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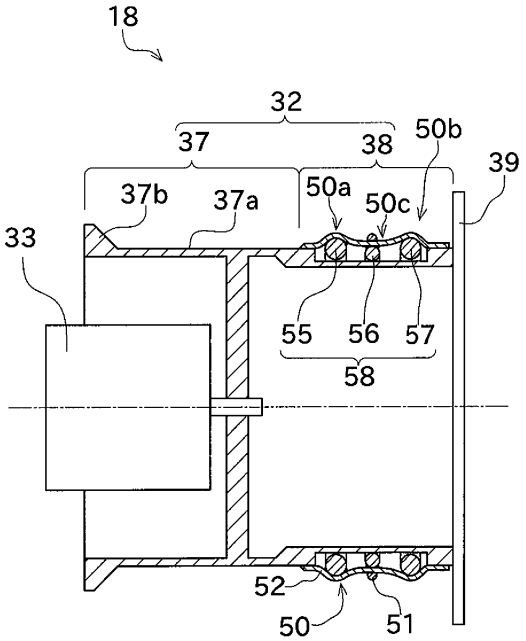
(54) YARN STORAGE DEVICE AND YARN WINDING DEVICE

(57) A yarn accumulation device (18) is configured to wind and accumulate a yarn on a yarn accumulation part (37) that is formed on an outer circumferential surface of a yarn accumulation roller (32), the yarn being unwound from the yarn accumulation part (37) in a direction along a rotation axis of the yarn accumulation roller (32). The yarn accumulation device (18) includes a tension applying part (38). The tension applying part (38) is arranged at an unwinding side of the yarn accumulation part (37). The tension applying part (38) is configured to rotate integrally with the yarn accumulation part (37) and in this condition applies a tension to the yarn being unwound from the yarn accumulation part (37). The tension applying part (38) includes a rubber ring (51) made of an expandable elastic material, and an enlarged/reduced portion (50) provided radially inside the rubber ring (51) and configured such that the yarn is nipped between the enlarged/reduced portion (50) and the rubber ring (51). The enlarged/reduced portion (50) is configured to enlarge or reduce its diameter in accordance with the speed of rotation of the yarn accumulation roller (32).

Fig.3



EP 2 674 378 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a yarn accumulation device included in a yarn winding machine, and more specifically relates to a mechanism in a yarn accumulation device for applying a tension to a yarn that is unwound from the yarn accumulation device.

BACKGROUND ART

[0002] In a yarn winding machine such as a spinning machine, a yarn accumulation device is known that temporarily accumulates a yarn by winding the yarn on a yarn accumulation roller.

[0003] In this type of yarn accumulation device, the yarn is pulled out along an extension of the axis line of the yarn accumulation roller, and thereby the yarn wound on the yarn accumulation roller is unwound. Here, the yarn accumulated on the yarn accumulation roller is wound in a helical shape on an outer circumferential surface of the yarn accumulation roller. Therefore, while the yarn pulled out from the yarn accumulation roller is unwound, the yarn is thrown around on the circumference of the yarn accumulation roller. At this time, the trajectory of the yarn being unwound expands outward due to a centrifugal force, and when the yarn is excessively thrown around, the unwinding of the yarn from the roller may be unstable. A portion in which the trajectory of the yarn being unwound expands as described above is called a balloon.

[0004] Ideally, when the yarn is pulled out from the yarn accumulation roller in this yarn accumulation device, the yarn wound in a helical shape is orderly unwound from the end side. However, in a case where an extremely small force is required for pulling out the yarn from the yarn accumulation roller (in a case where a resistance in pulling out the yarn is low), a mass of the yarn wholly falls off from the yarn accumulation roller at one time only with slight pulling of the yarn existing on the yarn accumulation device. This phenomenon in which a mass of yarn falls off at one time is called slaffing.

[0005] In this respect, in a fine spinning machine disclosed in Patent Document 1, a yarn accumulation device (yam loosening removal device) includes a flyer that is rotatable relative to the yarn accumulation roller while being engaged in a yam. This flyer is configured to cause a torque in the direction against the relative rotation. This can prevent excessive throwing-around of the yarn that is unwound from the yarn accumulation roller while being engaged in the flyer. Thus, occurrence of the balloon is suppressed, and unwinding of the yarn can be stabilized.

[0006] In the configuration shown in Patent Document 1, the yarn unwound from the yarn accumulation roller causes the relative rotation of the flyer against the torque. Due to the reaction thereof, a force is received from the flyer. The force received from the flyer causes a resistance in unwinding of the yarn from the yarn accumulation roller. Thus, the yarn receives the resistance when being unwound from the yarn accumulation roller, which consequently makes it difficult that the yarn falls off at once. As a result, occurrence of the slaffing, in which a mass of yarn existing on the yarn accumulation roller falls off, can be prevented.

[0007] Since the yarn receives the resistance when being unwound from the yarn accumulation device in the above-described manner, it is possible to keep the yarn tightened at a location between the flyer and a winding device that winds the yarn at the downstream of the flyer. Thus, an appropriate degree of tension can be applied to the yarn that is wound in the winding device. Therefore, a package with a high quality can be formed.

[0008] In the fine spinning machine shown in Patent Document 1, an increase in the winding speed in the winding device causes an increase in the speed of unwinding of the yarn from the yarn accumulation device. As a result, the speed of relative rotation of the flyer also increases. However, the speed of relative rotation of the flyer has a limitation in its own. Therefore, when the speed of unwinding of the yarn exceeds the limitation in the speed of relative rotation of the flyer, a delay occurs in the rotation of the flyer. This may cause failures such as occurrence of the balloon and winding of the yarn onto the flyer. Accordingly, in a yarn winding machine including the yarn accumulation device of Patent Document 1, there is a limitation in increasing the speed of winding of the yarn. Here, in a yarn winding machine including the yarn accumulation device with the flyer, the winding speed is limited to about 500m/min.

[0009] The fine spinning machine has a relatively low winding speed, and therefore can normally wind the yarn even in a case of adopting the yarn accumulation device with the flyer (the configuration shown in Patent Document 1). On the other hand, for example, in an automatic winder having a relatively high winding speed, the winding speed exceeds the limitation in the speed of rotation of the flyer, and therefore using of the yarn accumulation device with the flyer is difficult. Additionally, the automatic winder winds the yarn onto a wound bobbin while traversing (cross-winding) the yam. This traversing causes a periodic change in the speed. Moreover, the automatic winder performs a so-called disturb control in which the winding speed is rapidly changed in order to break a ribbon winding of the yam. Since the flyer has inertia, it is difficult that the rotation of the flyer follows such a change in the winding speed. This also presents a problem in applying the yarn accumulation device with the flyer to the automatic winder.

[0010] In this respect, a yarn joining winding device disclosed in Patent Document 2 includes a yarn accumulation device (length-measurement/accumulation part) provided with no flyer. In such a configuration in which a member (flyer) that causes a relative rotation is not provided, the above-described problem involved in the flyer does not occur even during a high-speed rotation

of the yarn accumulation device. The yarn accumulation device shown in Patent Document 2 includes, instead of the flyer, a stopper flange provided at the distal end of an accumulation drum part. Providing such a stopper flange can prevent occurrence of the phenomenon (slaffing) in which a mass of the yarn accumulated on the accumulation drum part falls off at one time. However, merely providing the stopper flange is not enough to give an appropriate resistance to the yarn that is unwound from the accumulation drum part. Therefore, it is impossible to prevent occurrence of a balloon during a high-speed rotation. Thus, the configuration shown in Patent Document 2 cannot be directly applied to the automatic winder.

[0011] Accordingly, the applicant has discussed a yarn accumulation device including a rubber ring instead of the flyer. To be specific, as shown in FIG. 11, this yarn accumulation device 100 is configured such that a rubber ring 102 is attached to an end portion, at the unwinding side, of a yarn accumulation roller 101 made of a metal, so that a yarn 99 unwound from the yarn accumulation roller 101 passes through a space between a surface of the yarn accumulation roller 101 and the rubber ring 102. The diameter of the rubber ring 102 is set smaller than the outer diameter of the yarn accumulation roller 101 under the condition that no load is applied thereto. This configuration causes the rubber ring 102 to squeeze an outer circumferential surface of the yarn accumulation roller 101. As a result, the yarn 99 can be nipped with a weak force in its portion passing through the space between the surface of the yarn accumulation roller 101 and the rubber ring 102. This enables an appropriate degree of resistance to be applied to the yarn 99 when the yarn 99 is unwound from the yarn accumulation roller 101.

[0012] As described above, the yarn accumulation device 100 shown in FIG. 11 has a very simple configuration in which the rubber ring 102 is attached to the yarn accumulation roller 101, but nevertheless is able to apply an appropriate degree of resistance to the yarn 99 that is unwound from the yarn accumulation roller 101. This can prevent occurrence of a balloon, slaffing, and the like, and additionally can apply an appropriate degree of tension to a yarn located downstream of the yarn accumulation device 100. The configuration shown in FIG. 11, which does not include a movable part such as a flyer, is excellent in the followability to a rapid change in the winding speed. Moreover, the rubber ring 102 causes an appropriate degree of frictional effect relative to the yarn 99 passing under the rubber ring 102, and rolls the yarn in a twist direction to thereby twist fluff in. Therefore, the effect of reducing fluff of the yarn 99 is highly exerted, which is an excellent feature of the rubber ring 102. Particularly, NBR (nitrile rubber) with an excellent abrasion resistance, or the like, is suitable for the material of the rubber ring 102.

[0013] Patent Document 3 discloses a configuration in which a yarn is nipped between a finger that extends from a yarn accumulator and a ring that is arranged around the finger. Patent Document 3 states that this configuration exerts a higher yarn pull-out tension and accordingly a relatively balanced yarn pull-out tension. However, in the configuration shown in Patent Document 3, it is necessary to form a plurality of fingers that act elastically toward the outside of the yarn accumulator. This increases the manufacturing cost. Additionally, in the configuration shown in Patent Document 3, a jacket surface is discontinued in the finger portion with respect to the circumferential direction. Thus, the yarn that is unwound while sliding at a position corresponding to this finger would be damaged. In this respect, the very simple configuration shown in FIG. 11 is achieved merely by providing the rubber ring. This enables a low manufacturing cost and small damage to the yam.

PRIOR-ART DOCUMENTS

PATENT DOCUMENTS

[0014]

Patent Document 1: Japanese Patent Application Laid-Open No. 2010-77576
Patent Document 2: Japanese Patent Application Laid-Open No. 2004-131276
Patent Document 3: Japanese Patent Application Laid-Open No. 63-262376 (1988)

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0015] In the yarn accumulation device 100 shown in FIG. 11, when the yarn accumulation roller 101 rotates, a centrifugal force acts on the rubber ring 102. The rubber ring 102 made of NBR has a low rate of elasticity of about 50%, and in other words, does not have "viscosity (elasticity)". Therefore, upon reception of the centrifugal force, the rubber ring 102 is easily separated from the surface of the yarn accumulation roller 101. Separation of the rubber ring 102 from the surface of the yarn accumulation roller 101 results in a failure to give an appropriate resistance to the yarn 99 that is unwound from the yarn accumulation roller 101. Consequently, occurrence of a balloon and slaffing cannot be prevented. Moreover, an appropriate tension cannot be applied to the yarn located downstream of the yarn accumulation device 100.

[0016] To deal with the above-described problems, it is conceivable to adopt a rubber ring (a rubber ring having a smaller diameter) configured to exert such a squeezing force that is able to act against the centrifugal force exerted during a high-speed rotation of the yarn accumulation roller 101. In this case, however, during a low-speed rotation (when the centrifugal force is small), the rubber ring 102 squeezes the yarn accumulation roller 101 with an excessive force. Therefore, an excessive

resistance is given when the yarn 99 is pulled out from the yarn accumulation roller 101 during a low-speed rotation. This causes another problem that, during a low-speed rotation, the stretched yarn 99 is broken when the yarn 99 is pulled out from the yarn accumulation roller 101.

[0017] It is also conceivable to adopt a rubber ring (elastic band) made of natural rubber instead of the rubber ring made of NBR. The rubber ring made of natural rubber has a rate of elasticity of 500% to 900%, and in other words, has "viscosity (elasticity)". Therefore, even when the centrifugal force acts on the rubber ring, the rubber ring can be kept in tight contact with the surface of the yarn accumulation roller 101 without separation therefrom. Thus, it is not necessary that the squeezing exerted by the rubber ring is made too strong so as to withstand the centrifugal force in a high-speed rotation. This can prevent the yarn from being stretched and broken during a low-speed rotation. In a case where the yarn accumulation device 100 shown in FIG. 11 adopts a rubber ring made of natural rubber, no problem occurs in the accumulation of the yarn and an acceptable yarn winding speed ranges from a low speed to a high speed (for example, 1200 m/min), as long as the rubber ring is fresh.

[0018] However, a rubber ring made of natural rubber does not have durability, and involves a problem that a surface of the rubber ring is shortly deteriorated due to friction with the yarn. Moreover, since the natural rubber has adhesion properties, for example, a problem arises that fibers, cotton fly, and the like, of the yarn are entwined to form a lump. Furthermore, even though the rubber ring made of natural rubber has a high rate of elasticity, a reduction in the resistance given to the yarn during a high-speed rotation of the yarn accumulation roller 101 cannot be avoided because the centrifugal force acts on the side where the rubber ring is opened.

[0019] The present invention has been made in view of the circumstances described above, and a primary object of the present invention is to provide a yarn accumulation device that is able to cover a wide range of winding from a low-speed winding to a high-speed winding.

