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(54) **Device for automatic wire tension adjustments during the various steps of winding in machines for winding electric coils**

Vorrichtung für automatische Drahtspannungsanpassungen während verschiedener Stufen von Wickelmaschinen zum Wickeln von elektrischen Spulen

Dispositif pour réglages automatiques de tension de fil pendant les différentes étapes d'enroulement dans les machines pour enrouler des bobines électriques

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Description

[0001] The present invention relates to a device for automatic wire tension adjustment during the various steps of winding in machines for winding electric coils.

[0002] As is known, the winding of coils for electrical or electromechanical components is performed generally by arranging the coils on spindles that are actuated so as to rotate the coils about their own axis and by feeding the wire to the coils so that it is progressively wound around them, although machines that perform winding by keeping the coils stationary and moving the wire around them also exist. Usually, in each coil, the wire is anchored, at the beginning and at the end of the winding, to pins provided on the coil, winding its ends around said pins.

[0003] In order to obtain regular and uniform winding, as required, the tension of the wire during winding must be kept as constant as possible.

[0004] In order to achieve this goal, adapted devices, known as wire tensioners, are known which comprise generally a supporting structure provided with eyes and pulleys that define a path for the wire that arrives from a spool-magazine and, along said path, usually there is a brake, a load cell for detecting the tension of the wire, and a takeup arm, which can rotate, with respect to the supporting structure, about a corresponding axis and has the function of keeping the wire under tension, compensating for the different demand for wire by the elements that wind it around the coil or the pins. The takeup arm is connected to springs that have the function of contrasting the rotation of the takeup arm when the demand for wire increases and to a damping element that has the function of damping the oscillations of the takeup arm about its own axis induced by the variations in the tension of the wire.

[0005] Substantially, in these wire tensioners of the known type, the tension of the wire during its winding is detected by means of the load cells and the braking action performed by the brake is changed automatically, by means of a control system with feedback, as a function of the value of the tension detected by the load cell with respect to the desired tension value.

[0006] While maintaining constant tension during the winding of the wire around the coil when said coil rotates at a constant speed does not entail particular problems, maintaining a constant tension during accelerations and decelerations of the rotation of the coil is difficult to achieve. The accelerations and decelerations of the rotation of the coil cause continuous oscillations of the takeup arm about its own axis, which can damage the damping element. This problem is felt particularly in the winding of wires having a relatively large diameter.

[0007] EP0926090A2 discloses a winding device and winding method in which a wire is fed from a spool which is rotated by a feeding motor. The wire is led to a bobbin on the tip of a spindle via a pulley on the tip of a tension arm and a pulley fixed on a rotational axis of an encoder. The rotational speed of the feeding motor is controlled depending on the winding speed of the wire onto the bobbin detected by the encoder. Variations in the tension of the wire are detected by a potentiometer as rotations of the tension arm, and the rotational speed of the feeding motor is regulated depending on such variations in tension.

[0008] EP2031610A1 discloses a wire winding device which winds a wire around a core, with a roller feeding the wire to the core, and a tension device which adjusts the tension of the wire supplied to the core from the roller. A speed detector detects the speed of the wire supplied to the core from the roller.

[0009] EP0424770A2 discloses a programmable self-adjusting device for tensioning wires during winding comprising, in the direction of advancement of a wire to be wound, a pre-braking device for tensioning the wire which winds on a brake pulley downstream of which there is a transmission roller which is supported by a compensating arm. At the exit from the transmission roller the wire engages a wire tension sensing unit which drives the brake pulley.

[0010] The aim of the present invention is to solve the problems described above, by providing a device for wire tension adjustment during the various steps of winding in machines for winding electric coils that allows to keep the tension of the wire substantially constant during the various steps of winding.

[0011] Within this aim, an object of the invention is to provide a device that allows to keep substantially constant the tension of the wire even during the steps of winding that cause accelerations and decelerations of the wire, such as for example in the transition from winding the wire around the pins to winding around the core of the coil and vice versa.

[0012] In accordance with the invention, there is provided a device for automatic wire tension adjustment as defined in the appended claims.

[0013] Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of the device according to the invention, illustrated by way of nonlimiting example in the accompanying drawings, wherein:

Figure 1 is a perspective view of the device according to the invention;
Figure 2 is a front elevation view of the device according to the invention;
Figure 3 is a sectional view of Figure 2, taken along the line III-III.

