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(54) **METHOD OF FORMING A FIBER WEB AND A FORMING SECTION FOR FORMING A FIBER WEB**

(57) The invention relates to a method for forming a fiber web (W), which method comprises steps of feeding a stock suspension (M) from a headbox onto a first, lower wire (10) of a forming unit, removing water from the stock suspension (M) in the forming unit at first in a single-wire part formed by the first, lower wire (10) and thereafter in a twin-wire part formed by the first, lower wire (10) and a second, upper wire (20). The method comprises steps of at first activating the stock suspension (M) by providing turbulence to the stock suspension (M) by at least one foil unit (15) with adjustable foils (40A, 40H) in the single-wire part, after the activating step providing pressure to the from the stock suspension (M) formed fiber web (W) by pressing means (50; 60): by a sleeve roll (50) with

decreasing radius or by a metal belt (60), in the twin-wire part. The invention also relates to a forming section for forming a fiber web (W), which forming section comprises a headbox for feeding stock suspension (M) and a forming unit for forming the stock suspension (M) to a fiber web (W), which forming unit comprises a single-wire part comprising a first, lower wire (10) and a twin-wire part comprising the first, lower wire (10) and a second, upper wire (20). The forming unit comprises in the single-wire part at least one foil unit (15) with adjustable foils (40A, 40H) and in the twin-wire part pressing means (50; 60): a sleeve roll (50) with decreasing radius or a metal belt (60).

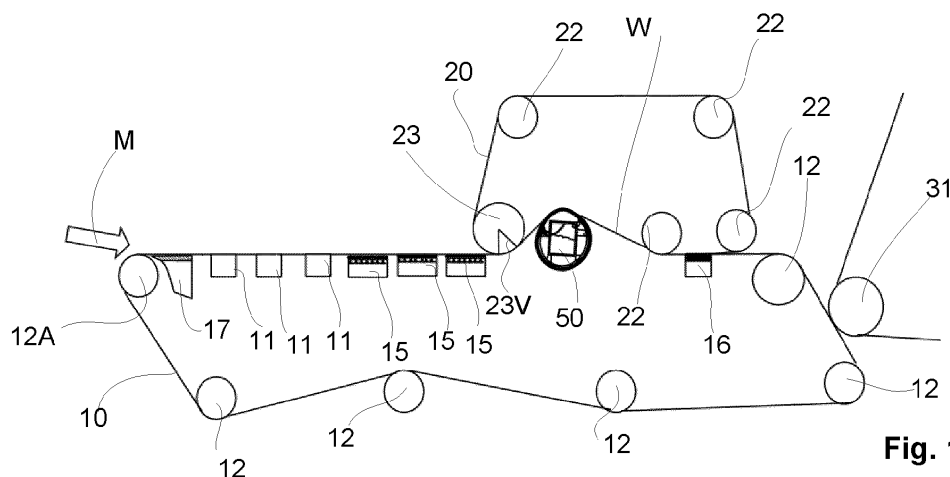


Fig. 1

Description

Technical field

[0001] The invention relates generally to producing fiber webs. Particularly the invention relates to a method of forming a fiber web according to the preamble of the independent method claim and to a forming section for forming a fiber web 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 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 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 grades: papers with a single ply and a basis weight of 25-300 g/m² and boards manufactured in single or multiply technology and having a basis weight of 80-600 m/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.

[0006] The stock suspensions to be used for producing different 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 grades virgin or recycled fibers are refined to very fine fibers i.e. to highly refined stocks for the required stock suspension. Some 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. The freeness of a stock suspensions defines drainability of a stock suspension in water. The freeness of the stock suspension is determined by a Schopper-Riegler test method and is given as a Schopper-Riegler value (°SR). For stock suspensions of highly refined stocks (high fines content or microfibrillated cellulose or nanofibrillated cellulose) and thus with difficult dewatering properties and limitations on dewatering the freeness, Schopper-Riegler value of the stock suspension is typically at least 60 °SR. These types of stock suspensions are used for example for fiber web grades of Speciality Papers and Barrier films, as well as for fiber web grades for Food packaging, Liquid packaging, Take-away packaging and Fast-food packaging type products.

[0007] The limitations of dewatering of stock suspensions with high °SR values i.e. with difficult freeness may cause increased need of vacuum for water removal but this naturally causes often highly increased energy consumption and can be used only to limited extent and/or need to reduction of basis weight to compensate the possible web sealing effect. The difficult dewatering properties may even cause need to use lower running speeds of the production, which naturally has a negative impact on cost efficiency.

[0008] In patent application publication EP2762635A1 is disclosed an adjustment mechanism comprising a lower pultrusion, an upper pultrusion and a plurality of cam blocks located between the lower pultrusion and the upper pultrusion, wherein the plurality of cam blocks are

longitudinally movable relative to the lower pultrusion and the upper pultrusion so that as the plurality of cam blocks longitudinally move, at least a portion of the upper pultrusion moves away from the lower pultrusion. The upper pultrusion and the lower pultrusion are free of longitudinal movement during longitudinal movement of the plurality of cam blocks, and the adjustment mechanism is height adjustable, angle adjustable, or both.

[0009] In patent publication EP2350385B1 is disclosed a forming section comprises a first and a second wire loop which form a twin-wire zone, which comprises and in which are arranged at least one dewatering element by means of which initial dewatering is performed from stock suspension fed by the headbox, and at least one dewatering device following said at least one dewatering element in the travel direction of the web, which dewatering device comprises a stationary support shaft on which support elements are supported at a distance from each other, an impermeable belt loop which is led to circle around the stationary support shaft supported by said support elements, wherein said at least one dewatering device further comprises at least one curvilinear dewatering zone over which the wires are led to travel supported by the belt loop, whereby the degree of curvature of the curve of the at least one curvilinear dewatering zone increases in the travel direction of the belt such that increasing dewatering pressure is applied to the stock suspension travelling between the wires on said at least one curvilinear dewatering zone, which increasing dewatering pressure is dependent on a tension of the wires and a radius of curvature of said at least one curvilinear dewatering zone, wherein the at least one curvilinear dewatering zone is preceded by two dewatering zones prevailing in opposite directions.