MEANS FOR SOLVING THE PROBLEMS AND EFFECTS THEREOF

[0020] Problems to be solved by the present invention are as described above, and next, means for solving the problems and effects thereof will be described.

[0021] In a first aspect of the present invention, a yarn accumulation device having the following configuration is provided. The yarn accumulation device is a yarn accumulation device configured to wind and accumulate a yarn on a yarn accumulation part that is formed on an outer circumferential surface of a rotating element, the yarn being unwound from the yarn accumulation part in a direction along a rotation axis of the rotating element, the yarn accumulation device including a tension applying part. The tension applying part is arranged at an unwinding side of the yarn accumulation part, and configured to rotate in synchronization with the yarn accumulation part and in this condition apply a tension to the yarn being unwound from the yarn accumulation part. The tension applying part includes a ring member made of an expandable elastic material, and an enlarged/reduced portion provided radially inside the ring member and configured such that the yarn is nipped between the enlarged/reduced portion and the ring member. The enlarged/reduced portion is configured to enlarge or reduce its diameter in accordance with the speed of rotation of the rotating element.

[0022] Nipping the yarn between the ring member made of the elastic material and the enlarged/reduced portion in this manner can apply a tension to the yarn being unwound from the yarn accumulation part. The enlarged/reduced portion is configured to enlarge or reduce its diameter in accordance with the speed of rotation of the rotating element. Accordingly, even in a case where the ring member expands outward due to a centrifugal force when the speed of rotation increases, the ring member and the enlarged/reduced portion can be kept in tight contact with each other. Thereby, an appropriate tension can be applied to the yarn during rotations including a low-speed rotation and a high-speed rotation.

[0023] Preferably, the yarn accumulation device is configured as follows. A recess for restricting movement of the ring member in a direction of the rotation axis of the rotating element is provided in the enlarged/reduced portion. Additionally, the ring member is attached in the recess of the enlarged/reduced portion.

[0024] This can prevent the ring member from being dragged by the yarn pulled out from the yarn accumulation device and consequently detached.

[0025] In the yarn accumulation device, it is preferable that the enlarged/reduced portion has a recess maintaining mechanism for maintaining the recess irrespective of enlargement and reduction in the diameter of the enlarged/reduced portion.

[0026] Accordingly, detachment of the ring member from the enlarged/reduced portion can be prevented during both a high-speed rotation and a low-speed rotation.

[0027] Preferably, the yarn accumulation device is configured as follows. An outer circumferential surface of the enlarged/reduced portion is constituted of an elastic film made of a film-like elastic material. The recess maintaining mechanism includes a concavity/convexity maintaining ring portion that is formed along a circumferential direction of the enlarged/reduced portion. The concavity/convexity maintaining ring portion is made of an elastic material, and arranged inside the elastic film.

[0028] Thus, arranging the concavity/convexity maintaining ring portion having an appropriate diameter inside the elastic film can form a recess in an outer surface of the elastic film (in the outer circumferential surface of the enlarged/reduced portion). Since the concavity/convexity maintaining ring portion is made of the elastic material,

the diameter of the concavity/convexity maintaining ring portion can be enlarged and reduced. Therefore, the diameter of the enlarged/reduced portion can be enlarged and reduced while the shape of the recess is maintained.

[0029] Preferably, the yarn accumulation device is configured as follows. A disk member is provided in an end portion of the rotating element at the unwinding side. The disk member has a diameter larger than an outer diameter of the enlarged/reduced portion under a state where the rotating element is stopped. The enlarged/reduced portion is provided between the yarn accumulation part and the disk member.

[0030] Accordingly, the yarn unwound from the yarn accumulation part comes into contact with the enlarged/reduced portion, and then is separated away from the enlarged/reduced portion, to travel while being guided by the disk member. Guiding the yarn in this manner can reduce the area over which the yarn is in contact with the enlarged/reduced portion. This can prevent fluffing of the yarn and a deterioration in the physical properties of the yam. This can also prevent a situation where the enlarged/reduced portion is rubbed by the yarn and damaged when the yarn is pulled out.

[0031] In the yarn accumulation device, it is preferable that a portion of the ring member that cooperates with the enlarged/reduced portion to nip the yarn therebetween is formed as a plane-shaped portion.

[0032] This can prevent the ring member from being twisted on the enlarged/reduced portion. Thus, a stable tension can be applied to the yarn.

[0033] In the yarn accumulation device, it is preferable that a drive part for enlarging or reducing the diameter of the enlarged/reduced portion is provided.

[0034] This enables a tension applied to the yarn to be not only kept constant but also increased or reduced.

[0035] In a second aspect of the present invention, a yarn accumulation device having the following configuration is provided. The yarn accumulation device is a yarn accumulation device configured to wind and accumulate a yarn on a yarn accumulation part that is formed on an outer circumferential surface of a rotating element, the yarn being unwound from the yarn accumulation part in a direction along a rotation axis of the rotating element, the yarn accumulation device including a tension applying part. The tension applying part is arranged at an unwinding side of the yarn accumulation part, and configured to rotate in synchronization with the yarn accumulation part and in this condition apply a tension to the yarn being unwound from the yarn accumulation part. The tension applying part includes a first ring-shaped elastic element, a synchronized rotation member, a second ring-shaped elastic element, and a cylindrical member. The first ring-shaped elastic element is mounted on a surface of the rotating element. The synchronized rotation member is arranged radially outside the rotating element, and configured to rotate in synchronization with the rotating element. The second ring-shaped elastic element is provided to the synchronized rotation member. The cylindrical member is provided to the synchronized rotation member such that the cylindrical member is opposed, from the radially outside, to the first ring-shaped elastic element. Under a state where the rotating element is stopped, the first ring-shaped elastic element is not in contact with the cylindrical member while the second ring-shaped elastic element is in contact with the surface of the rotating element. When the yarn accumulated on the yarn accumulation part is unwound, the yarn passes through a space between the first ring-shaped elastic element and the cylindrical member and a space between the second ring-shaped elastic element and the surface of the rotating element.

[0036] In this configuration, during a low-speed rotation of the rotating element, a tension is applied to the yarn by the surface of the rotating element and the second ring-shaped elastic element. In a high-speed rotation of the rotating element, a force acting in a direction that separates the second ring-shaped elastic element away from the rotating element is caused by a centrifugal force, and therefore the second ring-shaped elastic element can no longer apply an appropriate tension to the yarn. However, in a range of the high-speed rotation, the first ring-shaped elastic element is pressed to the cylindrical member due to a centrifugal force. Accordingly, during a high-speed rotation, a tension is applied to the yarn by the first ring-shaped elastic element and the cylindrical member. Thus, an appropriate tension can be applied to the yarn during both a low-speed rotation and a high-speed rotation.

[0037] In a third aspect of the present invention, a yarn winding machine including the above-mentioned yarn accumulation device and having the following configuration is provided. The yarn winding machine includes a yarn supply part that supplies a yarn, a yarn joining device that joins yarn ends that have been disconnected, the yarn accumulation device, a tension applying device that applies a tension to the yarn, and a winding part that winds the yarn supplied from the yarn supply part and forms a package. The yarn supply part, the yarn joining device, the yarn accumulation device, the tension applying device, and the winding part are arranged in this order along a direction of traveling of the yam. Even while the yarn joining device is performing a yarn joining operation, the winding part is able to continue winding with the tension applying device applying a tension to the yarn unwound from the yarn accumulation device.

[0038] That is, the yarn accumulation device is able to apply a constant tension to the yarn that is being unwound during both a low-speed rotation and a high-speed rotation. This facilitates a tension control performed by the tension applying device that is arranged downstream of the yarn accumulation device. Additionally, since the winding part winds the yarn accumulated on the yarn accumulation device, the winding operation can be continued without receiving any influence of the yarn joining operation and a fluctuation in the unwinding tension in the yarn supply part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039]

[FIG. 1] A side view of a winder unit provided in an automatic winder according to an embodiment of the present invention.
[FIG. 2] A side view of a yarn accumulation device.
[FIG. 3] A cross-sectional view of the yarn accumulation device.
[FIG. 4] A perspective view showing an external appearance of a tension applying part.
[FIG. 5] A cross-sectional view of the tension applying part during a low-speed rotation.
[FIG. 6] A cross-sectional view of the tension applying part during a high-speed rotation.
[FIG. 7] A cross-sectional view of a yarn accumulation device according to a second embodiment.
[FIG. 8] A cross-sectional view of a yarn accumulation device according to a third embodiment.
[FIG. 9] A cross-sectional view of a tension applying part according to the third embodiment during a low-speed rotation.
[FIG. 10] A cross-sectional view of the tension applying part according to the third embodiment during a high-speed rotation.
[FIG. 11] A side view of a conventional yarn accumulation device.

EMBODIMENT FOR CARRYING OUT THE INVENTION

[0040] Next, embodiments of the present invention will be described. FIG. 1 is a side view showing an outline of a winder unit 2 provided in an automatic winder that is a yarn winding machine according to a first embodiment of the present invention. The automatic winder of this embodiment is configured with a number of winder units 2 arranged side by side. This automatic winder includes a machine management device (not shown) and a blower box (not shown). The machine management device collectively manages the winder units 2. The blower box includes a compressed air source and a negative pressure source.

[0041] As shown in FIG. 1, the winder unit 2 mainly includes a yarn supply part 7 and a winding part 8. The winder unit 2 is configured to unwind a yarn (spun yam) 20 from a yarn supply bobbin 21 that is supported on the yarn supply part 7 and rewind the yarn 20 into a package 30. FIG. 1 shows a state of the winder unit 2 at a time of normal winding. In the description herein, the "time of normal winding" indicates a state where the yarn is continuous between the yarn supply bobbin 21 and the package 30 and additionally the yarn is being unwound from the yarn supply bobbin 21 and wound into the package 30.

[0042] The yarn supply part 7 is configured to hold the yarn supply bobbin 21, which is for supplying a yarn, in a substantially upright state. The yarn supply part 7 is also configured to discharge the yarn supply bobbin 21 that is empty. The winding part 8 includes a cradle 23 and a traverse drum 24. The cradle 23 is configured such that a wound bobbin 22 is mounted thereon. The traverse drum 24 is configured to traverse the yarn 20 and drive the wound bobbin 22.

[0043] The traverse drum 24 is arranged opposed to the wound bobbin 22. The traverse drum 24 is driven in rotation, and thereby the wound bobbin 22 is accordingly rotated. This enables the yarn 20 accumulated on a yarn accumulation device 18 which will be described later to be wound onto the wound bobbin 22. A traverse groove (not shown) is formed in an outer circumferential surface of the traverse drum 24. The traverse groove allows the yarn 20 to be traversed (cross-wound) with a predetermined width. In the above-described configuration, the yarn 20 is wound on the wound bobbin 22 while being traversed, to form the package 30 having a predetermined length and a predetermined shape. In the following description, the terms "upstream side" and "downstream side" mean the upstream side and the downstream side with respect to a direction of traveling of the yam.

[0044] Each of the winder units 2 includes a control part 25. The control part 25 is composed of hardware such as a CPU, a ROM, and a RAM (not shown), and software such as a control program stored in the RAM. The hardware and the software cooperate with each other, to control each configuration part of the winder unit 2. The control part 25 included in each winder unit 2 is configured to communicate with the machine management device. Accordingly, the machine management device can collectively manage operations of the plurality of winder units 2 included in the automatic winder.

[0045] The winder unit 2 also includes various devices that are arranged in a yarn travel path between the yarn supply part 7 and the winding part 8. More specifically, in the yarn travel path, an unwinding assist device 10, a lower yarn blow-up part 11, a first tension applying device 12, an upper yarn catch part 13, a yarn joining device 14, a yarn trap 15, a cutter 16, a clearer (yam defect detection device) 17, an upper yarn pull-out part 48, a yarn accumulation device 18, and a second tension applying device 19, are arranged in this order from the yarn supply part 7 side toward the winding part 8 side.

[0046] The unwinding assist device 10 assists the unwinding of the yarn 20 by bringing a movable member 40 into contact with a balloon, which is generated above the yarn supply bobbin 21 as a result of the yarn 20 being unwound from the yarn supply bobbin 21 and thrown around, and thereby appropriately controlling the size of the balloon.

[0047] The lower yarn blow-up part 11 is an air sucker device arranged immediately downstream of the unwinding assist device 10. The lower yarn blow-up part 11 is configured to blow up a lower yarn of the yarn supply bobbin 21 side toward the yarn joining device 14 side. When the yarn 20 is disconnected at a location between the yarn supply bobbin 21 and the yarn accumulation

device 18, the lower yarn blow-up part 11 can blow up the yarn of the yarn supply bobbin 21 and guide the yarn to the yarn joining device 14.

[0048] The first tension applying device 12 applies a predetermined tension to the yarn 20 that is traveling. In this embodiment, the first tension applying device 12 is configured as a gate type in which a movable comb is arranged relative to a fixed comb. When a yarn travels between the combs, a predetermined resistance is applied thereto. The movable comb is movable by means of a solenoid, which allows adjustment of the state of engagement between the combs. The control part 25 controls the solenoid and thereby can adjust the tension that the first tension applying device 12 applies to the yam. However, a configuration of the first tension applying device 12 is not limited to this. For example, a disk type tension applying device is also adoptable.

[0049] The upper yarn catch part 13 is arranged immediately upstream of the yarn joining device 14. The upper yarn catch part 13 is connected to a negative pressure source (not shown), and configured to generate a suction air stream to suck and catch the yarn of the yarn accumulation device 18 side at a time of yarn joining (details will be given later).

