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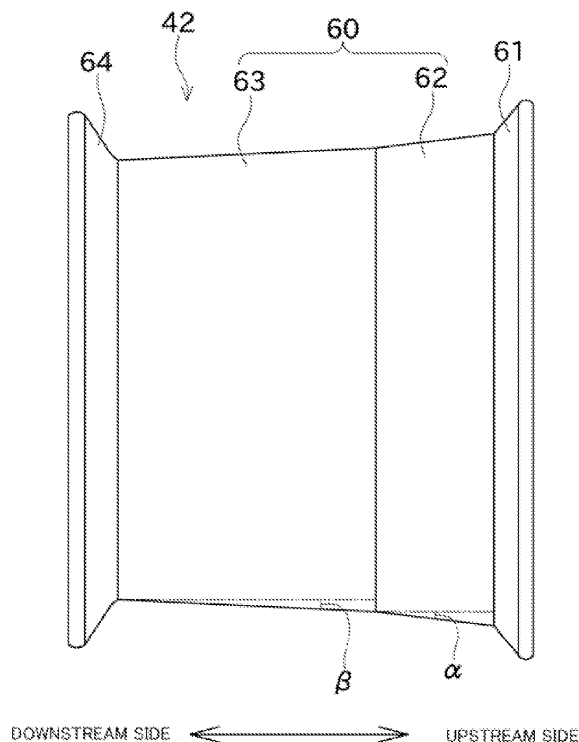
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(54) **Yarn slack eliminating device and textile machine including the same**

(57) A yarn slack eliminating device includes a roller 42. A winding range 60 of the roller 42 around which a yarn is wound is formed in a taper shape in which a diameter decreases from an upstream side where the yarn starts to be wound around towards a downstream side. The winding range 60 includes a first taper section 62 and a second taper section 63, and a taper angle becomes moderate towards the downstream side in two stages at the first taper section 62 and the second taper section 63. An area of the first taper section 62 having a large taper angle is smaller than an area of the second taper section 63 having a small taper angle (Fig. 4).

FIG. 4



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn slack eliminating device and, more specifically, to a roller provided in the yarn slack eliminating device for accumulating a yarn.

2. Description of the Related Art

[0002] Conventionally, in a high-speed spinning machine such as a pneumatic type spinning machine that forms a package by winding a spun yarn, when performing a yarn splicing operation or the like to splice the spun yarn with a yarn of the package, a package winding operation is stopped. However, the yarn is continuously fed from a spinning device even when the winding operation is being stopped. Therefore, yarn slackening and yarn buildup (i.e., a yarn that is stacked without being accumulated on a roller) need to be prevented.

[0003] In view of the above point, Japanese Unexamined Patent Application Publication No. 2006-306588 discloses a yarn slack eliminating device that includes a slack eliminating roller, which is rotationally driven by an electric motor, and a yarn hooking member, which can rotate with respect to the slack eliminating roller. While a winding operation is being stopped due to a yarn splicing operation, a yarn continuously fed from a spinning device is accumulated on the slack eliminating roller so as to prevent yarn slackening and yarn buildup. The yarn slack eliminating device adds relative rotational torque to the yarn hooking member by a magnetic mechanism, and thus, excels in following yarn tension fluctuation. The yarn slack eliminating device having the above-described structure can also function as a kind of a tension control device that suppresses the yarn tension fluctuation.

[0004] The slack eliminating roller (roller) of the yarn slack eliminating device disclosed in Japanese Unexamined Patent Application Publication No. 2006-306588 is formed in a taper shape at a yarn winding range. Accordingly, the yarn wound around the slack eliminating roller moves towards a downstream side as if being pushed by the yarn that is subsequently wound. Thus, the yarn can be wound around the slack eliminating roller in order without being just wound at an upstream side in the winding range. As a result, the yarn can be smoothly fed to a winding device.

[0005] In order to prevent the tension fluctuation that occurs at the downstream side of the yarn slack eliminating device from being propagated to an upstream side of the yarn slack eliminating device, it is effective to form a taper angle of the winding range to be large. That is, by forming the taper angle to be large, even if significant tension fluctuation occurs at the downstream side of the

yarn slack eliminating device, such tension fluctuation is absorbed at the winding range having the large taper angle, and thus, the propagation of the tension fluctuation towards the upstream side can be prevented. However, when the taper angle of the slack eliminating roller becomes large, a pitch of the yarn wound around the slack eliminating roller increases, and the yarn cannot be effectively accumulated, which thereby causes the slack eliminating roller to increase in size. Further, when the taper angle becomes large, a difference between a diameter of an upstream end and a diameter of a downstream end of the slack eliminating roller increases, which thereby generates slackening of the yarn wound around the downstream end of the slack eliminating roller. Moreover, when such slackening is significant, sloughing occurs, and the yarn cannot be unwound.

SUMMARY OF THE INVENTION

[0006] In order to overcome the problems described above, preferred embodiments of the present invention provide a yarn slack eliminating device that can suppress influence of tension fluctuation at an upstream side in a yarn traveling direction and smoothly unwind a yarn.

[0007] According to a first aspect of the present invention, a yarn slack eliminating device used in a textile machine includes a roller around which a yarn is wound. At least a portion of a winding range of the roller around which the yarn is wound includes a taper winding range, which is formed in a taper shape in which a diameter decreases from an upstream side where the yarn starts to be wound around towards a downstream side. A taper angle of the taper winding range gradually becomes moderate towards the downstream side.

[0008] Thus, by the winding range in the upstream side where the taper angle is large, tension fluctuation that has occurred at the downstream of the yarn slack eliminating device can be prevented from being propagated to the upstream of the yarn slack eliminating device. Since the taper angle gradually becomes moderate, even if the taper angle at the upstream side is large, a difference between a diameter of the upstream side and a diameter of the downstream side can be reduced. Thus, the yarn slack eliminating device can prevent yarn slackening, which occurs when the difference between the diameter of the upstream side and the diameter of the downstream side of the winding range increases. Accordingly, the occurrence of sloughing can be effectively prevented. Further, since the taper angle is gradually changed by a structure of the winding range of the roller, the yarn slack eliminating device can be easily manufactured without requiring a complicated operational process.

[0009] In the yarn slack eliminating device, the taper winding range includes an upstream winding range and a downstream winding range. A taper angle of the downstream winding range is smaller than a taper angle of the upstream winding range. An area of the upstream wind-

ing range is smaller than an area of the downstream winding range. Thus, while retaining a great accumulated amount of the yarn on the downstream winding range where the taper angle is small, the tension fluctuation that has occurred at the downstream of the yarn slack eliminating device can be prevented from being propagated to the upstream of the yarn slack eliminating device.

[0010] In the yarn slack eliminating device, the taper angle of the upstream winding range is preferably 1.5 degrees or greater and 3.5 degrees or smaller. Accordingly, the yarn can be smoothly accumulated, and the propagation of the tension fluctuation to the upstream of the yarn slack eliminating device can be reliably blocked.

