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(54) Method for producing fiber webs and production line for producing fiber webs

(57) The invention relates to a method for producing a fiber web (W), in which method the fiber web (W) is calendered in at least one calender (40; 70). Curl of the fiber web (W) is controlled by cooling the fiber web (W) before calendering the fiber web (W) in precalender (40) and/or in another calender (70). Dwell time between cooling and calendering, which is the time the fiber web (W) run takes from the first point of the cooling device (200) or moistening device (100) to the first calendering nip of the pre- or the other calender (40; 70), is at least 200 ms, preferably 200 - 5000 ms. The invention also relates to a production line for producing a fiber web (W), which comprises at least one calender (40; 70). For controlling the curl of the fiber web (W) the production line comprises at least one cooling device (200) located before a pre-calender (40) and/or another calender (70) and the distance between the first point of the cooling device (200) and the entering point of the fiber web (W) to first calendering nip of the pre- or the other calender (40; 70) is such that dwell time between the cooling and the calendering is at least 200 ms, preferably 200 - 5000 ms.

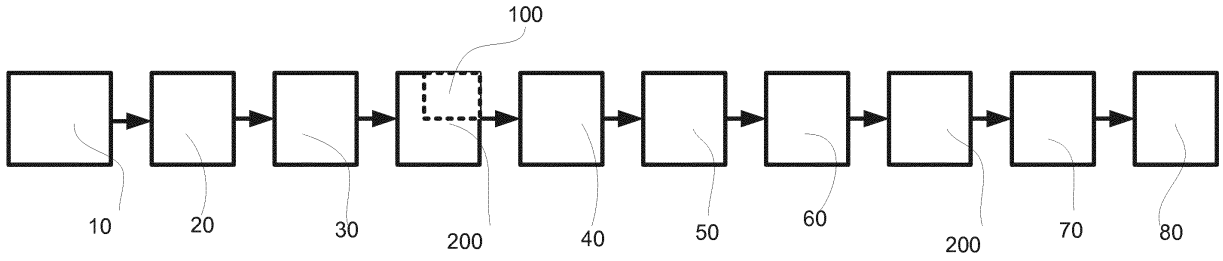

Fig. 2

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Description

[0001] In general present invention relates to producing fiber webs in a fiber web production line. More especially the present invention relates to a method according to preamble part of claim 1 and to a production line according to preamble part of claim 9.

[0002] As known from the prior art in fiber web producing processes typically comprise an assembly formed by a number of apparatuses arranged consecutively in the process line. A typical production and treatment line comprises a head box, a wire section and a press section as well as a subsequent drying section and a reel-up. The production and treatment line can further comprise other devices and/or sections for finishing the fiber web, for example a sizer, a pre-calender, a coating section, a final-calender and a reel-up. The production and treatment line also comprises at least one slitter-winder for forming customer rolls as well as a roll packaging apparatus. In this description and the following claims by fiber webs are meant for example a paper and board webs.

[0003] Pre-calendering is typically used for creating required surface properties for further treatment, for example for coating and final-calendering, which are generally carried out in order to improve the properties, like smoothness and gloss, of a web-like material such as a paper or board web. In calendering the web is passed into a nip, i.e. calendering nip, formed between rolls that are pressed against each other, in which nip the web becomes deformed as by the action of temperature, moisture and nip pressure. In the calender the nips are formed between a smooth-surfaced press roll such as a metal roll and a roll coated with resilient material such as a polymer roll or between two smooth-surfaced rolls. The resilient-surfaced roll adjusts itself to the forms of the web surface and presses the opposite side of the web evenly against the smooth-surfaced press roll. The nips can be formed also by using instead one of roll a belt or a shoe as known from prior art. Many different kinds of calenders to be used as a pre-calender and/or as an final-calender are known, for example hard nip calenders, soft nip calenders, supercalenders, metal belt calenders, shoe calenders, long nip calenders, multinip calenders etc.

[0004] One problem with calendering of fiber webs is to achieve required surface properties and simultaneously achieve required bulkiness i.e. relation of thickness of the web to its grammage (basis weight). When the fiber web has high bulkiness the basis weight can be reduced which results as considerable savings in raw material. Thus in recent times it has been one of the main focus points in developing calenders, mostly due to environmental and cost saving reasons.

[0005] Typically the fiber web is guided from the drying section to a precalender, when the temperature of the fiber web is about 80 - 90 °C. In the thickness direction of the web the middle layers of the web are hot and near plastic state, whereby during calendering the fiber web will compact also in the middle layers, which leads to unnecessary bulk loss.