[0050] The yarn trap 15 is arranged upstream of the cutter 16 and immediately downstream of the yarn joining device 14. A distal end of the yarn trap 15 is formed as a tube-like member, which is provided close to the travel path of the yarn 20 and connected to a negative pressure source (not shown). In this configuration, the suction air stream is generated at the distal end of the yarn trap 15. and thereby dusts such as cotton fly adhering to the traveling yarn 20 can be sucked and removed.

[0051] The clearer 17 is configured to detect a yarn defect (yarn fault) such as a slub by, for example, monitoring a yarn thickness of the yarn 20. When the clearer 17 detects a yarn defect, the clearer 17 transmits a disconnection signal to, for example, the control part 25. The disconnection signal instructs to cut and remove the yarn defect. The cutter 16 is arranged near the clearer 17, for immediately cutting the yarn 20 in response to the disconnection signal.

[0052] The upper yarn pull-out part 48 is an air sucker device, and configured to, at a time of yarn joining, pull out a yarn accumulated on the yarn accumulation device 18 and blow off the yarn toward a yarn guide member 60 (which will be described later).

[0053] The yarn accumulation device 18 includes a yarn accumulation roller 32 having a substantially cylindrical shape, and a roller drive motor 33 configured to drive the yarn accumulation roller 32 in rotation around the axis line thereof which serves as a rotation axis. The roller drive motor 33 is controlled by the control part 25. In this configuration, the yarn accumulation roller 32 is driven in rotation, and in this condition, the yarn 20 unwound from the yarn supply bobbin 21 is wound onto a circumference of the yarn accumulation roller 32. Thereby, the yarn 20 can be temporarily accumulated on the yarn accumulation roller 32. The yarn accumulated on the yarn accumulation roller 32 is pulled out in a direction along the axis line of the yarn accumulation roller 32, and then wound by the winding part 8. A detailed configuration of the yarn accumulation device 18 will be described later.

[0054] The yarn joining device 14 performs yarn joining between a yarn of the yarn supply bobbin 21 side and a yarn of the yarn accumulation device 18 side when the yarn is disconnected between the yarn supply bobbin 21 and the yarn accumulation device 18, which occurs, for example, at a time of yarn cutting in which the clearer 17 detects a yarn defect so that the cutter 16 cuts the yarn, at a time of yarn breakage in which the yarn being unwound from the yarn supply bobbin 21 is broken, or at a time of replacing the yarn supply bobbin 21. As the yarn joining device 14, one using fluid such as compressed air, mechanical one, or the like, is adoptable.

[0055] The second tension applying device 19 applies a predetermined tension to the yarn that has been pulled out from the yarn accumulation device 18, thereby controlling the tension of the yarn 20 at a time when the yarn 20 is wound by the winding part 8. The second tension applying device 19 is configured as a gate type tenser, which is similar to the first tension applying device. The control part 25 appropriately controls a solenoid of the second tension applying device 19, and thereby can adjust the tension that the second tension applying device 19 applies to the yarn. However, a configuration of the second tension applying device 19 is not limited to this. For example, a disk type tension applying device is also adoptable.

[0056] A bobbin feeder 26 of magazine type is arranged at the front side of the winder unit 2. The bobbin feeder 26 includes a rotary magazine can 27. The magazine can 27 is configured to hold a plurality of extra yarn supply bobbins 21. The bobbin feeder 26 intermittently drives and rotates the magazine can 27, and thereby feeds a new yarn supply bobbin 21 to the yarn supply part 7. The bobbin feeder 26 includes a yarn end holder 28 for sucking and holding a yarn end of the yarn supply bobbin 21 held on the magazine can 27.

[0057] Next, a yarn joining operation performed in the automatic winder of this embodiment will be described.

[0058] The yarn joining device 14 performs the yarn joining operation when the yarn of the yarn accumulation device 18 side and the yarn of the yarn supply bobbin 21 side are disconnected from each other because of yarn breakage, yarn cutting by the cutter 16. replacement of the yarn supply bobbin 21, or the like. To be specific, firstly, the control part 25 causes the lower yarn blow-up part 11 to blow up the yarn 20 of the yarn supply bobbin 21 side in an upward direction. The yarn 20 thus blown up is sucked and caught by the yarn trap 15. The yarn trap 15 is movable by a yarn trap driver 47. When the yarn trap 15 is moved under a state where the yarn trap 15 sucks and catches a yarn end of the yarn of the yarn supply bobbin 21 side, the yarn of the yarn supply bobbin 21 side can be introduced to the yarn joining device 14.

[0059] Around this time, the control part 25 puts the yarn accumulation roller 32 of the yarn accumulation device 18 into reverse rotation, and in this condition causes the upper yarn pull-out part 48 to blow off the yarn 20 existing on the yarn accumulation roller 32. The direction in which the upper yarn pull-out part 48 blows off the yarn 20 is oriented to a position where a yarn guide member 60 having a curved tube-like shape is arranged. The yarn 20 thus blown off is taken into the yarn guide member 60 from one end of the yarn guide member 60 and, along with an air stream, guided to the other end of the yarn guide member 60. An exit from the yarn guide member 60, which is provided at the other end thereof, is oriented toward a position where the upper yarn catch part 13 is arranged. In the above-described configuration, the yarn 20 of the yarn accumulation roller 32 side, which has been blown off by the upper yarn pull-out part 48, is sucked and caught by the upper yarn catch part 13. In the yarn guide member 60 having a tube-like shape, a slit extending in a longitudinal direction thereof is formed. Through this slit, the yarn 20 located in the yarn guide member 60 can be drawn out to the outside. The yarn drawn out from the yarn guide member 60 is further sucked by the upper yarn catch part 13, and thereby introduced to the yarn joining device 14. When the yarn of the yarn accumulation device 18 side is introduced to the yarn joining device 14, the control part 25 stops the reverse rotation of the yarn accumulation roller 32.

[0060] Through the above-described operation, the yarn of the yarn supply bobbin 21 side and the yarn of the yarn accumulation device 18 side can be introduced to the yarn joining device 14. In this condition, the control part 25 actuates the yarn joining device 14, to thereby join the yarn of the yarn supply bobbin 21 side and the yarn of the yarn accumulation device 18 side. After the yarn joining operation is completed, the control part 25 restarts a normal rotation of the yarn accumulation device 18, to thereby restart the winding of the yarn onto the yarn accumulation device 18.

[0061] As described above, even when the yarn is disconnected at a location between the yarn supply bobbin 21 and the yarn accumulation device 18, the winding of the yarn 20 into the package 30 in the winding part 8 can be continued without interruption. That is, in the automatic winder of this embodiment, as described above, the yarn accumulation device 18 is interposed between the yarn supply part 7 and the winding part 8, so that a certain amount of the yarn 20 is accumulated on the yarn accumulation device 18. Therefore, even when the supply of the yarn from the yarn supply bobbin 21 is interrupted for some reason (for example, during the yarn joining operation), the winding part 8 is able to wind the yarn that is accumulated on the yarn accumulation device 18. Thus, the winding of the yarn 20 into the package 30 can be continued.

[0062] Since a winding operation of the winding part 8 is not interrupted by the yarn joining operation or the like, the package 30 can be produced stably at a high speed. Additionally, since the yarn accumulation device 18 is interposed between the yarn supply bobbin 21 and the winding part 8, the winding in the winding part 8 can be performed without receiving an influence of a fluctuation in the tension occurring at a time of unwinding the yarn from the yarn supply bobbin 21.

[0063] Next, the yarn accumulation device 18 will be described with reference to FIGS. 2 and 3. As mentioned above, the yarn accumulation device 18 includes the yarn accumulation roller 32.

[0064] The yarn accumulation roller (rotating element) 32 is a roller member having a substantially cylindrical shape, and includes a yarn accumulation part 37 and a tension applying part 38. The yarn accumulation part 37 is formed on an outer circumferential surface of the yarn accumulation roller 32. As shown in FIG. 2, the yarn 20 unwound from the yarn supply bobbin 21 is introduced on one end of the yarn accumulation roller 32 to the outer circumferential surface of the yarn accumulation roller 32, and wound onto the yarn accumulation part 37. Then, the yarn 20 is pulled out through the other end of the yarn accumulation roller 32, and fed to the winding part 8 side. In the following description, with respect to the direction extending along the central axis of the yarn accumulation roller 32, the side of the yarn accumulation roller 32 (shown in the lower left in FIG. 2) on which the yarn of the yarn supply bobbin 21 is introduced to the yarn accumulation roller 32 will be called a base end side, and the side of the yarn accumulation roller 32 (shown in the upper right in FIG. 2) on which the yarn is pulled out from the yarn accumulation roller 32 will be called an unwinding side.

[0065] As shown in FIG. 3, the yarn accumulation part 37 includes a cylindrical portion 37a and a tapered portion 37b. An outer circumferential surface of the yarn accumulation part 37 is made of a metal.

[0066] The cylindrical portion 37a is configured such that a certain amount of the yarn 20 can be wound and accumulated on the outer circumferential surface of the cylindrical portion 37a. More specifically, the yarn of the yarn supply bobbin 21 is introduced to the outer circumferential surface of the cylindrical portion 37a from an end portion of the cylindrical portion 37a at the base end side thereof, and wound in a helical shape on the outer circumferential surface. The roller drive motor 33 drives the yarn accumulation roller 32 into rotation under a state where the yarn 20 is wound on the cylindrical portion 37a, and thereby the yarn 20 can be sequentially wound on a surface of the cylindrical portion 37a. When the yarn 20 newly coming to the end portion of the cylindrical portion 37a at the base end side is wound, the newly coming yarn 20 pushes away the yarn 20 that is already wound on the cylindrical portion 37a toward the end portion of the cylindrical portion 37a at the unwinding side thereof. Accordingly, the yarn 20 accumulated on the surface of the cylindrical portion 37a sequentially moves toward the end portion at the unwinding side. The diameter of the cylindrical portion 37a is not completely constant, but the

cylindrical portion 37a has a small taper whose diameter gradually decreases toward the unwinding side. This facilitates the movement of the yarn wound on the cylindrical portion 37a toward the end portion at the unwinding side.

[0067] The tapered portion 37b is formed continuous with the end portion of the cylindrical portion 37a at the base end side. The tapered portion 37b has a tapered shape whose diameter increases toward the side (base end side) opposite to the cylindrical portion 37a. Since the tapered portion 37b is formed in this manner, the yarn 20 wound on the tapered portion 37b moves from the tapered portion 37b to the cylindrical portion 37a due to the tension applied at a time of the winding. Accordingly, the yarn 20 previously wound on the cylindrical portion 37a is pushed up by the newly wound yarn 20. The yarn 20 sequentially moves from the tapered portion 37b to the cylindrical portion 37a in the above-mentioned manner, and thereby the yarn 20 is regularly wound in a helical shape on the cylindrical portion 37a.

[0068] The yarn 20 accumulated on the yarn accumulation part 37 is unwound toward the unwinding side. At this time, the tension applying part 38 arranged at the unwinding side of the yarn accumulation part 37 gives a predetermined resistance to the yarn being unwound (details will be given later).

[0069] As shown in FIG. 2, a yarn guide 29 for guiding a yarn is arranged ahead of the end portion of the tension applying part 38 at the unwinding side. The yarn guide 29 is configured to guide a yarn in a predetermined position on an extension of the rotation axis of the yarn accumulation roller 32. This enables the yarn 20 wound in a helical shape on the yarn accumulation roller 32 to be pulled out in the direction along the axis line of the yarn accumulation roller 32 when the yarn 20 is unwound from the yarn accumulation roller 32. The yarn 20, to which a tension has been applied by the tension applying part 38, is wound up to the downstream side (winding part 8 side) via the yarn guide 29.

[0070] As shown in FIG. 2, an upper limit sensor 36 and a lower limit sensor 35 are arranged near the yarn accumulation roller 32. The upper limit sensor 36 detects that the amount of the yarn 20 on the yarn accumulation roller 32 reaches a predetermined upper limit amount or more. The lower limit sensor 35 detects that the amount of the yarn 20 on the yarn accumulation roller 32 falls below a predetermined lower limit amount. Detection results of the lower limit sensor 35 and the upper limit sensor 36 are transmitted to the control part 25.

[0071] When the control part 25 detects that the upper limit sensor 36 is turned off and the yarn on the yarn accumulation roller 32 falls below the upper limit amount, the control part 25 appropriately controls the roller drive motor 33 to increase the speed of rotation of the yarn accumulation roller 32. Accordingly, the speed of winding of the yarn 20 onto the yarn accumulation roller 32 increases. As a result, the amount of the yarn 20 accumulated on the yarn accumulation roller 32 can be gradually increased. On the other hand, when the control part 25 detects that the upper limit sensor 36 is turned on and the yarn on the yarn accumulation roller 32 reaches the upper limit amount or more, the control part 25 appropriately controls the roller drive motor 33 to reduce the speed of rotation of the yarn accumulation roller 32. Accordingly, the speed of winding of the yarn 20 onto the yarn accumulation roller 32 decreases. As a result, the amount of the yarn 20 accumulated on the yarn accumulation roller 32 can be gradually reduced. Such a control enables the amount of the yarn 20 accumulated on the yarn accumulation roller 32 to be kept at a substantially constant value near the upper limit amount.

[0072] Additionally, when the control part 25 detects that the lower limit sensor 35 is turned off and the amount of the yarn 20 accumulated on the yarn accumulation roller 32 falls below the lower limit amount, the control part 25 stops the winding of the yarn 20 by the winding part 8. This prevents occurrence of a situation where the winding part 8 fully winds up the yarn existing on the yarn accumulation roller 32.

