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

(11) **EP 2 108 606 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.10.2009 Bulletin 2009/42

(51) Int Cl.:
B65H 18/20 *(2006.01)*

(21) Application number: **09155962.5**

(22) Date of filing: **24.03.2009**

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

(30) Priority: **10.04.2008 FI 20085301**

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(54) **Carrier-roll winder and method for using carrier-roll winder**

(57) The present invention relates to a carrier-roll winder (10) which comprises at least two surface support elements (15, 20) to support at least one reel (25) being formed at least for part of the forming time of the reel substantially below it and at least one loading device (30) which is arranged to support said reel (25) at least for part of the forming time of the reel substantially above it, and in which the carrier-roll winder is provided with at least one drive (15.1, 20.1, 30.1) so that the drive (15.1, 20.1, 30.1) is arranged to apply tangential force to the reel (25) being wound. The carrier-roll winder (10) comprises a control arrangement (100) which is arranged to control said at least one drive (15.1, 20.1, 30.1) of the carrier-roll winder so that the drive provides the reel/reels (25) being wound with an effect diminishing the bouncing phenomenon.

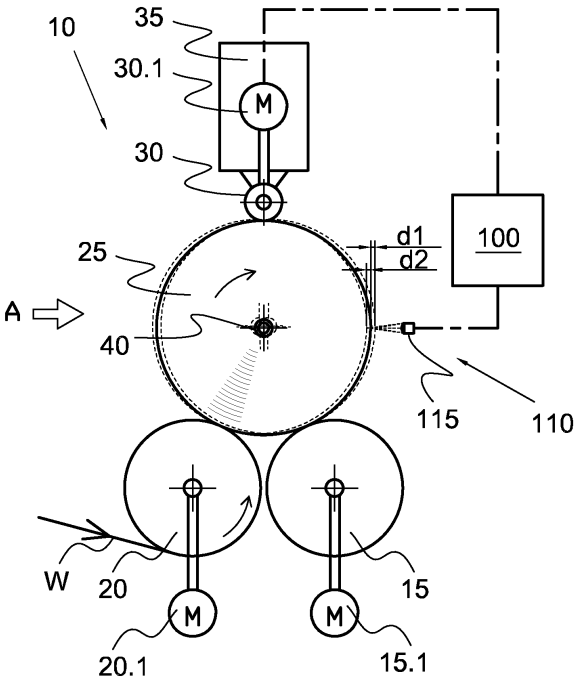

FIG. 1

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Description

[0001] The invention relates to a carrier-roll winder according to the preamble of claim 1, which comprises at least two surface support elements to support at least one reel being formed at least for part of the forming time of the reel substantially below it and at least one loading device which is arranged to support said reel substantially above it and in which the carrier-roll winder is provided with at least one drive so that the drive is arranged to apply tangential force to the reel being wound. The invention also relates to a method for using a carrier-roll winder according to the preamble of claim 9.

[0002] On a fibrous web slitter-winder, a full-width fibrous web is unwound from a so-called machine reel which web is cut into several partial webs parallel in the cross-machine direction on the cutting part of the slitter-winder and the partial webs are wound into partial web reels on the winding part of the slitter-winder. In slitter-winders of carrier-roll type, the partial web reels are wound on top of two carrier rolls or a carrier roll and a set of belt rolls. A simultaneously wound group of partial web reels, i.e. the so-called set, is additionally supported from the top with a rider roll or equivalent and edge reels from their winding cores. From prior art, an arrangement of this type is known, inter alia, in specification US4601441. With certain fibrous-web types, the forming of partial web reels can be achieved more advantageous if the rider roll is provided with a drive. Then, it is possible to apply moment/force, i.e. pull, to the surface of the reel with the rider roll. Specification US2003/0234315A1 describes a carrier-roll winder in which the rider roll unit comprises several rolls provided with a separate drive.

[0003] In a slitter-winder of the carrier-roll type, the whole set or single reels can start to oscillate on a relatively low frequency (about <10 Hz) in the machine direction on top of the carrier rolls. This is commonly called the "bouncing" phenomenon. Different from vibration, bouncing is such of its nature that it is very difficult, often even impossible to detect with normal vibration measurements. It is not also possible to prevent the phenomenon successfully and sufficiently with traditional vibration dampers. The phenomenon can also limit the maximum speed usable in winding, thus decreasing capacity. In the worst case, the phenomenon can cause the off-throwing of the set.

