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(54) **Device for automatically adjusting the tension of the feeding yarn of four-twist spindles**

(57) Device for automatically adjusting the inlet tension of the yarn in the inner balloon (B) in four-twist spindles, wherein the feeding yarn (F) is unwound from a feeding reel (11), passes through a rotary unwinder (50) and then enters into an inner axial cavity up to a bell-shaped deflecting element (51), from which the inner balloon (B) of the four-twist spindle (10) begins, where between the deflecting element and rotary unwinder a friction element is interposed which causes rotation speed variations in the bell-shaped deflecting element (51) and in the rotary unwinder caused by the tension variations of the yarn (F).

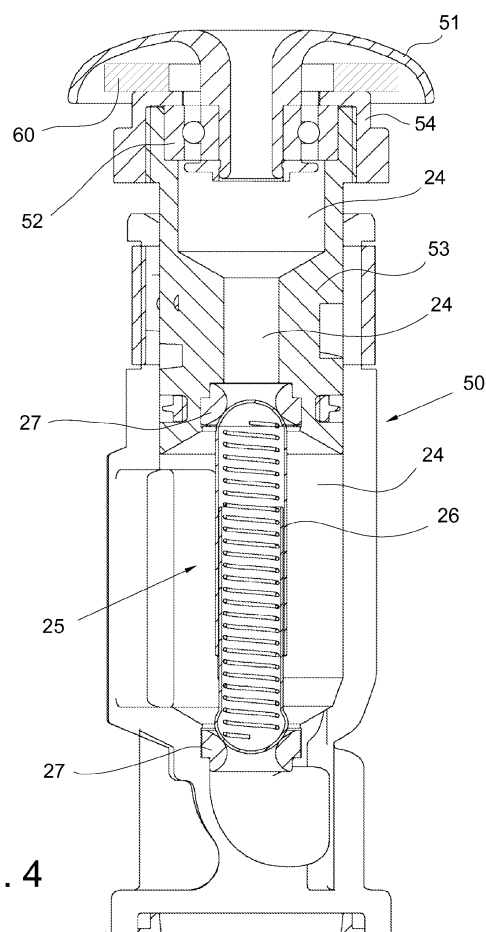


Fig. 4

Description

[0001] The present invention refers to a four-twist spindle for twisting machines and in particular to a device for adjusting the tension in the yarn for feeding a four-twist spindle.

[0002] For better clarifying the technical problems and in order to appreciate the technical solution according to the present invention reference herein is made to the diagram of the four-twist spindle indicated in figure 1 and to its operation illustrated in its exploded view indicated in figure 2, provided by way of non-limiting example. The four-twist spindle illustrated herein represents the mechanical diagram of the apparatus according to the patent application EP 1.726.693 on behalf of the present applicant. Reference can also be made to the diagram of a four-twist spindle according to patent EP 1.007.773. Further details regarding the operation of such devices can be observed in such documents.

[0003] According to the diagram of figures 1 and 2, the twisting spindle for multiple twists of textile yarns and threads, comprises a basket support 10 that contains a feeding reel 11 and which is held still using, for example, stationary magnets M. Generally, the reel 11 is prepared separately using doubled yarns wound in a doubler machine on a reel which is then brought to the twisting frame.

[0004] The four-twist spindle further comprises two parts rotating in the opposite direction, respectively a more inner upper rotating part 15 and a lower rotating part 16, both arranged beneath the fixed reel-bearing basket 10, the rotating parts 15 and 16 being coaxial to each other and with respect to the axis of the spindle, and an unwinder and transmission element 20 arranged above the reel 11. The yarn F which is unwound by the reel first passes through the unwinder element 20 which ends with the transmission element 21 arranged above the reel, then descends towards the inner upper rotating part 15 defining - around the reel - an inner balloon B, enters in said upper rotating part 15 with the radial conduit 28, it is deflected by the roller 29 and traverses an axial passage 30 provided in said inner upper rotating part 15. Upon reaching the exit of said passage 30, arranged on the rotational axis of the spindle, the yarn traverses a second transmission element 31, integral with the lower rotating part 16, and thus a radial passage 32 provided within said lower rotating part 16, exits from the latter and rises defining an outer balloon B', reaching a final transmission element 33 and lastly it is conveyed to pick-up means at an upper position. Such pick-up means, not shown in the figure for the sake of simplicity, draw at a constant and predetermined speed - and collect in a reel - the yarn which was processed in the four-twist spindle. In the path that follows from the upper transmission 21 to the final transmission 33, due to the rotation of the two parts rotating in the opposite direction, respectively the upper part 15 with the more inner balloon B and the lower part 16 with the more outer balloon B', the yarn receives two twist actions which sum-up and, more precisely re-

ceives two twists for each revolution of each of the two rotating parts 15 and 16.

[0005] The lower rotating part 16 is supported by a stationary bearing 14 which supports the entire four-twist spindle and it is actuated by outer motion transmission means, for example through a pulley 17 coaxial to the spindle which receives the rotary motion with a transmission belt. The lower rotating part 16 in turn transmits motion to the upper rotating part 15, for example through an epicycloidal transmission device 18, according to the abovementioned patent application EP 1.726.693 on behalf of the applicant, to which reference shall be made for further details. Such epicycloidal device 18 is contained within a fixed box part 19, also held locked with fixed magnets mounted on the bottom of the basket 10.

[0006] Above the feeding reel 11 there is comprised an unwinder device 20 which receives the doubled yarn F from the reel 11. Such unwinder 20 is mounted on the inner shaft 13 of the basket 10 with the interposition of a roller bearing 22. The entire unwinder 20 is rotated by the same doubled yarn F which is spiral unwound by the reel 11, passes into the end ring of the rotating arm 23 and enters into the axial cavity 24 of the unwinder 20 which re-ascends the unwinder itself up to the bell-shaped transmission element 21 arranged at its top. The linear unwinding speed is determined by the draw exerted by the pick-up unit arranged downstream, which also determines the hourly quantity of twisted yarn production.

