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(54) **Self-adjusting thread tensioning device for winding yarns**

(57) Device for tensioning a winding thread (2) in textile machines comprising a plurality of stationary deviator elements (22, 54) and a plurality of displaceable deviator elements (27, 47) arranged like a comb facing one another in a staggered and opposed manner so as to form a tortuous path for the thread that passes through the device, in which such deviator elements are provided with

sliding elements (38) elastically contrasted to move forth and back against the thread, each sliding element (38) being capable of moving independently from each other, in which the tortuousness of the path is adjusted with a mobile device (26) that modulates the load of the elastic elements (39, 49) working in contact with the thread, to obtain the desired tension in the thread in outlet from the thread tensioning device.

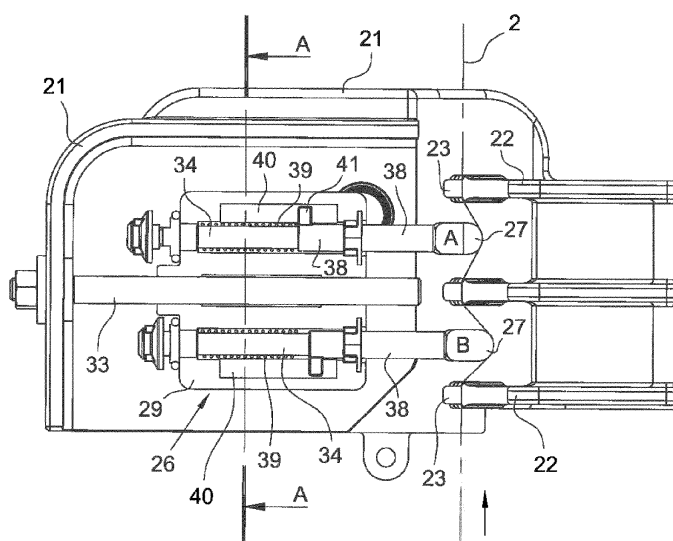


Fig. 2A

Description

[0001] The present invention refers to a device for inducing and adjusting the tension, known as tensioning, of a winding thread in textile machines.

[0002] The need to adjust the tension of the winding thread is common to many processes for producing and finishing yarns in the textile industry, however, in order to make both the technical problems tackled and solved by the present invention and its characteristics and advantages with respect to the prior art clearer, the present invention is described hereafter with reference to the spooling process carried out in a spooler in which the thread being processed is unwound from a spool and rewound in a package. As known, the spooler consists of a plurality of spooling units aligned along the front of the machine and provided with common control and service apparatuses.

[0003] The spooling unit is illustrated in its essential components in figure 1, omitting those not directly involved in the technical solution that constitutes the present invention. The feeding spool 1 is unwound by picking up its thread 2, which unwinds by quickly rotating forming a balloon 3: such a balloon increases its size as the unwinding proceeds. Such an increased size depends on the length of the free portion of the thread 2 from the pick-up point from the spool to the unwinding group 4, which comprises guide members of the thread and a sensor or detector of the presence of the thread, and then to the thread tensioning device 6, which induces an adjusted tension in the thread.

[0004] Along the path of the thread from the bottom upwards, after the thread tensioning device 6 the device 7 for joining the ends, known as splicer, is placed, to which the ends of the interrupted thread to be joined is brought, when interruptions of the thread occur, due to its breaking or due to intervention of the yarn clearer 10 that is located immediately downstream of the splicer 7. Downstream of the yarn clearer 10 a tension sensor 13 of the thread is placed. The purified thread is collected in the package 11, which is set in rotation by the roller 12, actuated at predetermined and substantially constant speed, on which the package rests supported with a package-holder arm 17. The rotating package 11 attracts the thread 2, unwinding it at high speed from the spool 1 kept immobile on a positioning pin 15.

[0005] The splicer 7 is served by suction mouths 8,9 that pick up the ends of the interrupted thread: a mouth 8 on the side of the package above (shown in its extreme positions, one lower with a full line and the other upper with a broken line) and another mouth 9 on the side of the spool that moves in rotation according to the arrow 16. Such mouths pick up the ends of the interrupted thread 2 and send them to the splicer 7 to re-establish the continuity of the winding thread 2.

[0006] The operation of the spooling unit is controlled by a control unit, not shown in the figures for the sake of simplicity, which receives the values of the tension of the

thread from the sensor 13 and that comprises, among its functions, also the command and control programme of the thread tensioning device 6 both during winding and during interrupted winding interventions for service interventions.

[0007] The density of the winding and the good shape of the package is then influenced by the tension of the winding thread. Such a tension is determined both by the winding speed and by the action of the thread tensioning device placed on the path of the thread between spool 1 and yarn clearer 10. According to the type of yarn and what the packages are intended for, the tension required for the thread that comes to wind on the package can be different, for example: with constant tension for normal packages, with substantially higher tension at the start of the package and then decreasing for elasticized yarns, with low and constant tension for dyeing packages.

[0008] Even if the roller 12 rotates at constant speed, through the effect of the geometry of the system for collecting on the package 11, the yarn is worked with significant pulsations of the return speed, especially when the yarn is wound in conical form on a conical tube. The cause of the pulsation of speed of the collection on a conical package derives essentially from different circumstances.

[0009] A first circumstance is the traverse, in other words the oscillatory distribution of the yarn on the package in formation, made through a thread-guide means with excursion between the two extremes of the winding. In spoolers, the thread-guide means generally consists of a helical groove formed on the actuation cylinder 12. Such an excursion periodically lengthens and shortens the length of the portion of thread that oscillates from the last transversal constraint up to the thread guide. It is at its minimum when the thread guide places the thread in the middle of the package and is at the half-stroke, and at its maximum when the thread guide deposits the thread at the two bases of the package and is at the extremes of its stroke. This periodic variation in length of the path of the thread thus translates into a first pulsation of the return speed of the thread: at each moment from the spool 1 the length of thread is returned which corresponds to the length of thread wound on the package increased or decreased by the periodic variation in length - positive and negative - of the path of the thread between spool and package, also taking into account that the thread 2 unwinds from the spool at pulsating height, apart from the possible irregular progression for the release of coils that are not unwound. According to the level of the detachment point of the thread from the spool, the size of the balloon 3 varies correspondingly and thus the tension that is generated on the thread varies by effect of the centrifugal force, which also has a pulsating progression that increases as the unwinding proceeds from the start to the end of the spool.

[0010] The unwinding tension of the spool 1 thus has a long period variation (of the order of a minute) from the start to the end of the spool and a short period variation

corresponding to the unwinding of a needled product with a frequency of the order of 3-7 Hz, which corresponds to the periodic excursions of the ring rail of the ring frame, to continuously lift and lower the rings to distribute the yarn 10 on the tube of every twinding spool.