[0004] Specification US4180216 presents as a solution for the bouncing problem transferring the rider roll during winding along the surface of the reel from its peak point as the reel increases with the purpose of changing the spring constant of the reel being completed. The specification also suggests using several rider rolls simultaneously to support the set. The adjustment of the position of the rider roll is described occurring pre-programmedly based on experience and the roll diameter of the set being completed, among others. With this type of an arrangement, it is in practice not possible to prevent the bouncing phenomenon sufficiently, because actual conditions in winding are always different from the ones of a previously compiled statistical model.

[0005] Specification US4171106 describes movable carrier rolls as the solution for the bouncing problem. The specification presents that the carrier rolls are transferred away from each other according as the reel diameter of the set increases. An arrangement of this type, in which both carrier rolls are movable, is technically very complex to implement in practice.

[0006] The object of the invention is indeed to provide such a carrier-roll winder and a method for using a carrier-roll winder by means of which the bouncing phenomenon is at least minimised. A particular object of the invention is to provide a carrier-roll winder of the slitter-winder of a fibrous web and a method of the carrier-roll winder.

[0007] The objects of the invention are mainly achieved with a carrier-roll winder according to claim 1 and a method according to claim 9.

[0008] Unless more particularly defined, in this context the following definitions are valid. A carrier-roll winder refers to a web winder in which at least one reel being formed is supported below the reel with at least two surface support devices of the reel, such as a roll or a set of belt rolls. The cross direction refers to the direction of the longitudinal axis of the surface support device, such as the roll, and the machine direction the direction perpendicular in relation to the cross direction and the vertical direction. A set refers to a set of partial web reels being wound simultaneously on the winder. A reel refers to one or more reels.

[0009] According to a first embodiment of the invention, the carrier-roll winder comprises at least two surface support elements of the reel arranged to support at least one reel being formed substantially below it and at least one loading device which is arranged to support said reel at least for part of the forming time of the reel substantially above it, and in which the carrier-roll winder is provided with at least one drive so that the drive is arranged to apply tangential force to the reel being wound. The invention is mainly characterised by that the carrier-roll winder comprises a control arrangement which is arranged to control said at least one drive of the carrier-roll winder so that the drive provides the reel/reels being wound with an effect diminishing the bouncing phenomenon.

[0010] The control arrangement comprises an arrangement for detecting and monitoring the bouncing phenomenon of the reel/reels which according to an embodiment comprises elements for registering momentary changes in the machine-directional position of said at least one reel. This is advantageously implemented so that the elements comprise a contact-free distance measuring device arranged to measure the position of the surface of the reel being formed.

[0011] According to an advantageous embodiment, the loading device of the carrier-roll winder is provided with a drive and the control arrangement is arranged to control the drive of the loading device so that tangential

force applied by the drive to the reel provides an effect diminishing the bouncing phenomenon. Advantageously, the loading device is a rider roll which extends in the cross direction over the whole set.

[0012] According to another embodiment of the invention, one or both of said surface support elements is provided with a drive and the control arrangement is arranged to control the drive of the surface support element so that tangential force applied by the drive to the reel provides an effect diminishing the bouncing phenomenon.

[0013] Advantageously, the control arrangement is arranged to control the drive so that with the drive is applied to the reel or reels tangential force provided by the bouncing phenomenon, resisting a change in the machine-directional position of the reel or reels substantially diverging from the steady state. In the method for using a carrier-roll winder according to the invention, partial web reels are wound supported by at least two surface support elements substantially below the partial web reels, and supported by at least one loading device at least for part of the forming time of the reel substantially above the partial web reels and, in which method, to the partial web reel/reels is applied tangential force by means of at least one drive and via at least one of said surface support elements or the loading device. The method is mainly characterised by that at least one drive is controlled so that the drive provides the reel/reels being wound with an effect diminishing the bouncing phenomenon.

[0014] Advantageously during winding, the occurrence of a possible machine-directional to-and-fro motion of the reels being wound (the bouncing phenomenon) is determined and, in the case of said motion occurring, the drive rotating the reel/reels is controlled to change the winding force applied to the reel/reels substantially at the pace of said to-and-fro motion so that the drive provides the reel/reels being wound with an effect diminishing the bouncing phenomenon.

[0015] According to an advantageous embodiment of the invention, the effect diminishing the bouncing phenomenon is applied to the reel/reels being wound via the loading device. The drive of the loading device is controlled so that its moment specification is changed to substantially cyclically variable.