[0006] It is known from prior art that bulkiness can be saved in calendering by cooling the fiber web before calendering, for example decreasing the temperature of middle layers of the fiber web by 10 °C. For example in DE 102005053968 is disclosed a method and an arrangement for calendering a paper or board or corresponding fiber web, in which the fiber web is guided through at least one heated calendering nip, where before the heated calendering nip the fiber web is guided via at least one cooling device. In this known method and arrangement the fiber web is cooled such that at least 50% of its thickness is under temperature of 30 °C and advantageously to even lower temperatures, even such that the fiber web is cooled to -10°C.

[0007] In a reel-up of the fiber web production line as a continuous web produced fiber web is reeled up into the form of a roll, a parent (machine, jumbo) roll. In the production process of the fiber web, the reeling is generally a first process part, wherein a continuous process is discontinued to be continued in sequences. One problem in reeling after calendering is that the fiber web is still rather warm, typically in temperature range of 50 - 80 °C, and during reeling of warm fiber web reeling faults may occur, coating defects may be caused and brightness of the fiber web may reduce, which leads to the need of cooling devices located after calendering, for example as disclosed in WO publication 2006/000630.

[0008] It is known that during drying of a fiber web a tendency of curl of the web may occur, in particularly when the drying is asymmetric i.e. drying of one side of the web has been more effective than the drying of the other side. Under these circumstances, the dried fiber web is usually curled and becomes concave towards the side of more effective drying and/or towards the latest dried side. It is also known from the prior art that the tendency of curl of fiber web is already affected in connection with the web formation, in particular at the formation stage by means of selection of the difference in speed between the slice jet and the wire, and by means of other running parameters. Further it is known from the prior art, for example, in the case of copying paper, by means of unequal-sidedness of drying in the after-dryer a suitable initial curl form is regulated for the web in order that the curl of the paper after one-sided or double-sided copying could be optimized. The reactivity of curl, i.e. the extent to which curl occurs per unit of change in moisture content, is influenced also by means of a multi-layer structure of the fiber web, which is produced in connection with the web formation in the wet end. From prior art are known many different ways to control curl during the drying of the fiber web. Typically the curl control is provided by controlling the temperature of a few last drying cylinder of the drying section, in some cases using the few last drying cylinders without heating, which then decreases the drying capacity of the drying section.

[0009] In EP 1015689 a method is described for drying a surface-treated paper web or equivalent in an after-

dryer of a paper machine as well as a dryer section of a paper machine for applying the method, wherein, in view of compensating for a tendency of curl of the paper web, in the after-dryer the paper web is dried in a dryer group/groups making use of a normal single-wire draw, and that, in connection with or after the drying, the paper web is treated by means of a device/devices in order to compensate for a tendency of curl of the paper web, which devices are, for example, a steam box, a blower unit, a moisturizing device, and/or a soft calender.

[0010] In WO 98/27273 is disclosed a method for drying of paper, which method the paper web to be dried is passed from the press section into a pre-dryer section and from the forward dryer section the paper web is passed into a finishing section, in which the paper web is coated/surface-sized by means of a coating/surface-sizing equipment, dried in an after-dryer section, after which the paper web is calendered in a calender and passed to a reeling station. In the method the curl of the paper web is controlled by means of elements and/or by means of assemblies and combinations formed out of said elements at least in the area of the finishing section. In this known method is mentioned as one alternative of the element to control the curl a steam box located between the dryer section and a calender and that in order to intensify the condensation in connection with the steam feed a cooling cylinder with adjustable temperature is employed.

[0011] The object of the present invention is further development of the earlier solutions described above so that the curl of the fiber web can be controlled more efficiently with increased drying capacity and simultaneously provide a method for effectively calendering fiber webs in which high bulkiness is received with less raw stock and a production line for carrying out the method.

[0012] A further object of the present invention is to approach the above problems from a new point of view and to suggest novel solutions contrary to conventional modes of thinking.

[0013] A further object of the present invention is to create a compact way to combine curl control, web cooling and moisture control.

[0014] To achieve the objects mentioned above and later the method according to the invention is mainly characterized by the features of the characterizing part of claim 1.

[0015] The production line according to the invention is mainly characterized by the features of the characterizing part of claim 9.

[0016] In accordance with the invention the curl of the fiber web is controlled by cooling the fiber web before calendering the fiber web in precalender and/or in another calender. In case the production line has a precalender and a final calender an optional cooling provided by additional, optional cooling means is provided before the final calender. According to an advantageous feature the cooling is two sided i.e. cooling is effected on both sides of the web.