[0011] A second circumstance, on the other hand, derives from the conicity of the package. In general, the conicity of the tubes is not very accentuated, but at the current winding speeds the consequent pulsations in return speed are not at all negligible. When the thread is wound in the part with greater diameter - known as the bottom of the package - it is pulled back at a higher speed and it is thus subjected to a higher tension. When, on the other hand, the thread is wound in the part with lesser diameter - known as the tip of the package - the opposite situation occurs, the thread is pulled back at a lower speed and is less taut.

[0012] The progression of the pulsations in speed and tension of the thread in the path from spool 1 to package 11 overall has a frequency in the range of 3-30 Hz.

[0013] A third circumstance, on the other hand, derives from the fact that the yarn is subject to significant variations in hairiness and friction coefficient, both in the spool itself (in general, from the start to the end of the spool, there is a different hairiness due to the variations in length of the spinning balloon), and between spool and spool due to the greater or lesser wear of the components of the spinning spindle.

[0014] The thread tensioning device 6, which is interposed on the path of the thread 2 between the spool 1 and the package 11, thus has the function of adjusting and compensating such variations in the return speed and in the tension of the winding thread, as well as of damping the possible vibrations due to the unwinding of the thread 2 from the spool 1. For these thread tensioning devices, the smaller the mobile contrast mass to the pulsation the greater the sensitivity of the adjustment and the control of the tension.

[0015] In general, in the prior art two types of thread tensioning device are used: the thread tensioning device with opposing discs to compress and brake the thread, without modifying its path, and the thread tensioning device with deflectors of the path of the thread, which brake the thread modifying its path to make it more or less tortuous. For example, patent EP 734.990 B1 to the Applicant describes a thread tensioning device with magnetic actuation discs, whereas EP 1.975.105 A2 to Murata describes a thread tensioning device with a plurality of pairs of discs with spring pressure. The thread tensioning devices with discs are able to effectively control tensions above 0.2-0.3 N, whereas for tensions below this value the thread tensioning devices with discs are imprecise and not very reliable.

[0016] In thread tensioning devices with discs, the discs are always almost in contact, since they are only distanced by the amount due to the thickness of the thread in transit and its defects. The tension conferred on the thread is equal to that of the entering thread in-

creased by the friction force generated on the thread by the pressure of the discs.

[0017] In thread tensioning devices with deflection of the path of the thread, the structure of the thread tensioning device consists of a plurality of deviators arranged like a comb or like a staggered rake to interpenetrate one another; such deviators draw near to each other and separate from each other integrally upon command, increasing or decreasing the tortuousness of the path and the resistance of the frictions induced on the thread. In general the thread tensioning devices with deflection according to the prior art have substantial drawbacks.

[0018] For example, patents US 5, 499, 772 and US 5, 738, 295 describe thread tensioning devices that control the adjustment with the excitation of a solenoid, whereas patent IT 1.276.819 describes their control through a pneumatic device. They require substantial mobile masses and, consequently, they are able to determine the tension imparted on the thread but they are not able to follow and dampen the pulsations in speed and tension at the frequencies quoted above.

[0019] Alternatively, the additional tension imparted with the thread tensioning device can be varied as the spool runs out, in a way set in advance.

[0020] Normally, with thread tensioning devices with a deflector that provide a controllable actuator, like pneumatic cylinders or excitable solenoids, it is possible to follow the evolution of the unwinding of the spool by imparting a command such as to obtain the average overall tension with a predetermined progression and measuring a posteriori the average tension of the thread that arrives at the package, for example through the sensor 13.

[0021] In other types of tensioning device with deflection that use fixed and mobile deviators, there is no possibility of adjusting the tension induced during the unwinding of the spool and the formation of the package, not even providing for the measurement of the tension of the thread in outlet.

[0022] Patent GB 315.429 describes a thread tensioning device with deflection comprising a series of fixed elements and a series of mobile elements that are staggered with respect to one another. The mobile elements are yielding and sprung independently and adapt to the passage of the thread. The pressure of the fixed series with respect to the mobile series is determined through weights and relays, but it is not in any way adjustable. The thread tensioning device assumes a configuration dependent on the yield of the thread in transit and cannot undergo any adjustment. In this thread tensioning device the configuration of the thread tensioning device and the tension exerted on the thread are not in any way adjustable, once the weight and the relays have been selected and installed. In utility models JP 51 17547 and JP 51 30235 the deviator elements consist of eyelets in which the thread is slotted, which make their use problematic in a normal automatic winding machine. Utility model JP 51 17547 describes a thread tensioning device with deflection comprising a series of fixed eyelets and a series

of mobile eyelets staggered with respect to one another supported and contrasted by independent springs. These elements are arranged on two bars that are angled with respect to one another with variable openings. Utility model JP 51 30235 describes a thread tensioning device of the same type, but with the independent springs arranged on both bars. The angle between the two bars is opened more or less by means of torsion springs. In these thread tensioning devices the configuration of the thread tensioning device and the tension exerted on the thread are not in any way adjustable, once the springs have been selected and installed.

[0023] The present invention is directed to a new thread tensioning device to the service of the spooler, and of the winding machines in general, which overcomes the drawbacks described up to now of the thread tensioning devices according to the prior art. The present invention, in its most general use as a thread tensioning device for winding yarns, and in particular for spooling units that make up the spooler is defined in the first claim. Its variants are defined in dependent claims 2 to 16.

[0024] The characteristics and advantages of the thread tensioning device according to the present invention are clearer from the description of a typical embodiment thereof, given as an example but not for limiting purposes, illustrated in figures 1 to 4.

[0025] Figure 1 schematically illustrates the side view of a spooling unit and is illustrative of the technical problem. Figures 2A-C illustrate the scheme of the thread tensioning device according to the present invention inserted in a spooling station. Figure 2A shows a front view of the device whereas figure 2B shows its section according to A-A. Figure 2C shows the device in axonometric view in greater detail.

[0026] The idea for a technical solution according to the present invention can be alternatively made according to the scheme of the structure shown in figure 3, which is equivalent to that according to figure 2.

[0027] Figure 4 is exemplificative of the idea for a solution that determines the operation of the thread tensioning device according to the present invention.

[0028] The device according to the present invention essentially consists of a thread tensioning device with deflection of the path of the thread, with a comb tensioning device having a plurality of stationary deviator elements and a plurality of displaceable deviator elements, in which said deviator elements are arranged facing each other in a staggered and opposed manner to form a tortuous path for the thread 2 that passes through it.

