(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 516 995 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
05.03.2025 Bulletin 2025/10

(21) Application number: **24187025.2**

(22) Date of filing: **08.07.2024**

(51) International Patent Classification (IPC):
D21F 1/48 *(2006.01)* ***D21F 1/52*** *(2006.01)*
D21F 9/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
D21F 1/48; D21F 1/526; D21F 9/003

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **28.08.2023 FI 20235950**

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(54) METHOD FOR CONTROLLING VACUUM IN A FORMING SECTION AND A FORMING SECTION WITH A CONTROL SYSTEM FOR CONTROLLING VACUUM OF THE FORMING SECTION

(57) The invention relates to a method for controlling vacuum in a forming section (200) comprising at least one forming unit (250), which forming unit (250) comprises a first wire (10) and a second wire (20) forming a twin-wire part and at least one vacuum forming shoe (16A-16C) located at the second wire (20). The method comprises steps of measuring dewatering at the at least one vacuum forming shoe (16A-16C), defining based on the measured dewatering of dewatering data information, and controlling vacuum at the at least one forming unit (250) based on the dewatering data information of the at least one vacuum forming shoe (16A-16C). The invention also relates to a forming section with a control system (100) for controlling vacuum in the forming section (200).

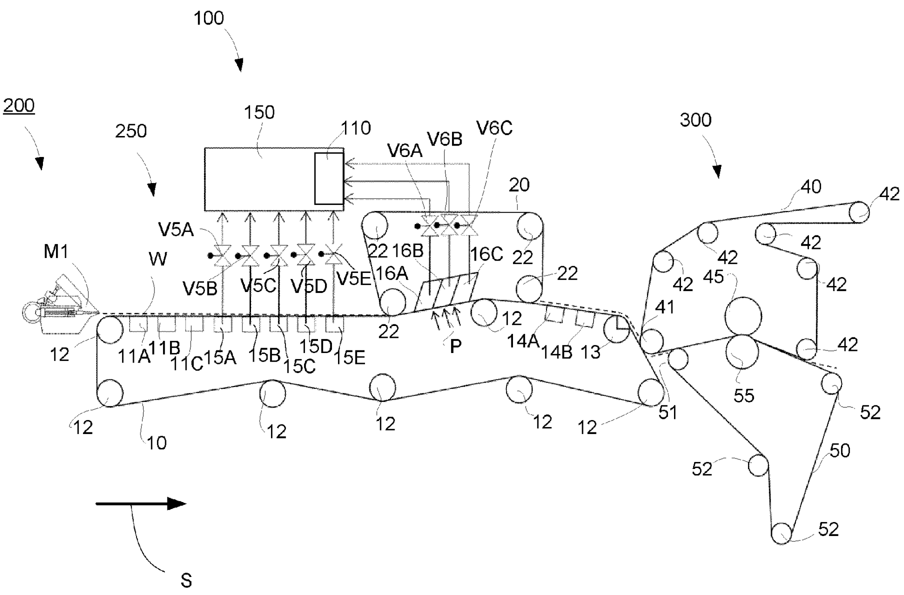

Fig. 1

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Description

Technical field

[0001] The invention relates generally to producing fiber webs. Particularly the invention relates to a method for controlling vacuum in a forming section according to the preamble of the independent method claim and to a forming section with a control system for controlling vacuum of the forming section according to the preamble of the independent forming section claim.

Background

[0002] As known from the prior art in fiber web machines, especially in paper and board machines, the fiber web is produced and treated in an assembly formed by a number of apparatuses arranged consecutively in a process line. A typical production and treatment line comprise a forming section comprising a headbox and a forming unit 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 sections for finishing the fiber web, for example, a size press, a calender, a coating section. The production and treatment line also comprise typically at least one winder for forming customer rolls as well as a roll packaging apparatus.

[0003] The task of the headbox is to supply fiber suspension for the fiber web production into the forming unit. In a multilayer headbox more than one fiber suspension flows are discharged from the headbox via flow channels for stock suspension layers, each for forming one layer of a multiply fiber web.

[0004] The task of a forming unit is to remove water from fiber suspension fed by the headbox. When the web is manufactured of watery fiber stock, water in the stock is removed on the forming section through a forming wire or forming wires for starting the formation of the web. Fibers remain on the forming wire or between the forming wires moving together. Depending on the grade of the web being manufactured, different types of stocks are used. The volume for which water can be removed from different stocks for achieving a web of good quality is a function of many factors, such as e.g. a function of the desired basis weight of the web, the design speed of the machine, and the desired level of fines, fibers and fill materials in the finished product. Many types of devices are known on the forming unit such as forming shoes, foil boxes, suction boxes, turning rolls, suction rolls, and rolls provided with an open surface, which have been used in many different arrangements and arrays when trying to optimize the volume, time and location of water being removed when forming the fiber web. The manufacturing a high-quality end-product of desired grade is a function of the volume of dewatering, the dewatering method, the duration of dewatering, and the location of dewatering. When it is desired to improve the water removal capacity and to maintain or improve the quality of the end-product, many times unforeseeable problems are created as the result of which either the water removal volume has to be decreased for maintaining the desired quality or the desired quality has to be sacrificed for achieving the greater water volume.

[0005] Fiber webs, especially paper and board are available in a wide variety of types and can be divided according to basis weight in two product grades: papers with a single ply and a basis weight of 25-300 g/m^2 and boards manufactured in single or multiply technology and having a basis weight of 80-600 m/m^2. It should be noted that the borderline between paper and board is flexible since board product grades with lightest basis weights are lighter than the heaviest paper product grades. Generally speaking, paper is used for printing and board for packaging.

[0006] The stock suspensions to be used for producing different product grades of fiber webs vary in respect of the fiber web grade to be produced but typically at least certain drainage level is to be achieved in the forming section in order to form a fiber web suitable to be treated in a press section of a fiber web production line and to further remove water by pressing the fiber web in the press section. For certain product grades virgin or recycled fibers are refined to very fine fibers i.e. to highly refined stocks for the required stock suspension. Some product grades may also have high fines content. The highly refined stock and high fines content decrease dewatering properties of the stock suspension, for example a web sealing effect of the fiber web is possible and thus limitations on dewatering in the forming unit might be caused.

