



(11) **EP 1 741 648 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.01.2007 Bulletin 2007/02

(51) Int Cl.:
B65H 18/22 (2006.01)

(21) Application number: **06397015.6**

(22) Date of filing: **30.06.2006**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

- Riihelä, Vesa
07190, Halkia (FI)
- Tynkkynen, Topi
01520, Vantaa (FI)
- Kojo, Teppo
04600, Mäntsälä (FI)
- Mäkinen, Risto
04600, Mäntsälä (FI)
- Tiilikainen, Marko
04500, Kellokoski (FI)
- Naatti, Ilkka
00620, Helsinki (FI)

(30) Priority: **08.07.2005 FI 20055397**

(71) Applicant: **Metso Paper, Inc.**
00130 Helsinki (FI)

(72) Inventors:

- **Kemppainen, Matti**
05400, Jokela (FI)
- **Tiitta, Jari**
04500, Kellokoski (FI)

(74) Representative: **Rahkonen, Erkki Juhani et al**
Tampereen Patenttitoimisto Oy,
Hermiankatu 12 B
33720 Tampere (FI)

(54) **A method of belt reeling and a belt reeler**

(57) A method in a belt reeler in which a reeling nip (7) is formed by a reeling core (6) or a growing machine reel (4) and at least one endless supporting member (3) travelling at least via a first wire guiding roll (1), and a second wire guiding roll (2). In the method several parameters are adjusted simultaneously to adjust the reel-

ing process, of which parameters at least the first parameter and the second parameter are one of the following: web tension (P1), wire tension (P2), distance of the machine reel from the wire turning roll (P3), depression of the wire/machine reel (P4), surface draw (P5, P5', P5''), peripheral force (P6).

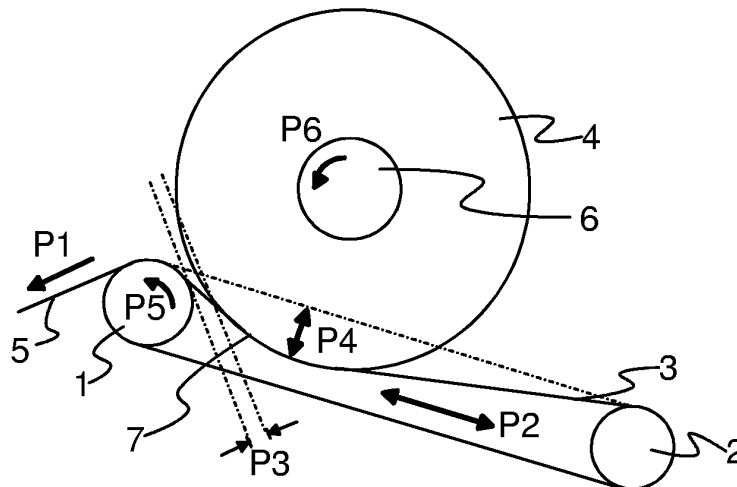


Fig. 1

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Description

Field of the invention

[0001] The invention relates to a method according to the preamble of the appended claim 1 for controlling a belt reeler. The invention also relates to a belt reeler according to the preamble of the appended claim 7. In addition, the invention relates to a method according to the preamble of the appended claim 11 for rebuilding a centre-driven reeler, and a reeling apparatus according to the preamble of the appended claim 12, as well as a reel change method according to the preamble of the appended claim 14.

Backaround of the invention

[0002] In the final end of a machine manufacturing paper, paperboard, soft tissue or the like or a finishing apparatus for paper, paperboard or soft tissue or the like, a paper web which is typically several meters wide and which has been produced and/or treated in the preceding machine sections, is reeled around a reeling core, i.e. a reel spool to form a machine reel. In this reeling up process a reeling cylinder that is bearing-mounted rotatable is typically used for guiding the paper web on the machine reel, wherein the nip contact between the reeling cylinder and the machine reel is utilized to influence the quality of the reel produced thereby. The ends of the reel spool are affected by means of a suitable loading mechanism to adjust the nip contact between the machine reel that is being formed and the reeling cylinder. Such reeling concepts and loading methods related thereto are disclosed, for example, in the Finnish patent 91383 and in the corresponding US patent 5,251,835, as well as in the Finnish patent application 950274 and in the corresponding US patent 5,690,298.

Summary of the invention

[0003] The main purpose of the present invention is to disclose a method that enables the formation of different kinds of reels with a belt reeler.

[0004] To attain this purpose, the method according to the invention is primarily characterized in what will be presented in the characterizing part of the independent claim 1. The belt reeler according to the invention, in turn, is primarily characterized in what will be presented in the characterizing part of the independent claim 7. The method according to the invention for rebuilding a reeler is primarily characterized in what will be presented in the characterizing part of the independent claim 11, and the reeling apparatus according to the invention is primarily characterized in what will be presented in the characterizing part of the independent claim 12, and the reel change method according to the invention is primarily characterized in what will be presented in the characterizing part of the independent claim 14. The other, de-

pendent claims will present some preferred embodiments of the invention.

[0005] Herein, a method is disclosed to be utilized in a belt reeler in which a reeling nip is formed by a reeling core or a growing machine reel and at least one endless supporting member travelling at least via a first wire guiding roll, and a second wire guiding roll. In the method several parameters are adjusted simultaneously to adjust the reeling process, of which parameters at least the first parameter and the second parameter are one of the following: web tension, wire tension, distance of the machine reel from the wire turning roll, depression of the wire/machine reel, surface draw, peripheral force. It is also possible that several, such as three, four, five or six of the parameters are those listed above. In some embodiments a parameter is determined by means of measurements or calculations.

[0006] Correspondingly, a belt reeler in which a reeling nip is formed by a reeling core or a growing machine reel and at least one endless supporting member arranged to travel at least via a first wire guiding roll and a second wire guiding roll, comprises at least means for determining and adjusting several parameters simultaneously to adjust the reeling process, of which parameters at least the first parameter and the second parameter are one of the following: web tension, wire tension, distance of the machine reel from the wire turning roll, depression of the wire/machine reel, surface draw, peripheral force.

[0007] In one embodiment the belt reeler is formed of a centre-driven reeler by replacing its reeling cylinder with a first wire guiding roll and adding at least a second wire guiding roll and an endless supporting member. In this context, the term centre drive refers to a driving means arranged in one or both ends of the shaft of a growing machine reel, especially to an electric drive typically equipped with a gearbox. With the concept centre-driven reeler reference is made to a reeler known from the state of the art, in which the reeling core and the growing machine reel are equipped with a centre drive.

[0008] In one embodiment the belt reeler is arranged in a reeling apparatus comprising at least two stationary reeling stations to form a machine reel. In a preferred embodiment the first wire guiding roll and the second wire guiding roll are arranged to move in relation to the reeling stations.

[0009] In an embodiment, the area of the reeling core outside the paper web is provided with an adhesive element against which a section of the paper web is guided when changing the reeling core.

[0010] The centre-driven reeler which comprises at least a reeling cylinder, can be rebuilt into a belt reeler in such a manner that the reeling cylinder is replaced with a first wire guiding roll and at least a second wire guiding roll and an endless supporting member are provided therein. It is also possible to use an old reeling cylinder or a part/parts thereof, such as roll mantle, bearings, electric drive, etc. as a first wire guiding roll. If necessary, it is possible to modify the surface of the reeling cylinder,

for example by lathing or grinding, so that it becomes suitable as a wire guiding roll.

[0011] The reeling apparatus, in turn, can be formed in such a manner that it comprises at least a belt reeler, in which the reeling nip is formed of a reeling core or a growing machine reel and at least one endless supporting member that is arranged to travel through at least the first wire guiding roll and the second wire guiding roll. Furthermore, the reeling apparatus comprises at least two stationary reeling stations to form a machine reel. Advantageously, the first wire guiding roll and the second wire guiding roll of the reeling core are arranged to move in relation to the reeling stations.

[0012] The reel change method, in turn, is characterized in that the method is intended to be used in a belt reeler in which a reeling nip is formed by a reeling core or a growing machine reel and at least one endless supporting member travelling at least via a first wire guiding roll, and a second wire guiding roll. In the method, the area of the reeling core outside the paper web and/or the wire is provided with an adhesive element against which a section of the paper web is guided when changing the reeling core.

[0013] One basic idea of the invention is to use a wire reeler or a belt reeler as a reeler, the function of which is guided by adjusting several different parameters as a function of the diameter of the machine reel and/or the web speed and the paper grade that is being run. In the description the term belt reeler is used, said term referring both to a belt reeler and to a wire reeler. Correspondingly, the term wire is used to refer both to the belt and to the wire.

[0014] The reeling process of the belt reeler can be adjusted, thus forming machine reels of desired kind. The factors affecting the reeling include for example web tension, wire tension, distance of the machine reel from the wire turning roll, depression of the wire/machine reel, surface draw and peripheral force. Preferably, parameters are adjusted as a function of the diameter of the machine reel and/or the web speed and the paper grade that is being run. Advantageously, several parameters are adjusted simultaneously, such as two, three, four, five or six aforementioned parameters. In addition to the aforementioned parameters, it is also possible to adjust other parameters.

[0015] The web tension is utilized to affect the tension of the machine reel structure. The web tension is typically generated primarily by means of a centre drive. The contribution of the centre drive in generating the web tension is advantageously greater than that of the wire turning roll in use, so that a sufficiently tight machine reel can be formed. The wire turning roll and/or the wire can also decelerate the speed in certain cases, wherein the entire web tension is drawn with the torque of the centre drive.