[0016] According to another advantageous embodiment of the invention, the effect diminishing the bouncing phenomenon to the reel/reels being wound is provided by controlling the drive of several rolls simultaneously.

[0017] Advantageously in the method, the frequency of the machine-directional to-and-fro motion of the reels being wound is determined and the drive is controlled so that its moment specification is changed variable substantially on the same frequency. The moment specification of the drive is advantageously changed on the frequency of below 5 Hz.

[0018] According to an embodiment of the invention, the method according to the invention is applied so that, in the method, tangential force applicable to the partial web reel/reels is provided with the combined effect of at least one drive and a brake device. When e.g. the rider roll is formed of several partial rolls with a common drive but each with its own brake device, it is possible to have an effect diminishing the bouncing with the brake device of one or more partial rolls.

[0019] According to an advantageous additional characteristic of the invention, it is possible to affect bouncing in embodiments, which apply the invention in connection with a loading device and the loading device comprises a belt cycle provided with sheaves, by deflecting the sheaves, whereby additional moment is provided to the rider roll by which it is possible to diminish bouncing. Such an arrangement is also implementable even though the drive was primarily used to implement constant moment.

[0020] According to an embodiment of the invention, the set is actively affected during winding so that the oscillation motion of the set, the bouncing, is slowed down by repeatedly inducing a force opposite to the oscillation motion, e.g. on each oscillation cycle or every other or third etc. The opposing force can be induced by means of the transmission of the support rolls of one reel, e.g. in carrier-roll winders provided with sets of belt rolls via the tension force of the belt. The opposing force can also be provided with the deviation of the support roll in the nip direction or the deflection of the support roll so that the effect is applied as greater to a desired point, advantageously to the middle of the set. Thus, the prevention of the natural oscillation form inducing the excitation of the bouncing phenomenon of the dynamics between the set and the support rolls is provided by a change in the dynamics so that the natural frequency alters and thus changing excitation frequencies can be avoided. This is also implementable as an adaptive arrangement by combining in the arrangement the measurement of the oscillation motion and cycle combined with the control of an element/actuator supplying the opposing force.

[0021] Other additional features characteristic of the invention are illustrated in the accompanying claims.

[0022] The invention and its operation will now be described with reference to the accompanying schematic figures in which

Fig. 1 shows a carrier-roll winder according to an embodiment of the invention,
Fig. 2 shows a carrier-roll winder according to another embodiment of the invention and
Fig. 3 shows part of the carrier-roll winder of Fig. 1 from direction A.

[0023] Fig. 1 shows a carrier-roll winder 10 according to an embodiment of the invention. The carrier-roll winder comprises as support rolls a front roll 15 and a rear roll 20 supported by which on the carrier-roll winder a reel 25 being wound of partial webs W is being formed. To support the reel 25 from the top is also arranged a rider roll 30. For the rider roll, there is in the carrier-roll winder a rider-roll beam 35. Above and below refer to the upside

and underside of a horizontal plane passing via the centre of the reel.

[0024] The support rolls 15, 20 of the carrier-roll winder 10 are provided with drives 15.1, 20.1 by means of which surface draw i.e. tangential force can be applied to the reel being formed. Also the rider roll 30 is provided with a drive 30.1.

[0025] Fig. 1 schematically shows the bouncing phenomenon which can be at least considerably minimised or even eliminated with the carrier-roll winder and the method according to the invention. In the bouncing phenomenon, a single reel or even the whole set, reference 25' in Fig. 3, moves back and forth in the machine direction mainly by rotating alternately on the surface of the front and rear roll 15, 20 in a way crudely described by Fig. 1 from its stable position.

[0026] The to-and-fro motion of single rolls is prevented by combining successive reels 25 of the set 25' from their winding cores to each other e.g. so that cores 40 functioning as the winding core of two adjacent reels 25 are combined with a sleeve 45 which sufficiently locks the cores to each other radially. This can be seen in Fig. 3 which shows part of the carrier-roll winder of Fig. 1 from direction A.

[0027] The bouncing phenomenon affecting the whole set 25' can be minimised when the carrier-roll winder 10 comprises a control arrangement 100 which is arranged to control at least one drive of the carrier-roll winder so that the drive provides the reels of the set with an effect diminishing the bouncing phenomenon.

