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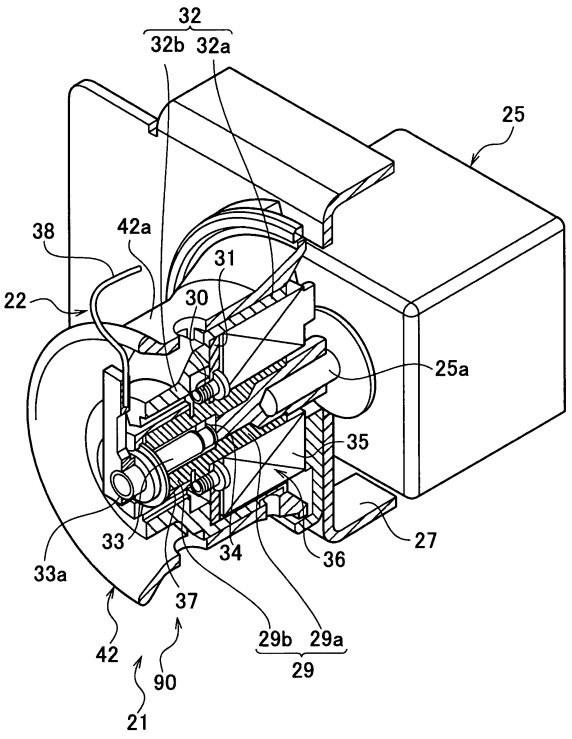
(54) Yarn slack eliminating device and spinning machine

(57) An object of the present invention is to provide a yarn slack eliminating device that enables tension applied to a yarn to be controlled while a spinning machine is in operation. A yarn slack eliminating device 12 includes an electric motor 25, a yarn slack eliminating roller 21, a yarn hooking member 22, an electromagnet 36, and a control section 74. The yarn slack eliminating roller 21 is rotationally driven by the electric motor 25. The yarn hooking member 22 is concentrically attached to the yarn slack eliminating roller 21 so as to be rotatable relative to the yarn slack eliminating roller 21. The electromagnet 36 generates a magnetic field to be applied to the yarn hooking member 22. The control section allows the magnetic field to generate a resistance torque resisting the rotation of the yarn hooking member 22 relative to the yarn slack eliminating roller 21. The control section 74 also controls an input to the electromagnet 36 to control the resistance torque (Fig. 3).

FIGURE 3



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Description

Field of the Invention

[0001] The present invention relates to a yarn slack eliminating device for a spinning machine which eliminates a possible yarn slack during a period from the spinning out of a spun yarn until the yarn is wound into a package. The present invention also relates to a spinning machine including the yarn slack eliminating device.

Background of the Invention

[0002] A conventional high-speed spinning machine such as a pneumatic spinning machine which winds a spun yarn to form a package is configured to, upon detecting a yarn defect, cut and remove the yarn defect portion using a cutter, and to use a splicing device to splice a leading end of a yarn continuously fed from a spinning device and a yarn end on the package side. The yarn splicing operation is performed with yarn winding stopped. Thus, a possible yarn slack needs to be eliminated.

[0003] In view of this, the Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-306588 discloses a yarn slack eliminating device including a yarn slack eliminating roller that is rotationally driven and a rotary yarn hooking member. In the yarn slack eliminating device, the yarn hooking member is concentrically attached to the yarn slack eliminating roller so as to be rotatable relative to the yarn slack eliminating roller. A resistance of an appropriate magnitude can be applied to the relative rotation using a combination of a permanent magnet and a hysteresis member.

[0004] With this configuration, the relative-rotation resistance force (resistance torque) applied to the yarn hooking member is a factor determining the winding tension of a yarn. If an appropriate tension fails to be applied to the yarn being wound, yarn breakage may occur, the resulting package may be unacceptable, or yarn unwindability may be affected during a post-process. Thus, the control of the resistance torque applied to the yarn hooking member is very important.

[0005] Meanwhile, the appropriate tension depends on a yarn type and a yarn thickness. Furthermore, even during yarn winding, the tension varies constantly depending on the varying winding diameter of the package or a yarn traverse position. For example, during yarn splicing or the like, a high tension may be instantaneously applied to the yarn. In this case, if the resistance torque applied to the yarn hooking member fails to be appropriately set, a problem such as yarn breakage may occur as described above.

[0006] In this connection, with the configuration of the yarn slack eliminating device disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-306588, the resistance torque can be varied steplessly by varying an area of an overlapping part of the hysteresis material and the permanent magnet. Thus, the yarn slack eliminating device can deal with various yarn types and yarn thicknesses. However, with this configuration, when the resistance torques of a plurality of units are to be changed at the same time for a setup change or the like, the yarn slack eliminating device of each of the units needs to be adjusted separately. This requires much time and effort. Furthermore, the configuration of the yarn slack eliminating device disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-306588 fails to allow the resistance torque to be finely adjusted or positively varied during yarn winding.

Summary of the Invention

[0007] The present invention has been made in view of the above-described circumstances. An object of the present invention is to provide a yarn slack eliminating device that enables the tension applied to the yarn to be controlled while the spinning machine is in operation.

[0008] A first aspect of the present invention provides a yarn slack eliminating device provided in a spinning machine and configured as follows. That is, the yarn slack eliminating device includes a driving source, a yarn slack eliminating roller, a yarn hooking member, an electromagnet, and a control section. The yarn slack eliminating roller is rotationally driven by the driving source. The yarn hooking member is concentrically attached to the yarn slack eliminating roller so as to be rotatable relative to the yarn slack eliminating roller. The electromagnet generates a magnetic field to be applied to the yarn hooking member.

The control section controls the magnetic field to generate a resistance torque resisting the rotation of the yarn hooking member relative to the yarn slack eliminating roller. The control section controls an input to the electromagnet to control the resistance torque. The control section can control the resistance torque while the spinning machine is in operation.

[0009] Thus, the resistance torque can be varied even while the spinning machine is performing a spinning operation. Consequently, control can be performed such that an appropriate tension is applied to a yarn.

[0010] In the yarn slack eliminating device, the control section controls the resistance torque according to a yarn winding diameter.

[0011] Thus, a package with preferred quality can be formed.

[0012] In the yarn slack eliminating device, the control section preferably performs control such that the resistance torque is set to be higher when the yarn winding diameter is small than when the yarn winding diameter is large.

[0013] Thus, the quality of the package can further be improved.

[0014] In the yarn slack eliminating device, the control section preferably performs control such that when the

spinning machine starts a spinning operation, the resistance torque is reduced before the yarn is hooked on the yarn hooking member.

[0015] Thus, the yarn can be prevented from being broken by a possible excessive tension instantaneously applied to the yarn.

[0016] In the yarn slack eliminating device, the control section preferably performs control such that the resistance torque is increased after an elapse of a predetermined period of time from the start of the spinning operation.

[0017] Thus, by simple control for determining the elapse of time, the control section can determine that the yarn has been wound around the yarn slack eliminating roller to appropriately adjust the resistance torque.

[0018] In the yarn slack eliminating device, the control section preferably performs control such that at the start of the spinning operation during a yarn splicing operation, the resistance torque is reduced before the yarn is hooked on the yarn hooking member.

[0019] Thus, the resistance torque can be appropriately controlled so as to prevent an excessive tension from being applied during yarn splicing, in which yarn breakage is likely to occur.

[0020] In the yarn slack eliminating device, the control section preferably controls the resistance torque in conjunction with traverse of the yarn.

[0021] Thus, an appropriate tension can be applied to the yarn according to a traverse position, allowing a package with a preferred shape to be formed.

[0022] In the yarn slack eliminating device, the control section performs control such that in case of forming a cone winding package, the resistance torque is reduced when the yarn is wound on a larger diameter side of the package, and the resistance torque is increased when the yarn is wound on a smaller diameter side of the package.

[0023] Thus, an appropriate tension can be applied to the yarn, allowing a high-quality cone winding package to be formed.

[0024] A second aspect of the present invention provides a spinning machine including the above-described yarn slack eliminating device.

[0025] Thus, a high-quality package can be produced.

[0026] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0027]

Figure 1 is a front view illustrating a general configuration of a spinning machine provided with a yarn slack eliminating device according to an embodiment of the present invention.

Figure 2 is a vertical cross-sectional view of the spinning machine.

Figure 3 is a partial cross-sectional perspective view of the yarn slack eliminating device according to an embodiment of the present invention.

Figure 4 is a partial vertical cross-sectional view of the yarn slack eliminating device.