[0007] Further, typically needed vacuum for water removal increases as the forming process advances and a higher vacuum is needed in order to achieve corresponding water removal efficiency. This causes often highly increased energy consumption and thus, vacuum can be used only to limited extent. When same vacuum is used in several successive suction boxes, effectiveness of the first suction box is good, but thereafter in the following suction boxes the water removal efficiency decreases significantly, even though the energy consumption remains about the same. The difficult dewatering situation may even cause need to use lower running speeds of the production, which naturally has a negative impact on cost efficiency.

[0008] In view of the above it is, thus, important that the vacuum is controlled in an efficient and reliable way in forming units and water removal devices using vacuum to form and to remove water from the fiber web in the forming section.

[0009] It is known for example that on fourdrinier and multi-fourdrinier forming sections each of suction boxes, such as vacuum foil boxes, of a fourdrinier wire, i.e. one-wire part, have has its own automatic control valve for controlling its vacuum, in controlling of which set points values are set either manually or following a fiber web grade dependent table of set point values. Thus, each vacuum foil box also requires its own control circuit with its set point values. This makes the control system for controlling vacuum in the forming section complicated. Also, this needs multiple selection and setting of the set point values. Thus, the control system is cumbersome in its structure as well as in operation.

[0010] It is also known for example that on fourdrinier and multi-fourdrinier forming sections at the fourdrinier wire the vacuum is controlled before an upper suction part, i.e. before a twin-wire part, of the fourdrinier or multi-fourdrinier forming section, the vacuum on the fourdrinier part, i.e. on the one-wire part, is controlled based on detected water removal of a vacuum forming shoe. Amount of the water removal varies due to variations of the forming process in machine direction, which has an effect on joining consistency and other quality factors, such as scar-like markings, diagonal worm-shaped defects and seagull wing -shaped defects. Thus, the water removal of the vacuum forming shoe is to be detected at short intervals and thus, also vacuum control requires continuous setting ups and thus, takes up time.

[0011] In patent application publication US2012145346A1 is disclosed a forming section in a machine for producing a web of fibrous material, said forming section comprising: at least one continuous rotating wire supporting a fibrous stock suspension at least indirectly; a compression zone; a plurality of dewatering units, at least two of said plurality of dewatering units being one of located in series and respectively located following each other in a direction of travel of said fibrous stock suspension inside said compression zone; and a control and/or regulating system including: a control and/or regulating device; at least one device for at least indirectly acquiring a value at least indirectly characterizing a dry content of the web in a transfer area from the forming section to a following function unit, said control and/or regulating device being linked with at least one said device for at least indirectly acquiring said value at least indirectly characterizing said dry content of the web in said transfer area from the forming section to said following function unit; a device for input of a desired value for a target dry content, said control and/or regulating device being linked with said device for input of said desired value for said target dry content; a plurality of control elements, said control and/or regulating device being linked at least indirectly with one of (a) said plurality of control elements respectively of individual ones of said plurality of dewatering units which are located prior to one of a plurality of last ones of said plurality of dewatering units, and (b) one of said plurality of control elements of a last one of said plurality of dewatering units inside said compression zone; and a device for creating a plurality of control variables for controlling respectively individual ones of said plurality of dewatering units.

[0012] In patent publication US4466873A is disclosed a vacuum dual control system for the flat box section of a papermaking machine comprising: a plurality of serially arranged vacuum boxes; a header interconnecting said boxes; a vacuum pump operatively connected to said boxes in a manner so that the vacuum applied to the boxes is a function of the speed of the pump; a first control means for operating the pump at an initial substantially constant high speed to produce the vacuum necessary to dewater a web in its initial condition; means for passing the web to be dewatered over the boxes so that suction applied therethrough by the pump running at its initial substantially constant high speed dewaters the web until the condition of the web changes sufficiently to cause the vacuum in the last box to increase to a predetermined maximum level; a second control means having set point adjustment means thereon to enable selection of a predetermined set point corresponding to the predetermined maximum vacuum level, said second control means being connected to the last box and the vacuum pump and including sensing means to sense the predetermined maximum vacuum level as determined by the second control means predetermined maximum vacuum level as determined by the second control means predetermined set point and only operable in place of said first control means; and means for terminating operation of said first control means and initiating operation of said second control means in response to the sensing means sensing the vacuum level reaching the maximum vacuum level as determined by the second control means set point to correspondingly lower the speed of the vacuum pump and maintain the maximum vacuum level.

[0013] An object of the invention is to create a method for controlling vacuum in a forming section, in which the disadvantages and problems of prior art are eliminated or at least minimized.

[0014] An object of the invention is to create a forming section with a control system for controlling vacuum of the forming section, in which the disadvantages and problems of prior art are eliminated or at least minimized.

[0015] An object of the invention is to create a method for controlling vacuum in a forming section and a forming section with a control system for controlling vacuum of the forming section, in which disadvantages and problems in controlling of vacuum in forming sections known from prior art are eliminated or at least minimized.

Summary

[0016] In order to achieve the above-mentioned objects, the method according to the invention is mainly characterized by the features of the characterizing clause of the independent method claim and the forming section according to the invention is mainly characterized by the features of the characterizing clause of the independent forming section claim. Advantageous embodiments and features are disclosed in the dependent claims.

[0017] According to an advantageous aspect of the invention, it is provided that vacuum of at the fourdrinier wire of the forming section, especially vacuum of each of the several, successive suction boxes at the fourdrinier wire, is automatically controlled on basis of dewatering amount of an upper wire part of a twin-wire part following the fourdrinier wire part, advantageously on basis of dewatering data information received from at least one vacuum forming shoe located in the upper wire part of a twin-wire part following the fourdrinier wire part. Additionally, the vacuum at the fourdrinier wire can be controlled on basis of measurement data received from a measuring device in the fiber web production line, for example on basis of layer thickness measurement.

[0018] It has also been surprisingly found out that in view of effectiveness of water removal as well as in view of energy consumption in regard of providing vacuum and driving output, vacuums of successive suction boxes are to be scaled increasing, advantageously uniformly increasing.

