



(11) **EP 2 905 246 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
28.02.2018 Bulletin 2018/09

(51) Int Cl.:
B65H 18/10 (2006.01) **B65H 23/06** (2006.01)
B65H 23/18 (2006.01) **B65H 23/195** (2006.01)
B65H 23/188 (2006.01)

(21) Application number: **13845624.9**

(86) International application number:
PCT/ES2013/000213

(22) Date of filing: **27.09.2013**

(87) International publication number:
WO 2014/057142 (17.04.2014 Gazette 2014/16)

(54) **METHOD AND SYSTEM FOR ADJUSTING TENSION DURING WINDING FOR A MACHINE WITH A WINDING STATION**

VERFAHREN UND SYSTEM ZUR EINSTELLUNG DER SPANNUNG BEIM AUFWICKELN FÜR EINE MASCHINE MIT EINER WICKELSTATION

PROCÉDÉ ET SYSTÈME D'AJUSTEMENT DE LA TENSION DE REMBOBINAGE POUR UNE MACHINE COMPRENANT UNE UNITÉ DE REMBOBINAGE

(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**

(30) Priority: **08.10.2012 ES 201200985**

(43) Date of publication of application:
12.08.2015 Bulletin 2015/33

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Description

Technical Field

[0001] According to a first aspect, the present invention relates to an adjustment method for adjusting tension during a rewinding operation for a machine including a rewinding station, and more particularly to a sensor-less open-loop adjustment method for adjusting tension based on speed control with limited rotational torque.

[0002] According to a second aspect, the invention relates to an adjustment system for adjusting tension during rewinding for a machine which includes a rewinding station suitable for implementing the method of the first aspect.

[0003] According to a third aspect, the invention relates to a computer program suitable for implementing the method of the first aspect.

[0004] According to a fourth aspect, the invention relates to a machine which includes a rewinding station implementing said adjustment method, incorporates the adjustment system and/or runs the computer program.

State of Prior Art

[0005] In the past, when it was only possible to regulate speed with a DC motor, most rewinding machines provided a current control to the rewinding motor. With it, current was limited in the armature of the motor, generally with a potentiometer that the operator had access to, and the current of the motor was displayed in a classic pointer indicator.

[0006] One of such proposals is described in patent document US3595495, in which rewinding is regulated by means of actuating a potentiometer which provides an adjustable and constant current from a current source used to increase or decrease the rotational speed of the rewinding mandrel to adjust tension of the web wound thereon.

[0007] With this system, the main problem was to prevent the motor from having the tendency to maintain its current intensity and increasing speed to a maximum when the material tears. The friction produced by the mechanical transmission system, which is generally high, was also overlooked. In summary, torque was applied to the motor and the motor was regulated without knowing the percentage of this torque that was really applied to the material. For this reason, when the use of electronics was extended to industry, enabling more precise regulation, standardization of a regulating system that is given feedback through a signal from a rewound material tension sensor began. Therefore, regardless of the type of control used in the motor, the purpose thereof was to regulate real known tension of the material.

[0008] This solution has been maintained for years because it is easy to apply, regardless of the mechanics used, but it suffers a series of drawbacks, in particular because any regulating system involves fluctuation, so

feedback systems require a series of adjustments in order to minimize these variations. As a result, precision of these systems is limited by the capabilities of the staff that works on adjusting them, making it difficult to find their optimal point.

[0009] The obligation of a strict path of the material, supported by the mandrels containing the tension reading element, conserving the angle of wrap, which complicates threading, etc., make said feedback regulating system an assembly that is clearly susceptible to improvement.

[0010] Patent document US4280669 proposes an automatic rewinding machine comprising, among others, a first mandrel and a second mandrel arranged consecutively and associated with respective first and second motors for rotating in the same direction so that a web wound around the first mandrel is unwound from same and rewound on the second rewinding mandrel with an amount of tension that can be adjusted by an adjustment method, consisting of applying on the second mandrel or rewinding mandrel a specific torque and arranging a guide mandrel in contact with the web to exert an inward radial force on the web being wound on the rewinding mandrel when the guide mandrel is rotated in a direction opposite that of the rewinding mandrel, such that tension in said web increases. Another adjustment system and another adjustment method are described in the patent document JP S 59 138556.

Disclosure of the Invention

[0011] It seems necessary to provide an alternative to the state of the art, in particular to known adjustment methods and systems for automatically regulating tension during rewinding, which dispenses with the need to use closed-loop control systems using tension sensors to provide feedback.

[0012] For that purpose, according to a first aspect the present invention provides an adjustment method for adjusting tension during rewinding for a machine which includes a rewinding station, said rewinding station being of the type comprising at least a first mandrel and a second mandrel associated with respective first and second motors for rotating in the same direction so that a web wound around the first mandrel is unwound from same and rewound on the second mandrel with an amount of tension that can be adjusted by the adjustment method, which method comprises controlling the speed of at least the second motor.

[0013] The method proposed by the first aspect of the invention is characterized in that, unlike the methods known in the state of the art, it is a sensor-less open-loop adjustment method for adjusting tension which comprises performing speed control on the second rewinding motor based on or by establishing a rotational torque of said motor, in the mentioned direction of rotation, limited to calculated values.

