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(54) **Compensation device of the tension pulsations in four-for-one twisting spindles**

(57) Device for compensating the feed tension in four-for-one twisting spindles in which a doubled yarn is unwound from a rotating unwinder which rotates by following the unwinding of the feed yarn, in which the yarn re-ascends a re-ascending internal axial cavity in which a compensator device is inserted, which lengthens and shortens the run of the yarn at its interior as a function of its tension.

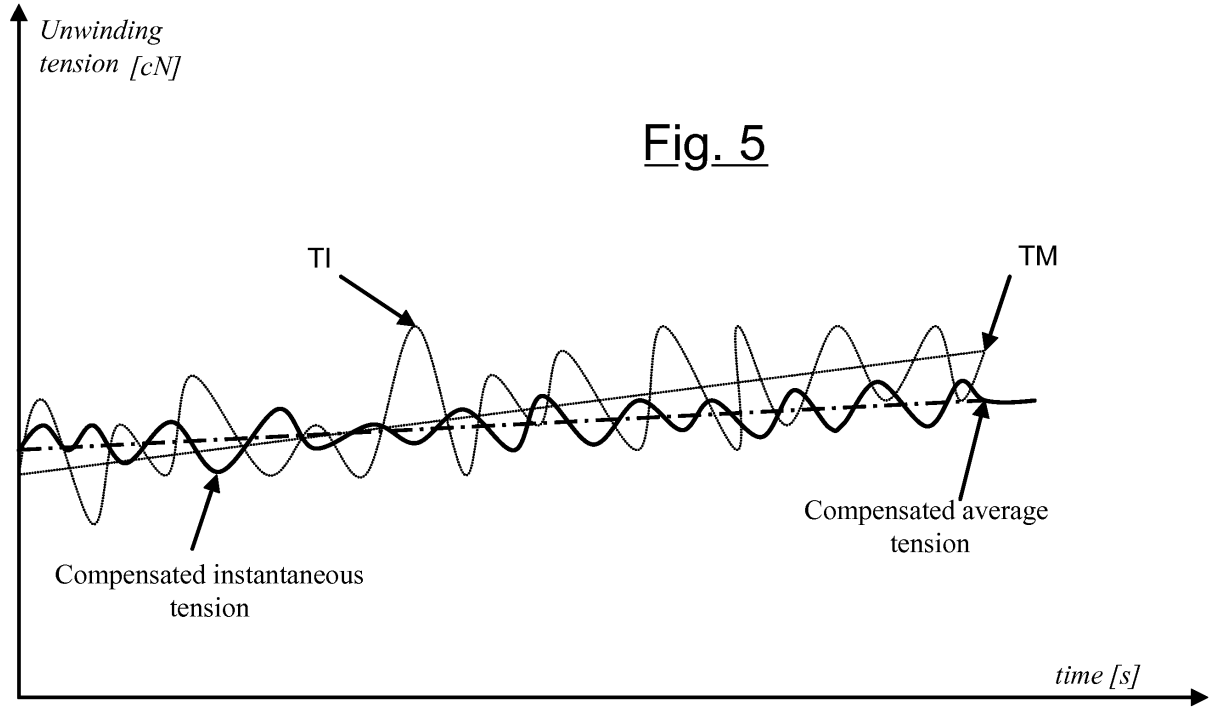

Fig. 5

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Description

[0001] The present invention refers to a four-for-one twisting spindle for twister machines and in particular to a device for regulating the tension in the feed yarn of a four-for-one twisting spindle.

[0002] In order to better clarify the technical problems involved and appreciate the technical solution according to the present invention, reference is made here to the four-for-one twisting spindle diagram reported in figure 1 and to its functioning illustrated with its exploded view reported in figure 2, as a non-limiting example. The four-for-one twisting spindle illustrated here mirrors the mechanical diagram of the apparatus according to the patent application EP 1.726.693 by the same applicant. Reference can also be made to the four-for-one twisting spindle diagram according to the patent EP 1.007.773. In such documents, greater details can be found on the functioning of such a device.

[0003] According to the diagram of figures 1 and 2, the twisting spindle for multiple twists of textile threads and yarns, comprises a basket support 10 for a feeding bobbin 11, which is maintained locked in place by using pairs of stationary magnets M, for example. Generally, the bobbin 11 is separately prepared with doubled yarns wound in a doubler machine on a package that is then brought to the twister.