[0073] Next, a configuration of the tension applying part 38 will be described in detail.

[0074] The tension applying part 38 is configured to rotate integrally with (rotate in synchronization with) the yarn accumulation part 37. The tension applying part 38 includes an enlarged/reduced portion 50 and a rubber ring (ring member) 51.

[0075] As shown in FIG. 3, an outer circumferential surface of the enlarged/reduced portion 50 is constituted of a rubber film 52 (elastic film) made of an elastic material (in this embodiment, made of NBR). A more specific description thereof is as follows. As shown in FIGS. 3 and 4, the yarn accumulation roller 32 includes the rubber film 52 having a substantially cylindrical shape. Both end portions of the rubber film 52 with respect to the axial direction are fixed to an outer circumference of the yarn accumulation roller 32 by appropriate means. Therefore, an outer circumference of the enlarged/reduced portion 50 has a substantially cylindrical shape. The outer diameter of the enlarged/reduced portion 50 is not constant but has concavity and convexity constituted of a first protrusion 50a, a second protrusion 50b, and a recess 50c formed between the first protrusion 50a and the second protrusion 50b.

[0076] The enlarged/reduced portion 50 has a recess maintaining mechanism 58 for maintaining the recess 50c. As shown in FIGS. 3 and 4, the recess maintaining mechanism 58 includes a plurality of concavity/convexity maintaining rings (concavity/convexity maintaining ring portion) 55, 56, and 57 that are arranged radially inside the rubber film 52. Each of the concavity/convexity maintaining rings 55, 56, and 57 is formed with a ring-like shape along the circumferential direction. The concavity/convexity maintaining rings 55, 56, and 57 are made of an elastic material (in this embodiment, made of NBR).

[0077] The plurality of concavity/convexity maintaining rings are arranged side by side in the axial direction of

the yarn accumulation roller 32. The first protrusion maintaining ring 55, the recess maintaining ring 56, and the second protrusion maintaining ring 57 are arranged in this order from the base end side. In a state where no load is applied (the rotation of the yarn accumulation roller 32 is stopped), the diameter of the recess maintaining ring 56 is smaller than the diameters of the protrusion maintaining rings 55 and 57. In this configuration, an outer circumferential surface of the rubber film 52 (the outer circumferential surface of the enlarged/reduced portion 50) has the first protrusion 50a corresponding to the diameter of the first protrusion maintaining ring 55, the recess 50c corresponding to the diameter of the recess maintaining ring 56, and the second protrusion 50b corresponding to the diameter of the second protrusion maintaining ring 57.

[0078] On the other hand, the rubber ring 51 is a ring member made of an elastic material (in this embodiment, made of NBR). The rubber ring 51 is provided in a position corresponding to the recess 50c of the enlarged/reduced portion 50, and arranged radially outside the recess 50c. In a state where no load is applied, the diameter of the rubber ring 51 is slightly smaller than the outer diameter of the recess 50c of the enlarged/reduced portion 50. This configuration causes the rubber ring 51 to squeeze, from the radially outside, a portion of the enlarged/reduced portion 50 corresponding to the recess 50c.

[0079] As shown in FIGS. 2 and 5, when the yarn 20 unwound from the yarn accumulation part 37 is pulled out from the yarn accumulation roller 32, the yarn 20 passes through a space between the outer circumferential surface of the enlarged/reduced portion 50 and the rubber ring 51 in the tension applying part 38. Since the rubber ring 51 squeezes the enlarged/reduced portion 50, the yarn 20 passing through the tension applying part 38 is nipped between the outer circumferential surface of the enlarged/reduced portion 50 and the rubber ring 51. This configuration is able to give an appropriate degree of resistance to the yarn 20 when the yarn 20 is pulled out from the yarn accumulation roller 32. As a result, slaffing can be prevented. Additionally, since a resistance is given to the yarn 20 when the yarn 20 is pulled out from the yarn accumulation roller 32, a portion of the yarn 20 located downstream of the yarn accumulation roller 32 can be kept tightened. Thus, an appropriate degree of tension can be applied to a portion of the yarn 20 located downstream of the yarn accumulation device 18. This enables the winding part 8 to wind up the yarn with an appropriate tension.

[0080] Moreover, the yarn 20 accumulated on the yarn accumulation part 37 is wound in a helical shape on the outer circumferential surface of the cylindrical portion 37a. Therefore, when being unwound from the cylindrical portion 37a, the yarn 20 is thrown around on the circumference of the enlarged/reduced portion 50. In the configuration of this embodiment, the yarn 20 that is thrown around is nipped between the outer circumferential surface of the enlarged/reduced portion 50 and the rubber ring 51. This can prevent the yarn 20 from being excessively thrown around, and thus can prevent occurrence of a balloon. Since the yarn 20 is thrown around when being unwound, the position where the yarn 20 passes in the space between the outer circumferential surface of the enlarged/reduced portion 50 and the rubber ring 51 shifts in the circumferential direction. Such a configuration in which the position where the yarn 20 passes shifts in the circumferential direction can prevent occurrence of a situation where only particular portions of the enlarged/reduced portion 50 and the rubber ring 51 are rubbed by the yarn 20 and worn out in a short time.

[0081] As mentioned above, the rubber ring 51 is attached in the recess 50c of the enlarged/reduced portion 50. Therefore, even though the rubber ring 51 is forced to move in the axial direction of the yarn accumulation roller 32 together with the yarn 20 being unwound, the protrusions 50a and 50b hinder such movement. This configuration can prevent the rubber ring 51 from being detached from the enlarged/reduced portion 50.

[0082] The yarn accumulation device 18 of this embodiment has a disk member 39 provided in an end portion of the enlarged/reduced portion 50 at the unwinding side. The disk member 39 is configured to rotate integrally with the yarn accumulation roller 32. The diameter of the disk member 39 is larger than the outer diameter of the enlarged/reduced portion 50 under a state where the rotation of the yarn accumulation roller 32 is stopped. Accordingly, when the yarn 20 is pulled out from the yarn accumulation roller 32, the yarn 20 is guided by the disk member 39. This can prevent the surface of the rubber film 52 of the enlarged/reduced portion 50 from being strongly rubbed by the yarn 20. As a result, wear-out of the rubber film 52 is reduced, and the durability can be improved. A more detailed description is as follows. As long as the yarn is wound on the yarn accumulation roller 32, the yarn 20 unwound from the yarn accumulation roller 32 is thrown around on the circumference of the rubber film 52 when the yarn 20 is passing. Therefore, a situation where only one portion of the rubber film 52 is strongly rubbed by the yarn 20 does not occur. However, once the yarn 20 accumulated on the yarn accumulation roller 32 is fully unwound, the yarn 20 that is not wound linearly passes through a space between the rubber film 52 and the rubber ring 51. If, at this time, the yarn 20 is in contact with the rubber film 52, a portion of this contact is strongly rubbed by the yarn 20, which may damage the rubber film 52. In this respect, as described above, the disk member 39 is provided, to allow the passing yarn 20 to float above the rubber film 52. This can prevent the yarn 20 from being in entangling contact with the rubber film 52. Thus, damage to the rubber film 52 due to the yarn 20 can be prevented. Additionally, the area over which the yarn 20 is in contact with the rubber film 52 can be reduced. This can consequently prevent fluffing of the yarn 20 and a deterioration in the physical properties of the yarn 20.

[0083] The rubber ring 51 has a plane-shaped portion

as shown in FIG. 5. In other words, when cut along a plane passing through the central axis line of the yarn accumulation roller 32, the rubber ring 51 has a substantially D-shaped (semicircular) cross-section. The rubber ring 51 is, in the plane-shaped portion, in contact with the outer circumferential surface of the enlarged/reduced portion 50. Although it is conceivable that the rubber ring 51 has a circular cross-section, a rubber ring having a circular cross-section is often twisted due to its shape. In this respect, the rubber ring 51 having a substantially D-shaped cross-section as illustrated in this embodiment is not easily twisted. Even if the rubber ring 51 having such a D-shaped cross-section is twisted, the plane-shaped portion thereof tends to be in contact with the enlarged/reduced portion 50, and thereby recovery from the twisting is achieved. Moreover, a rubber ring having a circular cross-section, which makes a point-contact with a yarn, may sometimes cause a stick-slip phenomenon so that a yarn breakage occurs due to a fluctuation in the tension. On the other hand, the rubber ring 51 having a substantially D-shaped cross-section, which makes a line-contact with a yarn, achieves a stable tension application. As thus far described, a substantially D-shaped cross-section makes the rubber ring 51 difficult to be twisted, and additionally causes the rubber ring 51 to be in line-contact with a yarn. Therefore, a resistance given to the yarn 20 passing under the rubber ring 51 is stabilized. This can prevent the yarn 20 from being stretched and broken, and also enables the winding part 8 to wind up the yarn 20 with a stable tension.

[0084] Next, an enlargement/reduction function of the enlarged/reduced portion 50 will be described.

[0085] As already described, the rotation of the yarn accumulation roller causes a centrifugal force to act on the rubber ring, which enlarges the diameter of the rubber ring. Therefore, in the conventional yarn accumulation device (the configuration shown in FIG. 11), it may be impossible to give an appropriate resistance to the yarn passing through the space between the rubber ring and the yarn accumulation roller.

[0086] In the yarn accumulation device 18 of this embodiment, on the other hand, the outer circumferential surface of the enlarged/reduced portion 50 is formed of the rubber film 52. Thus, when a centrifugal force acts on the enlarged/reduced portion 50, the outer diameter of the enlarged/reduced portion 50 is also enlarged, as shown in FIG. 6. That is, the diameter of the enlarged/reduced portion 50 can be enlarged and reduced in accordance with the speed of rotation of the yarn accumulation roller 32. Therefore, with enlargement in the diameter of the rubber ring 51 caused by the centrifugal force, the outer diameter of the enlarged/reduced portion 50 will also be enlarged accordingly. This can prevent the rubber ring 51 from being separated from the surface of the enlarged/reduced portion 50 even during a high-speed rotation. Accordingly, the yarn accumulation device 18 of this embodiment is able to give an appropriate resistance to the yarn 20 passing through the space between the surface of the enlarged/reduced portion 50 and the rubber ring 51 even during a high-speed rotation.

[0087] Since separation of the rubber ring 51 from the surface of the enlarged/reduced portion 50 can be prevented during a high-speed rotation as mentioned above, a rubber ring having a smaller squeezing force (a rubber ring having a relatively large diameter) as compared with the configuration shown in FIG. 11 is applicable. Adoption of a rubber ring having a relatively weak squeezing force can avoid a problem that the yarn 20 is stretched and broken due to an excessive increase in the resistance that is given to the yarn 20 during a low-speed rotation (at a time when the centrifugal force is small).

[0088] Additionally, with enlargement or reduction in the diameter of the rubber ring 51, the outer diameter of the enlarged/reduced portion 50 is enlarged or reduced accordingly. Therefore, in the configuration of this embodiment, the squeezing force of the rubber ring 51 squeezing the enlarged/reduced portion 50 can be kept substantially constant irrespective of the speed of rotation of the yarn accumulation roller 32. Moreover, the enlarged/reduced portion 50 is enlarged and reduced with a good responsiveness relative to a change in the speed of the yarn accumulation roller 32. Due to these characteristics, a certain type of a mechanical system, which can be called an automatic tension control system, is achieved. Therefore, a tension applied to a portion of the yarn 20 located downstream of the yarn accumulation device 18 can be kept substantially constant irrespective of the speed of rotation of the yarn accumulation roller 32. This makes it easy to control the second tension applying device 19 such that the tension of the yarn 20 at the downstream side of the yarn accumulation device 18 is kept within a desired range. As a result, the winding part 8 can form a package with a high quality.

[0089] In this embodiment, the concavity/convexity maintaining rings 55, 56, and 57 included in the recess maintaining mechanism 58 are made of an elastic material (made of NBR). This configuration enables the diameters of the concavity/convexity maintaining rings 55, 56, and 57, too, to be enlarged and reduced in accordance with the speed of rotation of the yarn accumulation roller 32. Therefore, the diameter of the enlarged/reduced portion 50 can be enlarged and reduced while the concavity and convexity thereof are maintained by the recess maintaining mechanism 58. Accordingly, irrespective of the speed of rotation of the yarn accumulation roller 32, the concavity and convexity of the enlarged/reduced portion 50 can prevent the rubber ring 51 from being dragged by the yarn 20 and consequently detached from the enlarged/reduced portion 50.

[0090] In this embodiment, the recess maintaining ring 56 is bonded to the rubber film 52 from the inner side of the rubber film 52, such that a portion of the rubber film 52 corresponding to the recess 50c does not expand and protrude outward due to a centrifugal force. On the other hand, the protrusion maintaining rings 55 and 57 need not always be bonded in such a manner. For example,

in this embodiment, the first protrusion maintaining ring 55 is bonded to the rubber film 52, and the second protrusion maintaining ring 57 is merely arranged inside the rubber film 52 and not bonded to the rubber film 52. This allows the second protrusion maintaining ring 57 to move with a certain amount of freedom in the direction along the rotation axis. Therefore, when the rubber film 52 is deformed by the centrifugal force, the second protrusion maintaining ring 57 can move to a natural position.