[0014] According to one embodiment, the adjustment

method comprises calculating said limited rotational torque values from the prior calculation of the following types of torque:

- rolling or friction torque necessary for the second motor to overcome the coefficient of friction of the elements configuring the motor and the transmission thereof;
- inertia, additional or acceleration torque, which is the torque necessary to accelerate a mass in order to reach a required speed within a desired time, and it depends on the mass to be accelerated and on the coefficient of acceleration itself, the mass being that which consists of the second mandrel itself and the web carried by same or rewound roll; and
- tension torque, which is the torque to be applied on the second motor and exerted on the web in order to obtain the desired tension, wherein one or more of said calculated values combined with one another can be used.

[0015] According to one embodiment, the method comprises calculating said rolling or friction torque by previously registering the torque used by the second motor throughout its entire range of use in revolutions of rotation and consulting said register for the rotational speed of the second motor.

[0016] In relation to inertia torque, according to one embodiment the method comprises calculating said inertia torque by obtaining said coefficient of acceleration for virtual shafts synchronized with real rotating shafts and by adding the load supported by the second mandrel.

[0017] For a variant of said embodiment, the method comprises calculating said load by means of calculating the moment of inertia thereof from dimensional data, including diameter and width, and physical data, including weight, of the rewound roll, and from the density of the reel calculated from said data, and multiplying the calculated moment of inertia value by the coefficient of acceleration in order to obtain the inertia torque.

[0018] In one embodiment, the method comprises calculating said tension torque from a required force setpoint and from the radius or diameter of the web roll or rewound roll.

[0019] According to one embodiment applied to a machine in which the first shaft and/or second shaft can move away from the second shaft and/or first shaft, respectively, as the diameter of the rewound web increases, the method comprises calculating the diameter of the rewound roll by directly inferring it from the position of the second shaft or of an element that can be moved therewith during said moving away.

[0020] According to a variant of said embodiment, said element that can move with the second shaft is a servomotor carrying out the mentioned moving away according to the diameter of the rewound web.

[0021] In a preferred embodiment, the method comprises calculating the limited rotational torque values by

adding up the values calculated for friction torque, inertia torque and tension torque.

[0022] According to a second aspect, the invention provides an adjustment system for adjusting tension during rewinding for a machine which includes a rewinding station comprising at least a first mandrel and a second mandrel associated with respective first and second motors for rotating in the same direction so that a web wound around the first mandrel is unwound from same and rewound on the second mandrel with an amount of tension that can be adjusted by the adjustment system, where the adjustment system comprises control means for controlling the speed of at least the second motor.

[0023] Unlike conventional adjustment systems, the adjustment system proposed by the second aspect of the invention is characteristically a sensor-less open-loop adjustment system, where the control means perform speed control on the second motor with rotational torque limited to calculated values.

[0024] In one embodiment of the adjustment system proposed by the second aspect of the invention, the first and second mandrels have respective rotating shafts parallel to one another, where the first shaft and/or second shaft can move away from the second shaft and/or first shaft, respectively, as the diameter of the rewound web increases, by means of actuating means including at least one servomotor.

[0025] The motors of the mandrels are preferably direct drive motors mounted directly on the rotating shafts of the mandrels without substantially more friction than that of the motor bearings themselves.

[0026] Control means are configured for calculating the limited rotational torque values by implementing the method of the first aspect.

[0027] According to a third aspect, the invention provides a computer program comprising program instructions for making a computation system, generally a PLC, implement the method of the first aspect.

[0028] The program of the third aspect can be run by a computation system that is part of the control means of the system proposed by the second aspect of the invention.

[0029] According to a fourth aspect, the invention provides a machine which includes a rewinding station, which applies the adjustment method of the first aspect and/or incorporates the adjustment system of the second aspect and/or comprises control means including a computation system running the computer program of the third aspect.

[0030] In a preferred embodiment of the machine proposed by the third aspect, the computation system is a programmable logic controller, or PLC.

[0031] Depending on the embodiment, the machine is a rewinding machine, or a machine that furthermore includes other functions to be performed between the unwinding and rewinding phases, comprising to that end between the first and second mandrel a step for longitudinally slitting and/or printing and/or laminating and/or

perforating the unwound/rewound web.

Brief Description of the Drawings

[0032] The aforementioned and other advantages and features will be better understood from the following detailed description of embodiments with reference to the accompanying drawings, which must be considered in an illustrative and non-limiting manner, in which:

Figure 1 is a side elevational view of the machine proposed by the fourth aspect of the invention, which includes a rewinding station and applies the adjustment method of the first aspect, in one embodiment, and

Figure 2 schematically shows a control diagram for the motor of the rewinding mandrel of a rewinding station of a machine for implementing the adjustment method proposed by the first aspect of the invention, according to one embodiment.

Detailed Description of Exemplary Embodiments

[0033] The emergence on the market of modern permanent magnet three-phase synchronous motors specifically designed for applications with high torque levels at low revolutions has led to reconsidering the idea of returning to the past to develop the adjustment or rewinding control method and system without the need for sensors as proposed by the present invention.

[0034] The method and system of the invention solve the problems relating to the path of the material, the need for customized adjustment, and regulation fluctuations, while at the same time they reduce costs by dispensing with tension reading elements.

[0035] For the embodiment herein described, the project is carried out in the Comexi Proslit S-Turret slitter-rewinder. To that end, Vascat MDD motors, which allow directly coupling the expandable rewinding shaft to the shaft of the motor, forming a sturdy, load-free assembly, have been used.

[0036] Figure 1 shows such S-Turret machine, with the rewinding station including the mentioned first mandrel 1 and second mandrel 2 associated with respective first and second motors (not illustrated) for rotating in the same direction so that the web L wound around the first mandrel 1 is unwound from same and rewound on the second mandrel 2 with an amount of tension that can be adjusted by the adjustment system (not illustrated).