[0016] By means of the wire tension it is, in turn, possible to affect the force transmitted between the wire and the surface of the machine reel to the machine reel. When the wire tension is increased, the force transmitted via

the nip to the machine reel is also increased, if other reeling parameters are kept constant. The tension of the wire is adjusted by means of actuators. The tension of the wire is typically in the order of approximately 15 to 35 kN/m, depending on the force required. The level of the force required is affected by several factors, such as paper grade, web speed, etc. When a stronger/less flexible belt or for example even a metal wire or a belt is utilized, the wire tension can, of course, be greater than the above-mentioned typical value.

[0017] The distance of the machine reel from the wire turning roll affects the length of the nip formed by the wire and the surface of the machine reel with constant depression. If the machine reel is located close to the wire turning roll, the nip becomes longer as the wire rises on the surface of the turning roll in a sharper angle. If the aim is to keep the length of the nip constant, the depression must be decreased when the machine reel is located close to the wire turning roll.

[0018] The depression of the wire/machine reel affects the surface area between the wire and the machine reel, via which the nip force is transmitted to the machine reel. When the depression increases, the surface area of the nip affecting the machine reel is increased, and the force effective per unit area, i.e. the nip pressure is even decreased. However, the total force effective through the nip is increased.

[0019] By means of surface draw it is possible to affect the tightness of the machine reel to be reeled. The surface draw is attained by producing torque differences, for example by decelerating the wire by means of the drive of the wire turning roll. The sum of the peripheral force and the torque of the wire turning roll approximately equals the web tension (naturally reeling friction and other losses affect the equation). It is also possible to perform the surface draw/deceleration by means of a separate roll or a wire.

[0020] By means of the above-described control solutions it is possible to attain various significant advantages when compared to solutions of prior art. Depending on the embodiment, it is possible to attain for example one or several of the following advantages.

- when the nip control of the belt reeler is implemented as presented above, either the actual pressure exerted by the wire on the reel or the parameter "equivalent linear load" comparable to the conventional linear load is adjusted
- the actual wire pressure against the machine reel or the "equivalent linear load" is adjusted by affecting the actual variables correlating with the primary function of the wire, i.e. removal of air from the machine reel
- when the torques of the drives and the deflection of the wire are taken into account in the calculation, the actual wire tension affecting the surface pressure/"equivalent linear load" is adjusted
- to control the wrap angle, it is possible to use two

complementary control variables (deflection of the wire and distance of the reel from the first belt/wire guiding roll

- in addition to the magnitude of the nip force it is also possible to affect its orientation

[0021] The belt reeler whose function can be controlled, if necessary, by adjusting several different parameters as a function of the diameter of the machine reel and/or the web speed and the paper grade that is being run, can be implemented in various ways. In one embodiment the belt reeler is formed of a so-called pope reeler. The term pope reeler refers to a known reel-up of prior art in which the reeling core and the growing machine reel are not equipped with a centre drive, but the rotating torque is transmitted to the reel from the rotating movement of the reeling cylinder via the reeling nip. The pope reeler is supplemented with a wire and a press roll equipped with a drive. The control of the wire loop is easier with a longer wire loop, because of which it is advantageous to use several rolls via which the wire loop circulates. In said manner it is advantageously possible to form a belt reeler with a moving reeling nip and a stationary secondary reeling station.

[0022] By means of such a reeler it is possible to form a so-called semi-hard nip (i.e. a nip comprising both a wire nip and a roll nip) for the duration of the entire reeling process. The wire nip enables removal of air, which is an advantageous feature especially at high speeds. The hard nip, in turn, is utilized to affect the hardness of the reel.

[0023] The reeler also enables fully supported web transfer to the reeler and easy tail threading. The solution has an advantageous effect on the overall structure, because it enables an advantageous positioning of the pulper and a low structure of the storage.

[0024] As to the modifications made in the reeler, the final way of implementing the belt reeler is substantially dependent on the original reeler. For example an existing reel-up equipped with a centre drive can be formed into a belt reeler by using their reeling cylinder as a wire guiding roll, advantageously as a turning roll. In addition, a second wire guiding roll and possibly other wire guiding rolls, as well as one or several press rolls are required.

[0025] In one embodiment two stationary reeling frames are arranged for the reel spools. Between the reeling frames travels a supporting member loop that forms a reeling nip and helps in taking the web from one reeling frame to another. The loop of the supporting member moves along with the diameter and adjusts the reeling nips according to the situation. The change is conducted by means of waterjet cutting change device, or the like. In addition to this, pick-up i.e. lifting devices, such as goosenecks may be required after each reeling frame, to bring the cut web again on a new reel spool. After the first reeling frame, a holding blow and/or a suction box may be required in the area of the tail cut by means of waterjet to prevent the tail from rising on the reel spool.

[0026] By means of such a reeler solution equipped with a stationary reeling frame it is possible to attain several advantages. Depending on the embodiment, it is possible to attain for example one or several of the following advantages.

- possible to implement with simple structures, such as storage frames, wherein the structure is cheap and durable
- storage with actuators not necessary
- structurally more economical to couple a stationary drive, when compared to a movable drive
- no drive change with possible problems in the middle of the reel
- no linear load change with possible problems in the middle of the reel
- possible press, change and other corresponding equipment easier to implement/add, as it is not necessary for them to move along with the reeling device
- steady, does not vibrate
- endures process disturbances and forces/strikes resulting therefrom
- second redundant station may produce full reels in one frame while the other is being serviced, reliability improves
- expandability, one embodiment can be supplemented with storages for empty reel spools, etc.
- stoppage times are shortened, because it is not always necessary to remove the reel spool from the machine and in case of lack of spool it is possible to bring the reel spool directly to the reeling frame faster
- transverse oscillation is easily accomplished in the machine direction in stationary stations

[0027] The supporting member loop of the belt reeler, in turn, can be utilized to attain for example one or several of the following advantages, depending on the embodiment

- controlled transfer of a full-width web to a reeling station possible
- much easier to move the supporting member loop than the heavier machine reel
- accurate force measurement of the tension adjustment of the supporting member loop,
- facilitates the transfer of broke to the pulper and cleaning in a web break

[0028] One embodiment, in turn, makes it possible to place reeling frames in two layers, wherein it is possible to attain some of the following advantages:

- low construction on the machine level, fits in a lower hall, no problems when operating with a crane
- easier to attain a safer reeler
- same floor opening can be used as a lift hole which is usually present in a mill,
- the construction of the pulper is better/less expen-

sive, low structure, no long ramps, less need for water

[0029] The belt reeler and its control method can be used in various ways. In a change method a new reel spool is provided with an adhesive element on the area remaining outside the wire, such as a double-sided adhesive tape, glue, etc. In a normal reeling situation the amount which the paper web is detached from the reel spool in the area outside the edge of the wire and from the adhesive surface of the reel spool corresponds to the thickness of the wire. The change is conducted for example by cutting a tail from a full-width web at the location of the adhesive element, for example from one edge of the web or from the middle. The tail cut by means of waterjet is deflected towards the reel spool for example by means of a movable member located after the nip, or by means of a deflection element fed in said point in the nip, wherein the tail touches the adhesive area and is attached thereto. The deflection element also enables the cutting of a wedge instead of a tail.

[0030] One change embodiment can also be utilized in conventional reelers. In the embodiment, an adhesive tape or a corresponding structure is installed in the area of a new reel spool outside the paper web. The cutting of a tail from the edge of the web starts at the same time when the nip is closed. For example an adhesive tape activated under pressure is activated when the nip is closed, whereafter the narrow tail is deflected in the lateral direction to the area of the adhesive area, wherein it adheres to the adhesive tape. The adherence of the tail to the adhesive tape is followed by spreading. The method is especially suitable for slow paperboard machines, wherein when the adhesive surface that is thinner than the thick paperboard web to be reeled is located outside the edge of the web in the reel spool, the adhesive surface does not touch the reeling cylinder when the nip is closed, but when the cut tail or the entire web is transferred transversely at the location of the adhesive surface, it touches the adhesive agent. By means of this change method, it is possible to eliminate for example the slackness at the bottom.

Description of the drawings

[0031] In the following, the invention will be described in more detail with reference to the appended principle drawings, in which

Figs 1 and 2 show a belt reeler and some of its parameters,

Figs 3 to 6 show in side views a belt reeler solution formed of a so-called pope reeler

Figs 7 to 9 show side views of a belt reeler solution formed of a centre-driven reeler of prior art, in which the reeling cylinder has

been stationary

Figs 10 to 12 show side views of another belt reeler solution formed of another kind of centre-driven reeler of prior art, in which the reeling cylinder has originally been movable in the horizontal direction

Figs 13 to 20 show side views of embodiments of belt reelers equipped with two reeling frames

Fig. 21 shows a belt reeler from above

[0032] For the sake of clarity, the figures only show the details necessary for understanding the invention. The structures and details that are not necessary for understanding the invention, but are obvious for anyone skilled in the art, have been omitted from the figures in order to emphasize the characteristics of the invention.

