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

(11) **EP 2 192 066 A2**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.06.2010 Bulletin 2010/22

(51) Int Cl.:
B65H 23/18 *(2006.01)*

(21) Application number: **09175640.3**

(22) Date of filing: **11.11.2009**

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

(30) Priority: **26.11.2008 FI 20086135**

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

(72) Inventors:
- **Pitkänen, Tatu**
  04460, Nummenkylä (FI)
- **Kemppainen, Matti M.**
  05400, Jokela (FI)
- **Tiitta, Jari**
  04500, Kellokoski (FI)
- **Tiilikainen, Marko**
  04500, Kellokoski (FI)

(74) Representative: **TBK-Patent**
Bavariaring 4-6
80336 München (DE)

(54) Method and arrangement for controlling winder device operation

(57) In an arrangement according to the invention for controlling the operation of a winder device, there are measuring and data-processing means (208) to determine at least one quality indicator representing the properties of a machine reel being formed (204) during the winding process by means of a measurement applied to the machine reel. From the machine reel, it is possible to determine e.g. hardness, density and/or top-layer tangential tension. In the arrangement, there is a controller apparatus (212) which is arranged to provide a first control circuit for adjusting specifications of winding parameters based on a determined quality indicator and a second control circuit for controlling the winder device based on the specifications of the winding parameters. The arrangement according to the invention is able to adjust the quality properties of the machine reel being formed by closed control already during the winding process.

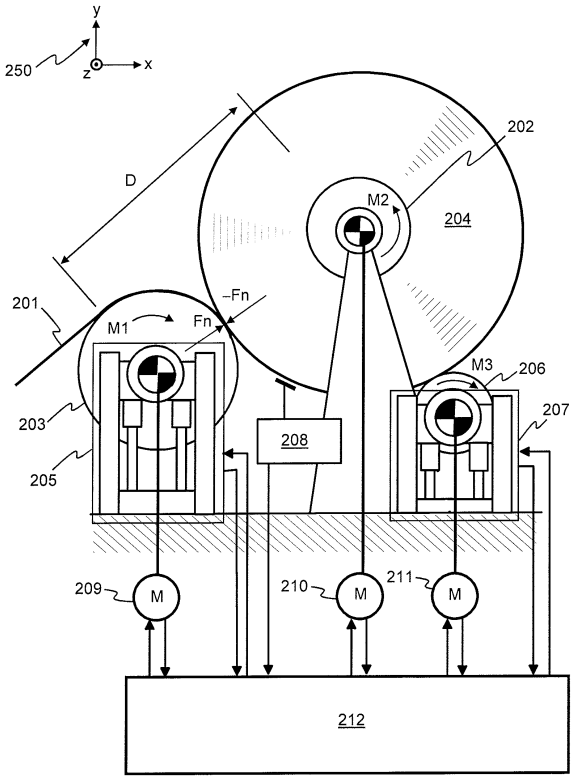

Figure 2.

EP 2 192 066 A2

Description

Field of invention

[0001] The invention relates to a method and an arrangement for controlling the operation of a winder device. The invention also relates to a winder device.

Background of invention

[0002] Fig. 1 shows an illustration of principle of a winder device in which paper or other material being wound 101 is wound around a winding shaft 102. In connection with paper machines, said winding shaft is often called a reel spool and the unit formed by the reel spool and the material wound around it is called a machine reel 104. In the winder device, there is a winding drum 103 which is pressed against the machine reel with a support apparatus 105 which includes a power output apparatus, such as e.g. hydraulic cylinders and pistons or servo-controlled screw guides, for producing a pressing force. The material being wound 101 travels from a nip between the winding drum 103 and the machine reel 104. To the winding drum 103 is applied a torque M1 and to the winding shaft 102 is applied a torque M2. The device producing the torque M2 is often called a centre drive. The winding drum 103 is pressed against the machine reel 104 for providing a radial component Fn (-Fn) of a force prevailing between the winding drum and the machine reel, which is called a nip force. Said nip force is typically expressed as force per machine-reel width (kN/m). Other forces related to winding are a tangential peripheral force prevailing on the surface of the machine reel 104 caused by the torque M2 and a tangential force caused by the torque M1 which the winding drum applies to the material being wound 101. In the winder device, there can further be a rider roll 106 which is pressed against the machine reel 104 with a support apparatus 107. The rider roll can be structured such that a cross-directional force profile of a force between the rider roll and the machine reel can be adjusted. To the rider roll can be applied a torque M3, whereby the rider roll applies a tangential surface draw to the machine reel. The nip force between the winding drum and the machine reel, the peripheral force provided with the centre drive of the machine reel, the web tension of the material being wound 101, the tangential force applied to the machine reel by the winding drum as well as the surface draw applied to the machine reel surface by the rider roll and the shape of the force profile represent control parameters of the winding process i.e. winding parameters by adjusting which the properties, such as the hardness, of the machine reel being formed can be affected. The aim is to form a reel of the material being wound 101 which fulfils the conditions set by the winding process and further processing in relation to handling and reel structure.

[0003] The values of said winding parameters function as specifications for the force and torque control of the drives of the winder device. In an arrangement according to prior art, the operating personnel of the winder device determine suitable values for the winding parameters by means of experience and manually performed measurements. The operator of the winder device can e.g. tap finished reels to determine whether the hardness of the finished reels is suitable and, if required, change the value of one or more winding parameters. However, such a control method is slow and laborious.