Figure 5 is a cross-sectional view taken along line A-A in Figure 4.

Figure 6 is a timing chart showing the relationship between a yarn splicing operation and the operation of the yarn slack eliminating device.

Detailed Description of the Preferred Embodiments

[0028] A spinning machine according to an embodiment of the present invention will be described with reference to the drawings. In the specification, "upstream" and "downstream" mean an upstream side and a downstream side, respectively, in a direction in which a yarn travels during spinning.

[0029] A spinning machine 1 shown in Figure 1 includes a large number of spinning units 2 arranged in a line. The spinning machine 1 includes a yarn splicing vehicle 3, a blower box 4, and a motor box 5. The yarn splicing vehicle 3 can travel in a direction in which the spinning units 2 are arranged.

[0030] As shown in Figure 1, each of the spinning units 2 includes, as main components, a draft device 7, a spinning device 9, a yarn feeding device 11, a yarn slack eliminating device 12, and a winding device 13 arranged in this order from upstream to downstream. The draft device 7 is provided in the vicinity of an upper end of a housing 6 of the spinning machine 1. A fiber bundle 8 fed from the draft device 7 is spun by the spinning device 9. A spun yarn 10 discharged from the spinning device 9 is fed by the yarn feeding device 11. The spun yarn 10 passes through a yarn clearer 52 described below and is then wound by the winding device 13. Accordingly, a package 45 is formed.

[0031] The draft device 7 drafts a sliver 15 into a fiber bundle 8. As shown in Figure 2, the draft device 7 includes four rollers, that is, a back roller 16, a third roller 17, a middle roller 19, and a front roller 20. The middle roller 19 is provided with an apron belt 18.

[0032] The configuration of the spinning device 9 is not illustrated in detail. The spinning device 9 of the present embodiment adopts a pneumatic type that utilizes a whirling air stream to generate the spun yarn 10 from the fiber bundle 8.

[0033] The yarn feeding device 11 includes a delivery roller 39 and a nip roller 40. The delivery roller 39 is supported by the housing 6 of the spinning machine 1. The nip roller 40 is provided in contact with the delivery roller 39. The yarn feeding device 11 rotationally drives the delivery roller 39 using an electric motor (not shown in the drawings), with the spun yarn 10 discharged from the spinning device 9 sandwiched between the delivery roller

39 and the nip roller 40. The yarn feeding device 11 thus feeds the spun yarn 10 toward the winding device 13 side.

[0034] The winding device 13 includes a cradle arm 71 swingably supported around a support shaft 70. The cradle arm 71 can rotatably support a bobbin around which the spun yarn 10 is wound. The winding device 13 further includes a winding drum 72 and a traverse device 75. The winding drum 72 is configured to make contact with and drive the bobbin or an outer peripheral surface of the package 45 formed by winding the spun yarn 10 around the bobbin. Furthermore, the traverse device 75 includes a traverse guide 76 that can be engaged with the spun yarn 10. The traverse guide 76 is fixed to a traverse rod 77 located horizontally across a plurality of the spinning units 2. While the traverse rod 77 is reciprocated by a driving means (not illustrated in the drawings), the winding drum 72 is driven by an electric motor (not illustrated in the drawings). Accordingly, the package 45 making contact with the winding drum 72 is rotated, and the spun yarn 10 is wound into the package 45 while being traversed.

[0035] A yarn clearer 52 is provided at a front side of the housing 6 of the spinning machine 1 and slightly downstream of the yarn feeding device 11. The spun yarn 10 spun by the spinning device 9 passes through the yarn clearer 52 before being wound by the winding device 13. The yarn clearer 52 monitors the thickness and speed of the traveling spun yarn 10. Upon detecting a yarn defect in the spun yarn 10, the yarn clearer 52 transmits a yarn defect detection signal to a unit controller 73.

[0036] Upon receiving the yarn defect detection signal, the unit controller 73 controls a cutter 57 to immediately cut the yarn and stops the draft device 7, the spinning device 9 and the like. Moreover, the unit controller 73 controls the yarn splicing vehicle 3 to travel to the front of the corresponding spinning unit 2. The unit controller 73 thereafter drives the spinning device 9 and the like again, and controls the yarn splicing vehicle 3 to perform splicing. Then, a spinning operation and a winding operation can be resumed.

[0037] As shown in Figures 1 and 2, the yarn splicing vehicle 3 includes a splicer (splicing device) 43, a suction pipe 44, and a suction mouth 46. The yarn splicing vehicle 3 is provided so as to travel on a rail 41 disposed in the housing 6 of the spinning machine 1. When yarn breakage or yarn cut occurs in a certain spinning unit 2, the yarn splicing device 3 travels to such spinning unit 2, and is then stopped. While moving pivotably upward around a shaft, the suction pipe 44 sucks and catches a yarn end discharged from the spinning device 9. The suction pipe 44 then moves pivotably downward around the shaft to guide the caught yarn end to the splicer 43. While moving pivotably downward around a shaft, the suction mouth 46 sucks and catches a yarn end from a package 45 rotatably supported by the winding device 13. The suction mouse 46 then moves pivotably upward around the shaft to guide the caught yarn end to the splicer 43. The splicer 43 splices the guided yarn ends together.

[0038] The yarn slack eliminating device 12 is provided in each of the plurality of spinning units 2. The yarn slack eliminating device 12 eliminates the slack of the spun yarn 10 between the spinning device 9 and the winding device 13 (between the spinning device 9 and the splicer 43) to apply an appropriate tension to the spun yarn 10.

[0039] Specifically, the yarn slack eliminating device 12 includes a yarn slack eliminating roller 21, a yarn hooking member 22, an upstream guide 23, an air cylinder 24, an electric motor (driving source) 25, a downstream guide 26, and an excitation coil 35. The yarn slack eliminating roller 21 is configured to be driven and rotated by the electric motor 25 to wind the spun yarn 10 around the outer periphery of the yarn slack eliminating roller 21 to accumulate the spun yarn 10 thereon. The yarn hooking member 22 is located concentrically with the yarn slack eliminating roller 21. The yarn hooking member 22 is configured to rotate integrally with or independently of the yarn slack eliminating roller 21 depending on conditions. The upstream guide 23 is located slightly upstream of the yarn slack eliminating roller 21. The upstream guide 23 is movable between an advanced position and a retracted position by means of the air cylinder 24. The downstream guide 26 is provided downstream of the yarn slack eliminating roller 21.

[0040] The yarn slack eliminating device 12 includes a yarn slack eliminating device control section (hereinafter referred to as a control section) 74. The control section 74 controls a voltage applied to the excitation coil 35, expansion and contraction of the air cylinder 24, rotation of the electric motor 25, and the like.

[0041] When the upstream guide 23 is located at the advanced position, the yarn path of the spun yarn 10 is held by the upstream guide 23 so as to prevent the spun yarn 10 from engaging with the yarn hooking member 22. Meanwhile, when the upstream guide 23 is located at the retracted position, the yarn path is moved to a position where the spun yarn 10 engages with the yarn hooking member 22 and is wound around the yarn slack eliminating roller 21.

[0042] The yarn slack eliminating roller 21, the upstream guide 23, the air cylinder 24, the electric motor 25, the downstream guide 26, the excitation coil 35, and the like are supported by the spinning unit 2 via a fixation member such as a bracket 27.

[0043] As shown in Figures 3 and 4, the yarn slack eliminating roller 21 includes a rotation system structure 90. The rotation system structure 90 includes an inner magnetic pole member 29, an outer magnetic pole member 32, and a yarn slack eliminating roller main body 42. The inner magnetic pole member 29 is coupled to a rotating shaft 25a of the electric motor 25 via a coupling member. A non-magnetic member 31 is mounted on the inner magnetic pole member 29 by a mounting screw 30. The outer magnetic pole member 32 is coupled to the inner magnetic pole member 29 via the non-magnetic member 31. The yarn slack eliminating roller main body 42 is fixed to the outer magnetic pole member 32. The

inner magnetic pole member 29, the outer magnetic pole member 32, and the yarn slack eliminating roller main body 42 are configured to be rotatable by the electric motor 25 while remaining integrated together.