[0091] As thus far described, the yarn accumulation device 18 of this embodiment is configured such that the yarn 20 is wound and accumulated on the yarn accumulation part 37 that is provided on the outer circumferential surface of the yarn accumulation roller 32 and such that the yarn 20 is unwound from the yarn accumulation part 37 in the direction along the rotation axis of the yarn accumulation roller 32, and the yarn accumulation device 18 has the tension applying part 38. The tension applying part 38 is arranged at the unwinding side of the yarn accumulation part 37, and configured to rotate integrally with the yarn accumulation part 37 and in this condition apply a tension to the yarn 20 being unwound from the yarn accumulation part 37. The tension applying part 38 includes the rubber ring 51 and the enlarged/reduced portion 50. The rubber ring 51 is made of an expandable elastic material. The enlarged/reduced portion 50 is provided radially inside the rubber ring 51, and configured such that the yarn 20 is nipped between the enlarged/reduced portion 50 and the rubber ring 51. The enlarged/reduced portion 50 enlarges or reduces its diameter in accordance with the speed of rotation of the yarn accumulation roller 32.

[0092] Nipping the yarn 20 between the rubber ring 51 and the enlarged/reduced portion 50 in this manner can apply a tension to the yarn 20 being unwound from the yarn accumulation part 37. The enlarged/reduced portion 50 is configured to enlarge or reduce its diameter in accordance with the speed of rotation of the yarn accumulation roller 32. Accordingly, even in a case where the rubber ring 51 expands outward due to a centrifugal force when the speed of rotation increases, the rubber ring 51 and the enlarged/reduced portion 50 can be kept in tight contact with each other. Thereby, an appropriate tension can be applied to the yarn 20 during rotations including a low-speed rotation and a high-speed rotation.

[0093] The yarn accumulation device 18 of this embodiment is configured as follows. The enlarged/reduced portion 50 has the recess 50c for restricting movement of the rubber ring 51 in the direction of the rotation axis of the yarn accumulation roller 32. The rubber ring 51 is attached in the recess 50c of the enlarged/reduced portion 50.

[0094] This can prevent the rubber ring 51 from being dragged by the yarn 20 pulled out from the yarn accumulation device 18 and consequently detached.

[0095] In the yarn accumulation device 18 of this embodiment, the enlarged/reduced portion 50 has the recess maintaining mechanism 58 for maintaining the recess 50c irrespective of enlargement and reduction in the diameter of the enlarged/reduced portion 50.

[0096] Accordingly, detachment of the rubber ring 51 from the enlarged/reduced portion 50 can be prevented during both a high-speed rotation and a low-speed rotation.

[0097] The yarn accumulation device 18 of this embodiment is configured as follows. The outer circumferential surface of the enlarged/reduced portion 50 is formed of the rubber film 52. The recess maintaining mechanism 58 includes the concavity/convexity maintaining rings 55, 56, and 57 that are formed along the circumferential direction of the enlarged/reduced portion 50. The concavity/convexity maintaining rings 55, 56, and 57 are made of an elastic material, and arranged inside the rubber film 52.

[0098] Thus, arranging concavity/convexity maintaining rings having appropriate diameters inside a rubber film can form the recess 50c in an outer surface of the rubber film 52 (in the outer circumferential surface of the enlarged/reduced portion 50). Since the concavity/convexity maintaining rings 55, 56, and 57 are made of an elastic material, the diameters of the concavity/convexity maintaining rings 55, 56, and 57 can be enlarged and reduced. Therefore, the diameter of the enlarged/reduced portion 50 can be enlarged and reduced while the shape of the recess 50c is maintained.

[0099] The yarn accumulation device 18 of this embodiment is configured as follows. The yarn accumulation roller 32 has, in its end portion at the unwinding side, the disk member 39 whose diameter is larger than the outer diameter of the enlarged/reduced portion 50 under a state where the rotation of the yarn accumulation roller 32 is stopped. The enlarged/reduced portion 50 is provided between the yarn accumulation part 37 and the disk member 39.

[0100] The yarn 20 unwound from the yarn accumulation part 37 comes into contact with the enlarged/reduced portion 50, and then is separated away from the enlarged/reduced portion 50, to travel while being guided by the disk member 39. Guiding the yarn 20 in this manner can reduce the area over which the yarn 20 is in contact with the enlarged/reduced portion 50. This can prevent fluffing of the yarn 20 and a deterioration in the physical properties of the yarn 20. This can also prevent a situation where the enlarged/reduced portion 50 is rubbed by the yarn and damaged when the yarn is pulled out.

[0101] In the yarn accumulation device 18 of this embodiment, a portion of the rubber ring 51 that cooperates with the enlarged/reduced portion 50 to nip the yarn 20 therebetween is formed as a plane-shaped portion.

[0102] This can prevent the rubber ring 51 from being twisted on the enlarged/reduced portion 50. Thus, a stable tension can be applied to the yarn 20.

[0103] The automatic winder of this embodiment includes the yarn supply part 7, the yarn joining device 14, the yarn accumulation device 18, the second tension applying device 19, and the winding part 8 that are arranged

in this order along the direction of traveling of the yam. The yarn supply part 7 supplies the yarn 20. The yarn joining device 14 joins the yarn ends that have been disconnected. The second tension applying device 19 applies a tension to the yarn 20. The winding part 8 winds the yarn 20 supplied from the yarn supply part 7 and forms a package. Even while the yarn joining device 14 is performing the yarn joining operation, the winding part 8 is able to continue the winding with the second tension applying device 19 applying a tension to the yarn 20 unwound from the yarn accumulation device 18.

[0104] That is, the yarn accumulation device 18 is able to apply a constant tension to the yarn that is being unwound during both a low-speed rotation and a high-speed rotation. This facilitates a tension control performed by the second tension applying device 19 that is arranged downstream of the yarn accumulation device 18. Additionally, since the winding part 8 winds the yarn 20 accumulated on the yarn accumulation device 18, the winding operation can be continued without receiving any influence of the yarn joining operation and a fluctuation in the unwinding tension in the yarn supply part 7.

[0105] In a case where a yarn having less strength is mixed in a package, the yarn having less strength may cause a yarn breakage during a warper process that is a process subsequent to a rewinding operation performed by the automatic winder. Occurrence of a yarn breakage in the warper process is not preferable, because it leads to a considerable drop in the efficiency of production. Accordingly, it is preferable that such a yarn having less strength is removed during the rewinding operation performed by the automatic winder.

[0106] The automatic winder of this embodiment is able to apply a constant tension to a yarn that is being unwound during both a low-speed rotation and a high-speed rotation. Therefore, a yarn having less strength, which cannot withstand the constant tension, is cut at a location downstream of the yarn path between the rubber ring 51 and the enlarged/reduced portion 50. The yarn having been cut is held under a state of being nipped between the rubber ring 51 and the enlarged/reduced portion 50. This does not cause a situation where a failure in accumulation (such as slaffing or overflow) occurs because the yarn end ramps around during a period from when the yarn breakage occurs to when the yarn accumulation roller 32 is stopped. Accordingly, it is possible that, after the yarn accumulation roller 32 is stopped, the yarn nipped between the rubber ring 51 and the enlarged/reduced portion 50 is joined with the yarn of the package side and thus the winding operation is continued. Moreover, occurrence of a yarn breakage due to a yarn having less strength during the warper process can be prevented.

[0107] Next, a second embodiment of the present invention will be described with reference to FIG. 7. In the following description, configuration parts identical or similar to those of the above-described first embodiment will be denoted by the same reference numerals on the drawings as those of the first embodiment, and descriptions thereof may be omitted.

[0108] As shown in FIG. 7, a yarn accumulation roller 32 provided in a yarn accumulation device 182 of this embodiment includes a roller main part 61 and an extensible moving part 62 that is arranged at the unwinding side of the roller main part 61. The extensible moving part 62 and the roller main part 61 are coupled by a spline fitting part 63. Thus, the roller main part 61 and the extensible moving part 62 are configured to integrally rotate about the axis line of the yarn accumulation roller 32, and also to move relative to each other in the direction of the axis line.

[0109] The roller main part 61 includes the yarn accumulation part 37. One axial end portion of the rubber film 52 is fixed to the roller main part 61 side and the other axial end portion thereof is fixed to the extensible moving part 62 side by appropriate means such as bonding. That is, in this embodiment, the rubber film 52 is arranged so as to stretch between the roller main part 61 and the extensible moving part 62.

[0110] The yarn accumulation roller 32 of this embodiment is configured to drive the extensible moving part 62 in the direction of the axis line of the yarn accumulation roller 32. A specific description will be given below. In this embodiment, a rotational drive shaft of the roller drive motor 33 is a hollow shaft, and the roller main part 61 is fixed to this rotational drive shaft. An extensible drive rod 64 is arranged inside the rotational drive shaft such that the axis line of the extensible drive rod 64 is coincident with the axis line of the rotational drive shaft.

[0111] The extensible moving part 62 is attached via a bearing 65 to an end portion of the extensible drive rod 64 at the unwinding side. On the other hand, a feed screw 66 is formed in an end portion of the extensible drive rod 64 at the base end side. The yarn accumulation device 182 of this embodiment includes an extension drive part 67 for moving the extensible drive rod 64 in the direction of the axis line by means of the feed screw mechanism. The operation of the extension drive part 67 is controlled by the control part 25. The extension drive part 67 is appropriately controlled with the above-described configuration, and thereby the extensible moving part 62 can be moved in the direction of the axis line of the yarn accumulation roller 32.

[0112] This can change the degree of stretch of the rubber film 52 extending between the roller main part 61 and the extensible moving part 62. Therefore, the outer diameter of the enlarged/reduced portion 50 can be changed. Moving the extensible moving part 62 in a direction that increases the outer diameter of the enlarged/reduced portion 50 increases the squeezing force of the rubber ring 51 squeezing the enlarged/reduced portion 50, and as a result, a resistance given to the yarn 20 can be made larger. On the other hand, moving the extensible moving part 62 in a direction that decreases the outer diameter of the enlarged/reduced portion 50 weakens the squeezing force of the rubber ring 51 squeezing the

enlarged/reduced portion 50, and as a result, a resistance given to the yarn 20 can be made smaller.

[0113] Since a resistance given to the yarn 20 can be increased and reduced in this manner, a tension applied to a portion of the yarn located downstream of the yarn accumulation device 181 can be appropriately adjusted. Accordingly, appropriately controlling the extension drive part 67 by means of the control part 25 during, for example, the yarn winding operation, enables a tension applied to a portion of the yarn 20 located downstream of the yarn accumulation device 18 to be changed as needed depending on the situation.

[0114] As thus far described, the yarn accumulation device 181 of this embodiment includes the extension drive part 67 for enlarging and reducing the diameter of the enlarged/reduced portion 50.

[0115] This enables a tension applied to the yarn to be not only kept constant but also increased or reduced.

[0116] Next, a third embodiment of the present invention will be described with reference to FIG. 8. In the following description, configuration parts identical or similar to those of the above-described first embodiment will be denoted by the same reference numerals on the drawings as those of the first embodiment, and descriptions thereof may be omitted.

[0117] As shown in FIG. 8, in a yarn accumulation device 182 of this embodiment, a tension applying part 381 is arranged at the unwinding side of the yarn accumulation part 37, and configured to rotate in synchronization with the yarn accumulation part 37 and in this condition apply a tension to the yarn 20 being unwound from the yarn accumulation part 37. More specifically, the tension applying part 381 includes a first ring-shaped rubber plate (first ring-shaped elastic element) 70 and a synchronized rotation member 71. The first ring-shaped rubber plate 70 is mounted to the yarn accumulation roller 32, and configured to rotate integrally with the yarn accumulation roller 32. The synchronized rotation member 71 is arranged radially outside the yarn accumulation roller 32, and configured to rotate in synchronization with the yarn accumulation roller 32.

[0118] The synchronized rotation member 71 is supported on a bearing 72, and freely rotatable with its rotation axis being coincident with the rotation axis of the yarn accumulation roller 32. A magnet 73 is arranged in the yarn accumulation roller 32. The synchronized rotation member 71 has a magnet 74 that is arranged opposed to the magnet 73. In this configuration, when the yarn accumulation roller 32 is driven in rotation by the roller drive motor 33, a magnetic force occurring between the magnet 73 and the magnet 74 causes the synchronized rotation member 71 to rotate in synchronization with the yarn accumulation roller 32.

[0119] A second ring-shaped rubber plate (second ring-shaped elastic element) 75 is mounted to the synchronized rotation member 71. To be more specific, when seen in a cross-section (see FIGS. 8 and 9) cut along a plane extending through the axis line of the yarn accumulation roller 32, one end of the second ring-shaped rubber plate 75 is fixed to the synchronized rotation member 71. When seen in this cross-section, the other end of the second ring-shaped rubber plate 75 is free. An end portion of the second ring-shaped rubber plate 75 at this free side will be referred to as a free end of the second ring-shaped rubber plate 75.

[0120] On the other hand, the first ring-shaped rubber plate 70 is mounted on the outer circumferential surface of the yarn accumulation roller 32 in the following manner. That is, when seen in a cross-section (see FIGS. 8 and 9) cut along a plane extending through the axis line of the yarn accumulation roller 32, one end of the first ring-shaped rubber plate 70 is fixed to the outer circumferential surface of the yarn accumulation roller 32. When seen in this cross-section, the other end of the first ring-shaped rubber plate 70 is free. An end portion of the first ring-shaped rubber plate 70 at this free side will be referred to as a free end of the first ring-shaped rubber plate 70.

[0121] The synchronized rotation member 71 has a cylindrical member 76 that is arranged radially outside the first ring-shaped rubber plate 70 and opposed to the first ring-shaped rubber plate 70.