[0011] In order to detect the yarn amount accumulated on the roller, the yarn slack eliminating device preferably includes a yarn amount detecting section which is arranged near the upstream winding range. Thus, control can be effectively performed such that at least a certain amount of the yarn is accumulated on the upstream winding range. As a result, by effectively using the upstream winding range, which highly absorbs the tension fluctuation, the tension fluctuation that has occurred at the downstream of the yarn slack eliminating device can be prevented from being propagated to the upstream of the yarn slack eliminating device.

[0012] A second aspect of the present invention provides a textile machine that includes the yarn slack eliminating device. Accordingly, even when the tension fluctuation occurs at the downstream of the yarn slack eliminating device, the propagation of the tension fluctuation can be prevented by the yarn slack eliminating device, and various operations can be stably performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Fig. 1 is a front view of a spinning machine according to an embodiment of the present invention.

[0014] Fig. 2 is a side cross-sectional view of the spinning machine according to the embodiment of the present invention.

[0015] Fig. 3 is a schematic cross-sectional view illustrating control of a yarn slack eliminating device and a winding device.

[0016] Fig. 4 is a side view of a winding range of a roller.

[0017] Fig. 5 is a side view of a winding range of a roller according to a modified example in which a taper angle decreases in three stages.

[0018] Fig. 6 is a side view of a winding range of a roller according to a modified example in which an inverse taper portion is provided.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0019] A preferred embodiment of the present invention will be described with reference to the drawings. In the description, "upstream" and "downstream" respec-

tively refer to upstream and downstream in a direction in which a yarn travels during a spinning operation.

[0020] As illustrated in Fig. 1, a spinning machine 1 according to the present embodiment includes a plurality of spinning units 2, a yarn splicing cart 3, a doffing cart 4, a blower box 80, a motor box 5, and a frame 6. The spinning units 2 are aligned on the frame 6. Each of the spinning units 2 forms a package 45 of prescribed length. The frame 6 includes a rail 41 and a traveling path 86 which are arranged along a direction in which the spinning units 2 are aligned. The yarn splicing cart 3 can travel along the rail 41. The doffing cart 4 can travel along the traveling path 86.

[0021] Next, the spinning unit 2 will be described. As illustrated in Fig. 1, each of the spinning units 2 includes a draft device 7, a spinning device 9, a yarn feeding device 11, a yarn slack eliminating device 12, and a winding device 13, which are arranged in this order from the upstream to the downstream. The draft device 7 is provided in the vicinity of an upper end of the frame 6 of the spinning machine 1. The draft device 7 drafts a sliver 15 into a fiber bundle 8. The spinning device 9 spins the fiber bundle 8 fed from the draft device 7 by applying twists to the fiber bundle 8. A spun yarn 10 discharged from the spinning device 9 is fed by the yarn feeding device 11, and after passing through a yarn clearer 52 to be described later, the spun yarn 10 is wound by the winding device 13 into the package 45 via the yarn slack eliminating device 12.

[0022] As illustrated in Fig. 2, the draft device 7 includes a back roller 16, a third roller 17, a middle roller 19, and a front roller 20. Further, an apron belt 18 is wound around the middle roller 19. The draft device 7 drafts the sliver 15 by these draft rollers and feeds the sliver 15 to the spinning device 9 provided on the downstream side.

[0023] The spinning device 9 is a pneumatic type which uses a whirling airflow to form the spun yarn 10 from the fiber bundle 8. The spinning device 9 is not limited to the pneumatic type, and may adopt any type that spins the fiber bundle 8.

[0024] The yarn feeding device 11 includes a delivery roller 39 and a nip roller 40. The delivery roller 39 is supported by the frame 6 of the spinning machine 1. The nip roller 40 is in contact with the delivery roller 39. Under a state in which the spun yarn 10 discharged from the spinning device 9 is nipped between the delivery roller 39 and the nip roller 40, the delivery roller 39 is rotationally driven by a not-illustrated electric motor to feed the spun yarn 10 to the winding device 13.

[0025] The yarn clearer 52 is arranged at a position that is located on a front surface side of the frame 6 of the spinning machine 1 and slightly downstream of the yarn feeding device 11. The spun yarn 10, which has been 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 a thickness of the traveling spun yarn 10. When a yarn defect of the spun

yarn 10 is detected by the yarn clearer 52, the yarn clearer 52 transmits a yarn defect detection signal to a control section 73 (which is not illustrated in Fig. 2). When the control section 73 receives the yarn defect detection signal, the control section 73 immediately cuts the spun yarn 10 by a cutter 57, and stops the draft device 7 and the spinning device 9 or the like. The control section 73 transmits a control signal to the yarn splicing cart 3, and the yarn splicing cart 3 travels to the front of the spinning unit 2. Then, the control section 73 re-drives the spinning device 9 or the like, controls the yarn splicing cart 3 to perform a yarn splicing operation, and restarts a spinning operation and a winding operation. The yarn slack eliminating device 12 is provided further downstream of the yarn clearer 52. After passing through the yarn clearer 52, the spun yarn 10 is fed to the yarn slack eliminating device 12.

[0026] The yarn slack eliminating device 12 eliminates slackening and buildup of the spun yarn 10 which has passed through the yarn clearer 52, and adjusts winding tension. The slack eliminating device 12 will be described in detail later. The spun yarn 10, of which the winding tension is adjusted by the yarn slack eliminating device 12, is fed to the winding device 13 provided on the downstream side.

[0027] The winding device 13 includes a cradle arm 71, a winding drum 72, and a traverse device 75. One end of the cradle arm 71 is supported on a supporting shaft 70 in a manner that the cradle arm 71 can swing around the supporting shaft 70, and another end can support a bobbin 48, around which the spun yarn 10 is wound, in a manner that the bobbin 48 can be rotated. The winding drum 72 can be driven in contact with an outer peripheral surface of the bobbin 48 or the package 45, which is formed by winding the spun yarn 10 around the bobbin 48. The traverse device 75 includes a traverse guide 76 that can be engaged with the spun yarn 10. By driving the winding drum 72 by a not-illustrated electric motor while reciprocating the traverse guide 76 by a not-illustrated driving section, the package 45 that is in contact with the winding drum 72 can be rotated, and the spun yarn 10 can be wound into the package 45 while being traversed.

[0028] As illustrated in Figs. 1 and 2, the yarn splicing cart 3 includes a splicer (yarn splicing device) 43, a suction pipe 44, and a suction mouth 46. When a yarn cut or a yarn breakage occurs in a certain spinning unit 2, the yarn splicing cart 3 travels on the rail 41 to such spinning unit 2 and stops. While vertically swinging around a shaft, the suction pipe 44 sucks and catches an end of the spun yarn 10 fed from the spinning device 9, and then guides the spun yarn 10 to the splicer 43. While vertically swinging around a shaft, the suction mouth 46 sucks and catches an end of the spun yarn 10 from the package 45, which is supported by the winding device 13, and then guides spun yarn 10 to the splicer 43. The splicer 43 performs a yarn splicing operation on the yarn ends guided by the yarn splicing suction pipe 44 and the suc-

tion mouth 46.