[0014] With reference to the figures, the device according to the invention, generally designated by the reference numeral 1, comprises a supporting structure 2, which supports a series of elements that cooperate with each other in defining a path for the wire 3 that must be fed to the coil around which it is to be wound.

[0015] Along such path there are means 5 for detecting the tension of the wire 3 and there is a takeup arm 6, which can rotate about an axis 7 with respect to the supporting structure 2 due to the variations of the tension of the wire 3.

[0016] According to the invention, the device comprises, along the path of the wire 3, an element 4 for pushing and braking the wire 3 and comprises furthermore means 8 for detecting the rotation of the takeup arm 6 about the axis 7 with respect to the supporting structure 2, and the rotation detection means 8 are connected functionally to the pushing and braking element 4 for an automatic adjustment of the degree of thrust or braking applied to the wire 3 as a function of the detected value of the rotation of the takeup arm 6 about the axis 7.

[0017] More particularly, the supporting structure 2, in the illustrated embodiment, is constituted by a box-like body 9, which supports, on one of its faces, a series of elements that are engaged by the wire 3 to be fed to the coil.

[0018] Conveniently, the pushing and braking element 4 comprises a pulley 10 on which the wire 3 is wound and a motor 11 which actuates the pulley 10 with a torque that can be varied and adjusted as a function of the tension of the wire 3 detected by the means 5 for detecting the tension of the wire 3 and/or as a function of the rotation of the takeup arm 6 detected by the rotation detection means 8, so as to maintain a preset tension of the wire 3 in a substantially constant manner.

[0019] The means 5 for detecting the tension of the wire 3 comprise a pair of pulleys 12, 13, which have mutually parallel axes and are engaged in sequence by the wire 3 that is fed to the coil and are connected, in a per se known manner, to a load cell 14, which detects constantly the tension applied to the wire 3.

[0020] Conveniently, the takeup arm 6 is connected to means for damping its rotation about the corresponding axis 7.

[0021] More particularly, the takeup arm 6 is pivoted, about the axis 7, to the supporting structure 2 by means of an intermediate portion thereof. At one end of the takeup arm 6 there is a pulley 15, around which the wire 3 to be fed to the coil engages, while the other end of the takeup arm 6 engages against a lever 16, which also is pivoted to the supporting structure 2 about an axis 17 that is parallel to the axis 7. The lever 16 connects the takeup arm 6 to the damping means, which are constituted by a damping element 18, of a known type, and elastic means act on the lever 16 and are constituted by springs 19, 20, which contrast the rotation of the takeup arm 6 about the axis 7 in the direction of rotation that would lead to a reduction of the path followed by the wire 3 along the device according to the invention. In practice, the springs 19, 20 have the function of compensating for any slackening of the wire 3 during the operation of the device.

[0022] It should be noted that in Figure 3 the damping element 18 is constituted by a damping element of the pneumatic type, but it might also be constituted by a damping element of a different type, for example of the electrical type, or another damping element of a known type.

[0023] The means 8 for detecting the rotation of the takeup arm 6 comprise an angular transducer 21, which is connected to the takeup arm 6.

[0024] Preferably, the pulley 10 of the pushing and braking element 4 is arranged upstream of the takeup arm 6 along the advancement direction of the wire 3 during the winding of the coil.

[0025] According to the invention, the means 5 for detecting the tension of the wire 3 are arranged downstream of the takeup arm 6 along the advancement direction of the wire 3 during the winding of the coil.

[0026] More particularly, the wire 3 to be wound, which arrives from a spool-magazine, in input to the device, passes through an eye 22, then through a guiding element 23, then passes through a pair of cleaning felts 24a, 24b, passes through a passage 25 defined in the arm 26 that supports the pair of pulleys 12, 13, winds around the pulley 10 of the pushing and braking element 4, then engages a guiding pulley 27, winds around the pulley 15 of the takeup arm 6 and finally engages the pair of pulleys 12, 13 before it is conveyed to the spool around which it must be wound.