[0037] The rewinder of this machine consists of two motors mounted on a rotating turret so that they can work in an alternating manner. Said motors are responsible for rewinding the material at a regulated and constant tension. Due to regulating difficulties by means of closed-loops with load cells involved with the different possible paths of material, the present invention proposes open-loop adjustment by using torque-limiting control means.

[0038] This type of control allows not being conditioned

by the passing of the material along a specific path which includes a reading element (load cells, compensator, etc.), while at the same time prevents bothersome fluctuations due to regulation itself.

[0039] According to the present invention, the motor is controlled by speed control but with torque being limited to calculated values. This is possible because the motors to be regulated are direct drive motors mounted directly on the shaft of the reel, without any friction other than that of the motor bearings themselves, thereby preventing losses of torque in pulleys, gears, chains or other transmission elements.

[0040] Thus, with torque being limited, a desired tension of the material is achieved.

[0041] In order to allow the material that is to be rolled to remain tensed, the speed applied to the motor is the driving machine speed plus an excess speed of 10 m/min, as illustrated in the diagram of Figure 2, which shows the different control blocks or steps used for carrying out the adjustment of the rewinding tension according to the present invention.

[0042] Continuing with the description of Figure 2, it can be seen therein how the speed value thus obtained in m/min (meters per minute) is switched to rpm (turns per minute), using to that end the diameter of the rewound roll and the number π , and the obtained value is used as the speed limit to be applied to an input of a controller block, in this case PI (proportional-integral), of that indicated in Figure 2 as speed loop, at the other input of which a motor speed monitoring signal, in this case the speed of the motor of the second mandrel 2, or rewinding mandrel, is entered.

[0043] There is obtained at the output of the speed loop a torque value which is limited by the torque limit value calculated as explained below.

[0044] The following must be taken into account to calculate the torque limit value to be applied to the motor:

Rolling or friction torque - is the torque necessary for exceeding the coefficient of friction of the elements configuring the motor and the transmission thereof; Inertia torque - is the torque necessary to accelerate a mass, and it depends on the mass to be accelerated and on the coefficient of acceleration itself; Tension torque - is the torque that is really exerted on the material in order to obtain the desired tension.

[0045] The sum of all these torques results in the torque limit to be applied to the motor. The different methods for calculating each of them are described below.

Friction torque:

[0046] This torque is primarily based on the mechanical construction that is coupled to the motor to drive the load. It depends entirely on this assembly, and in relation to this particular case, the value is minimal and furthermore very stable.

[0047] As a result of the innovative mechanical assembly of direct drive motors, the kinematic chain between motor and load is reduced to the bearings supporting the shaft. This entails a drastic reduction of friction and furthermore stability in said friction. If the enormous variety of electronic aids adopted by novel motor control equipment were combined with this mechanical revolution, it would translate into the possibility to register the rolling torque necessary for the motor in each of the working revolutions.

[0048] The resulting torque/revolutions graph serves to anticipate the torque limit throughout the entire range of revolutions of the motor.

[0049] Siemens Sinamics equipment provides a function that aids in calculating this torque. It is the 'Friction characteristic' function, which allows capturing the torque used by the motor throughout its entire range of use in revolutions.

[0050] This function only requires specifying the limit of revolutions at which the motor will work. The system starts up the motor, without a load, and registers the current torque as the speed gradually increases. A torque/revolutions graph which will be stored in the equipment is thereby obtained. The result of this graph will provide the resulting friction torque according to the speed at which the motor rotates. Furthermore, the torque value for the current speed is reflected in parameter r3841, so this will be the value to be taken into account as the friction torque of the method and system of the present invention for the embodiment herein described.

Inertia torque:

[0051] This torque is based on adding the torque necessary in order to accelerate. To accelerate a mass, depending on the required coefficient of acceleration, it will be necessary to apply additional torque in order to reach a required speed within a desired time.

[0052] The S-Turret electronics provide the possibility of synchronizing real shafts with virtual shafts (which are perfect as regards reactions). This synchronization provides real values of the degree of acceleration of the assembly, so it is not difficult to calculate the inertia torque of the mass that constitutes the load, which must be added at the time of acceleration.

[0053] This additional torque, or acceleration torque, also depends on the mass of the load to be accelerated. To calculate this torque, there are different functions in Siemens software that will help. Firstly, the moment of inertia of the load is calculated by means of the 'Moment Inertia' block included in the CFC programming software in DCC. By correctly parametrizing this block, which must be fed data such as diameter, width, density of the reel, etc., the resulting moment of inertia of the reel is given in Nms^2 . This result, which refers to the mass of the reel, is multiplied by the coefficient of acceleration ($1/\text{s}^2$) in order to obtain the torque in Nm. This is the inertia torque,

which is only applied at the time of acceleration.

Tension torque:

[0054] This torque is the one that is really applied to the motor because it is the torque necessary for tensing the material, and it is calculated from the required setpoint and from the radius of the roll to be wound. Calculation comprises multiplying the setpoint value entered by the operator (N) by the radius of the reel (m) in order to obtain the Nm necessary for limiting the motor.

[0055] At this point, it is crucial to obtain a diameter of the reel that is real and stable enough to prevent tension fluctuations or working with a tension other than that required. The diameter of the reel also affects the calculation of the inertia torque because in order to calculate the value of this torque, the mass of the element to be accelerated, which is directly related to the diameter of the reel, must be taken into account.