[0017] According to the invention in the method the fiber web is cooled by cooling device before calendering of the fiber web in the precalender and/or before in another calender of the production line such that after cooling the fiber web is guided to the precalender or to the other calender and that dwell time between cooling and calendering, which is the time the fiber web run takes from the first point of the cooling or moistening device to the first calendering nip of the pre- or the other calender is at least 200 ms, preferably 200 - 5000 ms.

[0018] According to an advantageous feature of the invention the temperature of the fiber web when entering the first calendering nip is 10 - 55°C, preferably 20 - 50 °C.

[0019] According to an advantageous feature of the invention the temperature of the middle of the fiber web when entering the first calendering nip is 10 - 55 °C, preferably 20 - 50 °C.

[0020] According to an advantageous feature of the invention the fiber web is moisturized by a moisturizing device before and/or after and/or during cooling in the cooling device for enhancing the cooling of the fiber web by evaporation.

[0021] According to an advantageous feature of the invention in the method the fiber web is reeled in a reel-up after the calendering in final calender such that the temperature of the web is not higher than 55 °C, preferably in temperature in the range of 20 - 50 °C and that if necessary the fiber web is cooled before the calendering.

[0022] According to advantageous feature the fiber web is cooled by contactless cooling effect by the cooling device. The cooling device is for example an air borne cooling device or impingement cooling device.

[0023] According to advantageous feature the fiber web is cooled by contacting cooling effect by the cooling device.

[0024] According to an advantageous aspect of the invention the fiber web is cooled after drying before precalendering.

[0025] According advantageous features of the invention the cooling device provides for blowing or creating a flow of cooled gas, for example air.

[0026] In order to control the curl of the fiber web in accordance with the invention the amount of cooling is controlled on each or on one side of the fiber web, advantageously moisturizing amount is controlled on each or on one side of the fiber web.

[0027] In the following the invention is further explained in detail with reference to the accompanying drawing in which:

In figure 1 is very schematically shown an example of a production line for producing fiber web according to the prior art.

In figure 2 is very schematically shown an example of a production line for producing fiber web according to one example of the invention.

In figures 3 - 6 is schematically shown examples of production lines for producing fiber web according to some examples of the invention,

In figure 7 is schematically shown various configurations for moisturizing and cooling devices in a fiber web production line and

In figures 8 - 10 is schematically shown further examples of configurations for moisturizing and cooling devices in a fiber web production line according to some advantageous examples of the invention.

[0028] In the figures and the description thereof same reference signs have been used for corresponding parts, part components and sections unless otherwise mentioned.

[0029] In the very schematical example of a production line for producing fiber webs shown in figure 1 the production line according to prior art comprises a board or paper machine with dryer section 10, a sizer 20 with an after dryer 30, an optional moisturizer 100, a precalender 40, a coater 50 with dryer 60, a calender 70, an optional web cooler 150 and a reel-up 80. Typical speeds of fiber web production lines are for board 600 - 1000 m/min, for liner 1000 - 1400 m/min and for paper 1200 - 2000 m/min. In prior art production lines the temperature of the web coming out from dryer section 10 is typically 90 - 150 °C, often about 95 °C and its solids content is 92 - 96%. In prior art production lines curl control is typically done at dryer section 10 by running one drying cylinder row at lower temperature, which results as more or less one-sided drying. This may mean a significant capacity loss, since drying potential is not fully in use, if for example 10 - 20 drying cylinders are used at low temperature. Hot fiber web is generally preferred in sizing, since it improves sizing agent penetration and rapid beginning of sizing agent drying. The web temperature after drying in after dryer 30 of the sizer 20 is typically 85 - 90 °C. The after dryer 30 of the sizer may optionally be followed by a moisturizer 100, where water spray is used in order to enhance gradient calendering in the precalender 40. Typically the amount of spray water added to the web is 1 - 3 g/m^2. When the fiber web enters the precalender its' temperature is typically 60 - 90 °C. If in the precalendering short nip calendering is used it increases the web temperature only about 10 - 15 °C, thus the ingoing temperature of the web when entering the coater 50 is 80 - 90 °C. After coating in the coater 50 the fiber web is dried in a dryer 60, after which the temperature of the web is 70 - 120 °C. Before the reel-up 80 the web may optionally be cooled by a web cooler 150 in order to ensure low reeling temperature under 55 °C to ensure reeling quality.