[0044] A side of the yarn slack eliminating roller main body 42 which has the yarn hooking member 22 will be referred to as a leading end, and a side thereof which is connected to the electric motor 25 will be referred to as a base end. As shown in Figure 4, an outer peripheral surface 42a of the yarn slack eliminating roller main body 42 includes a base end side taper portion 42b, a cylindrical portion 42c, and a leading end side taper portion 42d arranged in this order from the base end towards the leading end. The base end side taper portion 42b and the leading end side taper portion 42d are gently tapered such that an end surface side of each of the taper portions corresponds to a larger diameter side. The cylindrical portion 42c is shaped such that a leading end side thereof is slightly narrowed. Moreover, the cylindrical portion 42c is continuous with the taper portions 42b and 42d, with no step formed between the cylindrical portion 42c and each of the taper portions 42b and 42d.

[0045] During a yarn splicing operation of the yarn splicing vehicle 3, the yarn slack eliminating device 12 allows the yarn hooking member 22 to wind the spun yarn 10 from the spinning device 9 side, around an outer peripheral surface 42a of the yarn slack eliminating roller main body 42. When the yarn splicing operation is completed, the yarn slack eliminating device 12 allows the yarn hooking member 22 to unwind the spun yarn 10 wound and accumulated around the outer peripheral surface 42a, towards the winding device 13. When winding the spun yarn 10 around the yarn slack eliminating roller main body 42, the winding starts from the base end of the yarn slack eliminating roller main body 42. When unwinding the spun yarn 10 from the yarn slack eliminating roller main body 42, the unwinding starts from the leading end of the yarn slack eliminating roller main body 42.

[0046] The base end side taper portion 42b allows the supplied spun yarn 10 to move from a larger diameter portion to a smaller diameter portion of the outer peripheral surface 42a of the yarn slack eliminating roller main body 42 to reach the cylindrical portion 42c, located midway between the larger and smaller diameter portions. Thus, the spun yarn 10 can be orderly wound around the surface of the cylindrical portion 42c. Furthermore, the leading end side taper portion 42d has a function of preventing a slip-off phenomenon in which while the spun yarn 10 is being unwound, all of the wound spun yarn 10 slips off from the yarn slack eliminating roller main body 42 at one time. The leading end side taper portion 42d also has a function of progressively winding back the spun yarn 10 from the smaller diameter portion towards the larger diameter portion on the end surface side of the yarn slack eliminating roller main body 42 to allow the spun yarn 10 to be smoothly drawn out.

[0047] An electromagnet 36 as a magnetic field forming means includes an annular excitation coil 35 fixed to the bracket 27 or the like. The inner magnetic pole member 29 is located inside the excitation coil 35. The outer magnetic pole member 32 is located outside the excitation coil 35.

[0048] The inner magnetic pole member 29 includes an opposite portion 29a and an inner magnetic pole 29b. The opposite portion 29a is provided facing an inner side of the excitation coil 35. The inner magnetic pole 29b extends in an axial direction from the opposite portion 29a. The outer magnetic pole member 32 includes an opposite portion 32a and an outer magnetic pole 32b. The opposite portion 32a is provided facing an outer side of the excitation coil 35. The outer magnetic pole 32b extends in an axial direction from the opposite portion 32a.

[0049] As shown in Figure 5 as a cross-sectional view taken along line A-A in Figure 4, the inner magnetic pole 29b includes an outward projection 50 projecting outward in a radial direction. The outer magnetic pole 32b includes an inner projection 51 projecting inward in the radial direction. A plurality of (in the present embodiment, eight) the outward projections 50 are formed and arranged in a circumferential direction at equal intervals, and also a plurality of (in the present embodiment, eight) the inward projections 51 are formed and arranged in the circumferential direction at equal intervals. A magnetic field forming space 53 is formed between the outward projections 50 and the inward projections 51.

[0050] The yarn hooking member 22 includes a flyer shaft 33, a flyer 38, and an annular member 37. The yarn hooking member 22 is configured to be rotatable independently of the rotation system structure 90 of the yarn slack eliminating roller 21. Specifically, the flyer shaft 33 is arranged concentrically with the inner magnetic pole member 29 and is supported via bearing means 34 so as to be rotatable relative to the inner magnetic pole member 29. The annular member 37 made of a magnetic hysteresis material is fixed to the flyer shaft 33. The annular member 37 is inserted into the magnetic space 53.

[0051] The flyer 38 is fixed to a tip portion 33a of the flyer shaft 33. The flyer 38 is shaped to be appropriately curved towards the outer peripheral surface 42a of the yarn slack eliminating roller main body 42. Thus, the flyer 38 can engage with the spun yarn 10 (can hook the spun yarn 10) to guide the spun yarn 10 to the outer peripheral surface of the yarn slack eliminating roller main body 42.

[0052] The yarn slack eliminating device 12 operates as follows. That is, when the excitation coil 35 in the electromagnet 36 is energized, the inner magnetic pole member 29 and the outer magnetic pole member 32 are excited. Accordingly, a magnetic field is generated in the magnetic field forming space 53, and a force (a resistance force based on a hysteresis loss) acting to hold a phase relative to the yarn slack eliminating roller 21 acts on the annular member 37 located so as to cross the magnetic field. As described above, a resistance torque can be generated between the yarn slack eliminating roller 21 and the yarn hooking member 22 by the electromagnet

36, provided in the yarn slack eliminating roller 21, and the annular member 37, provided at the yarn hooking member 22 and made of the hysteresis material.

[0053] As shown in Figures 3 and 4, in the present embodiment, the inner magnetic pole member 29 and the outer magnetic pole member 32 are arranged with respect to the non-rotatable excitation coil 35 so as to rotate integrally with the yarn slack eliminating roller 21. In this state, when the excitation coil 35 is energized, the magnetic field rotates with the yarn slack eliminating roller 21. Since the annular member 37 is located inside the magnetic field, a torque (resistance torque) is obtained which resists the rotation of the yarn hooking member 22 relative to the yarn slack eliminating roller 21.

[0054] The resistance torque varies depending on the magnitude of the magnetic field. Thus, any resistance torque can be obtained by adjusting a voltage or current applied to the excitation coil 35. Furthermore, even during spinning (during yarn winding), the resistance torque can be appropriately varied by varying the voltage or the like applied to the excitation coil 35.

[0055] Next, the operation of the spinning machine 1 configured as described above will be described below. Each of the spinning units 2 of the spinning machine 1 allows the draft device 7 to feed the fiber bundle 8 to the spinning device 9. The spun yarn 10 spun and generated by the spinning device 9 is fed to the downstream side by the yarn feeding device 11, and passes through the cutter 57 and the yarn clearer 52. The spun yarn 10 is finally fed, via the yarn slack eliminating device 12, to the winding device 13, where the spun yarn 10 is wound into the package 45.

[0056] When the yarn clearer 52 of a certain spinning units 2 detects a defect (yarn defect) in the spun yarn 10, the unit controller 73 of such spinning unit 2 cuts the spun yarn 10 using the cutter 57. Simultaneously with the cutting of the spun yarn 10 with the cutter 57, the unit controller 73 stops the rotation of the back roller 16 and the third roller 17 of the draft device 7. The fiber bundle 8 is tearingly cut between the stopped third roller 17 and the continuously rotating middle roller 19. A part of the spun yarn 10 located downstream of the cut portion is sucked and removed by a suction means (not shown in the drawings).

[0057] The unit controller 73 of the spinning unit 2 transmits a yarn splicing request signal to the yarn splicing vehicle 3. Upon receiving the yarn splicing request signal, the yarn splicing vehicle 3 moves to and stops at a position where the yarn splicing vehicle 3 faces the spinning unit 2. Then, the unit controller 73 sends a signal to the control section 74 at an appropriate timing, to start rotating the yarn slack eliminating roller 21 of the yarn slack eliminating device 12. Simultaneously with the start of rotation of the yarn slack eliminating roller 21, the unit controller 73 controls the air cylinder 24 to advance the upstream guide 23 of the yarn slack eliminating device 12. The upstream guide 23 thus holds the yarn path such that the spun yarn 10 to be spun next does not engage with the yarn hooking member 22 of the yarn slack eliminating device 12 other than when required.

[0058] At this time, the control section 74 performs control such that the voltage applied to the excitation coil 35 of the yarn slack eliminating device 12 is changed to a predetermined value so as to sufficiently reduce the resistance torque exerted on the yarn hooking member 22. That is, at an instant when the flyer 38 of the yarn slack eliminating device 12 catches and engages with the spun yarn 10, a tension higher than usual is applied to the spun yarn 10, which is thus likely to be broken. In this connection, according to the present embodiment, the control section 74 performs control such that the resistance torque applied to the yarn hooking member 22 is reduced before the flyer 38 engages with the spun yarn 10. Consequently, possible yarn breakage can be prevented, allowing operating efficiently to be improved.