[0056] Conventional systems for obtaining the diameter are not entirely stable. Calculating on the basis of speeds tends to fluctuate and to require filtering. Reading on the basis of an external sensor usually obtains erroneous data due to irregularities on the surface of the reel or differences between different types of material. A more stable and real system is necessary for an optimal result of the application of the method and system of the present invention.

[0057] In the S-Turret, the rewinding shaft moves longitudinally via two synchronized servomotors as diameter increases. As a result of this feature, the current position of the servomotors directly expresses the radius of the reel, conferring absolute stability to the value.

[0058] The sum of these three calculated torque values is sent to the motor regulating equipment as torque limit, which will tense the web with the desired values.

[0059] In particular, according to the diagram of Figure 2, the value of said sum, in Nm, is sent to the block indicated as torque limit, where the torque obtained from the speed loop is limited with such value, the limited value being applied to one of the inputs of the control block, in this case PI (proportional-integral), of that indicated as torque loop, in the other input of which a real torque monitoring signal is received, and based on which the torque to be applied to the motor is controlled, in this case by means of a corresponding current signal (indicated by its units "Amperes" in Figure 2) to feed the motor.

[0060] If, as described above with reference to Figure 2, a certain excess speed is added to the speed reference to have a regulating margin, the result is which can be qualified as a sensor-less rewinder or rewinder without sensor.

[0061] This torque limit must act only in the direction of rotation of the material, leaving the opposite direction with the maximum limit of the motor to allow braking in the event of a quick shut-down, with the maximum torque available.

[0062] Using this method and system results in a series

of advantages that require a series of premises that are provided in the S-Turret. The main advantage is tension stability since it is a completely theoretical system that is only based on calculations. The stability of the various calculated torques, which are finally added up, is crucial to obtain an optimal result.

[0063] The friction torque is stable as a result of the use of direct drive motors, which minimize friction and make such friction more stable over time. In a system with a different type of transmission, it cannot be assured that with the passage of time this friction will remain equally stable compared to a system such as the S-Turret system.

[0064] The inertia torque is stable because the coefficient of acceleration is obtained directly from the Virtual Master, or virtual shaft working at the machine speed, in an immediate and precise manner.

[0065] The tension torque is stable as a result of the system for obtaining diameter of the reel. In other systems, diameter is obtained from a calculation between speeds (which tends to fluctuate), or through an external sensor (which obtains erroneous data due to irregularities on the surface of the reel or differences between different types of material). In the S-Turret, diameter is obtained through the position of the servomotors which are responsible for the transverse movement of the winding shaft. This diameter is completely stable, without interferences, and absolutely real, which confers enviable stability to the calculation of the tension torque.

[0066] A person skilled in the art may introduce changes and modifications in the described embodiments without departing from the scope of the invention as it is defined in the attached claims.

Claims

1. An adjustment method for adjusting tension during rewinding for a machine having a rewinding station, said rewinding station comprising at least a first mandrel (1) and a second mandrel (2) associated with respective first and second motors rotating in the same direction so that a web (L) wound around the first mandrel (1) is unwound from same and rewound on said second mandrel (2) with an amount of tension that can be adjusted by an adjustment method which comprises controlling the speed of at least the second winding motor and is **characterized in that** it is a sensor-less open-loop adjustment method which comprises performing said speed control on the second rewinding motor based on a rotational torque thereof, in said direction of rotation, limited to calculated values, and **in that** it comprises calculating said limited rotational torque values of the second rewinding motor from the prior calculation of the following types of torque:

- rolling or friction torque necessary for the sec-

ond motor to exceed the coefficient of friction of the elements configuring the motor and the transmission thereof;

- inertia, additional or acceleration torque, which is the torque necessary to accelerate a mass in order to reach a required speed within a desired time, and it depends on the mass to be accelerated and on the coefficient of acceleration itself, the mass being that which consists of the second mandrel (2) itself and the web (L) carried thereby or rewound roll; and

- tension torque, which is the torque to be applied on the second motor and exerted on the web in order to obtain a desired tension; and

calculating the limited rotational torque values by adding up the values calculated for friction torque, inertia torque and tension torque.

2. The method according to claim 1, **characterized in that** it comprises calculating said rolling or friction torque by previously registering the torque used by the second motor throughout its entire range of use in revolutions of rotation and consulting said register for the rotational speed of the second motor.

3. The method according to claim 1, **characterized in that** it comprises calculating said inertia torque by obtaining said coefficient of acceleration for virtual shafts synchronized with a first real rotating shaft (E1) and a second real rotating shaft (E2) of the mandrels (1, 2) and by adding the load supported by the second rewinding mandrel (2) corresponding to the second shaft (E2).

4. The method according to claim 3, **characterized in that** it comprises calculating said load by means of calculating the moment of inertia thereof from dimensional data, including diameter and width, and physical data, including weight, of a rewound roll, and multiplying the calculated moment of inertia value by the coefficient of acceleration in order to obtain the inertia torque.

5. The method according to claim 1, **characterized in that** it comprises calculating said tension torque from a required force setpoint and from the radius or diameter of the web roll or rewound roll.

6. The method according to claim 3, **characterized in that** the first rotating shaft (E1) and/or second rotating shaft (E2) can move away from the second rotating shaft (E2) and/or first rotating shaft (E1), respectively, as the diameter of the rewound web increases, the method comprising calculating said diameter of the rewound roll by directly inferring it from the position of the second rotating shaft (E2) or of an element that can be moved therewith during said

moving away.