[0007] Within the cavity 24 an element 25 for tensioning the yarn is arranged. In the diagram according to figures 1 and 2 - see also the further detailed enlarged scale illustration shown in figure 4 below - it consists in an elastic piston 26 having a spring therein which presses the doubled yarn F against two annular seats 27 arranged at the two upper and lower rounded ends of the piston 26. Such tensioner 25 corresponds to the need that both ends of the doubled yarn F reach the transmission 21 perfectly parallel and having a certain tension. In the undesired case that, during the preliminary doubling operation of the yarn F, one of the two ends results slack and in the twisting there is a slot of the yarn projecting, this would represent an unacceptable defect of the twisted yarn. The tensioner 25 is therefore an equalizer of the doubled yarn F in order to prevent going beyond a possible slack end present in the doubled yarns. One characteristic of the spindle consists in the fact that the yarn, for at least one part of its course, can form free balloons B and B' that are not delimited externally.

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

[0009] The four-twist spindle receives its single rotational drive from the axial shaft of the lower rotating part 16, for example through the pulley 17 to rotate at 10,000 rpm. The epicycloidal transmission device 18 transmits motion to the upper rotating part 15 with a speed of about

50%: the upper part in turn rotates, for example, at 5000 rpm.

[0010] Since, as mentioned previously, during its run the yarn F receives two twists for each revolution of each of the two rotating parts, for each work minute the doubled yarn that passes receives 10,000 revolutions twice from the rotating part 16 and 5000 revolutions twice from the rotating part 15, i.e. 30,000 total rpm. If regarding the yarn F a twisting of 600 twists per linear meter is required, in the four-twist spindle it is thus possible to process 50 metres of yarn F per minute, by actuating the device downstream of the pick-up with a draw of 50 m/min.

[0011] For the structure and the functioning of the twisting frame, the prevailing part of the tensions present on the yarn is however due to the centrifugal force of the balloons of the yarn which rotate at a high speed, and the technical problem regarding the stability of the balloon 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 reel 11. Actually, the tension of the yarn F depends, besides from the centrifugal force of the balloon, also on the unwinding geometry, i.e. from the angles that the yarn F being unwound obtains with the arm 23 and with the reel 11. These angles vary both depending on the unwinding point and depending on the diameter of the reel 11. Given that the average angles increase from the beginning to the end of the unwinding, the average resistance to the unwinding increases progressively, while tension pulses also superimpose to the average tension, given that the pick-up point of the yarn F from the surface of the reel 11 continuously has a top-bottom excursion and vice versa.

[0012] Due to the draw of the downstream pick-up device, from the end ring of the rotating arm 23, the yarn F is removed from the reel 11 immobile in its basket, from which, for example, 50 metres per minute are unwound.

[0013] Due to the constant linear speed draw, the angular coordinate of the pick-up point of the yarn on the reel rotates at a speed which increases slowly proportionally to the consumption of the reel 11, while the level of the pick-up point has a top-bottom excursion and vice versa, thus periodically varying the length of the section of yarn that runs between the pick-up point and the end ring of the rotating arm 23, as well as the angular displacement between them.

[0014] At the beginning of the reel, with reference to the previous exemplification data, the unwinding speed of the yarn at 50 m/min corresponds to a few tenths of turns unwound per minute: the yarn F slowly rotates around the reel with spiral progression. When the reel 11 is instead almost finished, the abovementioned 50 m/min of linear speed of the unwinding yarn reach hundreds of turns unwound per minute: the yarn F rotates quickly around the reel 11 still with spiral progression and with an analogous tension pulse.

[0015] Due to the increasing speed rotation of the yarn F unwound from the reel 11, also the unwinder 20 - which picks up the yarn F through the rotating arm 23 - is

dragged in rotation by the draw of the yarn itself at a rotation which is initially slow at a speed of a few tenths of rotations per minute up to a faster rotation at several hundreds of rotations per minute when the reel is finishing.

[0016] Due to the resistant tension pulse of the yarn F, also the arm 23 and the entire unwinder 20 rotate at a pulsating speed and, due to their inertia, they give an amplifying effect of the resisting tension pulsation of the yarn F during its unwinding.

[0017] Referring to figure 2, upon exit from the axial duct 24 of the unwinder 20 the yarn F lies on the transmission device 21 and it is deflected downwards by the draw exerted by the upper rotating part 15 and starts to form the inner balloon B driven into rotation at a high speed, for example 5000 rpm. The bell-shaped transmission device 21 of figure 1 and 2 receives the yarn from the axial duct 24 of the unwinder 20 - which rotates in the opposite direction with respect to the rotation of the balloon B at a reduced speed, between a few tenths of rpm at the beginning of the reel 11 and a few hundreds of rpm. The relative rotational speed - between the two sections of the yarn respectively arriving from the end ring of the arm 23 of the unwinder 20 and exiting from the bell-shaped transmission 21 - is the sum of the two rotational speeds. Thus, at the exit of the bell-shaped element 21 the yarn not only slides on the bell-shaped element at a speed of tens of metres/min in the longitudinal direction, but also rotates by sliding on the bell-shaped element itself drawn by the balloon B, which for example rotates at 5000 rpm: due to the friction between the yarn and the surface of the bell-shaped element 21, the bell-shaped transmission element 21 is drawn by the yarn and it tends to rotate at a speed close to that of the balloon.

[0018] At the exit of the upper transmission 21 of the unwinder 20 the yarn F descends again forming the inner balloon B.

[0019] The trend of the instantaneous tension of the yarn over time in its path for re-ascending towards the upper transmission 21 is shown - by way of example - by the solid line T1 of figure 3, from the beginning to the end of the reel 11. The trend of the average tension of the yarn is instead shown by the dash and dot line TM. The instantaneous tension pulsates irregularly and averagely increasing from the beginning to the end. Such overall tension is the result of all the forces and resistances offered by the yarn and by the system in motion from the pick-up point up to the entrance into the radial conduit 28.