[0059] Subsequently, when the suction pipe 44 of the yarn splicing vehicle 3 is pivotably moved upward, driving of the draft device 7 and the spinning device 9 is started almost in synchronism with the upward pivotable movement of the suction pipe 44, and the spun yarn 10 spun from the spinning device 9 is sucked and caught by the suction pipe 44. Furthermore, at the same time, on the winding device 13 side, the suction mouth 46 of the yarn splicing vehicle 3 moves pivotably downward to suck and catch the yarn end wound around the package 45. The suction pipe 44 and the suction mouth 46 guide the respective sucked yarn ends to the splicer 43 for yarn splicing.

[0060] Immediately before the splicer 43 starts the yarn splicing operation, the air cylinder 24 in the yarn slack eliminating device 12 contracts and retracts to move the upstream guide 23 to the retracted position. Then, the yarn path of the spun yarn 10 is changed so as to overlap the rotational track of the flyer 38. As a result, the spun yarn 10 engages with the flyer 38, which rotates to wind the spun yarn 10 around the outer peripheral surface 42a of the yarn slack eliminating roller 21.

[0061] That is, the spun yarn 10 continues to be spun by the spinning device 9 even during the yarn splicing operation of the splicer 43. Thus, in this state, a large amount of spun yarn 10 may be accumulated on the upstream side of the splicer 43. However, in the spinning machine 1 according to the present embodiment, during the yarn splicing operation of the splicer 43, the yarn slack eliminating device 12 winds the spun yarn 10 around the yarn slack eliminating roller 21 to prevent the spun yarn 10 from being slackened or accumulated. As a result, the yarn splicing operation and a spinning resuming operation can be smoothly carried out.

[0062] Furthermore, as described above, the resistance torque applied to the yarn hooking member 22 in this case is set to be low enough to prevent possible yarn breakage. Thus, the spun yarn 10 is prevented from being subjected to an excessive tension at an instant when the flyer 38 engages with the spun yarn 10. Consequently, the spun yarn 10 can be wound around the yarn slack

eliminating roller 21 without being broken.

[0063] Then, after an elapse of a predetermined period of time from the resumption of driving of the above-described spinning device 9, the control section 74 performs control such that the voltage applied to the excitation coil 35 of the yarn slack eliminating device 12 is changed to a predetermined value so that the yarn hooking member 22 is subjected to a resistance torque of an appropriate magnitude.

[0064] That is, the resistance torque applied to the yarn hooking member 22 is reduced when the driving of the spinning device 9 is resumed. This is to reduce a possible impact at an instant when the flyer 38 engages with the spun yarn 10. Consequently, after the spun yarn 10 starts to be wound around the yarn slack eliminating roller 21, the resistance torque needs to be recovered in order to apply an appropriate tension to the spun yarn 10. In the present embodiment, a sensor is not provided for sensing that the spun yarn 10 has been wound around the yarn slack eliminating roller 21. However, according to the present embodiment, when a predetermined period of time elapsed after the start of spinning, a determination is made that the spun yarn 10 has started to be wound around the yarn slack eliminating roller 21, and then an appropriate tension is applied to the spun yarn 10. The series of resistance torque control operations enable a reduction in the likelihood of yarn breakage in the yarn slack eliminating device 12.

[0065] Next, timings of the above-described operations will be described with reference to Figure 6.

[0066] It is assumed that at a timing (t1) shown in Figure 6, the yarn clearer 52 of one of the spinning units 2 detects a yarn defect, causing the spun yarn 10 to be cut with the cutter 57. Then, the unit controller 73 once stops a spinning performed by the spinning device 9. Although not shown in the drawings, the unit controller 73 also sends a control signal to the winding device 13 to allow the winding device 13 to immediately stop the rotation of the package 45.

[0067] Moreover, the unit controller 73 immediately sends a signal to the control section 74 to allow the control section 74 to stop the electric motor 25 for the yarn slack eliminating device 12. As a result, the rotation of the yarn slack eliminating device 21 and the flyer 38 is stopped. At the same time, the control section 74 controls the electromagnet 36 such that the resistance torque applied to the yarn hooking member 22 becomes zero. Thus, energy saving can be achieved.

[0068] Then, the unit controller 73 sends a predetermined signal to the yarn splicing vehicle 3, which thus travels to the spinning unit 2 in which the yarn has been cut. Thereafter, the unit controller 73 controls the splicer 43 to start the yarn splicing operation. In the following description, it is assumed that at a timing (t2), the splicer 43 starts the yarn splicing operation. The unit controller 73 sends a signal to the control section 74 of the yarn slack eliminating device 12 at almost the same timing (t2) as that of the start of the yarn splicing operation. The control section 74 starts rotating the yarn slack eliminating roller 21, while controlling the electromagnet 36 so as to reduce the resistance torque applied to the yarn hooking member 22 to prevent the spun yarn 10 from being broken.

[0069] The unit controller 73 performs control such that the output of the spun yarn 10 by the spinning device 9 is resumed at a timing (t3) shortly after the start of the yarn splicing operation by the splicer 43. The yarn splicing vehicle 3 uses the suction pipe 44 to catch the spun yarn 10 spun by the spinning device 9, and at a timing (t4), the yarn splicing vehicle 3 guides the spun yarn 10 to the splicer 43.

[0070] The air cylinder 24 is contracted and retracted at almost the same timing (t5) as when the spun yarn 10 is transferred from the suction pipe 44 to the splicer 43. As a result, the flyer 38 engages with the spun yarn 10, and the spun yarn 10 starts to be wound around the yarn slack eliminating roller 21. The unit controller 73 then sends a signal to the control section 74 to allow the control section 74 to perform control such that the resistance torque of the flyer 38 is set back to a normal value at a timing (t6), that is, a predetermined time after the spinning start timing (t3), described above. A period of time (time TM1 shown in Figure 6) from the catching of the spun yarn 10 by the flyer 38 until the resistance torque is recovered is desirably short.

[0071] Furthermore, as described above, the flyer 38 and the flyer shaft 33 are rotatable independently of the yarn slack eliminating roller 21. However, the flyer 38 rotates integrally with the yarn slack eliminating roller 21 unless a mechanism composed of the electromagnet 36 and the annular member 37 imposes a load of at least a predetermined magnitude on the flyer 38. During the above-described yarn splicing operation, the traveling of the downstream side spun yarn 10 is stopped, thus reducing the load imposed on the flyer 38. Therefore, the flyer 38 rotates integrally with the yarn slack eliminating roller 21 to wind the spun yarn 10 around the outer peripheral surface 42a of the yarn slack eliminating roller 21.

[0072] Subsequently, after the splicer 43 completes the yarn splicing operation, the winding device 13 allows the winding drum 72 to rotate the package 45 to resume winding of the spun yarn 10.

[0073] As described above, the spun yarn 10 spun by the spinning device 9 is wound around the outer peripheral surface 42a of the continuously rotating yarn slack eliminating roller 21 from the start of the yarn splicing operation by the splicer 43 until the winding operation is resumed. However, when the winding device 13 resumes the winding operation, a yarn speed at which the spun yarn 10 is drawn out from the yarn slack eliminating roller 21 is higher than that at which the spun yarn 10 is wound around the yarn slack eliminating roller 21. This is because the ratio of a feed-out speed of the yarn feeding device 11 to a winding speed of the winding device 13 is set so as to apply an appropriate tension to the spun yarn 10. Consequently, the flyer 38 of the yarn slack eliminat-

ing device 12 rotates independently of the yarn slack eliminating roller 21 rotating continuously in a winding direction. The spun yarn 10 accumulated on the yarn slack eliminating roller 21 is thus gradually unwound.

[0074] During the unwinding of the spun yarn 10 from the yarn slack eliminating roller 21, the flyer 38 prevents the possible slip-off of the spun yarn 10 and guides the spun yarn 10 so that the spun yarn 10 is averagely unwound from the yarn slack eliminating roller 21. Moreover, the flyer 38 contacts with the spun yarn 10 to apply an appropriate resistance to the spun yarn 10. Thus, an appropriate tension is applied to the spun yarn 10, which is then suitably wound into the package 45.