[0029] The doffing cart 4 includes a doffing device 92, a cradle operating arm 90, a doffing suction pipe 88, and a bunch-winding arm 91. When the package 45 is fully wound in a certain spinning unit 2, the doffing cart 4 travels on the traveling path 86 to such spinning unit 2 and stops. The cradle operating arm 90 can operate the cradle arm 71 of the winding device 13. The doffing suction pipe 88 is telescopic, and can suck and catch the end of the spun yarn 10 fed from the spinning device 9 to guide the end of the spun yarn 10 to the bobbin 48 set in the winding device 13. The bunch-winding arm 91 can fix the spun yarn 10 on the bobbin 48 by straight-winding the spun yarn 10 around the bobbin 48.

[0030] Next, the yarn slack eliminating device 12 will be described in detail with reference to Fig. 3. The yarn slack eliminating device 12 includes a slack eliminating roller 21, a yarn hooking member 22, an accumulated amount detecting sensor 74, and an electric motor 25. The electric motor 25 drives and rotates the slack eliminating roller 21, and is connected with the slack eliminating roller 21. The electric motor 25 is electrically connected with the control section 73, and the control section 73 properly controls the rotation of the slack eliminating roller 21.

[0031] In the vicinity of the yarn slack eliminating device 12, an upstream guide 23 is provided upstream of the yarn slack eliminating device 12, and a downstream guide 26 is provided downstream of the yarn slack eliminating device 12. The spun yarn 10 is guided to a proper yarn path by the upstream guide 23 and the downstream guide 26. As illustrated in Fig. 3, the upstream guide 23 is connected with a drive mechanism including a cylinder 24 or the like. The upstream guide 23 can be moved between an advanced position and a receded position by expansion and contraction of the cylinder 24. By moving the upstream guide 23, the yarn path of the spun yarn 10 can be changed, and the yarn hooking member 22 can be engaged with the spun yarn 10 as necessary. More specifically, by moving the upstream guide 23 to the advanced position by the cylinder 24, the spun yarn 10 and the yarn hooking member 22 can be kept disengaged from one another. By moving the upstream guide 23 to the receded position by the cylinder 24, the yarn hooking member 22 can be engaged with the spun yarn 10.

[0032] The slack eliminating roller 21 includes a roller 42 that is fixed on a motor shaft 27 of the electric motor 25. A winding range 60 is formed on an outer peripheral surface of the roller 42. The spun yarn 10 fed from the spinning device 9 can be wound (accumulated) around the winding range 60. The yarn hooking member 22 is arranged at an end of the slack eliminating roller 21 on a front side of the spinning machine 1. The yarn hooking member 22 includes a flyer shaft 33, which is supported in a manner that the flyer shaft 33 can rotate with respect to the slack eliminating roller 21, and a flyer 38, which is fixed on a tip end of the flyer shaft 33. The flyer shaft 33

is rotated integrally with or independently from the slack eliminating roller 21 in accordance with a condition. A permanent magnet is attached to either one of the flyer shaft 33 and the roller 42, and a magnetic hysteresis member is attached to another one of the flyer shaft 33 and the roller 42. A resistance torque that is against the rotation of the yarn hooking member 22 with respect to the slack eliminating roller 21 is generated by these magnetic mechanisms.

[0033] The flyer 38 is rotated integrally with the flyer shaft 33. The flyer 38 is formed to appropriately curve towards the outer peripheral surface (the winding range 60) of the roller 42. Thus, the flyer 38 can be engaged with the spun yarn 10 (i.e., hook the spun yarn 10) and guide the spun yarn 10 to the winding range 60 of the roller 42.

[0034] The accumulated amount detecting sensor 74 is a non-contact type optical sensor and is electrically connected with the control section 73. The accumulated amount detecting sensor 74 detects whether or not at least a certain amount of the yarn has been wound around the winding range 60 of the roller 42, and transmits a detection signal thereof to the control section 73. The accumulated amount detecting sensor 74 includes a light emitting section and a light receiving section (detecting section) in a manner that the light emitting section and the light receiving section face an upstream side portion of the winding range 60.

[0035] Next, a structure of the roller 42 will be described with reference to Fig. 4. Fig. 4 is a side view of the winding range 60 of the roller 42. In the following description, a "base-end side" refers to a side of the roller 42 that is connected with the electric motor 25. A "tip-end side" refers a side of the roller 42 where the flyer 38 is arranged at the front side of the spinning machine 1. Although a detailed description will be made later, in the yarn slack eliminating device 12, the spun yarn 10 is first wound around the base-end side of the roller 42, gradually moves towards the tip-end side, and is then unwound. Accordingly, the base-end side and the tip-end side of the roller 42 respectively correspond to the upstream side and the downstream side in the yarn traveling direction.

[0036] The roller 42 includes a base-end flange section 61, the winding range 60, and a tip-end flange section 64, which are arranged in this order from a base-end side (upstream side) to a tip-end side (downstream side). The base-end flange section 61, the winding range 60, and the tip-end flange section 64 are integrally formed from suitable metal. The winding range 60 includes a taper winding range, which is formed in a taper shape in which a diameter of the portion around which the yarn is wound decreases from the upstream side towards the downstream side. Further, in the taper winding range, a taper angle of a first taper section (upstream winding range) 62 located on the upstream side and a taper angle of a second taper section (downstream winding range) 63 located on the downstream side differ from one another. Each section of the roller 42 will be described from the

upstream side.

[0037] The base-end flange section 61 is formed in a taper shape in which an end surface side has a larger diameter, and a connection portion that is connected with the first taper section 62 has a smaller diameter. The base-end flange section 61 is flatly connected (without difference in level) with the first taper section 62. By forming the base-end flange section 61 in the taper shape in which the diameter decreases towards the first taper section 62, the spun yarn 10 guided from the upstream side can be guided to a winding start position located in the vicinity of the connection portion between the base-end flange section 61 and the first taper section 62.

[0038] As illustrated in Fig. 4, the first taper section 62 is formed in a straight taper shape that is tapered by angle α from the upstream side towards the downstream side. The first taper section 62 is connected with the second taper section 63 as if being slightly bent at the downstream side. The angle α is preferably 1.5 degrees or greater and 3.5 degrees or smaller. In the present embodiment, the taper angle α is set to be 1.5 degrees. The accumulated amount detecting sensor 74 is arranged to face the first taper section 62, and monitors a yarn amount that is in the vicinity of the winding start position where the spun yarn 10 starts to be wound around.

[0039] The second taper section 63 is connected with the first taper section 62, and is formed in a straight taper shape that is tapered by angle β from the upstream side towards the downstream side. The taper angle β of the second taper section 63 is set to be smaller than the taper angle α of the first taper section 62 ($\alpha > \beta$). In the description, the "taper angle" refers to an angle at which the outer peripheral surface (yarn winding surface) of the roller 42 is inclined with respect to a rotational axis of the roller 42. In the present embodiment, the taper angle of the second taper section 63 is set to be 1.0 degree. Thus, the spun yarn 10 can be smoothly wound, and can be fed towards the downstream side in good condition.

[0040] The length of the second taper section 63 is greater than the length of the first taper section 62 in an axial direction of the roller 42. Accordingly, an area of the range around which the yarn can be wound in the first taper section 62 is smaller than an area of the range around which the yarn can be wound in the second taper section 63. The second taper section 63 is flatly connected (without difference in level) with the tip-end flange section 64 on the downstream side.

