treatment system control is also connected to measurement devices for the height and horizontal position of the application device. The control of the movements of the application device can be manual or based on programmable control.

[0043] The treatment substance can be any for curtain application suitable treatment substance, a sizing agent and/or a coating agent. The treatment substance can be a substance with low or high viscosity or a composition with low or high viscosity. The treatment substance can be a sizing agent for example starch, carboxy methyl cellulose (CMC), polyvinyl alcohol (PVOH), polyvinyl acetate (PVA) or other synthetic or bio-based polymer latexes. The treatment substance can be a pigmented sizing agent or a coating color for example binder chemical or mixture of binder chemicals e.g. starch with mineral pigments and/or fillers. The treatment substance can be a cellulose based material e.g. micro-fibrillated cellulose (MFC), nano-fibrillated cellulose (NFC), nanocrystalline cellulose (NCC), cellulose nano-whiskers (CNW) or microcrystalline cellulose (MCC) or the treatment sub-

stance can be a cellulose based composite. The treatment substance can be a lignin based chemical or a mixture of those. The treatment substance can also be another biopolymer like chitosan, alginate, bio-polyester, polyhydroxyalkanoate, or a mixture of those.

[0044] In this description and the following claims by fiber webs are meant in particular paper and board webs. Also, in this description and the claims by treatment of the fiber web is meant sizing and/or coating of the fiber web and thus, by treatment substance sizing agent and/or coating color, respectively.

[0045] The exemplifying embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" and its derivatives are used in this patent application as an open limitation that does not exclude the existence of also unrecited features. The features described hereinafter are mutually freely combinable unless explicitly stated otherwise.

Brief description of the drawings

[0046] In the following the invention is further explained in detail with reference to the accompanying drawing in which:

In figure 1 is schematically shown an advantageous example of a treatment system,

In figure 2 is schematically shown an advantageous example of an application device with a by-pass,

In figure 3 is schematically shown as a partial end view an advantageous example of an application device,

In figure 4 is schematically shown as a partial end view another advantageous example of an application device and

In figure 5 is schematically shown as a partial end view yet another advantageous example of an application device.

Detailed description

[0047] 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.

[0048] In the example of figure 1 is schematically shown an example of a treatment system 10 for treating, for example for sizing or coating, a moving fiber web W. In the figure 1 the main running direction of the fiber web is denoted by an arrow S i.e. generally the fiber web W under treatment proceeds in the figure substantially upwards from left to right. The fiber web W is guided from

a previous section of the fiber web production to beginning of the treatment system 10. In this advantageous example the fiber web W is running slightly inclined but substantially upwards and is treated by indirect treatment in the treatment system 10 comprising a treatment nip N formed between two rotating treatment rolls 30. The treatment substance is applied by an application device 20, onto the surface of the corresponding treatment roll 30 as a curtain C and then the treatment substance is guided on the surface of the treatment roll 30 to the treatment nip N, in which treatment nip N the treatment substance is transferred onto the surfaces of the fiber web W. In this example both sides of the fiber web are treated but also only one of the sides of the fiber web W can be treated, in which case only one of the treatment rolls 30 with an application device 20 is utilized or the treatment substance is applied only from one of the application devices 20 via correspondingly one of the treatment rolls 30. In this example the treatment substance is transferred onto the surface of the fiber web W by indirect treatment but also direct treatment can be utilized, i.e. the treatment substance is applied by the application device/-es onto the surface of the fiber web directly without the transfer first via the surface/-s of the treatment roll/-s 30. In the example of figure 1 the application devices 20 are curtain application devices, which apply the treatment substance as a curtain C as non-contacting application.

[0049] To avoid an at least partially inclined profile of the applied treatment substance in the cross-direction of the fiber web W i.e. in longitudinal direction of the application device 20, which profile is for example decreasing from the feed opening of the application device 20 towards the end/ends of the application device 20 or vice versa, in the treatment system the application device 20 comprising the distribution chamber 21, at least one feed opening, at least one flow-through and a lip opening comprises at least one means configured to adjust flow of the treatment substance in the distribution chamber 21 to control the profile of the treatment substance applied in cross direction of the fiber web W i.e. in longitudinal direction of the application device 20. The means configured to adjust flow of the treatment substance in the distribution chamber 21 to control the profile of the applied treatment substance in cross direction of the fiber web W i.e. in longitudinal direction of the application device 20 is/are configured to adjust the flow of the treatment substance in the distribution chamber 21 without altering outer shape 27 of the distribution chamber 21. The means configured to adjust flow of the treatment substance in the distribution chamber can be configured to form a by-pass flow and/or the means configured to adjust flow of the treatment substance in the distribution chamber can be formed of replaceable elements which are changed to the application device 20 for adjusting the flow of the treatment substance.