[0020] Contrary to the outer balloon B', the inner balloon B has not a compensating pulley due to lack of space and the geometry of the system. Due to the reasons outlined above the yarn of the inner balloon B naturally has a pulsating tension which causes the instability of the balloon. Due to such reason, the inner balloon B continuously varies its shape and size. The tension of the inner balloon B cannot be too high or too low. Extremely low

tensions can cause interferences between the two balloons B and B', but the greatest hazard lies in the excess of tension. An excess of tension of the descending balloon B can reduce the winding of the reserve of the second balloon B' around the surface 36 moving it to the condition of instability. Such excess can also reduce the radial dimension of the inner balloon B and cause the contact between the balloon itself rotating at a high speed with the cylindrical surface of the fixed basket 10, with the ensuing interruption of the yarn. Upon contact, the yarn adheres to the basket and it is wound thereon tearing off immediately.

[0021] The technical problem of instability of the inner balloon B instead is not observable in the double-twist spindles, in which there is only an outer balloon which re-ascends upwards. Actually, the double-twist spindle has a lower compensating pulley capable of absorbing the tension and length variation of the outer balloon which re-ascends upwards, varying the development angle of the balloon rotating around such pulley. For example, reference is made to patent US 4,759,175 and to model JP 63 162.877 regarding a double-twist spindle provided with a lubricating liquid dispenser on the processed yarn. In such documents an upper bell-shaped deflecting element is described, in which however the yarn enters rotating from above and descends axially into the central cavity. Such upper bell-shaped element cannot rotate, due to the fact that it is fixed in position using O-rings, in turn held in peripheral grooves, which also serve as sealing elements for the lubricating liquid. In the described device the guide of the feeding yarn arranged on a rotating arm which follows the unwinding of the yarn from the feeding reel is also provided. However, such arm is idle and it is not provided with any braking device. No braking device, neither for the upper fixed bell-shaped element nor for the unwinder arm, is described in such documents in that it is a double-twist spindle which does not require it.

[0022] As already explained further in detail in the patent applications EP 2.028.300 and 2.028.301 of the applicant, the tension of unwinding of the yarn from the reel 11 is not regular. Therefore, as previously explained, the unwinding tension averagely increases from the beginning to the end of the reel, same case applying to the speed of rotation of the unwinder, which may vary from the initial 50-100 rpm to the final 500-600 rpm, increasing by 3-4 times, according to the ratio between the initial and final diameters of the reel.

[0023] Furthermore, the periodical excursion of the pick-up point of the yarn F from the reel 11 generates, as mentioned, a tension pulse due to the unwinding geometry; due to its inertia, the unwinder 20 has the harmful effect of amplifying such tension pulse. In fact, once the reel 11 surpasses the upper pick-up point, an increase of tension occurs for unwinding the yarn F: the arm 23 of the unwinder 20 is subjected to an acceleration, passes the pick-up point of the yarn and, given the absence of the yarn to pull it, rotates free due to its inertia, while when the reel 11 surpasses the lower pick-up point, the

opposite occurs i.e. the pick-up point of the yarn passes the arm 23 of the unwinder 20 and rotates it again.

[0024] Therefore, during the deceleration of the unwinder 20, the yarn F should transmit an additional rotary torque thereto to return it to the operating speed: these effects of surpassing and restarting the drawing of the unwinder 20 therefore generate further tearings on the yarn F which sum to the tension pulses leading to unwanted effects.

[0025] In summary, the reduction of the diameter of the reel 11 causes the increase of the average unwinding tension and the average rotational speed of the unwinder 20, while the unwinding tension variations between the upper and the lower part of the reel 11 cause sudden periodic accelerations and decelerations of the rotary motion of the unwinder 20.

[0026] Thus, the technical problem regards the braking of the system to reduce such speed variations caused by the unwinder 20 and the effect on the tension pulses correlated thereto, so as to avoid excessive tension variations with ensuing interferences of the balloons B and B' and unwanted breakages.

[0027] Devices for controlling and for compensating tension pulses of the feeding yarn in four-twist spindles were proposed in the prior art, for example with patent applications EP 2.028.300 and 2.028.301 of the applicant.

[0028] Document EP 2.028.301 describes a technical solution which introduces on the path for the re-ascending of the yarn a thread tightener which operates by varying the length of the path of the yarn between the end ring of the rotating arm 23 and the bell-shaped transmission element 21 arranged at the top of the unwinder 20. Document EP 2.028.300 instead provides for making the bell-shaped transmission element 21 idle with respect to the unwinder 20 and providing the unwinder with a magnetic brake arranged on the fixed part.

[0029] Such brake allows reducing the angular speed variations of the unwinder 20 due to the non-constant draw of the yarn picked up by the reel 11, but induces a supplementary and constant tension in the yarn.

[0030] A device for moving the unwinder from outside by actuating it with its own motor with a speed corresponding to the unwinding one was proposed in EP 1.045.053: this would allow avoiding tension pulses.

[0031] Therefore, the present invention aims at providing a device for braking the system capable of overcoming the performance offered by the prior art devices and capable of allowing controlling the trend and tension of the inner balloon B at the point where the yarn picked up from the reel 11 arrives at the bell-shaped transmission element 21 and constitutes the beginning of said balloon, causing a friction effect of the bell-shaped transmission element 21 on the unwinder 20 and thus modulating the relative rotational speed between said elements.

[0032] The present invention, in the most general meaning of unwinder device employed by a four-twist twisting frame is defined in the first claim. Variants or

preferred embodiments are defined in the dependent claims 2 to 11.

[0033] Characteristics and advantages of the unwinder according to the present invention will become more apparent from the following exemplifying and non-limiting description with reference to the attached schematic drawings wherein:

figure 1 shows the diagram of the structure of a four-twist spindle,
figure 2 shows its exploded view illustrating its operation,
figure 3 shows the progression over time of the tension of the yarn in its path for re-ascending towards the upper transmission in the spindles according to the previous figures,
figure 4 shows the diagram of the unwinder device according to the present invention,
figure 5 shows some shape and constitution variants of the gasket between the unwinder and deflecting element.