[0041] The tip-end flange section 64 is formed in a taper shape in which an end surface side has a larger diameter, and a connection portion that is connected with the second taper section 63 has a smaller diameter. The tip-end flange section 64 can prevent a sloughing phenomenon in which the spun yarn 10 wound around the roller 42 from sloughing all at once when being unwound from the roller 42.

[0042] The spun yarn 10 fed from the upstream side is wound around the roller 42, which is rotated at a prescribed rotational speed, via the yarn hooking member

22. The spun yarn 10 wound around the roller 42 is guided to the winding start position of the first taper section 62 while sliding on the tapered peripheral surface of the base-end flange section 61. The spun yarn 10 wound around the first taper section 62 is pushed towards the downstream side (towards the tip-end side of the roller 42) by the spun yarn 10 that is sequentially wound from the upstream side. Since the first taper section 62 is formed in the taper shape, the spun yarn 10 is spirally wound around the winding range 60 in order without being unevenly wound at the winding start position (at the connection portion between the base-end flange section 61 and the first taper section 62). Since the connection portion between the first taper section 62 and the second taper section 63 is smoothly connected, even when the spun yarn 10 is accumulated on the second taper section 63 beyond the first taper section 62, the spun yarn 10 can be wound around the second taper section 63 in good condition without being caught at the connection portion. Since the taper angle of the winding range 60 decreases in two stages, the difference between the diameter of the winding range 60 at the winding start position and the diameter of the winding range 60 in the vicinity of the tip-end flange section 64 can be reduced. Thus, it is possible to prevent the occurrence of the sloughing phenomenon in the downstream side of winding range 60 where the diameter is small, i.e., to prevent a bundle of the spun yarn 10 forming several circles that has floated from the peripheral surface of the roller 42 from sloughing all at once towards the tip-end side of the roller 42.

[0043] The yarn hooking member 22 can be rotated independently from the slack eliminating roller 21. A resistance torque that is against the rotation of the yarn hooking member 22 is added by the magnetic mechanisms. Accordingly, when the tension applied to the spun yarn 10 engaged with the flyer 38 is stronger than the resistance torque, the yarn hooking member 22 is rotated independently from the slack eliminating roller 21 to unwind the spun yarn 10 from the slack eliminating roller 21. On the other hand, when the tension applied to the spun yarn 10 is small, the yarn hooking member 22 is rotated integrally with the slack eliminating roller 21 to wind the spun yarn 10 around the slack eliminating roller 21. When the tension applied to the spun yarn 10 decreases (i.e., when the spun yarn 10 is likely to slacken), the yarn slack eliminating device 12 operates to wind the spun yarn 10, and when the tension applied to the spun yarn 10 increases, the yarn slack eliminating device 12 operates to unwind the spun yarn 10. Thus, the yarn slack eliminating device 12 can eliminate the slackening of the spun yarn 10 and apply appropriate tension to the spun yarn 10. While the spun yarn 10 is wound from the base-end side (i.e., from the connection portion between the base-end flange section 61 and the first taper section 62), the spun yarn 10 is unwound from the tip-end side of the roller 42 during the unwinding operation of the spun yarn 10.

[0044] Basically, the tension applied to the spun yarn 10 is defined by a yarn feeding speed of the yarn feeding device 11 and a winding speed of the winding device 13. In other words, when the winding speed is greater than the yarn feeding speed, the tension applied to the spun yarn 10 increases. When the winding speed is lower than the yarn feeding speed, the tension applied to the spun yarn 10 decreases. Since the yarn feeding speed of the yarn feeding device 11 (the spinning speed) is normally constant, the tension applied to the spun yarn 10 changes mainly by the winding speed of the winding device 13.

[0045] During a normal winding operation, in order to apply an appropriate winding tension to the spun yarn 10, a rotational speed of the winding drum 72 is set such that the winding speed is slightly greater than the yarn feeding speed of the yarn feeding device 11. Accordingly, the spun yarn 10 already wound around the slack eliminating roller 21 is gradually unwound, and an amount of the spun yarn 10 accumulated on the slack eliminating roller 21 is decreased. During the normal winding operation, the yarn slack eliminating device 12 uses only the range of the first taper section 62 to accumulate the spun yarn 10. Basically, it is during the yarn splicing operation and the doffing operation when the spun yarn 10 is wound around the second taper section 63 in the roller 42.

[0046] Next, a description will be made on an operation of detecting the accumulated amount of the spun yarn 10 in the yarn slack eliminating device 12 and an operation of controlling the winding speed. As described above, the accumulated amount detecting sensor 74 detects whether or not at least a certain amount of the spun yarn 10 has been accumulated on the roller 42. In the present embodiment, in terms of preventing the spun yarn 10 from slipping on the roller 42, the accumulated amount detecting sensor 74 monitors the accumulated amount of the spun yarn 10 such that the number of times the spun yarn 10 is wound around the winding range 60 always exceeds at least 15 times. More specifically, the accumulated amount detecting sensor 74 detects a portion on the roller 42 where the spun yarn 10 is wound for approximately the fifteenth time. When the accumulated amount detecting sensor 74 detects that the spun yarn 10 is not wound at such detection portion, the accumulated amount detecting sensor 74 transmits a signal to the control section 73 to indicate that the amount of the spun yarn 10 accumulated on the winding range 60 has fallen below a prescribed amount.

[0047] When the control section 73 receives, from the accumulated amount detecting sensor 74, a signal indicating that the accumulated amount of the spun yarn 10 on the roller 42 has fallen below the prescribed amount, the control section 73 drives a not-illustrated lift cylinder to control the cradle arm 71 to swing in a direction of arrow (i.e., swing towards the left) in Fig. 3, and move the package 45 away from the winding drum 72. Accordingly, the transmission of a driving force to the package 45 from the winding drum 72 is blocked. The package 45, which has lost the driving force, continues to rotate

by inertia, however, the winding speed thereof gradually decreases.

[0048] When the winding speed decreases, the amount of the spun yarn 10 fed from the winding range 60 to the winding device 13 per unit time decreases, and gradually falls below an amount of the spun yarn 10 that is newly wound around the winding range 60 from the upstream side per unit time. As a result, the accumulated amount of the spun yarn 10 recovers. A determination of whether or not at least a certain amount of the spun yarn 10 has been wound around the winding range 60 of the roller 42 is made in accordance with a period of time for which the package 45 is moved away from the winding drum 72 by the cradle arm 71. The period of time for which the package 45 is moved away from the winding drum 72 is properly set in accordance with a winding diameter of the package 45 and other conditions or the like. For example, when the diameter of the package 45 is large, the inertia is great, and the decrease in the winding speed is moderate. Accordingly, for example, the period of time for which the package 45 is moved away from the winding drum 72 is controlled to be longer.