Detailed description of the invention

[0033] Fig. 1 shows in principle the structure of a belt reeler and a wire reeler. The reeler comprises at least a first wire guiding roll 1 and a second wire guiding roll 2. Through the wire guiding rolls 1, 2 travels an endless supporting member loop 3, which in the example is a wire or a belt. The reeler may also comprise larger number of rolls than the two rolls 1, 2 shown in the Figure. One or several rolls (so-called turning rolls) are rotated with a drive, which is advantageously adjustable. The solution according to Fig. 2 also comprises a wire guiding roll 8, via which the supporting member loop 3 travels, and a press roll 10. It is also possible to implement other kind of solution by combining the features of Figs 1 and 2 together. For example, the solution of Fig. 1 can be supplemented either with a third wire guiding roll 8 or a press roll 10.

[0034] Figs 1 and 2 also describe a reel 4 in a reeling stage. The reel 4 is formed by reeling a web 5 moving along the track around a reeling core 6, i.e. in the example around a reel spool. In the example the reel spool 6 is also rotated with a centre drive, which is advantageously adjustable.

[0035] The reeling process of the belt reeler can be adjusted in a controlled manner, thus forming machine reels 4 of the desired kind. The parameters effective in the reeling include the following parameters, shown in principle in Fig. 1:

- web tension P1
- wire tension P2
- distance of the machine reel from the wire turning roll P3
- depression of the wire/machine reel P4
- surface draw P5, P5', P5"
- peripheral force P6

[0036] To adjust the quality of the machine reel 4, the parameters P1 to P6 are adjusted for example as a function of the diameter of the reel and/or the web speed and the paper grade that is being run.

[0037] The web tension P1 must be sufficient to attain optimal machine reel structure 4. The web tension P1 is typically generated substantially by means of a centre drive. The contribution of the centre drive in the generation of web tension P1 is advantageously greater than that of the wire turning roll 3, so that it is possible to form a sufficiently tight machine reel 4.

[0038] By means of the tension P2 of the wire 3 it is possible to affect the force transmitted via the wire and the surface of the machine reel 4 to the machine reel. When the tension P2 of the wire 3 is increased, the force transmitted via the nip 7 to the machine reel 4 is also increased, if other reeling parameters are kept constant. The tension P2 of the wire 3 is adjusted by means of actuators. The tension P2 of the wire 3 is typically in the order of approximately 15 to 35 kN/m, depending on the force required. The level of the force required is affected by several factors, such as paper grade, web speed, etc.

[0039] During the run, the deflection and the tension P2 of the wire 3 can be adjusted in such a manner that the effective pressure exerted by the wire 3 on the reel 4 remains constant, or it is adjusted in accordance with a desired "formula" as a function of the diameter of the reel. The effective pressure exerted by the wire 3 on the machine reel 4 is the tension of the wire P2 divided with the radius of the machine reel.

[0040] The "equivalent linear load" exerted by the wire 3 on the machine reel 4 can be adjusted (effective pressure multiplied with the length of the nip) in accordance with a desired "formula" as a function of the diameter, or the "equivalent linear load" is kept constant. The length of the nip 7 is attained by multiplying the wrap angle of the wire 3 with the radius of the machine reel 4. When this is reduced, the equivalent linear load is the wrap angle of the wire 3 multiplied with the tension P2 of the wire.

[0041] The torque of the wire guiding roll or rolls 1, 2 and the drive of the machine reel 4, and advantageously also their bearing friction are taken into account in the measurement, calculation and/or adjustment of the tension P2 of the wire 3. The torques and frictions either increase or reduce the tension of the wire 3 locally. Local change typically occurs on both sides of the drawing or holding point. The torques and frictions also increase or reduce the deflection of the wire 3, i.e. the angle of incidence and departure of the wire.

[0042] The distance P3 of the machine reel 4 from the turning roll of the wire 3 affects the length of the nip 7 formed by the wire and the surface of the machine reel with constant depression (>0). If the machine reel 4 is located close to the first wire guiding roll 1 of the wire 3, which in the example is also a turning roll, the nip 7 becomes longer as the wire rises on the surface of the turning roll in a sharper angle. If the aim is to keep the length

of the nip 7 constant, the depression P4 must be decreased when the machine reel 4 is located close to the turning roll 1 of the wire 3.

[0043] The depression P4 of the wire/machine reel affects the area between the wire 3 and the machine reel 4, via which the nip force is transmitted to the machine reel. When the depression P4 increases, the area of the nip 7 affecting the machine reel 4 is increased, and the force effective per unit area is decreased. However, the total force effective through the nip 7 increases.

[0044] The deflection P4 of the wire/machine reel can be affected for example when the deflection of the wire 3 is calculated and adjusted on the basis of the locations of the wire guiding rolls 1, 2, the reel spool 6 and the diameter of the machine reel 4. The diameter of the machine reel 4 is measured for example by means of an ultrasound, laser or other kind of sensor positioned in a primary and/or secondary reeling device 9. The diameter of the machine reel 4 can also be determined by means of calculations on the basis of the web speed of the drives and the speed of rotation of the machine reel. The web speed can be determined by means of web speed calculation of electric drives, or directly for example by measuring with a laser surface speed measuring device.

[0045] The depression P4 of the wire/machine reel can also be affected when calculating and adjusting the deflection of the wire 3 on the basis of the locations of the wire guiding rolls 1, 2, and the reel spool 6. The calculation is based on the fact that when the length of the wire 3 remains constant, the diameter of the reel 4 can be calculated accurately on the basis of the location data of the wire guiding rolls 1, 2 and the reel spool 6.

[0046] The depression P4 of the wire/machine reel can also be affected by adjusting the "equivalent linear load" exerted by the wire 3 on the machine reel 4 (effective pressure multiplied with the length of the nip 7) in accordance with a desired "formula" as a function of the diameter, or the "equivalent linear load" is kept constant. The length of the nip 7 is attained by multiplying the wrap angle of the wire with the radius of the machine reel 4. When this is reduced, the equivalent linear load is the wrap angle of the wire 3 multiplied with the tension P2 of the wire.

[0047] By means of surface draw P5 it is possible to affect the tightness of the machine reel 4 to be reeled. The surface draw P5 is advantageously produced by decelerating the wire 3 by means of the drive of the wire turning roll. The difference of the deceleration produced by the peripheral force of the centre drive and the wire turning roll is the web tension P1.

[0048] According to Fig. 2, the surface draw P5' can also be produced in such a manner that the machine reel 4 is positioned directly against the first wire turning roll 1, i.e. the surface draw is not substantially transmitted via the wire. Thus, the distance P3 of the machine reel 4 from the turning roll of the wire 3 is substantially zero, taking into account the thickness of the wire positioned between the roll and the machine reel.

[0049] The surface draw P5" can also be produced by means of a separate press roll 10, as shown for example in Fig. 2. This alternative for a surface draw parameter is illustrated in Fig. 2 with the reference numeral P5". Thus, it is possible to adjust the reel formation by means of the combined effect of the surface draw P5 produced by the press roll 10 P5" and the wire 3, for example by means of the differences of the surface draws. By means of the difference of the surface draw torques (P5" to P5) produced by the press roll 10 and the wire 3 it is possible to control the tension of the reel 4 and attain a hard roll nip at the same time, which advantageously increases the tightness of the reel when compared to surface draw attained by the wire only.

[0050] In one embodiment it is also possible to produce the surface draw as a combined effect of the surface draw torques P5' and P5", i.e. the placing of the machine reel directly against the first wire guiding roll 1 produces the surface draw P5' of this part, and additionally surface draw P5" is produced by means of the press roll 10.

[0051] The torques of the drives are adjusted in the direction of resultant force exerted by the wire 3 on the surface of the reel 4 in such a manner that it is optimal in view of the nip force and removal of air.

[0052] The wrap angle of the wire 3 is adjusted by the deflection of the wire and the distance P3 of the machine reel 4 from the first wire guiding roll 1. The distance P3 affects the angle of incidence and departure of the wire 3 from the nip 7, and thus the direction and magnitude of the resultant force of the machine reel.

[0053] Figs 3 to 6 show a reeler solution. The presented belt reeler is formed of a so-called pope reeler. The belt reeler comprises at least a first wire guiding roll 1 and a second wire guiding roll 2. The reeling cylinder of the pope reeler has been converted into a first wire guiding roll 1 and advantageously into a turning roll. Furthermore, the pope reeler has been supplemented with a second wire guiding roll 2, a wire 3 and a wire guiding roll 8, which is advantageously equipped with a drive. Thus, it is advantageously possible to form a belt reeler with a moving reeling nip 7 and a stationary reeling station 9. The stationary reeling station 9 may also be a moving carriage or the like.

[0054] By means of such a reeler it is possible to form a so-called semi-hard nip 7 for the duration of the entire reeling process. The semi-hard nip 7 comprises both a wire nip and a roll nip. The wire nip 7 enables removal of air, which is an advantageous feature especially at high speeds. The hard nip 7, in turn, is utilized to affect the hardness of the reel 4.

[0055] The reeler enables fully supported web transfer to the reeler. Fig. 3 describes the initial situation of the reeling. The reel spool 6 is driven by a primary carriage and the reel spool 6 is in touch with the first wire guiding roll 1 via a supporting belt loop 3. Fig. 3 shows the second wire guiding roll 2 in its first position, i.e. down in the front. The tension of the supporting member loop 3 is adjusted with a wire guiding roll 8. To guide the supporting loop

3, the apparatus may also comprise several wire guiding rolls. Furthermore, the figure shows a secondary reeling station 9 equipped with a drive, which is advantageously stationary. The figure also shows a press roll 10 in the vicinity of the secondary reeling station 9, which can also function during the entire reeling process or part of the same, or it can be a mere surface binding device during/after the reel change.