[0034] Characteristics and advantages of the unwinder device according to the present invention will become more apparent from the description of a typical exemplifying and non-limiting embodiment thereof, illustrated in figure 4.

[0035] The device according to the invention meets the needs of reducing the tension variations of the yarn entering the inner balloon B due to the tension pulses of unwinding the yarn from the feeding reel and the rotary speed of the unwinder, which are inherent to the system and thus not eliminable.

[0036] The unwinder device 50 according to the present invention, and illustrated in figure 4, is made according to the present description regarding the lower part, i.e. the arm 23, the inner axial cavity 24 with tensioner 25 of the yarn F, which consists in an elastic piston 26 which presses the yarn against two annular seats 27 arranged at the two upper and lower rounded ends of the piston 26.

[0037] In order to obtain an improved braking effect and a greater stability of the path of the yarn in the four-twist spindle, a preferred embodiment of the present invention provides that in the reel-bearing basket 10 a reel 11 is arranged with a winding direction of the doubled yarn F preferably matching the direction of rotation of the inner balloon B, so that the unwinding thereof during the spindle functioning is opposite with respect to the rotation of the inner balloon B.

[0038] As already described in the previous patent application EP 2.028.301, between the bell-shaped deflecting element 51 and the underlying unwinder 50, a ball bearing 52 is inserted, fitted at the top of the body 53 that contains the axial cavity 24 for ensuring the independence of rotation of the bell-shaped transmission element 51 with respect to the underlying unwinder 50, which rotate in opposite direction with respect to each other sum-

ming the rotational speed of the inner balloon B and the angular speed of unwinding the reel 11, which corresponds to the rotational speed of the unwinder 50.

[0039] A distinctive characteristic of the present invention lies in the introduction of a braking element between the body of the unwinder and the upper bell-shaped deflecting element which reduces the tension pulses and relative speed due to the unwinding of the feeding yarn.

[0040] Between the body of the unwinder 50 and the bell-shaped deflecting element 51 there is actually interposed a braking element constituted by an annular gasket 60. The annular gasket 60 is inserted in the space available between the deflecting element 51 and the unwinder 50, free to execute small axial and radial movements with respect to said two elements: it can thus rotate at speeds different than those of the unwinder 50 and of the bell-shaped deflecting element 51. Such annular gasket 60, due to its weight, lies with its lower face on the top of the body 53, and in particular on the upper face of the ring 54 for locking the bearing 52, and it can have - due to the radial movement freedom thereof - a more or less extensive contact with the inner face of the bell-shaped deflecting element 51.

[0041] The braking effect induced by the annular gasket 60 is exerted both on the unwinder 50 and on the deflecting element 51, when such gasket 60 rotates at a speed different from such elements. The intensity of the braking effect of the gasket 60 on the unwinder 50 directly depends on the difference of speed between them, also considering the relative direction of rotation. Same case applies to the braking effect exerted by the gasket 60 on the bell-shaped deflecting element 51.

[0042] The annular gasket 60 is made using material resistant to wear, with low coefficients of friction, low density and high elasticity. It can be made with felt of natural and synthetic fibres, or with polymer-based plastic materials, sintered or foamed, for example with fluorinated polymers such as teflon or with polyolefin such as polyethylene.

[0043] As shown in figure 5, the annular gasket 60 can be made in open form or closed form. Regarding assembly and maintenance, the left closed form is more suitable with the gaskets made of softer material while, when the gasket is made of stiffer material, in the right open form the gasket is interrupted with a cut 61, made in its circumference, so as to allow easy assembly and replacement thereof.

[0044] The gasket 60, as the rotary speed of the deflecting element 51 increases, is drawn thereby by friction and centrifuged against the inner surface of the deflecting element 51. Hence, this leads to two effects: due to the centrifugal thrust there increases both the contact area of the upper edge of the gasket 60 against the inner surface of the deflecting element 51 and the number of fibres of the felt or of particles of plastic material that are at contact against the inner surface of the deflecting element 51. The result is that the braking action caused on the deflecting element 51 and on the unwinder 50 in-

creases as the relative speed of the deflecting element 51 and of the ring 54 increases. Higher speeds correspond to greater braking force and vice versa.

[0045] The inner surface of the bell-shaped deflecting element 51 and upper surface of the ring 54 must be sufficiently smooth, preferably with roughness not exceeding 1.2 micrometres, so as to limit the wear on the annular gasket 60.

[0046] The bell-shaped deflecting element 51 rotates at variable speeds which are caused by the speed of the inner balloon B, which generally rotates at 4000-5000 rpm; the unwinder 50 rotates at lower speeds, not exceeding 500-600 rpm. The speeds of said two elements 50 and 51 are opposite and thus they sum with respect to the ring gasket 60.

[0047] The bell-shaped deflecting element 51 does not rotate at a constant speed: the speed thereof depends on the tension of the yarn. As mentioned above, due to the friction between the yarn and the outer surface of the deflecting element 51, generated by the tension of the yarn, the deflecting element 51 is drawn by the yarn and tends to rotate at a speed close to that of the balloon.

[0048] If the tension of the yarn is high - like in the case of large counts under processing, or high pick-up speed, or at the end of the reel - the friction between the yarn and deflecting element 51 increases, the torque transmitted from the yarn to the deflecting element 51 increases and the deflecting element 51 rotates at a speed closer to that of the balloon B, even in the presence of the increasing braking exerted by the annular gasket 60. On the contrary, i.e. when the tension of the yarn is low, the bell-shaped deflecting element 51 slides with respect to the rotating yarn of the balloon and reduces speed thereof, rotating at a speed considerably lower than that of the balloon B, due to the braking effect exerted by the annular gasket 60.

[0049] The outer surface of the rotary bell-shaped deflecting element 51 is made with a discrete coefficient of friction, so that the yarn rotated at the speed of the balloon B, which for example rotates at 5000 rpm, exerts an efficient drawing on the bell-shaped deflecting element 51. Values of coefficient of friction for the outer surface of the bell-shaped deflecting element 51 comprised between 0.1 and 0.3 are generally suitable for providing the invention.