[0030] In the very schematical example of a production line for producing fiber webs in accordance with the invention shown in figure 2 the production line comprises a board or paper machine with dryer section 10, a sizer 20 with an after dryer 30, a cooling device, for example a web cooler 200 with optional moisturizer 100, a precalender 40, a coater 50 with dryer 60, a cooling device, for example a web cooler 200, a calender 70 and a reel-up 80. The speeds of fiber web production line are for board 600 - 1000 m/min, for liner 1000 - 1400 m/min and for paper 1200 - 2000 m/min. In this example the temperature of the web coming out from dryer section 10 is 90 - 150 °C, preferably about 95 °C and the solids content of the fiber web is 92 - 96%. The curl control is done by the web cooler 200 located before the precalender 40 thus at dryer section 10 all drying cylinders may be run at high drying temperature and thus fully utilizing all drying cylinders. This means a significant capacity increase, since drying potential is fully in use. Hot fiber web preferred in sizing improves sizing agent penetration and rapid beginning of sizing agent drying. The web temperature after drying in after dryer 30 of the sizer 20 is typically 85 - 90 °C. The after dryer 30 of the sizer 20 is followed for curl control of the fiber web by a web cooler 200 with an optional moisturizer 100. By the web cooler 200, preferably by a flotation chill box, the fiber web is effectively cooled to temperature 35 - 55 °C. The cooling is preferably evaporative cooling, which enhances the cooling. Optionally a moisturizer 100 is used, in which water sprays further enhance cooling rate and to adjust web moisture before precalendering. Preferably the web chilling and spray moisturizing is done on both sides of the web and two-sidedness is adjusted to control the curling. Advantageously the cooling effect of the web cooler 200 is 30 - 50 °C. Thus low ingoing temperature 30 - 50 °C to the precalender 40 is achieved, by which bulk savings are provided, in particular in case of short nip precalendering either hard or soft nip calendering. Advantageously web moisture is adjusted to suitable level, for example 6 - 10 %. In precalender 40 an effective moisture and temperature gradient precalendering takes place. In the precalendering advantageously used short nip calendering increases the web temperature only about 10 - 15 °C, thus the ingoing temperature of the web when entering the coater 50 is 45 - 60 °C. After coating in the coater 50 the fiber web is dried in a dryer 60, after which the temperature of the web is 70 - 120 °C. Before the calendering in the final calender 70, the fiber web is advantageously cooled by a cooling device, for example a web cooler 200. Preferably the web cooler 200 is a contact cooler or air flotation cooler. By the web cooler 200 the ingoing temperature of the fiber web is reduced to 30 - 55 °C and further bulk savings are achieved. Thus the temperature of the fiber web after calendering is also lower 50 - 55 °C and the low temperature needed in reeling in the reel-up 80 is provided without further cooling devices as the temperature of the fiber web is 50 - 55 °C after calendering.

[0031] In figure 3 the fiber web W is guided from the paper or board machine with dryer section 10 prior to the calendering in a calender 70 to an optional moisturizing device 100 and thereafter to cooling device 200, which is followed by an optional moisturizing device 100. From the calender 70 the fiber web is guided reeling in a reel-

up 80. In this example the fiber web W to be produced is uncoated and the production line is provided with two sided cooling with the cooling device 200 and the curl control of the fiber web W is done two sided by the moisturizing sprays of the moisturizing devices 100 and chilling blows of the cooling device 200.

[0032] In figure 4 the fiber web W is guided from the paper of board machine with dryer section 10 prior to the precalendering in a precalender 40 to an optional moisturizing device 100 and thereafter to cooling device 200. Precalendering is followed by coating of the fiber web W in a coater 50 with dryer 60. After coating the fiber web W can optionally be cooled by a cooling device 200 before the final calendering in a calender 70. The calendering of the fiber web W is followed by reeling in a reel-up 80. In this example the fiber web W to be produced is coated and the curl control of the fiber web W is done two sided by the optional moisturizing sprays of the moisturizing devices 100 and by chilling blows of the cooling device 200.

[0033] In figure 5 the fiber web W is guided from the paper of board machine with dryer section 10 to be sized in a sizer 20. After sizing the fiber web is dried in a dryer 30 and prior to the calendering in a calender 70 the fiber web W is guided to an optional moisturizing device 100 and thereafter to cooling device 200. The calendering of the fiber web W is followed by reeling in a reel-up 80. In this example the fiber web W to be produced is uncoated and the curl control of the fiber web W is done two sided by the optional moisturizing sprays of the moisturizing devices 100 and by chilling blows of the cooling device 200.