[0004] The four-for-one twisting spindle also comprises two parts rotating in opposite directions, respectively an upper, more internal rotating part 15 and a lower rotating part 16, both arranged under the bobbin-holder basket 10, the rotating parts 15 and 16 being coaxial with each other and with respect to the spindle axis, and a transmission and unwinder element 20 arranged above the bobbin 11. The yarn F that is unwound from the bobbin first passes through an unwinder element 20, which terminates with the upper transmission element 21 arranged above the bobbin, then descends towards the internal, upper rotating part 15, defining an inner balloon B around the bobbin. It enters into said upper rotating part 15 with the radial duct 28, is deflected with the roller 29 and crosses an axial passage 30 made in said internal, upper rotating part 15. Once it reaches the exit of said passage 30, arranged on the spindle rotation axis, the yarn crosses a second transmission element 31, integral with the lower rotating part 16, and then a radial passage 32 made inside said lower rotating part 16; it exits from this and ascends, defining an outer balloon B', arriving at a final transmission 33. The yarn F is finally sent to collection means in an upper position, not shown in the figure for the sake of simplicity, which draw at constant and predetermined speed - and collect in packages - the yarn that was worked in the four-for-one twisting spindle. In the run that follows from the upper transmission 21 to the final transmission 33, the yarn receives two twists for every revolution of each of the two rotating parts.

[0005] The lower rotating part 16 is supported by a stationary bearing 14 that sustains the entire four-for-one twisting spindle and is driven by external motion transmission means, for example by means of a pulley 17 coaxial with the spindle which receives the rotary motion with a transmission belt, in turn transmitting the motion to the upper rotating part 15, for example through an epicycloidal transmission device 18, according to the mentioned patent application EP 1.726.693 by the same applicant, to which reference is made for more details. Such epicycloidal device 18 is contained within a fixed box part 19, also held locked in place with pairs of fixed magnets mounted on the bottom of the basket 10.

[0006] Above the feeding bobbin 11, an unwinder device 20 is comprised which receives the doubled yarn F from the bobbin 11. Such unwinder 20 is mounted on the inner shaft 13 of the basket 10 with the interposition of a rolling bearing 22. The entire unwinder 20 is placed in rotation by the same doubled yarn F which unwinds as a spiral from the bobbin 11, passes into the terminal ring of the rotating arm 23 and enters inside the axial cavity 24 of the unwinder 20 which re-ascends the unwinder itself up to the bell-shaped transmission 21 at its top. The linear unwinding speed is determined by the draw of the collection unit placed downstream, which also determines the hourly quantity of twisted yarn production.

[0007] A yarn tensioning element 25 is placed inside the cavity 24. In the diagram of figures 1 and 2 - and also in greater scale in the following figure 4 - this consists of an elastic piston 26 with a spring at its interior that presses the doubled yarn F against two annular seats 27 placed at the two upper and lower rounded ends of the piston 26 and which defines the axial direction run of the yarn F. Such tensioner 25 meets the need that both ends of the doubled yarn F arrive at the transmission 21 precisely parallel to each other and with a certain tension. In the undesired case that, in the preliminary doubling operation of the yarn F, one of the two ends results slack and in the twisting there is a slot of projecting yarn, this would be an unacceptable defect of the twisted yarn. The tensioner 25 is therefore an equaliser of the doubled yarn F in order to prevent going beyond a possible slack end present in the doubled yarns. One feature of the spindle consists of the fact that the yarn, for at least one part of its course, can form free balloons B and B' that are not externally delimited.

[0008] In order to better clarify the technical problems faced and resolved with the present invention, the twisting process is described with reference to figure 2 with regard to the actual speed during the spindle functioning.

[0009] The four-for-one twisting spindle receives its single drive from the axial shaft of the lower rotating part 16, for example by means of the pulley 17, and is driven for example at 10,000 rev/min. The epicycloidal transmission device 18 transmits the motion to the upper rotating part 15 with a speed of about 50%: the upper part rotates in turn, for example, at 5000 rev/min.

[0010] Since, as said above, during its run the yarn F receives two twists for every revolution of each of the two rotating parts, per every minute of work the doubled yarn

that passes receives 10,000 revolutions, twice, from the rotating part 16 and 5,000 revolutions, twice, from the rotating part 15, i.e. 30,000 rev/min in total. If a twisting of 600 twists per linear meter is required for the yarn F, it is thus possible to work 50 meters of yarn F per minute in the four-for-one twisting spindle, actuating the device downstream of collection with a draw of 50 m/min.

[0011] For the structure and functioning of the twister, most of the tensions on the yarn are due to the centrifugal force of the balloons of the yarn which rotates at high speed. The technical problem of balloon stability derives not so much from the value of the yarn tension but from its irregularity due to the unwinding of the yarn F from the feeding bobbin 11.