[0019] According to an advantageous aspect of the invention, when controlling vacuum at the fourdrinier wire in the forming section with several, successive suction boxes at the fourdrinier wire, only the set point value of the last suction box is set independently and the set point values of preceding suction boxes is calculated from the set point value of the following suction box such, that the set point value of the vacuum P_i of a suction box is smaller than the set point value of the vacuum P_{i+1} of the following suction box, where i is 1, 2, 3, 4,... Thus, the equation for calculating a vacuum of a suction box in an arrangement of several, successive suction boxes is $P_i < P_{i+1}$ and the set point value of the vacuum of the last suction box in the arrangement of several, successive suction boxes is set independently on basis of a measurement result of dewatering, for example manually. Thus, the equation for calculating pressure is $P_i > P_{i+1}$, for example P_i = -5 kPa and P_{i+1}=-10 kPa. According to an advantageous example, first a minimum vacuum is set for the first of the suction boxes after the head-box and a maximum vacuum is set for the last of the suction boxes of the successive arrangement of the suction boxes and when the vacuum of the last suction box changes, the vacuum of the previous suction boxes is calculated based on the equation $P_i < P_{i+1}$. Additionally, the set point value may be defined on basis of information in a stored data collection of set point values for different fiber web product grades. Thus, need for storing data relating to set point values according to basis weights is avoided. Function for the equation for calculating the vacuum of a suction box in the arrangement of several, successive suction boxes is advantageously $P_i = a*P_{i+1}$, where a is a coefficient and 0<a<1, more advantageously 0,5<a<1,0. Also other function formats are possible, as long as $P_i<P_{i+1}$.

[0020] According to an advantageous aspect of the invention, when controlling vacuum in the forming section with a fourdrinier wire and with a vacuum forming shoe, the control system is provided with an intelligent add-on configured to detect amount of the dewatering at the vacuum forming shoe and control vacuum at the fourdrinier wire to keep the dewatering at the fourdrinier wire at the desired level (dead band). The vacuum at the fourdrinier wire is controlled by controlling vacuum of water removal devices located at the fourdrinier wire. The vacuum at the fourdrinier wire part is controlled by controlling the main vacuum such, that desired water removal at following upper wire part is achieved, i.e. by controlling water removal by controlling the vacuum at the fourdrinier wire part the upper wire part has enough water to be removed. This provides a steady, non-operator-related control of the vacuum and thus, production quality variations are decreased, and good, stabile level of quality is achieved.

[0021] According to an advantageous aspect of the invention, when controlling vacuum in the forming section with a fourdrinier wire and with a vacuum forming shoe, the control system is provided with an intelligent add-on configured to detect amount of the dewatering at the vacuum forming shoe and control set point value of the main vacuum at the fourdrinier wire to fix amount of dewatering at the vacuum forming shoe to a selected range by controlling set point value of the main vacuum at the fourdrinier wire. Advantageously, an operator sets a set point value of the dewatering amount in a time interval (for example l/s) and the control provides that the amount in a time interval of the dewatering is kept at the set range (for example 10 l/s).

[0022] Advantageously, the forming section comprises an arrangement of several, successive suction boxes at the fourdrinier wire and the vacuum there of is controlled. According to an advantageous embodiment the set point value of the vacuum of the last of the several, successive suction boxes at the fourdrinier wire is set on basis of the detected amount of the dewatering at the vacuum forming shoe.

[0023] In the present invention the control system comprises at least one controller comprising at least a processor and a memory and a computer code for example a software application, to provide control instructions on basis of dewatering amount of an upper wire part of a twin-wire part following the fourdrinier wire part, advantageously on basis of dewatering data information received from at least one vacuum forming shoe located in the upper wire part of a twin-wire part following the fourdrinier wire part. Thus, the controller of the control system receives, collects, processes, stores and transmits data. The control system and the controller may be configured as one entity, or it may be configured of separate units connected with each other by means of data transfer connections. The control system and the controller are configured to provide control data to control vacuum in the forming section. The control data is transmitted to control the vacuum in the forming section. The control data may be transmitted to a control unit of an element and/or of a device and/or of a section of the fiber web production line. The controller may be configured to provide automatic control and/or to manual control of the vacuum of the forming section.

[0024] In the description and in the claims by the expression "to control (and its derivates)" is meant to control at least one element and/or at least one device operationally connected to the forming section.

[0025] The controller of the control system advantageously comprises at least one processor and at least one memory including computer program code, the at least one memory and the computer program code are configured, with the at least one processor, to generate and transmit signals as first control data to the forming section based on first information data received from the forming section, and based on second information data received the fiber web production line and/or based on third data received automatically and/or manually as input value/-s from a data storage.

[0026] The method of controlling vacuum of the forming section advantageously comprises receiving first, and second and/or third information data, processing the received first, and second and/or third information data according to predetermined configuration, based on the processed data, generating signals according to predetermined configuration to control the vacuum of the forming section.

[0027] By the method and the forming section according to the invention provide for optimal, uniformly increasing vacuum profile in the arrangement of several, successive suction boxes at the fourdrinier wire only by changing the set point value of the last of the several, successive suction boxes in the arrangement. The invention also provides that the manual operations in controlling the vacuum in the forming section is minimized and thus, human errors by operators are decreased, as vacuum circuits of individual suction boxes of the arrangement of the several, successive suction boxes do not need to be set individually manually. Further, the invention provides that desired, increasing vacuum profile is automatically controlled at the fourdrinier wire and thus, improved quality and runnability is achieved, for example more even distribution of fines is provided. Solution according to invention decreases fiber web machine energy consumption, increases forming section ceramics and fabrics lifetime and optimized fiber web properties. By this way is possible to dewater the fiber web so that web is not compacted too early. It improves glue penetration in the sizer and decreases vacuum need in the forming section.

Brief description of the drawings

[0028] In the following the invention is explained in detail with reference to the accompanying drawing to which the invention is not to be narrowly limited.

In figure 1 is shown schematically an advantageous example of a forming section with a vacuum control system according to the invention and for an advantageous example of the method for controlling vacuum in a forming section according to the invention,

In figure 2 is shown schematically another advantageous example of a forming section with a vacuum control system according to the invention and for another advantageous example of the method for controlling vacuum in a forming section according to the invention,

In figure 3 is shown schematically examples of vacuum set-up graphs in connection with advantageous examples of the invention.

[0029] During the course of the following description like numbers and signs will be used to identify like elements according to the different views which illustrate the invention and its advantageous examples. In the figures some repetitive reference signs may have been omitted for clarity reasons.