7. The method according to claim 6, **characterized in that** said element that can move with the second rotating shaft (E2) is a servomotor responsible for carrying out said moving away according to the diameter of the rewound web. 5
8. An adjustment system for adjusting tension during rewinding for a machine having a rewinding station, said rewinding station comprising at least a first mandrel (1) and a second mandrel (2) associated with respective first and second motors rotating in the same direction so that a web (L) wound around the first mandrel (1) is unwound from same and rewound on said second mandrel (2) with an amount of tension that can be adjusted by an adjustment method, where the adjustment system comprises speed control means for controlling the speed of at least the second rewinding motor and is **characterized in that** it is a sensor-less open-loop adjustment system based on a control speed, and **in that** said control means perform said speed control on the second motor by limiting the rotational torque thereof, in said direction of rotation, to calculated values. 10 15 20 25
9. The adjustment system according to claim 8, **characterized in that** said first mandrel (1) and said second mandrel (2) have respective rotating shafts (E1, E2) parallel to one another, where the first shaft (E1) and/or second shaft (E2) can move away from the second shaft (E2) and/or first shaft (E1), respectively, as the diameter of the rewound web (L) increases, by means of actuating means, including at least one servomotor. 30 35
10. The adjustment system according to claim 9, **characterized in that** said first and second motors are direct drive motors and are mounted directly on the rotating shafts (E1, E2) of the mandrels (1, 2) without substantially more friction than that of the motor bearings themselves. 40
11. A machine which includes a rewinding station, that incorporates an adjustment system for adjusting tension during rewinding according to any one of claims 8 to 10. 45
12. The machine according to claim 11, **characterized in that** it includes between the first mandrel (1) and second mandrel (2) at least one step for longitudinally slitting and/or printing and/or laminating and/or perforating the web unwound/rewound. 50 55

Patentansprüche

1. Einstellverfahren zur Einstellung der Spannung

beim Aufwickeln für eine Maschine aufweisend eine Wickelstation, wobei die genannte Wickelstation mindestens einen ersten Dorn (1) und einen zweiten Dorn (2) umfasst, welche mit jeweiligen ersten und zweiten Motoren assoziiert sind, welche sich in die gleiche Richtung drehen, so dass eine um den ersten Dorn (1) herum aufgewickelte Bahn (L) vom selben abgewickelt wird und auf dem zweiten Dorn (2) aufgewickelt wird, mit einer Menge an Spannung, die mittels eines Einstellverfahrens eingestellt werden kann, welches das Steuern der Geschwindigkeit mindestens des zweiten Wickelmotors umfasst und **dadurch gekennzeichnet ist, dass** es ein sensorloses Einstellverfahren mit offener Schleife, welches das Durchführen der genannten Geschwindigkeitssteuerung auf dem zweiten Wickelmotor basierend auf einem Drehmoment desselben, in der genannten Drehrichtung, begrenzt auf berechnete Werte umfasst, und dass es das Berechnen der genannten begrenzten Drehmomentwerte des zweiten Wickelmotors aus der vorherigen Berechnung der folgenden Arten von Moment umfasst:

- das Furch- oder Reibungsmoment, welches für den zweiten Motor nötig ist, um den Reibungskoeffizient, der den Motor und das Getriebe desselben ausbildet, zu überschreiten;
- ein Trägheits-, zusätzliches oder Beschleunigungsmoment, welches das Moment ist, dass nötig ist, um eine Masse zu beschleunigen, um eine erforderliche Geschwindigkeit innerhalb einer gewünschten Zeit zu erreichen, und es hängt von der zu beschleunigenden Masse und vom Beschleunigungskoeffizient selbst ab, wobei die Masse diejenige ist, die aus dem zweiten Dorn (2) selbst und der davon getragenen Bahn (L) oder der aufgewickelten Rolle besteht; und
- das Spannungsmoment, welches das Moment ist, das auf den zweiten Motor anzuwenden ist und auf der Bahn ausgeübt wird, um eine gewünschte Spannung zu erhalten; und

das Berechnen der begrenzten Drehmomentwerte mittels des Zusammenrechnens der für das Reibungsmoment, Trägheitsmoment und Spannungsmoment berechneten Werte.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es das Berechnen des genannten Furch- oder Reibungsmomentes umfasst, mittels des vorherigen Erfassens des vom zweiten Motor über dessen gesamten Verwendungsbereich verwendeten Moments in Rotationsumdrehungen und des Abrufens der genannten Erfassung für die Drehgeschwindigkeit des zweiten Motors.
3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es das Berechnen des genannten

Trägheitsmoment umfasst, mittels des Erhaltens des genannten Beschleunigungskoeffizienten für virtuelle Wellen, welche mit einer ersten echten Drehwelle (E1) und einer zweiten echten Drehwelle (E2) der Dorne (1, 2) synchronisiert sind, und mittels des Zusammenrechnens der vom zweiten Wickeldorn (2) getragenen Last, welche der zweiten Welle (E2) entspricht.