[0010] An object of the invention is to create a method for forming a fiber web, in which the disadvantages and problems of prior art are eliminated or at least minimized.

[0011] An object of the invention is to create a forming section for forming a fiber web, in which the disadvantages and problems of prior art are eliminated or at least minimized.

[0012] An object of the invention is to create a method and a forming sections for forming a fiber web from a stock suspension with difficult dewatering properties.

Summary

[0013] 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.

[0014] According to the invention in the method for forming a fiber web comprises feeding a stock suspension from a headbox onto a first, lower wire of a forming

unit, removing water from the stock suspension in the forming unit at first in a single-wire part formed by the first, lower wire and thereafter in a twin-wire part formed by the first, lower wire and a second, upper wire, wherein the method comprises at first activating the stock suspension by providing turbulence to the stock suspension by at least one foil unit with adjustable foils in the single-wire part and after the activating step providing pressure to the from the stock suspension formed fiber web by pressing means: by a sleeve roll with decreasing radius or by a metal belt, in the twin-wire part.

[0015] According to an advantageous feature of the invention during the activating step angle and/or height of the adjustable foils is adjusted.

[0016] According to an advantageous feature of the invention during the activating step the fiber web is effected by alternately by angle-adjustable foils and height-adjustable foils of the foil unit with the adjustable foils.

[0017] According to an advantageous feature of the invention freeness, Schopper-Riegler value, of the stock suspension is at least 60 °SR.

[0018] According to an advantageous feature of the invention pressing means directs 50 - 400 kPa dewatering pressure to the fiber web.

[0019] According to an advantageous feature of the invention the activating step comprises vacuum based water removal by vacuum water removal means alternating, advantageously sequentially, with the activating of the stock suspension by the providing turbulence to the stock suspension (M) by the foil units with adjustable foils in the single wire part.

[0020] According to an advantageous feature of the invention in the method pressure is provided to the from the stock suspension formed fiber web by the sleeve roll with decreasing radius, which comprises a stationary support shaft, an belt loop, which is led to circle around the stationary support shaft, the sleeve roll further comprises at least one curvilinear dewatering zone consisting of two partial curves such that the radius of curvature of a first partial curve is greater than the radius of curvature of a second partial curve following the first partial curve in the travel direction of belt loop.

[0021] According to the invention the forming section for forming a fiber web comprises a headbox for feeding stock suspension and a forming unit for forming the stock suspension to a fiber web, which forming unit comprises a single-wire part comprising a first, lower wire and a twin-wire part comprising the first, lower wire and a second, upper wire, wherein the forming unit comprises in the single-wire part at least one foil unit with adjustable foils and in the twin-wire part pressing means, a sleeve roll with decreasing radius or a metal belt.

[0022] According to an advantageous feature of the invention the adjustable foils of the foil unit/units comprise angle-adjustable foils and/or the height-adjustable foils.

[0023] According to an advantageous feature of the invention the adjustable foils of the foil unit comprise angle-adjustable foils and the height-adjustable foils posi-

tioned in the foil unit alternately.

[0024] According to an advantageous feature of the invention the forming unit comprises in the twin-wire part a forming roll with an open water removal sector located before the pressing means.

[0025] According to an advantageous feature of the invention the forming unit comprises in the twin-wire part a guide roll and a curved suction box with suction located before the pressing means.

[0026] According to an advantageous feature of the invention the foil unit/units with adjustable foils are located as last water removal means of the single-wire section of the forming unit.

[0027] According to an advantageous feature of the invention the forming unit comprises in the single-wire part at least two foil units with adjustable foils and at least one vacuum water removal means and the foil units with adjustable foils and the vacuum water removal means are located alternating, advantageously sequentially, in the single-wire part.

[0028] According to an advantageous feature of the invention the sleeve roll with decreasing radius comprises a stationary support shaft, an belt loop, which is led to circle around the stationary support shaft, that the sleeve roll further comprises at least one curvilinear dewatering zone consisting of two partial curves such that the radius of curvature of a first partial curve is greater than the radius of curvature of a second partial curve following the first partial curve in the travel direction of belt loop.

[0029] According to an advantageous feature of the invention the metal belt is formed as a loop guided by guide rolls and is located inside the second, upper wire and opposite to the metal belt, inside the first, lower wire is located a roll with a suction zone.

[0030] By the method and the forming section according to the invention the drainage of a stock suspension with difficult dewatering properties is improved significantly and a fiber web is formed suitable to be guided to a press section. The energy consumption and the functionality of the forming process is maintained at a level corresponding to situation with stock suspensions with good/normal dewatering properties.

Brief description of the drawings

[0031] 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 example of a forming section according to an advantageous example of the invention and for an advantageous example of the method according to the invention,

In figure 2 is shown schematically another example of a forming section according to another advantageous example of the invention and for another ad-

vantageous example of the method according to the invention,

In figure 3 is shown schematically yet an example of a forming section according to yet an advantageous example of the invention and for yet an advantageous example of the method according to the invention,

In figure 4 is shown schematically a drainage graph in connection with advantageous examples of forming sections according to the invention and for an advantageous example of the method according to the invention,

In figure 5 is shown schematically an example of adjustable foils and their pulsation effect,

In figure 6 is shown schematically an example of a sleeve roll with decreasing radius and

In figure 7 is shown schematically yet another advantageous example of the invention.