Detailed description

[0030] In figures 1-2 is shown advantageous examples of a forming section 200 with a vacuum control system for advantageous examples of a method for controlling vacuum in a forming section. Each forming section 200 comprises at least one head box M1, M2 for feeding stock suspension to a forming unit 250. The forming section 200 comprises a control system 100 for controlling vacuum in the forming unit 250 of the forming section 200. In figure 1 is shown an example in connection with production of a single layer fiber web W or in connection with production of a multilayer fiber web with multilayer W headbox. and in figure 2 is shown an example in connection with production of a two-layer fiber web W. In the example of the figure 1 in addition to the forming section 200 also beginning of a press section 300 following the forming section 200 is shown.

[0031] In figure 1 is shown an example of a forming section 200 for producing a single layer fiber web W with single layer headbox M1 or a multilayer fiber web W with multilayer headbox M1. Running direction is indicated by an arrow S. The forming section 200 in this example comprises the one headbox M1 and a forming unit 250, also beginning of a press section 300 is shown. In the example the forming section 200 is thus for production of a fiber web W, which can contain one or more fiber web layers. The forming section 200 comprises a headbox M1, from which the stock suspension is fed to the forming unit 250 beginning as single-wire part with substantially horizontal run i.e. a fourdrinier part comprising a first wire 10 for single-wire runs and a second wire 20 for twin-wire runs for forming the fiber web W. In case in which single layer fiber web W is manufactured, to the headbox M1 only one stock suspension is fed, but in case in which multilayer fiber web W is manufactured, to the headbox M1 is fed two or more equivalent or different kind of stock suspensions. Stock suspensions can differ from each other based on raw material, fiber length, fiber freeness or additives difference. Each wire 10, 20 comprises rolls 12, 22 for guiding, tensioning and/or driving the first and the second wire 10, 20 as endless first and second wire loops 10, 20. The stock suspension from the headbox M1 is first fed onto a single-wire run of a first wire 10, i.e. onto the fourdrinier wire 10 and thereafter the stock on the fourdrinier wire 10 is guided past inside the loop of the first wire 10 at the beginning run thereof located water removal means 11A-11C, which can be for example foil boxes and/or suction devices, and then past the loop of the first wire 10 located suction boxes 15A-15E with controllable vacuum. During the run on the first wire 10 the fiber web water removal is substantially horizontal. The first one-wire run is followed by a twin-wire run, during which the fiber web is running between the two wires 10, 20 of a twin-wire part of the forming unit 250. During this twin-wire run water is removed by controllable water removal means 16A-16C, advantageously controllable vacuum forming shoes 16A-16B having optional adjustable loading blades P in the opposite, first wire loop 10. The twin-wire run is followed by another single-wire run, on which run further water removal means 14A, 14B are located, which can also function as support means for supporting the run of the fiber web W. After the forming section 250 the fiber web W is guided via inside the first fire loop 10 located suction roll 13 of the forming unit 250 towards a pick-up roll 41 for transferring the fiber web to a first press fabric 40 of the press section 300. The press section also comprises a second press fabric 50 with a roll 51. The press fabrics 40, 50 comprise rolls 42, 52 for guiding, tensioning and/or driving the fabrics 40; 50 as an endless loop. In the press section the fiber web W is guided between the first press fabric 40 and the second press fabric 50 to a press nip formed between a first press roll 45 and a second press roll 55.

[0032] In the example of the figure 1 the control system 100 for controlling vacuum in the forming section 200 comprises a controller 150 connected operationally to several, successive suction boxes 15A-15E with controllable vacuum at the first wire 10, i.e. at the fourdrinier wire 10. Each of the successive suction boxes 15A-15B comprises a control element V5A-V5E, for example an adjustable valve V5A-V5E, to control vacuum of the corresponding suction box 15A-15B. When controlling vacuum in the forming section 200, especially in the forming unit 250 a vacuum set point value of the last suction box 15E is set independently and the set point values of preceding suction boxes 15A-15D is calculated from the set point value of the following suction box 15B-15E such, that the set point value of the vacuum P_i of a suction box 15A-15B is smaller than the set point value of the vacuum P_{i+1} of the following suction box 15B-15E, where i indicated the order of the suction box and is 1, 2, 3, 4,..., where 1 is the location of the first suction box 15A-15E in the running direction S or in the example i is indicated by signs A, B, C,... Thus, the equation for calculating the vacuum of a suction box 15A-15D in an arrangement of several, successive suction boxes 15A-15E is $P_i < P_{i+1}$ and the set point value of the vacuum of the last suction box 15E in the arrangement of several, successive suction boxes 15A-15E is set independently, on basis of a calculated set point value, which is calculated for example on basis of a measurement result of dewatering. Additionally, the set point value of the vacuum may be defined together on basis of information in a stored data collection of set point values for different fiber web product grades. Function for the equation for calculating the vacuum of a suction box 15A-15D in the arrangement of several, successive suction boxes 15A-15E is advantageously $P_i = a*P_{i+1}$, where a is a coefficient and $0<a<1$, more advantageously $0,5<a<1,0$. Also other function formats are possible, as long as $P_i<P_{i+1}$. It can also provided that vacuum of each of the several, successive suction boxes 15A-15E at the fourdrinier wire 10 is automatically controlled on basis of data information received from a measurement device of the fiber web production line, for example on basis of layer thickness measurement, and/or on basis of dewatering data information received from the forming unit 250, for example from at least one vacuum forming shoe 16A-16C located at the second wire 20, i.e. the upper wire 20 in the upper wire part of the twin-wire part following the fourdrinier wire part. The control system 100 may also be provided with an intelligent add-on 110 configured to detect amount of the dewatering at the vacuum forming shoe/-s 1A-16C and control vacuum at the fourdrinier wire 10 to keep the dewatering at the fourdrinier wire 10 at the desired level (dead band). The vacuum at the fourdrinier wire 10 is controlled by controlling vacuum of at least one of water removal devices 11A-11C, 15A-15E, preferably vacuum of the successive suction boxes 15A-15E, located at the fourdrinier wire 10. Advantageously, an operator sets a set point value of the dewatering amount of the first top suction unit suction box 16A of the successive suction boxes 16A-16C in a time interval (for example l/s) and the control provides that the amount in a time interval of the dewatering is kept at the set range (for example 10 l/s).Alternatively, an operator can set a set point value of the dewatering amount of the last suction box 15E of the successive suction boxes 15A-15E in a time interval (for example l/s) and the control provides that the amount in a time interval of the dewatering is kept at the set range (for example 10 l/s).