[0075] That is, the flyer 38 according to the present embodiment has a yarn hooking function and an unwinding tension applying function. The yarn hooking function is a function by which the flyer 38 introduces the spun yarn 10 onto the yarn slack eliminating roller 21 immediately before the start of the splicing operation by the splicer 43. The unwinding tension applying function is a function by which the flyer 38 applies a predetermined unwinding tension when the spun yarn 10 wound around the yarn slack eliminating device 21 is unwound.

[0076] As described above, the yarn slack eliminating device 12 according to the present embodiment can appropriately control the resistance torque applied to the yarn hooking member 22 to wind the spun yarn 10 around the yarn slack eliminating roller 21 without causing yarn breakage. However, according to the present embodiment, the yarn slack eliminating device 12 is more positively utilized as a device controlling the tension applied to the spun yarn 10. In other words, according to the present embodiment, the yarn slack eliminating device 12 performs control such that the yarn tension is constantly varied during any periods of time including the period of the yarn splicing operation, thus further improving the package quality.

[0077] A description will be given below of the control of the yarn tension performed by the yarn slack eliminating device 12 according to the present embodiment.

[0078] That is, in the present embodiment, the control section 74 performs control such that the voltage applied to the excitation coil 35 of the yarn slack eliminating device 12 is appropriately varied depending on the winding diameter of the package 45 so as to apply an optimum resistance torque to the yarn hooking member 22.

[0079] The optimum yarn tension depends on the winding diameter of the package 45. Preferably, the yarn tension is always controlled in order to form an optimum package 45. For example, when continuously wound into the package 45 with the yarn tension not controlled, the spun yarn 10 is wound loosely in an inner diameter portion of the package 45 and tightly in an outer diameter portion thereof.

As a result, the spun yarn 10 in the inner diameter portion of the package 45 is pressed by the spun yarn 10 in the outer diameter portion and sticks out from the end surface of the package 45 (bulge winding).

[0080] To prevent the bulge winding as described above, the present embodiment is configured as follows. First, the control section 74 monitors a yarn speed signal from the yarn clearer 52 during a spinning operation and measures an elapsed time for yarn winding. Then, the control section 74 roughly calculates the length of the spun yarn 10 wound into the package 45 in accordance with the yarn speed and the elapsed time. The control section 74 calculates the winding diameter of the package 45 in accordance with the yarn length obtained, and the control section 74 then performs control such that a predetermined resistance torque is applied to the yarn hooking member 22 according to the winding diameter. Specifically, the control section 74 performs control such that the resistance torque at the start of the yarn winding is lower than that when the yarn winding diameter is increased.

[0081] Thus, the possible bulge winding can be prevented, allowing a package 45 with an optimum shape to be formed.

[0082] Furthermore, in the present embodiment, the control section 74 can perform control such that the voltage applied to the excitation coil 35 of the yarn slack eliminating device 12 is appropriately varied in conjunction with the traverse position of the spun yarn 10 so as to optimize the resistance torque applied to the yarn hooking member 22.

[0083] For example, when winding a cone package, if the tension of the spun yarn 10 is not controlled according to the traverse position, the spun yarn 10 is wound loosely in the smaller diameter portion and tightly in the larger diameter portion. As a result, an appropriate package 45 cannot be formed.

[0084] To solve this problem, the following configuration is possible. That is, in accordance with a signal from traverse position detecting means (not shown in the drawings), the control section 74 performs control such that the predetermined resistance torque is applied to the yarn hooking member 22. For example, sensors arranged at the opposite ends of the reciprocating stroke of the traverse rod 77 can be used as the traverse position detecting means. In accordance with signals from the sensors, the control section 74 determines the traverse position to perform control such that a predetermined resistance torque is applied to the yarn hooking member 22 according to the traverse position. Specifically, for example, in case of winding a cone package, the control section 74 performs control such that the resistance torque is increased when the spun yarn 10 is traversed to the smaller diameter side, and is reduced when the spun yarn 10 is traversed to the larger diameter side.

[0085] Thus, the yarn slack eliminating device 12 can absorb a possible variation in yarn tension resulting from the traversing. As a result, a high-quality package 45 can be formed.

[0086] As described above, the yarn slack eliminating device 12 according to the present embodiment includes the electric motor 25, the yarn slack eliminating roller 21,

the yarn hooking member 22, the electromagnet 36, and the control section 74. The yarn slack eliminating roller 21 is rotationally driven by the electric motor 25. The yarn hooking member 22 is concentrically attached to the yarn slack eliminating roller 21 so as to be rotatable relative to the yarn slack eliminating roller 21. The electromagnet 36 generates a magnetic field to be applied to the yarn hooking member 22. The control section 74 allows the magnetic field to generate the resistance torque resisting the rotation of the yarn hooking member 22 relative to the yarn slack eliminating roller 21. The control section 74 controls the input to the electromagnet 36 to control the resistance torque. The control section 74 can control the resistance torque while the spinning machine 1 is in operation.

[0087] Thus, the resistance torque can be varied even while the spinning machine 1 is performing a spinning operation. Consequently, control can be performed such that an appropriate tension is applied to the spun yarn 10. Furthermore, the resistance torque can be controlled in real time, allowing control to be performed such that an optimum yarn tension is applied to the spun yarn 10 according to spinning conditions.

[0088] Furthermore, the control section 74 according to the present embodiment controls the resistance torque according to the yarn winding diameter.

[0089] Thus, the yarn tension can be varied according to the yarn winding diameter, allowing the quality of the package 45 to be improved.

[0090] The control section 74 according to the present embodiment performs control such that the resistance torque is set to be higher when the yarn winding diameter is small than when the yarn winding diameter is large.

[0091] Thus, formation of an unacceptable package such as bulge winding can be prevented, thus allowing the quality of the package 45 to further be improved.

[0092] Furthermore, the control section 74 according to the present embodiment performs control such that when the spinning machine 1 starts spinning, the resistance torque is reduced before the spun yarn 10 is hooked on the yarn hooking member 22.

[0093] Thus, possible yarn breakage can be prevented which results from an excessively high tension applied to the spun yarn 10 when the flyer 38 engages with the spun yarn 10.

[0094] Furthermore, the control section 74 according to the present embodiment performs control such that the resistance torque is increased at the timing (t6) corresponding to a predetermined period of time after the start of the spinning operation (timing t3).

[0095] Thus, in accordance with a simple control, a determination can be made that the spun yarn 10 has been wound around the yarn slack eliminating roller 21, and the resistance torque can be set back to an appropriate value.

[0096] Furthermore, in the present embodiment, the control section 74 performs control such that at the start of the spinning following yarn splicing, the resistance torque is reduced before the spun yarn 10 is hooked on the yarn hooking member 22.

[0097] Thus, the resistance torque can be appropriately controlled so as to prevent an excessive tension from being applied during yarn splicing, in which yarn breakage is likely to occur.

[0098] Furthermore, the control section 74 controls the resistance torque in conjunction with traverse of the spun yarn 10.

[0099] Thus, the variation in tension resulting from the traversing of the spun yarn 10 can be absorbed by the yarn slack eliminating device 12. Consequently, an appropriate tension can be applied to the spun yarn 10 according to the traverse position. Therefore, the package 45 with preferred quality can be formed.

[0100] Furthermore, in the present embodiment, the control section 74 performs control such that in case of winding a cone package, the resistance torque is reduced when the spun yarn 10 is wound around the larger diameter side of the package 45, and the resistance torque is increased when the spun yarn 10 is wound on the smaller diameter side of the package 45.

[0101] Thus, an appropriate tension can be applied to the spun yarn 10, allowing a cone winding package with preferred quality to be formed.

[0102] A preferred embodiment of the present invention has been described. However, the above-described configuration can be varied, for example, as described below.

[0103] According to the above-described embodiment, a control is performed such that, during yarn splicing operation, the resistance torque applied to the yarn hooking member 22 becomes zero at the timing t1, shown in Figure 6. To prevent possible yarn breakage during a yarn splicing operation, it is sufficient to change the resistance torque applied to be yarn hooking member 22 to a predetermined value at the timing (t2). Thus, the resistance torque may have any value at the timing (t1). For example, as shown by an alternate long and two short dashes line in Figure 6, the resistance torque may avoid being changed until the timing (t2). This simplifies the control of the resistance torque.

[0104] The control section 74 may be provided inside in the yarn slack eliminating device 12 or provided on the spinning unit 2 side. If the control section 74 is provided on the spinning unit 2 side, the control section 74 may be configured as a part of the function of the unit controller 73.