[0032] 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 have been omitted for clarity reasons.

Detailed description

[0033] In figures 1-3 and 7 is shown three advantageous examples of a forming section for advantageous examples of a forming method. Each forming section comprises a head box for feeding stock suspension M to a forming unit. The forming unit comprises foil units 15 with adjustable foils 40A; 40H (fig. 5) and the examples of figures 1 and 2 comprise a sleeve roll 50 with decreasing radius providing pressure effect to enhance water removal. In the example of figure 1 in beginning of a twin-wire part an upper wire 20 is guided onto surface of the fiber web W in area of a forming roll 23 and in the example of figure 2 in area of a curved suction box 25 with suction. Instead, the sleeve roll 50 with decreasing radius the example of figure 3 comprises a metal belt 60, which metal belt water provides a pressure effect, which removes water from the fiber web W into a roll 63 with a suction zone 63V or to openings or like in a mantle of the roll. In figure 7 is schematically shown an example, in which the forming unit comprising in the single-wire part at least two foil units 15 with adjustable foils 40A, 40H (fig. 5) has a configuration of the activating step of foil units 15 with adjustable foils 40A, 40H and the water removal means 11 alternating, advantageously sequentially. In this example the water removal means 11 are water removal means 11 removing water by vacuum i.e. so called vacuum water

removal boxes.

[0034] In the forming method for forming a stock suspension with difficult dewatering properties the drainage is increased by first activating the stock suspension M by providing turbulence by at least one foil unit 15 with adjustable foils 40A, 40H to the stock suspension M and thereafter providing pressure to the from the stock suspension M formed fiber web W by pressing means 50; 60, advantageously by the sleeve roll 50 with decreasing radius or by the metal belt 60.

[0035] In figure 1 is shown an example of a forming section for a fiber web. The forming section comprises a headbox, from which the stock suspension M is fed to the forming unit beginning as a single-wire part comprising a first wire 10 located as a lower wire below the stock M changing to the fiber web W as the water is removed. The single-wire part is followed by the twin-wire part comprising a second wire 20 for forming an upper wire of the twin-wire part, in which the lower wire is formed by the first wire 10. Each wire comprises rolls 12, 22 for guiding and driving the wire 10; 20 as an endless loop. The stock suspension M is first fed onto the first, lower wire 10 and onto area of a forming board 17 and thereafter the stock M on the wire 10 is guided past inside the loop of the wire 10 located water removal means 11, which can be for example foil boxes and/or suction devices. The run of the wire 10 during the water removal on the single-wire part is substantially horizontal. The forming board 17 comprises a foils and gaps between the foils, by which water is removed from the stock M either with gravity or suction effect. Advantageously in the beginning of the forming board 17 foils does not create pressure pulsations to the stock and in the end of the forming board 17 pressure pulsations are created to the stock. The beginning of the forming unit with the substantially horizontal single-wire part comprising the forming board 17 removing water by gravity or suction and the water removal means 11 is followed by foil units 15 with adjustable foils 40A, 40H (fig. 5). The adjustable foils 40A, 40H provide a turbulence in the fiber web W, which rearranges fibers and fines in the fiber web W improving dewatering properties of the fiber web W. Foil units 15 with adjustable foils 40A, 40H can also be after forming board 17 and before water removal means 11 or between water removal means 11, which can be for example foil boxes and/or suction devices

[0036] The fiber web W guided on the wire 10 is after the single-wire part guided to the twin-wire part, in which the fiber web W is guided in between the lower wire 10 and the upper wire 20 as their runs meet on a forming roll 23. Thus, in the beginning of the twin-wire part the upper wire 20 is guided onto surface of the fiber web W in area of the forming roll 23. The forming roll 23 located inside the loop of the second upper wire 20 is the first water removal means of the twin-wire part. Advantageously, the forming roll 23 comprises grooves or openings, into which the water from the fiber web W is removed. The grooves and the openings can extend

through the mantle of the forming roll 23, in which case the forming roll 23 is connected to an under-pressure source. The forming roll 23 comprises an open water removal sector 23V. The forming roll 23 is followed by a sleeve roll 50 with decreasing radius providing pressure to the fiber web W and thus, enhancing the water removal. The sleeve roll 50 directs 50 - 400 kPa dewatering pressure to the fiber web W. The sleeve roll 50 with decreasing radius is located inside the loop of the first, lower wire 10. After the sleeve roll 50 with decreasing radius suction means 16 are located, also inside the loop of the first, lower wire 10. The suction means 16 as such remove water but also stabilize running of the wires 10, 20. At the end of the twin-wire part the fiber web W is guided towards a pick-up roll 31 for transferring the fiber web W to a first press fabric of a press section.

[0037] In figure 2 is shown an example of a forming section for a fiber web. The forming section comprises a headbox, from which the stock suspension M is fed to the forming unit beginning as a single-wire part comprising a first wire 10 located as a lower wire below the stock M changing to the fiber web W as the water is removed. The single-wire part is followed by the twin-wire part comprising a second wire 20 for forming an upper wire of the twin-wire part, in which the lower wire is formed by the first wire 10. Each wire comprises rolls 12, 22 for guiding and driving the wire 10; 20 as an endless loop. The stock suspension M is first fed onto the first, lower wire 10 and onto area of a forming board 17 and thereafter the stock M on the wire 10 is guided past inside the loop of the wire 10 located water removal means 11, which can be for example foil boxes and/or suction devices. The run of the wire 10 during the water removal on the single-wire part is substantially horizontal. The forming board 17 comprises foils and gaps between the foils, by which water is removed from the stock M either with gravity or suction effect. Advantageously in the beginning of the forming board 17 foils does not create pressure pulsations to the stock and in the end of the forming board 17 pressure pulsations are created to the stock. The beginning of the forming unit with the substantially horizontal single-wire part comprising the forming board 17 removing water by suction and the water removal means 11 is followed by foil units 15 with adjustable foils 40A, 40H (fig. 5). The adjustable foils 40A, 40H provide a turbulence in the fiber web W, which rearranges fibers and fines in the fiber web W improving dewatering properties of the fiber web W. Foil units 15 with adjustable foils 40A, 40H can also be after forming board 17 and before water removal means 11 or between water removal means 11, which can be for example foil boxes and/or suction devices.