[0033] In the figure 2 an example of a forming section 200 for producing a multilayer fiber web W with at least two layers is shown. Running direction of forming of first layer/-s W1 is denoted by an arrow S1 and running direction of forming of second layer/-s W2 and combined layers W1, W2 is denoted by an arrow S2. The forming section is provided with two headboxes M1, M2, one or both of which can be single layer headboxes M1, M2 or multilayer headboxes M1, M2. The forming section 200 in this example comprises the two headboxes M1 and a forming unit 250. In the example the forming section 200 is for production of a multilayer fiber web W, which can contain two or more fiber web layers W1, W2. The forming section 200 comprises one headbox M1, from which the stock suspension is fed to the forming unit 250 for forming of a first layer/-s of the fiber web W. The forming unit 250 begins as single-wire part with substantially horizontal run i.e. a fourdrinier part comprising a first wire 10 for single-wire runs and a second wire 20 for twin-wire runs for forming the fiber web W. In case in which the first layer/-s comprises only single layer, to the headbox M1 only one stock suspension is fed, but in case in which the first layer/-s of the multilayer fiber web W comprises more than one layers to the headbox M1 is fed two or more equivalent or different kind of stock suspensions. Stock suspensions can differ from each other based on raw material, fiber length, fiber freeness or additives difference. Each wire 10, 20 comprises rolls 12, 22 for guiding, tensioning and/or driving the wire 10; 20 as an endless loop. The stock suspension from the headbox M1 is first fed onto a single-wire run of a first wire 10, i.e. onto the fourdrinier wire 10 and thereafter the stock/-s on the fourdrinier wire 10 is guided past inside the loop of the first wire 10 at the beginning run thereof located water removal means 11A-11C, which can be for example foil boxes and/or suction devices, and then past the loop of the first wire 10 located suction boxes 15A-15E with controllable vacuum. During the run on the first wire 10 the fiber web water removal is substantially horizontal. The first one-wire run is followed by a twin-wire run, during which the fiber web is running between the first wire 10 and the second wire 10, 20 forming a twin-wire part of the forming unit 250. During this twin-wire run water is removed by controllable water removal means 16A-16C, advantageously controllable vacuum forming shoes 16A-16B having optional adjustable loading blades P in the opposite wire loop 10. The twin-wire run is followed by another single-wire run, on which run further water removal means 14A, 14B are located, which can also function as support means for supporting the run of the fiber web W. The forming section 200 further comprises another, a second headbox M2, from which the stock suspension is fed to the forming unit 250 for forming of a second layer/-s of the fiber web W. The forming unit 250 for the second layer/-s is a single-wire part with substantially horizontal run comprising a third wire 30 for forming the fiber web W. In case in which the second layer/-s comprises only single layer, to the second headbox M2 only one stock suspension is fed, but in case in which the first layer/-s of the multilayer fiber web W comprises more than one layers to the headbox M2 is fed two or more equivalent or different kind of stock suspensions. Stock suspensions can differ from each other based on raw material, fiber length, fiber freeness or additives difference. The third wire 30 comprises rolls 32 for guiding, tensioning and/or driving the wire 30 as an endless loop. The stock suspension from the second headbox M2 is fed onto the single-wire run of the third wire 30, and thereafter the stock/-s on the third wire 30 is guided past inside the loop of the first wire 10 at the beginning run thereof located water removal means 31A-31F, which can be for example foil boxes and/or suction devices, and then the first and second layer/-s are combined at a combining roll 17 located inside the first wire loop 10 to the multilayer fiber web W. The combining roll 17 is followed by another single-wire run, on which run further water removal means 34A-34B are located, which can be for example foil boxes and/or suction devices and can also function as support means for supporting the run of the multilayer fiber web W. After the forming section 250 the fiber web W is guided to the press section, indicated by the arrow 300.

[0034] In the example of the figure 2 the control system 100 for controlling vacuum in the forming section 200 comprises a controller 150 connected operationally to several, successive suction boxes 15A-15E with controllable vacuum at the first wire 10, i.e. at the fourdrinier wire 10. Each of the successive suction boxes 15A-15B comprises a control element V5A-V5E, for example an adjustable valve V5A-V5E, to control vacuum of the corresponding suction box 15A-15B. When controlling vacuum in the forming section 200, especially in the forming unit 250 a vacuum set point value of the last suction box 15E is set independently and the set point values of preceding suction boxes 15A-15D is calculated from the set point value of the following suction box 15B-15E such, that the set point value of the vacuum P_i of a suction box 15A-15B is smaller than the set point value of the vacuum P_{i+1} of the following suction box 15B-15E, where i indicated the order of the suction box and is 1, 2, 3, 4,..., where 1 is the location of the first suction box 15A-15E in the running direction S1 or in the example i is indicated by signs A, B, C,... Thus, the equation for calculating the vacuum of a suction box 15A-15D in an arrangement of several, successive suction boxes 15A-15E is $P_i < P_{i+1}$ and the set point value of the vacuum of the last suction box 15E in the arrangement of several, successive suction boxes 15A-15E is set independently, for example manually, on basis of a measurement result of dewatering. Additionally the set point value can be calculated on basis of information in a stored data collection of set point values for different fiber web product grades. Function for the equation for calculating the vacuum of a suction box 15A-15D in the arrangement of several, successive suction boxes 15A-15E is advantageously $P_i = a*P_{i+1}$, where a is a coefficient and $0<a<1$, more advantageously $0,5<a<1,0$. Also other function formats are possible, as long as $P_i<P_{i+1}$. It can also provided that vacuum of each of the several, successive suction boxes 15A-15E at the fourdrinier wire 10 is automatically controlled on basis of data information received from a measurement device of the fiber web production line, for example on basis of layer thickness measurement, and/or on basis of dewatering data information received from the forming unit 250, for example from at least one vacuum forming shoe 16A-16C located at the second wire 20, i.e. the upper wire 20 of of the twin-wire 10, 20 part following the fourdrinier wire 10 part. The control system 100 may also be provided with an intel-