4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** es das Berechnen der genannten Last umfasst, mittels des Berechnens des Trägheitsmoments derselben aus dimensional Daten, umfassend Durchmesser und Breite, und physikalischen Daten, umfassend Gewicht, einer aufgewickelten Rolle, und das Multiplizieren des berechneten Trägheitsmomentwert mit dem Beschleunigungskoeffizient, um das Trägheitsmoment zu erhalten. 5
5. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es das Berechnen des genannten Spannungsmoments aus einem erforderlichen Krafteinstellwert und aus dem Radius oder Durchmesser der Bahnrolle oder der aufgewickelten Rolle umfasst. 10
6. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** sich die erste Drehwelle (E1) und/oder die zweite Drehwelle (E2) jeweils von der zweiten Drehwelle (E2) und/oder der ersten Drehwelle (E1) entfernen kann, während sich der Durchmesser der aufgewickelten Bahn erhöht, wobei das Verfahren das Berechnen des genannten Durchmessers der aufgewickelten Rolle umfasst, mittels des direkten Ableiten desselben aus der Stellung der zweiten Drehwelle (E2) oder aus einem Element, welches sich dadurch während des Entfernens bewegen kann. 15
7. Verfahren nach Anspruch 6, **dadurch gekennzeichnet, dass** das genannte Element, welches sich mit der zweiten Drehwelle (E2) bewegen kann, ein Servomotor ist, welcher für das Durchführen der genannten Entfernung gemäß dem Durchmesser der aufgewickelten Bahn zuständig ist. 20
8. Einstellsystem zur Einstellung der Spannung beim Aufwickeln für eine Maschine, welche eine Wickelstation aufweist, wobei die genannte Wickelstation mindestens einen ersten Dorn (1) und einen zweiten Dorn (2) umfasst, welche mit jeweiligen ersten und zweiten Motoren assoziiert sind, welche sich in die gleiche Richtung drehen, so dass eine um den ersten Dorn (1) herum aufgewickelte Bahn (L) vom selben abgewickelt wird und auf dem genannten zweiten Dorn (2) aufgewickelt wird, mit einer Menge an Spannung, welche mittels eines Einstellverfahrens eingestellt 25

stellt werden kann, wobei das Einstellsystem Geschwindigkeitssteuermittel umfasst, für das Steuern der Geschwindigkeit mindestens des zweiten Wickelmotors und **dadurch gekennzeichnet ist, dass** es ein sensorloses Einstellsystem mit offener Schleife basierend auf einer gesteuerten Geschwindigkeit ist, und dass die genannte Steuermittel die genannte Geschwindigkeitssteuerung auf dem zweiten Motor durchführen, mittels des Begrenzens des Drehmoments desselben, in der genannten Drehrichtung, auf die berechnete Werte.

9. Einstellsystem nach Anspruch 8, **dadurch gekennzeichnet, dass** der genannte erste Dorn (1) und der genannte zweite Dorn (2) jeweilige Drehwellen (E1, E2) aufweist, welche parallel zueinander sind, wobei sich die erste Welle (E1) und/oder die zweite Welle (E2) jeweils von der zweiten Welle (E2) und/oder der ersten Welle (E1) entfernen können, während sich der Durchmesser der aufgewickelten Bahn (L) erhöht, mittels Betätigungsmittel, umfassend mindestens einen Servomotor. 30
10. Einstellsystem nach Anspruch 9, **dadurch gekennzeichnet, dass** die genannten ersten und zweiten Motoren, Motoren mit Direktantrieb sind und direkt auf den Drehwellen (E1, E2) der Dorne (1, 2) montiert sind, ohne im Wesentlichen mehr Reibung als diejenige der Motorlager selbst. 35
11. Maschine, welche eine Wickelstation umfasst, welche ein Einstellsystem zur Einstellung der Spannung beim Aufwickeln gemäß einem der Ansprüche 8 bis 10 beinhaltet. 40
12. Maschine nach Anspruch 11, **dadurch gekennzeichnet, dass** sie zwischen dem ersten Dorn (1) und dem zweiten Dorn (2) mindestens einen Schritt für das längliche Schneiden und/oder Drucken und/oder Kaschieren und/oder Durchbohren der abgewickelten/aufgewickelten Bahn umfasst. 45

Revendications

1. Une méthode de réglage pour régler la tension pendant le réenroulement pour une machine ayant une station de réenroulement, cette station de réenroulement comportant au moins un premier mandrin (1) et un deuxième mandrin (2) reliés à des premier et deuxième moteurs respectifs tournant dans le même sens de sorte qu'une bande (L) enroulée autour du premier mandrin (1) est déroulée de celui-ci et réenroulée sur ce deuxième mandrin (2) avec une quantité de tension pouvant être réglée par une méthode de réglage comportant le contrôle de la vitesse d'au moins le deuxième moteur d'enroulement et **caractérisée** en ce qu'il s'agit d'une méthode de réglage 50

de boucle ouverte sans capteur comportant effectuer ce contrôle de vitesse sur le deuxième moteur de réenroulement basé sur un couple de rotation de celui-ci dans ce sens de rotation, limité à des valeurs calculées et en ce qu'il comporte le calcul de ces valeurs de couple de rotation limitées du deuxième moteur de réenroulement à partir du calcul précédent des types de couples suivants :

- couple de roulement ou de friction nécessaire pour que le deuxième moteur dépasse le coefficient de friction des éléments configurant le moteur et sa transmission ;
- couple d'inertie, additionnel ou d'accélération, qui est le couple nécessaire pour accélérer une masse afin d'arriver à la vitesse requise dans un temps désiré et il dépend de la masse à accélérer et du propre coefficient d'accélération, la masse étant celle qui consiste en le propre deuxième mandrin (2) et la bande (L) qui y est transportée ou le rouleau réenroulé ; et
- couple de tension, qui est le couple à appliquer sur le deuxième moteur et exercé sur la bande afin d'obtenir la tension désirée ; et

calculer les valeurs de couple de rotation limitées en additionnant les valeurs calculées pour le couple de friction, le couple d'inertie et le couple de tension.