[0038] The fiber web W guided on the wire 10 is after the single-wire part guided to the twin-wire part, in which the fiber web W is guided in between the lower wire 10 and the upper wire 20. After a guide as roll 24. The guide roll 24 is located inside the loop of the second upper wire 20. Also, the curved suction box 25 is located inside the

loop of the second, upper wire 20 and provides the first water removal means of the twin-wire part. The curved suction box 25 is followed by a sleeve roll 50 with decreasing radius providing pressure to the fiber web W and thus, enhancing the water removal. The sleeve roll 50 with decreasing radius is located inside the loop of the first, lower wire 10. The sleeve roll 50 directs 50 - 400 kPa dewatering pressure to the fiber web W. After the sleeve roll 50 with decreasing radius suction means 16 are located, also inside the loop of the first, lower wire 10. The suction means 16 as such remove water but also stabilize running of the wires 10, 20. At the end of the twin-wire part the fiber web W is guided towards a pick-up roll 31 for transferring the fiber web W to a first press fabric of a press section.

[0039] In figure 3 is shown an example of a forming section for a fiber web. The forming section comprises a headbox, from which the stock suspension M is fed to the forming unit beginning as a single-wire part comprising a first wire 10 located as a lower wire below the stock M changing to the fiber web W as the water is removed. The single-wire part is followed by the twin-wire part comprising a second wire 20 for forming an upper wire of the twin-wire part, in which the lower wire is formed by the first wire 10. Each wire comprises rolls 12, 22 for guiding and driving the wire 10; 20 as an endless loop. The stock suspension M is first fed onto the first, lower wire 10 and onto area of a forming board 17 and thereafter the stock M on the wire 10 is guided past inside the loop of the wire 10 located water removal means 11, which can be for example foil boxes and/or suction devices. The run of the wire 10 during the water removal on the single-wire part is substantially horizontal. The forming board 17 comprises foils and gaps between the foils, by which water is removed from the stock M either with gravity or suction effect. Advantageously in the beginning of the forming board 17 foils does not create pressure pulsations to the stock and in the end of the forming board 17 pressure pulsations are created to the stock M. The beginning of the forming unit with the substantially horizontal single-wire part comprising the forming board 17 removing water by suction and the water removal means 11 is followed by foil units 15 with adjustable foils 40A, 40H (fig. 5). The adjustable foils 40A, 40H provide a turbulence in the fiber web W, which rearranges fibers and fines in the fiber web W improving dewatering properties of the fiber web W. Foil units 15 with adjustable foils 40A, 40H can also be after forming board 17 and before water removal means 11 or between water removal means 11, which can be for example foil boxes and/or suction devices.

[0040] The fiber web W guided on the wire 10 is after the single-wire part guided to the twin-wire part, in which the fiber web W is guided in between the lower wire 10 and the upper wire 20 as their runs meet on a forming roll 23. Thus, in the beginning of the twin-wire part the upper wire 20 is guided onto surface of the fiber web W in area of the forming roll 23. The forming roll 23 located

inside the loop of the second upper wire 20 is the first water removal means of the twin-wire part. Advantageously, the forming roll 23 comprises grooves or openings, into which the water from the fiber web W is removed. The grooves and the openings can extend through the mantle of the forming roll 23, in which case the forming roll 23 is connected to an under-pressure source. The forming roll 23 comprises an open water removal sector 23V. The forming roll 23 is followed by a metal belt 60, which metal belt 60 provides a pressure effect, which removes water from the fiber web W into a roll 63 with a suction zone 63V or to openings, grooves or like in a mantle of the roll. The metal belt 60 is formed as a loop guided by guide rolls 62 and is located inside the second, upper wire 20. Opposite to the metal belt 60 unit, inside the first, lower wire 10 is located the roll 63 with the suction zone 63V. The pressure provided by the metal belt 60 enhances the water removal from the fiber web W and presses the water to be removed by the roll 63 with the suction zone 63V. The metal belt 60 directs 50 - 400 kPa dewatering pressure to the fiber web W. After the metal belt 60 suction means 16 are located, also inside the loop of the first, lower wire 10. The suction means 16 as such remove water but also stabilize running of the wires 10, 20. At the end of the twin-wire part the fiber web W is guided towards a pick-up roll 31 for transferring the fiber web W to a first press fabric of a press section.

[0041] In figure 4 is shown a drainage graph in connection with advantageous examples of forming sections. In the figure 4 the forming section corresponds mainly to the example of figure 1, only with more support foils 16 at the end of the twin-wire part. It should be noted that the drainage graph corresponds substantially to any of the described examples and provides the drainage principles of the method and the forming section according to the invention. In the graph part of the figure 4 the X-axis presents the position along the forming unit and the Y-axis presents headbox flow in percent (%). In the drainage graph is included a "normal" drainage curve N, the solid curve, shows drainage in case of good/typical/normal dewatering properties for comparison and the drainage curve P, the dot-and-dash curve, shows drainage in case of difficult dewatering properties, when the Schopper-Riegler value of the stock suspension is at least 60 °SR, when the method according to the invention is used in the forming section according to the invention. As can be seen based the drainage curve N for normal dewatering properties the drainage curve proceeds almost linearly downwards as water is removed, while the stock suspension M and later the fiber web W production proceeds in the forming section. It can be readily noted based on the curve P for difficult dewatering properties that towards the end of the single-wire part the drainage curve turns almost horizontal i.e. the water removal does not proceed but as the effect of the foil units 15 with adjustable foils 40A, 40H begins and turbulence is effected to the stock suspension the drainage curve P the drain-