[0012] Due to the draw of the collection device that is downstream, from the terminal ring of the rotating arm 23, the yarn F is pulled away from the bobbin 11 locked in its basket, from which unwinding takes place at 50 metres per minute, for example. At the start of the bobbin, the 50 m/min correspond to about 100 spirals unwound per minute: the yarn F rotates slowly around the bobbin with spiral progression. The resistance to the unwinding and the corresponding tension of the yarn F varies depending on the drawing point of the yarn with a pulsation that corresponds to the bobbin 11 traversing: it goes from a minimum value when the yarn is drawn from the highest part of the bobbin to a maximum value when the yarn is drawn from the lower part of the bobbin 11. Such pulsation is due both to the variation of the yarn section length, which extends from the bobbin drawing point to the ring of the rotating arm 23, and to the greater or lesser friction that the yarn sliding on the bobbin encounters. The variation of the unwinding tension between the upper part and the lower part of the bobbin essentially depends on the fact that the yarn that is unwound in ascending or descending direction encounters different resistance from the adjoining spirals.

[0013] When the bobbin 11 is close to finishing, the aforesaid 50 m/min of linear speed correspond with 400 spirals unwound per minute (the limit value is 500-600): the yarn F rotates quickly around the bobbin 11, always with spiral progression and with analogous tension pulsation, and with greater frequency.

[0014] Due to the increasing speed rotation of the yarn F unwound from the bobbin 11, also the unwinder 20 that draws the yarn F is driven by the drawing of the yarn itself in a rotation that is slow at first, at a speed of a few dozen rev/min, up to a faster rotation at several hundred revolutions per minute when the bobbin is finishing. The unwinding resistance is progressively increasing due to the greater rotation speed to transmit to the unwound yarn spiral F that extends from the bobbin 11 to the unwinder 20.

[0015] Such driving in rotation is transmitted through the rotating arm 23. Due to the resisting tension pulsation of the yarn F, also the arm 23 and the entire unwinder 20 rotate at pulsating speed and give an amplifying effect of the resisting tension pulsation of the yarn F during its unwinding. The variation of the resistance of the doubled yarn F at the drawing in fact leads to a periodic offset between the angular coordinates of the drawing point, where it is separated from the bobbin, and the rotating arm 23. Since the free length of the yarn F varies periodically, extending from the drawing point on the bobbin to the terminal ring of the rotating arm 23 and from such ring the yarn is instead drawn at substantially constant speed, the pulsation of said free length leads to a pulsation of the angular drawing and pulling speed that is exerted by the arm 23 on the yarn. In the reversal points of the yarn F unwinding from the feeding bobbin 11, there are angular accelerations/decelerations of the unwinder arm 23 with respect to the drawing point of the yarn from its winding. The unwinder 20 has a certain inertia proportional to its weight and structure; it is driven in rotation by the yarn F drawn upward and that is unwound from the bobbin 11. When the drawing direction is reversed at the upper edge of the bobbin, the yarn F suddenly increases its unwinding resistance and the displacement angle between the arm 23 and the drawing point of the yarn increases: the unwinder 20 goes beyond the drawing point of the yarn and there is a positive tension peak due to the increase of angular displacement, followed by a certain release, i.e. a "negative" tension peak. On the other hand, when the drawing direction is reversed at the edge of the bobbin 11, the yarn F decreases its unwinding resistance and the displacement angle between the arm 23 and the drawing point of the yarn decreases: the unwinder 20 has a certain inertia, but it then adapts and in the transition there is a certain release of tension due to the reduction of angular displacement. In other words, when the yarn is more resistant, it is tauter and the angular displacement is greater. The longer the section of yarn F between the drawing point and the ring, the more the yarn encounters friction; when such yarn is shortened, it resists less and the opposite occurs.

[0016] At the outlet of the upper transmission 21 of the unwinder 20, the yarn F re-descends, forming the inner balloon B. The progression over time of the instantaneous tension of the yarn during its re-ascending run towards the upper transmission 21 is shown as an example in the solid line TI of figure 3, from the start to the end of the bobbin 11. The progression of the average tension of the yarn is instead shown in the dashed-dotted line TM. The instantaneous tension is irregularly pulsing and on average increasing from start to finish. Such overall tension is the resultant of all the forces and resistances offered by the yarn and by the system in motion from the drawing point up to the inlet of the radial duct 28.

[0017] Unlike the outer balloon B', the inner balloon B does not have a compensating pulley due to the space unavailability and system geometry. For the above reasons, the yarn of the inner balloon B naturally has a pulsating tension that causes instability of the balloon itself. For this reason, the inner balloon B continuously varies its shape and size. The tension of the inner balloon B can neither be too high nor too low. Overly low tensions

can cause interferences between the two balloons B and B', but the greatest danger lies in excess tension. Excess tension of the descending balloon B can reduce the winding of the reserve of the second balloon B' around the bowl-shaped surface 36 - which acts as a compensation pulley - bringing it to a condition of instability. Such excess can also diminish the radial size of the inner balloon B and cause the contact between the balloon itself, rotating at high speed, with the cylindrical surface of the fixed basket 10, with the consequent braking of the yarn. Upon contact, the yarn adheres to the basket and is wound thereon, being immediately torn.