Summary of invention

[0004] The invention relates to a novel method for controlling the operation of a winder device, in which method during the winding process:

- determining by means of a measurement applied to the machine reel at least one quality indicator which represents the properties of the machine reel being formed,
- adjusting based on said at least one quality indicator a specification of at least one winding parameter affecting said winding process and
- controlling said winder device based on the specification of said at least one winding parameter.

[0005] The method according to the invention employs measurement and determination methods by means of which it is possible to determine the quality properties of a machine reel being formed during the winding process of said machine reel. Said measurement and determination methods are e.g. the hardness measurement of the reel, which can be based on e.g. measuring an impact caused by a spring force, the thickness measurement of an air foil, the determination of the reel density, and the determination of the tangential tension WOT (wound on tension) of the top layer of the machine reel. Based on a difference between the determined quality property (or properties) and the desired quality property (or properties), one or more winding parameters are adjusted, which can be e.g. nip force between the winding drum and the machine reel, peripheral force provided with the centre drive of the machine reel, web tension of the

material being wound, tangential force applied to the machine reel by the winding drum, and/or surface draw applied to the surface of the machine reel by the rider roll and the shape of the force profile. With the method according to the invention, it is possible to adjust the quality properties of the machine reel being formed by closed control already during the winding process, whereby the quality of winding can be improved and additionally the work of the operating personnel of the winder device can be decreased compared to the prior-art arrangement described above in this document.

[0006] The invention also relates to a novel arrangement for controlling the operation of a winder device. In the arrangement according to the invention, there are measuring and data-processing means to determine at least one quality indicator representing the properties of a machine reel being formed during the winding process by means of a measurement applied to said machine reel and a controller apparatus which is arranged to provide:

- a first control circuit for adjusting a specification of at least one winding parameter affecting said winding process during said winding process based on said at least one quality indicator and

- a second control circuit for controlling said winder device during said winding process based on the specification of said at least one winding parameter.

[0007] Said first control circuit and second control circuit are advantageously cascaded in relation to each other such that said second control circuit is arranged to operate as an inner control loop and said first control circuit is arranged to operate as an outer control loop the output of which is arranged to operate as the specification to be given to said second control circuit.

[0008] The invention also relates to a novel winder device which consists of:

- a winding shaft for forming a machine reel from a material being wound,

- measuring and data-processing means to determine at least one quality indicator representing the properties of said machine reel during the winding process by means of a measurement applied to said machine reel and

- a controller apparatus which is arranged to provide a) a first control circuit for adjusting a specification of at least one winding parameter affecting said winding process during said winding process based on said at least one quality indicator and b) a second control circuit for controlling said winder device during said winding process based on the specification of said at least one winding parameter.

[0009] The various embodiments of the invention are characterised by what is presented in the dependent claims.

Brief description of figures

[0010] The embodiments of the invention and their advantages will now be described in more detail with reference to the accompanying figures in which:

Fig. 1 shows a side view of a winder device according to prior art,

Fig. 2 shows a side view of a winder device which contains an arrangement according to an embodiment of the invention for controlling the operation of said winder device,

Fig. 3 shows a control diagram which illustrates the control of a winder device implemented with an arrangement according to an embodiment of the invention, and

Fig. 4 shows a block diagram of a method according to an embodiment of the invention for controlling the operation of a winder device.

[0011] Fig. 1 was described above in this document in connection with the description of prior art.

Detailed description of embodiments of invention

[0012] Fig. 2 shows a side view of a winder device which contains an arrangement according to an embodiment of the invention for controlling the operation of said winder device. In the winder device, there is a winding shaft 202 around which paper or other material being wound 201 is wound, whereby a machine reel 204 is formed. In the winder device, there is a winding drum 203 which is pressed against the machine reel with a support apparatus 205 which includes a

power output apparatus, such as e.g. hydraulic cylinders and pistons or servo-controlled screw guides, for producing a pressing force. The material being wound 201 travels from a nip between the winding drum 203 and the machine reel 204. To the winding drum 203 is applied a torque M1 and to the winding shaft 202 is applied a torque M2. The winding drum 203 is pressed against the machine reel 204 for providing a nip force Fn (-Fn) between the winding drum and the machine reel. In the winder device, there can further be a rider roll 206 which is pressed against the machine reel 204 with a support apparatus 207. The rider roll can be structured such that a cross-directional (z direction of the co-ordinates 250) force profile of a force between the rider roll and the machine reel can be adjusted. To the rider roll can be applied a torque M3, whereby the rider roll applies a tangential surface draw to the machine reel. The nip force between the winding drum and the machine reel, the peripheral force provided with the centre drive of the machine reel, the web tension of the material being wound 201, the tangential force applied to the machine reel by the winding drum as well as the surface draw applied to the machine reel surface by the rider roll and the shape of the force profile represent control parameters of the winding process i.e. winding parameters by adjusting which the properties, such as the hardness, of the machine reel 204 being formed can be affected.

[0013] In the arrangement for controlling the operation of the winder device, there are measuring and data-processing means 208 to determine at least one quality indicator representing the properties of the machine reel being formed 204 during the winding process by means of a measurement applied to said machine reel. Said measurement is performed during said winding process. In the arrangement, there further is a controller apparatus 212 which is arranged to provide a first control circuit for adjusting a specification of at least one winding parameter affecting said winding process during said winding process based on said at least one quality indicator and a second control circuit for controlling said winder device during said winding process based on the specification of said at least one winding parameter. Said first control circuit and second control circuit are advantageously cascaded in relation to each other such that said second control circuit is arranged to operate as the inner control loop and said first control circuit is arranged to operate as the outer control loop the output of which is arranged to operate as the specification to be given to said second control circuit. The controller apparatus 212 is arranged to control the operation of motors 209, 210 and 211 producing torques M1, M2 and M3 and the operation of the support apparatuses 207 and 205. By controlling the operation of the motors 209, 210 and 211 and the support apparatuses 207 and 205, the controller apparatus is able to adjust winding parameters.