[0034] In figure 6 the fiber web W is guided from the paper of board machine with dryer section 10 to be sized in a sizer 20. After sizing the fiber web is dried in a dryer 30 and prior to the precalendering in a precalender 40 the fiber web W is guided to an optional moisturizing device 100 and thereafter to cooling device 200. Precalendering is followed by coating of the fiber web W in a coater 50 with dryer 60. After coating the fiber web W can optionally be cooled by a cooling device 200 before the final calendering in a calender 70. The calendering of the fiber web W is followed by reeling in a reel-up 80. In this example the fiber web W to be produced is coated and the curl control of the fiber web W is done two sided by the optional moisturizing sprays of the moisturizing devices 100 and by chilling blows of the cooling device 200.

[0035] In figure 7 is schematically shown various configurations for moisturizing devices 100 and cooling devices 200 in fiber web production line examples in accordance with advantageous examples of the invention. The moisturizing devices 100 are optional and can be located either separate from or in connection with the cooling devices 200. The moisturizing devices 100 and the cooling devices 200 are located two sided in respect of the fiber web W so that the curl control, when needed, can be effected to both sides of the fiber web W.

[0036] In figures 8 - 10 is schematically shown various configurations for moisturizing devices 100 and cooling devices 200 in fiber web production line examples in accordance with advantageous examples of the invention. The moisturizing devices 100 are optional and can be located either separate from or in connection with the cooling devices 200. The moisturizing devices 100 and the cooling devices 200 are located two sided in respect of the fiber web W so that the curl control, when needed, can be effected to both sides of the fiber web W. In the examples of figures 8 - 10 is also shown some configurations to provide a long influencing time for the cooling before calendering 40; 70.

[0037] In figure 8 the fiber web is guided to an extended run by guide elements 125 that guide the fiber web W to an extended run via the basement level of the fiber web production hall. By dashed line F is indicated the floor lever of the main fiber web production hall. Along the extended run cooling devices 200 and optional moisturizing devices 100 can be located.

[0038] In figure 9 the fiber web is guided to an extended run by guide elements 125 that guide the fiber web W to an extended run via the upper parts above the main production line of the fiber web production hall. By dashed line F is indicated the floor lever of the main fiber web production hall. Along the extended run cooling devices 200 and optional moisturizing devices 100 can be located.

[0039] In figure 10 the fiber web is guided to an extended run by guide elements 125 that guide the fiber web W to an extended run meandering via the upper parts and lower parts of the main production line in the fiber web production hall. Along the extended run optional moisturizing devices 100 can be located. The cooling is provided by open web draws and optionally for example the first two guide elements 125 may be cooled rolls or turn elements. In this example the optional cooling devices may be located before or during the meandering extended run of the fiber web W before to the calender 40; 70.

Claims

1. Method for producing a fiber web (W), in which method the fiber web (W) is calendered in at least one calender (40; 70), **characterized in that** curl of the fiber web (W) is controlled by cooling the fiber web (W) before calendering the fiber web (W) in precalender (40) and/or in another calender (70) and that dwell time between cooling and calendering, which is the time the fiber web (W) run takes from the first point of the cooling device (200) or moistening device (100) to the first calendering nip of the pre- or the other calender (40; 70), is at least 200 ms, preferably 200 - 5000 ms.

2. Method according to claim 1, **characterized in that** the fiber web (W) is pre-calendered in a precalender

(40) and additionally calendered in a final calender (70) and that the fiber web is cooled by optional cooling device (200) is provided before the final calender (70).

3. Method according to claims 1 or 2, **characterized in that** the cooling of the fiber web (W) is two sided i.e. cooling is effected on both sides of the fiber web (W).

4. Method according to any of claims 1-3, **characterized in that** the temperature of the fiber web when entering the first calendering nip is 10 - 55 °C, preferably 20 - 50 °C.

5. Method according to any of claims 1-4, **characterized in that** the temperature of the middle of the fiber web when entering the first calendering nip is 10 - 55 °C, preferably 20 - 50 °C.

6. Method according to any of claims 1-5, **characterized in that** the fiber web (W) is moisturized by a moisturizing device (100) before and/or after cooling in the cooling device (200) and/ or moisturized in the cooling device (200) for enhancing the cooling of the fiber web (W) by evaporation.

7. Method according to claim 1, **characterized in that** the fiber web (W) in the method the fiber web is reeled in a reel-up after the calendering in final calender such that the temperature of the web is not higher than 55 °C, preferably in temperature in the range of 20 - 50 °C and that if necessary the fiber web is cooled before the calendering.

8. Method according to claim 1, **characterized in that** to control the curl of the fiber web the amount of cooling is controlled on each or on one side of the fiber web and that advantageously moisturizing amount is controlled on each or on one side of the fiber web.