[0056] When the reeling is in progress the second wire guiding roll 2 is brought into a second position i.e. up in the front, as shown in Fig. 4. Thus, the second wire guiding roll 2 is brought in contact with the reel spool 6 via the supporting belt loop 3. The wire guiding roll 8 is utilized to adjust the tension of the supporting member loop.

[0057] In Fig. 5 the reel spool 6 is positioned in the secondary reeling station 9. The nip 7 is thus formed with a second wire guiding roll 2, which in the figure is positioned in its third position, i.e. up in the back. Typically the surface binding device 10 is brought in contact with the surface of the reel 4 that is being formed.

[0058] As the reeling proceeds and the reel 4 to be formed grows, the second wire guiding roll 2 is lowered down, as shown in Fig. 6. When the reel 4 starts to reach its target size, the next reel spool 6 is brought in contact with the first wire guiding roll 1 by means of the primary carriage drive for change purposes. When the change has taken place, the second wire guiding roll returns from the described fourth position to its first position, and further to the other above-described positions as the reeling proceeds.

[0059] As can be seen in Figs 3 to 6, a nip 7 that comprises a wire nip and a hard nip is constantly in use in the presented embodiment. Often it is easier to control the wire loop 3 with a longer wire loop. Thus, is it advantageous to use several rolls via which the wire loop 3 circulates. The third wire guiding roll 8 is necessary also in that respect that the wire guiding roll 2 moves, and still the length of the wire 3 remains the same. Thus, the movement of the wire guiding roll 8 compensates the change produced by the movement of the roll 2 in the length of the wire loop 3.

[0060] The presented solution makes it possible to change a conventional reeler into a wire reeler in a simple manner. In the belt reeler it is possible to use the above-described control methods to produce a reel 4 of a desired kind. Furthermore, in some embodiments the presented belt reeler makes an advantageous positioning of the pulper possible. Furthermore, the structure enables a low storage, because the up-and-down movement of the carriages performs the lowering of the reeling cores 6 in the storage.

[0061] Figs 3 to 6 present a way of implementing a belt reeler. As to the modifications made in the reeler, the final way of implementing the belt reeler is substantially dependent on the original reeler. Figs 7 to 12 show some other embodiments of implementing a belt reeler.

[0062] Figs 7 to 9 show a belt reeler formed of a so-called Optireel reeler. The reeler comprises at least two

wire guiding rolls 1, 2. The first wire guiding roll 1 is stationary and in said embodiment it is the reeling cylinder of the original reeler, or a wire guiding roll replaced in the corresponding position. The wire guiding roll 2 of the example is arranged movable. Depending on the application, there may also be a larger number of rolls. The moving wire guiding roll 2 is utilized to control for example some parameters of the supporting belt, such as the tension P2 and depression P4 of the wire.

[0063] Fig. 7 shows a situation in which the formation of the reel 4 around a new reel spool 6 is started. The figure also shows the reel 4 that is being formed. As can be seen in the figure, the nip 7 of the reel 4 that is being formed is essentially a wire nip. The nip 7 of the reel 4 that is being started is, in turn, substantially a hard nip formed with a roll-wire combination 1, 3 by means of which a sufficiently tight reel bottom is attained.

[0064] As the reeling proceeds, the reel 4 that is being formed is transferred along a supporting belt loop 3 towards the other end of the wire reeler, in which the second wire guiding roll 2 is located. This situation is shown in Figs 8 and 9.

[0065] In the example shown in Figs 7 to 9 the web 5 to be reeled is passed to the reeler substantially horizontally. In some reeler embodiments, the passing of the web 5 can occur from another direction. For example in the embodiment shown in Figs 10 to 12 the web 5 is passed to the reeler substantially vertically. Figs 10 to 12 show in principle a belt reeler deviating from the preceding embodiment. Such a reeler can be formed for example of a centre-driven reeler of prior art, in which the reeling cylinder has originally moved in the horizontal direction. Thus, for a large part of the reeling time the reel spool 6 can be stationary, while the reeling cylinder moves as the reeling proceeds. The web 5 is brought to the reeler advantageously in the vertical direction, so that the effect of the web tension P1 on the horizontal movement of the wire guiding roll 1 and on the horizontal nip load measured from its loading members would be as small as possible.

[0066] The reeler shown in Figs 10 to 12 comprises at least two wire guiding rolls 1, 2. The first wire guiding roll 1 is arranged to move substantially horizontally, and in said embodiment it is the reeling cylinder of the original reeler, or a new wire guiding roll replaced in a corresponding position. If necessary, the wire guiding roll 1 can be locked so that it moves in a fixed position continuously or for some time. The wire guiding roll 2 of the example is arranged movable. Depending on the embodiment, there may also be several rolls, and in view of the use, it is often advisable to use for example four, five or six rolls. One or several moving wire guiding rolls 2 are utilized to control for example some parameters of the supporting member loop, such as the tension P2 and depression P4 of the wire.

[0067] Fig. 10 shows a situation in which the formation of a reel 4 around a new reel spool 6 is started. The figure also shows the reel 4 that is being formed. As can be

seen in the figure, the nip 7 of the reel 4 that is being formed is essentially a wire nip. The nip 7 of the reel 4 that is being started is, in turn, substantially a hard nip formed by a roll-wire combination 1, 3.

[0068] As the reeling proceeds, the reel 4 that is being formed is transferred along a supporting belt loop 3 towards the other end of the wire reeler, in which the second wire guiding roll 2 is located. This situation is shown in Figs 11 and 12. In one embodiment, the reel 4 that is being formed may remain in its place from the beginning of the reeling almost until the end of the reel formation, wherein the supporting member loop 3 or at least its first roll 1 is transferred according to the growth of the reel, for example horizontally to the left. The actuators can be actuators used for moving the reeling cylinder of an original prior art reeler, such as horizontal guides and loading cylinders. As long as the reeling takes place against the roll 1 with a hard nip, the nip load of the nip 7 can be determined at least partly from sensors connected to the actuators of the roll 1, such as force sensors and pressure sensors of the hydraulic cylinder. In the situation of Fig. 11, the nip load can be determined in addition to the loading measurement of the roll 1 on the basis of the tension/depression P2, P4 of the wire and/or as a combination of the measurements.

[0069] In the above-presented belt reeler solutions relating to Figs 7 to 12, the position of the reel spool 6 is arranged movable at least in some stage of the reeling. It is also possible to implement the belt reeler in such a manner that the reel spool 6 that is being formed rotates in its place during the reeling process.

[0070] Figs 13 and 14 show a reeler solution comprising two stationary reeling stations 11, 12, such as reeling frames, for reel spools 6. Between the reeling stations 11, 12 travels a supporting member loop of the belt reeler 3 that forms a reeling nip 7 and helps in taking the web from one reeling station 11, 12 to another. The supporting member loop 3 of the reeler moves along with the diameter of the reel 4 and both opens and/or closes the reeling nips according to the situation. In Fig. 13 the first reel 4 is being completed in the second reeling frames 12, and the formation of the new reel is being transferred to the first reeling frames 11. In Fig. 14, in turn, the reel has been completed in the first reeling frames 11 and the new reel is reeled in the second station 12.

[0071] The reeler comprises at least a first wire guiding roll 1 and a second wire guiding roll 2. Depending on the embodiment, there may also be several rolls, and in view of the use, it is often advisable to use for example four, five or six rolls. In the embodiment of Figs 15 and 16, there are for example three rolls that are arranged movable. In Fig. 15 the first reel 4 is being completed in the second reeling station 12, and the formation of a new reel is being transferred to the first reeling frames 11. In Fig. 16, in turn, the reel has been completed in the first reeling frames 11 and the new reel is reeled in the second station 12.

[0072] The reeling stations (reeling frames) 11, 12 can

also be positioned on different heights with respect to each other, as shown in Figs 17 to 20. In Figs 17 and 18 the supporting member loop 3 travels via two wire guiding rolls 1, 2 and in Figs 19 and 20 via several rolls. By means of several rolls it is possible to attain easier control of the wire 3. In Figs 17 and 19 the first reel 4 is being completed in the second reeling station 12, and the formation of a new reel is being transferred to the first reeling frames 11. In Figs 18 and 20, in turn, the reel 4 has been completed in the first reeling frames 11 and a new reel is being reeled in the second station 12.

[0073] In Figs 13 to 20 the tail threading in connection with belt reelers takes place advantageously in a similar manner as in current reelers. The empty reel spool 6 can be located in either reeling frame 11, 12. In the tail threading the tail of the web 5 is passed and spread in full width. Thereafter the tip of a wedge is cut and the end of the web 5 is blown around a reel spool 6 located either in the first 11 or in the second reeling frame 12 for example by means of a gooseneck or the like. The tip of the wedge can be cut with a suitable device, such as a waterjet cutting change device.

[0074] When the reeling is in progress, the reeling frame 11, 12 used in the reeling must be changed when the reel 4 has been completed. When the full machine reel 4 is positioned in the latter reeling frame 12, the tip of the wedge is cut in the change with the waterjet cutting change device. The tip of the wedge is blown on an empty reel spool 6 located in the first reeling frame 11. Thus, it is possible to operate substantially in a similar manner as in tail threading or in changes currently conducted by means of a waterjet cutting change device.