[0018] The present invention is directed towards a new unwinder device for four-for-one twisting spindles that allows controlling the inner balloon B and regulating the yarn tension, overcoming the drawbacks described above. The present invention, in its most general meaning as unwinder device employed by a twister, is defined in the first claim. Its preferred variants or embodiments are defined in the dependent claims 2 - 5.

[0019] The characteristics and advantages of the unwinder according to the present invention will be clearer from the following exemplifying and non-limiting description referred to the attached schematic diagrams in which:

Figure 1 reports the scheme of the structure of a four-for-one twisting spindle,

Figure 2 reports its exploded view, illustrating its functioning,

Figure 3 shows the progression over time of the yarn tension in its re-ascending run towards the upper transmission in the spindles according to figures 1 and 2,

Figure 4 shows the scheme of the unwinder device according to the present invention,

Figure 5 shows the progression over time of the yarn tension in its re-ascending run towards the upper transmission with the unwinder illustrated in figure 4.

[0020] The characteristics and advantages of the present invention will be more evident from the description of an exemplifying but non limiting embodiment thereof illustrated in figure 4.

[0021] The unwinder device 50 is made according to the preceding description regarding its terminal parts, i.e. the arm 23, the internal axial cavity 24, the annular deflecting seats 27 and the upper bell-shaped transmission 21.

[0022] In the central part of the axial cavity 24, a compensator device 51 is inserted which permits lengthening and shortening the run of the yarn F as a function of its tension.

[0023] The compensator 51 consists of an L-shaped lever 52, centrally hinged with a horizontal-axis pin 53 inserted in the body 54 of the unwinder 50 which contains the axial cavity 24, and therefore capable of clockwise and anticlockwise movement in a vertical plane. In the upper end 55, the L-shaped lever 52 bears a transmission pulley 56 supported with the insertion of rolling bearing, for example a ball bearing. The yarn F slides on said pulley 56 with C-shaped progression, between the two seats 27 and the same pulley 56.

[0024] The opposite end 60 of the L-shaped lever 52 is abutted against an elastic resistance. In the embodiment of figure 4, the elastic resistance is composed of an elastic piston 61, consisting of two blind coaxial cylinders, penetrating each other, which internally bear a spring 62 that opposes their compression to shorten the piston itself. Said elastic piston 61 is achieved with a section adapted for being housed in a vertical cavity 63 with consistent section. Such cavity is integral with the body 54 of the unwinder 50 which contains the axial cavity 24 and is placed at 180° with respect to the pin 53.

[0025] At the bottom of such cavity 63, an adjustable counter-piece 64 is placed for determining the level of the elastic piston 61 that is abutted there. Above the upper part of the end 60, an analogous adjustable counter-piece 65 is placed for determining the level of the end stop of the pulley 56 towards the left, or rather the maximum length of the yarn F spiral deflected by the pulley itself.

[0026] In order to leave space for the travel of the compensator 51, in the embodiment of figure 4 the tensioning element 25 of the doubled yarn is arranged in the lower part of the cavity 24. As better illustrated in large scale in figure 4, it consists of an elastic piston 26 with a spring at its interior that presses, with its upper part, the doubled yarn F against the lower annular seat 27. The lower part of the elastic piston 26 is instead abutted against the horizontal arm 59 of the L-shaped lever 52. In such embodiment, the tensioning element 25 presses the yarn F less when it is already tauter and works more when the yarn F is looser.

[0027] During the unwinding of the bobbin 11, the pulsating progression of the unwinding tension was shown as an example in figure 3. With a tension increase, the yarn F tends to bring the pulley 56 and the arm 55 of the lever 52 to the axis of the cavity 24, shortening the run of the yarn and compensating for its tension. The lever 52 rotates in a clockwise direction. The opposite end 60 of the lever 52 tends to be lowered and to compress the spring 62, shortening the elastic piston 61. In addition to this, there is a decrease of the winding of the yarn F against the ceramic seats 27.

[0028] With a release of the yarn F tension, the spring 62 prevails and extends the elastic piston 61: the opposite end 60 is raised, the lever 52 rotates in an anticlockwise direction and tends to move the pulley 56 and the arm 55 away from the axis of the cavity 24, lengthening the run of the yarn and compensating for its tension. With the release of the tension, the winding of the yarn F around the ceramic seats 27 increases. The compensator 51 therefore also accomplishes the function of tensioner 25 of figures 1 and 2.