ligent add-on 110 configured to detect amount of the dewatering at the vacuum forming shoe/-s 16A-16C and control vacuum at the fourdrinier wire 10 to keep the dewatering at the fourdrinier wire 10 at the desired level (dead band). The vacuum at the fourdrinier wire 10 is controlled by controlling vacuum of at least one of water removal devices 11A-11C, 15A-15E, preferably vacuum of the successive suction boxes 15A-15E, located at the fourdrinier wire 10. Advantageously, an operator sets a set point value of the dewatering amount of the first top suction unit suction box 16A of the successive suction boxes 16A-16C in a time interval (for example l/s) and the control provides that the amount in a time interval of the dewatering is kept at the set range (for example 10 l/s). Alternatively, an operator can set a set point value of the dewatering amount of the last suction box 15E of the successive suction boxes 15A-15E in a time interval (for example l/s) and the control provides that the amount in a time interval of the dewatering is kept at the set range (for example 10 l/s).

[0035] In the examples of figures 1-2 the control system 100 comprises at least one controller 150 comprising at least a processor and a memory and a computer code for example a software application, to provide control instructions based on measurement results of dewatering amount of an upper wire 20 part of a twin-wire 10, 20 part following the fourdrinier wire 10 part, advantageously on basis of dewatering data information received from at least one vacuum forming shoe 16A-16C located in the upper wire 20 part of a twin-wire 10, 20 part following the fourdrinier wire 20 part. Thus, the controller 150 of the control system 100 receives, collects, processes, stores and transmits data. The control system 100 and the controller 150 may be configured as one entity or it may be configured of separate units connected with each other by means of data transfer connections. The control system 100 and the controller 150 is configured to provide control data to control vacuum in the forming section. The control data is transmitted to control the vacuum in the forming section 200. The control data may be transmitted to a control unit of an element and/or of a device and/or of a section of the fiber web production line. The controller 150 may be configured to provide automatic control and/or to manual control of the vacuum of the forming section 200. The controller 150 of the control system 100 advantageously comprises at least one processor and at least one memory including computer program code, the at least one memory and the computer program code are configured, with the at least one processor, to generate and transmit signals as first control data to the forming section 200 based on first information data received from the forming section 200, and based on second information data received the fiber web production line and/or based on third data received automatically and/or manually as input value/-s from a data storage. The method of controlling vacuum of the forming section 200 advantageously comprises: receiving first, and second and/or third information data, processing the received first, and second and/or third information data according to predetermined configuration, based on the processed data, generating signals according to predetermined configuration to control the vacuum of the forming section 200.

[0036] In figure 3 is shown examples of vacuum set-up graphs C1-C3. On X-axis are shown successive suction boxes 15A-15E and on Y-axis is indicated set point value of the corresponding vacuum box. As can be seen from the graphs C1-C3 only by changing the set point value of the last suction box 15E optimally, uniformly increasing vacuum profiles are provided by controlling the vacuum of the previous of successive boxes 15A-15D by controlling the vacuum as described above, on basis of equation $P_i = a*P_{i+1}$, where a is a coefficient and 0<a<1, more advantageously 0,5<a<1,0. The set point value of the last can be selected for example on basis of layer thickness measurement or by dewatering amount in connection with an upper wire of the twin wire part following the fourdrinier wire part. In the example graphs C1-C3 the vacuum set point value of the last suction box 15E has been increased at selected intervals, for example at 2 kPa steps, in a vacuum value range, for example 0-16 kPa with coefficient a value of 0,7.

[0037] In the description in the foregoing, although some functions have been described with reference to certain features and examples, those functions may be performable by other features and examples whether described or not. Although features have been described with reference to the certain examples, those features may also be present in other examples whether described or not.

[0038] Above only some advantageous examples of the inventions have been described to which examples the invention is not to be narrowly limited and many modifications and alterations are possible within the invention.

Claims

1. Method for controlling vacuum in a forming section (200) comprising at least one forming unit (250), which forming unit (250) comprises a first wire (10) and a second wire (20) forming a twin-wire part and at least one vacuum forming shoe (16A-16C) located at the second wire (20), which method comprises steps of

- measuring dewatering at the at least one vacuum forming shoe (16A-16C),
- defining based on the measured dewatering of dewatering data information, and
- controlling vacuum at the at least one forming unit (250) based on the dewatering data information of the at least one vacuum forming shoe (16A-16C), **characterized in that** in the method the vacuum is controlled in a forming unit (250)

having a fourdrinier wire section before the twin-wire part and the fourdrinier wire section comprising suction boxes (15A-15E) in the fourdrinier wire loop and that in the method vacuum of the suction boxes (15A-15E) is controlled based on the dewatering data information of the at least one vacuum forming shoe (16A-16C).

2. Method according to claim 1, **characterized in that** in the method vacuum of the at least forming unit (250) further comprising as the first wire (10) a fourdrinier wire (10) and an arrangement of several successive suction boxes (15A-15E) with controllable vacuum at the fourdrinier wire (10), that the method comprises steps of

- setting of set point value of last suction box (15E) in running direction (S; S1) of the forming unit (250) of the several successive suction boxes (15A-15E) with controllable vacuum based on the dewatering data information of the at least one vacuum forming shoe (16A-16C, and
- calculating set point value of at least one of preceding successive (15A-15D) with controllable vacuum from set point value of the following suction box in the running direction (S; S1) of the forming unit (250) such, that the set point value of the vacuum (P_i) of the preceding suction box is smaller than the set point value of the vacuum (P_{i+1}) off the following suction box in the running direction (S; S1) of the forming unit (250).

3. Method according to claim 1 or 2, **characterized in that** in the method equation for calculating the vacuum of a preceding suction box (15A-15D) in the arrangement of several, successive suction boxes (15A-15E) is $P_i < P_{i+1}$, where i is order (1, 2, 3, 4...) of the suction box in the running direction (S; S1) of the forming unit (250).

4. Method according to any of claims 1-3, **characterized in that** in the method equation for calculating the vacuum of a preceding suction box (15A-15D) in the arrangement of several, successive suction boxes (15A-15E) is $P_i = a*P_{i+1}$, where a is a coefficient and 0<a<1, more advantageously 0,5<a<1,0, and where i is order (1, 2, 3, 4...) of the suction box in the running direction (S; S1) of the forming unit (250).