age curve P turns again downwards and water is removed, while the stock suspension M proceeds at the end of the single-wire part but at the very end the drainage is decreasing and water removal slowing as the drainage curve again begins to turn towards horizontal direction. As the fiber web W formed of the stock suspension M proceeds to the twin-wire part and meets the effect of the forming roll 23 the drainage curve P again turns more downwards and by the pressure effect of the sleeve roll 50 with decreasing radius the drainage curve P is more intensively turning downwards. From the drainage graph of figure 4 can also be seen that the effect of the foil units 15 with adjustable foils 40A, 40H promotes to drainage for significant percentage, T1 and the effect of the forming roll 23 and the sleeve roll 50 with decreasing radius promotes to even more significant percentage T2 to the drainage.

[0042] The method for forming the fiber web W comprises feeding a stock suspension M from the headbox onto the first, lower wire 10 of the forming unit, which stock suspension M has difficult dewatering properties, removing water from the stock suspension M in the forming unit at first in a single-wire part formed by the first, lower wire 10 and thereafter in a twin-wire part formed by the first, lower wire 10 and the second, upper wire 20. The method also comprises at first activating the stock suspension M by providing turbulence to the stock suspension M by at least one foil unit 15 with the adjustable foils 40A, 40H and after the activating step providing pressure to the from the stock suspension M formed fiber web W by the pressing means 50; 60, advantageously by the sleeve roll 50 with decreasing radius or by the metal belt 60. In the method the activating of the stock suspension M is effected during run of the stock suspension M on the first, lower wire 10 in the single-wire part before the twin-wire part beginning, when headbox flow in percent is at most 80 %, and finished when the headbox flow in percent is at least 50%. In the method the pressure providing is affected during run of the fiber web W in the twin-wire part beginning, when headbox flow in percent is at most 50 %, and finished, when the headbox flow in percent is at least 15%.

[0043] In figure 5 is shown an example of the foil unit 15 with adjustable foils 40A, 40H. The adjustment type AT of the adjustable foils 40A, 40H can be either angle-adjustable, arrows A, foils 40A or height-adjustable, arrows H. The adjustable foils 40A, 40H are supported on a support surface 41 of the foil unit 15. Each adjustable foil 40A, 40B comprises support arms 43, 44, support plate 46 and foil plate 45. The foil plates 45 are in contact with lower side of the first, lower wire 10, on support of which the stock suspension M is guided forward in the forming unit and formed to the fiber web W. The foils 40A, 40H also comprise a joint 44, which in case of angle-adjustable foils 40A provide the angle adjustment A and in case of height-adjustable foils provide the height adjustment H. Advantageously, the angle-adjustable foils 40A and the height-adjustable foils 40H are positioned

in the foil unit 15 alternately. Angle-adjustment A of the angle-adjustable foils 40A is advantageously 0-5°. Height-adjustment H of the height-adjustable foils 40H is advantageously provided such, that the foil plate 45 of the height-adjustable foil 40H is in maximum in contact with the lower surface of the first, lower wire 10 substantially at its whole width in machine direction S or the foil plate 45 of the height-adjustable foil 40H is in minimum not at all in contact with the lower surface of the first, lower wire 10 or the contact is selected between the maximum and the minimum. By arrow S is denoted the machine direction i.e. the running direction of the forming unit and by the curve Q is shown the pressure profile effect of the adjustable foils 40A, 40H in the stock suspension M.

[0044] In figure 6 is schematically shown a sleeve roll 50 with decreasing radius, which comprises a stationary support shaft 51 on which support elements 52 are supported at a distance from each other, an impermeable belt loop 53 which is led to circle around the stationary support shaft 51 supported by the support elements 52. The sleeve roll 50 further comprises at least one curvilinear dewatering zone K via which the wires 10, 20 are led to travel supported by the belt loop 53. The degree of curvature of the curve of the curvilinear dewatering zone K increases in the travel direction of the belt 53 such that increasing dewatering pressure is applied to the stock suspension travelling between the wires 10, 20 on said at least one curvilinear dewatering zone K. Radius of curvature of the curvilinear dewatering zone K consists of two partial curves such that the radius of curvature K1 of a first partial curve is greater than the radius of curvature K2 of a second partial curve following the first partial curve K1 in the travel direction of belt loop 53. Radius of curvature of the curvilinear dewatering zone K can contain several curves such that the radius of curvatures decreases in the running direction of the wires 10, 20.

[0045] In figure 7 is schematically shown an example, in which the forming unit comprising in the single-wire part with foil units 15 with adjustable foils 40A, 40H (fig. 5) has a configuration of foil units 15 with adjustable foils 40A, 40H and water removal means 11 alternating, advantageously sequentially. In this example the water removal means 11 are water removal means 11 removing water by vacuum i.e. so called vacuum water removal boxes. In this example between the foil units 15 one or more vacuum water removal means 11 is/are located. This provides in the single-wire part alternating in the activating step first activating the stock suspension by providing turbulence to the stock suspension by the foil unit 15 with adjustable foils and then removing water by the vacuum water removal means 11 and thereafter again activating the stock suspension by providing turbulence to the stock suspension by the next foil unit 15. This way the drainage properties of the fiber web are formed in order to enhance drainage by the vacuum water removal means. When forming fiber webs with difficult dewatering properties, sometimes the bottom side fiber

structure of the fiber web tends to seal and thus by the turbulence activation by the foil unit/-s 15 with adjustable foils, the freeness of the fiber structure is returned. In the example of the figure there is first two foil units 15 with adjustable foils and then two vacuum water removal means 11 followed by two foil units 15 with adjustable foils and again two vacuum water removal means 11. The number of alternating foil units 15 and water removal means 11 may vary and it can be same or different.