[0029] According to an embodiment, the displaceable deviator elements are placed on board of a mobile device provided with an actuation to modify the tortuousness of the path of the thread 2 and to vary its induced tension. In the technical solution shown in figures 2A-C, the thread tensioning device comprises a support structure 21 that is fixed to the frame of the spooling unit. On the right inner part of the support 21 a plurality of fixed deviator elements 22 is arranged projecting inwards and distributed accord-

ing to the rise vertical of the thread 2. Said fixed deviators 22 are provided with an end part 23 with a guiding concave part of the thread 2, preferably made from a low friction and wear-resistant material. Inside the guiding part there can be an idle roller 24 to decrease the sliding of the thread 2.

[0030] On the left inner part of the support 21 the mobile device 26 of the thread tensioning device is arranged which supports a plurality of displaceable deviators 27 projecting inwards and distributed according to the rise vertical of the thread 2 to move horizontally to enter the vertical intervals between the fixed deviators 22, to deviate the thread 2 and to modify the tortuousness of its path.

[0031] The mobile device 26 is moved horizontally through a plate 29 moved, to advance towards the right or move back towards the left, by an actuator 30 controlled by the control unit of the spooling unit.

[0032] According to the present invention the actuator 30 is made through an electric motor driven in frequency by the control unit of the spooling station; a preferred embodiment of the present invention provides for the use of a stepper motor. Such a type of actuator determines the degree of tortuousness of the path, but it does not directly induce tension in the thread unlike actuators described in the prior art documents already quoted, that directly determine the pressure on the thread. According to the present invention, the mobile device 26 is actuated by an actuating actuator 30 driven by a control unit of the spooling station that receives the signals of the tension sensor 13 measuring tension of the thread. Said actuating actuator 30, in view of the signal of said tension sensor 13, modulates the degree of compression of the springs 39 working in contact with the thread 2, to obtain the desired tension in the thread in outlet from the thread tensioning device.

[0033] Thanks to the actuating actuator 30, it is possible to modulate the degree of compression of the springs continuously, in other words during the working of the device, in order to continuously change said degree of compression in light of the actual tension of the thread varying during the functioning of the device.

[0034] According to a possible embodiment, the tension sensor 13 is arranged downstream of the thread tensioning device. It is also possible to arrange the tension sensor 13 downstream and/or upstream of the thread tensioning device. If more than one tension sensor 13 is provided, the signals of each tension sensor 13 are sent to the actuating actuator 30 by means of the control unit.

[0035] According to an embodiment, the actuating actuator 30 regulates the pre-load of the springs 39,49 by acting on pre-load means which modify the pre-load of the springs 39,49 themselves.

[0036] According to an embodiment, the actuating actuator 30 regulates the pre-load of the springs 39,49 by moving the displaceable deviator elements 27,47.

[0037] According to an embodiment, at least one of the

pluralities of deviator elements 22,54;27,47 is placed on a plurality of elements 38,51, sliding with respect to guide bars 34,52 so as to move forth and back due to the effect of the tension of the deviated thread 2 and of the contrast of the opposing springs 39,49.

[0038] According to an embodiment, at least one of the pluralities of deviator elements 22,54;27,47 is placed on a plurality of elements 38,51, rotating with respect to hinges so as to rotate due to the effect of the tension of the deviated thread 2 and of the contrast of the opposing springs 39,49.

[0039] According to an embodiment, the actuating actuator 30 comprises hydraulic and/or pneumatic actuators.

[0040] According to another embodiment, such an actuator 30 comprises a stepper motor 31 which, for example, is driven in frequency by said control unit to carry out a controlled rotation, combined with a motion converter 32. In the actuator 30, the controlled rotation of the motor 31 is converted into horizontal linear displacement through a converter 32, for example through a rack or through a screw/mother screw system, which makes the mobile device 26 move forth and back with respect to the fixed deviators 22, moving its plate 29 with respect to one or more guides 33 fixed to the support 21. In figure 2B, the element 32 shows a gear of the motor that engages with a rack integral with the plate 29 and moves it forth and back.

[0041] The mobile device 26 is alternatively moved horizontally into two positions, of rest or work respectively.

[0042] The stepper motor 31 works just during displacements.

[0043] The first position is that of the mobile device 26 completely moved back and without deviation of the thread from the straight path, to leave the path of the thread completely free when winding is not in progress, for example when the joining of the thread is carried out. During such an operation, the mouth 9 on the side of the spool, which moves in rotation according to the arrow 16, reinserts the end of the interrupted thread in the thread tensioning device 6.

[0044] The second position is shown in figure 2A and is that of the mobile device 26 advanced in working position to create tortuousness in the path of the thread when winding is in progress.

[0045] The mobile device 26 supports, in its left part, two or more guide bars 34, mounted on a mobile plate 29 and distributed according to the vertical to enter between the intervals of the fixed deviators 22. On the right end of the pairs of guide bars 34 sliding elements 38 are arranged, provided with cylindrical cavities inside them corresponding to the bars 34. The sliding elements 38 are slotted on the outside of the bars 34 and are contrasted by small springs 39 that rest at the left on the plate 29. The sliding elements 38 end with the deviators 27 and can move forth and back due to the effect of the tension of the deviated thread 2 and of the contrast of

the opposing springs 39.

[0046] The forth and back sliding of the sliding elements 38 is guided through cavities 40, made in the plate 29, in which the projections 41 of the elements 38 slide, of size corresponding to the cavities 40, so that the deviators 27 cannot rotate, but can only slide.

[0047] The end deviators 27 of the elements 38 are also provided with a guiding concave end part of the thread 2, preferably made from wear-resistant and low-friction material, for example ceramic.

[0048] In order to understand the structure and the operation of the device according to the invention it is useful to consider the behaviour of the thread that slides by winding on a deviator element illustrated in figure 4. The thread 2 moving from the bottom upwards, having its entry tension τ_i , is deviated by the deviator element 27. Its tension is amplified exponentially by the amount $e(\alpha f)$ until it reaches the outlet tension τ_u that equals $\tau_i \times e(\alpha f)$. Such an amplifying effect depends both on the winding angle α and on the friction f that in turn depends on the speed and hairiness. The deviated thread 2 exerts a horizontal force F deriving from the composition of the two entry and exit tensions onto the deviator 27:

[0049]

$$F = \tau_i (e(\alpha f) + 1) \sin \alpha/2$$

[0050] The element 27 receives the transversal thrust F that tends to move it towards the left and to compress the contrast spring 39 that, in turn, rests on the plate 29. As τ_i increases, the force F increases and the deviator 27 is thrust towards the left, increasing the compression of the spring 39. Vice-versa, as τ_i decreases, the force F decreases and the deviator 27 is thrust towards the right, releasing the compression of the spring 39. The tension of the thread tends to make its path less tortuous, whereas the reaction of the spring tends to make it more tortuous. Taking into account the fact that the reaction of the spring 39 increases directly with its deformation and that the force F decreases with the decrease in the angle α the two forces necessarily balance each other out in an intermediate situation. The more the spring 39 is compressed, the more the thread 2 is tightened and vice-versa.