[0075] When the full machine reel 4, in turn, is positioned in the first reeling frame 11, the tip of the wedge is cut off in the change by means of the waterjet cutting change device. The tip of the wedge is prevented from turning with the web 5 on the surface of the machine reel 4 that is being formed. For this it is possible to use for example suction underneath the wire 3 or preventive blowing on top of the wire. Thus, the tip of the wedge continues its travel along the surface of the supporting member loop 3 to the second reeling frame 12. When the web 5 has passed the reel spool 6 in the second reeling frame 12, the waterjet cutting change device performs a cutting all the way to the edges, and the web 5 is blown around the reel spool 6 in the second reeling frame.

[0076] In connection with the belt reeler it is possible to use the following change method. Fig. 21 shows in a top view a belt reeler comprising a first wire guiding roll 1 and a second wire guiding roll 2 through which the wire 3 travels. In the figure, the wire 3 is shown in broken lines, because the paper web 5 that is wider than the wire has been positioned on top of the wire 3, travelling through the nip 7 between the wire and the reel spool 6. In the change method the new reel spool 6 is provided with an adhesive element 13 in the area remaining outside the wire/wires 3. The adhesive element 13 can be formed in

various ways, for example by means of a double-sided adhesive tape, by spraying of glue, etc. The change is conducted by cutting a tail in the cross direction at the location of the adhesive element 13 (for example from one edge of the web or from the middle). The tail cut by means of waterjet is deflected towards the reel spool 6 for example by means of a movable member 14 located after the nip 7, or by means of a deflection element fed in said point in the nip 7. The deflection element also makes the cutting of a wedge instead of a tail possible. At the same time when the tail/wedge adheres on the adhesive element 13 in the reel spool 6, the spreading of the web on the reel spool begins (spreading of cutting devices 15).

[0077] In view of reel formation, i.e. especially the straightness of the nip it is advantageous that the wire 3 is not larger in width, that it is advantageously narrower than the web 5 from which the reel 4 is formed. Thus it is easy to arrange the adhesive element 13 at the edge of the reel spool 6 without said adhesive element adhering to the wire 3.

[0078] In cases where the change is conducted in the middle of the web 5, a space is arranged in the middle of the reeler at the location of the adhesive element 13, because it is advantageous to have the adhesive element 13 in such a location where the wire is not present. The belt reeler that comprises two or several wires 3, the space between the wires may be formed only for the duration of the change by deviating one or several wires sideways.

[0079] During the change the controlled detachment of the tail from the reel spool 6 can be ensured by means of a suitable solution. One such a solution is a so-called tail-shooter blowing plate that keeps the tail down. The purpose of the solution is to ensure that the floating web 5 does not accidentally adhere to the adhesive element 13 too early. This is possible especially when the distance between the adhesive element 13 from the web 5 before the change is small, for example not larger than the thickness of the wire 3, or smaller. The distance is also affected by the thickness of the adhesive element 13 and the shape of the coating of the reel spool 6, which can be for example narrower at the ends.

[0080] One change embodiment can also be utilized in conventional reelers. In the embodiment, an adhesive element 13, such as an adhesive tape, pressure-activated adhesive tape or a corresponding structure is installed in the reel spool 6, in an area outside the paper web. The pressure-activated adhesive tape is activated when the nip 7 is closed and the adhesive tape is subjected to pressure. By placing the adhesive element 13 outside the web it is possible to efficiently prevent the adhesive element and the web from adhering to each other prematurely, wherein the change can be timed for example in the waterjet cutting change. The cutting of a tail from the edge of the web starts at the same time when the nip 7 is closed. Thereafter the narrow tail is deviated in the lateral direction at the location of the adhesive area 13,

wherein it adheres to the adhesive agent. The adherence of the tail to the adhesive agent is followed by spreading. The method is suitable especially for slow paperboard machines and for solutions in which the wire 3 is not narrower than the web.

[0081] For example when a thick paperboard web is being reeled and the adhesive element 13 that is narrower than the web to be reeled 5 is located in the reel spool 6 outside the edge of the web, the adhesive element 13 does not touch the reeling cylinder 1 when the nip 7 is closed. It is not until the cut tail or the entire web 5 is transferred in the cross-direction at the location of the adhesive element 13 that it touches the adhesive agent and performs a change.

[0082] The reeler used for the change comprises several different structures and parts. The final configuration depends on the application and the purpose of use of the device. The device can for example contain a tail cutting device.

[0083] By combining, in various ways, the modes and structures disclosed in connection with the different embodiments of the invention presented above, it is possible to produce various embodiments of the invention in accordance with the spirit of the invention. Therefore, the above-presented examples must not be interpreted as restrictive to the invention, but the embodiments of the invention may be freely varied within the scope of the inventive features presented in the claims hereinbelow.

Claims

1. A method in a belt reeler in which a reeling nip (7) is formed by a reeling core (6) or a growing machine reel (4) and at least one endless supporting member (3) travelling at least via a first wire guiding roll (1) and a second wire guiding roll (2), **characterized in that** several parameters are determined and adjusted simultaneously to adjust the reeling process, of which parameters at least the first parameter and the second parameter are one of the following: web tension (P1), wire tension (P2), distance of the machine reel from the wire turning roll (P3), depression of the wire/machine reel (P4), surface draw (P5, P5', P5"), peripheral force (P6).
2. The method according to claim 1, **characterized in that** the parameter is determined by means of measurements or calculations.
3. The method according to claim 1 or 2, **characterized in that** the belt reeler is formed of a centre-driven reeler by replacing its reeling cylinder with a first wire guiding roll (1) and adding at least a second wire guiding roll (2), and an endless supporting member (3).
4. The method according to any of the preceding claims, **characterized in that** the belt reeler is arranged in a reeling apparatus comprising at least two stationary reeling stations (11, 12) to form a machine reel (4).
5. The method according to claim 4, **characterized in that** the first wire guiding roll (1) and the second wire guiding roll (2) are arranged to move in relation to the reeling stations (11, 12).
6. The method according to any of the preceding claims, **characterized in that** the area of the reeling core (6) outside the paper web and/or the wire is provided with an adhesive element (13) against which a section of the paper web is guided when changing the reeling core.
7. A belt reeler in which a reeling nip (7) is formed by a reeling core (6) or a growing machine reel (4) and at least one endless supporting member (3) arranged to travel at least via a first wire guiding roll (1) and a second wire guiding roll (2), **characterized in that** the belt reeler comprises at least means for determining and adjusting several parameters simultaneously to adjust the reeling process, of which parameters at least the first parameter and the second parameter are one of the following: web tension (P1), wire tension (P2), distance of the machine reel from the wire turning roll (P3), depression of the wire/machine reel (P4), surface draw (P5, P5', P5"), peripheral force (P6).
8. The belt reeler according to claim 7, **characterized in that** the belt reeler is formed of a centre-driven reeler by replacing its reeling cylinder with a first wire guiding roll (1) and adding at least a second wire guiding roll (2), and an endless supporting member (3).
9. The belt reeler according to claim 7 or 8, **characterized in that** the belt reeler is located in a reeling apparatus comprising at least two stationary reeling stations (11, 12) to form a machine reel (4).
10. The belt reeler according to claim 9, **characterized in that** the first wire guiding roll (1) and the second wire guiding roll (2) are arranged to move in relation to the reeling stations (11, 12).
11. A method for rebuilding a centre-driven reeler, said reeler comprising at least a reeling cylinder, **characterized in that** the centre-driven reeler is formed into a belt reeler by replacing its reeling cylinder with a first wire guiding roll (1) and adding at least a second wire guiding roll (2), and an endless supporting member (3).
12. A reeling apparatus comprising at least a belt reeler

in which a reeling nip (7) is formed by a reeling core (6) or a growing machine reel (4) and at least one endless supporting member (3) arranged to travel at least via a first wire guiding roll (1) and a second wire guiding roll (2),

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characterized in that the belt reeler comprises at least two stationary reeling stations (11, 12) to form a machine reel (4).

13. The belt reeler according to claim 12, **characterized in that** the first wire guiding roll (1) and the second wire guiding roll (2) are arranged to move in relation to the reeling stations (11, 12).

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14. A reel change method to be used in a belt reeler in which a reeling nip (7) is formed by a reeling core (6) or a growing machine reel (4) and at least one endless supporting member (3) travelling at least via a first wire guiding roll (1) and a second wire guiding roll (2), **characterized in that** the reeling core (6) is provided with an adhesive element (13) located in such an area in the reeling core which at least in the beginning of the reeling process remains outside the reeling nip (7), to which adhesive element (13) a section of the paper web is guided when changing the reeling core.

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15. The method according to claim 14, **characterized in that** the adhesive element (13) is located at the end of the reeling core (6).

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16. The method according to claim 14 or 15, **characterized in that** the adhesive element (13) is formed by spraying of glue or by means of an adhesive tape.

