



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.06.2023 Bulletin 2023/23

(51) International Patent Classification (IPC):
B65H 23/00 ^(2006.01)

(21) Application number: **21211713.9**

(52) Cooperative Patent Classification (CPC):
(C-Sets available)
B65H 23/005; B65H 2220/03; B65H 2511/512;
B65H 2513/11; B65H 2701/173 (Cont.)

(22) Date of filing: **01.12.2021**

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

(72) Inventors:
• **Heege, Thomas**
56761 Dungenheim (DE)
• **Torres Saavedra, Antonio**
56330 Koborn-Gondorf (DE)
• **WEBER, Ainas**
53474 Bad Neuenahr-Ahrweiler (DE)

(71) Applicants:
• **Ontex BV**
9255 Buggenhout (BE)
• **Ontex Group NV**
9320 Erembodegem (BE)

(74) Representative: **Saurat, Thibault**
Ontex BV
Legal Department
Korte Keppestraat 21
9320 Erembodegem (BE)

(54) **APPARATUS AND METHOD FOR UNWINDING A WEB MATERIAL**

(57) The current invention concerns an apparatus (10) for unwinding a web material (12) comprising :
a. an output shaft (26) for unwinding a web roll (14) of web material (12);
b. a driving system (22,24) for actuating said output shaft (26) and unwinding the web roll (14), said driving system (22) comprising an actuator (22) and optionally a transmission mechanism (24);
c. a measuring device (28) arranged to measure the radius of the web roll (14);

d. a controller unit (32) configured to receive signals (30) from the measuring device (28), process said data and emit at least one signal (34,36) to the driving system (22,24) for maintaining or modifying the unwinding speed of said web roll (14).

According to the invention, the measuring device (28) is arranged at a distance from the web-take off point (18) where the web material (12) leaves the web roll (14). The invention also concerns a method exploiting such apparatus.

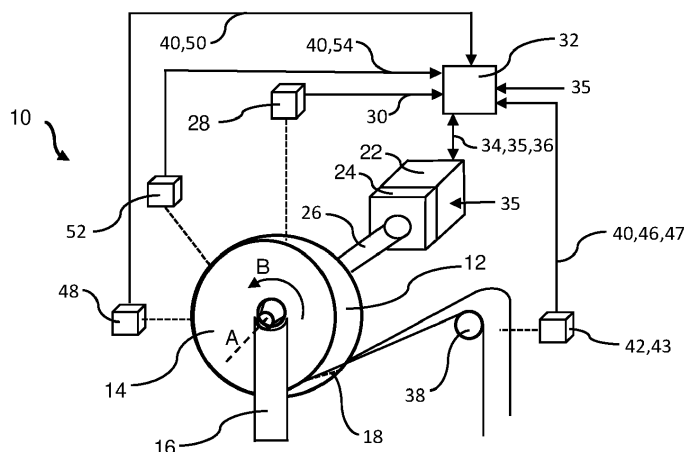


FIG.1

(52) Cooperative Patent Classification (CPC): (Cont.)

C-Sets

B65H 2220/03, B65H 2220/02, B65H 2220/03;
B65H 2513/11, B65H 2220/02, B65H 2220/03

Description

TECHNICAL FIELD

[0001] The present invention relates to a method of guiding a web at a substantially constant speed. In particular the present invention relates to operations in the manufacturing of absorbent articles such as unwinding web rolls that are wound, in particular spirally wound web rolls, and removing web from said rolls. The invention also relates to an apparatus for the execution of said method.

BACKGROUND

[0002] Webs for the production of hygiene products like diapers or incontinence pants usually consist of flexible materials and are transported loosely in containers or as web rolls wound around an axis. A special technical problem lies with unwinding the web rolls in regard to removing the web material from the container for further processing.

[0003] Indeed, because of the soft nature of the web material used to manufacture absorbent article, it is common for a web roll to become out-of-round. Not only the soft nature of the web material, but also the physical size of the web rolls, the length of time during which the web rolls are stored, and the fact that roll grabbers used to transport web rolls grab them about their circumference can contribute to this problem. As a result, by the time many web rolls are placed on an unwinding station they have changed from the desired cylindrical shape to an out-of-round, or deformed shape.

[0004] In extreme cases, the web rolls can become oblong or generally egg-shaped. But, even when the web roll is are only slightly out-of-round, there are considerable problems. With a perfectly round web roll, the feed rate of a web material coming off of the rotating web roll can be equal to the driving speed of a surface driven web roll and thus can remain constant.

[0005] However, with a deformed web roll the feed rate varies from the driving speed of a surface drive web roll depending upon the radius at the web take-off point at any moment in time. It will be appreciated that for obtaining the best production yield, it is desirable that the rotational speed of the web roll remains substantially constant.

[0006] A common approach to manage these issues is to implement a tension control systems at the end of the unwinding station. However, this solution corresponds to a system which is reacting to a change of tension and then adapts the rotational speed of the web roll but it is not adapted for as deformed web roll where the take-off point radius is constantly changing. To some extent, this change is unaccounted for by typical tension control systems.

[0007] The invention thereto aims to provide a method and apparatus which ensures an efficient and reliable

bonding of the film material onto the absorbent material.

SUMMARY OF THE INVENTION

[0008] The present invention provides an apparatus for unwinding a web material comprising :

a. an output shaft for unwinding a web roll of web material;

b. a driving system for actuating said output shaft and unwinding the web roll, said driving system comprising an actuator and optionally a transmission mechanism;

c. a measuring device configured to measure the radius of the web roll;

d. a controller unit configured to receive signals from the measuring device, process said data and emit at least one signal to the driving system for maintaining or modifying the unwinding speed of said web roll.