[0049] When a prescribed period of time elapses after the package 45 was moved away from the winding drum 72, and then, when at least a certain amount of the spun yarn 10 is wound around the winding range 60 of the roller 42, the control section 73 controls the cradle arm 71 to swing towards the right in Fig. 3 such that the package 45 comes into contact with the winding drum 72. At this time, when the package 45, which has been rotating by inertia, makes contact with the winding drum 72, rapid tension fluctuation occurs. The tension fluctuation occurred by such contact with the winding drum 72 tends to be propagated to the upstream side via the yarn slack eliminating device 12. However, the roller 42 of the yarn slack eliminating device 12 according to the present embodiment includes the first taper section 62 having the taper angle of 1.5 degrees that is formed as a propagation preventing range, which prevents the tension fluctuation occurred at the downstream side from being propagated to the upstream side. Accordingly, even if rapid tension fluctuation occurs when the winding drum 72 makes contact with the package 45, the tension fluctuation can be prevented by the first taper section 62 from being propagated to the upstream of the yarn slack eliminating device 12.

[0050] As described above, the yarn slack eliminating device 12 monitors, by the accumulated amount detecting sensor 74, the spun yarn 10 accumulated on the first taper section 62, and a feedback-control is performed on the cradle arm 71 to adjust the winding speed. Accordingly, the amount of the spun yarn 10 accumulated on the winding range 60 of the roller 42 can be adjusted. Thus, while always maintaining the state in which at least a certain amount of the spun yarn 10 is accumulated on the slack eliminating roller 21, the winding tension can be maintained constant. In the present embodiment, the accumulated amount detecting sensor 74 is arranged to

monitor the accumulated amount of the spun yarn 10 in the first taper section 62. Thus, even when the tension fluctuation occurs in the winding device 13, such tension fluctuation which tends to be propagated to the upstream of the yarn slack eliminating device 12 can be reliably absorbed by the first taper section 62.

[0051] In the spinning machine 1 according to the present embodiment, during the yarn splicing operation by the yarn splicing cart 3 and the doffing operation by the doffing cart 4, since the winding operation by the winding device 13 is stopped, buildup of the spun yarn 10 is prevented by accumulating the spun yarn 10 on the yarn slack eliminating device 12. For example, in the yarn splicing operation, the winding operation is stopped, and the splicer 43 of the yarn splicing cart 3 performs the yarn splicing operation. During such yarn splicing operation, the spun yarn 10 fed from the spinning device 9 is accumulated on the winding range 60 of the yarn slack eliminating device 12. Thus, the buildup of the spun yarn 10 can be prevented, and the winding operation can be smoothly restarted. In the doffing operation, the winding operation is stopped, and the bunch-winding arm 91 performs a bunch-winding operation such that the yarn end is fixed on an empty bobbin 48. Also during the doffing operation, similarly to the yarn splicing operation, the spun yarn 10 fed from the spinning device 9 is accumulated on the winding range 60 of the yarn slack eliminating device 12 to prevent the buildup of the spun yarn 10. Accordingly, after the doffing operation, the operation can smoothly proceed to the winding operation. During such yarn splicing operation and doffing operation, a great amount of the spun yarn 10 is accumulated on the winding range 60 compared with the amount accumulated during the normal winding operation, and the spun yarn 10 is accumulated also on the second taper section 63 beyond the first taper section 62.

[0052] Since the taper angle of the second taper section 63 is more moderate than the taper angle of the first taper section 62, the pitch of the spun yarn 10 wound around the second taper section 63 can be reduced, and the spun yarn 10 can be effectively wound around the second taper section 63. Moreover, as described above, since the second taper section 63 is wider than the first taper section 62, a great amount of the spun yarn 10 can be wound around the second taper section 63. Thus, an upper limit of the amount of the spun yarn 10 that can be accumulated can be increased within a scope in which the spun yarn 10 is not doubly-wound further on the spun yarn 10 that has already been wound around the winding range 60. Accordingly, similarly to the yarn splicing operation and the doffing operation, even when a great amount of the spun yarn 10 is accumulated on the winding range 60, the yarn slack eliminating device 12 of the present invention can accumulate, on the winding range 60, a winding amount that is sufficient for winding the spun yarn 10 in good condition.

[0053] As described above, in the yarn slack eliminating device 12 according to the present embodiment, the

winding range 60 of the roller 42 around which the spun yarn 10 is wound includes the taper winding range that is formed in a taper shape in which the diameter decreases from the upstream side where the yarn starts to be wound towards the downstream side. The taper angle of the taper winding range (winding range 60) gradually becomes moderate towards the downstream side.

[0054] Accordingly, the upstream side portion of the winding range 60, which has a larger taper angle, can prevent the tension fluctuation of the spun yarn 10 that has occurred at the downstream of the yarn slack eliminating device 12 from being propagated to the upstream of the yarn slack eliminating device 12. Moreover, since the taper angle of the winding range 60 gradually becomes moderate towards the downstream side, even if the taper angle in the upstream side portion of the winding range 60 is large, the difference between the diameter of the upstream side and the diameter of the downstream side of the winding range 60 of the roller 42 can be reduced. Thus, it is possible to prevent loosening of the spun yarn 10, which occurs when the difference between the diameter of the upstream side and the diameter of the downstream side of the winding range 60 increases. Accordingly, the unwinding operation for the winding device 13 can be smoothly performed. Since the loosening of the spun yarn 10 can be prevented as described above, the occurrence of sloughing can be effectively prevented. Further, since the taper angle of the winding range 60 of the roller 42 is gradually changed, the yarn slack eliminating device 12 can be easily manufactured without requiring a complicated operational process.

[0055] In the yarn slack eliminating device 12 according to the present embodiment, the taper winding range (winding range 60) of the roller 42 includes the first taper section (upstream winding range) 62 and the second taper section (downstream winding range) 63 where the taper angle is small. The taper angle of the second taper section 63 is smaller than the taper angle of the first taper section 62. An area of the first taper section 62 is smaller than an area of the second taper section 63.

[0056] Thus, by changing the taper angle in two stages, while obtaining a great accumulation amount of the spun yarn 10 on the second taper section 63 where the taper angle is small, the tension fluctuation of the spun yarn 10 that occurs at the downstream of the yarn slack eliminating device 12 can be prevented from being propagated to the upstream of the yarn slack eliminating device 12.

[0057] In the yarn slack eliminating device 12 according to the present embodiment, the taper angle of the first taper section 62 is set to be 1.5 degrees, which is within the scope of 1.5 degrees or more and 3.5 degrees or smaller. Thus, the spun yarn 10 can be smoothly accumulated, and the propagation of the tension fluctuation to the upstream of the yarn slack eliminating device 12 can be reliably blocked.

[0058] The yarn slack eliminating device 12 according to the present embodiment includes the accumulated

amount detecting sensor 74 that is arranged in the vicinity of the first taper section 62 to detect the amount of the spun yarn 10 accumulated on the roller 42. Thus, the control operation can be effectively performed to accumulate at least a certain amount of the spun yarn 10 on the first taper section 62. Accordingly, by effectively using the first taper section 62, which can highly absorb the tension fluctuation, the tension fluctuation of the spun yarn 10 that occurs at the downstream of the yarn slack eliminating device 12 can be prevented from being propagated to the upstream of the yarn slack eliminating device 12. In the present embodiment, a determination as to whether or not a sufficient amount of the spun yarn 10 has been accumulated on the roller 42 is made in accordance with the period of time for which the package 45 is moved away from the winding drum 72. Therefore, one accumulated amount detecting sensor 74 is sufficient for controlling to accumulate at least a certain amount of the spun yarn 10 on the roller 42, and a structure of the yarn slack eliminating device 12 can be simplified.