9. Production line for producing a fiber web (W), which comprises at least one calender (40; 70), **characterized in that** for controlling the curl of the fiber web (W) the production line comprises at least one cooling device (200) located before a precalender (40) and/or another calender (70) and that the distance between the first point of the cooling device (200) and the entering point of the fiber web (W) to first calendering nip of the pre- or the other calender (40; 70) is such that dwell time between the cooling and the calendering is at least 200 ms, preferably 200 - 5000 ms.

10. Production line according to claim 9, **characterized in that** the cooling device (200) is located between the dryer (10) and the precalender (40) and/or between the dryer (10) and the other calender (70) and that the cooling device (200) comprises a moisturizing device (100).

11. Production line according to claim 9 or 10, **characterized in that** the production line comprises a precalender (40) and additionally a final calender (70) and at least one optional cooling device (200) located before the final calender (70).

12. Production line according to any of claims 9 - 11, **characterized in that** the cooling device (200) is provided on both sides of the web.

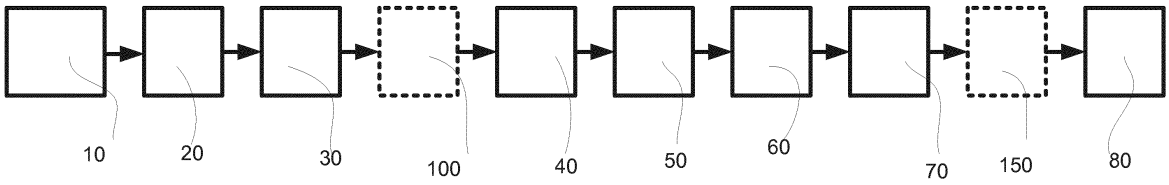

Fig. 1 Prior art

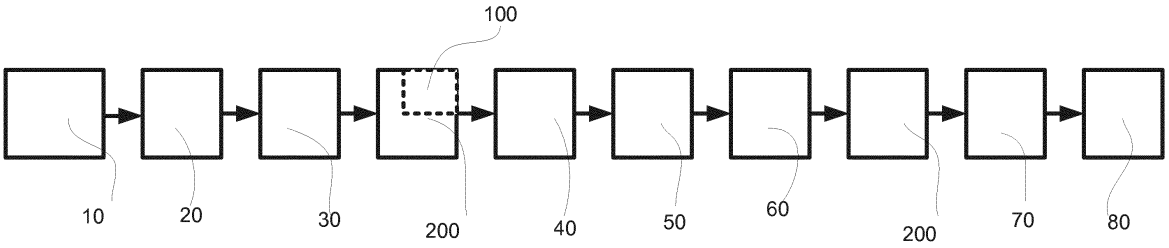

Fig. 2

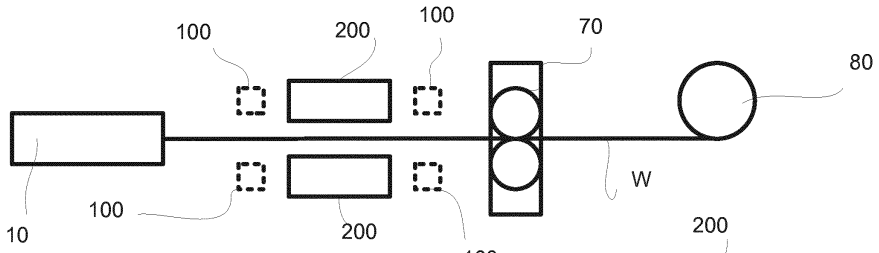

Fig. 3

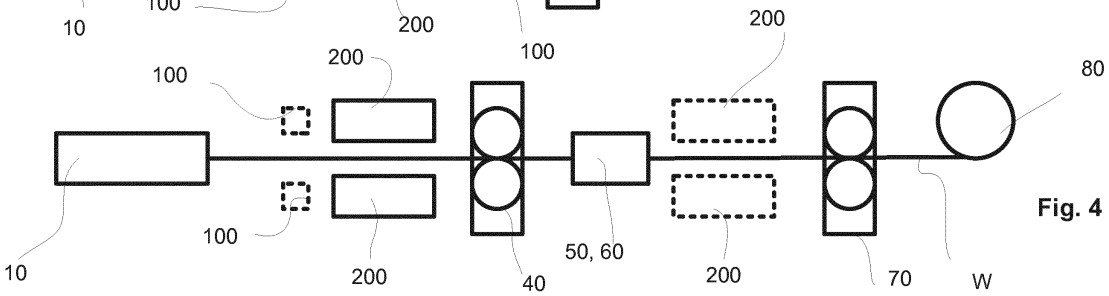

Fig. 4

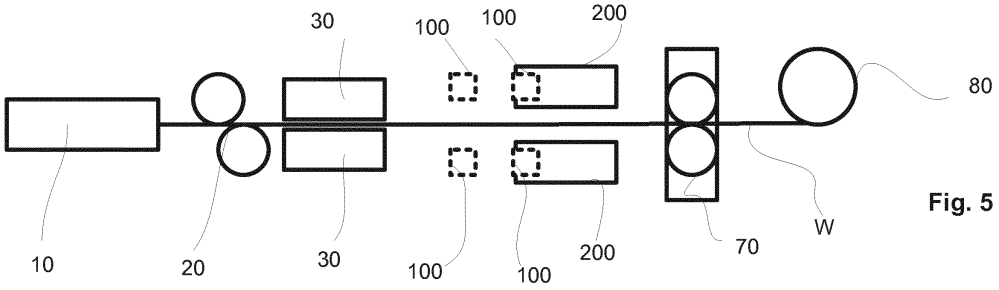

Fig. 5

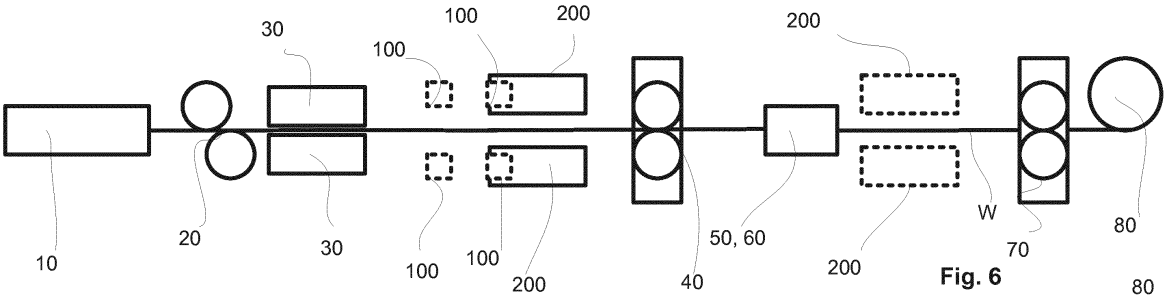
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Fig. 6

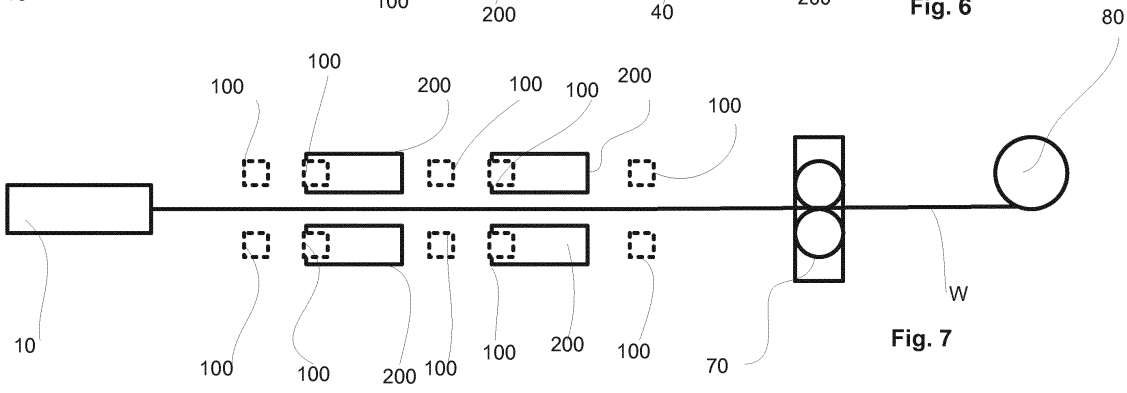
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Fig. 7