[0028] When examining the bouncing phenomenon shown by Fig. 1 by way of an example in more detail, it is found that the reel can rotate around the support roll 15 clockwise, motion d1. Then when rotating, each reel is pressed with greater force against the rider roll 30. Equivalently, the set can rotate around the support roll 20 counter clockwise, motion d2. Also from the effect of this motion d2, the reels are pressed with greater force against the rider roll 30. Then, nip force momentarily risen on the rider roll also increases friction force between the rider roll 30 and the surface of the reel 25. When according to the invention the drive 30.1 provides the reels of the set 25' with an effect diminishing the bouncing phenomenon, the effect of the drive on the actual reels 25 of the set is ensured along with said increase of friction force. The increase of friction force thus occurs at such points of time when via the rider roll 30 the change of the operation of the drive has to be conveyed to the reels of the set 25'. Hence, the arrangement according to the invention is very advantageous.

[0029] It is evident that the rider roll is not necessarily for the whole forming time of the reel in connection with the surface of the reel but the invention can also be applied with such winders and/or winding processes in which the rider roll is released away from the connection of the reel for part of the winding time.

[0030] The control arrangement 100 is arranged to adjust the moment of the drive 30.1 of the rider roll 30 so that with the rider roll is applied an effect diminishing the bouncing phenomenon to the reels of the set. In a situation in which the set rotates around the support roll 15 clockwise, motion d1, the surface speed of the reels 25 in relation to the rider roll 30 increases momentarily, whereby for diminishing the bouncing phenomenon during the motion d1 the specification of the drive 30.1 of the rider roll is changed momentarily smaller. Equivalently in a situation in which the set rotates around the support roll 20 counter clockwise, motion d2, the surface speed of the reels 25 in relation to the rider roll 30 decreases momentarily, whereby for diminishing the bouncing phenomenon during the motion d2 the specification of the drive 30.1 of the rider roll is changed momentarily greater. The adjustment can be based on e.g. on the adjustment of drive moment and/or speed.

[0031] Fig. 1 shows an arrangement joined in the control arrangement for detecting and monitoring the bouncing phenomenon 110. In this embodiment, it comprises elements 115 for registering changes in the machine-directional position of the reel. In more detail, said elements comprise a contact-free distance measuring device with which the position and thus also the motion of the reels 25 can be measured. The position of the surface of the reels 25 will of course change also when the diameter increases, but this slowly changing part of the measurement is filtered out and only the so-called dynamic position change i.e. momentary position change is monitored. This measuring data is sent to the control arrangement 100. If the reels 25 start to oscillate, the adjuster calculates a correction term for e.g. the moment or speed adjuster of the drive of the rider roll. Now, the rider roll 30 and the drive 30.1 of the rider roll stop oscillation by applying a change of a tangential force component to the reels 25 which resists the bouncing motion of the reels 25. In a bouncing situation, the frequency of the oscillation of the reels 25 is quite low, whereby measuring the position of the reels 25 is well suited for this purpose. The measurement is possible to implement alternatively e.g. with an ultrasound or opto-electronic sensor as well as with e.g. various camera arrangements. Also other types of arrangements suitable for the determination of the momentary position of the reels can be applicable.

[0032] Fig. 2 shows another embodiment of the invention. Here, an arrangement in connection with the control arrangement 100 for detecting and monitoring the bouncing phenomenon is implemented with several different ways which can be used separately or together complementing each other.

[0033] The bouncing phenomenon can be detected according to the first embodiment by monitoring the power intake or moment of the drives 15.1, 20.1 of the support rolls 15, 20. The above-described to-and-fro motion of the reels is visible in the power intake of the drives 15.1 and/or 20.1 and its variation can be used in the control of the rider roll for correcting the bouncing phenomenon. In a situation in which the set rotates around the support roll 15 clockwise, motion d1, and equivalently in a situa-

tion in which the set rotates around the support roll counter clockwise, motion d2, the power intakes of the drives 15.1 and 20.1 change at the pace of the motion of the reels and the moment of the drive 30.1 of the rider roll is controlled according to this embodiment based on the changes in the power intakes of the drives 15.1 and 20.1.

[0034] The bouncing phenomenon can be detected according to another embodiment from the bearing forces of the support rolls. The support rolls are provided with a power sensor 120 which is in connection with the control arrangement 100 for controlling the moment of the drive 30.1 of the rider roll in a way according to the invention.