[0009] According to the invention, the measuring device is arranged at a distance from a web-take off point where the web material leaves the web roll.

[0010] According to the invention, by arranging the measuring device at a distance from the point where the web material leaves the web roll ensures that the system has enough calculation time so that the control unit can take into account other factors such as an operator's inputs, a motor speed feedback, or additional control feedbacks.

[0011] According to an embodiment, the angular distance between the measuring device and the web take-off point in reference to the web roll and its centre and following the unwinding direction, is greater than about 10°, preferably greater than about 45°, more preferably greater than about 90°. Said angular distance can be greater than about 180°.

[0012] According to an embodiment, the measuring device is arranged on the diametrical opposite side of the web take off point in reference to the web roll.

[0013] According to an embodiment, the measuring device is configured to measure the radius of the web roll with a rate of 1 measurement point per every 3 to 30 ms.

[0014] According to an embodiment, the apparatus comprises a stationary secondary guiding roll that is configured to rotate around an axis, said web material being conveyed from the web take-off point to the secondary guiding roll.

[0015] According to an embodiment, the apparatus further comprises a velocity sensor configured to measure the velocity of the web material and emit this measurement an output signal to the control unit.

[0016] According to an embodiment, the velocity sensor is arranged downstream, relative to the conveying of

the web material, of the web take-off point, preferably downstream of the secondary guiding roll.

[0017] According to an embodiment, the apparatus further comprises a rotational position and speed determining device configured to measure the rotational speed and position at the web roll and emit this measurement as an output signal to the control unit.

[0018] According to an embodiment, the apparatus further comprises an image detection device configured to determine if a print mark is well positioned on the web roll and emit this measurement as an output signal to the control unit.

[0019] According to an embodiment, wherein the control unit is configured to receive signals from the measuring device, and at least one of the signal emitted by the velocity sensor and/or image detection device and/or rotational position and speed determining device, process said data and emit at least one signal to the driving system for maintaining or modifying the unwinding speed of said web roll.

[0020] All of these embodiments mentioned above can be taken individually or in combination.

[0021] The invention also pertains to a method for unwinding a web material preferably using an apparatus as described above, said method comprises the following steps:

- a) measuring radius R of the web roll using the measurement device and emitting this measurement as an output signal to the control unit;
- b) processing this measurement in combination with other input signals such as an operator's input and/or the current actuating speed of the actuator;
- c) calculating the rotational speed required based on said measurements;
- d) emitting a signal to the driving system such as an ideal speed reference signal and/or a corrected speed reference signal;
- e) adjusting the speed of the drive system to either accelerate, decelerate or stop the web roll depending on the situation.

[0022] According to an embodiment, in the processing step b, the control unit further processes at least one signal emitted by the velocity sensor and/or image detection device and/or rotational position and speed determining device.

[0023] All of these embodiments mentioned above can be taken individually or in combination.

[0024] Further embodiments are described below and in the claims.

DESCRIPTION OF FIGURES

[0025] The drawings and figures are illustrative in nature and not intended to limit the subject matter defined by the claims. The following detailed description can be understood when read in conjunction with the following

drawings, where like structure is indicated with like reference numerals in which:

FIG. 1 illustrates a schematic representation of the apparatus according to the invention;

FIG. 2 illustrates a profile or side view of a portion of FIG. 1;

FIG. 3A to 3C illustrates different embodiments of the web roll; and

FIG. 4 illustrates a profile or side view of a portion of FIG. 1;

FIG. 5 and 6 illustrates a profile or side view of a portion of FIG. 1 according to another embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The present invention concerns an improved apparatus and method for unwinding a web material.

[0027] Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

[0028] As used herein, the following terms have the following meanings:

"A", "an", and "the" as used herein refers to both singular and plural referents unless the context clearly dictates otherwise. By way of example, "a compartment" refers to one or more than one compartment.

"About" as used herein referring to a measurable value such as a parameter, an amount, a temporal duration, and the like, is meant to encompass variations of +/-20% or less, preferably +/-10% or less, more preferably +/-5% or less, even more preferably +/-1% or less, and still more preferably +/-0.1% or less of and from the specified value, in so far such variations are appropriate to perform in the disclosed invention. However, it is to be understood that the value to which the modifier "about" refers is itself also specifically disclosed.

"Angular distance" refers herein as the angle between two points in reference to the centre of the web roll.

"Comprise," "comprising," and "comprises" and "comprised of" as used herein are synonymous with "include", "including", "includes" or "contain", "containing", "contains" and are inclusive or open-ended terms that specifies the presence of what follows e.g. component and do not exclude or preclude the presence of additional, non-recited components, features, element, members, steps, known in the art or

disclosed therein.

[0029] The term "nonwoven web material" means a sheet material having a structure of individual fibers or threads which are interlaid, but not in a regular manner such as occurs with knitting or weaving processes. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes.

[0030] The recitation of numerical ranges by endpoints includes all numbers and fractions subsumed within that range, as well as the recited endpoints.

[0031] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration only of specific embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilised and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

[0032] In the manufacture of web material products including paper products such as paper towels, bath tissue, facial tissue, and the like, the web material which is to be converted into such products is initially manufactured on large web roll and placed on unwind stands. The embodiments described in detail below provide non-limiting examples of an apparatus for reducing feed rate variations in a web material when unwinding a web roll to transport the web material from the web roll at a web take-off point. In particular, the embodiments described below provide an apparatus which takes into account any out-of-round characteristics of the web roll and makes appropriate adjustments to reduce web feed rate variations.