[0059] The spinning machine 1 includes the yarn slack eliminating device 12. Therefore, even when the tension fluctuation of the spun yarn 10 occurs at the downstream of the yarn slack eliminating device 12, the propagation of the tension fluctuation can be prevented by the yarn slack eliminating device 12, and a yarn speed at the upstream of the yarn slack eliminating device 12 can be stabilized. Moreover, the yarn clearer 52 is provided upstream of the yarn slack eliminating device 12. Since the yarn slack eliminating device 12 prevents the tension fluctuation that has occurred at the downstream of the yarn slack eliminating device 12 from being propagated to the upstream of the yarn slack eliminating device 12, the speed of the spun yarn 10 passing through the yarn clearer 52 can be stabilized, and an accuracy of detecting a yarn defect can be improved. Thus, by providing the spinning machine 1 with the yarn slack eliminating device 12 of the present invention, a quality of the spun yarn 10 can be effectively improved.

[0060] The taper angle of the roller 42 according to the present embodiment changes in two stages, however, such structure may be modified such that the taper angle of the roller changes in three stages or more. Further, the taper angle may also be changed properly in accordance with circumstances.

[0061] Next, with reference to Fig. 5, a modified example will be described in which the taper angle of the roller changes in three stages. Other than the structure in which a taper angle of a roller 142 changes in three stages, the modified example described below is similar to the above-described embodiment. Therefore, like elements are given like reference numerals in the drawing, and description thereof may be omitted.

[0062] Similarly to the above-described embodiment, the roller 142 of the modified example includes the base-end flange section 61, a winding range 160, and the tip-end flange section 64, which are arranged in this order

from the base-end side (upstream side) to the tip-end side (downstream side). The winding range 160 includes a taper winding range, which is formed in a taper shape in which a diameter of the portion around which the yarn is wound decreases from the upstream side towards the downstream side. In the taper winding range, a taper angle of a first taper section 162 located on the most upstream side, a taper angle of a second taper section 163 located midway in the winding range 160, and a taper angle of a third taper section 164 located on the most downstream side differ from each other. Each taper section of the winding range 160 will be described from the upstream side.

[0063] The first taper section 162 is formed in a straight taper shape that is tapered by an angle α_2 from the upstream side towards the downstream side. The first taper section 162 is connected with the second taper section 163 as if being slightly bent at the downstream side. The angle α_2 is a taper angle of 1.5 degrees in the modified example.

[0064] The upstream side of the second taper section 163 is connected with the first taper section 162. The downstream side of the second taper section 163 is connected with the third taper section 164. The second taper section 163 is formed in a straight taper shape that is tapered by an angle β_2 from the upstream side towards the downstream side. The angle β_2 is a taper angle of 1.0 degree in the modified example.

[0065] The upstream side of the third taper section 164 is connected with the second taper section 163. The downstream side of the third taper section 164 is connected with the tip-end flange section 64. The third taper section 164 is formed in a straight taper shape that is tapered by an angle γ from the upstream side towards the downstream side. The angle γ is a taper angle of 0.3 degrees in the modified example.

[0066] In the roller 142 of the modified example, the taper angle decreases in three stages from the upstream side towards the downstream side ($\alpha_2 > \beta_2 > \gamma$). In this structure, the spun yarn 10 fed from the upstream side is wound around the roller 142, which is rotating at the prescribed rotational speed, via the yarn hooking member 22.

[0067] Thus, by decreasing the taper angle in three stages, while maintaining the function of effectively preventing the propagation of the tension fluctuation of the spun yarn 10 towards the upstream side by the first taper section 162, the difference between a diameter at a winding start position of the winding range 160 and a diameter on the downstream side of the winding range 160 located in the vicinity of the tip-end flange section 64 can be further reduced. Thus, the sloughing phenomenon can be effectively prevented.

[0068] In the above embodiment, the entire winding range 60 is formed in the taper shape in which the diameter decreases from the upstream side towards the downstream side, however, the winding range 60 is not limited to such structure. For example, an upstream por-

tion of the winding range may be formed in a taper shape in which a diameter decreases from the upstream side towards the downstream side, and a downstream portion of the winding range may be formed in a taper shape in which a diameter increases from the upstream side towards the downstream side.

[0069] Next, with reference to Fig. 6, a roller 242 according to another modified example will be described in which a portion in the downstream side of a winding range 260 is formed in an inverse taper shape. In this modified example, like elements are also given like reference numerals in the drawing for the structure that is similar to the above-described structure, and description thereof may be omitted.

[0070] As illustrated in Fig. 6, an upstream portion of the winding range 260 includes a taper winding range that is formed in a taper shape in which a diameter decreases from the upstream side towards the downstream side. The taper winding range includes a first taper section 262 that is tapered by angle α and a second taper section 263 that is tapered by angle β such that the taper angle decreases in two stages ($\alpha > \beta$). An inverse taper section 264 in which a diameter increases from the upstream side towards the downstream side is formed downstream of the second taper section 263. Even if the spun yarn 10 wound around the winding range 260 floats from a peripheral surface of the second taper section 263, when the spun yarn 10 reaches the inverse taper section 264 where the diameter increases towards the downstream side, gap between the winding range 260 and the spun yarn 10 can be reduced. As a result, the sloughing phenomenon can be effectively prevented.

[0071] Preferred embodiments of the present invention have been described above, however, the above-described structure, may be changed as described below.

[0072] In the above-described embodiment, only one accumulated amount detecting sensor 74 is provided for monitoring the amount of the spun yarn 10 accumulated on the winding range 60. However, the present invention is not limited to such structure. For example, an upstream accumulated amount detecting sensor may be arranged on the upstream side of the winding range, and a downstream accumulated amount detecting sensor may be arranged on the downstream side of the winding range. Then, a control may be performed such that at least a certain amount of the spun yarn 10 is accumulated on the winding range in accordance with signals from the upstream accumulated amount detecting sensor and the downstream accumulated amount detecting sensor.

[0073] For example, a mechanism for generating the resistance torque that is against the rotation of the yarn hooking member 22 with respect to the slack eliminating roller 21 may be changed to an electromagnetic mechanism using an electromagnet or to a mechanical mechanism using a frictional force, or the like, in place of the magnetic mechanism.

[0074] The spinning machine 1 according to the above-

described embodiment primarily includes the draft device 7, the spinning device 9, the yarn feeding device 11, the yarn slack eliminating device 12, and the winding device 13, however, such embodiment may be changed. For example, devices in the above-described embodiment may be partially omitted, or other members may be added to the above-described structure. Further, the present invention is not limited to spinning machines, but may be applied to other textile machines such as an automatic winder or the like.