[0027] Conveniently, the pushing and braking element 4 and the means 5 for detecting the tension of the wire 3 are part of a first automatic adjustment loop with feedback for automatic adjustment of the degree of thrust or braking applied by the pushing or braking element 4 and therefore for an automatic adjustment of the tension of the wire 3 mainly in the steps for winding the coil at a substantially constant rotation rate thereof.

[0028] The means 8 for detecting the rotation of the takeup 6 arm are connected functionally to the pushing and braking element 4 by means of a system for automatic adjustment with feedback in order to vary the degree of thrust or braking applied to the wire 3 by the pushing and braking element 4 following the detection of a rotation of the takeup arm 6 about its own axis 7 with respect to the supporting structure 2.

[0029] Conveniently, the pushing and braking element 4 and the means 8 for detecting the rotation of the take up arm 6 are part of a second automatic adjustment loop with feedback of the tension of the wire 3 for automatic adjustment of the degree of thrust or braking applied to the wire 3 by the pushing and braking element 4 as a function of the detected value of the rotation of the takeup arm 6 about the axis 7 and therefore for automatic adjustment of the tension of the wire 3 mainly in the steps for winding the coil with a variable rotation rate thereof.

[0030] Operation of the device according to the invention is as follows.

[0031] While the coil is actuated with a substantially constant rotary motion about its own axis 7, the oscillations of the takeup arm 6 about the axis 7 are substantially nil and the tension of the wire 3 is adjusted and kept

substantially constant mainly by means of the first automatic adjustment loop with feedback, i.e., by means of the detection of the tension of the wire 3 performed by means of the load cell 14 and by means of an actuation of the pushing and braking element 4 as a function of the detected tension value with respect to the desired value.

[0032] During the accelerations and decelerations of the rotation of the coil, which would induce oscillations of the takeup arm 6 about its own axis 7, the beginning of the oscillations is detected promptly by the angular transducer 21 and, by means of the second automatic adjustment loop with feedback, the thrust or braking action performed by the pushing and braking element 4 is changed automatically, by means of an adequate actuation of the pushing and braking element 4, as a function of the detection performed by the angular transducer 21.

[0033] In particular, when the tension of the wire 3 increases, the pushing and braking element 4 applies a pushing action to the wire 3, facilitating its advancements toward the coil being wound and thus returning the tension of the wire 3 to the desired value.

[0034] In this manner, the takeup arm 6, even during the steps for winding the coil that require accelerations and decelerations of the rotation of the coil, remains substantially stationary and a substantially constant tension of the wire 3 is ensured during the winding of the coil even in these steps.

[0035] In practice it has been found that the device according to the invention achieves fully the intended aim, since it allows to maintain substantially constant the tension of the wire during the various steps of the winding of the coil, and in particular allows to keep substantially constant the tension of the wire even during the winding steps that require an acceleration and a deceleration of the rotation of the coil about its own axis.

[0036] The device thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

[0037] In practice, the materials used, as well as the dimensions, may be any according to requirements and to the state of the art.

[0038] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A device for automatic wire tension adjustment during the various steps of winding in machines for winding electric coils, comprising a supporting structure (2) that supports a series of elements that define a path for the wire (3) to be fed to the coil being wound, along said path there being means (5) for detecting the tension of the wire (3) and a takeup arm (6) that can rotate about an axis (7) with respect to said supporting structure (2) due to the variations of the tension of the wire (3), along said path there being an element (4) for pushing and braking the wire (3) and the device further comprising means (8) for detecting the rotation of said takeup arm (6) about said axis (7) relative to said supporting structure (2), said means (8) for detecting the rotation of said takeup arm (6) being connected functionally to said pushing and braking element (4) for an automatic adjustment of the degree of thrust or braking applied to the wire (3) as a function of the detected value of the rotation of said takeup arm (6) about said axis (7), said means (8) for detecting the rotation of said takeup arm (6) being connected functionally to said pushing and braking element (4) by means of a system for automatic adjustment with feedback in order to vary the degree of thrust or braking applied to the wire (3) by said pushing and braking element (4) as a consequence of the detection of a rotation of said takeup arm (6) about its own axis (7) with respect to said supporting structure (2), said pushing and braking element (4) and said means (5) for detecting the tension of the wire (3) being part of a first automatic adjustment loop with feedback of the tension of the wire (3) for an automatic adjustment of the degree of thrust or braking applied to the wire (3) by said pushing and braking element (4) as a function of the detected value of the tension of the wire (3) during a substantially constant rotation rate of winding of the wire (3), said pushing and braking element (4) and said means (8) for detecting the rotation of said takeup arm (6) being part of a second automatic adjustment loop with feedback of the tension of the wire (3) for an automatic adjustment of the degree of thrust or braking applied to the wire (3) by said pushing and braking element (4) as a function of the detected value of the rotation of said takeup arm (6) about the corresponding axis (7) during a variable rotation rate of winding of the wire (3), and said means (5) for detecting the tension of the wire (3) being arranged downstream of said takeup arm (6) along the advancement direction of the wire (3) during the winding of the coil.