[0029] In figure 5, the effect is illustrated of the embod-

iment of the unwinder 50 with the compensator 51, illustrated with reference to figure 4; it is seen here how the tension irregularities of the unwound yarn F are clearly reduced with respect to those of the preceding figure 3, reported as reference with the lighter dotted line. The values of the compensated instantaneous tension are reported with the darker, solid line: they show clearly reduced pulsations and the compensated average tension values show a lower difference between the start and end of the bobbin 11.

[0030] With the unwinder according to the present invention, the values of the compensated instantaneous tension shown with the darker line show clearly reduced pulsations, generally passing from an amplitude of 40% with respect to the average value to an amplitude pulsation of around 15%.

[0031] The more regular progression of the unwinding tension allows the balloon B to assume a more regular progression, far from the basket. The compensator 51 can be easily regulated, both regarding angular travels of the arm 55 and pulley 56, by adjusting the end stops 64,65, and also regarding the opposing action of the piston 61, by modifying the thrust of the spring 62.

Claims

1. Device for compensating and regulating the feed tension in four-for-one twisting spindles in which a doubled feed yarn (F) of the four-for-one twisting spindle (10) is unwound from a fixed feeding bobbin (11) by means of a rotating unwinder (50) provided with a radial arm (23) and which rotates by following the unwinding of the feed yarn, **characterised in that** the rotating unwinder (50) has an inner axial cavity (24) for the re-ascending of the yarn (F) which comes from the terminal ring of the rotating arm (23), follows said cavity up to a bell-shaped deflecting and transmission element (21), from which the inner balloon (B) of the four-for-one twisting spindle (10) has its beginning, and **in that** in the central part of the axial cavity (24), a compensator device (51) is inserted which allows lengthening and shortening the run of the yarn F at its interior as a function of its tension.

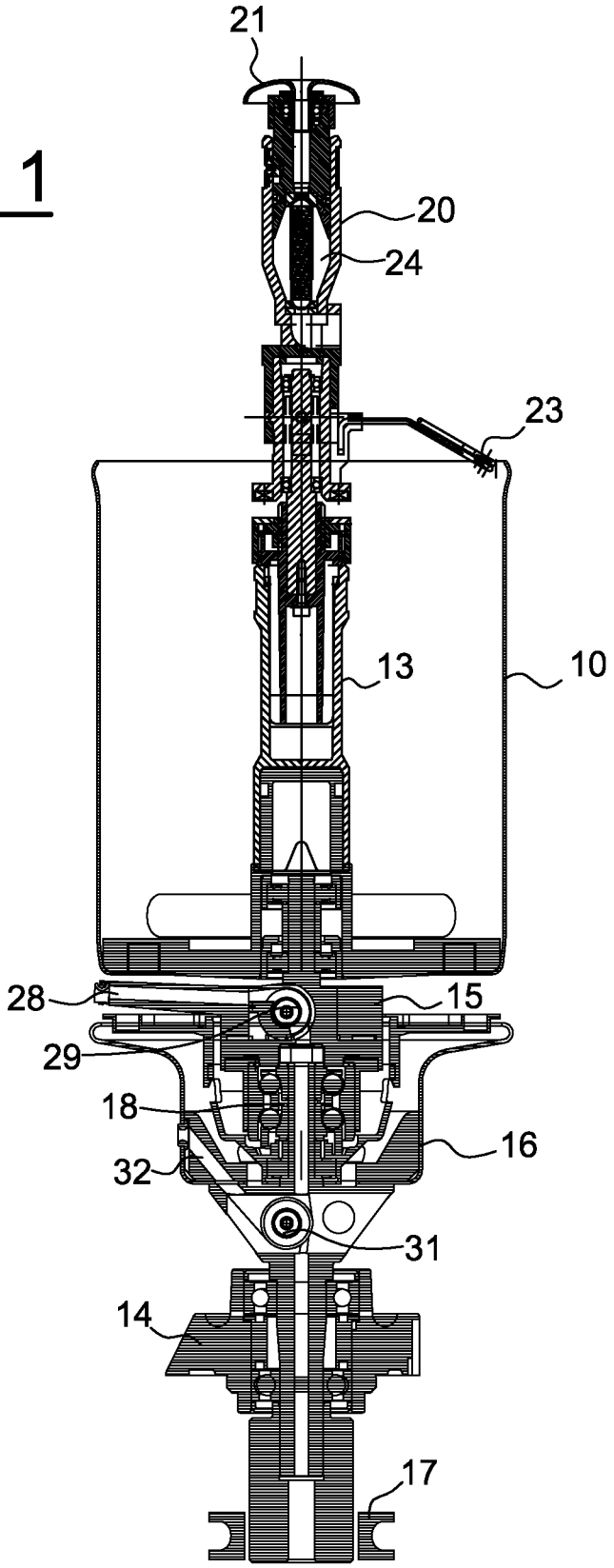
2. Device for compensating and regulating the feed tension in four-for-one twisting spindles according to claim 1, **characterised in that** the compensator (51) consists of an L-shaped lever (52), centrally hinged with a horizontal-axis pin (53) and which bears, in its upper end (55), a transmission pulley (56) on which the yarn (F) slides with C-shaped progression between two axial seats (27) and the same pulley (56).