[0105] Instead of the arrangement that detects the yarn winding diameter from the yarn speed and the elapsed period of time, an arrangement may be provided which detects the yarn winding diameter using a dedicated winding diameter sensor provided in the spinning unit 2.

[0106] The timing at which the resistance torque is recovered may be such that the recovery is performed after an elapse of a predetermined period of time from the start of a spinning operation or after an elapse of a predetermined period of time from when the upstream guide 23

has moved to the retracted position and the spun yarn 10 can be engaged with the flyer 38.

[0107] Even for packages other than the cone winding package, the package quality can be improved by controlling the resistance torque according to the yarn traverse position. For example, in case of a cheese winding package, the yarn tension increases when the yarn is traversed towards the package end than when the yarn is traversed in a central portion of the width of the package. Thus, a package with a uniform winding tension can be formed by reducing the resistance torque when the traverse position is located at one of the opposite ends of the package width, while increasing the resistance torque when the traverse position is located in the central portion of the package width.

[0108] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the invention.

Claims

1. A yarn slack eliminating device (12) provided in a spinning machine (1), the yarn slack eliminating device (12) comprising:

   a driving source (25);
   a yarn slack eliminating roller (21) rotationally driven by the driving source (25);
   a yarn hooking member (22) concentrically attached to the yarn slack eliminating roller (21) so as to be rotatable relative to the yarn slack eliminating roller (21);
   an electromagnet (36) generating a magnetic field applied to the yarn hooking member (22); and
   a control section (74) allowing the magnetic field to generate a resistance torque resisting the rotation of the yarn hooking member (22) relative to the yarn slack eliminating roller (21), the control section (74) controlling an input to the electromagnet (36) to control the resistance torque, **characterized in that** the control section (74) can control the resistance torque while the spinning machine (1) is in operation.

2. The yarn slack eliminating device (12) according to Claim 1, **characterized in that** the control section (74) controls the resistance torque according to a yarn winding diameter.

3. The yarn slack eliminating device (12) according to Claim 2, **characterized in that** the control section (74) performs control such that the resistance torque is set to be higher when the yarn winding diameter is small than when the yarn winding diameter is large.

4. The yarn slack eliminating device (12) according to any one of Claims 1 to 3, **characterized in that** the control section (74) performs control such that when the spinning machine (1) starts a spinning operation, the resistance torque is reduced before the yarn is hooked on the yarn hooking member (22).

5. The yarn slack eliminating device (12) according to Claim 4, **characterized in that** the control section (74) performs control such that the resistance torque is increased after an elapse of a predetermined period of time from the start of the spinning operation.

6. The yarn slack eliminating device (12) according to Claim 4 or Claim 5, **characterized in that** the control section (74) performs control such that at the start of the spinning operation during a yarn splicing operation, the resistance torque is reduced before the yarn is hooked on the yarn hooking member (22).

7. The yarn slack eliminating device (12) according to any one of Claims 1 to 6, **characterized in that** the control section (74) controls the resistance torque in conjunction with traverse of the yarn.

8. The yarn slack eliminating device (12) according to Claim 7, **characterized in that** the control section (74) performs control such that in case of winding a cone winding package, the resistance torque is reduced when the yarn is wound on a larger diameter side of the package, and is increased when the yarn is wound on a smaller diameter side of the package.

9. A spinning machine (1) including the yarn slack eliminating device (12) according to any one of Claims 1 to 8.

FIGURE 1

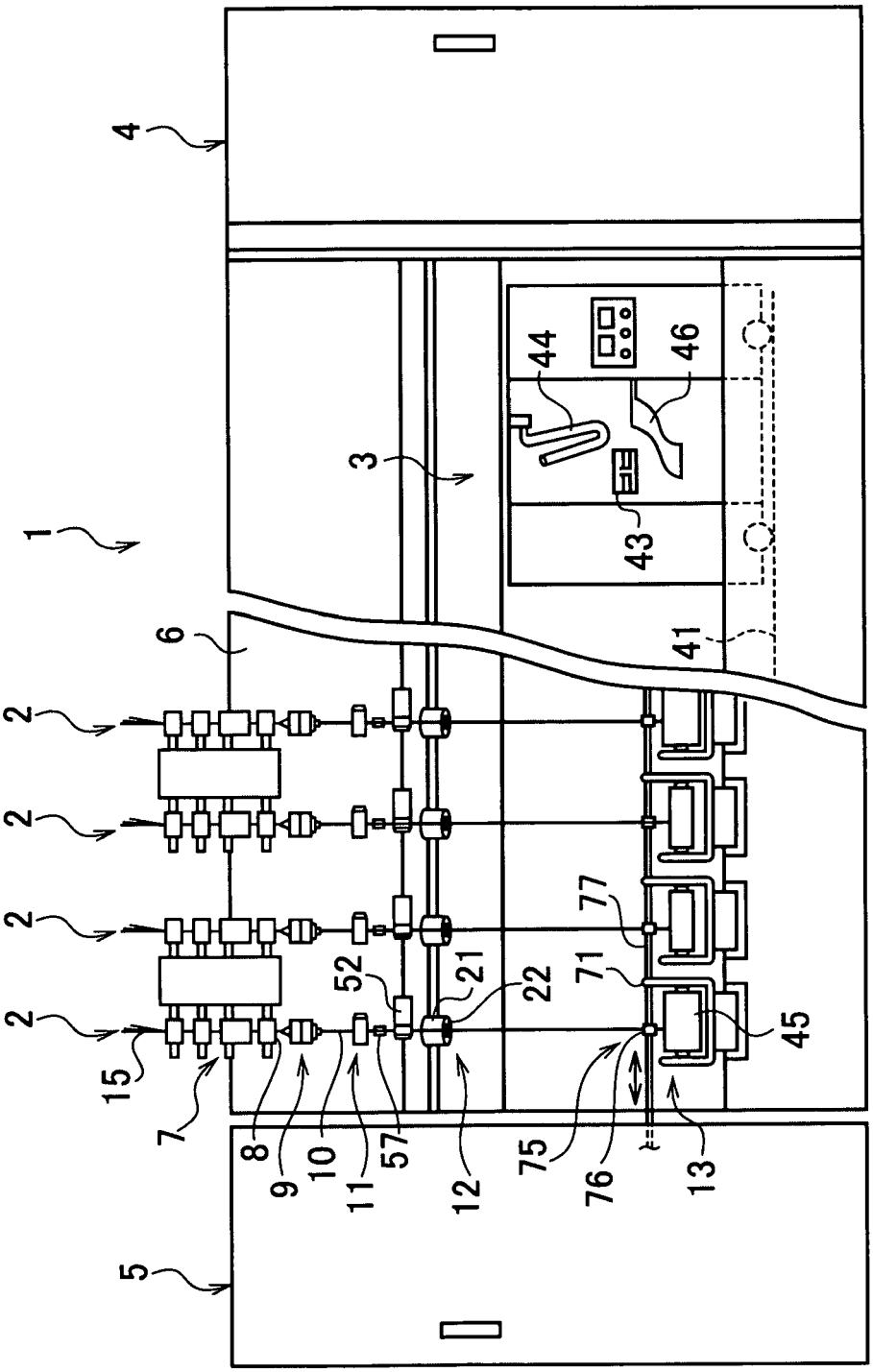
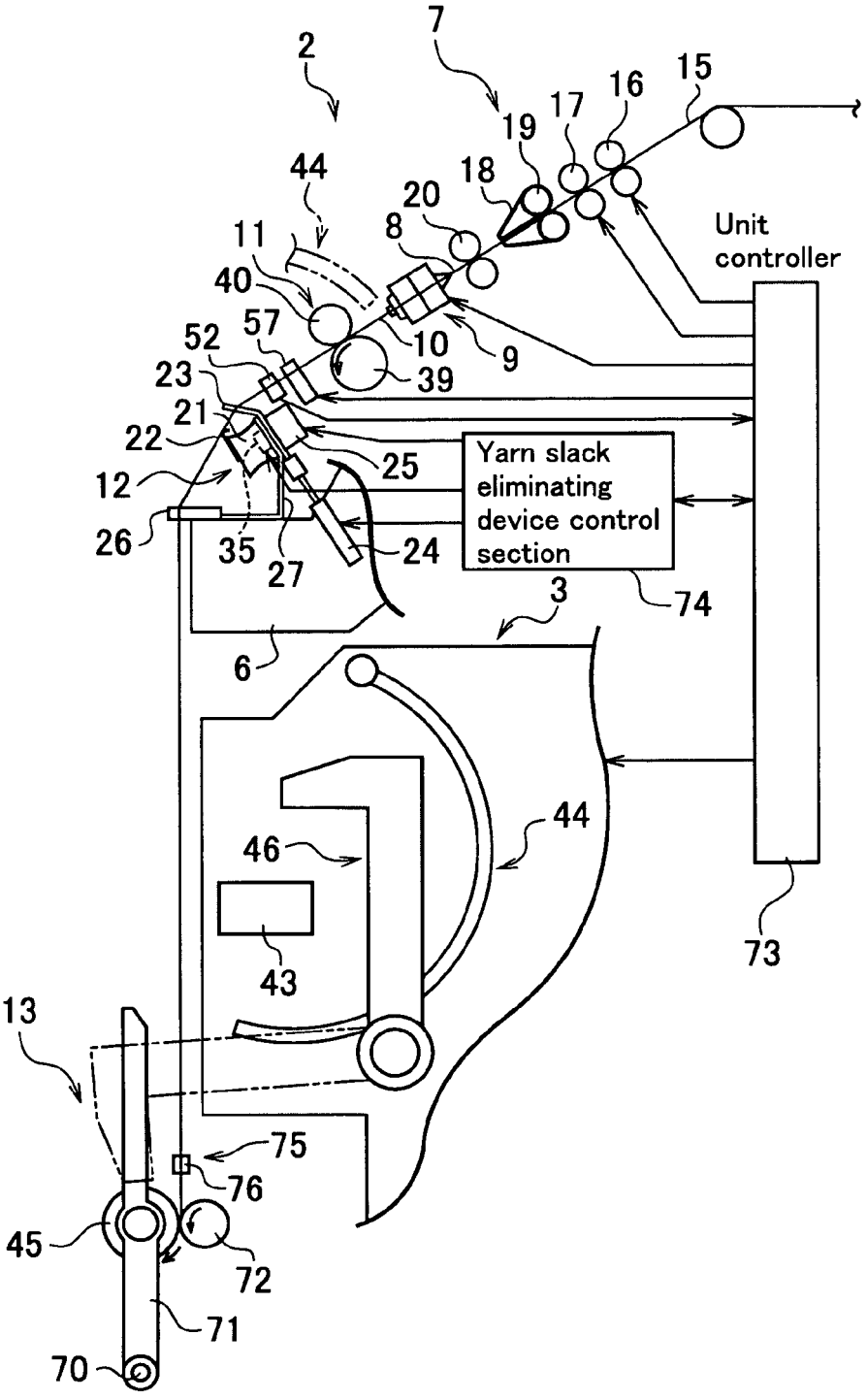