[0035] The bouncing phenomenon can be detected according to a yet another embodiment from the core locks 45. The core locks are arranged to support the end reels in the cross direction via sockets joined in the winding core. The core lock is controllably movable supported in the support structure. The core lock is provided with a position sensor 130 by means of which (depending on the structure of the core lock) data is communicated to the control arrangement 100 of momentary changes in the position of the reel 25, e.g. changes in the angle α of the support arm of the core lock. Controlling the drive 30.1 of the rider roll is now performed based on this data in a way according to the invention. Even though motion is conveyed in practice to the core locks due to, inter alia, the eccentricity of the reels, a signal given by such a motion can be distinguished of the bouncing phenomenon and filtered out of the process.

[0036] Furthermore referring to Fig. 1, next will be described another arrangement according to an embodiment of the invention. The bouncing phenomenon can be prevented in addition to, or alternatively to, controlling the moment of the drive 30.1 of the rider roll based on the position changes of the reel 25 or the set 25' so that the moment of the support rolls 15, 20 is controlled based on the position changes of the reel 25 or the set 25'. In a situation in which the set rotates around the support roll 15 clockwise, motion d1, for diminishing the bouncing phenomenon during the motion d1, the moment of the drive 15.1 of the support roll 15 is controlled momentarily with a smaller specification. Equivalently in a situation in which the set rotates around the support roll 20 counter clockwise, motion d2, for diminishing the bouncing phenomenon during the motion d2, the moment of the drive 20.1 of the support roll 20 is controlled momentarily with a greater specification.

[0037] According to an embodiment, in the control system 100 is determined a frequency on which the detected bouncing phenomenon occurs, whereby at least one drive is controlled by changing its specification substantially on the same said frequency but typically in a different stage. The bouncing frequency is typically below 10 Hz. The control system can simply comprise only an adjuster and a control apparatus.

[0038] According to another embodiment, in the control system 100 is determined a frequency on which the detected bouncing phenomenon occurs, whereby at least one drive is controlled by changing its specification on a second frequency dependent on the determined frequency. The second frequency can be a frequency based on experience or e.g. a multiple of said determined frequency.

[0039] It should be noticed that only a few of the most advantageous embodiments of the invention were described above. Thus, it is evident that the invention is not limited to the above-mentioned embodiments, but it can be applied in many ways within the scope defined by the enclosed claims. For example, when controlling the drives, it is possible to apply other control variable alternatives differing from the described. It is also possible that single features described in connection with different embodiments are used within the scope of the basic idea of the invention in connection with other embodiments and/or combine various units of the described features, if so required and technical possibilities for this existing.

[0040] The present invention relates to a carrier-roll winder (10) which comprises at least two surface support elements (15, 20) to support at least one reel (25) being formed at least for part of the forming time of the reel substantially below it and at least one loading device (30) which is arranged to support said reel (25) at least for part of the forming time of the reel substantially above it, and in which the carrier-roll winder is provided with at least one drive (15.1, 20.1, 30.1) so that the drive (15.1, 20.1, 30.1) is arranged to apply tangential force to the reel (25) being wound. The carrier-roll winder (10) comprises a control arrangement (100) which is arranged to control said at least one drive (15.1, 20.1, 30.1) of the carrier-roll winder so that the drive provides the reel/reels (25) being wound with an effect diminishing the bouncing phenomenon.

Claims

1. A carrier-roll winder (10) which comprises at least two surface support elements (15, 20) to support at least one reel (25) being formed substantially below it and at least one loading device (30) which is arranged to support said reel (25) at least for part of the forming time of the reel substantially above it, and in which the carrier-roll winder is provided with at least one drive (15.1, 20.1, 30.1) so that the drive (15.1, 20.1, 30.1) is arranged to apply tangential force to the reel (25) being wound, **characterised in that** the carrier-roll winder (10) comprises a control arrangement (100) which is arranged to control said at least one drive (15.1, 20.1, 30.1) of the carrier-roll winder so that the drive provides the reel/reels (25) being wound with an effect diminishing the bouncing phenomenon.

2. A carrier-roll winder according to claim 1, **characterised in that** the control arrangement (100) comprises an arrangement (110) for detecting and mon-

itoring the bouncing phenomenon.

3. A carrier-roll winder according to claim 2, **characterised in that** the arrangement (110) for detecting and monitoring the bouncing phenomenon comprises elements (115, 120, 130) for registering momentary changes in the machine-directional position of said at least one reel (25).