2. The device according to claim 1, wherein said pushing and braking element (4) is arranged upstream of said takeup arm (6) along the advancement direction of the wire (3) during the winding of the coil.

3. The device according to one or more of the preceding claims, wherein said pushing and braking element (4) comprises a pulley (10) on which the wire (3) winds and a motor (11) that drives said pulley (10) with a torque that can vary as a function of the tension

of the wire (3) detected by said means (5) for detecting the tension of the wire (3) and/or as a function of the rotation of said takeup arm (6) detected by said means (8) for detecting the rotation of said takeup arm (6).

4. The device according to one or more of the preceding claims, wherein said means (8) for detecting the rotation of said takeup arm (6) comprise an angular transducer (21).

5. The device according to one or more of the preceding claims, wherein said takeup arm (6) is connected to means (18) for damping its rotation about the corresponding axis (7).

Patentansprüche

1. Eine Vorrichtung zur automatischen Drahtspannungsanpassung während der verschiedenen Wickelstufen in Maschinen zum Wickeln elektrischer Spulen, die eine tragende Struktur (2) umfasst, welche eine Reihe von Elementen trägt, die einen Pfad für den Draht (3) bestimmen, der der aufzuwickelnden Spule zugeführt werden soll, wobei sich entlang dem Pfad Mittel (5) zur Erfassung der Spannung des Drahts (3) und ein Aufnahmearm (6) befinden, der sich aufgrund der Schwankungen in der Spannung des Drahts (3) im Verhältnis zu der tragenden Struktur (2) um eine Achse (7) drehen kann, wobei sich entlang dem Pfad ein Element (4) zum Schieben und Bremsen des Drahts (3) befindet und die Vorrichtung weiter Mittel (8) zur Erfassung der Drehung des Aufnahmearms (6) um die Achse (7) relativ zu der tragenden Struktur (2) umfasst, wobei die Mittel (8) zur Erfassung der Drehung des Aufnahmearms (6) funktional mit dem Schub- und Bremselement (4) verbunden sind, zum Zwecke einer automatischen Anpassung des Grades an Schub oder Bremswirkung, die auf den Draht (3) einwirken, in Abhängigkeit vom erfassten Wert der Drehung des Aufnahmearms (6) um die Achse (7), wobei die Mittel (8) zur Erfassung der Drehung des Aufnahmearms (6) funktional über ein System für die automatische Anpassung mit Rückkopplung mit dem Schub- und Bremselement (4) verbunden sind, um den Grad an Schub oder Bremswirkung, die von dem Schub- und Bremselement (4) auf den Draht (3) ausgeübt werden, infolge der Erfassung einer Drehung des Aufnahmearms (6) um seine eigene Achse (7) im Verhältnis zu der tragenden Struktur (2) zu variieren, wobei das Schub- und Bremselement (4) und die Mittel (5) zur Erfassung der Spannung des Drahts (3) Teil einer ersten automatischen Rückkopplungsschleife der Spannung des Drahts (3) zum Zwecke einer automatischen Anpassung des Grades des Schubs oder der Bremswirkung, die von dem Schub- und Bremselement (4) auf den Draht (3) ausgeübt werden, infolge des erfassten Werts der Spannung des Drahts (3) bei einer im Wesentlichen konstanten Rotationsrate der Aufwicklung des Drahts (3) sind, wobei das Schub- und Bremselement (4) und die Mittel (8) zur Erfassung der Drehung des Aufnahmearms (6) Teil einer zweiten automatischen Rückkopplungsschleife der Spannungs des Drahts (3) zum Zwecke einer automatischen Anpassung des Grades des Schubs oder der Bremswirkung, die von dem Schub- und Bremselement (4) auf den Draht (3) ausgeübt werden, in Abhängigkeit vom erfassten Wert der Drehung des Aufnahmearms (6) um die entsprechende Achse (7) bei einer veränderlichen Rotationsrate der Aufwicklung des Drahts (3) sind, und die Mittel (5) zur Erfassung der Spannung des Drahts (3) stromabwärts von dem Aufnahmearm (6) entlang der Vorschubrichtung des Drahts (3) während des Aufwickelns der Spule angeordnet sind.