[0014] In an arrangement according to an embodiment of the invention, the measuring and data-processing means 208 are arranged to determine the density of the top layers of the machine reel 204. Then, the determined density represents a quality indicator defined of the machine reel based on which a specification of at least one winding parameter is adjusted.

[0015] The measuring and data-processing means 208 can be arranged to determine said density e.g. on the basis of the peripheral speed of the machine reel v_k [m/s], the rotation speed of the machine reel Ω [rotations/s], the web speed of the material being wound 201 v_r [m/s] and the basis weight of said material being wound m_A [g/m^2]. The peripheral speed of the machine reel and the web speed of the material being wound can be determined e.g. with contact measuring devices, such as e.g. measuring wheels, or contact-free measuring devices, such as e.g. surface-speed lasers. The peripheral speed of the machine reel is not necessarily equal to the web speed of the material being wound, because the material being wound may stretch in the winding process. Based on the peripheral speed of the machine reel, a radius R [m] of the machine reel can be determined by equation:

$$R = v_k/2\pi\Omega \qquad (1)$$

[0016] A volume increase ΔV [m^3] of the machine reel occurred in a time period T_1 ... T_2 [s] is

$$\Delta V = \pi W[R(T_2)^2 - R(T_1)^2], \qquad (2)$$

where W [m] is a web width of the material being wound 201 i.e. width in the z direction of the co-ordinates 250, $R(T_1)$ is a radius of the machine reel at the starting time T_1 of said time period, and $R(T_2)$ is a radius of the machine reel at the finishing time T_2 of said time period. A mass increase Δm [kg] of the machine reel occurred in said time period is

$$\Delta m = v_r W m_A (T_2 - T_1). \quad (3)$$

[0017] A density ρ [kg/m^3] of a part of the machine reel formed in said time period is

$$\rho = \Delta m / \Delta V. \quad (4)$$

[0018] According to a second example, the measuring and data-processing means 208 can be arranged to determine said density on the basis of a distance D measured between the rotation axis of the machine reel 204 and the rotation axis of the winding drum 203, the radius R_R of the winding drum, the web speed v_r of the material being wound 201, and the basis weight m_A of said material being wound. Based on the distance D, a radius R of the machine reel can be determined by equation:

$$R = D - R_R \quad (5)$$

[0019] The density of a part of the machine reel formed in the time period T_1 ... T_2 can be calculated by means of equations (2)-(4).

[0020] In an arrangement according to an embodiment of the invention, the measuring and data-processing means 208 are arranged to determine a tangential tension WOT (wound on tension) prevailing on the top layer of the machine reel based on the remainder v_k - v_r of the peripheral speed of the machine reel 204 and the web speed of the material being wound 201, the web tension T_r of the material being wound and the elastic properties of the material being wound. Then, the determined tangential tension WOT represents a quality indicator defined of the machine reel based on which a specification of at least one winding parameter is adjusted. The peripheral speed of the machine reel and the web speed of the material being wound can be determined e.g. with contact measuring devices, such as e.g. measuring wheels, or contact-free measuring devices, such as e.g. surface-speed lasers. A relative stretch ε of the material being wound can be calculated from equation:

$$\varepsilon = v_k / v_r - 1. \quad (6)$$

[0021] A tangential tension WOT prevailing on the top layer of the machine reel can be calculated from equation:

$$WOT = T_r + \varepsilon E, \quad (7)$$

where E is an implicit variable representing the elasticity of the material being wound 201 which can be e.g. read from a table. The term εE describes the additional tension obtained by the material in the winding process.

[0022] In an arrangement according to an embodiment of the invention, the measuring and data-processing means 208 are arranged to determine the hardness of the surface of said machine reel. Then, the determined hardness represents a quality indicator based on which a specification of at least one winding parameter is adjusted. The measurement of the hardness of the machine-reel surface can be based e.g. on the measurement of an impact motion caused by a spring force.

[0023] It should be noted that the above equations are only examples on how one or more quality indicators can be determined by means of measurements applied to the machine reel. As evident to those skilled in the art, quality indicators can also be determined by other kinds of measurements and mathematical methods.

[0024] In an arrangement according to an embodiment of the invention, the controller apparatus 212 is arranged to

adjust specifications of several winding parameters in a predetermined priority order based on at least one quality indicator. The specification of a winding parameter being lower in said priority order is arranged to be adjusted as a response to a situation in which a sufficient change has not been achieved in said at least one quality indicator by adjusting the specification of a winding parameter upper in said priority order. Let us assume e.g. that the adjustable winding parameters are: r_1 = nip force between the winding drum and the machine reel [kN/m], r_2 = peripheral force provided with the centre drive of the machine reel [N], r_3 = web tension of the material being wound 201 [N], r_4 = tangential force applied to the machine reel by the winding drum [N], and r_5 = surface draw applied to the surface of the machine reel by the rider roll. Furthermore, let us assume that ranges of variation have been defined for said winding parameters i.e. the lowest permissible value and the highest permissible value are defined for each winding parameter. The priority order of said winding parameters can be e.g. the following: r_2, r_1, r_4, r_5 and r_3. Then, the web tension r_3 is not adjusted until the controls of the other winding parameters r_2, r_1, r_4 and r_5 have not provided a desired result i.e. there is a situation in which the quality indicator differs from its target value and the control measure has set each of said other winding parameters to its lowest or highest permissible value. Said priority order can also be asymmetric such that the position of each winding parameter in said priority order is dependent on the direction of change in the winding parameter in question. For instance, the web tension can be last in said priority order if the web tension should be increased, but first if the web tension should be decreased.