[0050] The kinetic energy for drawing the deflecting element 51 is provided by the rotation of the balloon of the yarn, in turn generated by the drive system which keeps the spindle rotating at a constant speed.

[0051] Upon variation of the difference of the rotational speed between the bell-shaped deflecting element 51 and the balloon B, the tangential component of the output speed of the yarn varies with respect to the deflecting element 51. During the release of the tension there is no "bellying" of the balloon B but there is a slight increase of the spiral progression of the balloon between the deflecting element 51 and the inlet into the radial conduit 28 of figure 2. There occurs the opposite upon the in-

crease of tension.

[0052] Regarding the unwinder 50, it is forced to follow the unwinding of the yarn. The tension to which the unwinder is subjected, due to the tension of the unwound yarn F, corresponds to the torque that must be provided to it to keep it in rotation to overcome the resistance due to frictions. In the transient phases, as explained previously, during the deceleration of the unwinder, the yarn should transmit an additional rotary torque thereto to return it to the operational speed.

[0053] The functioning of the braking system constituted by the annular gasket 60 slack and interposed between the deflecting element 51 and the unwinder 50 can be explained as follows. The degree of braking action depends on the sum of the two rotational speeds and on the friction of the gasket 60: the gasket 60, free to move radially and lying on the upper surface of the ring 54, has an upper edge lying against the inner surface of the deflecting element 51, and thus the braking action occurs through the relative sliding between two rotating parts.

[0054] Through the body of the gasket 60, the friction action between these counter-rotating components has the effect of dissipating kinetic energy and thus causing the braking action. The kinetic energy dissipated during the braking action is obviously provided by the rotation of the balloon of the yarn, in turn generated by the drive system which keeps the spindle rotating constantly. Then, given that the bell-shaped deflecting element 51 still rotates at speeds much higher than those of the unwinder 50, its kinetic energy is always greater than that of the unwinder and the braking action is mainly exerted on the unwinder 50.

[0055] For example, the rotary accelerations of the bell-shaped deflecting element 51 and of the unwinder 50, caused by an increase of tension of the yarn F, produce an increase of the sum of the two rotary speeds and, hence, due to the friction of the annular gasket 60 the braking action on the two counter-rotating elements increases. Analogously, the rotary decelerations of the bell-shaped deflecting element 51 and of the unwinder 50, caused by the reduction of tension of the yarn F, produce a reduction of the sum of the two rotational speeds and, hence, due to the friction of the annular gasket 60 the braking action on the two counter-rotating elements reduces.

[0056] At the beginning of the reel 11 the unwinder 50 rotates at a low speed and the average tension of the yarn is low, the bell-shaped deflecting element 51 thus rotates at a lower speed with respect to the rotation of the balloon B: the braking action of the system - which is proportional to the sum of the speeds - is thus low.

[0057] At the end of the reel 11 the unwinder 50 rotates at high speed and the average tension of the yarn is high, the bell-shaped deflecting element 51 thus rotates at a high speed drawn by the rotation of the balloon B: the braking action of the system - which is proportional to the sum of the speeds - is thus high.

[0058] In order to better explain the effect obtained by

inserting the gasket 60 between the unwinder and bell-shaped deflecting element, it is suitable to clarify what occurs in four-twist spindles without them: in the unwinding transients wherein the tension of the yarn increases, the unwinder accelerates abruptly in that it is subjected to a sudden increase of tension and tends to surpass the point where the yarn is picked up by the reel; surpassing generates a drop of the tension of the yarn, with the ensuing jerking operation of the rotation of the unwinder.

[0059] Otherwise, in four-twist spindles provided with the gasket 60 between the unwinder 50 and the bell-shaped deflecting element 51 in the unwinding transients wherein the tension of the yarn increases, the unwinder starts to accelerate, but at the same time the yarn F, due to the greater tension, draws the deflecting element 51 with greater force which starts to accelerate; the increase of the relative speeds of the unwinder 50 and of the deflecting element 51 lead to an increase of the sliding on the gasket 60, which is countered by exerting a greater braking action. Considering the fact that the kinetic energy of the deflecting element 51 is considerably greater than that of the unwinder 50, the braking effect is discharged further onto the unwinder which, lastly, accelerates less than would be the case in absence of the annular gasket 60. Thus, the unwinder 50 cannot surpass the pick-up point of the yarn and thus eliminating the jerking operation of the rotation thereof.

[0060] In the unwinding transients in which the tension of the yarn F drops, the opposite development in this case, it analogously occurs that upon the drop of the tension of the yarn F, the unwinder starts slowing, the yarn F - due to the lower tension - simultaneously draws the deflecting element 51 with lower force and thus the deflecting element starts decelerating; the reduction of the relative speeds of the unwinder 50 and of the deflecting element 51 leads to a reduction of the sliding on the gasket 60, which thus generates a lower braking action: the unwinder, subjected to a lower braking, decelerates less than would be the case in absence of the gasket.

[0061] In summary, the interposition of the annular gasket 60 between the unwinder 50 and the bell-shaped deflecting element 51 thus has the effect of reducing abrupt variations of the rotation of the unwinder 50 and thus reducing excessive tension variations which can generate interferences of the balloons and breakage of the yarn.

[0062] The operational characteristics of the device according to the invention are very different from those of the tension compensators in the four-twist twisting frames of the prior art.

[0063] The braking system according to the invention is applied to the bell-shaped deflecting element 51 with respect to the unwinder 50 and it is of the adjusting and self-compensating type: it is of the adjusting type due to the fact that its average braking action increases as the diameter of the feeding reel 11 reduces; it is self-compensating due to the fact that it counters the speed variations of the unwinder 50 in the transients, which cause

abrupt tension variations and unwanted breaking of the yarn.