[0050] In treatment systems, where the treatment substance is applied indirectly and to both sides of the fiber web W, the curtain application devices 20 are provided

for the treatment rolls 30 at respective sides of the fiber web W such that the possible inclination of the applied layers on the sides of the fiber web W compensate each other and the cross-directional profile of the applied treatment substance in total is substantially even. Advantageously, their corresponding ends in view of the location of the feed opening of the application device 20 are at opposite cross-directional sides of the fiber web W.

[0051] Advantageously, the treatment rolls 30 are coated treatment rolls with a soft or a hard coating, known as such by one skilled in the art. The soft coating is advantageously a rubber or polyurethane coating having hardness of 0 - 100 P&J. The coating can also be a harder polymeric roll cover (rubber, polyurethane or composite) having surface hardness 80 - 100 Shore D, advantageously at least 90 Shore D. The coating can also be a hard metallic or ceramic coating having advantageously hardness of at least 300 HV. Advantageously the composite cover is epoxy reinforced with glass fiber and/or carbon fiber and/or aramid fiber. The treatment rolls 30 may have similar or different type of coating.

[0052] In the treatment system 10 height of the application device 20 i.e. the distance between the treatment roll 30 and the application device 20 is advantageously adjusted by at least one actuator, advantageously by at least one screw jack, which has advantageously a power source advantageously a hydraulic motor or an electric motor, for example a servo motor, or is manually/mechanically operated. In the treatment system the height of the application device can also be adjusted by at least one hydraulic cylinder or by at least one pneumatic cylinder. In case a hydraulic motor is used movement speed can be ramp controlled by a proportional valve. A control device connected to the treatment system control is also advantageously connected to measurement devices for the height and horizontal position of the application device. The control of the movements of the application device can be manual or based on programmable control.

[0053] In figure 2 is shown side projection one schematic example of an application device 20 with a by-pass 45 for applying treatment substance on a moving fiber web W. The application device 20 is a curtain application device 20, which has a feed opening 20F connected to the feed line 40 for the treatment substance at one end the curtain application device 20. At the other end the curtain application device 20 has a flow-through 20FT. The treatment system comprises an adjustable by-pass line 45 from the flow-through to the feed line 40 and by adjusting the by-pass flow in the by-pass line 45 by control means 46, for example by a control valve/-s or by a volumetric pump/-s or by a valve/-s with a mass flow meter or by altering the height of the line for the by-pass flow the flow in the curtain application device 20 is controlled such that the profile of the applied treatment substance is to be as desired, advantageously even. At the minimum the by-pass flow in the by-pass line 45 is 0%, when all treatment substance fed to the curtain ap-

plication device 20 is applied to the fiber web. At maximum the by-pass flow in the by-pass line 45 is 90% of the total amount of the treatment substance fed to the curtain application device 20. Advantageously, the by-pass flow in the by-pass line 45 is 0%-60% of the total amount of the treatment substance fed to the curtain application device 20.