[0122] The first ring-shaped rubber plate 70 is arranged such that the free end of the first ring-shaped rubber plate 70 is not in contact with an inner circumferential surface of the cylindrical member 76 under a state where the rotation of the yarn accumulation roller 32 is stopped. The second ring-shaped rubber plate 75 is arranged such that the free end of the second ring-shaped rubber plate 75 is in contact with an outer circumferential surface of the yarn accumulation roller 32 under a state where the rotation of the yarn accumulation roller 32 is stopped.

[0123] The yarn accumulation device 182 of this embodiment is configured such that, when the yarn accumulated on the yarn accumulation part 37 is pulled out from the yarn accumulation roller 32, the yarn passes through a space between the first ring-shaped rubber plate 70 and the inner circumferential surface of the cylindrical member 76 and a space between the second ring-shaped rubber plate 75 and the outer circumferential surface of the yarn accumulation roller 32.

[0124] In this configuration, during a low-speed rotation, the outer circumferential surface of the yarn accumulation roller 32 and the second ring-shaped rubber plate 75 are in contact with each other as shown in FIG. 9. Therefore, the yarn being unwound from the yarn accumulation part 37 is pulled out from the yarn accumulation roller 32 in a state of being nipped between the outer circumferential surface of the yarn accumulation roller 32 and the second ring-shaped rubber plate 75. In other words, during a low-speed rotation, the yarn pulled out from the yarn accumulation roller 32 is given a resistance by the outer circumferential surface of the yarn accumulation roller 32 and the second ring-shaped rubber plate 75.

[0125] However, when the speed of rotation of the yarn

accumulation roller 32 increases, the free end of the second ring-shaped rubber plate 75 rises up from the outer circumferential surface of the yarn accumulation roller 32 due to a centrifugal force, to make it impossible that the yarn 20 is nipped between the second ring-shaped rubber plate 75 and the outer circumferential surface of the yarn accumulation roller 32. Accordingly, the yarn accumulation device 182 of this embodiment is configured such that the free end of the first ring-shaped rubber plate 70 opens radially outward and comes into contact with the inner circumferential surface of the cylindrical member 76 at the speed of rotation equal to the speed of rotation at which the free end of the second ring-shaped rubber plate 75 rises up from the outer circumferential surface of the yarn accumulation roller 32.

[0126] Under a state where the second ring-shaped rubber plate 75 is in contact with the inner circumferential surface of the cylindrical member 76, when the yarn 20 unwound from the yarn accumulation part 37 is pulled out from the yarn accumulation roller 32, the yarn 20 is nipped between the first ring-shaped rubber plate 70 and the inner circumferential surface of the cylindrical member 76, as shown in FIG. 10. In other words, during a high-speed rotation, the yarn 20 pulled out from the yarn accumulation roller is given a resistance by the first ring-shaped rubber plate 70 and the inner circumferential surface of the cylindrical member 76.

[0127] In the above-described manner, the yarn accumulation device 182 of this embodiment is configured such that the yarn 20 is nipped by the second ring-shaped rubber plate 75 during a low-speed rotation and when the speed of rotation increases so that a centrifugal force increases, the yarn 20 is nipped by the first ring-shaped rubber plate 70 instead of the second ring-shaped rubber plate 75. Since the member that gives a resistance to the yarn 20 is changed in accordance with the speed of rotation, an appropriate resistance can be given to the yarn during both a high-speed rotation and a low-speed rotation.

[0128] As thus far described, the yarn accumulation device 182 of this embodiment is configured such that the yarn 20 is wound and accumulated on the yarn accumulation part 37 that is provided on the outer circumferential surface of the yarn accumulation roller 32 and the yarn 20 is unwound from the yarn accumulation part 37 in the direction along the rotation axis of the yarn accumulation roller 32, and the yarn accumulation device 182 has the tension applying part 381. The tension applying part 381 is arranged at the unwinding side of the yarn accumulation part 37, and configured to rotate integrally with the yarn accumulation part 37 and in this condition apply a tension to the yarn 20 being unwound from the yarn accumulation part 37. The tension applying part 381 includes the first ring-shaped rubber plate 70, the synchronized rotation member 71, the second ring-shaped rubber plate 75, and the cylindrical member 76. The first ring-shaped rubber plate 70 is mounted on the surface of the yarn accumulation roller 32. The synchronized rotation member 71 is arranged radially outside the yarn accumulation roller 32, and configured to rotate in synchronization with the yarn accumulation roller 32. The second ring-shaped rubber plate 75 is provided to the synchronized rotation member 71. The cylindrical member 76 is provided to the synchronized rotation member 71 such that the cylindrical member 76 is opposed, from the radially outside, to the first ring-shaped rubber plate 70. Under a state where the yarn accumulation roller 32 is stopped, the first ring-shaped rubber plate 70 is not in contact with the cylindrical member 76 while the second ring-shaped rubber plate 75 is in contact with the surface of the yarn accumulation roller 32. When the yarn accumulated on the yarn accumulation part 37 is unwound, the yarn 20 passes through a space between the first ring-shaped rubber plate 70 and the cylindrical member 76 and a space between the second ring-shaped rubber plate 75 and the surface of the yarn accumulation roller 32.

[0129] In this configuration, during a low-speed rotation of the yarn accumulation roller 32, a tension is applied to the yarn by the surface of the yarn 20 accumulation roller 32 and the second ring-shaped rubber plate 75. In a high-speed rotation of the yarn accumulation roller 32, a force acting in a direction that separates the second ring-shaped rubber plate 75 away from the yarn accumulation roller 32 is caused by a centrifugal force, and therefore the second ring-shaped rubber plate 75 can no longer apply an appropriate tension to the yarn 20. However, in a range of the high-speed rotation, the first ring-shaped rubber plate 70 is pressed to the cylindrical member 76 due to a centrifugal force. Accordingly, during a high-speed rotation, a tension is applied to the yarn 20 by the first ring-shaped rubber plate 70 and the cylindrical member 76. Thus, an appropriate tension can be applied to the yarn 20 during both a low-speed rotation and a high-speed rotation.

[0130] While some preferred embodiments of the present invention have been described above, the above-described configurations can be changed, for example, as follows.

[0131] Although NBR is used for the elastic material, this is not limiting. Any material is adoptable for the elastic material of the present invention, as long as the material possesses an adequate elasticity and an adequate durability.

[0132] In the above-described embodiment, the recess maintaining mechanism 58 includes a plurality of concavity/convexity maintaining rings 55, 56, and 57 each having a ring-like shape extending along the circumferential direction of the rubber film 52. Here, since the rubber film 52 expands outward due to a centrifugal force, it is possible to form the first protrusion 50a and the second protrusion 50b by means of this centrifugal force. That is, even in a case of not providing the protrusion maintaining rings 55 and 57, protrusions can be formed by means of the centrifugal force. Therefore, the protrusion maintaining rings 55 and 57 may be omitted.

[0133] Although the concavity/convexity maintaining ring portion is configured with ring-shaped members being arranged inside the rubber film 52, this is not limiting. It may be also acceptable that the rubber film 52 and concavity/convexity maintaining rings are integrated. For example, a ring-shaped thick portion may be formed inside the rubber film 52. Alternatively, it may be also acceptable that a toughened portion capable of maintaining a recess shape and a protruding shape is provided in the enlarged/reduced portion 50. so that a recess and a protrusion are formed and maintained.

[0134] It is not always necessary that each winder unit 2 includes the control part 25. and instead a plurality of winder units may be controlled by a single control part. In the configuration described above, the single control part 25 collectively controls a plurality of members. However, this is not limiting. For example, an individual control part may be provided corresponding to each member to be controlled.

[0135] It may be acceptable to omit the second tension applying device 19. In this case as well, in the yarn accumulation device 18 of this embodiment, the tension of the yarn being unwound from the yarn accumulation roller 32 is stabilized irrespective of the speed of rotation. Therefore, stable winding is achieved in the winding part 8.

[0136] In the described configuration, the control part 25 is composed of hardware and software. However, it may be acceptable that the function of the control part 25 is partially or wholly implemented by hardware dedicated therefor.

[0137] In the embodiments described above, the winder unit 2 feeds the yarn supply bobbin 21 by means of the bobbin feeder 26 of magazine type. However, this configuration is not limiting. For example, in a possible alternative configuration, a tray having the yarn supply bobbin 21 set thereon may be transported along an appropriate path, to thereby feed the yarn supply bobbin 21 to the winder unit 2.

[0138] In the embodiments described above, the winding part 8 is configured to traverse the yarn 20 by means of the traverse drum 24. Instead, for example, an arm-type traverse mechanism may be adopted to traverse the yarn 20.

[0139] In the embodiments described above, the automatic winder is configured to guide a yarn by blowing off the yarn toward the yarn joining device 14. However, this is not limiting. For example, it may be also acceptable that the automatic winder is configured to suck and catch the yarn of the yarn supply bobbin 21 and the yarn existing on the yarn accumulation roller 32 and guide the yarns thus sucked and caught to the yarn joining device 14 by means of appropriate drive means.

[0140] The present invention is not limited to an automatic winder, and the present invention is applicable to other types of yarn winding machines including a yarn joining device.

DESCRIPTION OF THE REFERENCE NUMERALS

[0141]

18 yarn accumulation device (first embodiment)
181 yarn accumulation device (second embodiment)
182 yarn accumulation device (third embodiment)
32 yarn accumulation roller (rotating element)
37 yarn accumulation part
38 tension applying part
39 disk member
50 enlarged/reduced portion
51 rubber ring (ring member)
52 rubber film (elastic film)
55, 56, 57 concavity/convexity maintaining ring (concavity/convexity maintaining ring portion)
58 recess maintaining mechanism
70 first ring-shaped rubber film (first ring-shaped elastic element)
71 synchronized rotation member
75 second ring-shaped rubber film (second ring-shaped elastic element)
76 cylindrical member

Claims

1. A yarn accumulation device configured to wind and accumulate a yarn on a yarn accumulation part that is formed on an outer circumferential surface of a rotating element, the yarn being unwound from the yarn accumulation part in a direction along a rotation axis of the rotating element,
the yarn accumulation device including a tension applying part arranged at an unwinding side of the yarn accumulation part, the tension applying part being configured to rotate in synchronization with the yarn accumulation part and in this condition apply a tension to the yarn being unwound from the yarn accumulation part,
the tension applying part including:

a ring member made of an expandable elastic material; and
an enlarged/reduced portion provided radially inside the ring member, and configured such that the yarn is nipped between the enlarged/reduced portion and the ring member,

the enlarged/reduced portion being configured to enlarge or reduce its diameter in accordance with the speed of rotation of the rotating element.

2. The yarn accumulation device according to claim 1, wherein
a recess for restricting movement of the ring member in a direction of the rotation axis of the rotating element is provided in the enlarged/reduced portion,

the ring member is attached in the recess of the enlarged/reduced portion.

3. The yarn accumulation device according to claim 2, wherein
the enlarged/reduced portion has a recess maintaining mechanism for maintaining the recess irrespective of enlargement and reduction in the diameter of the enlarged/reduced portion.

4. The yarn accumulation device according to claim 3, wherein
an outer circumferential surface of the enlarged/reduced portion is constituted of an elastic film made of a film-like elastic material,
the recess maintaining mechanism includes a concavity/convexity maintaining ring portion that is formed along a circumferential direction of the enlarged/reduced portion,
the concavity/convexity maintaining ring portion is made of an elastic material, and arranged inside the elastic film.

5. The yarn accumulation device according to any one of claims 1 to 4, wherein
a disk member is provided in an end portion of the rotating element at the unwinding side, the disk member having a diameter larger than an outer diameter of the enlarged/reduced portion under a state where the rotating element is stopped,
the enlarged/reduced portion is provided between the yarn accumulation part and the disk member.

6. The yarn accumulation device according to any one of claims 1 to 5, wherein
a portion of the ring member that cooperates with the enlarged/reduced portion to nip the yarn therebetween is formed as a plane-shaped portion.