FIGURE 2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44
18
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8
11
Unit controller
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57
10
9
52
39
23
21
22
25
Yarn slack eliminating device control section
12
26
35
27
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74
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43
73
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72
71
70

FIGURE 3

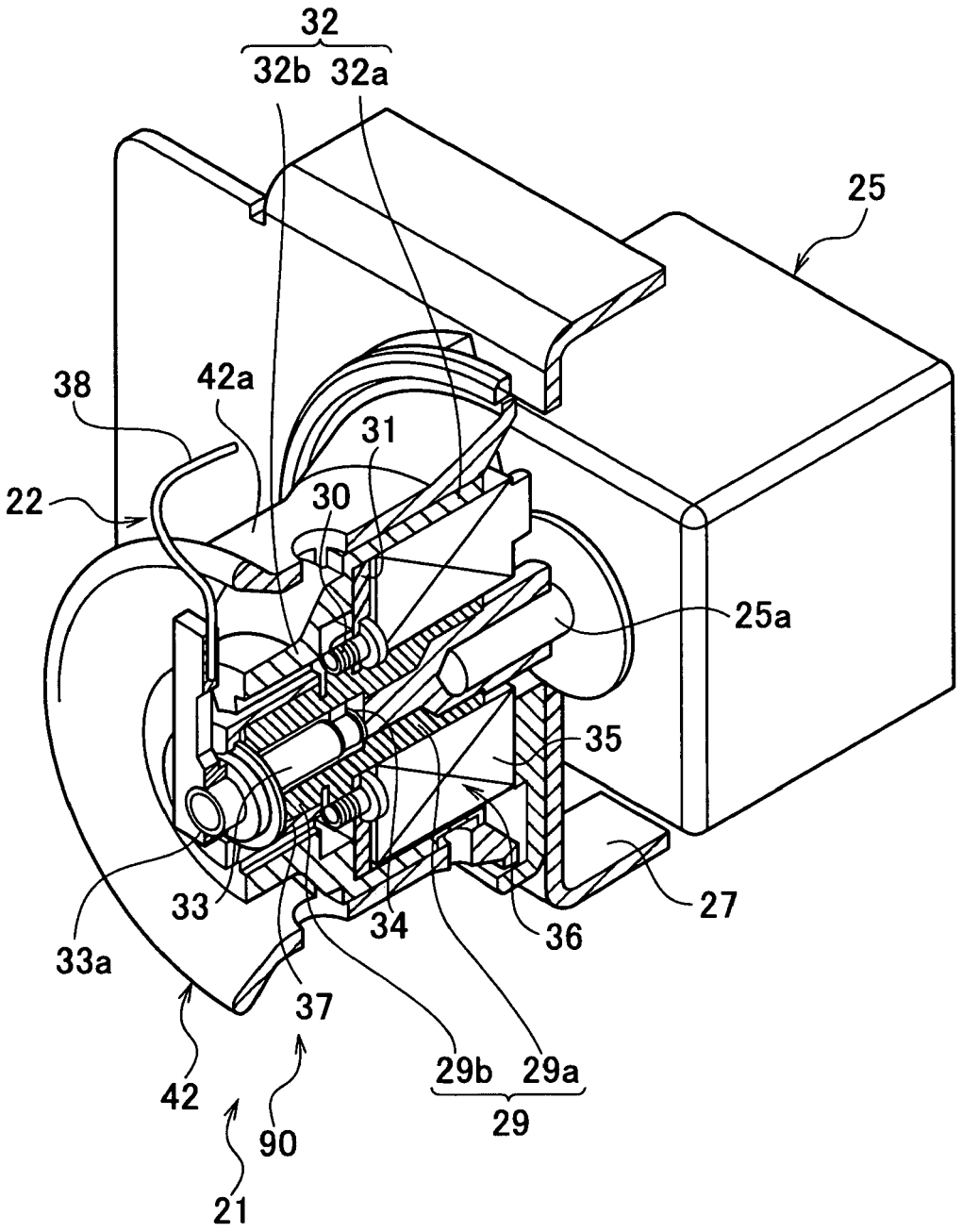
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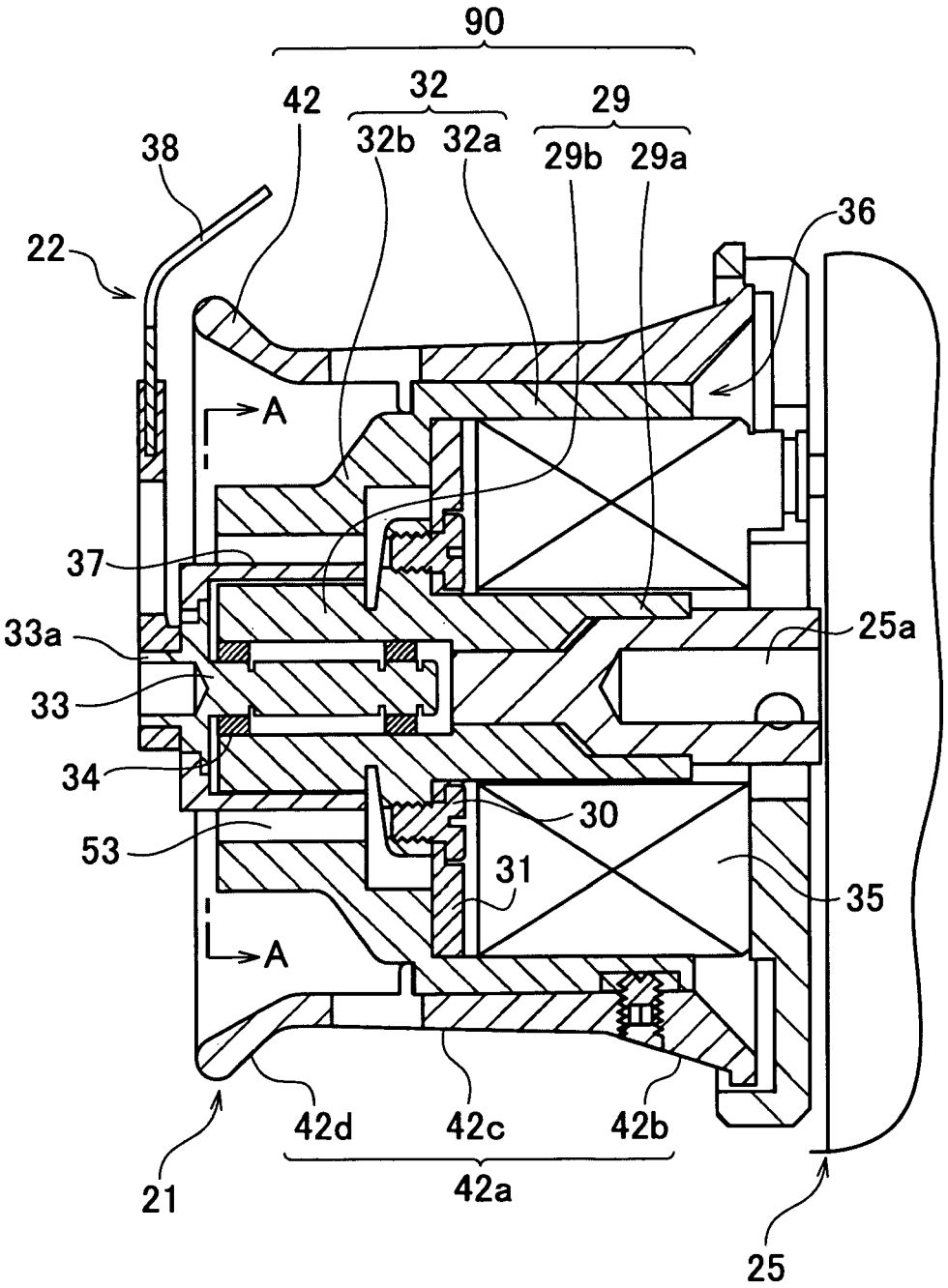
FIGURE 4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42c
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25