Claims

1. A yarn slack eliminating device, which includes a roller (42; 142; 242) around which a yarn is wound and is used in a textile machine,
characterized in that at least a portion of a winding range (60; 160; 260) of the roller (42; 142; 242) around which the yarn is wound includes a taper winding range (62, 63; 162, 163, 164; 262, 263, 264), which is formed in a taper shape in which a diameter decreases from an upstream side where the yarn starts to be wound around towards a downstream side, and
a taper angle of the taper winding range (62, 63; 162, 163, 164; 262, 263, 264) gradually becomes moderate towards the downstream side.
2. The yarn slack eliminating device according to claim 1, **characterized in that** the taper winding range (62, 63; 162, 163, 164; 262, 263, 264) includes an upstream winding range (62; 162; 262) and a downstream winding range (63; 163; 263),
a taper angle of the downstream winding range (63; 163; 263) is smaller than a taper angle of the upstream winding range (62; 162; 262), and
an area of the upstream winding range (62; 162; 262) is smaller than an area of the downstream winding range (63; 163; 263).
3. The yarn slack eliminating device according to claim 2, **characterized in that** the taper angle of the upstream winding range (62; 162; 262) is 1.5 degrees or greater and 3.5 degrees or smaller.
4. The yarn slack eliminating device according to claim 2 or claim 3, **characterized by** further comprising a yarn amount detecting section (74), which is arranged near the upstream winding range (62; 162; 262) to detect an amount of the yarn accumulated on the roller (42; 142; 242).
5. A textile machine comprising the yarn slack eliminating device (12) according to any one of claim 1 through claim 4.