[0054] In the examples of figures 2 and 3 is shown an application device 20 comprising a distribution chamber 21 extending in cross direction over the width of the fiber web W. The distribution chamber 21 has the feed opening 20F (fig. 2) at one end and the flow-through 20FT at the other end. The curtain application device 20 comprises at least one replaceable lip element 25A; 25B, advantageously replaceable lip elements 25A, 25B. In curtain application device 20 a lip opening 24 extends from the distribution chamber 21 and forms the curtain C. The lip opening 24 is formed between the two lip elements 25A, 25B. The different replaceable lip element/-s 25A; 25B is/are advantageously designed such, that the width of the lip opening 24 in the cross-direction of the fiber web W alters such, that the flow profile in the distribution chamber 21 and thus, the profile of the applied treatment substance is desired and as needed for each type of treatment substance application. The lip element/-s 25A; 25B is/are advantageously configured to alter the length and width of the lip opening 24 in flow direction of the curtain C in cross-direction of the fiber web W. The upper parts of lip element/-s 25A, 25B i.e. the ends towards the distribution chamber 21 is/are advantageously configured to alter the characteristics of the distribution chamber 21 in respect of the flow of the treatment substance. Different upper part configurations can be seen in the examples of figure 3 and 4. The replaceable lip element/-s 25A, 25B provide for the possibility of using the same curtain application device 20 for different types of treatment substances, i.e. only the lip elements 25A, 25B are changed, when the treatment substance type is changed. The replaceable lip elements 25A, 25B provide for the possibility of defining the profile of the treatment substance to be applied and the flow of the treatment substance in the distribution chamber 21. The replaceable lip element/-s 25A, 25B can be of different materials or of same material.

[0055] The curtain application device 20 may also comprise a replaceable insert to be placed in the distribution chamber 21 to adjust the flow of the treatment substance in the distribution chamber 21 by altering its inner dimensions and inner form such, that the profile of the treatment substance to be applied is as desired. For example the insert may have a tapered form to adjust the cross-directional dimensions and flow area of the distribution chamber 21 to compensate the at least partially inclined profile of the applied treatment substance.

[0056] As shown in the example of the figure 5 the curtain application device 20 advantageously comprises edge guides 26 (only one end is shown in the figure 5), which are located along each edge of the lip opening 24

(figs 3 and 4). The edge are substantially short, advantageously the length of the edge guides is 50-300 mm, more advantageously 100-200 mm. The treatment system 10 also comprises respectively collection trays 29 for the edge guides 26 that are not connected to the application device 20 but fixedly attached to another part, for example a frame part, of the treatment system. The distance between the lower surface of the collection tray 29 and the surface of the treatment roll 30 is short 0,1-10 mm, advantageously 1-4 mm. Thus, the edge taper will not cause problems. The collected treatment substance from the collecting tray 29 is further guided to another collecting tray 28 of the treatment system 10 or to the machine circulation of the treatment system 10. The curtain application device 20 may also comprise a shield plate for each of the collection trays 29 for the edge guides 26 to prevent splashing.

[0057] 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.

[0058] 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.

Reference signs used in the drawing:

[0059]

- 10 treatment system
- 20 curtain application device
- 20F feed opening
- 20FT flow-trough
- 21 distribution chamber
- 24 lip opening
- 25A lip element
- 25B lip element
- 26 edge guide
- 27 outer shape of the distribution chamber
- 28 collecting tray
- 29 collection tray
- 30 treatment roll
- 40 feed line
- 45 by-pass line
- 46 control means
- C treatment substance curtain
- N treatment nip
- S process direction
- W fiber web