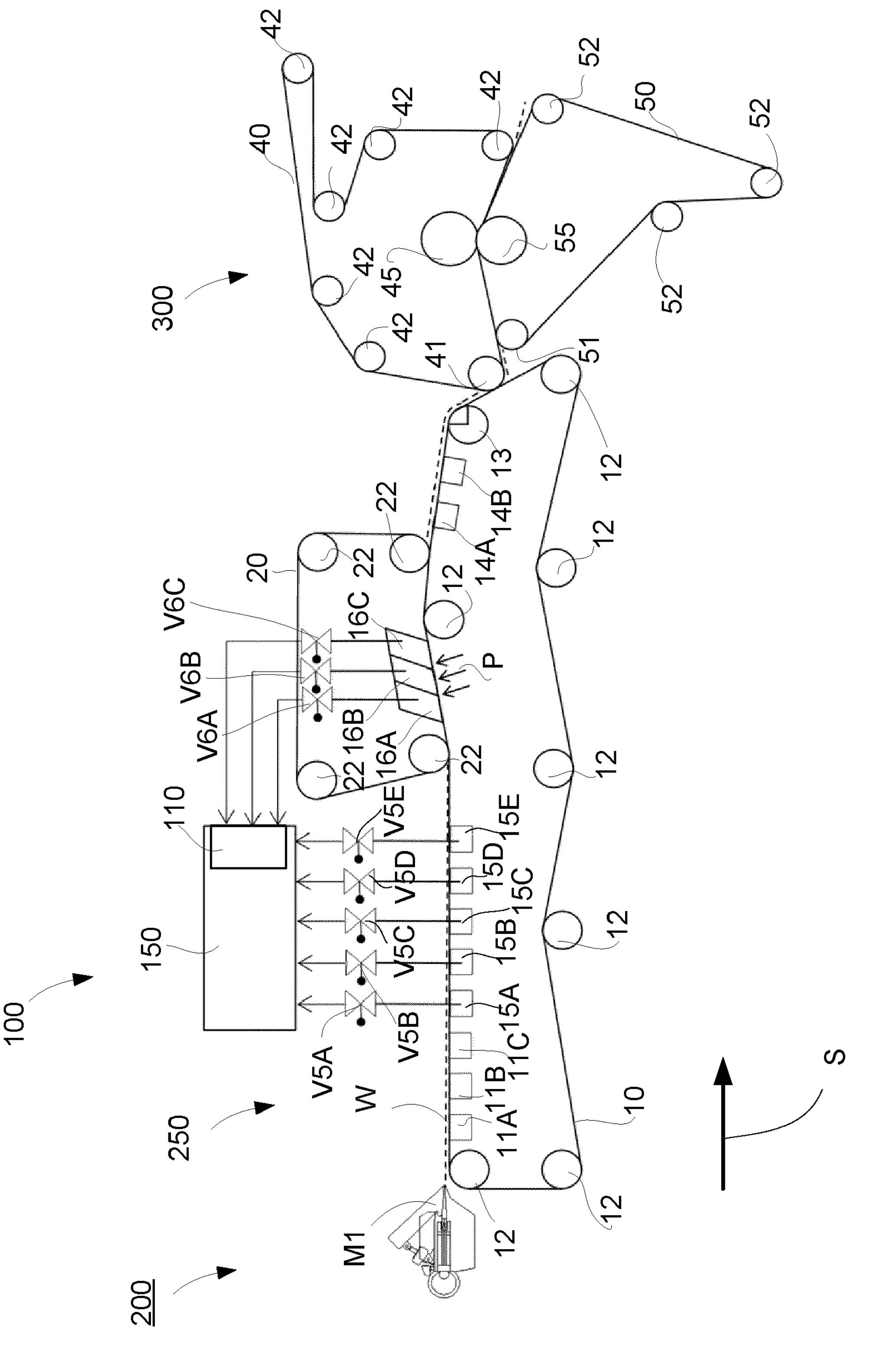
5. Method according to any of claims 1-4, **characterized in that** in the method the vacuum is controlled by a control system (100) comprising at least one controller (150) comprising at least a processor and a memory and a computer code for example a software application, to provide control instructions based on manually set data and/or measurement results received from at least one vacuum forming shoe (16A-16C), and optionally from other water removal devices of the forming section (200) and/or the fiber web production line.

6. Forming section with a control system (100) for controlling vacuum in the forming section (200) comprising at least one forming unit (250) with a first wire (10) and a second wire (20) forming a twin-wire part and at least one vacuum forming shoe (16A-16C) located at the second wire (20), which control system (100) comprises at least one controller (150) configured to define a set point value of for controlling the vacuum at the forming unit (250) on basis of dewatering data information received from the dewatering data information measured at the at least one vacuum forming shoe (16A-16C) such, that the set point value of the vacuum (Pi) of the preceding suction box is smaller than the set point value of the vacuum (P_{i+1}) off the following suction box, **characterized in that** the forming section comprises a forming unit (250) having a fourdrinier wire section before the twin-wire part and the fourdrinier wire section comprising suction boxes (15A-15E) in the fourdrinier wire loop and that in the vacuum of the suction boxes (15A-15E) is configured to be controlled based on the dewatering data information of the at least one vacuum forming shoe (16A-16C).

7. Forming section according to claim 6, **characterized in that** the forming unit (250) further comprises at the first wire (10) a one fourdrinier wire (10) and an arrangement of several successive suction boxes (15A-15E) with controllable vacuum at the fourdrinier wire (10), and that the at least one controller (150) is configured to define a set point value of last suction box (15E) of the several successive suction boxes (15A-15E) on basis of dewatering data information received from the dewatering data information measured at the at least one vacuum forming shoe (16A-16C) such, that the set point value of the vacuum (Pi) of the preceding suction box is smaller than the set point value of the vacuum (P_{i+1}) off the following suction box.

8. Forming section according to claim 6 or 7, **characterized in that** the controller (150) comprises at least a processor and a memory and a computer code for example a software application, to provide control instructions based on manually set data and/or measurement results received from the forming section, and optionally from the fiber web production line.