[0025] In an arrangement according to an embodiment of the invention, the controller apparatus 212 is arranged to adjust specifications of several winding parameters based on at least one quality indicator. Said winding parameters are attached with predetermined weighing coefficients which are arranged to express the ratio of a change in the specification of each winding parameter and a change in said at least one quality indicator. Let us assume e.g. that the adjustable winding parameters are one or more of the following: r1 = nip force between the winding drum and the machine reel [kN/m], r2 = peripheral force provided with the centre drive of the machine reel [N], r3 = web tension of the material being wound 201 [N], r4 = tangential force applied to the machine reel by the winding drum [N], and r5 = surface draw applied to the surface of the machine reel by the rider roll. Let us further assume e.g. that the determinable quality indicators are one or more of the following: density p, hardness h and tangential tension prevailing on the top layer WOT. Let us additionally assume that for the specification of each winding parameter is defined a nominal value $r_{i,ref0}$ (i = 1, 2, ..., 5) which corresponds a pre-determined advantageous operating point. The specification $r_{i,ref}$ of the winding parameter r_i (i = 1, 2, ..., 5) can be adjusted e.g. based on equation:

$$r_{i,ref} = r_{i,ref0} + W_{i,\rho}\,(\rho - \rho_{ref}) + W_{i,h}\,(h - h_{ref}) + W_{i,WOT}\,(WOT - WOT_{ref}), \qquad (8)$$

where ρ_{ref}, h_{ref} and WOT_{ref} are target values of determined quality indicators and $W_{i,\rho}$, $W_{i,h}$ and $W_{i,WOT}$ are predetermined weighing coefficients which are arranged to express the ratio between the change in the specification of the winding parameter r_i and the change in the equivalent quality indicator, e.g. $W_{i,\rho} = \Delta r_{i,ref}/\Delta\rho$. Equation (8) corresponds an example in which the specification of the winding parameter is adjusted on the basis of three determined quality indicators (p, h, WOT). It should be noted that the number of used quality indicators can be some other than three and/or that the quality indicator (quality indicators) can be some other quantity (quantities) representing the properties of the machine reel.

[0026] In an arrangement according to an embodiment of the invention, the controller apparatus 212 is arranged to adjust the specification of said at least one winding parameter based on at least one control variable given by the operator in addition to at least one quality indicator. The control variable given by the operator can be e.g. a nominal value $r_{i,ref0}$ of the specification of the winding parameter in equation (8).

[0027] In an arrangement according to an embodiment of the invention, the controller apparatus 212 is arranged to adjust the form profile of the rider roll 206 of the winding device based on at least one of the following: temporal variation of the form profile of the machine reel 204 and air volume measured from the machine reel. The form profile of the machine reel means variation in the radius of the machine reel as a function of the axial direction.

[0028] Fig. 3 shows a control diagram which illustrates the control of a winder device implemented with an arrangement according to an embodiment of the invention. In the control diagram, there are a first control circuit 301 and a second control circuit 302. The control circuit 301 forms an outer closed control loop and the control circuit 302 forms an inner closed control loop which is part of said outer closed control loop. Target values 303 of the quality indicators of the machine reel are compared to quality indicators 311 determined by means of measurements from the machine reel (block 309). It is e.g. possible to measure the diameter/hardness profile of the machine reel e.g. by a measuring roll in which the measurement is based on a pressure-sensitive film. The measuring roll, in which the measurement is based on the pressure-sensitive film, can be e.g. a measuring roll of the type known by the applicant's trade name 'iRoll'. By means of a difference variable 314 representing quality deviations, the specifications of the winding parameters are adjusted (block 304). The specifications of the winding parameters can be further adjusted (set) on the basis of control variables given by the operator (block 305). For instance based on the variation of the diameter/hardness profile of the

machine reel, it is possible to increase or decrease the target density of the machine reel and/or the tangential tension WOT (wound on tension) prevailing on the top layer of the machine reel and/or to change the mutual ratios of various winding parameters. For example in a situation, in which the variation of the diameter/hardness profile of the machine reel is great i.e. the machine reel is lumpy, whereby air easily remains within the machine reel, it is worthwhile to increase the peripheral force instead of increasing the nip force, because the increase in the nip force would hinder the exit of air from the machine reel and thus would have an undesired effect. Based on the output information of the block 304 and possibly also the block 305, specifications 313 of the winding parameters are formed (block 306). The specifications 313 of the winding parameters are compared to prevailing winding parameters 312. Based on difference variables given by the comparison, forces produced by the operating system of the winder device and/or torques are adjusted (block 307). Friction, mass inertias and other possible mechanical factors (block 308) have an effect according to known laws of physics on how the forces and torque affect prevailing winding parameters. In the control diagram, there can further be a separate control circuit by means of which the form profile of the rider roll is adjusted (block 310) on the basis of one or more quality indicators 311 determined from the machine reel.