[0033] With regard to these non-limiting examples, the described apparatus makes it possible to operate effectively and efficiently an unwind stand as part of a paper converting operation at maximum operating speed without encountering any significant and/or damaging deviations in the tension of the web material as it leaves an out-of-round web roll at the web take-off point.

[0034] FIG. 1 illustrates an apparatus 10 according to one embodiment, for reducing feed rate variations in a web material 12 when unwinding a web roll 14 of said web material 12 around a central, longitudinal or rotational axis A. The web roll 14 can be carried by a support 16 or it can be carried by an output shaft 26 exclusively. The apparatus 10 is configured to enable that the web material 12 unwinds from the web roll 14 at a fixed web take-off point 18 at constant speed. The web material 12 can for example be a nonwoven web material.

[0035] The apparatus 10 includes a driving system comprising an actuator 22, or motor, optionally coupled with a transmission mechanism 24, such as a gearbox 24 and an output shaft 26, or any other adequate trans-

mission mechanism, for imparting a rotational movement to the web roll 14. The driving system, through the actuator 22 and the transmission mechanism 24, rotates the web roll 14 in a counter-clockwise direction B as illustrated in Fig. 1. Alternatively, the driving system can be configured to rotate the web roll 14 in a clockwise direction.

[0036] The apparatus 10 further comprises a measuring device 28 for measuring the radius of the web roll 14. The measuring device 28 is adapted to measure the radius of the web roll 14 in a recurring sequence and send this data as output signals 30 to a control unit 32 which can process this information and generate and emit both an ideal speed reference signal 34 and/or a corrected speed reference signal 36 for the drive system, more specifically for the actuator 22 so that it can modify and adjust, if needed, the rotational speed, i.e. unwinding speed, of the web roll 14. The measuring device 28 is configured to measure the radius of the parent 14 at a high rate preferably such as 300 measurement points per second, or a measurement point every 30 ms to 3 ms. In particular, the ideal speed reference signal 34 can be based upon an operator's input 35 and the corrected speed reference signal 36 is generated for adjusting the driving speed of the drive system to a corrected driving speed. The operator's input 35 can be entered on and recorded by the actuator 22 or directly by the control unit 32.

[0037] To adjust the driving speed of the driving mechanism 22, 24, the control unit 32 is associated with: i) the measuring device 28 for receiving the measured radius for the web roll 14 (output signal 30) and ii) the driving mechanism for receiving any operator's input and/or the current actuating speed (output signal 35) for controlling the speed of the driving mechanism based upon the ideal speed reference signal 34 and the corrected speed reference signal 36.

[0038] Fig. 2 schematically illustrates the web roll 14 from a profile view. The web material 12 is spirally wound around a central axis A forming the web roll 14 and leaves the web roll 14, i.e. unwinds, at a web take-off point 18 and is conveyed here toward a secondary guiding roll 38 that is arranged at a fixed distance from the web roll 14. The secondary guiding roll 38 may be stationary and can also optionally be configured to rotate around an axis C, also the centre of said roll 38. In this case, the secondary guiding roll 38 rotates preferably in a free-wheel manner or it can be rotatably actuated at a constant speed.

[0039] The web material 12 can be conveyed after the secondary guiding roll 38 toward different elements depending on the manufacturing process line. For example, the web material 12 can be conveyed to a third guiding roll 41 as illustrated in Fig. 2, or the web material can be guided toward a cutting station comprising a roller with a knife and a roller acting as an anvil, or toward an embossing station comprising a roller with protrusions and a roller acting as an anvil.

[0040] The difference in shape between each web roll 14, i.e. if a web roll does not have a perfectly circular

profile, the effect of the out-of-round of the web roll 14, causes the web take-off point 18 to fluctuate in time and the angle α , corresponding to the angle between the lowest point of the roll 14 at any given time and the take-off point 18 (see Fig. 2), also varies depending on time. Fig. 3A, 3B and 3C illustrate a web roll 14 with an oval, or egg-shaped, profile or with a deformation caused by a mishandle. We can see that the angle α'' is greater than the angle α which is itself greater than the angle α' . The angle α''' can be greater or lesser than the other α angles depending on the degree of deformation. It also makes sense that with such elliptic profile, the angular speed for different points of the web roll 14 is not homogenous as opposed to a perfectly circular web roll 14.

[0041] The object of the invention is to pro-actively anticipate these differences in angular speeds and exploit the apparatus 10 as described above to calculate the value of the angle α for each point of the web roll 14 to deduce the web take-off point 18 to accelerate, decelerate or stop (in case of emergencies) the web roll 14 to ensure that the web material 12 effectively leaves the roll 14 at the same web take-off point 18. In other terms, the apparatus 10 ensures that the web take-off point 18 is more or less stationary and that the angle α stays substantially constant (up to a more or less difference of 10°), or in other words that the web material 12 always departs from the roll at the same location (same radial configuration). By leaving the roll 14 at the same point, the tension in the web material 12 is constant for the rest of the process line and it possible to use more fragile material that are prone to rupture when using a conventional system (with tension detector). Indeed if the web material 12 is conveyed and maintained at a constant tension, between 5 and 20 N, without having any fluctuation in the tension (more or less 5 N), a fragile web material can go through the process line without having a risk of rupturing.