[0051] The idea for a solution forming the basis of the present invention is therefore based on the modulation of the load or the degree of compression of the springs 39, also called pre-load, working in contact with the thread 2. In the embodiment according to figure 2 such modulation is obtained with the modification of the transversal coordinate of the resting of the springs 39 on the plate 29, modifying the relative position of the mobile device and making the springs 39 work with different degrees of compression, thus determining a variation of their reaction or counter-thrust that permits to vary the tension induced on the thread by the deviation. When

the spring 39 is made to work under conditions that on average are more relaxed, the tension induced on the thread is less. When the spring 39 is made to work on average more compressed, the thread receives a higher tension.

[0052] In other words, having an excursion range of the spring, the idea for a solution forming the basis of the present invention of modulating the load of the springs 39 takes advantage of the provision of making the spring work in the specific portion of this range that generates the required counter-thrust, more or less high according to how the thread tensioning device must amplify, by more or less, the tension of the thread that arrives from the bottom to obtain the desired tension in the thread in outlet from the top.

[0053] Of course, the regulation of the preload of the springs, can be made not only by moving the mobile device, but also by regulating the pre-load means of the springs themselves. For example, the pre-load means can comprise bushings that can be moved, for example rotated, in order to modify the length or inclination at rest of the spring. In other words, if the spring is precompressed, the pre-load increase and the spring does not compress any more until the load externally acting on the spring does not overcome said pre-load.

[0054] Of course if the spring is a linear spring it can compress or extend along a linear direction; anyway it is possible to use torsion springs, laminar or deflection springs and so on.

[0055] Therefore, it is also possible to modify the pre-load of the springs without moving the mobile device and/or deviators.

[0056] Taking into account that it is not possible to predict the multiplying effect of the tension that occurs in the deviations that follow, since each deviation has an effect that is independent from the other, the present invention intends to adjust the relative position of the two fixed and mobile devices based on the tension value detected by means of the sensor 13 of the thread tensioning device which is, for example positioned downstream the tensioning device.

[0057] We will now describe the operation of the device of figures 2A-C. As stated, the device is able to take up two positions: a first position or rest position, in which the motor 31 moves back the plate 29 to its left end stroke leaving the path of the thread free, and a second working position, in which the motor 31 makes the plate advance to the right and against the thread 2, so that the deviators 27 cooperate with the fixed deviators 22 to induce a tortuous path in the thread 2, as shown in figure 2A. As a function of the degree of advancing of the second position, the path of the thread 2 is more or less tortuous and the average tension induced in the thread is substantially constant. The degree of advancing of the plate 29 controlled through the motor 31 constitutes the roughest calibration and thus induces an average tension in analogy with that generated through the thread tensioning devices according to the prior art.

[0058] As already stated, from the start to the end of the spool, the size of the balloon 3 in rotation increases and its tension varies with its centrifugal force: from the start to the end of the unwinding of the spool 2 the tension τ_i of the thread 1 that comes from the spool increases significantly. Consequently, if it is required for the tension of the exiting thread to have a certain value, the increase in the tension induced in the thread tensioning device must necessarily be decreased.

[0059] The variation of the configuration of the thread tensioning device is determined by the control unit of the spooling unit that receives the signals of the tension sensor 13 and that knows the degree of advancing of the package 11 and of depletion of the spool 1, to determine the desired tension in outlet from the thread tensioning device. Equally, in the control unit the desired tension values are set for the thread that reaches the package.

[0060] Advantageously, during the course of the unwinding of a spool 1, the degree of advancing of the plate 29 can be varied at discrete intervals according to the degree of depletion of the spool. In the path of the thread illustrated with reference to figure 1, the average tension of the thread is detected through the sensor 13. As a consequence of such detection, when the average tension in the thread exiting from the thread tensioning device is detected to be growing and beyond a predetermined value, the working position of the mobile plate 29 can be advantageously varied at discrete intervals to reduce the tortuousness of the path of the thread 2 and to take the average tension of the thread back within the preset limits. In the period between two interventions of variation of the degree of advancing of the plate 29, the only moving parts of the thread tensioning device are the deviators 27.

[0061] A peculiar characteristic of the present invention lies in the second self-adjustment, finer and more sensitive, which is made through the mobile deviators that move by sliding independently from one another with respect to the plate 29.

[0062] In figures 2A-C the elastic abutment with the springs 39 opposing the end deviators 27 - for damping the pulsations of tension - is positioned on the mobile device 26 of the device, brought to working to the working position by means of the motor 31.

[0063] The idea for a technical solution according to the present invention can be carried out in an equivalent manner with the structure shown in figure 3, in which, on the other hand, the elastic abutment with the springs 49 - for damping the pulsations of tension - is positioned on the right fixed part of the device, whereas the mobile device 26 of the device brought to working keeps the deviators 47 in a fixed position.

[0064] For this purpose, on the right structure 21 sliding elements 51 are arranged, with cylindrical cavities inside them, corresponding to guide bars 52. The sliding elements 51 are slotted onto the outside of the bars 52 and are contrasted by small springs 49 that rest at the right on the structure 21. The sliding elements 51 end with the

mobile deviators 54 and can move forth and back due to the effect of the tension of the deviated thread 2 and of the contrast of the opposing springs 49.

[0065] The forth and back sliding of the sliding elements 51 is guided through cavities 56, made in the structure 21, in which corresponding projections 57 of the elements 51 slide so that the mobile deviators 54 cannot rotate but can only slide. Similarly to fixed deviators 22 of figures 2 the mobile deviators 54 are also provided with a guiding concave end part of the thread 2, preferably made from a low friction and wear-resistant material.

[0066] The embodiment of figure 3 also used the idea for a solution of the modulation of the degree of compression of the springs 39 in contact with the working thread 2. In the embodiment according to figure 3 such modulation is obtained with the modification of the transversal coordinate of the fixed deviators 47 brought to working through the plate 29, modifying the relative position of said deviators 47 with respect to the deviators 54 and making the springs 49 work with different degrees of compression, thus determining a variation of their reaction or counter-thrust that permits to determine the tension induced on the thread by the deviation.

[0067] For the correct operation of the device according to the invention - in the damping of the vibrations during the course of the unwinding of the thread from the spool and the winding of the thread on the package - it is essential for the deviators 27,54 placed on the sliding elements 38,51 to be independent from one another and free to slide with respect to their guides 34,52 to contrast and damp, through their springs 39,49, the variations in tension of the thread coming both from the top and from the bottom.

[0068] The sliding deviators that move reacting to the tension of the thread can be arranged on one of the two sides, or they can be arranged on both sides.