[0029] In a winder device according to an embodiment of the invention, there are (numbers refer to Figs. 2 and 3):

- a winding shaft (202) for forming a machine reel (204) from a material being wound (201),
- measuring and data-processing means (208) to determine at least one quality indicator (311) representing the properties of said machine reel during the winding process by means of a measurement applied to said machine reel,
- a controller apparatus (212) which is arranged to provide:

    a) a first control circuit (301) for adjusting a specification (313) of at least one winding parameter (312) affecting said winding process during said winding process based on said at least one quality indicator and

    b) a second control circuit (302) for controlling said winder device during said winding process based on the specification of said at least one winding parameter.

[0030] Fig. 4 shows a block diagram of a method according to an embodiment of the invention for controlling the operation of a winder device. In the method:

- determining (functional block 401) by means of a measurement applied to the machine reel at least one quality indicator which represents the properties of the machine reel being formed,
- adjusting (functional block 402) based on said at least one quality indicator, which can be e.g. the diameter/hardness profile of the machine reel, a specification of at least one winding parameter affecting said winding process and
- controlling (functional block 403) said winder device based on the specification of said at least one winding parameter.

[0031] In a method according to an embodiment of the invention, said quality indicator represents the density of the top layers of said machine reel.

[0032] In a method according to an embodiment of the invention, said density is determined on the basis of the peripheral speed of said machine reel, the rotation speed of said machine reel, the web speed of the material being wound, and the basis weight of said material being wound.

[0033] In a method according to an embodiment of the invention, said density is determined on the basis of the distance between the rotation axis of said machine reel and the rotation axis of the winding drum, the radius of said winding drum, the web speed of the material being wound, and the basis weight of said material being wound.

[0034] In a method according to an embodiment of the invention, said quality indicator represents the tangential tension prevailing on the top layer of said machine reel, which is determined on the basis of the remainder of the peripheral speed of said machine reel and the web speed of the material being wound, the web tension of said material being wound, and the elastic properties of said material being wound.

[0035] In a method according to an embodiment of the invention, said quality indicator represents the hardness of the surface of said machine reel.

[0036] In a method according to an embodiment of the invention, specifications of several winding parameters of said winding process are adjusted by means of said at least one quality indicator and the specifications of said winding parameters are adjusted in a predetermined priority order such that the specification of a winding parameter being lower in said priority order is adjusted as a response to a situation in which a sufficient change has not been achieved in said at least one quality indicator by adjusting the specification of a winding parameter being upper in said priority order.

[0037] In a method according to an embodiment of the invention, said at least one winding parameter is one or more of the following: nip force between the winding drum and said machine reel, peripheral force provided with the centre drive of said machine reel, web tension of the material being wound, and surface draw applied to the surface of said machine reel by the rider roll.

[0038] In a method according to an embodiment of the invention, the specification of said at least one winding parameter is adjusted based on at least one control variable given by the operator in addition to said at least one quality indicator.

[0039] In a method according to an embodiment of the invention, the form profile of the rider roll of said winding device is adjusted based on at least one of the following: temporal variation of the form profile of said machine reel and air volume measured from said machine reel.

[0040] In a method according to an embodiment of the invention, specifications of several winding parameters of said winding process are adjusted based on said at least one quality indicator and in said winding parameters are attached predetermined weighing coefficients which represent a ratio of the change in the specification of each winding parameter and the change in said at least one quality indicator.

[0041] As evident to those skilled in the art, the invention and its embodiments are not limited to the above-described embodiment examples. Expressions included by the claims, representing the existence of characteristics, such as "the arrangement includes a controller apparatus", are unlimited such that the description of characteristics does not exclude the existence of such other characteristics which are not stated in the independent or dependent claims.

[0042] In an arrangement according to the invention for controlling the operation of a winder device, there are measuring and data-processing means (208) to determine at least one quality indicator representing the properties of a machine reel being formed (204) during the winding process by means of a measurement applied to the machine reel. From the machine reel, it is possible to determine e.g. hardness, density and/or top-layer tangential tension. In the arrangement, there is a controller apparatus (212) which is arranged to provide a first control circuit for adjusting specifications of winding parameters based on a determined quality indicator and a second control circuit for controlling the winder device based on the specifications of the winding parameters. The arrangement according to the invention is able to adjust the quality properties of the machine reel being formed by closed control already during the winding process.

Claims

1. A method for controlling the operation of a winder device, in which method, determining (401) during the winding process by means of a measurement applied to a machine reel (204) at least one quality indicator (311) which represents the properties of the machine reel being formed, **characterised by** in the method during said winding process:

   - adjusting (402) based on said at least one quality indicator a specification (313) of at least one winding parameter (312) affecting said winding process and
   - controlling (403) said winder device based on the specification of said at least one winding parameter.

2. A method according to claim 1, **characterised by** said quality indicator representing the density of the top layers of said machine reel.

3. A method according to claim 2, **characterised by** determining said density on the basis of the peripheral speed of said machine reel, the rotation speed of said machine reel, the web speed of a material being wound (201), and the basis weight of said material being wound.

4. A method according to claim 2, **characterised by** determining said density on the basis of the distance between the rotation axis of said machine reel and the rotation axis of a winding drum (203), the radius of said winding drum, the web speed of the material being wound (201), and the basis weight of said material being wound.