3. Device for compensating and regulating the feed tension in four-for-one twisting spindles according to claim 2, **characterised in that** the end (60) opposite the end (55) of the L-shaped lever (52) is abutted against an elastic resistance.

4. Device for compensating and regulating the feed tension in four-for-one twisting spindles according to claim 3, **characterised in that** the elastic resistance is composed of an elastic piston (61), which contains a spring (62) which opposes its compression to shorten the piston itself.

5. Device for compensating and regulating the feed tension in four-for-one twisting spindles according to claim 3, **characterised in that** the elastic piston (61) is mounted with an adjustable counter-piece (64) for determining the level on which it is abutted and that above the upper part of the end (60) an analogous adjustable counter-piece (65) is placed for determining the level of the pulley (56) end stop, or rather the maximum length of the yarn F spiral deflected by the pulley itself.

Fig. 1



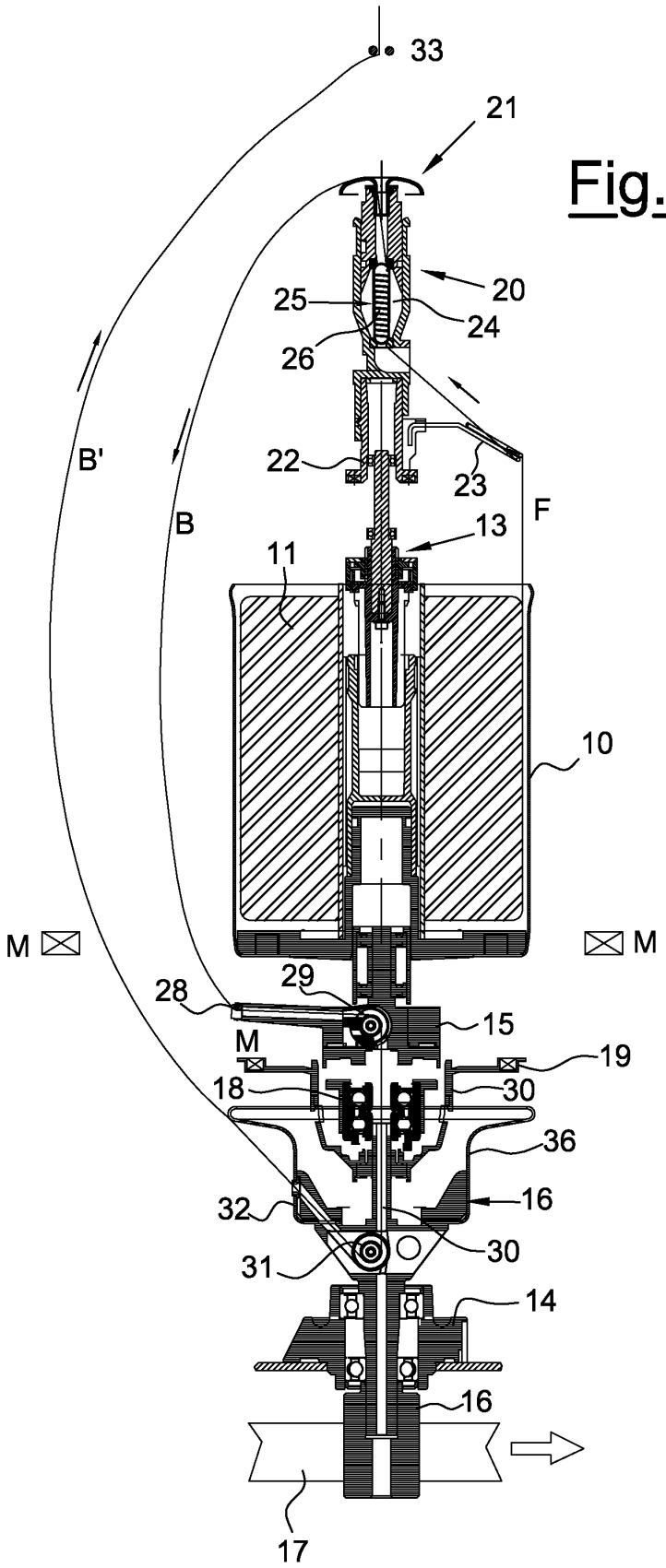

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Fig. 2

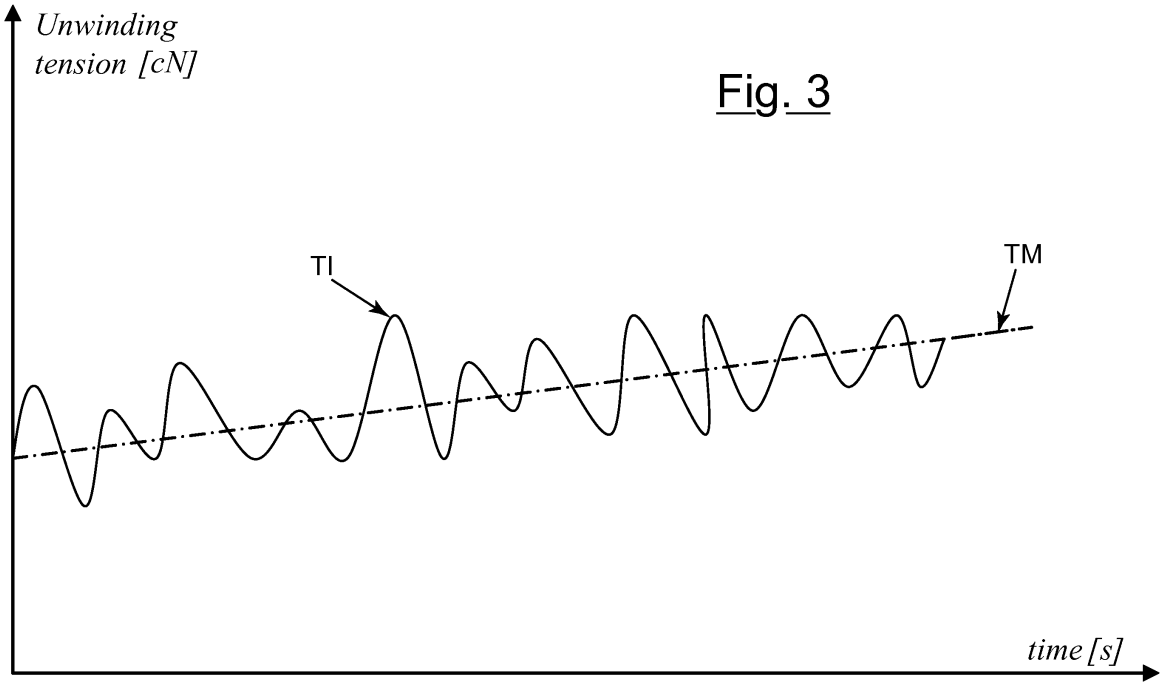
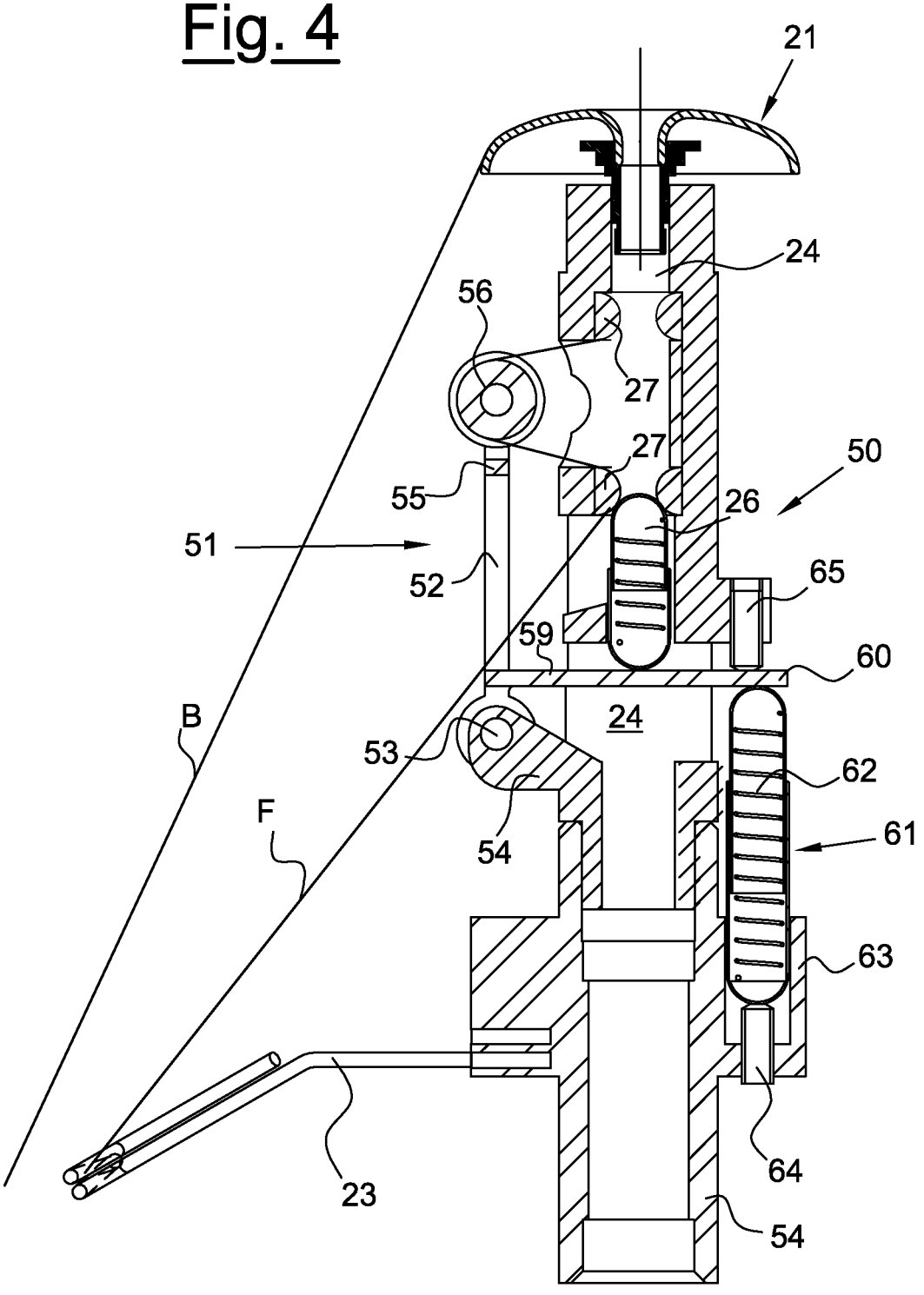