5 Claims

1. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles, wherein a doubled yarn (F) for feeding into the four-twist spindle (10) is unwound from a fixed feeding reel (11) through a rotary unwinder (50) equipped with a radial arm (23) rotating following the unwinding of the feed yarn (F), in which the rotary unwinder (50) has an inner axial cavity (24) for re-ascending of the yarn (F) that comes from the end ring of the rotating arm (23) and that passes through said cavity up to a deflecting bell shaped transmission element (51), from which the inner balloon (B) of the four-twist spindle (10) begins, in which such a bell shaped deflecting element (51) is made independent with respect to the unwinder (50) below, the rotary independence of the bell shaped element (51) being obtained with a ball bearing (52), fitted at the top of the body (53) that contains the axial cavity (24), **characterised in that** between the body of the unwinder (50) and the bell-shaped deflecting element (51) a braking element is arranged that consists of an annular gasket (60), arranged on the top of the unwinder (50) and in contact with the bell shaped deflecting element (51).
2. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the winding direction of the reel (11) of doubled yarn (F) matches the direction of rotation of the inner balloon (B), so that its unwinding during the functioning of the spindle is the opposite way to the rotation of the inner balloon (B).
3. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the annular gasket (60) works, respectively, with its lower face constantly resting on the upper face of the ring (54) for locking the bearing (52) on the unwinder (50) and, on the opposite side, with its upper face in contact with the inner face of the bell shaped deflecting element (51).
4. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the annular gasket (60) has no axial constraints and is radially labile with respect to the unwinder (50).
5. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles

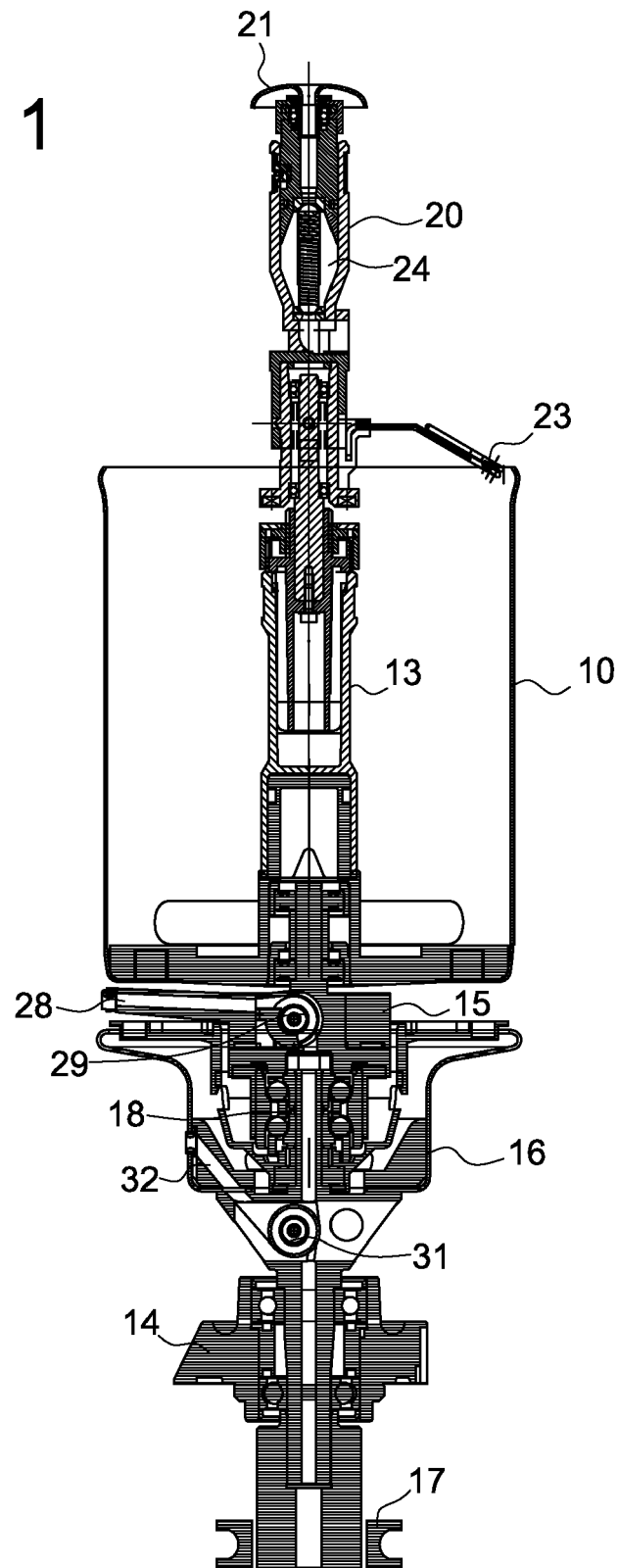
according to claim 1, **characterised in that** the annular gasket (60) is centrifuged against the inner surface of the deflecting element (51).