2. La méthode conformément à la revendication 1, **caractérisée en ce qu'elle** comprend le calcul de ce couple de roulement ou de friction en enregistrant au préalable le couple utilisé par le deuxième moteur sur toute sa gamme d'utilisation en révolutions de rotation et en consultant cet enregistrement pour la vitesse de rotation du deuxième moteur.
3. La méthode conformément à la revendication 1, **caractérisée en ce qu'elle** comprend le calcul de ce couple d'inertie par l'obtention de ce coefficient d'accélération pour des axes virtuels synchronisés ayant un premier axe de rotation (E1) réel et un deuxième axe de rotation (E2) réel des mandrins (1,2) et en additionnant la charge supportée par le deuxième mandrin de réenroulement (2) correspondant au deuxième axe (E2).
4. La méthode conformément à la revendication 3, **caractérisée en ce qu'elle** comprend le calcul de cette charge au moyen du calcul de son moment d'inertie à partir des données des dimensions, y compris le diamètre et la largeur et les données physiques, y compris le poids d'un rouleau réenroulé et en multipliant la valeur du moment d'inertie calculée par le coefficient d'accélération afin d'obtenir le couple d'inertie.
5. La méthode conformément à la revendication 1, **ca-**

ractérisée en ce qu'elle comprend le calcul de ce couple de tension à partir de la valeur de référence de la force requise et à partir du rayon ou du diamètre du rouleau de bande ou du rouleau réenroulé.

6. La méthode conformément à la revendication 3, **caractérisée en ce que** le premier axe de rotation (E1) et/ou le deuxième axe de rotation (E2) peut s'éloigner du deuxième axe de rotation (E2) et/ou du premier axe de rotation (E1) respectivement, au fur et à mesure que le diamètre de la bande réenroulée augmente, la méthode comportant le calcul de ce diamètre du rouleau réenroulé en l'induisant directement de la position du deuxième axe de rotation (E2) ou d'un élément pouvant être déplacé avec lui durant ce mouvement d'éloignement.
7. La méthode conformément à la revendication 6, **caractérisée en ce que** cet élément qui peut se déplacer avec ce deuxième axe de rotation (E2) est un servomoteur responsable d'effectuer cet éloignement conformément au diamètre de la bande réenroulée.
8. Un système de réglage pour régler la tension durant le réenroulement pour une machine ayant un station de réenroulement, cette station de réenroulement comportant au moins un premier mandrin (1) et un deuxième mandrin (2) reliés aux premier et deuxième moteurs respectifs dans le même sens de sorte que la bande (L) enroulée autour du premier mandrin (1) est déroulée de celui-ci et réenroulée sur ce deuxième mandrin (2) avec une quantité de tension pouvant être réglée par une méthode de réglage, où le système de réglage comprend des moyens pour le contrôle de la vitesse d'au moins le deuxième moteur de réenroulement et **caractérisé en ce qu'il** est un système de réglage de boucle ouverte sans capteur basé sur une vitesse de contrôle et **en ce que** ces deuxièmes moyens de contrôle effectuent ce contrôle de vitesse sur le deuxième moteur en limitant son couple de rotation, dans ce sens de rotation, à des valeurs calculées.
9. Le système de réglage conformément à la revendication 8, **caractérisé en ce que** ce premier mandrin (1) et ce deuxième mandrin (2) ont des axes de rotation respectifs (E1, E2) parallèles entre eux, où le premier axe (E1) et/ou le deuxième axe (E2) peut s'éloigner du deuxième axe (E2) et/ou du premier axe (E1) respectivement au fur et à mesure que le diamètre de la bande réenroulée (L) augmente, par des moyens d'actionnement, comprenant au moins un servomoteur.
10. Le système de réglage conformément à la revendication 9, **caractérisé en ce que** ces premier et deuxième moteurs sont des moteurs à entraînement

direct et sont montés directement sur les axes de rotation (E1, E2) des mandrins (1,2) sans sensiblement plus de friction que celle des propres paliers du moteur.

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11. Une machine comprenant une station de réenroulement qui incorpore un système de réglage pour régler la tension durant le réenroulement conformément à une quelconque des revendications 8 à 10.

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12. La méthode conformément à la revendication 11, **caractérisée en ce qu'elle** comprend entre le premier mandrin (1) et le deuxième mandrin (2) au moins une étape pour découper et/ou imprimer et/ou laminier et/ou perforer la bande déroulée/réenroulée.