[0046] 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.

[0047] 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 forming a fiber web (W), which method comprises steps of

- feeding a stock suspension (M) from a headbox onto a first, lower wire (10) of a forming unit,
- removing water from the stock suspension (M) in the forming unit at first in a single-wire part formed by the first, lower wire (10) and thereafter in a twin-wire part formed by the first, lower wire (10) and a second, upper wire (20), **characterized in that** the method comprises steps of - at first activating the stock suspension (M) by providing turbulence to the stock suspension (M) by at least one foil unit (15) with adjustable foils (40A, 40H) in the single-wire part,
- after the activating step providing pressure to the from the stock suspension (M) formed fiber web (W) by pressing means (50; 60): by a sleeve roll (50) with decreasing radius or by a metal belt (60), in the twin-wire part.

2. Method according to claim 1, **characterized in that** during the activating step angle (A) and/or height (H) of the adjustable foils (40A, 40H) is adjusted.

3. Method according to claim 1 or 2, **characterized in that** during the activating step the fiber web (W) is effected by alternately by angle-adjustable foils (40A) and height-adjustable foils (40H) of the foil unit (15) with the adjustable foils (40A; 40H).

4. Method according to any of claims 1-3, **character-**

ized in that freeness, Schopper-Riegler value, of the stock suspension (M) is at least 60 °SR.

5. Method according to any of claims 1-4, **characterized in that** pressing means (50; 60) directs 50 - 400 kPa dewatering pressure to the fiber web (W).

6. Method according to any of claims 1-5, **characterized in that** in the method the activating step comprises vacuum based water removal by vacuum water removal means (11) alternating, advantageously sequentially, with the activating of the stock suspension by the providing turbulence to the stock suspension (M) by the foil units (15) with adjustable foils (40A, 40H) in the single wire part.

7. Forming section for forming a fiber web (W), which forming section comprises a headbox for feeding stock suspension (M) and a forming unit for forming the stock suspension (M) to a fiber web (W), which forming unit comprises a single-wire part comprising a first, lower wire (10) and a twin-wire part comprising the first, lower wire (10) and a second, upper wire (20), **characterized in that** the forming unit comprises in the single-wire part at least one foil unit (15) with adjustable foils (40A, 40H) and in the twin-wire part pressing means (50; 60): a sleeve roll (50) with decreasing radius or a metal belt (60).

8. Forming section according to claim 7, **characterized in that** the adjustable foils (40A, 40H) of the foil unit/units (15) comprise angle-adjustable foils (40A) and/or the height-adjustable foils (40H).

9. Forming section according to claim 7 or 8, **characterized in that** the adjustable foils (40A, 40H) of the foil unit (15) comprise angle-adjustable foils (40A) and the height-adjustable foils (40H) positioned in the foil unit (15) alternately.

10. Forming section according to any of claims 7-9, **characterized in that** the forming unit comprises in the twin-wire part a forming roll (23) with an open water removal sector (23V) located before the pressing means (50; 60).

11. Forming section according to any of claims 7-9, **characterized in that** the forming unit comprises in the twin-wire part a guide roll (24) and a curved suction box (25) with suction located before the pressing means (50; 60).

12. Forming section according to any of claims 7-11, **characterized in that** the foil unit/units (15) with adjustable foils (40A, 40H) are located as last water removal means of the single-wire section of the forming unit.

13. Forming section according to any of claims 7-12,
characterized in that the forming unit comprises in
the single-wire part at least two foil unit (15) with
adjustable foils (40A, 40H) and at least one vacuum
water removal means (11) and that the foil units (15) 5
with adjustable foils (40A, 40H) and the vacuum wa-
ter removal means (11) are located alternating, ad-
vantageously sequentially, in the single-wire part.
14. Forming section according to any of claims 7-13, 10
characterized in that the sleeve roll (50) with de-
creasing radius comprises a stationary support shaft
(51), an belt loop (53), which is led to circle around
the stationary support shaft (51), that the sleeve roll
(50) further comprises at least one curvilinear dewater- 15
tering zone (K) consisting of two partial curves such
that the radius of curvature (K1) of a first partial curve
is greater than the radius of curvature (K2) of a sec-
ond partial curve following the first partial curve (K1)
in the travel direction of belt loop (53). 20
15. Forming section according to any of claims 7-13,
characterized in that the metal belt (60) is formed
as a loop guided by guide rolls (62) and is located
inside the second, upper wire (20) and that opposite 25
to the metal belt (60), inside the first, lower wire (10)
is located a roll (63) with a suction zone (63V).