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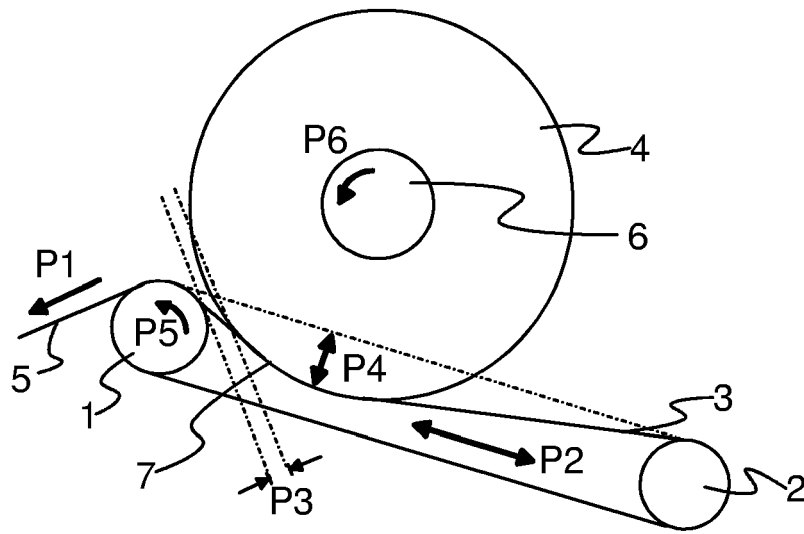