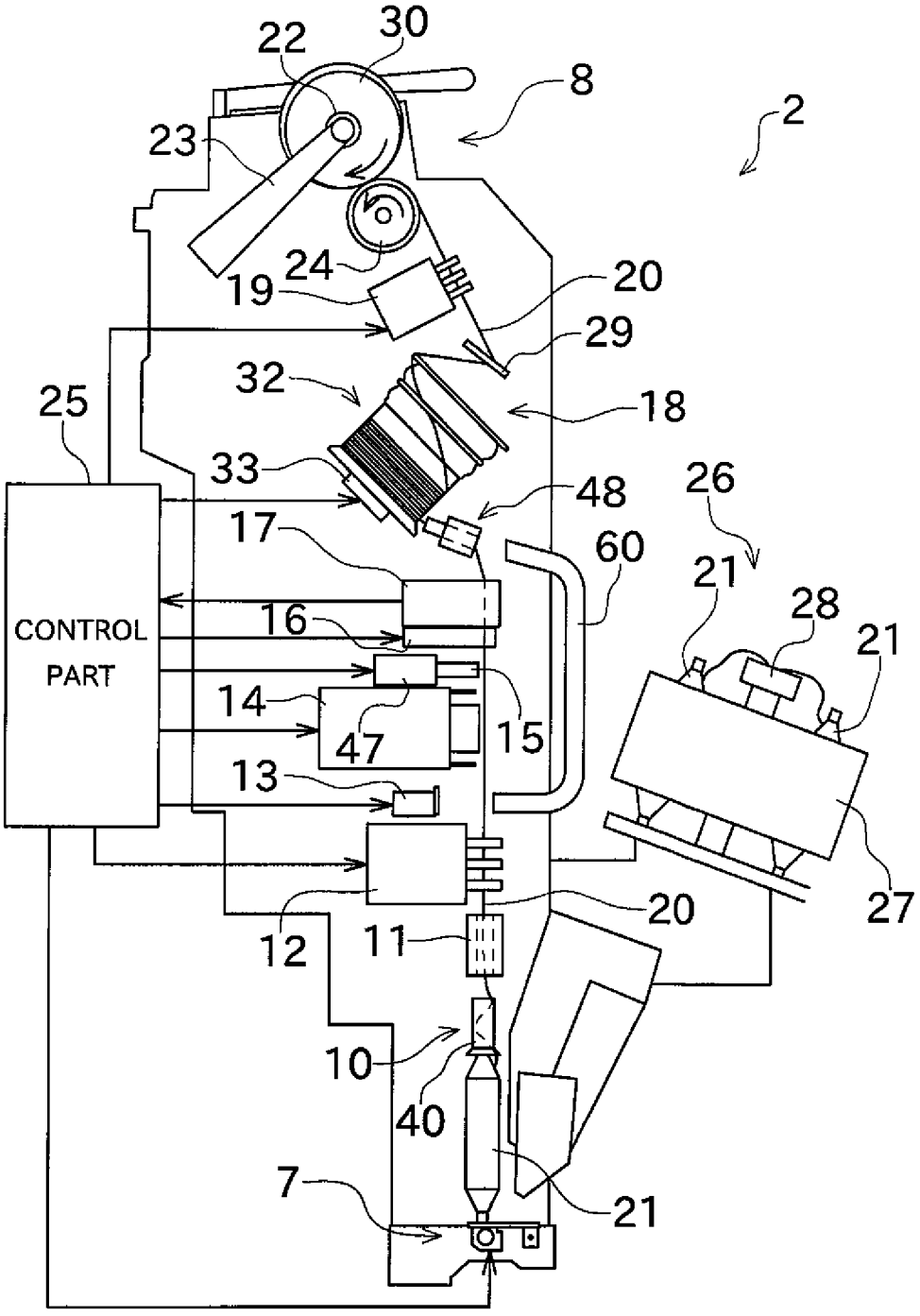
7. The yarn accumulation device according to any one of claims 1 to 6. wherein
a drive part for enlarging or reducing the diameter of the enlarged/reduced portion is provided.

8. A yarn accumulation device configured to wind and accumulate a yarn on a yarn accumulation part that is formed on an outer circumferential surface of a rotating element, the yarn being unwound from the yarn accumulation part in a direction along a rotation axis of the rotating element,
the yarn accumulation device including a tension applying part arranged at an unwinding side of the yarn accumulation part, the tension applying part being configured to rotate in synchronization with the yarn accumulation part and in this condition apply a tension to the yarn being unwound from the yarn accumulation part,
the tension applying part including:
a first ring-shaped elastic element mounted on a surface of the rotating element;
a synchronized rotation member arranged radially outside the rotating element, and configured to rotate in synchronization with the rotating element;
a second ring-shaped elastic element provided to the synchronized rotation member; and
a cylindrical member provided to the synchronized rotation member such that the cylindrical member is opposed, from the radially outside, to the first ring-shaped elastic element,

under a state where the rotating element is stopped, the first ring-shaped elastic element is not in contact with the cylindrical member while the second ring-shaped elastic element is in contact with the surface of the rotating element,
when the yarn accumulated on the yarn accumulation part is unwound, the yarn passes through a space between the first ring-shaped elastic element and the cylindrical member and a space between the second ring-shaped elastic element and the surface of the rotating element.

9. A yarn winding machine comprising the yarn accumulation device according to any one of claims 1 to 8, the yarn winding machine including a yarn supply part that supplies a yarn, a yarn joining device that joins yarn ends that have been disconnected, the yarn accumulation device, a tension applying device that applies a tension to the yarn, and a winding part that winds the yarn supplied from the yarn supply part and forms a package, the yarn supply part, the yarn joining device, the yarn accumulation device, the tension applying device, and the winding part being arranged in this order along a direction of traveling of the yarn,
even while the yarn joining device is performing a yarn joining operation, the winding part is able to continue winding with the tension applying device applying a tension to the yarn unwound from the yarn accumulation device.

Fig.1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CONTROL
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Fig.2

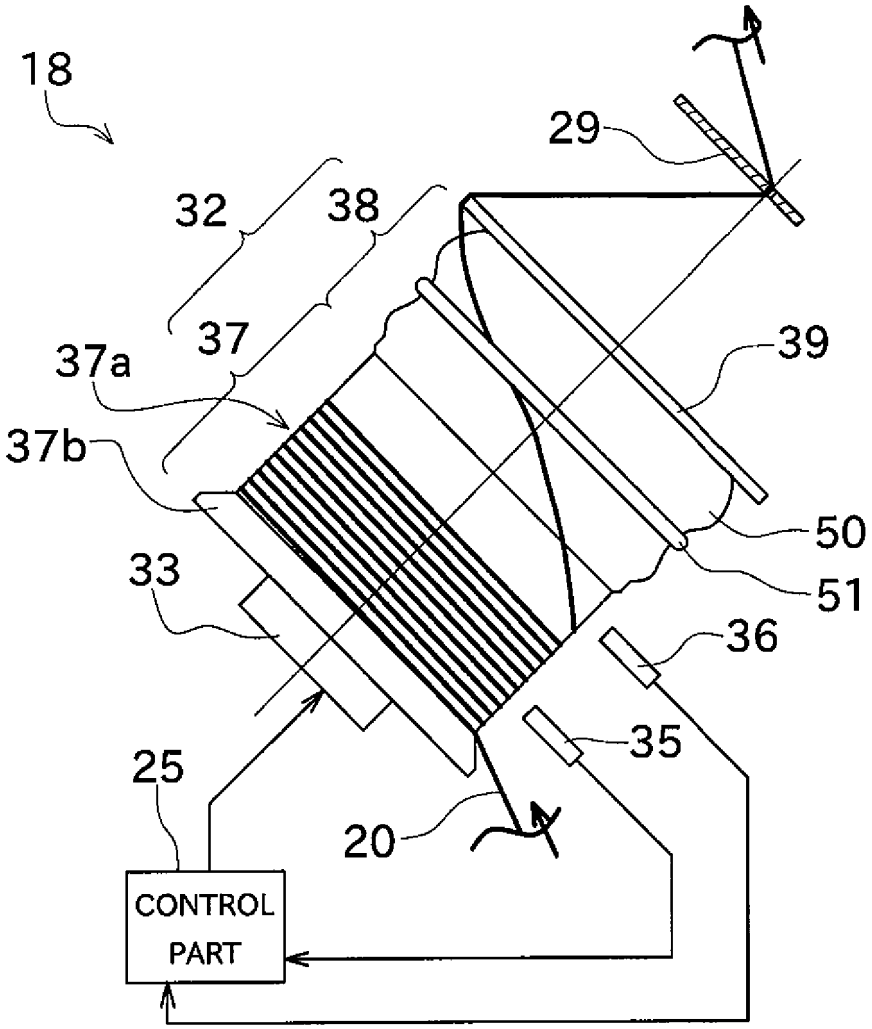


Fig.3

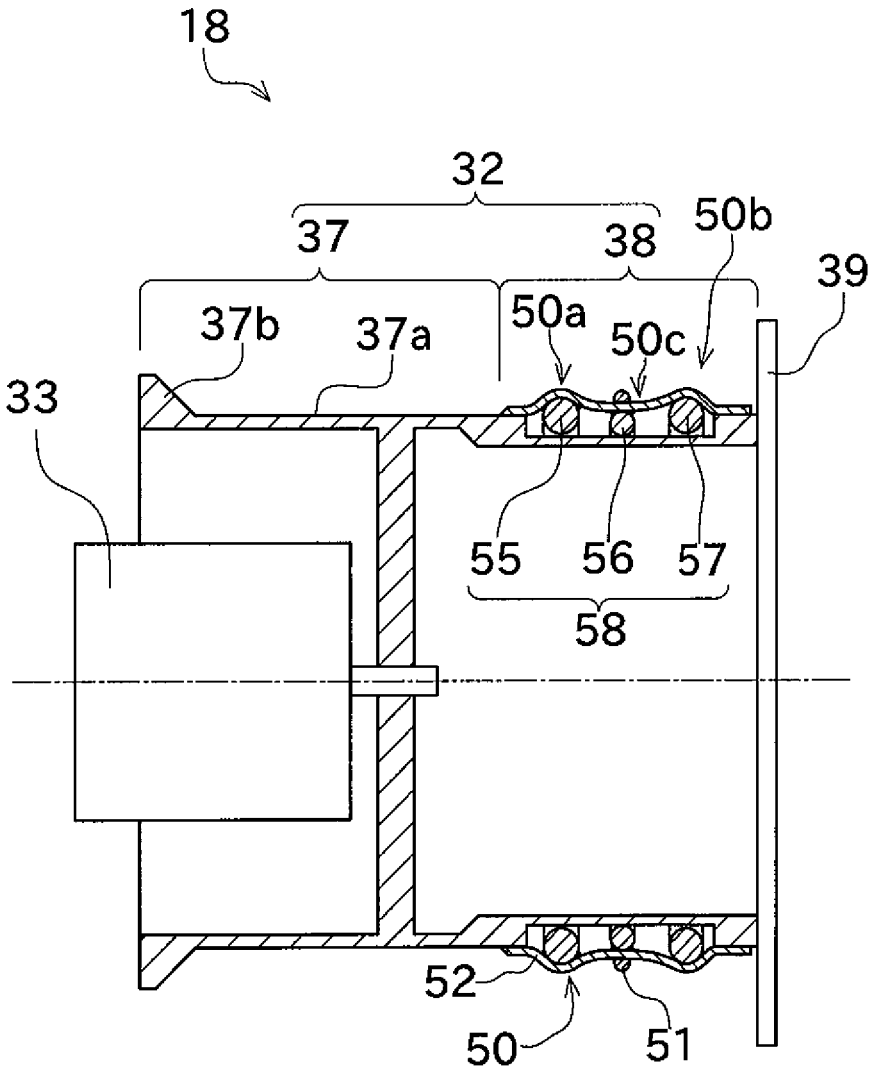


Fig.4

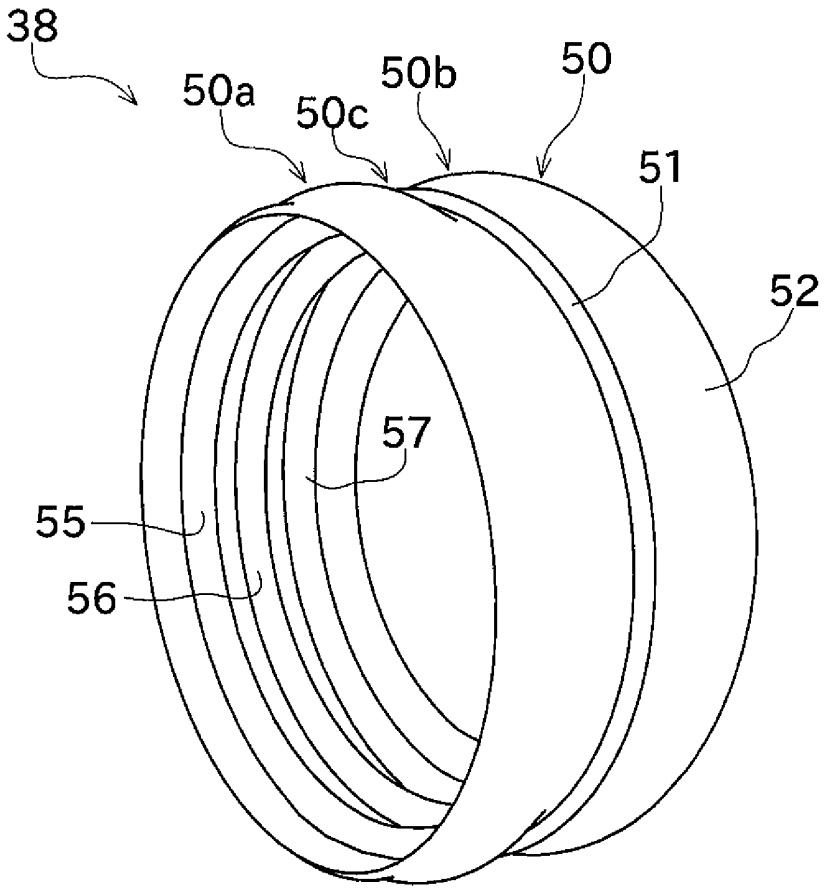


Fig.5

DURING LOW-SPEED ROTATION

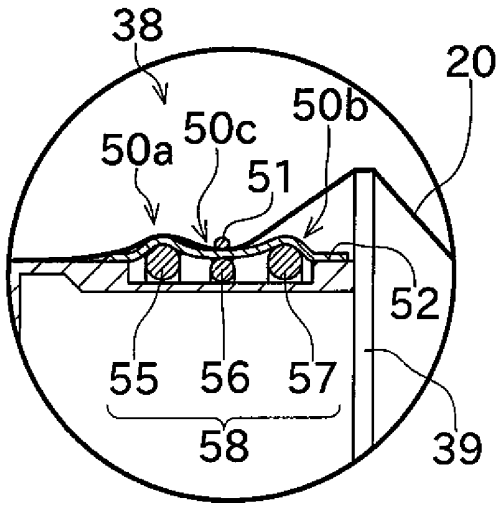
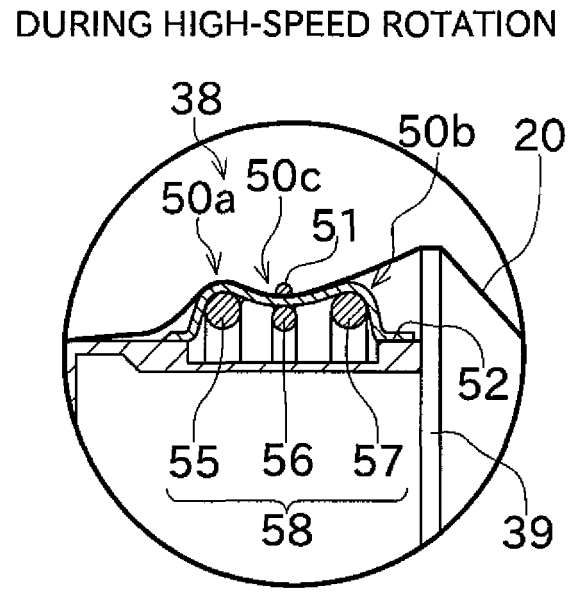