[0042] To effectively calculate the effective web take-off point 18, the apparatus 10 exploits the following equations (1) and (2) :

$$\alpha = \arcsin \left(\frac{(R-r)}{D} \right) \quad (1)$$

$$\cos \alpha = \frac{M}{D} \quad (2)$$

with D corresponding to the distance between the centres of the web roll 14 and the secondary guiding roller 38 (e.g. the distance AC in Fig. 2); R representing the radius of the web roll 14 at the web take-off point 18, r representing the radius of the secondary guiding roller 38 and M representing the distance between the web take-off point 18 and the point where the web material 12 first contacts the secondary guiding roller 38.

[0043] Therefore by exploiting these equations, it is

possible to anticipate the web take-off point 18 and adjust the speed of the web roll 14 so that the web material 12 always leaves the web roll at the same point in space to ensure a constant tension of the web material 12. In other terms, r and D are constants (the secondary guiding roll is arranged stationary at a fixed location in the process line and has a given radius), the system by measuring R at a given time can determine the angle α and the web take-off point 18. By repeating the measurements (for example 300 measurements points per second), it is possible to have a complete assessment of the values of R for every points of the roll 14 and thereby have a complete prediction and control of the web material unwinding.

[0044] The measuring device 28 is arranged at a distance from the take-off point 18. In other words, in reference to the centre of the web roll 14, the measuring device 28 is arranged at an angular distance from the web take-off point 18.

[0045] The angle defined by the measuring device 28, the centre of the roll 14 and the web take-off point 18 is different than 0° . As illustrated in Fig. 1, in relation to the centre of the web roll 14 and following the unwinding direction, the angle, or the angular distance, between the measuring device 28 and the web take-off point 18 is greater than about 10° , preferably greater than about 45° , more preferably greater than about 90° ($\pi/2$), even more preferably greater than about 180° (π). As illustrated in figure 2, said angular distance is equal to $180^\circ + \alpha$. In reference to the web roll 14, the measuring device is preferably arranged on the diametrical opposite side of the web take-off point 18. This ensures that the system has enough calculation time so that the control unit can take into account other factors such as operator's inputs 35, motor speed feedback 36, additional control feedbacks 40 that will be explained hereunder.

[0046] The apparatus 10 can also comprise a velocity sensor 42 configured to measure the velocity of the web material 12. The velocity sensor 42 acts as a control system to ensure that the web material is conveyed at a constant speed and thus is maintained at a constant tension. The velocity sensor 42 is preferably placed downstream, relative to the conveying of the web material 12, of the secondary conveying roller 38 to measure the speed of the web material 12 once it has passed the secondary conveying roller 38. The velocity sensor 42 can also be placed between the web roll 14 and the secondary conveying roller 38 to measure the speed of the web material between these two elements. The velocity sensor 42 is configured to emit an output signal 46 to the control unit 32 so that it can maintain or adjust the speed of the drive system 22, 24 to either accelerate, decelerate or stop the web roll 14 depending on the situation.

[0047] The apparatus 10 may further comprise a rotational position and speed determining device 48, called rotational speed sensor 48 henceforth, such as a rotary or shaft optical encoder, resolver, a synchro, a rotary variable differential transformer (RVTD), any similar device capable of determining rotational speed and posi-

tion, can be used to determine the rotational speed and position at the web roll 14. This device can also be associated to the control unit 32 by sending an output signal 50 to indicate the rotational speed of the web roll 14 at a given point. The output signal 50 emitted by the rotational speed sensor 48 can be considered as an additional control feedback 40 so that the control unit 32 can adjust the speed of the drive system 22,24 to either accelerate, decelerate or stop the web roll 14 depending on the situation.

[0048] The rotational speed sensor 48 can be arranged at a distance from the measuring device 28 as illustrated in Fig. 1. Preferably, the rotational speed sensor 48 is arranged to measure the rotational speed of the web roll 14 at an angular position of the roll 14 located between the point of measurement of the measuring device 28 and the web take-off point 18. In Fig. 1, the rotational speed sensor 48 is arranged at a 90° (or $\pi/2$) angle in reference to the centre of the web roll 14 from the measuring device 28. The rotational speed sensor 48 can be arranged at other angular position, such as to define an angle between 5° to 180° in reference to the centre of the web roll 14 and the measuring device 28.

[0049] According to an alternative the rotational speed sensor 48 is arranged between the web-take-off point 18 and the measuring device 28 in reference to the unwinding direction of the web material.

[0050] According to an embodiment, the measuring device 28 and the rotation speed sensor 48 are combined, or associated, or juxtaposed, to have only one point of measurement where the radius and the speed of the web roll are determined simultaneously.

[0051] For sake of clarity, the previous content is schematically illustrated and summarized hereunder. Considering Fig. 4, the web roll 14 once supported by the stand 16 rotates here in a counter-clockwise direction B around an axis A that also corresponds to the centre of the web roll 14 (as illustrated in Fig. 4), in other words, the point A represents the centre of the web roll 14. The web roll 14, being as substantially circular cylindric element, extends angularly over an angle E having a value of 360° or 2π , or in other words, the web roll 14 extends in a full revolution and has a substantially circular profile.