Fig. 1

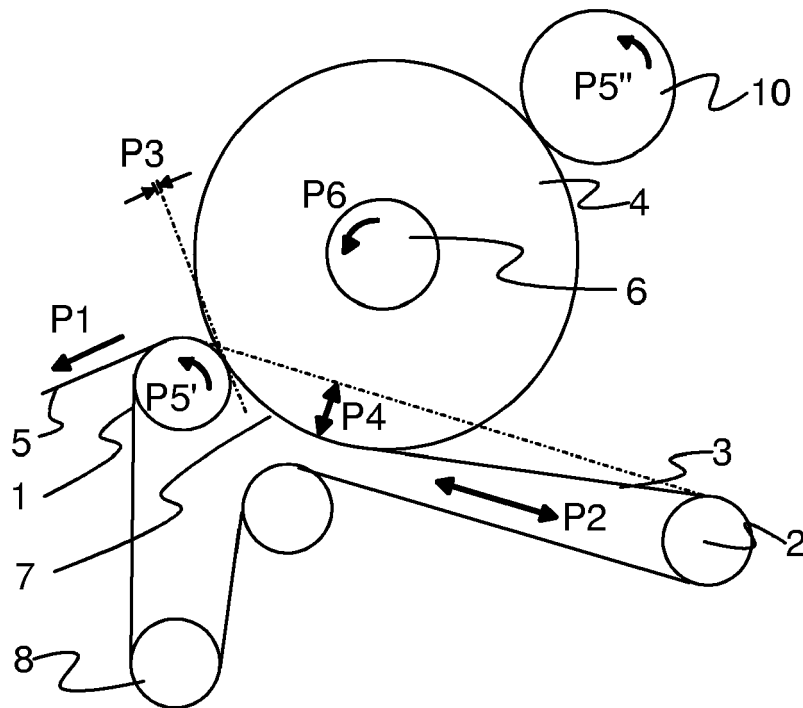


Fig. 2

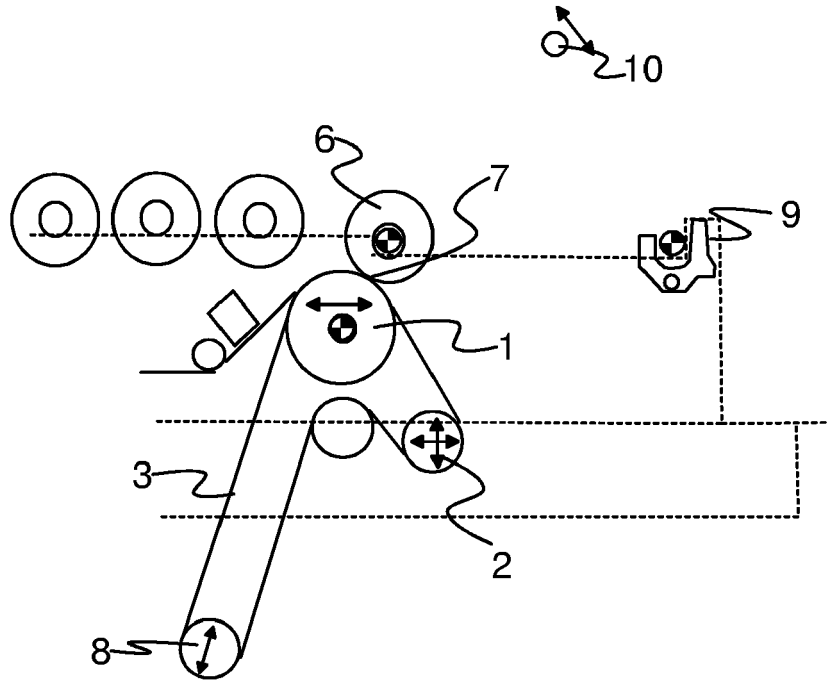


Fig. 3

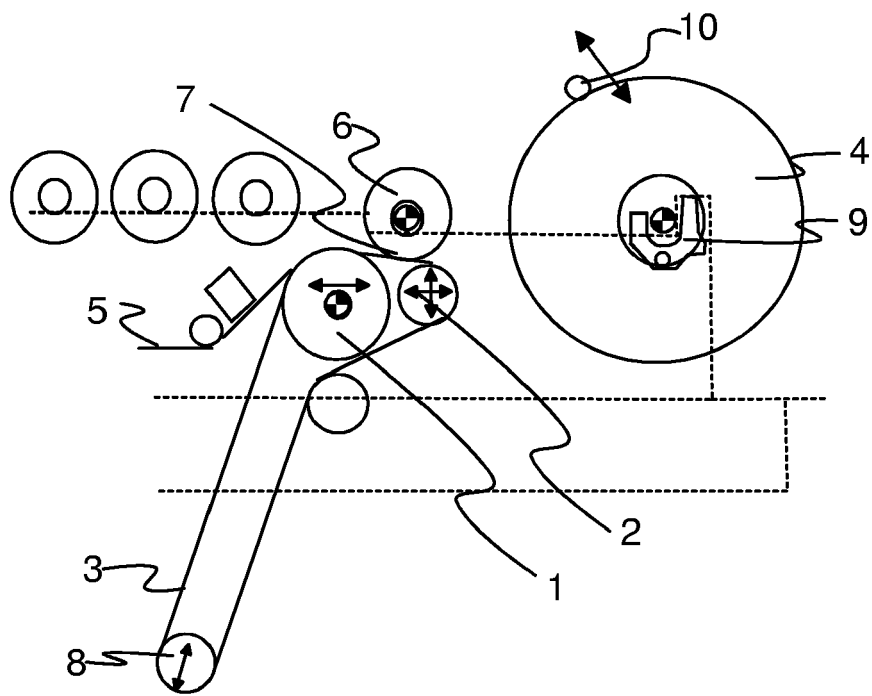


Fig. 4

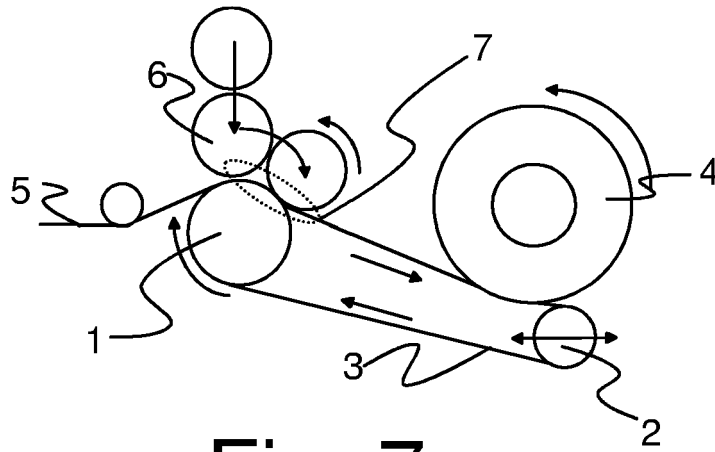


Fig. 7

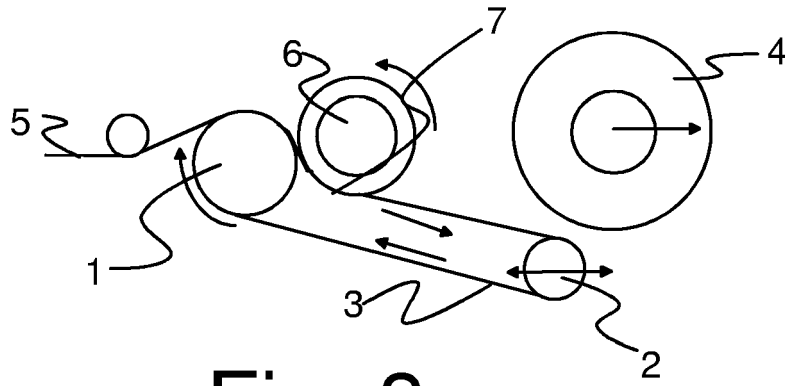


Fig. 8

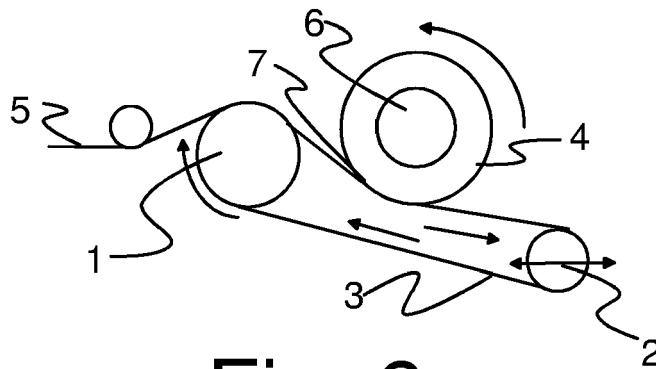


Fig. 9

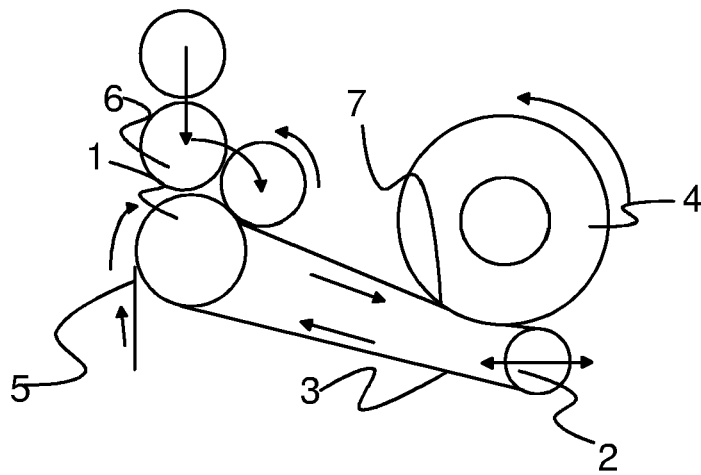


Fig. 10

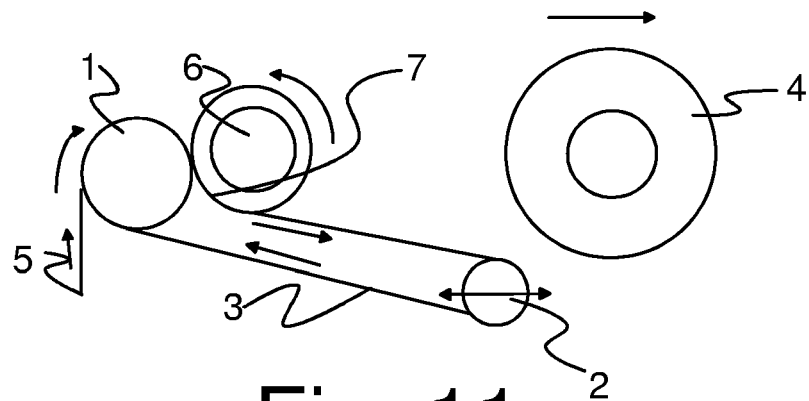


Fig. 11

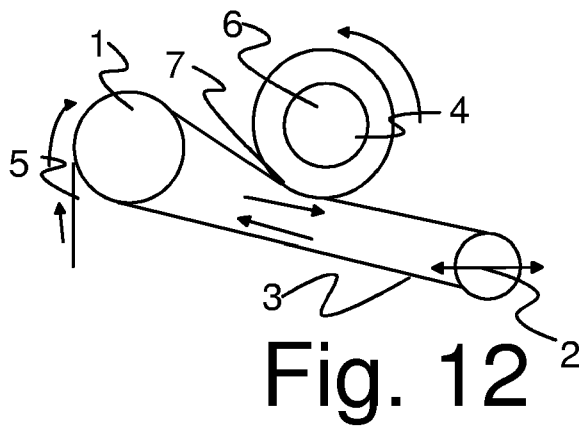


Fig. 12

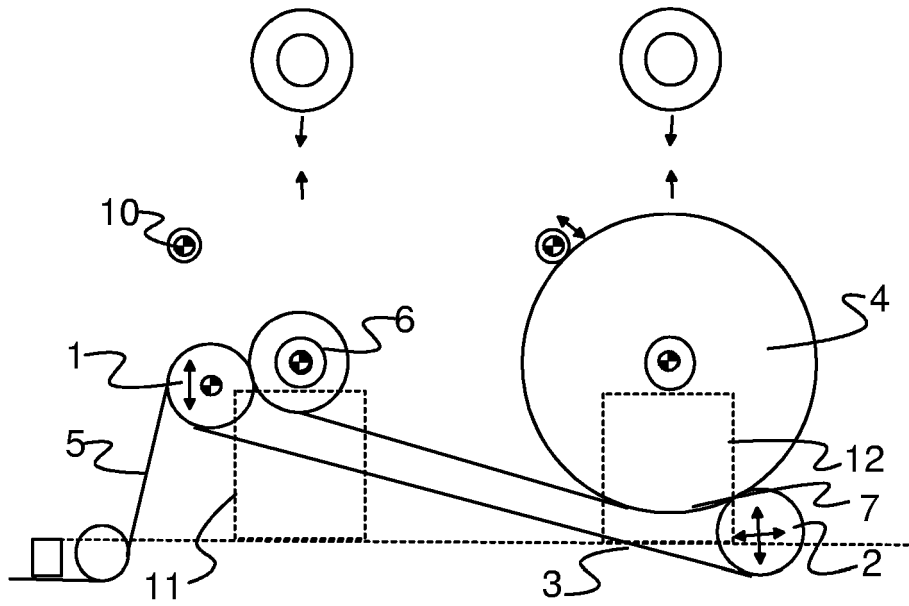