4. A carrier-roll winder according to claim 3, **characterised in that** the elements for registering the momentary changes in the machine-directional position of the reel (25) comprises a contact-free distance measuring device (115) arranged to measure the position of the surface of the reel (25) being formed.

5. A carrier-roll winder according to claim 1, **characterised in that** the loading device (30) is provided with a drive (30.1), and that the control arrangement (100) is arranged to control the drive of the loading device so that the tangential force applied by the drive (30.1) to the reel (25) provides an effect diminishing the bouncing phenomenon.

6. A carrier-roll winder according to claim 1, **characterised in that** one or both of said surface support elements (15, 20) is provided with a drive (15.1 20.1), and that the control arrangement (100) is arranged to control the drive (15.1, 20.1) of the surface support element so that the tangential force applied by the drive to the reel (25) provides an effect diminishing the bouncing phenomenon.

7. A carrier-roll winder according to claim 1, **characterised in that** the control arrangement is arranged to control the drive so that with the drive is applied to the reel or reels tangential force provided by the bouncing phenomenon, resisting a change in the machine-directional position of the reel or reels substantially diverging from the steady state.

8. A method for using a carrier-roll winder, in which method, partial web reels are wound supported by at least two surface support elements substantially below the partial web reels, and supported by at least one loading device at least for part of the forming time of the reel substantially above the partial web reels and, in which method, to the partial web reel/reels is applied tangential force by means of at least one drive and via at least one of said surface support elements or the loading device, **characterised in that** the drive is controlled so that the drive provides the reel/reels being wound with an effect diminishing the bouncing phenomenon.

9. A method according to claim 8, **characterised in that,** during winding, the occurrence of a possible machine-directional to-and-fro motion of the reels being wound (the bouncing phenomenon) is determined and, in the case of said motion occurring, the drive rotating the reel/reels is controlled to change the winding force applied to the reel/reels substantially at the pace of said to-and-fro motion so that the drive provides the reel/reels being wound with an effect diminishing the bouncing phenomenon.

10. A method according to claim 9, **characterised in that** the effect diminishing the bouncing phenomenon is applied to the reel/reels being wound via the loading device.

11. A method according to claim 10, **characterised in that** the drive is controlled so that its moment specification is changed to substantially variable.

12. A method according to claim 11, **characterised in that** the drive is controlled so that its moment specification is changed to substantially cyclically variable.

13. A method according to claim 9, **characterised in that** the moment specification of the drive is advantageously changed on the frequency of below 5 Hz.

14. A method according to claim 9, **characterised in that,** in the method, the frequency of the machine-directional to-and-fro motion of the reels being wound is determined and the drive is controlled so that its moment specification is changed variable substantially on a frequency determined by said frequency or substantially on the same frequency.

15. A carrier-roll winder (10) which comprises at least two surface support elements (15, 20) to support at least one reel (25) being formed substantially below it and at least one loading device (30) which is arranged to support said reel (25) at least for part of the forming time of the reel substantially above it, **characterised in that** the carrier-roll winder (10) comprises a control arrangement (100) which is arranged to control at least one winding support force so that the reel/reels (25) being wound is provided with an effect diminishing the bouncing phenomenon.