Fig.6


DURING HIGH-SPEED ROTATION
38
50b
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50a
50c
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Fig.7

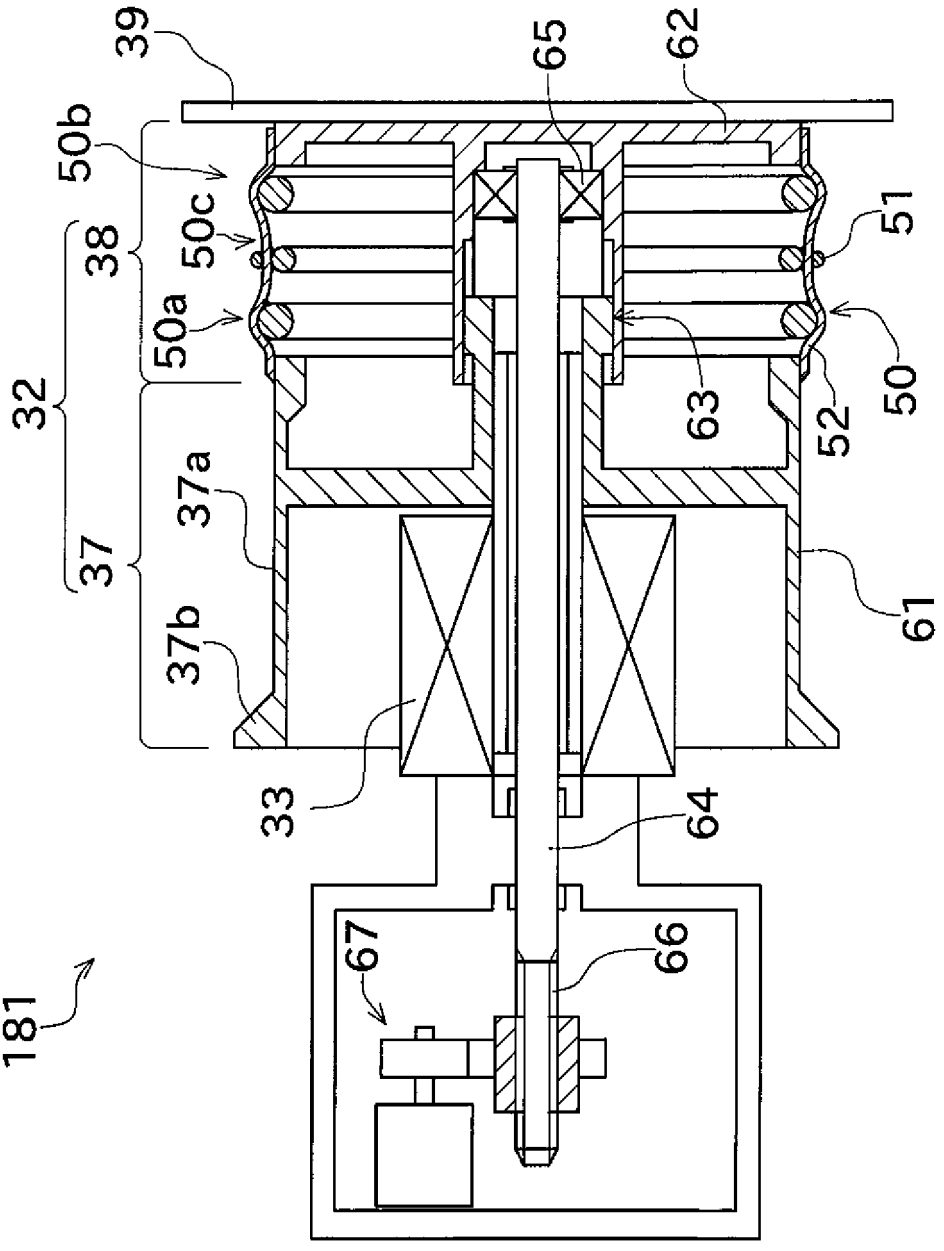


Fig.8

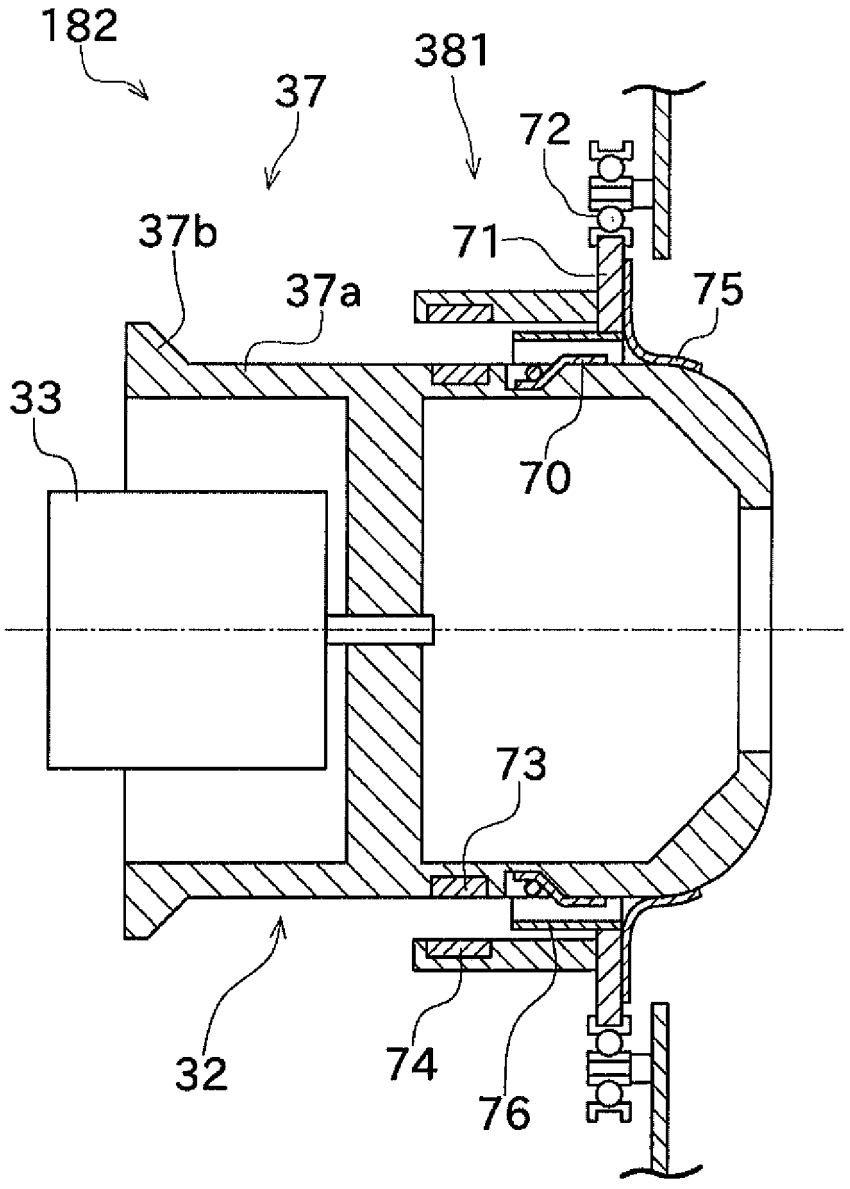


Fig.9

DURING LOW-SPEED ROTATION

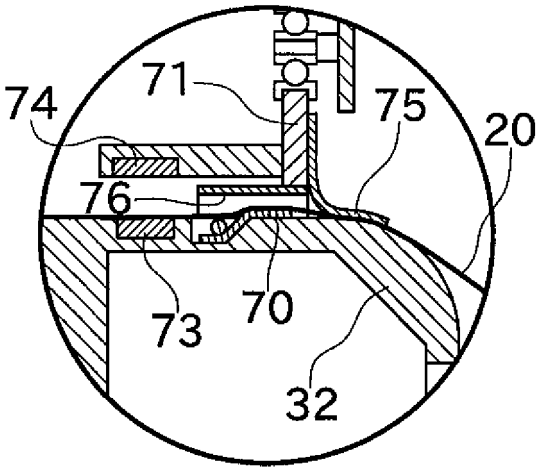


Fig.10

DURING HIGH-SPEED ROTATION

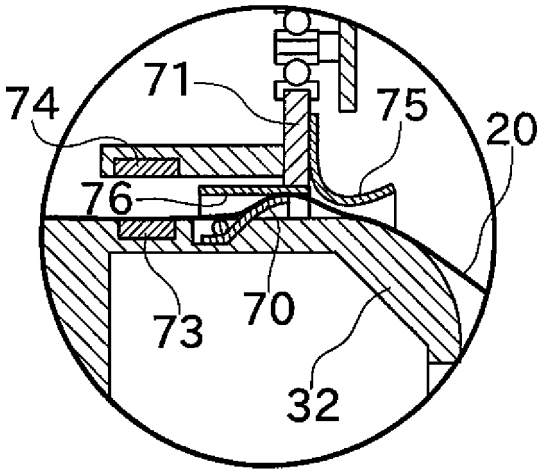
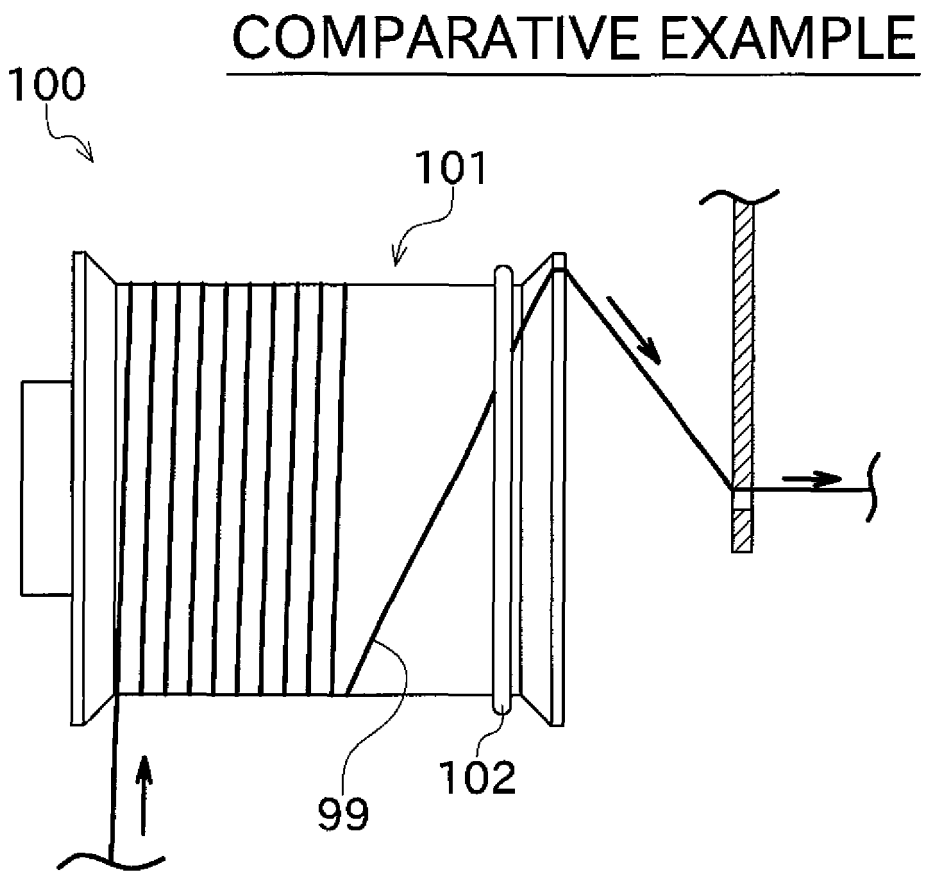


Fig.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/006976

A. CLASSIFICATION OF SUBJECT MATTER
B65H51/22(2006.01)i, *B65H59/10*(2006.01)i, *D01H13/00*(2006.01)i, *D01H13/10*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65H51/22, B65H59/10, D01H13/00, D01H13/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2012
Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 9-508182 A (Iro AB.), 19 August 1997 (19.08.1997), page 13, line 16 to page 14, line 23 & US 5778943 A & WO 1995/020700 A2	1-9
A	JP 54-82465 A (Toray Industries, Inc.), 30 June 1979 (30.06.1979), page 3, upper right column, lines 12 to 15; fig. 1 (Family: none)	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 January, 2012 (30.01.12)	07 February, 2012 (07.02.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2004131276 A **[0014]**
- JP 63262376 A **[0014]**
- JP 1988 A **[0014]**