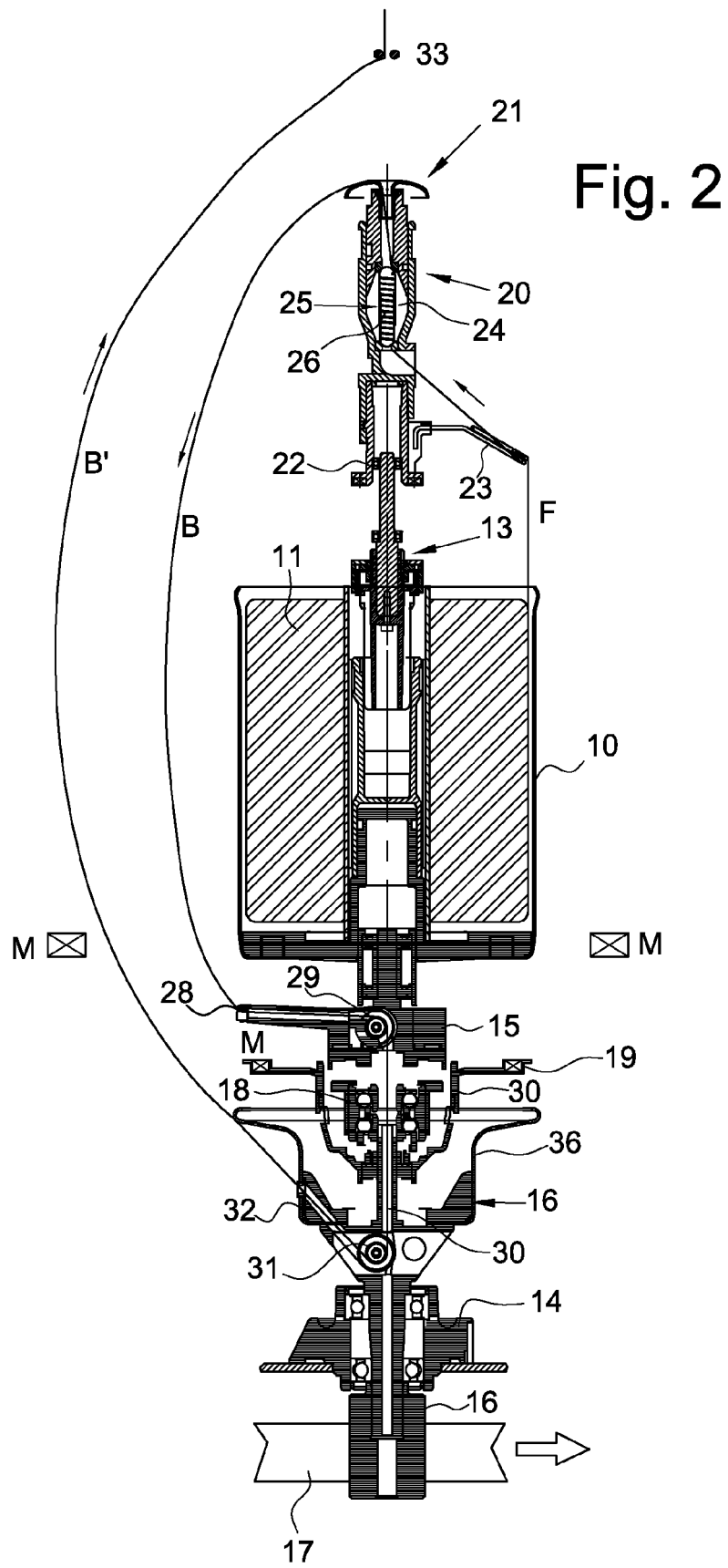
6. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 5, **characterised in that** the annular gasket (60) centrifuged against the inner surface of the deflecting element (51) has increasing contact and number of contact points against the inner face of the bell shaped deflecting element (51) as the sum of the rotation speeds of the bell shaped deflecting element (51) and of the unwinder (50) increases. 15
7. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 6, **characterised in that** the increase in contact area and in number of contact points of the annular gasket (60) against the inner face of the bell-shaped deflecting element (51) and against the upper face of the locking ring (54) of the unwinder (50) determines an increasing friction force as the sum of the relative speeds of the two elements (50) and (51) increases. 20 25
8. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the annular gasket (60) is made from felt of natural or synthetic fibres. 30
9. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the annular gasket (60) is made with polymer-based plastic materials. 35
10. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 9, **characterised in that** the annular gasket (60) is made with fluorinated polymers. 40
11. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 9, **characterised in that** the annular gasket (60) is made with olefin polymers. 45
12. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the inner surfaces of the bell-shaped deflecting element (51) and upper surface of the locking ring (54) have a roughness of less than 1.2 micrometres. 50 55
13. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the fric-

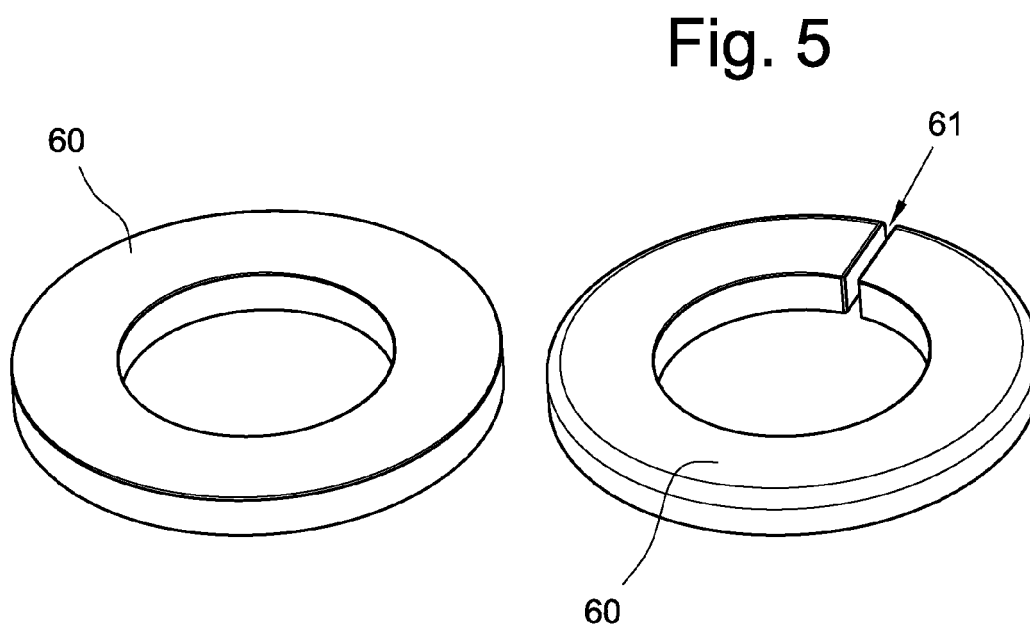
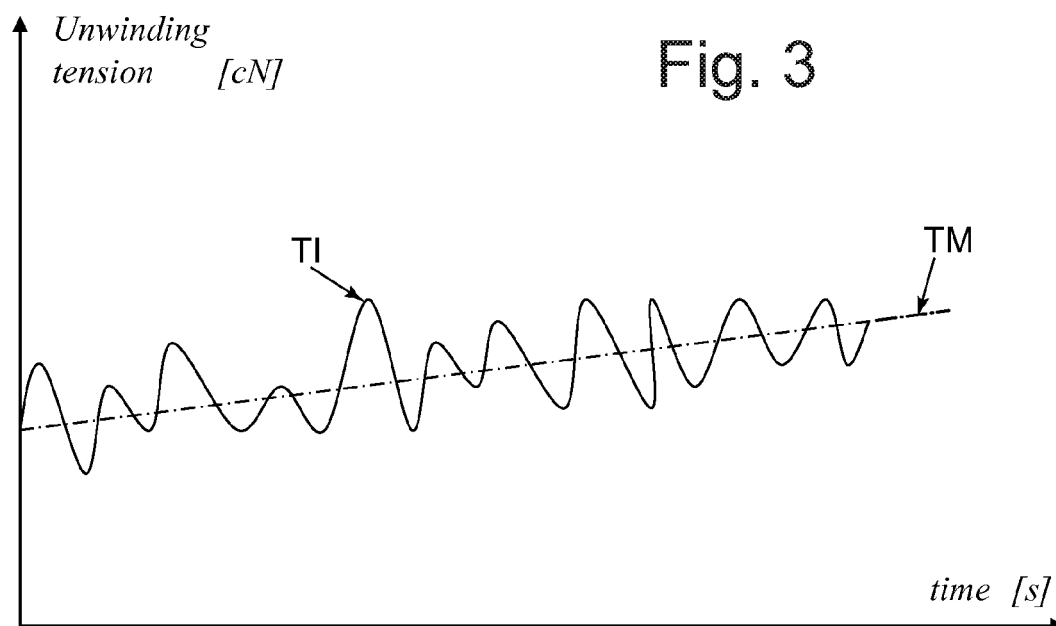
tion coefficient values of the outer surface of the bell shaped element (51) with the yarn (F) are between 0.1 and 0.3.