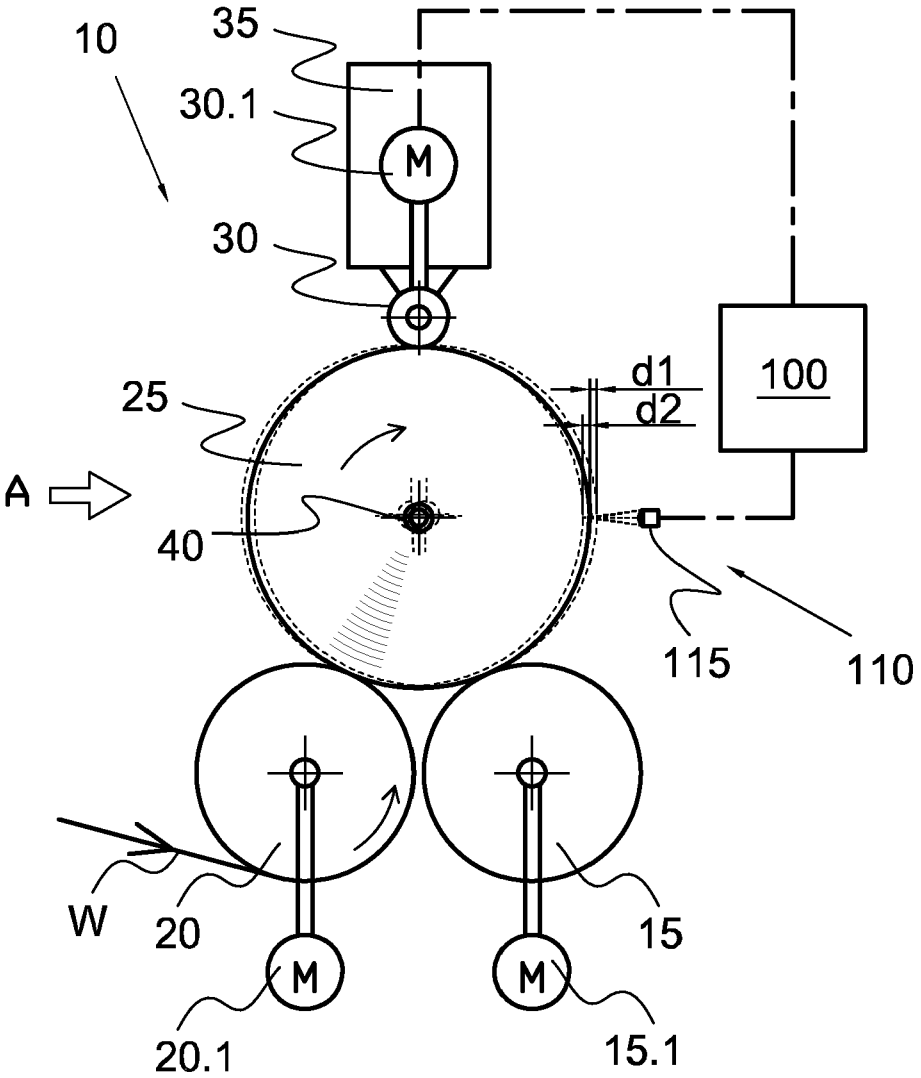

FIG. 1

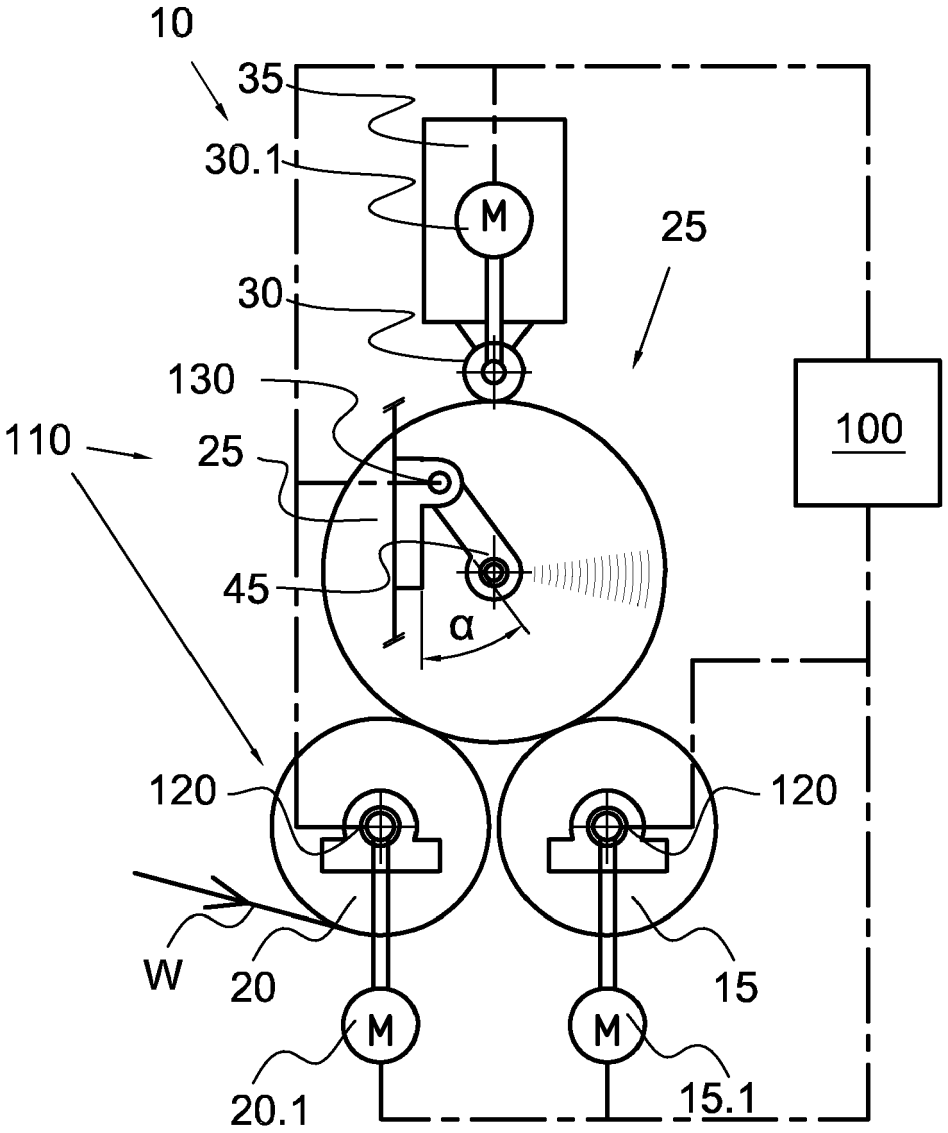

FIG. 2

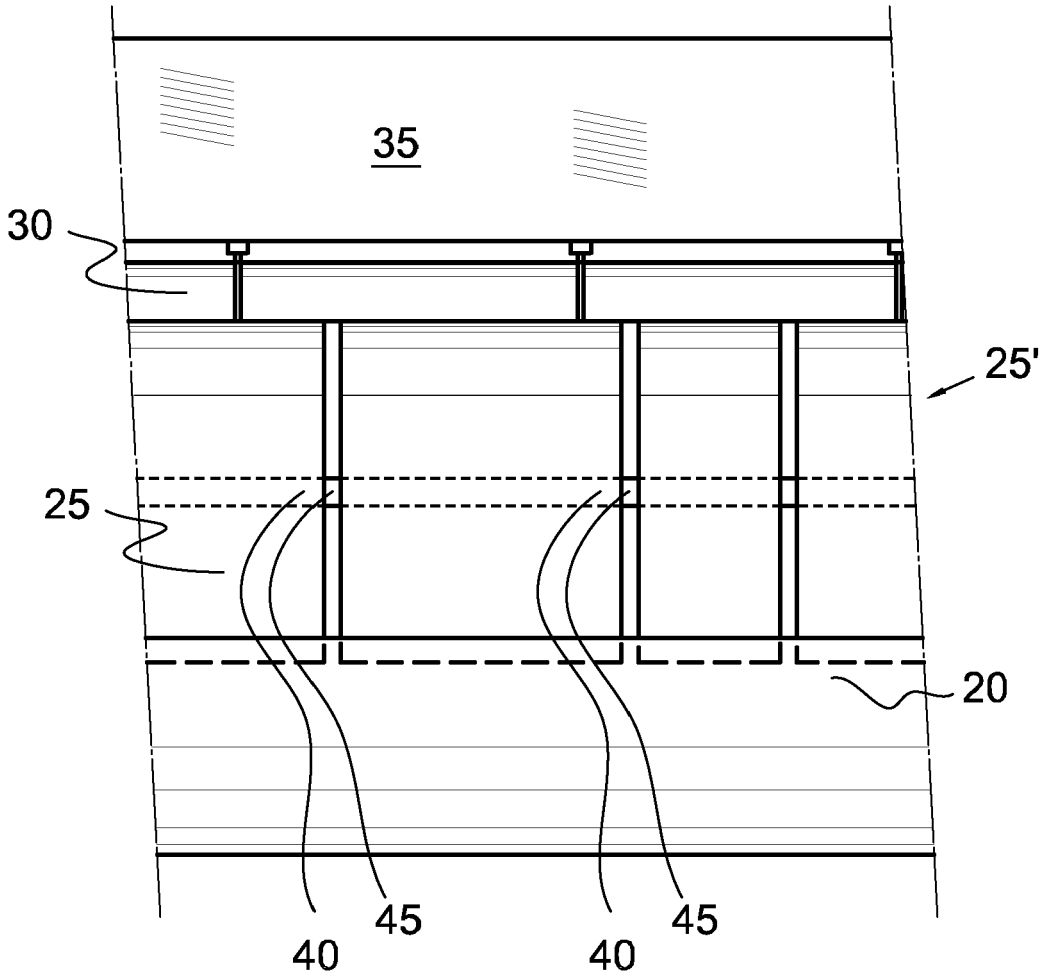

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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