[0052] As illustrated in the drawings and defined herein, the angular position Y is the point of measurement carried out by the measuring device 28 and is the point of reference 0° (or 2π), or the start of the revolution. The web roll 14 rotates and the web material 12 at the point Y rotates to reach the angular position Z. The angular position Z is the point of measurement carried out by the rotational speed sensor 48. As illustrated here, the angle defined by the angular positions Z and Y in relation to the centre A is 90° (or $\pi/2$), or $\widehat{ZAY}$ is equal to 90° . As seen previously, this angle $\widehat{ZAY}$ is comprised in a range between 0° (if the two sensors are combined) and 180° for example. The web roll 14 further rotates and the web material 12 at the point Z rotates to reach the angular

position X. The angular position X is the web take-off point 18. Given that the secondary guiding roll 38 is at the right end side of the web roll 14, as illustrated in Fig. 1, the angular position X is located on a bottom-right end side of the web roll 14, once the web roll 14 is placed on

the support 16. In other words the angle $\widehat{XAY}$ is greater than 180° (or π). The angle α is the difference between

the angle $\widehat{XAY}$ and 180° , or in other words,
 α (in degrees) = $\widehat{XAY} - 180^\circ$ or α (in radians) = $\widehat{XAY} - \pi$.

[0053] By assessing the radius R of the web roll at position Y, the control unit 32, taking into consideration additional factors or inputs such as the velocity of the web material 12, the current speed of the web roll at position Z, the operator's inputs for example setting a production pace, is able to properly adjust the speed of the web roll 14 so that the web material 12 at position Y reaches the position Z at the desired time and maintain angle α constant. In other words, the control unit 32 has sufficient time to take into consideration other factors and adapt the speed of the roll 14 to have a constant angle α and thus to maintain a constant tension and velocity of the web material 12.

[0054] According to an embodiment, the apparatus can further comprise an image detection device 52, such as an ultrasound laser that, can be used to determine if print marks such as drawings, logos or any ornamental elements, are well positioned on the web material 12 and web roll 14. This device can also be associated to the control unit 32 by sending an output signal 54 to indicate the correct positioning of the print marks of the web roll 14 at a given point. The output signal 50 emitted by the rotational speed sensor 48 can be considered as an additional control feedback 40 so that the control unit 32 can adjust the speed of the drive system 22,24 to either accelerate, decelerate or stop the web roll 14 depending on the situation.

[0055] The image detection device 52 can be arranged at a distance from the measuring device 28 as illustrated in Fig. 1. In Fig. 1, the image detection device 52 is arranged between the measuring device 28 and the rotational speed sensor 48 in reference to the unwinding of the web material 12. The image detection device 52 can be arranged at other angular positions such as between the rotational speed sensor 48 and the web take-off point 18 or between the web-take-off point 18 and the measuring device 28 in reference to the unwinding direction of the web material.

[0056] The apparatus 10 can also comprise a tension control system such as a tension sensor 43 configured to measure the tension of the web material 12. The tension sensor 43 acts as a control system to ensure that the web material is conveyed at a constant tension. The tension sensor 43 is preferably placed downstream, relative to the conveying of the web material 12, of the sec-

ondary conveying roller 38 to measure the tension of the web material 12 once it has passed the secondary conveying roller 38. The tension sensor 43 can also be placed between the web roll 14 and the secondary conveying roller 38 to measure the tension of the web material between these two elements. The tension sensor 43 is configured to emit an output signal 47 to the control unit 32 so that it can maintain or adjust the speed of the drive system 22,24 to either accelerate, decelerate or stop the web roll 14 depending on the situation. The tension sensor 43 can separate or combined to the velocity sensor 42.

[0057] To sum up, the additional control feedbacks 40 can comprise an operator's input 35 and/or the motor speed feedback 36 and/or the output signal 50 emitted by the rotational speed sensor 48 and/or the output signal 46 emitted by the velocity sensor 42 and/or the output signal 54 emitted by the image detection device 52 and/or the output signal 47 emitted by the tension sensor 43.

[0058] The control unit 32 preferably comprises a proportional-integral controller, or more preferably a proportional-integral-derivative controller, as a control loop mechanism employing where the additional control feedbacks 40 listed above are the process variables. For example, if the signal emitted by the tension sensor 43 is the process variable then the tension is the parameter variable that will be used to define if the error between the measured value Tension (t) and the desired set point (5 N) needs a correction or not and adapting the speed of the roll taking into account the measured radius R. Of course other additional control feedbacks 40 can be used as the process variable and there can be more than one additional control feedback 40 used as the process variable.

[0059] According to an embodiment, the measuring device 28 and the image detection device 52 are combined, or associated, or juxtaposed, to have only one point of measurement where the radius and the positioning of the print marks are determined simultaneously.

[0060] The invention also pertains to a method for unwinding a web material using such an apparatus comprising the following steps:

- a) measuring radius R of the web roll 14 at a given time (t) using the measurement device 28 and emitting this measurement as an output signal 30 to the control unit 32;
- b) processing this measurement in combination with other input signals 35 such as an operator's input and/or the current actuating speed of the actuator 22;
- c) calculating the rotational speed required based on said measurements for the roll to reach the desired the web-take point 18 at the desired time;
- d) emitting a signal 34,36 to the driving system 22,24 such as an ideal speed reference signal 34 and/or a corrected speed reference signal 36;
- e) adjusting the speed of the drive system 22,24 to either accelerate, decelerate or stop the web roll 14

depending on the situation.

[0061] This method can be carried out in a loop based on a fixed or variable time cycle, for example one measurement every 500 microseconds, or one measurement every 300 microseconds for three minutes then one measurement every second.

[0062] According to an embodiment, in the processing step b, the control unit 32 further processes at least one signal 40, 46, 50, 54 emitted by the velocity sensor 42 and/or image detection device 52 and/or rotational position and speed determining device 48.