5. A method according to claim 1, **characterised by** said quality indicator representing the tangential tension prevailing on the top layer of said machine reel, which is determined on the basis of the remainder of the peripheral speed of said machine reel and the web speed of the material being wound (201), the web tension of said material being wound, and the elastic properties of said material being wound.

6. A method according to claim 1, **characterised by** said quality indicator representing the hardness of the surface of said machine reel.

7. A method according to claim 1, **characterised by** adjusting specifications of several winding parameters of said

winding process by means of said at least one quality indicator and adjusting the specifications of said winding parameters in a predetermined priority order such that the specification of a winding parameter being lower in said priority order is adjusted as a response to a situation in which a sufficient change has not been achieved in said at least one quality indicator by adjusting the specification of a winding parameter being upper in said priority order.

8. A method according to claim 1, **characterised in that** said at least one winding parameter is one or more of the following: nip force between the winding drum (203) and said machine reel, peripheral force provided with the centre drive of said machine reel, web tension of the material being wound (201), and surface draw applied to the surface of said machine reel by a rider roll (206).

9. A method according to claim 1, **characterised in that** the specification of said at least one winding parameter is adjusted based on at least one control variable given by the operator in addition to at least one quality indicator.

10. A method according to claim 1, **characterised in that** the form profile of the rider roll (206) of said winding device is adjusted on the basis of at least one of the following: temporal variation of the form profile of said machine reel and air volume measured from said machine reel.

11. A method according to claim 1, **characterised by** adjusting specifications of several winding parameters of said winding process based on said at least one quality indicator and attaching in said winding parameters predetermined weighing coefficients which represent a ratio of the change in the specification of each winding parameter and the change in said at least one quality indicator.

12. An arrangement for controlling the operation of a winder device, in which arrangement there are measuring and data-processing means (208) to determine at least one quality indicator (311) representing the properties of a machine reel being formed (204) during the winding process by means of a measurement applied to said machine reel, **characterised in that**, in the arrangement, there further is a controller apparatus (212) which is arranged to provide:

- a first control circuit (301) for adjusting a specification (313) of at least one winding parameter (312) affecting said winding process during said winding process based on said at least one quality indicator and
- a second control circuit (302) for controlling said winder device during said winding process based on the specification of said at least one winding parameter.

13. A winder device which consists of:

- a winding shaft (202) for forming a machine reel (204) from a material being wound (201) and
- measuring and data-processing means (208) to determine at least one quality indicator (311) representing the properties of said machine reel during the winding process by means of a measurement applied to said machine reel,

characterised in that, in said winder device, there further is a controller apparatus (212) which is arranged to provide:

- a first control circuit (301) for adjusting a specification (313) of at least one winding parameter (312) affecting said winding process during said winding process based on said at least one quality indicator and
- a second control circuit (302) for controlling said winder device during said winding process based on the specification of said at least one winding parameter.

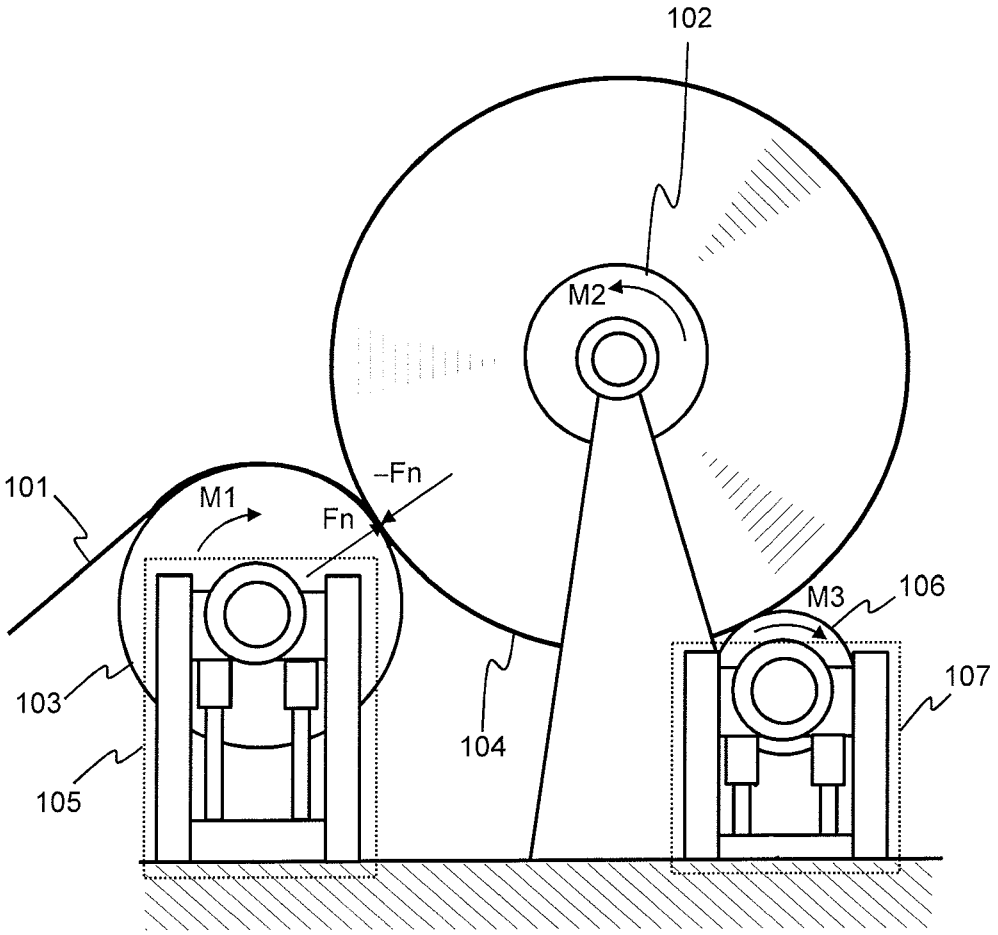

Figure 1.