[0069] With reference to figures 2A-C, it can be seen that the two deviators 27, respectively indicated with the letter A and B, are independent from one another and move back more or less, with respect to their mobile support plate 29, as a function of the tension of the thread that rests in their end cavity.

[0070] Such independent deviators, indicated in figures 2A-C with reference numeral 27 and in figure 3 with reference numeral 54, perform the function of damping the vibrations and the pulsations in tension coming both from below for the unwinding of the thread from the spool with balloon of variable size, and from above for the winding on the package at linear pulsating speed. Figure 2A shows as an example that the upper element 27 shown with A is farther back to the left with respect to the lower element 27 shown with B: this indicates that from the bottom upwards the tension increases. In such an example, the upper springs 39 indeed manage to move the element 27 towards the right with a smaller displacement with respect to that obtained by the lower springs 39, because at the top the contrast due to the tension of the thread 2 is greater.

[0071] The characteristic of the mutually independent mobile deviators 27,54 is useful for the correct operation of the device according to the invention, essentially in terms of the damping of the vibrations that is not allowed with devices according to the prior art.

[0072] The device according to the invention indeed performed a plurality of functions integrated with each other and achieves substantial advantages with respect to thread tensioning devices according to the prior art; more specifically, these include that such a device:

[0073] - acts as an amplifier of the entry tension, which increases exponentially based on the successive deviations, producing a tension dependent on the deviation of the thread and on the friction that is adjusted based on the tension detected through the sensor 13 operating on the degree of compression of the springs 39, 49 in contact with the working thread 2,

[0074] - separates the contact points of the thread with the thread tensioning device in its two portions from spool to thread tensioning device and from thread tensioning device to package. With its upper element 27, 54 shown with A, the device damps and compensates the vibrations of tensions coming from the upper part avoiding, or at least limiting, the drops of the thread from the two ends of the package 11 in formation. With its lower element 27, 54 shown with B, the device damps and compensates the vibrations of tensions coming from the lower part due to the pulsating variation of the balloon 3, for the up- and-down excursion of the pick-up point from the winding on the spool 1,

[0075] - operates on the thread with deviators capable of independent movement with respect to one another and dependent on the tension of the thread that rests on each deviator,

[0076] - uses a mobile device with small masses of interference to obtain a device that is more sensitive and more reactive in damping. In the case of the embodiment of figure 2, the mobile part consists just of the sliding elements 38 and their ceramic ends 27. In the case of the embodiment of figure 3, the mobile part consists just of the sliding elements 51 and their ceramic ends 54. These mobile groups have a very low inertia and react quickly to the pulsations,

[0077] - adjusts the average tension of the thread 2 by varying the working position of the plate 29,

[0078] - during the processing of the thread, works just with the springs 39, 49 to react to the pulsations in tension that come from the spool and from the package, apart from the possible adjustment interventions at discrete intervals, in which the stepper motor 31 intervenes to move the plate 29.

Claims

1. Device for inducing and adjusting the tension, known as tensioning, of a winding thread (2) in textile machines comprising a comb tensioning device having

a plurality of stationary deviator elements (22,54) and a plurality of displaceable deviator elements (27,47), said deviator elements being arranged facing each other in a staggered and opposed manner to form a tortuous path for the thread (2) that passes through the device, the displaceable deviator elements (27,47) being placed on board of a mobile device (26) capable of modifying the tortuousness of the path of the thread (2) between said deviator elements, the mobile device (26) being alternatively placed in a rest position so as to leave the path of the thread (2) free or in a working position wherein the mobile device (26) is advanced against the thread (2) being processed to create tortuousness in the path of the thread (2), at least one of the pluralities of deviator elements (22,54; 27,47) being contrasted by springs (39,49), so as to move due to the effect of the tension of the deviated thread (2) and of the contrast of the opposing springs (39,49) **characterised in that** each displaceable deviator element (27,47) is capable of moving independently from each other, and **in that** the device comprises an actuating actuator (30) driven by a control unit of the spooling station that receives the signals of a tension sensor (13) measuring the tension of the thread, wherein the actuating actuator, in view of the signal of said tension sensor (13), modulates the degree of compression of the springs (39,49) working in contact with the thread (2), to obtain the desired tension in the thread in outlet from the thread tensioning device.

2. Device for tensioning a winding thread (2) in textile machines according to claim 1, wherein the actuating actuator (30) regulates the pre-load of the springs (39,49) by acting on pre-load means which modify the pre-load of the springs (39,49) themselves.
3. Device for tensioning a winding thread (2) in textile machines according to claim 1 or 2, wherein the actuating actuator (30) regulates the pre-load of the springs (39,49) by moving the displaceable deviator elements (27,47).
4. Device for tensioning a winding thread (2) in textile machines according to any one of the preceding claims, wherein at least one of the pluralities of deviator elements (22,54; 27,47) is placed on a plurality of elements (38,51), sliding with respect to guide bars (34,52) so as to move forth and back due to the effect of the tension of the deviated thread (2) and of the contrast of the opposing springs (39,49).
5. Device for tensioning a winding thread (2) in textile machines according to any one of the preceding claims, wherein at least one of the pluralities of deviator elements (22,54; 27,47) is placed on a plurality

of elements (38,51), rotating with respect to hinges so as to rotate due to the effect of the tension of the deviated thread (2) and of the contrast of the opposing springs (39,49).

6. Device for tensioning a winding thread (2) in textile machines according to any one of the preceding claims, wherein the tension sensor (13) is arranged downstream of the thread tensioning device.
7. Device for tensioning a winding thread (2) in textile machines according to any one of the preceding claims, wherein the actuating actuator (30) comprises a stepper motor.
8. Device for tensioning a winding thread (2) in textile machines according to any one of the preceding claims, wherein the actuating actuator (30) comprises an electric motor driven in frequency by the control unit.
9. Device for tensioning a winding thread (2) in textile machines according to any one of the preceding claims, wherein the actuating actuator comprises hydraulic and/or pneumatic actuators.
10. Device for tensioning a winding thread (2) in textile machines according to any one of claims 1 to 9, **characterised in that** the plurality of displaceable deviator elements (27) is arranged on a mobile device (26) of the thread tensioning device and it is equipped with the sliding elements (38) with respect to their guide bars (34), whereas the plurality of opposing stationary elements (22) is fixed.
11. Device for tensioning a winding thread (2) in textile machines according to any one of preceding claims, **characterised in that** the plurality of displaceable deviator elements (47) is arranged on a mobile device (26) of the thread tensioning device, which, brought to work, keeps the deviator elements (47) in a fixed position, whereas the plurality of opposing stationary deviator elements (54) is provided with sliding elements (51) on their bars (52).
12. Device for tensioning a winding thread (2) in textile machines according to any one of preceding claims, **characterised in that** the actuating actuator (30) is combined with a motion converter (32) through which the controlled rotation of the motor (31) is converted into horizontal linear displacement, which makes the mobile device (26) move forth and back with respect to the path of the thread (2).
13. Device for tensioning a winding thread (2) in textile machines according to claim 10, 11 or 12, **characterised in that** the mobile device (26) with the two or more guide bars (34) is mounted on a mobile plate

(29) whereon guide cavities (40) are made for the forth and back sliding of the sliding elements (38) that engage in it corresponding projections (41).