[0063] In this method, the additional control feedbacks 40 can comprise an operator's input 35 and/or the motor speed feedback 36 and/or the output signal 50 emitted by the rotational speed sensor 48 and/or the output signal 46 emitted by the velocity sensor 42 and/or the output signal 54 emitted by the image detection device 52.

[0064] In some unfortunate cases, the roll can be too deformed and the apparatus and method mentioned hereabove may put too much strain on the motor device when accelerating too fast or decelerating too slow to ensure that the roll reaches the proper web-take off point. In such cases, it is preferable to add a web-take off device 56 as illustrated in Fig.5 and Fig.6. Said device comprises a mobile component 58 comprising a reciprocating mechanism such as a piston, spring, pneumatic cylinder or similar reversible mechanism, the mobile component can also comprise shock absorbing means. The device 56 also comprises an arm 60, or rod or cantilever, linked at one end to the mobile component 58. The device 56 comprises a roller 62 arranged at the second end of the arm 60, i.e. at the end that is opposite to where the arm 60 is linked to the mobile component 58. The roller 62 ensures that the web material 12 always passes on its outer surface thereby forcing the web material 12 to pass by a substantially stationary point which can be considered as the web take off point 18 in these unfortunate cases. The measure device 28 is at an angular distance from the roller 64 and thus the web take off point. The roller 62 can be displaced when the web roll 14 comes into contact with said roller 62, the roller 62 thereby displaces the arm and the mobile component can absorb the choc or displacement and move the arm and roller 62 back to its original position once the web roll 14 doesn't abut against the roller 62. This mobile component can also be associated to the control unit 32 by sending an output signal to indicate the displacement of the roller 62 at a given point. The output signal emitted by the mobile component 58 can be considered as an additional control feedback 40 and can be taken into consideration in the method described above.

[0065] The embodiments described above can be taken alone or in combination. The apparatus can comprise a measuring device 28 in combination or not with a rotational speed sensor 48 and/or with an image detection device 52 and/or with a velocity sensor 42 and/or a tension sensor 43.

Claims

1. Apparatus (10) for unwinding a web material (12) comprising :

- a. an output shaft (26) for unwinding a web roll (14) of web material (12);
- b. a driving system (22,24) for actuating said output shaft (26) and unwinding the web roll (14), said driving system (22) comprising an actuator (22) and optionally a transmission mechanism (24);
- c. a measuring device (28) configured to measure the radius of the web roll (14);
- d. a controller unit (32) configured to receive signals (30) from the measuring device (28), process said data and emit at least one signal (34,36) to the driving system (22,24) for maintaining or modifying the unwinding speed of said web roll (14);

characterized in that the measuring device (28) is arranged at a distance from a web-take off point (18) where the web material (12) leaves the web roll (14).

- 2. Apparatus according to claim 1, wherein the angular distance between the measuring device (28) and the web take-off point (18) in reference to the web roll (14) and its center and following the unwinding direction, is greater than about 10°, preferably greater than about 45°, more preferably greater than about 90°.
- 3. Apparatus according to claim 2, wherein the measuring device (28) is arranged on the diametrical opposite side of the web take off point (18) in reference to the web roll (14).
- 4. Apparatus according to any of the claims 1 to 3, wherein the measuring device (28) is configured to measure the radius of the web roll (14) with a rate of 1 measurement point per every 3 to 30 ms.
- 5. Apparatus according to any of the claims 1 to 4, wherein the apparatus comprises a stationary secondary guiding roll (38) that is configured to rotate around an axis (C), said web material (12) being conveyed from the web take-off point (18) to the secondary guiding roll (38).
- 6. Apparatus according to any of the claims 1 to 5, wherein the apparatus further comprises a velocity sensor (42) configured to measure the velocity of the web material (12) and emit this measurement an output signal (46) to the control unit (32).
- 7. Apparatus according to claim 6, wherein the velocity sensor (42) is arranged downstream, relative to the

conveying of the web material (12), of the web take-off point (18), preferably downstream of the secondary guiding roll (38).

- 8. Apparatus according to any of the claims 1 to 7, wherein the apparatus further comprises a rotational position and speed determining device (48) configured to measure the rotational speed and position at the web roll (14) and emit this measurement as an output signal (50) to the control unit (32).
- 9. Apparatus according to any of the claims 1 to 8, wherein the apparatus further comprises an image detection device (52) configured to determine if a print mark is well positioned on the web roll (14) and emit this measurement as an output signal (54) to the control unit (32).
- 10. Apparatus according to any of the claims 1 to 9, wherein the apparatus further comprises a tension sensor (43) configured to measure the tension of the web material (12) and emit this measurement as an output signal (47) to the control unit (32).
- 11. Apparatus according to any of the claims 6 to 10, wherein the control unit (32) is configured to receive signals (30) from the measuring device (28), and at least one of the signal (40, 46, 47, 50, 54) emitted by the velocity sensor (42) and/or tension sensor (43) and/or image detection device (52) and/or rotational position and speed determining device (48), process said data and emit at least one signal (34,36) to the driving system (22,24) for maintaining or modifying the unwinding speed of said web roll (14).
- 12. Method for unwinding a web material preferably using an apparatus according to any of the claims 1 to 11, **characterized in that** said method comprises the following steps:
 - a. measuring radius R of the web roll (14) at a given time (t) using the measurement device (28) and emitting this measurement as an output signal (30) to the control unit (32);
 - b. processing this measurement in combination with other input signals (35) such as an operator's input and/or the current actuating speed of the actuator (22);
 - c. calculating the rotational speed required based on said measurements;
 - d. emitting a signal (34,36) to the driving system (22,24) such as an ideal speed reference signal (34) and/or a corrected speed reference signal (36);
 - e. adjusting the speed of the drive system (22,24) to either accelerate, decelerate or stop the web roll (14) depending on the situation.