Fig. 3

Fig. 4



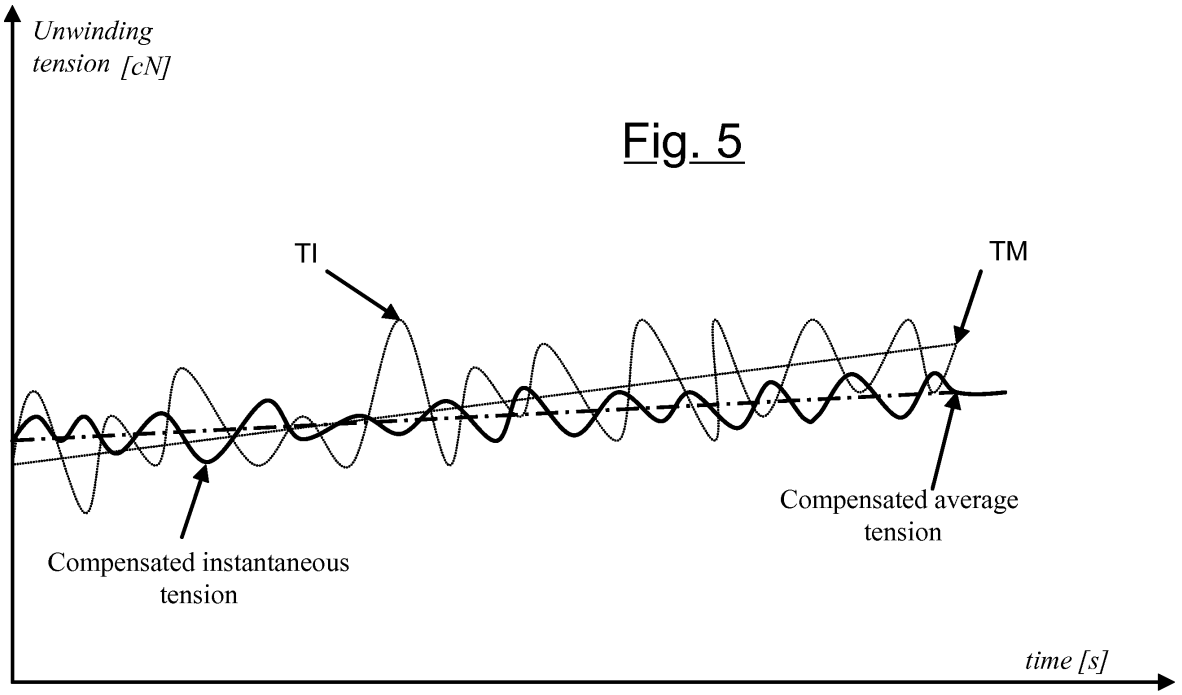

Unwinding
tension [cN]
TI
TM
Compensated instantaneous
tension
Compensated average
tension
time [s]

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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- EP 1007773 A **[0002]**