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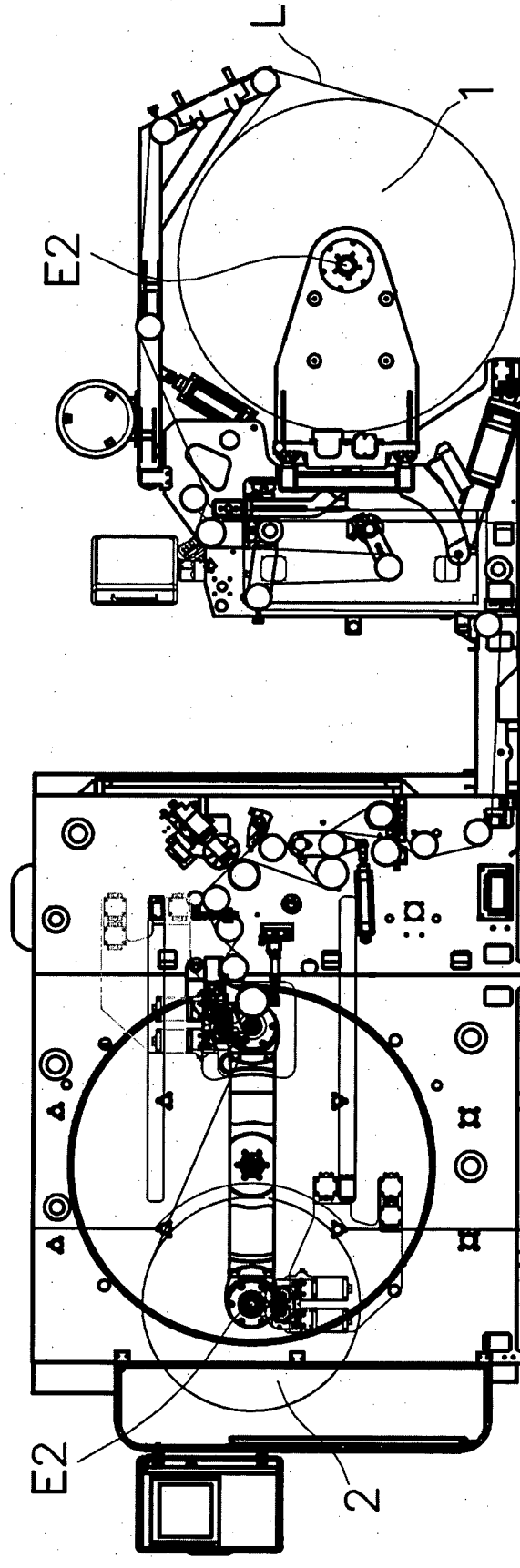


Fig. 1

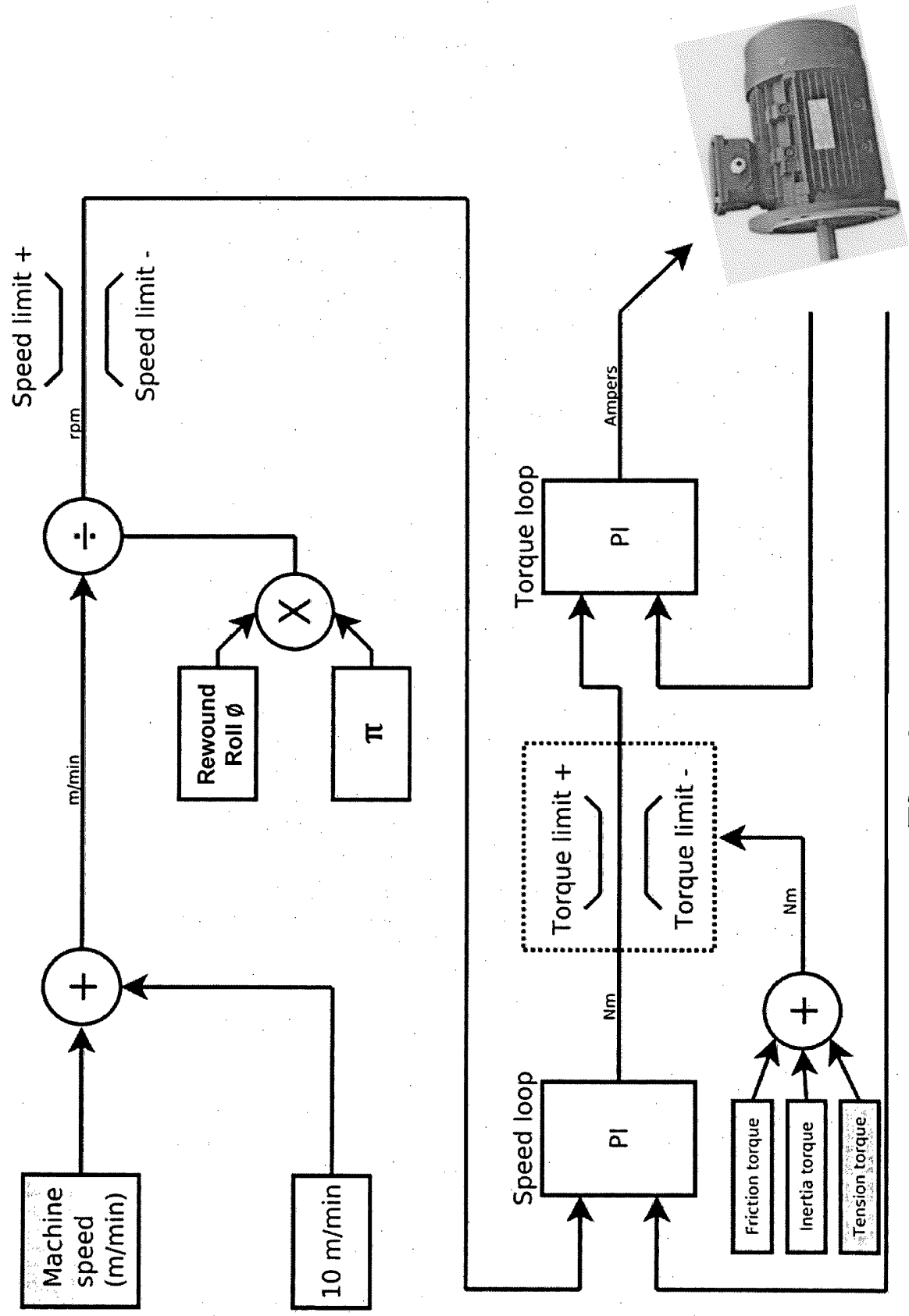


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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