13. Method according to claim 12, wherein in the processing step b, the control unit (32) further processes at least one signal (40, 46, 50, 54) emitted by the velocity sensor (42) and/or image detection device (52) and/or rotational position and speed determining device (48) and/or tension sensor (43). 5

10

15

20

25

30

35

40

45

50

55

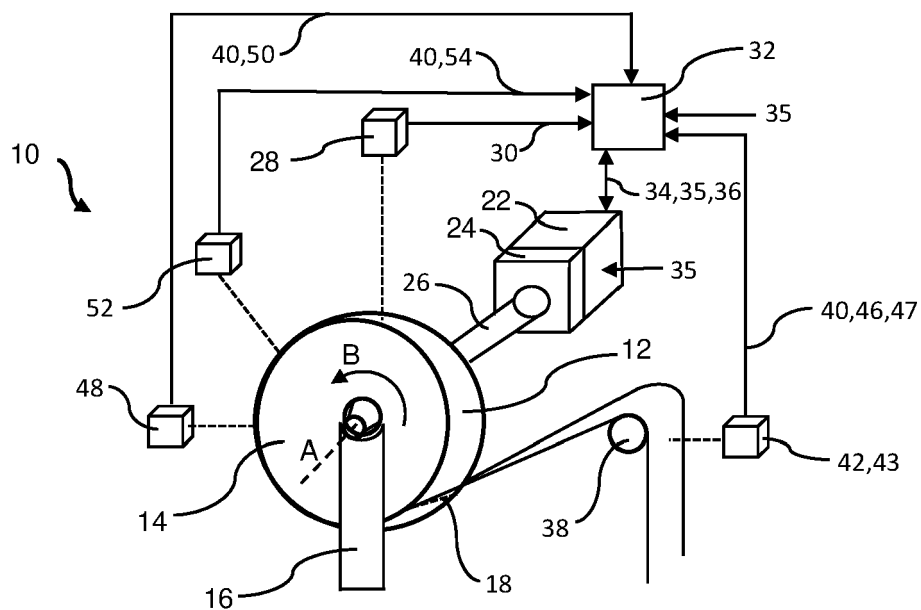


FIG.1

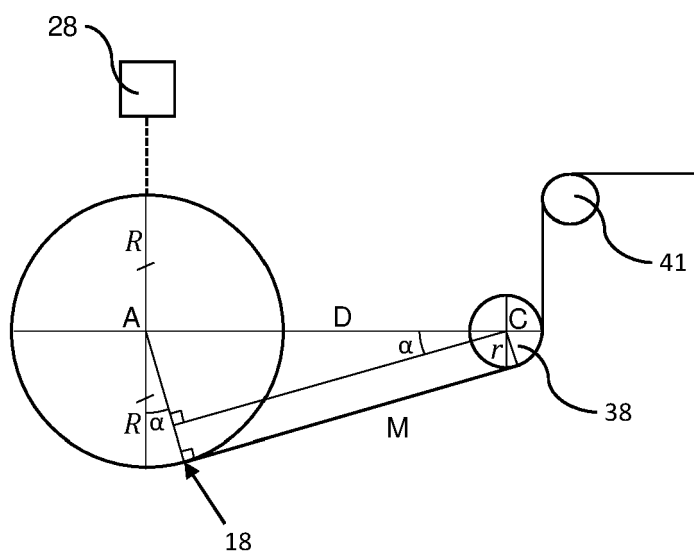


FIG. 2

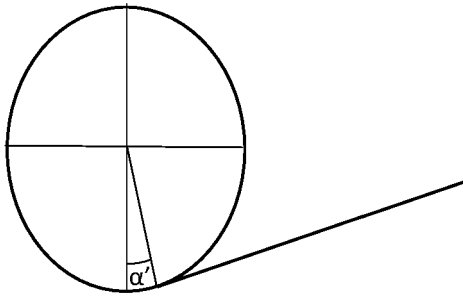


FIG. 3A

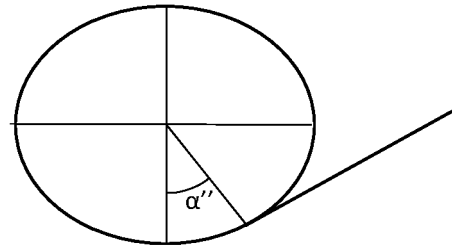


FIG. 3B

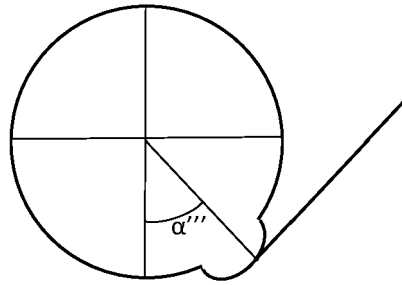


FIG. 3C

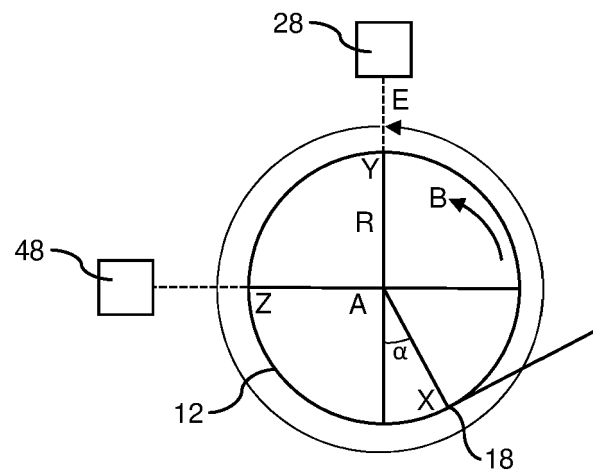


FIG. 4

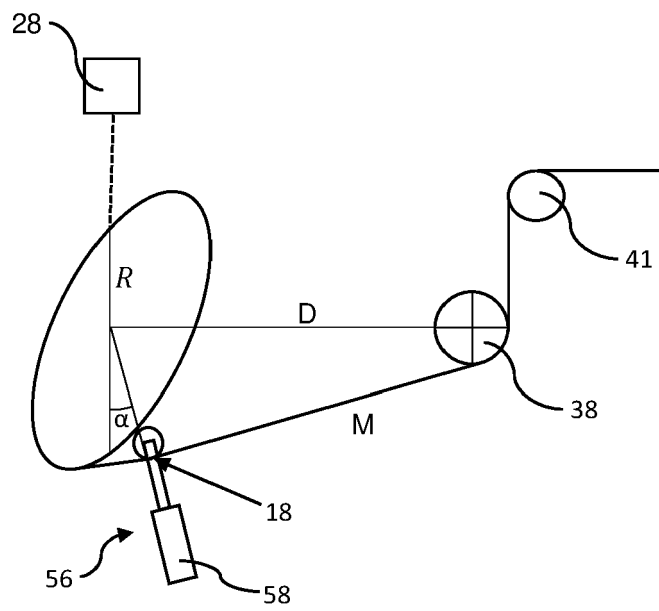


FIG. 5

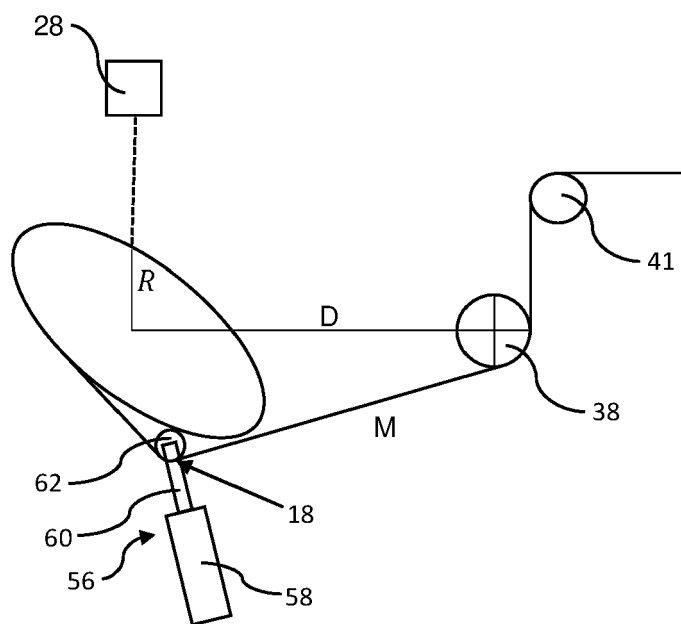


FIG. 6



EUROPEAN SEARCH REPORT

Application Number

EP 21 21 1713

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03:82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H09 142707 A (FUJI IRON WORKS) 3 June 1997 (1997-06-03)	1, 3-13	INV. B65H23/00
Y	* the whole document *	2	
Y	WO 95/18762 A1 (WICHITA COMPANY LTD [GB]; JURY COLIN BERTRAM [GB] ET AL.) 13 July 1995 (1995-07-13) * claims; figures *	2	
X	US 2012/097786 A1 (BINNER SR PAUL ALAN [US]) 26 April 2012 (2012-04-26) * claims; figures *	1-13	