Claims

1. Method of treating a fiber web, in which method the fiber web (W) is treated in a treatment system (10), in particular coated by curtain coating or sized by curtain sizing, which treatment system (10) comprises at least one curtain application device (20) and two treatment rolls (30) between of which treatment rolls (30) a treatment nip (N) is formed, in which method at least one curtain (C) of a treatment substance is provided by the application device (20), **characterized in that** in the method an application device (20), which comprises a distribution chamber (21), at least one feed opening (20F), at least one flow-through (20FT) and a lip opening (24), is used to provide the curtain (C) of the treatment substance and that in the method profile of the applied treatment substance in cross direction of the fiber web (W) i.e. in longitudinal direction of the application device (20) is controlled by at least one means configured to adjust flow of the treatment substance in the distribution chamber (21).
2. Method according to claim 1, **characterized in that** in the method the means adjust flow of the treatment substance in the distribution chamber (21) to control the profile of the applied treatment substance in cross direction of the fiber web (W) i.e. in longitudinal direction of the application device (20) without altering outer shape (27) of the distribution chamber (20).
3. Method according to claim 1 or 2, **characterized in that** in the method the profile is controlled by adjusting at least one by-pass flow in at least one by-pass line (45), which is connected to a feed line (40) connected to one of the feed openings (20F) and to one of the flow-throughs (20FT).
4. Method according to any of claims 1 - 3, **characterized in that** in the method the profile is controlled by adjusting the shape of the lip opening (24) formed between two lip elements (25A, 25B) of the application device (20) by changing to the application device (20) a lip element/-s (25A, 25B) dimensioned such, that a desired shape of the lip opening (24) is provided.
5. Method according to any of claims 1 - 4, **characterized in that** in the method the treatment substance is applied to both sides of the fiber web (W), that the curtain application devices (20) are provided for the treatment rolls (30) for respective sides of the fiber web (W) such that their respective ends in view of the location of the feed opening/-s (20F) are at opposite cross-directional edges of the fiber web (W).
6. Method according to any of claims 1 - 5, **characterized in that** in the method the treatment substance is applied indirectly via the treatment rolls (30) to the fiber web (W).
7. Method according to any of claims 1 - 6, **characterized in that** in the method the profile is controlled by adjusting the flow of the treatment substance in a distribution chamber (21) of the curtain application device (20) by a replaceable insert to be placed in the distribution chamber (21) by altering its inner dimensions and inner form by the replaceable insert.
8. Method according to any of claims 1 - 7, **characterized in that** the method is used for applying different treatment substances and/or treatment substances with substantially different properties.
9. Treatment system for treatment of a fiber web (W), in particular a coating system for curtain coating or a sizing system for curtain sizing, which treatment system (10) comprises at least one curtain application device (20) and two treatment rolls (30) between of which treatment rolls (30) a treatment nip (N) is formed, **characterized in that** the application device (20) comprises a distribution chamber (21), at least one feed opening (20F), at least one flow-through (20FT) and a lip opening (24) and that the treatment system (10) further comprises at least one means configured to adjust flow of the treatment substance in the distribution chamber (21) to control the profile of the treatment substance applied in cross direction of the fiber web (W) i.e. in longitudinal direction of the application device (20).
10. Treatment system according to claim 9, **characterized in that** the means configured to adjust flow of the treatment substance in the distribution chamber (21) to control the profile of the applied treatment substance in cross direction of the fiber web (W) i.e. in longitudinal direction of the application device (20) is/are configured to adjust the characteristics of the distribution chamber (21) in respect of the flow of the treatment substance without altering outer shape (27) of the distribution chamber (21).
11. Treatment system according to claim 9 or 10, **characterized in that** the treatment system (10) comprises at least one by-pass line (45), which is connected to a feed line (40) connected to one of the feed openings (20F) and to one of the flow-throughs (20FT), a control means (46) in the by-pass line (45) and that the profile of the applied treatment substance is configured to be controlled by adjusting the by-pass flow in the by-pass line (45) by the control means (46).
12. Treatment system according to any of claims 9 - 11, **characterized in that** in the treatment system (10) the lip opening (24) is formed between lip elements

(25A, 25B), that at least one of the lip elements (25A; 25B) is replaceable and the profile is controlled by adjusting the shape of the lip opening (24) formed between the lip elements (25A, 25B) of the application device (20) by changing to the application device (20) a lip element/-s (25A, 25B) dimensioned such, that a desired shape of the lip opening (24) is provided.

13. Treatment system according to any of claims 9 - 12, **characterized in that** the treatment system comprises two curtain application devices (20), one for each of the treatment rolls (30) for respective sides of the fiber web (W) and that the application devices (20) are located such that their respective ends in view of the location of the feed opening/-s (20F) are at opposite cross-directional sides of the fiber web (W).
14. Treatment system according to any of claims 9 - 13, **characterized in that** the treatment system (10) comprises a replaceable insert to be placed in the distribution chamber (21) to alter its inner dimensions and inner shape.
15. Treatment system according to any of claims 9 - 14, **characterized in that** the treatment system (10) is configured to be utilized for different treatment substances and/or for treatment substances with substantially different properties.