- 5 14. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the annular gasket (60) is made in closed form.
- 10 15. Device for automatically adjusting the inlet tension of yarn into the inner balloon (B) in four-twist spindles according to claim 1, **characterised in that** the annular gasket is made in open form, making a cut (61) in its circumference.

Fig. 1







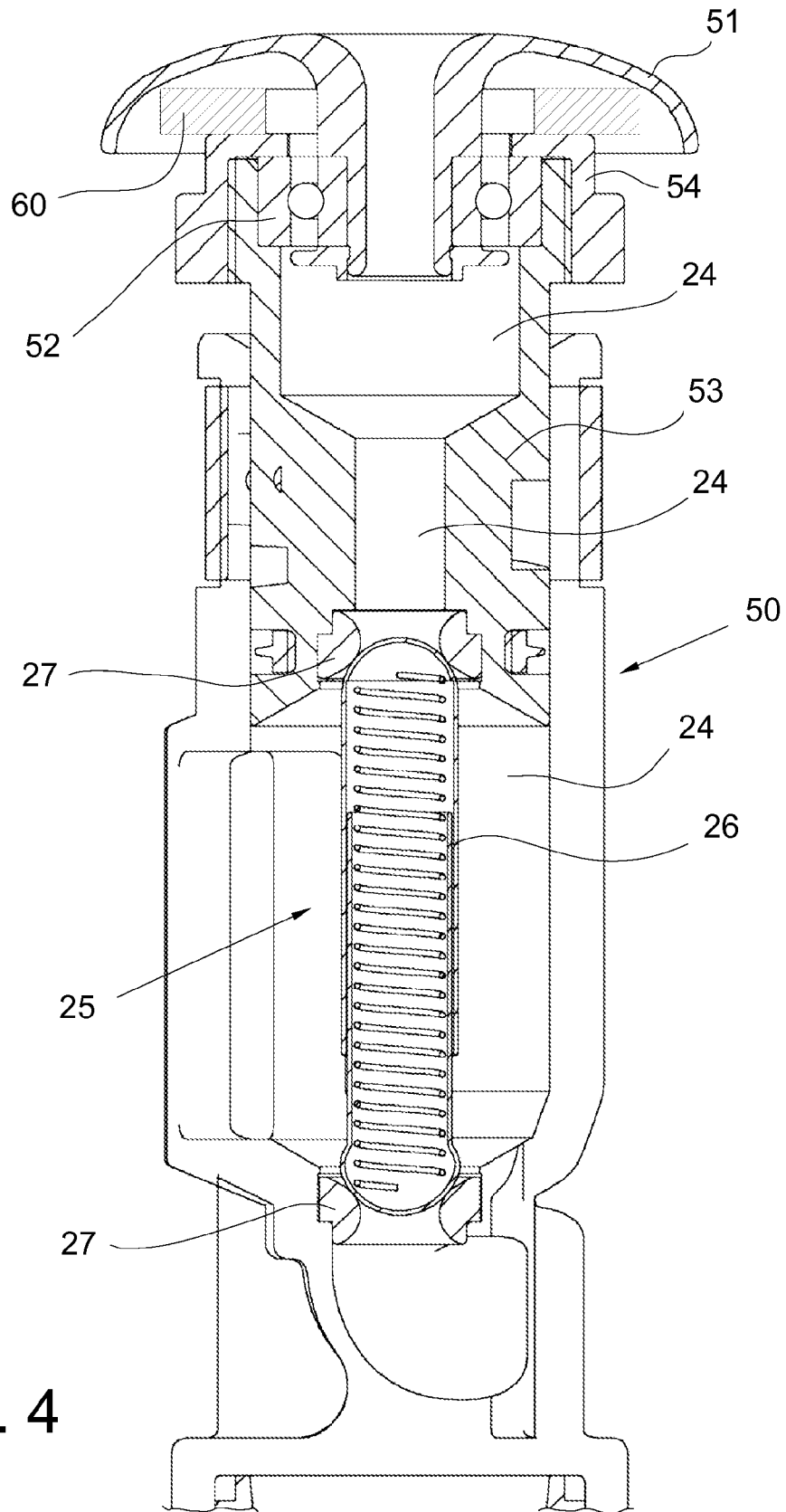


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 11 15 4974

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			D01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 May 2011	Examiner Dupuis, Jean-Luc
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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06-05-2011

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