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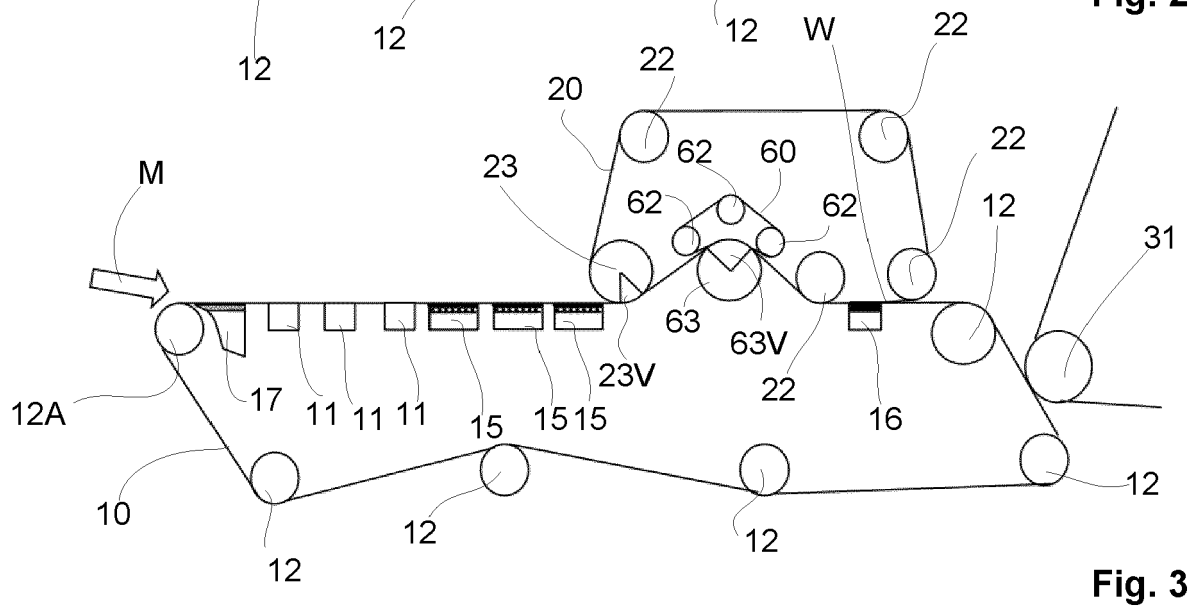
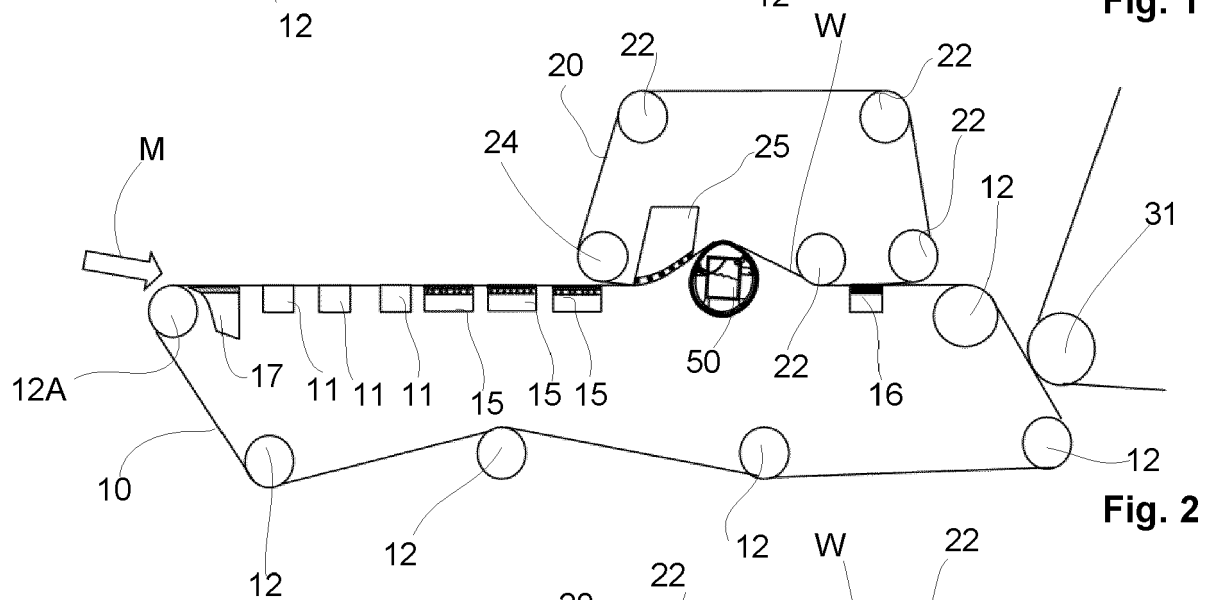
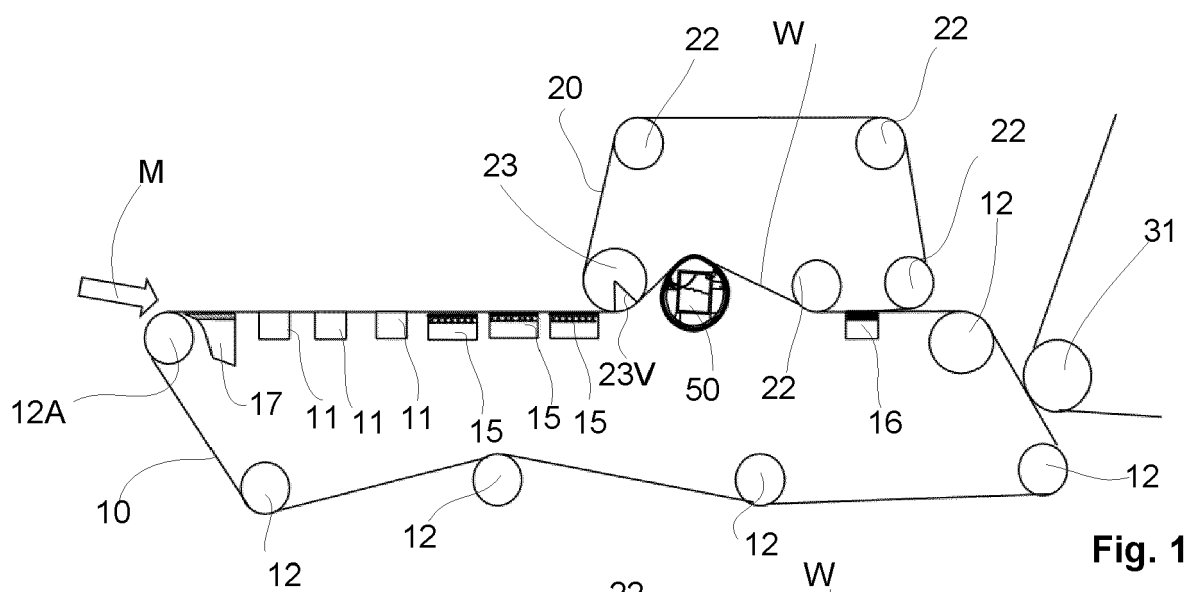
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