14. Device for tensioning a winding thread (2) in textile machines according to any one of claims 10 to 13, **characterised in that** in the structure (21) guide cavities (56) are made for the forth and back sliding of the sliding elements (51) provided with projections (57) corresponding with said cavities (56). 5 10
15. Device for tensioning a winding thread (2) in textile machines according to any one of claims 10 to 14, **characterised in that** the deviator elements (27,54; 22,47) are provided with a guiding concave end part of the thread (2) and made from a low friction and wear-resistant material. 15
16. Device for tensioning a winding thread (2) in textile machines according to claim 15, **characterised in that** inside the guiding concave end part an idle roller (24) is placed. 20

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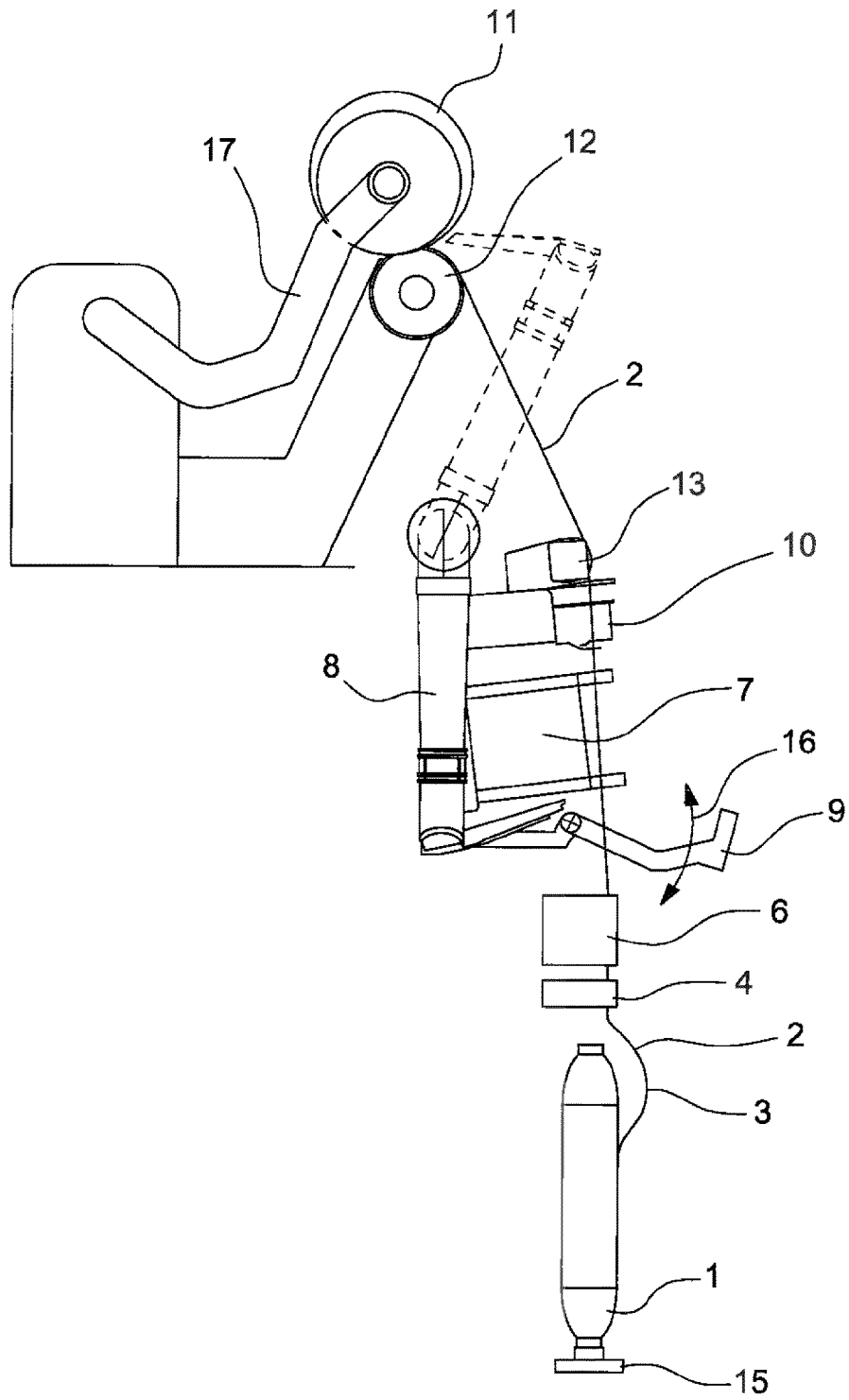