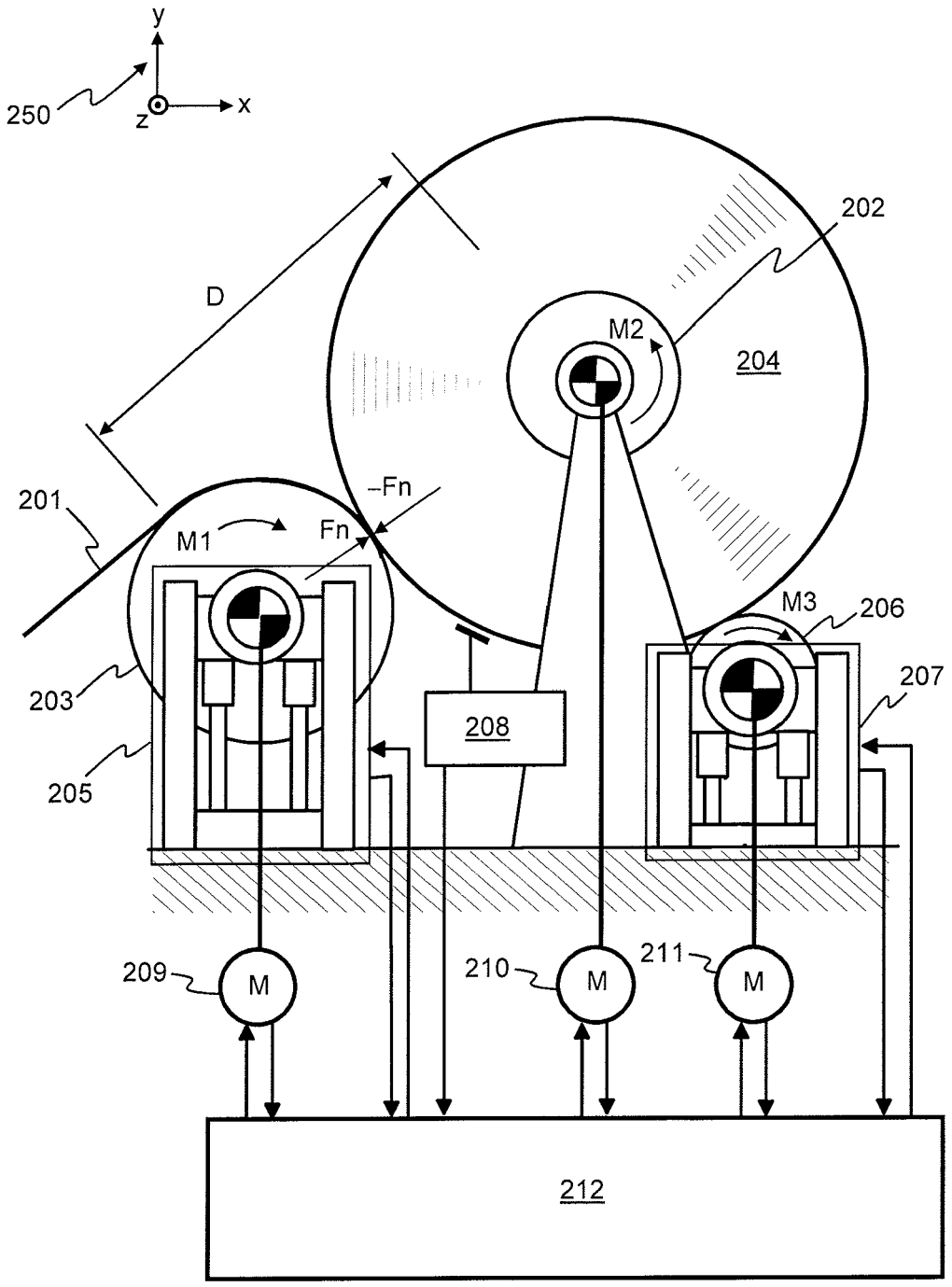
y
x
z
250
D
202
M2
204
201
-Fn
Fn
M1
M3
206
207
203
208
205
209
M
210
M
211
M
212

Figure 2.