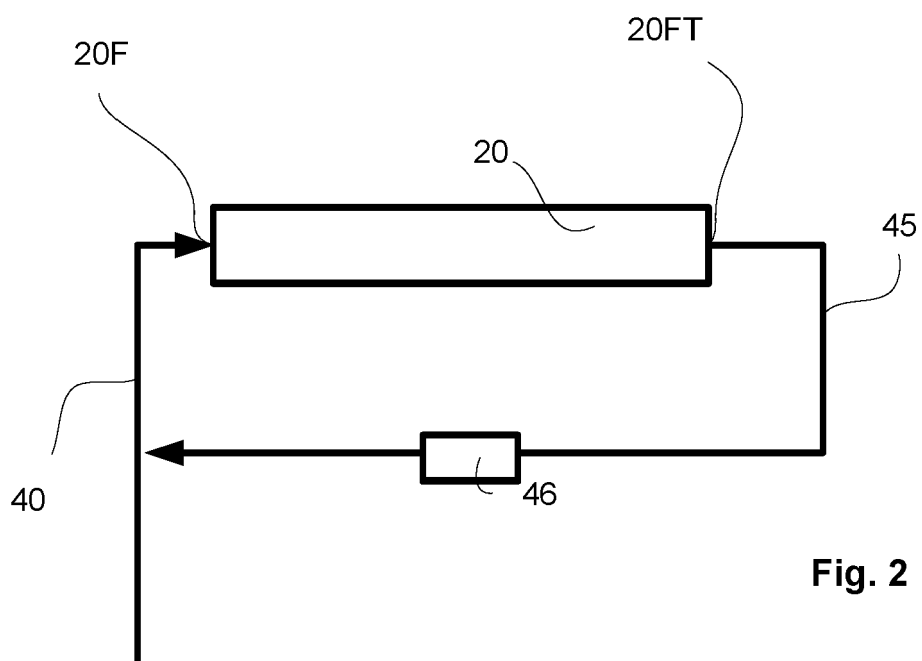
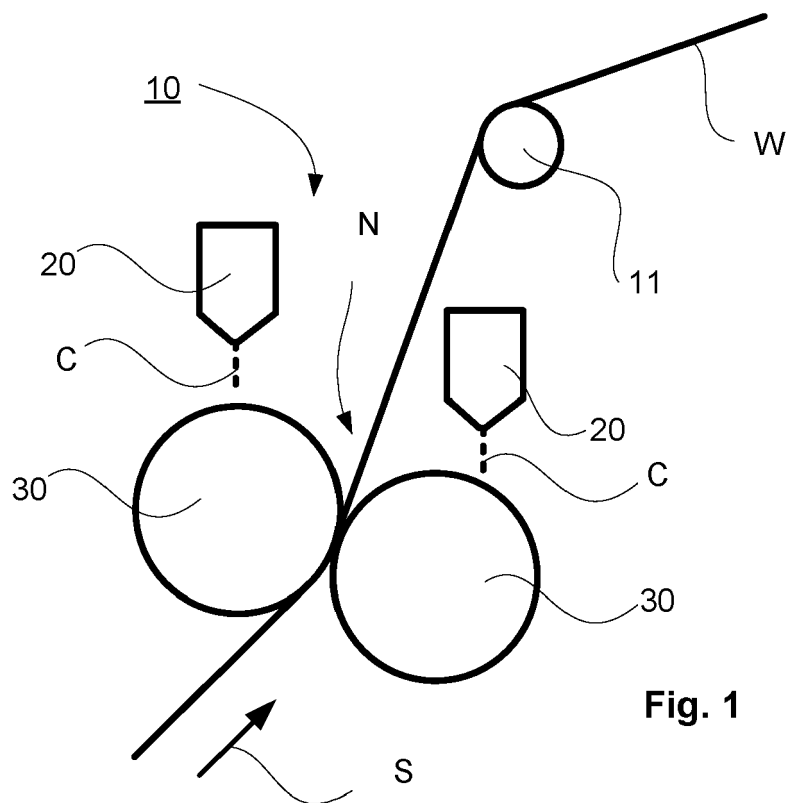
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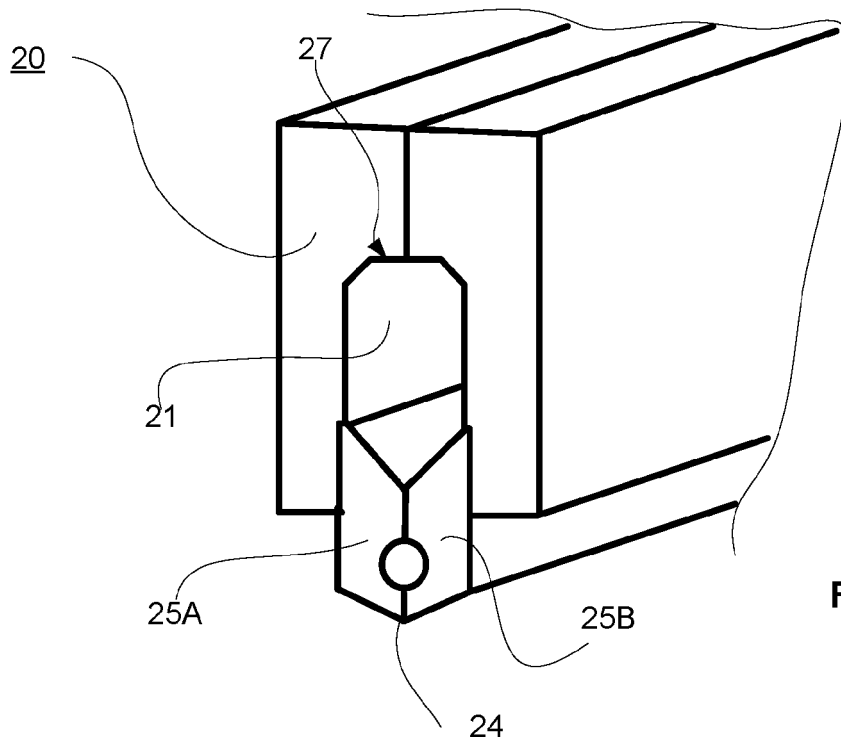