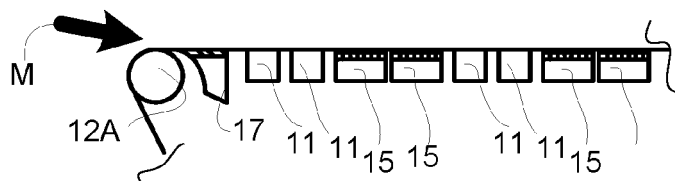
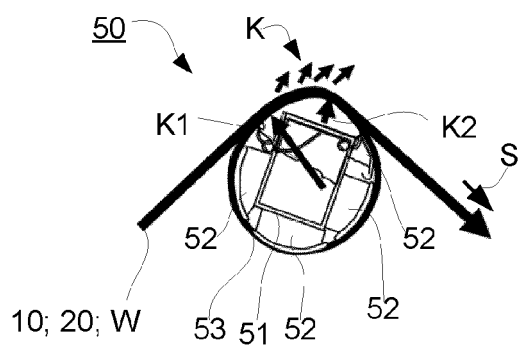
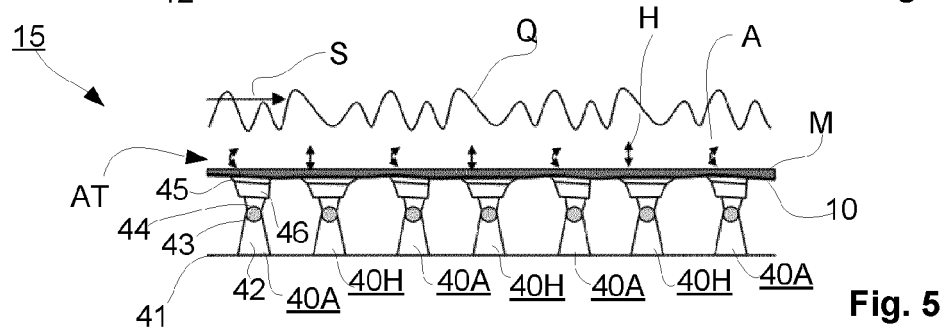
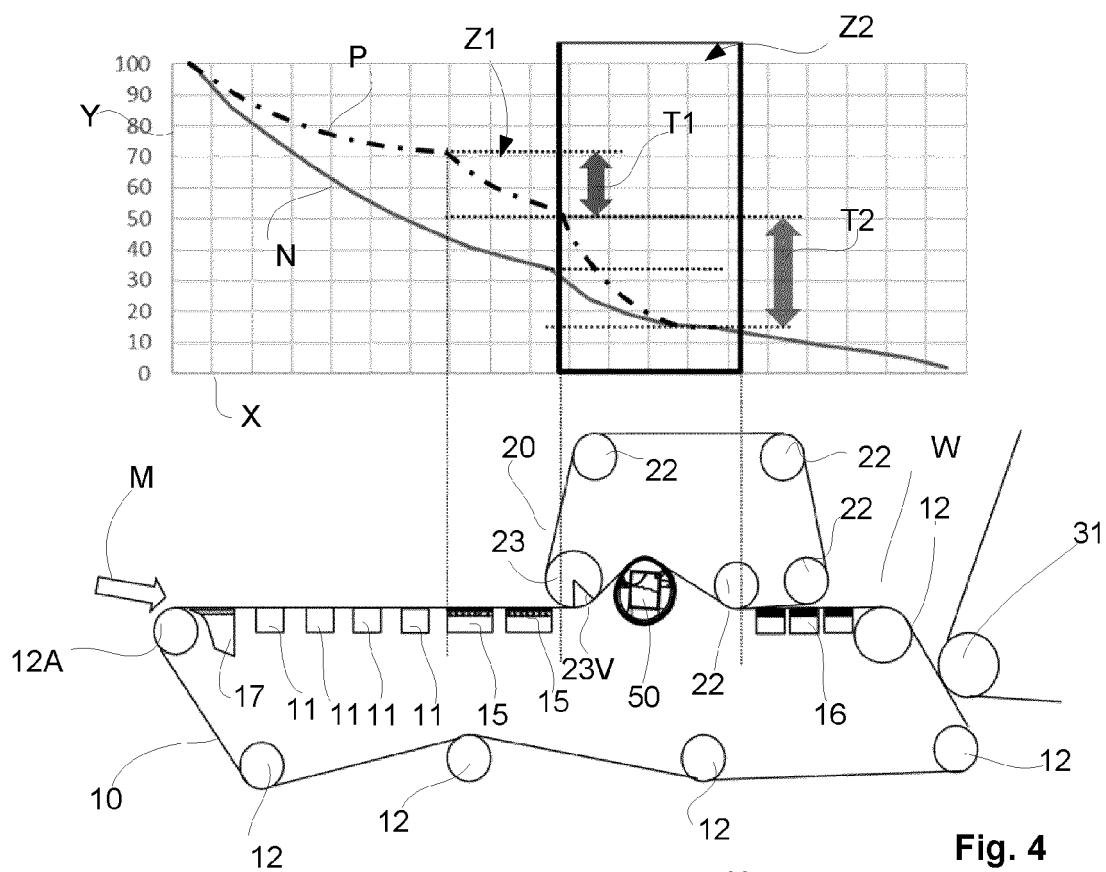
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