FIGURE 5

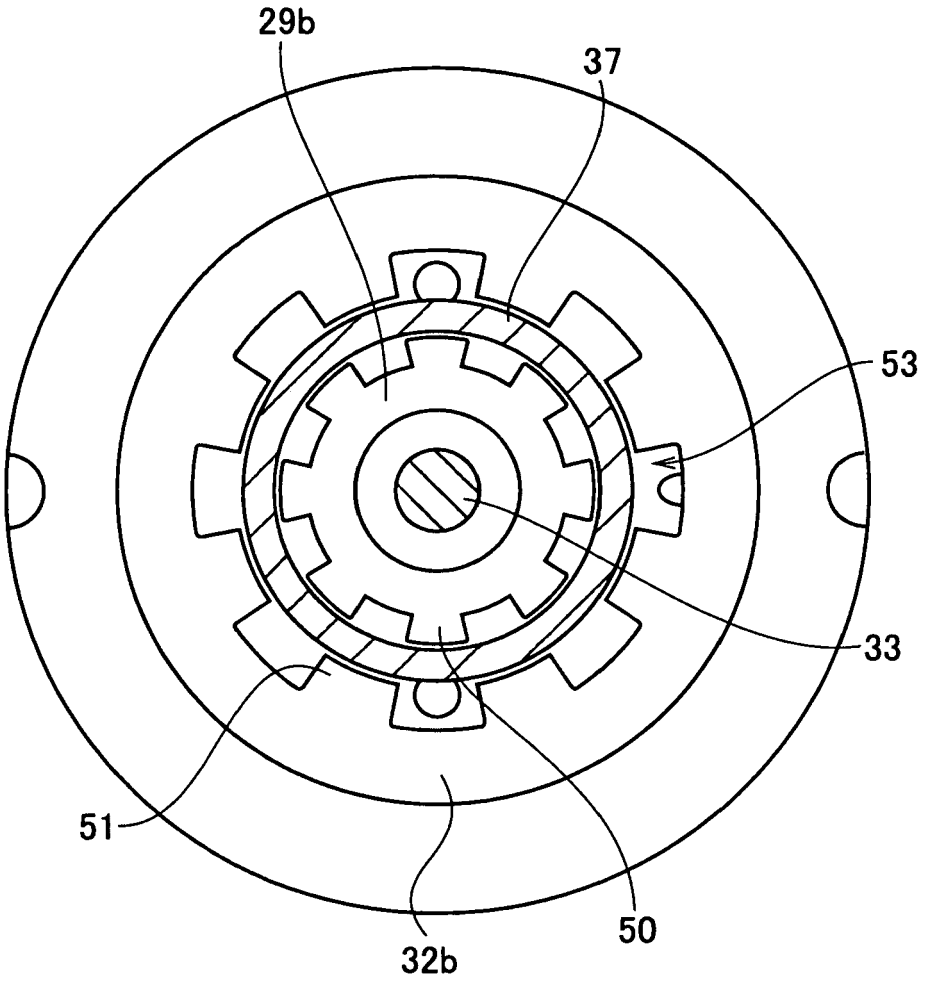
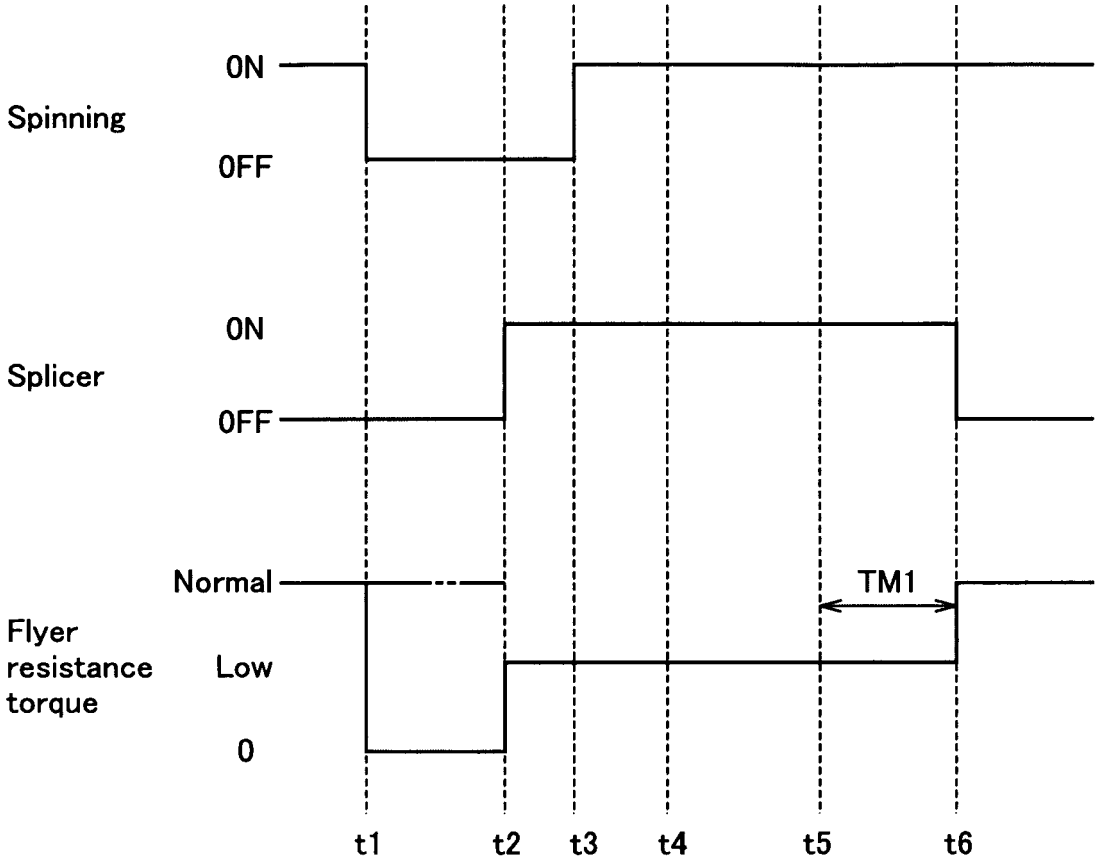


FIGURE 6


Spinning
ON
OFF
Splicer
ON
OFF
Flyer resistance torque
Normal
Low
0
TM1
t1
t2
t3
t4
t5
t6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006306588 A **[0003] [0006] [0006]**