2. Die Vorrichtung gemäß Anspruch 1, wobei das Schub- und Bremselement (4) entlang der Vorschubrichtung des Drahts (3) während des Aufwickelns der Spule stromaufwärts von dem Aufnahmearm (6) angeordnet ist.

3. Die Vorrichtung gemäß einem oder mehreren der obigen Ansprüche, wobei das Schub- und Bremselement (4) eine Riemenscheibe (10) umfasst, an der sich der Draht (3) aufwickelt, und einen Motor (11), der die Riemenscheibe (10) mit einem Drehmoment antreibt, das in Abhängigkeit von der Spannung des Drahts (3) variieren kann, die von den Mitteln (5) zur Erfassung der Spannung des Drahts (3) erfasst wird, und/oder in Abhängigkeit von der Drehung des Aufnahmearms (6), die von den Mitteln (8) zur Erfassung der Drehung des Aufnahmearms (6) erfasst wird.

4. Die Vorrichtung gemäß einem oder mehreren der obigen Ansprüche, wobei die Mittel (8) zur Erfassung der Drehung des Aufnahmearms (6) einen Winkelaufnehmer (21) umfassen.

5. Die Vorrichtung gemäß einem oder mehreren der obigen Ansprüche, wobei der Aufnahmearm (6) mit Mitteln (18) zur Dämpfung seiner Drehung um die entsprechende Achse (7) verbunden ist.

Revendications

1. Dispositif pour réglage automatique de tension de fil pendant les diverses étapes d'enroulement dans des machines, destinées à enrouler des bobines électriques, comprenant une structure formant support (2), qui supporte une série d'éléments qui définissent une voie pour le fil (3) à amener à la bobine

qui est enroulée ; le long de ladite voie, un moyen (5), destiné à détecter la tension du fil (3) et un bras d'appel (6), qui peut tourner autour d'un axe (7) par rapport à ladite structure formant support (2) en raison des variations de la tension du fil (3) y existant ; le long de ladite voie, un élément (4) de poussée et de freinage du fil (3) y existant et le dispositif comprenant en outre un moyen (8), destiné à détecter la rotation dudit bras d'appel (6) autour dudit axe (7) par rapport à ladite structure formant support (2), ledit moyen (8), destiné à détecter la rotation dudit bras d'appel (6), étant relié de manière fonctionnelle audit élément de poussée et de freinage (4), pour un réglage automatique du degré de poussée ou de freinage, appliqué au fil (3) en tant que fonction de la valeur détectée de la rotation dudit bras d'appel (6) autour dudit axe (7), ledit moyen (8), destiné à détecter la rotation dudit bras d'appel (6), étant relié de manière fonctionnelle audit élément de poussée et de freinage (4), au moyen d'un système de réglage automatique avec rétroaction, afin de faire varier le degré de poussée ou de freinage, appliqué au fil (3) par ledit élément de poussée et de freinage (4), à titre de conséquence de la détection d'une rotation dudit bras d'appel (6) autour de son propre axe (7) par rapport à ladite structure formant support (2), ledit élément de poussée et de freinage (4) et ledit moyen (5), destiné à détecter la tension du fil (3), faisant partie d'une première boucle de réglage automatique, avec rétroaction de la tension du fil (3), pour un réglage automatique du degré de poussée ou de freinage, appliqué au fil (3) par ledit élément de poussée et de freinage (4), en tant que fonction de la valeur détectée de la tension du fil (3) pendant une fréquence de rotation sensiblement constante d'enroulement du fil (3), ledit élément de poussée et de freinage (4) et ledit moyen (8), destiné à détecter la rotation dudit bras d'appel (6) faisant partie d'une seconde boucle de réglage automatique, avec rétroaction de la tension du fil (3), pour un réglage automatique du degré de poussée ou de freinage, appliqué au fil (3) par ledit élément de poussée et de freinage (4), en tant que fonction de la valeur détectée de la rotation dudit bras d'appel (6) autour de l'axe (7) correspondant, pendant une fréquence de rotation variable d'enroulement du fil (3) et ledit moyen (5), destiné à détecter la tension du fil (3), étant agencé en aval dudit bras d'appel (6), le long de la direction d'avancement du fil (3) pendant l'enroulement de la bobine.