X	US 2012/097787 A1 (BINNER SR PAUL ALAN [US]) 26 April 2012 (2012-04-26) * claims; figures *	1-13	
X	US 2012/097788 A1 (BINNER SR PAUL ALAN [US]) 26 April 2012 (2012-04-26) * claims; figures *	1-13	
X	DE 101 58 985 A1 (HEIDELBERGER DRUCKMASCH AG [DE]) 11 July 2002 (2002-07-11) * the whole document *	1-13	TECHNICAL FIELDS SEARCHED (IPC)
X	US 2007/131817 A1 (FROMM GREGORY [US] ET AL) 14 June 2007 (2007-06-14) * the whole document *	1-13	B65H
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 3 May 2022	Examiner Haaken, Willy
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 21 1713

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-05-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H09142707 A	03-06-1997	JP 2683892 B2 JP H09142707 A	03-12-1997 03-06-1997
WO 9518762 A1	13-07-1995	NONE	
US 2012097786 A1	26-04-2012	CA 2756242 A1 US 2012097786 A1	25-04-2012 26-04-2012
US 2012097787 A1	26-04-2012	CA 2756287 A1 US 2012097787 A1	25-04-2012 26-04-2012
US 2012097788 A1	26-04-2012	CA 2756248 A1 US 2012097788 A1	25-04-2012 26-04-2012
DE 10158985 A1	11-07-2002	DE 10158985 A1 US 2002123417 A1	11-07-2002 05-09-2002
US 2007131817 A1	14-06-2007	EP 1960297 A1 US 2007131817 A1 WO 2007070126 A1	27-08-2008 14-06-2007 21-06-2007