9. Forming section according to any of claims 6-8, **characterized in that** the control system (100) is provided with an intelligent add-on (110) configured to detect amount of the dewatering at the vacuum forming shoe/-s (16A-16C) and to control vacuum at the fourdrinier wire (10) to keep the dewatering at the fourdrinier wire (10) at the desired level.



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14A
14B
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V6A
V6B
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16B
16C
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V5A
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V5D
V5E
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100
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S
M1
200

Fig. 1

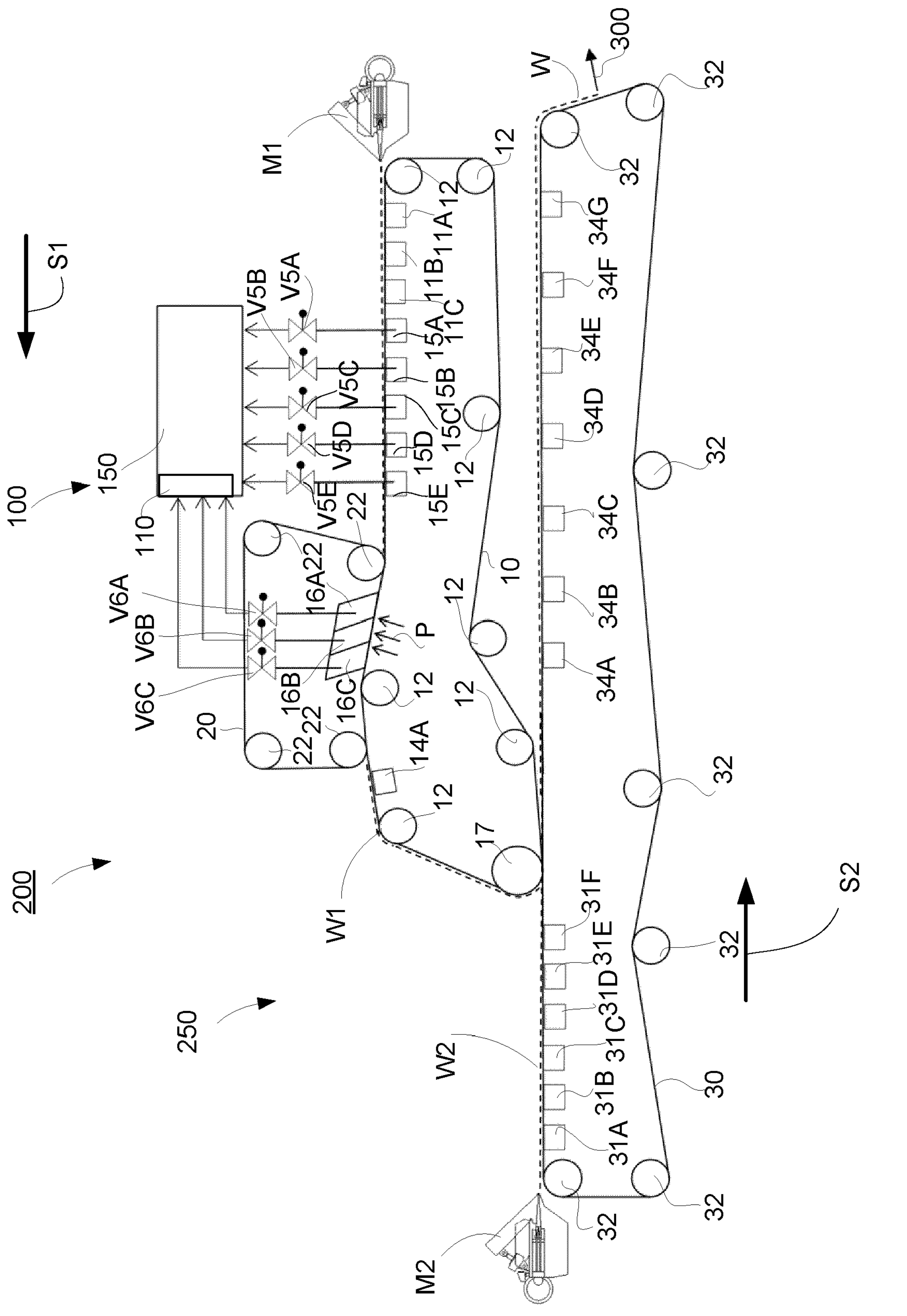
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Fig. 2

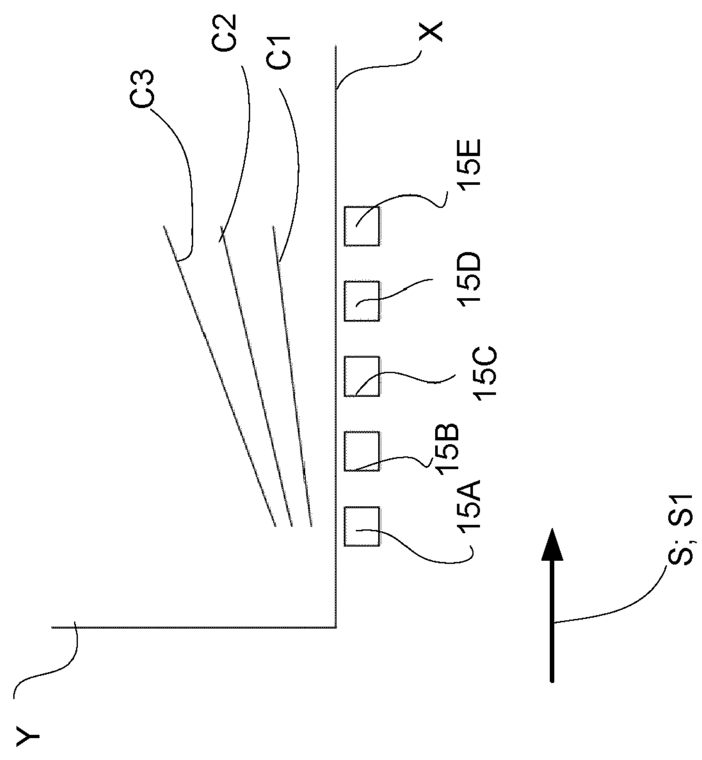

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 7025

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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D21F
D21J

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	10 December 2024	Baysal, Kudret

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