Fig. 1

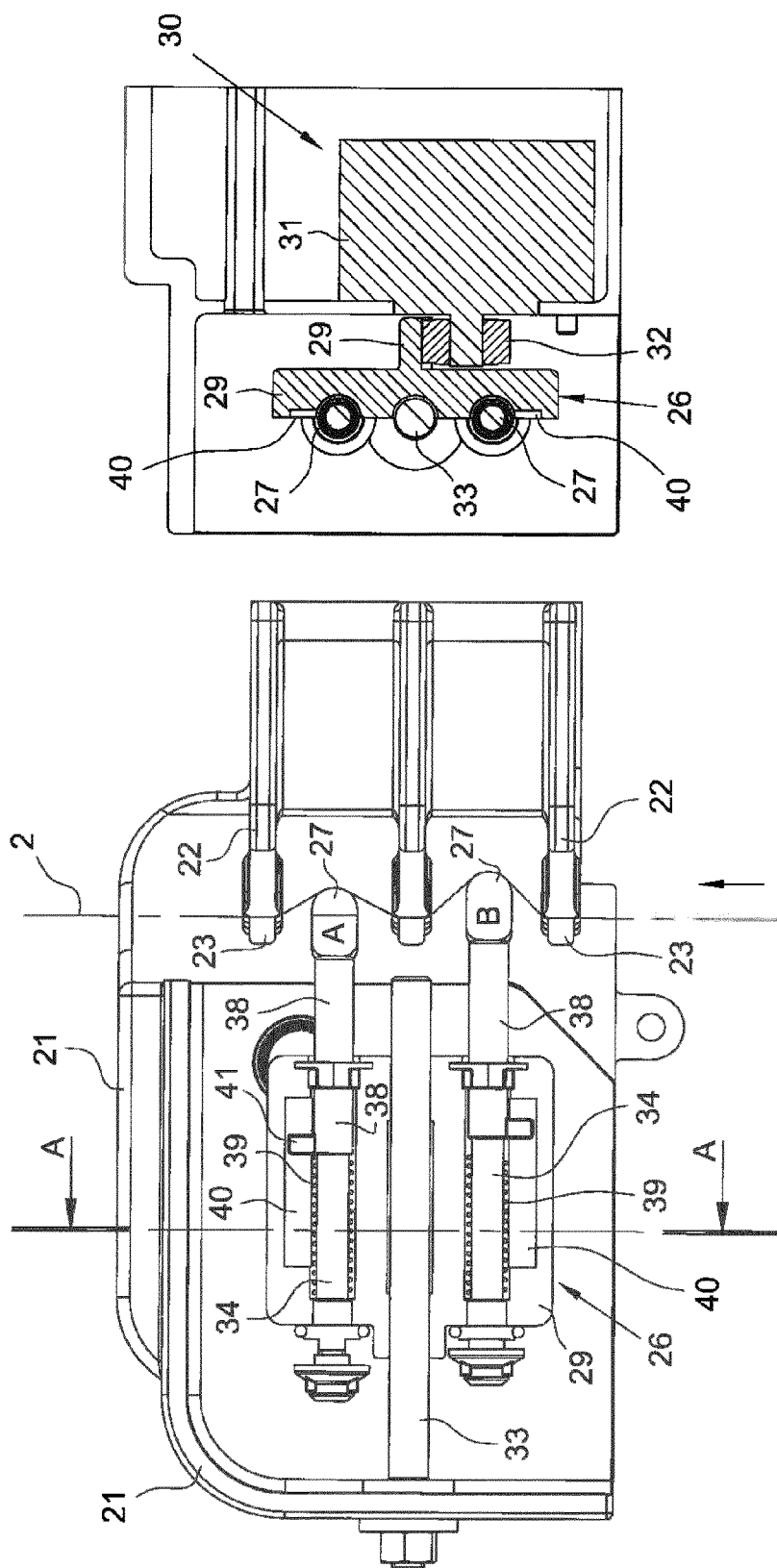


Fig. 2A

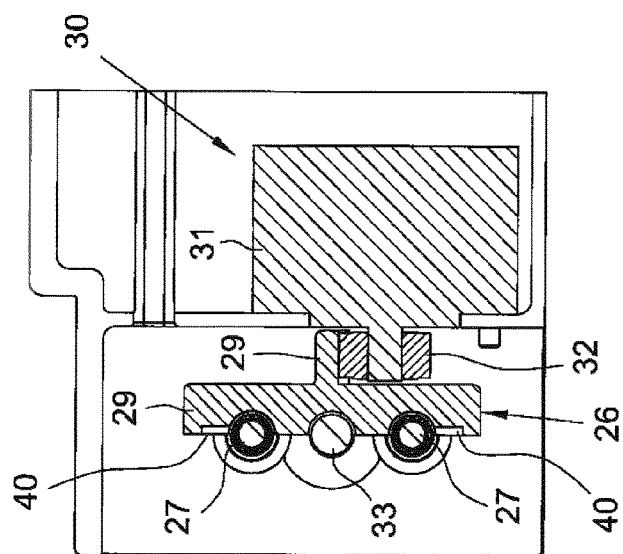


Fig. 2B

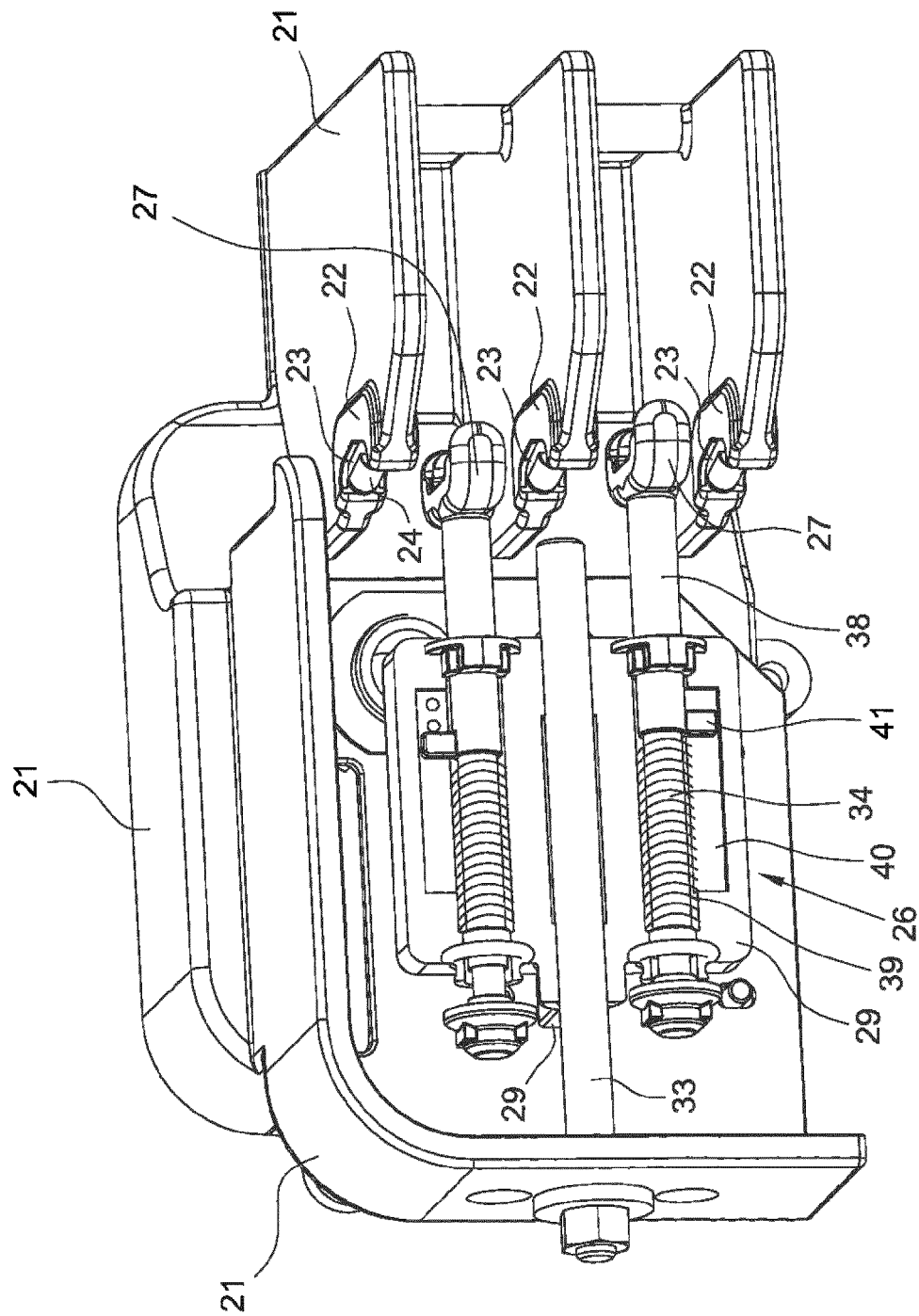
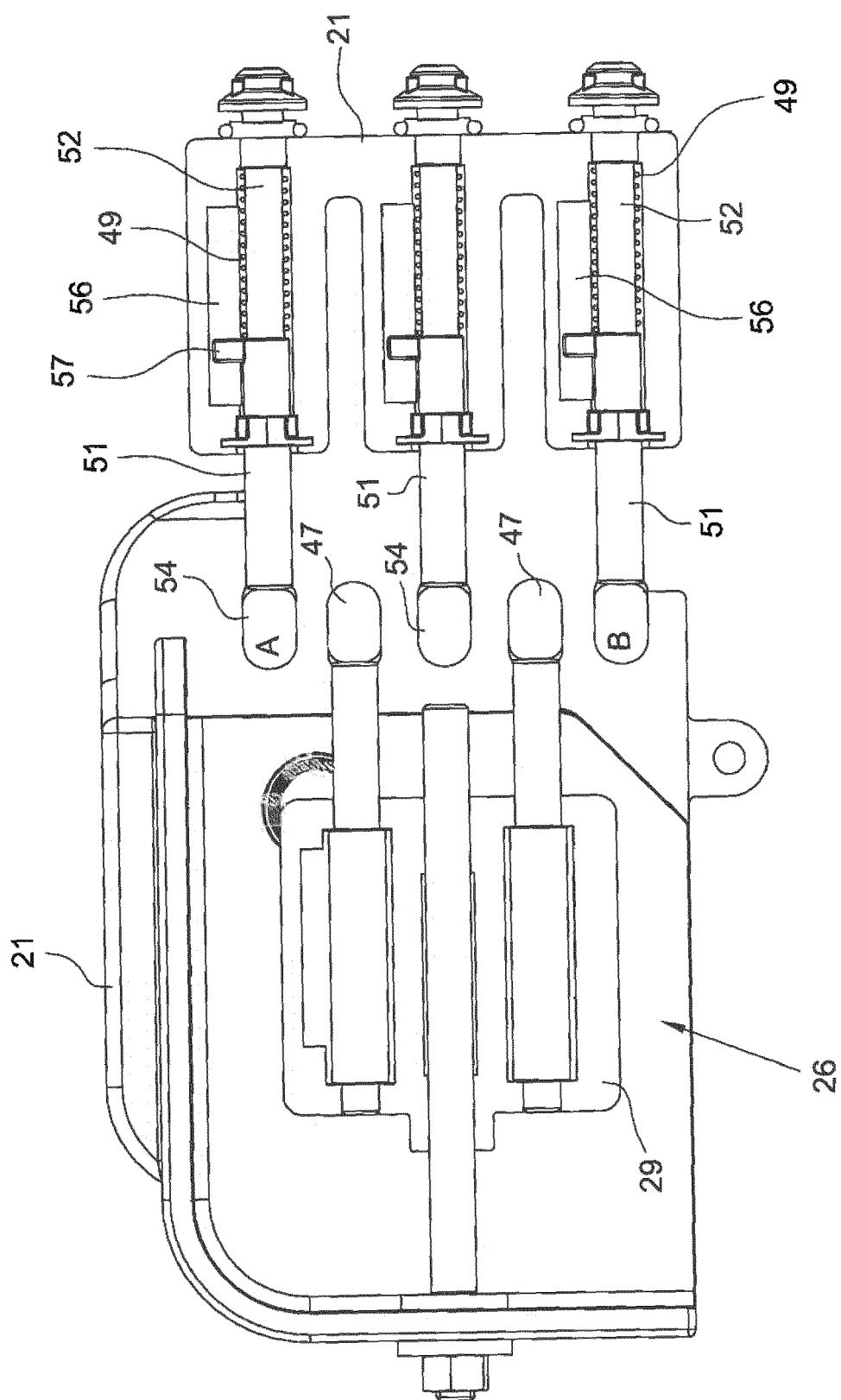


Fig. 2C



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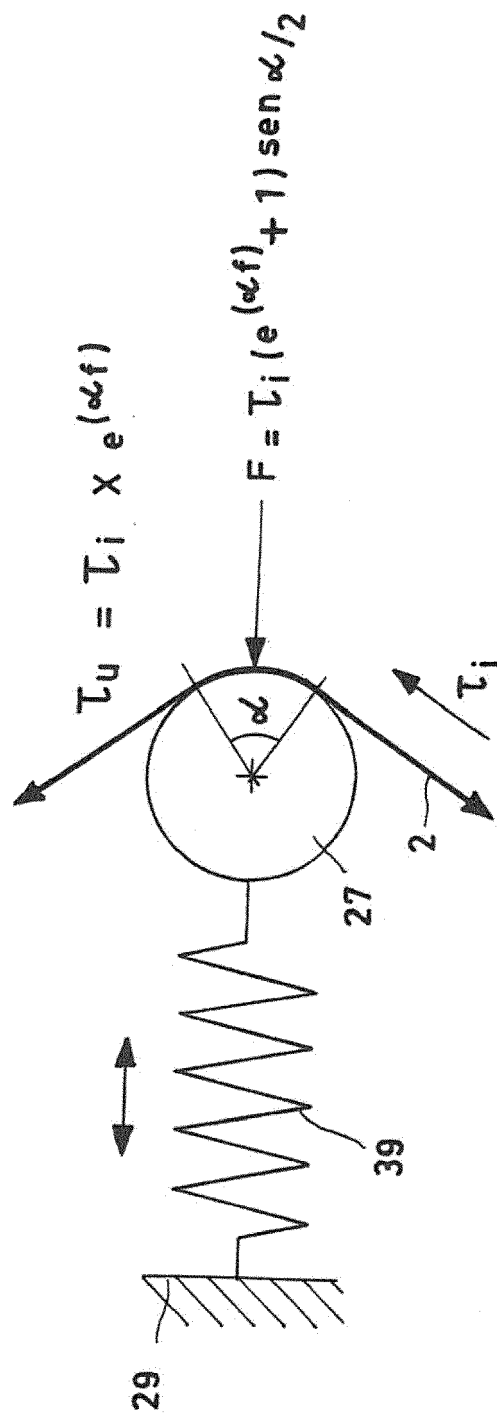


Fig.4



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 Application Number
EP 13 16 0937

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Place of search		Date of completion of the search	Examiner
The Hague		10 May 2013	Lemmen, René
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