2. Dispositif selon la revendication 1, dans lequel ledit élément de poussée et de freinage (4) est agencé en amont dudit bras d'appel (6), le long de la direction d'avancement du fil (3), pendant l'enroulement de la bobine.

3. Dispositif selon une ou plus des revendications précédentes, dans lequel ledit élément de poussée et de freinage (4) comprend une poulie (10), sur laquelle s'enroule le fil (3) et un moteur (11), qui entraîne ladite poulie (10) avec un couple qui peut varier, en tant que fonction de la tension du fil (3), détectée par ledit moyen (5), destiné à détecter la tension du fil (3) et / ou que fonction de la rotation dudit bras d'appel (6), détectée par ledit moyen (8), destiné à détecter la rotation dudit bras d'appel (6).

4. Dispositif selon une ou plus des revendications précédentes, dans lequel ledit moyen (8), destiné à détecter la rotation dudit bras d'appel (6), comprend un transducteur angulaire (21).

5. Dispositif selon une ou plus des revendications précédentes, dans lequel ledit bras d'appel (6) est relié à un moyen (18), destiné à amortir sa rotation autour de l'axe (7) correspondant.

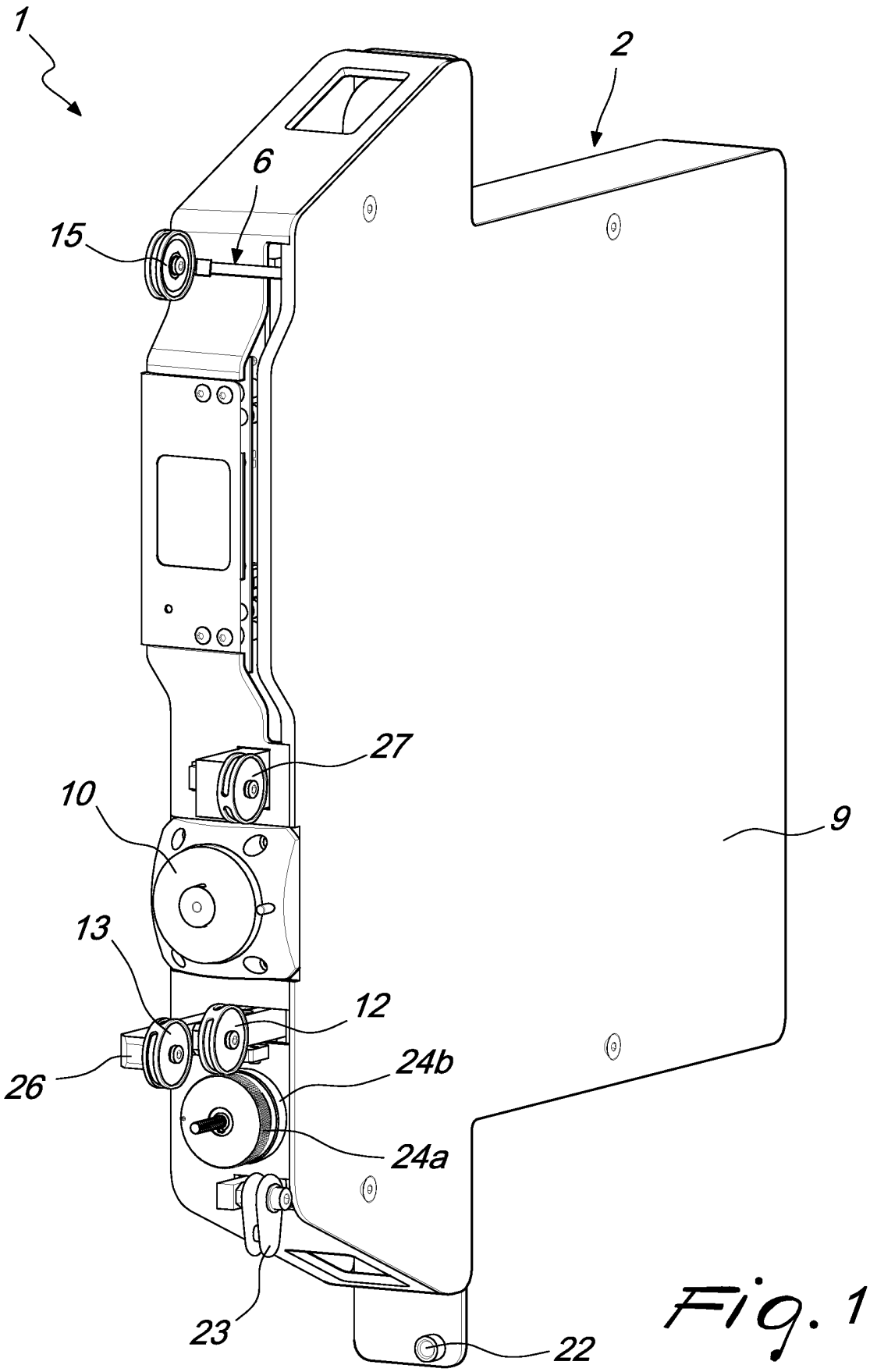

Fig. 1

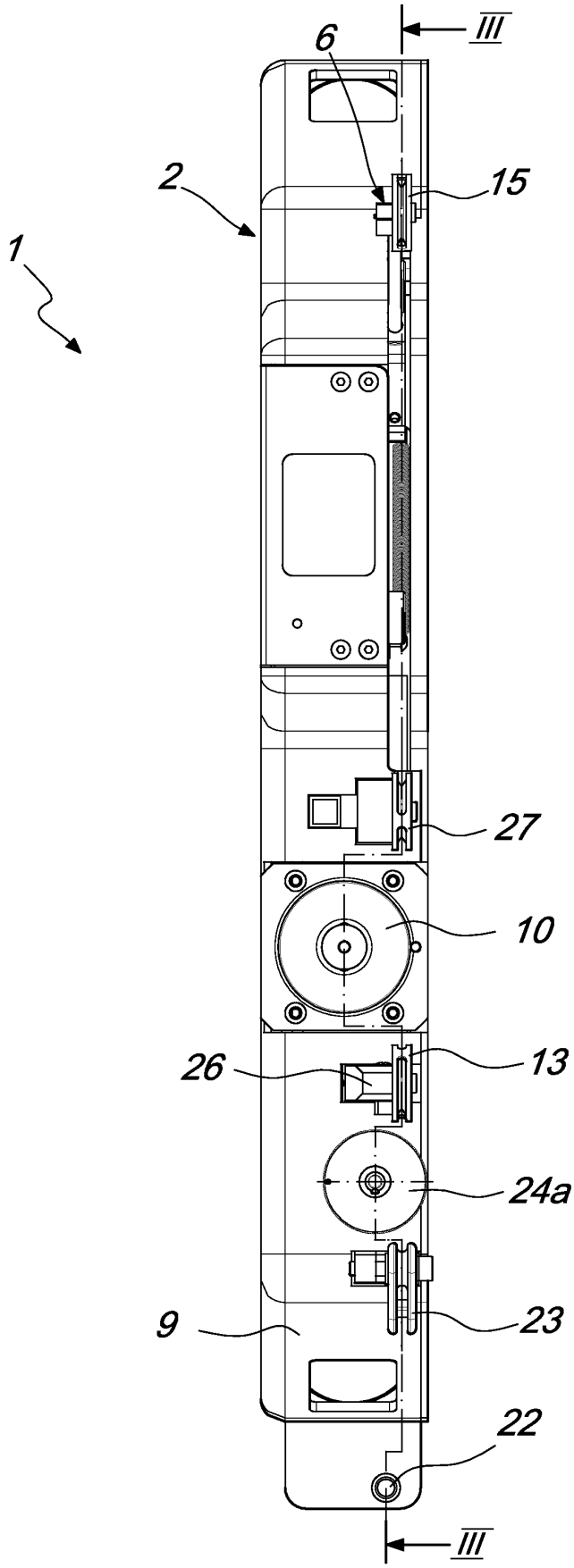

Fig. 2

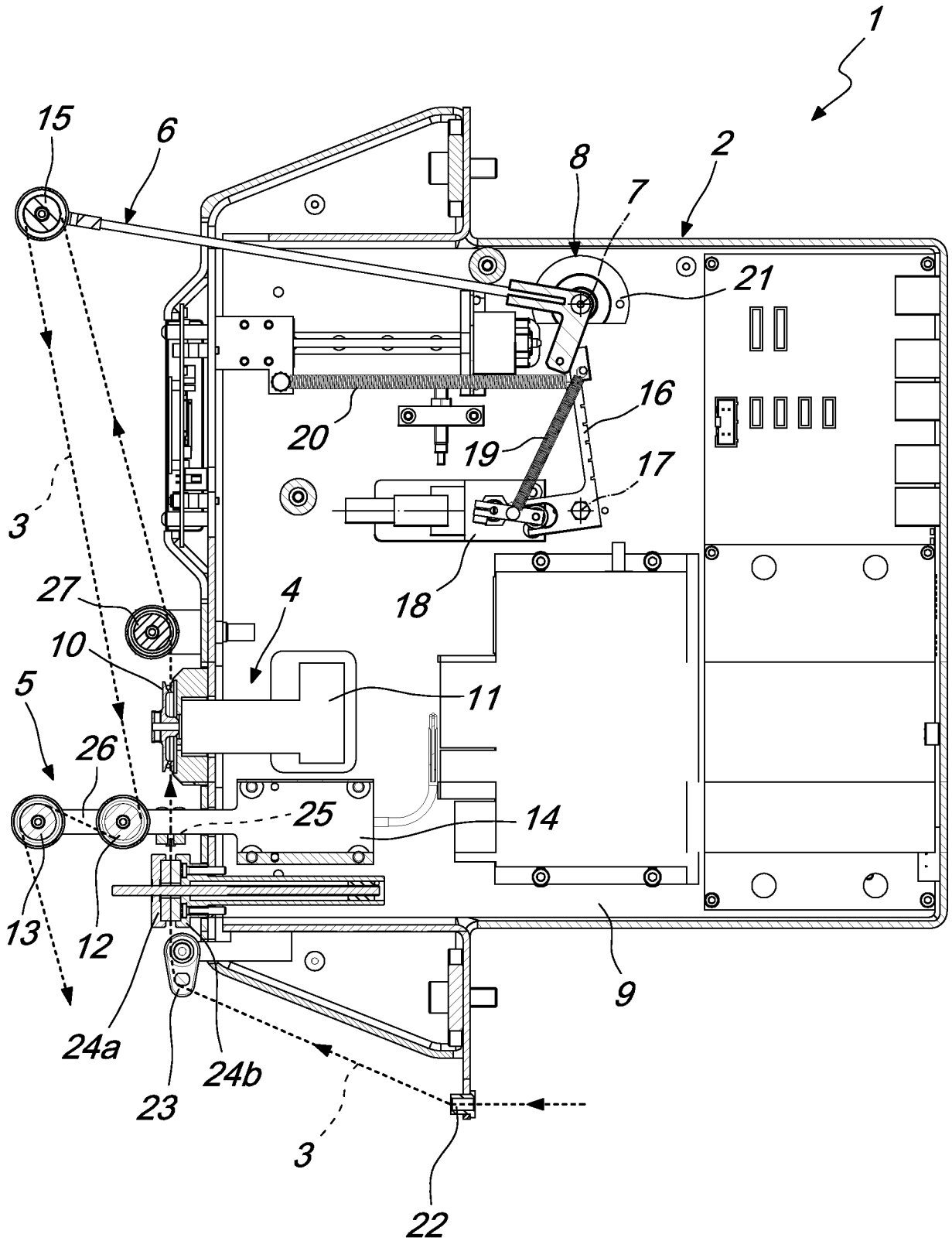
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Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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- EP 0424770 A2 **[0009]**