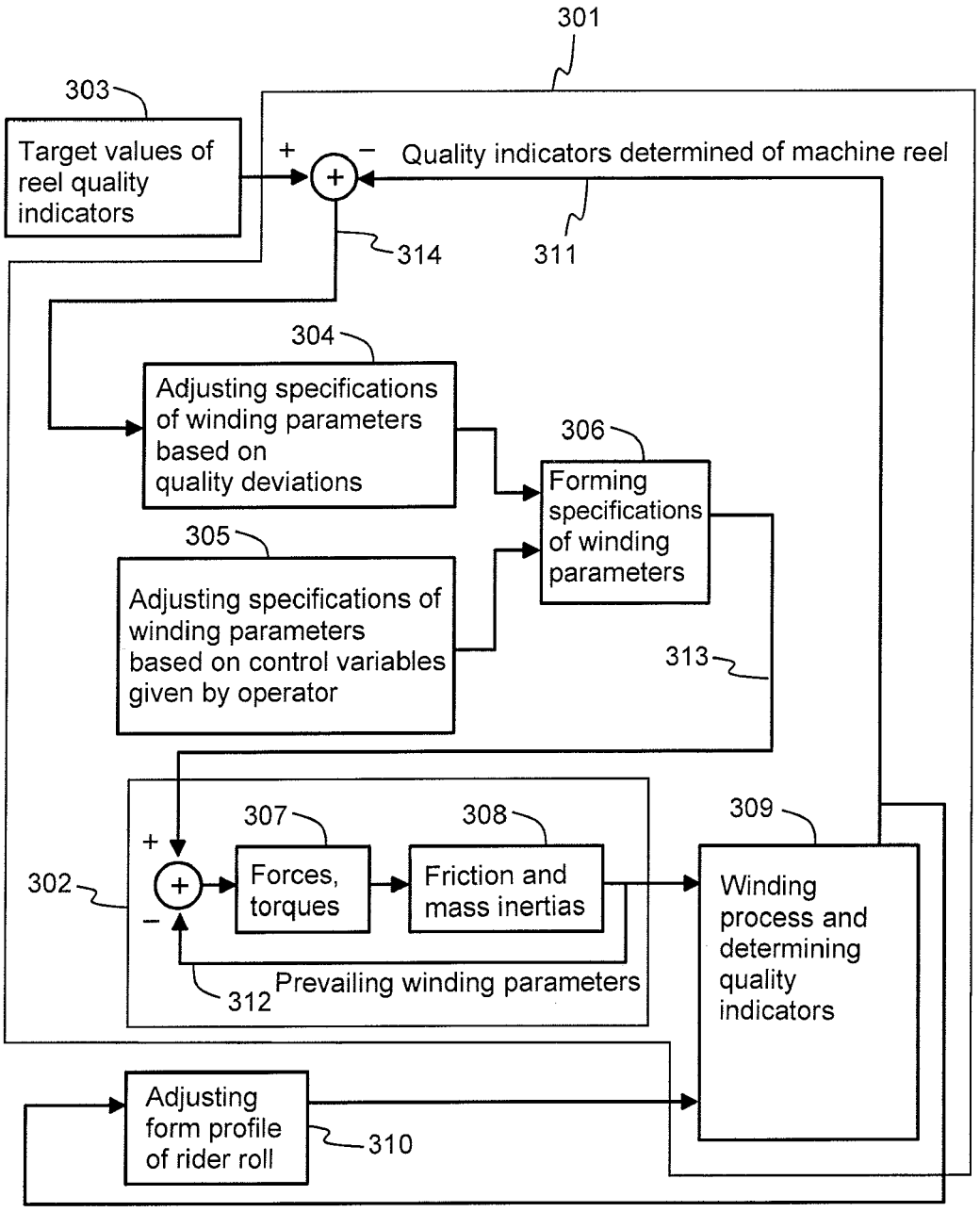
301
303
Target values of reel quality indicators
+
−
Quality indicators determined of machine reel
314
311
304
Adjusting specifications of winding parameters based on quality deviations
306
Forming specifications of winding parameters
305
Adjusting specifications of winding parameters based on control variables given by operator
313
307
308
309
302
+
−
Forces, torques
Friction and mass inertias
Winding process and determining quality indicators
312
Prevailing winding parameters
Adjusting form profile of rider roll
310

Figure 3.

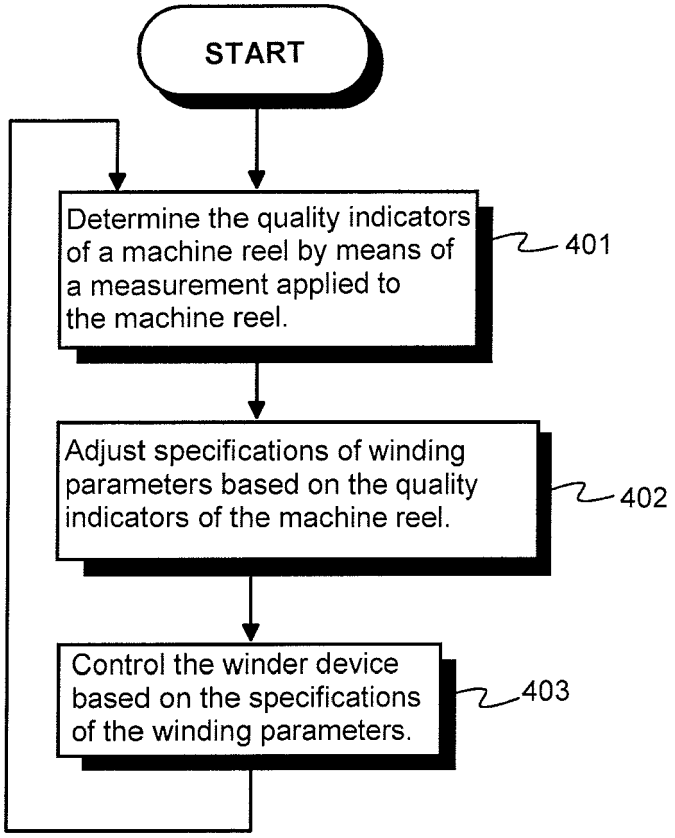
START
Determine the quality indicators of a machine reel by means of a measurement applied to the machine reel.
401
Adjust specifications of winding parameters based on the quality indicators of the machine reel.
402
Control the winder device based on the specifications of the winding parameters.
403

Figure 4.