Fig. 3

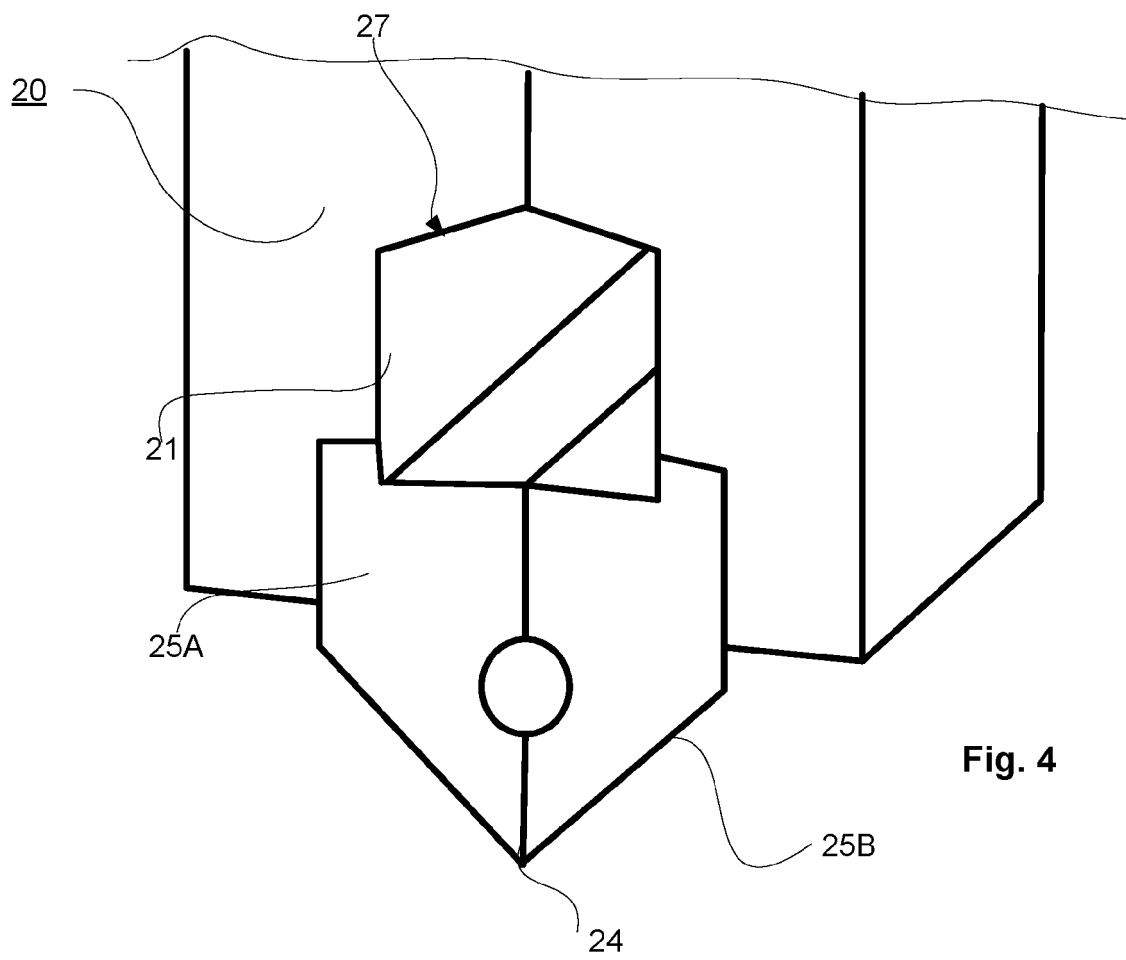
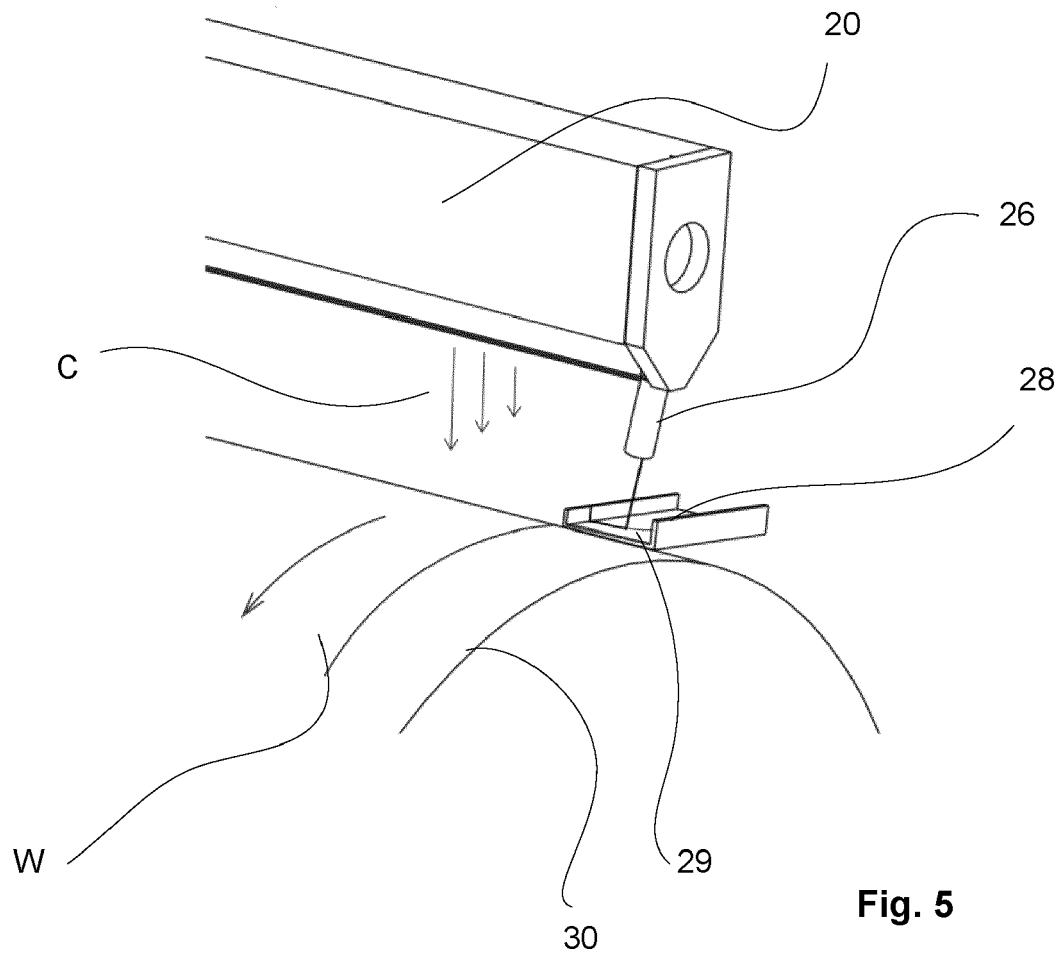


Fig. 4





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