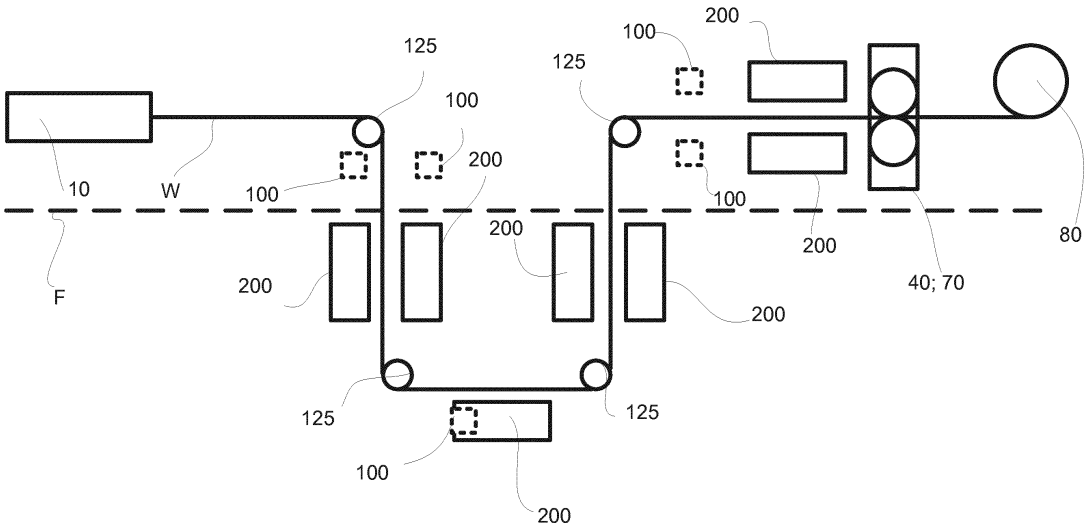
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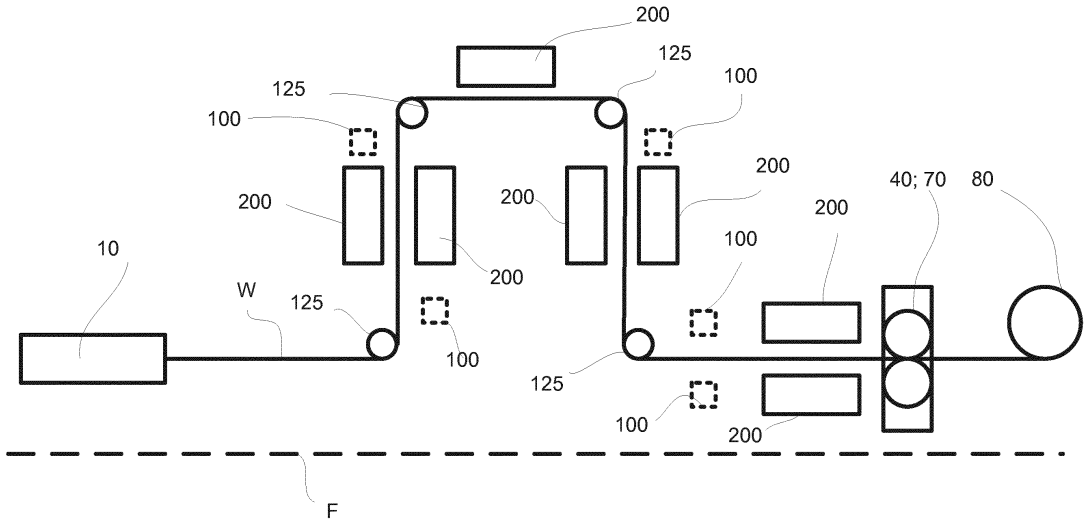
Fig. 8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200
F

Fig. 9

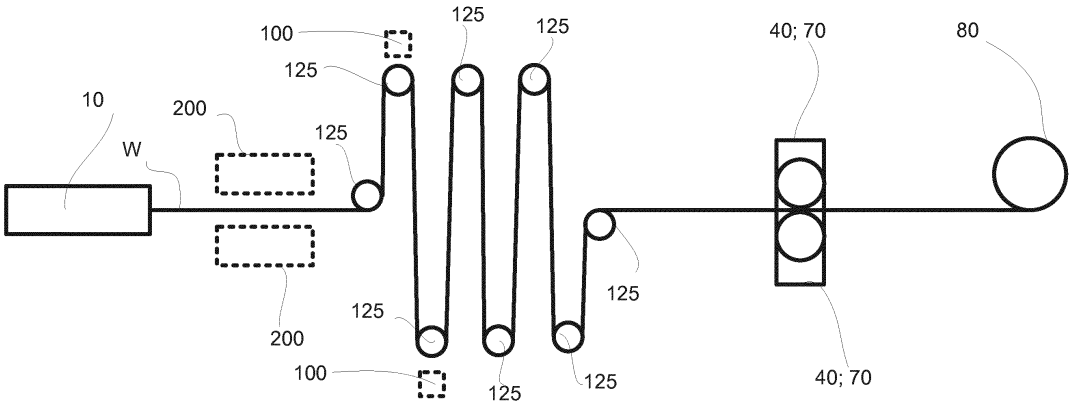
100
125
125
125
40; 70
80
10
200
125
W
125
200
125
100
125
125
125
40; 70

Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 13 15 4162

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Place of search	Date of completion of the search	Examiner
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