Fig. 13

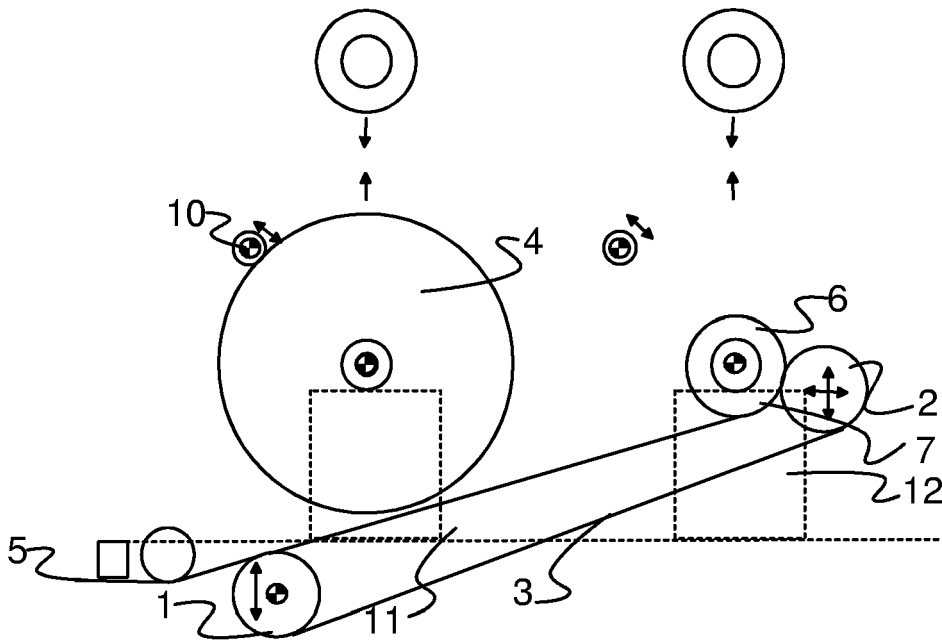


Fig. 14

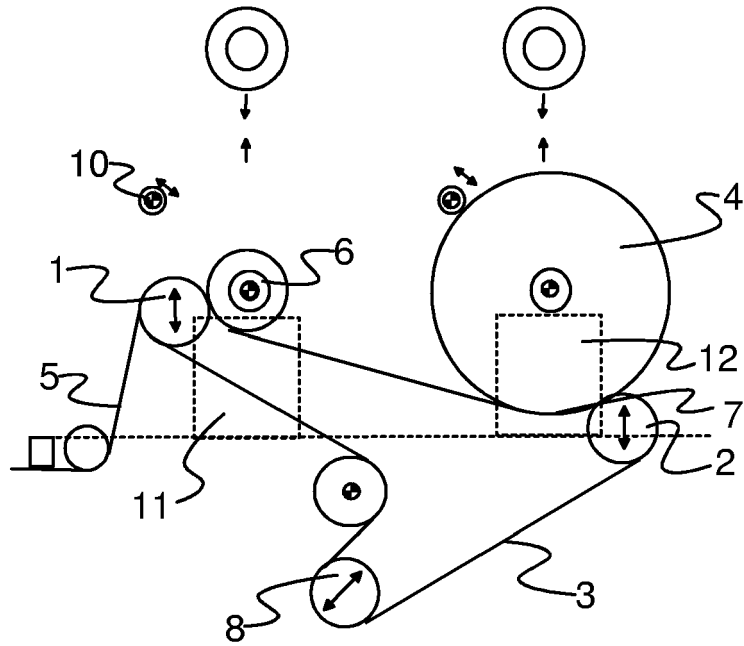


Fig. 15

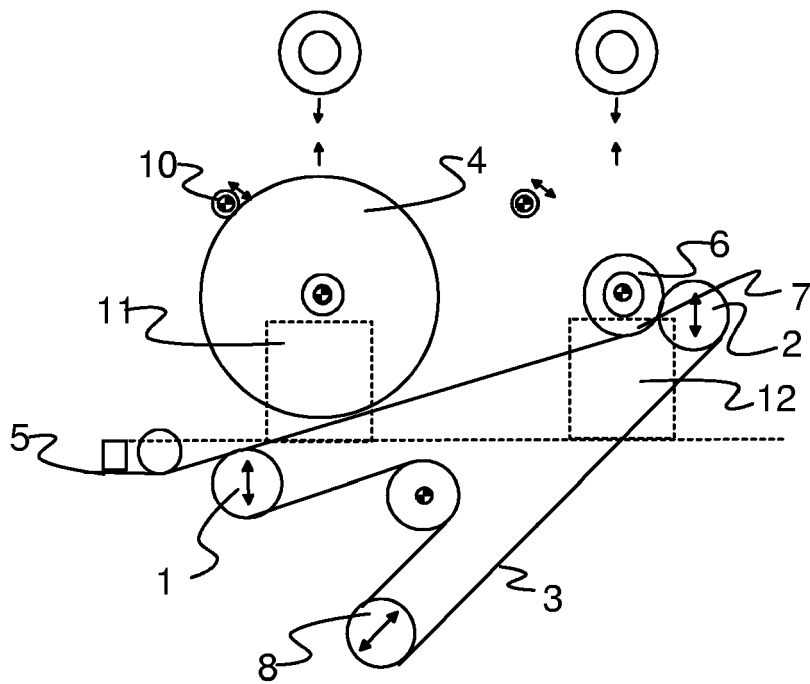


Fig. 16

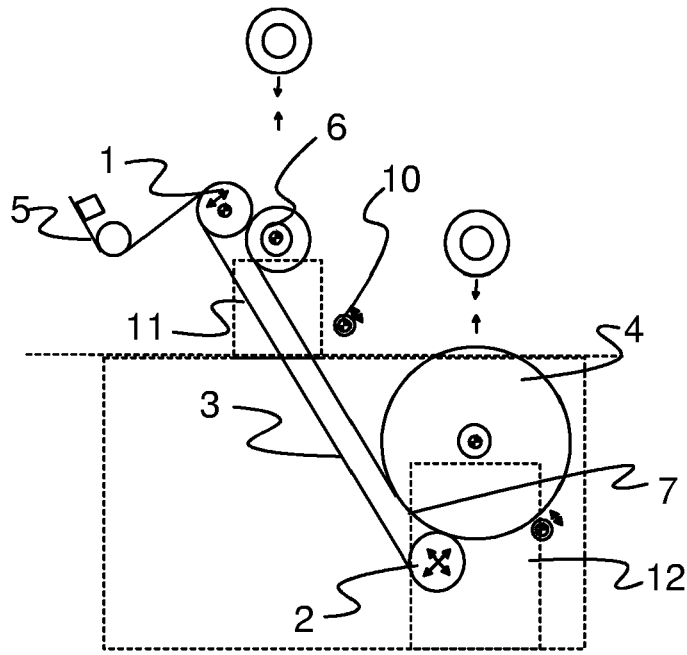


Fig. 17

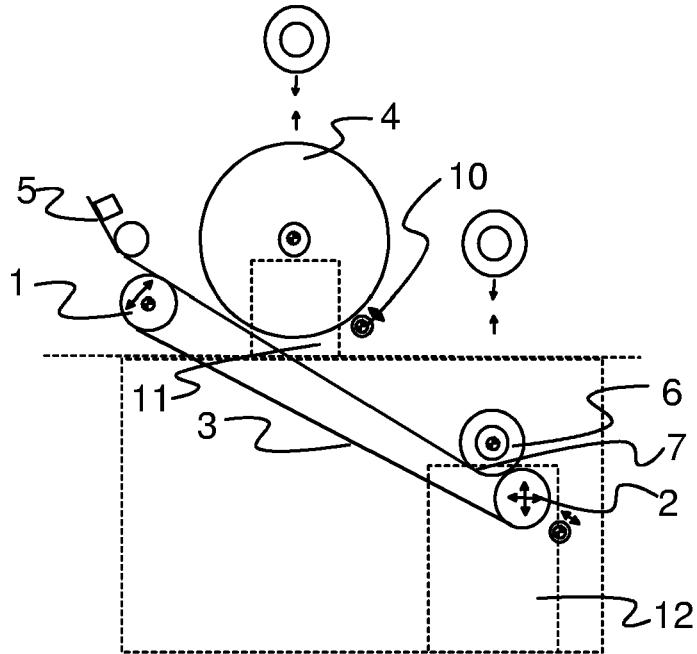


Fig. 18

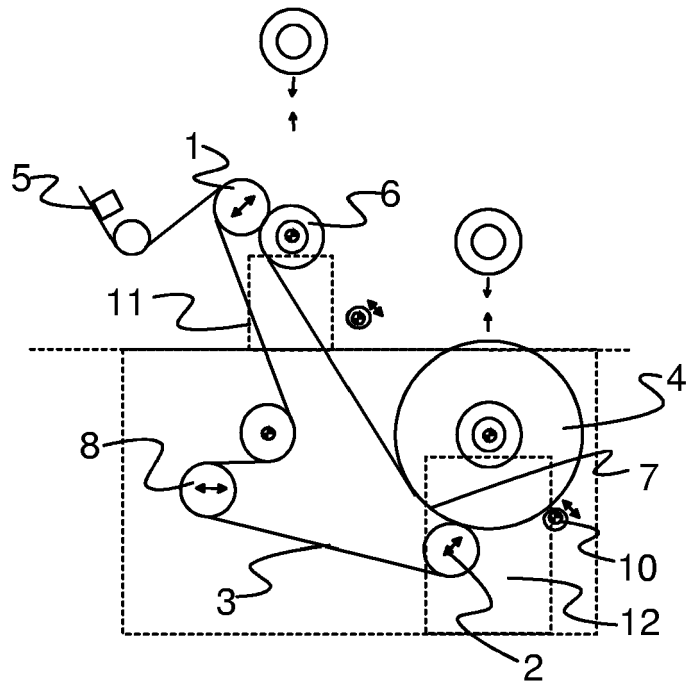


Fig. 19

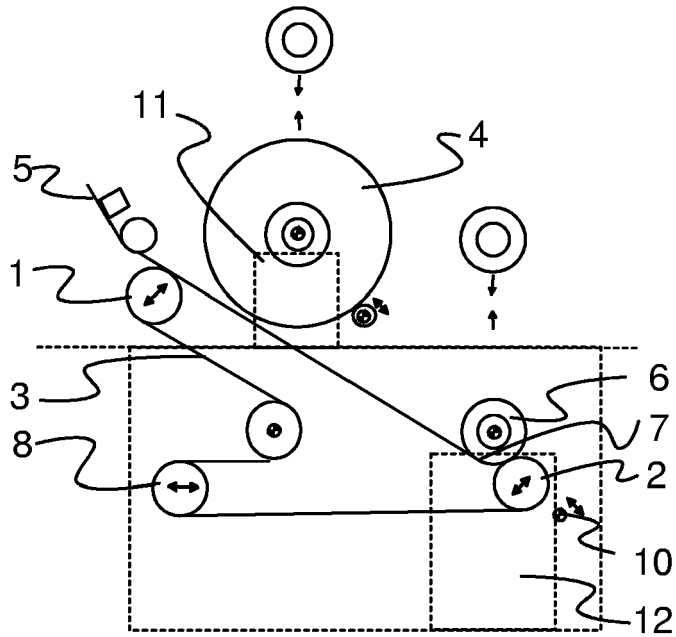


Fig. 20

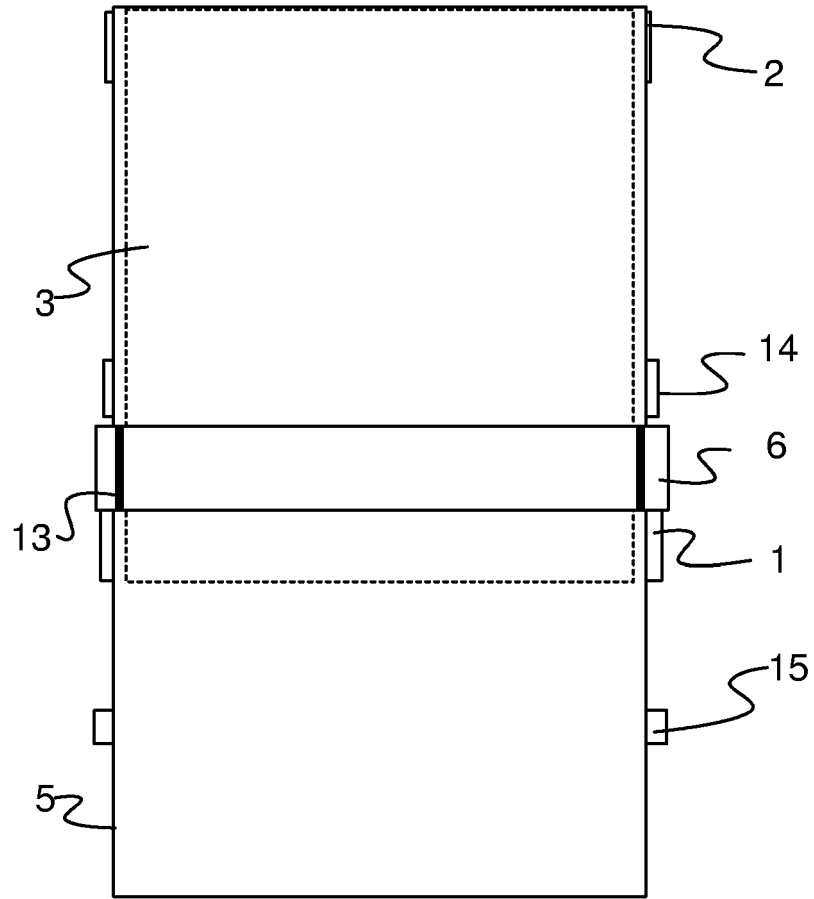


Fig. 21

REFERENCES CITED IN THE DESCRIPTION

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