FIG. 1

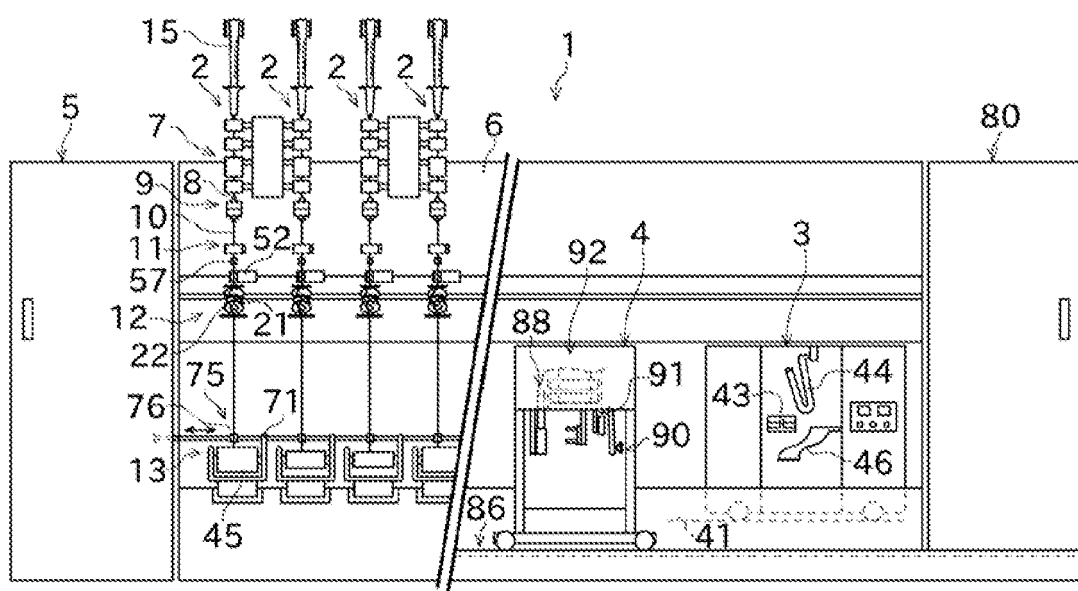


FIG. 2

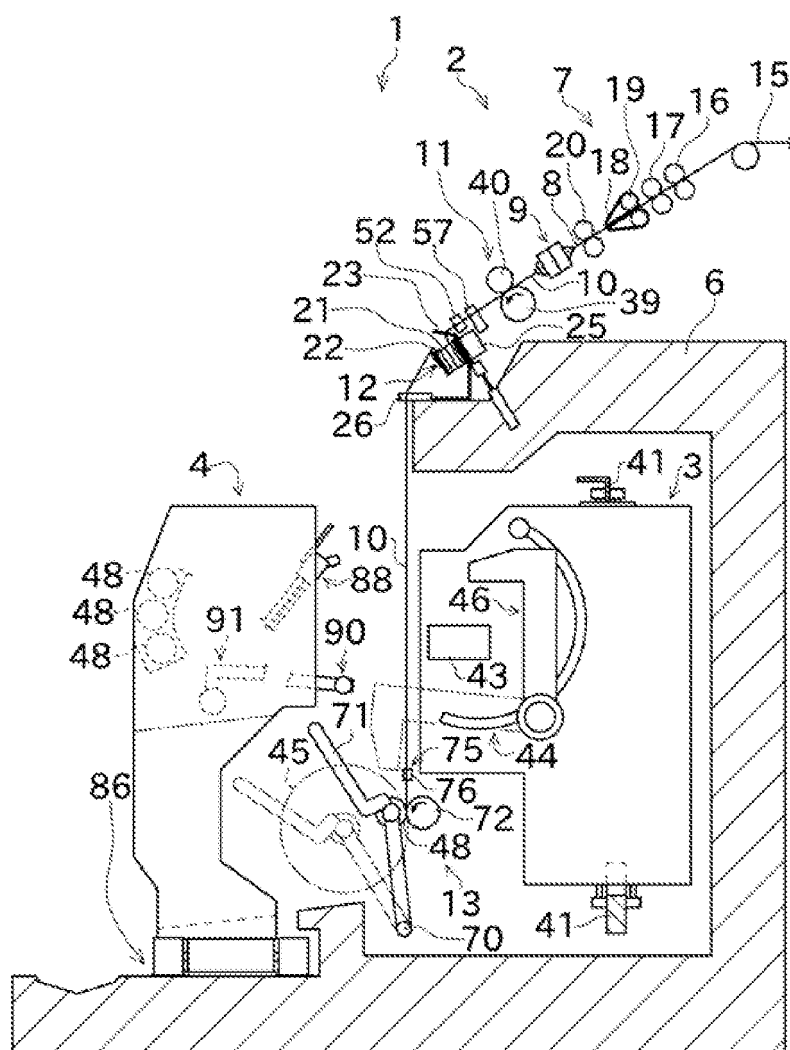


FIG. 3

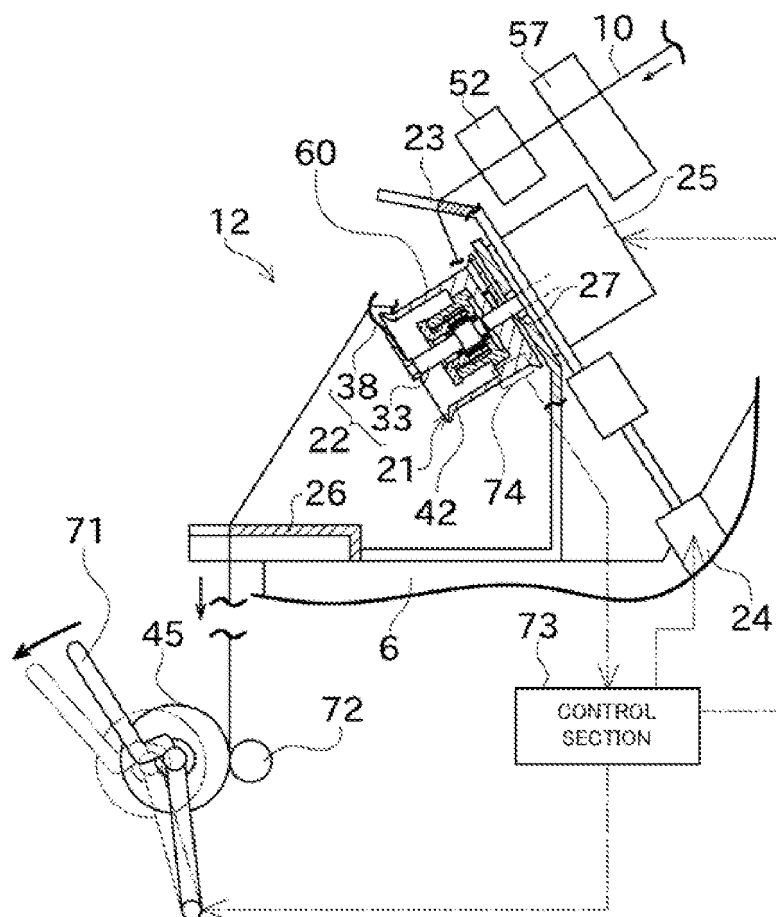


FIG. 4

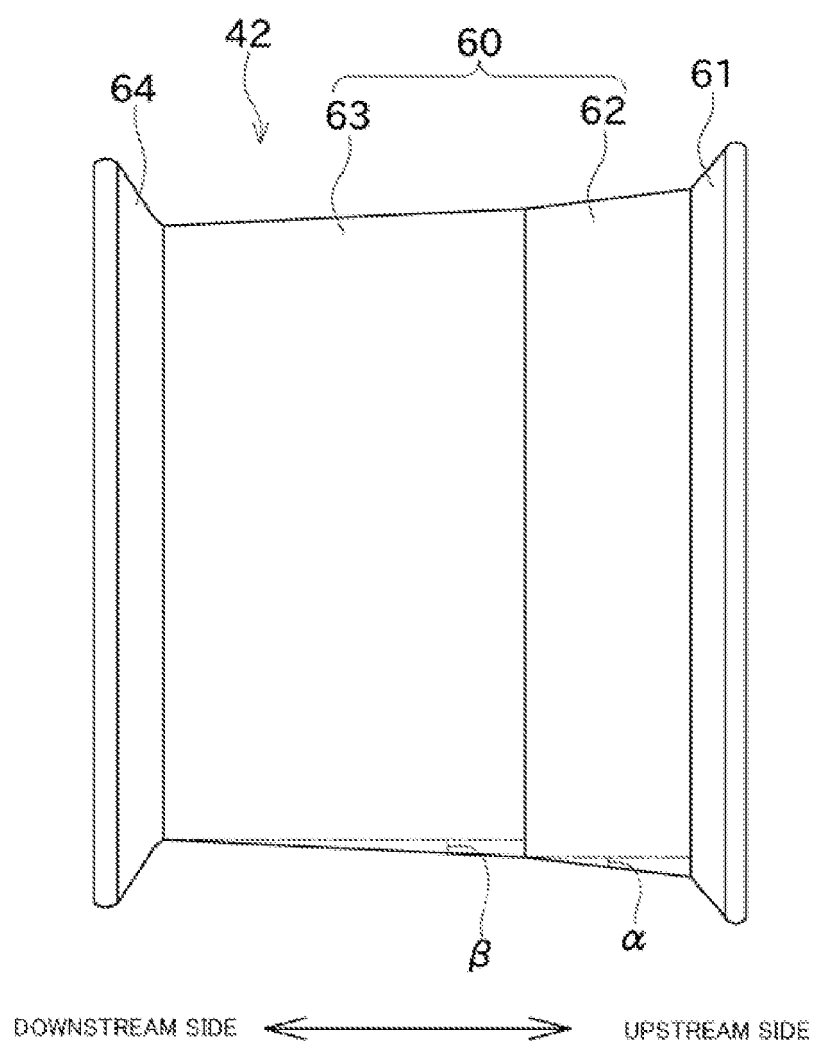


FIG. 5

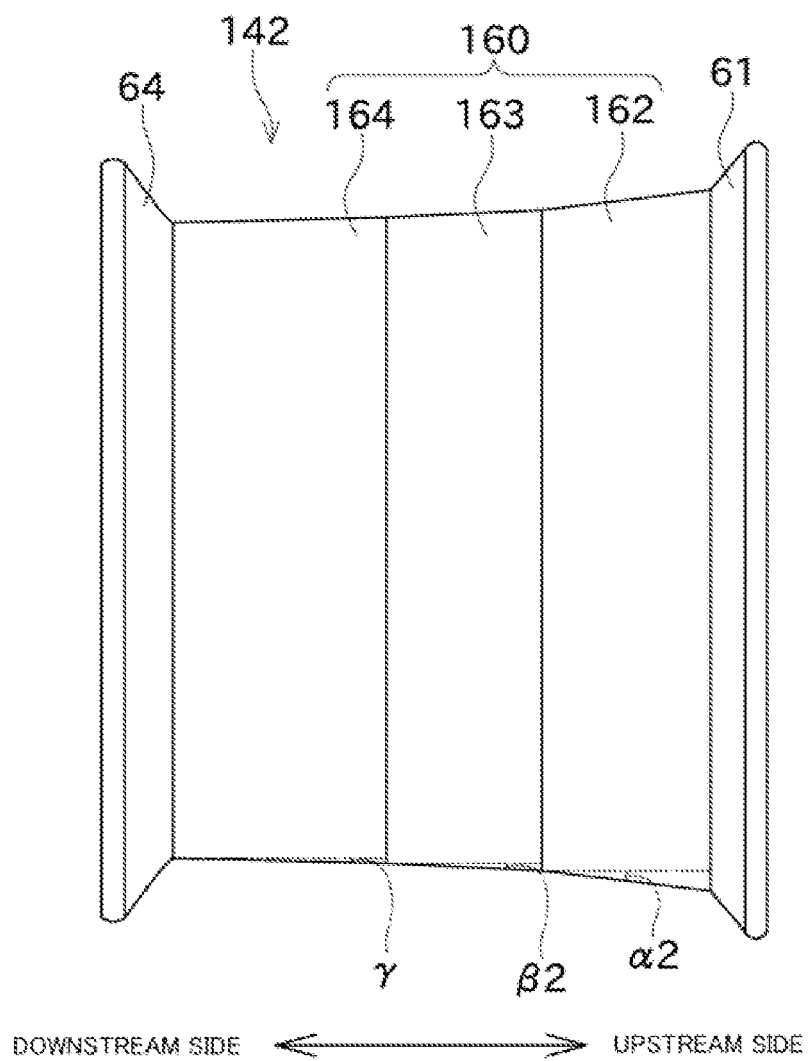
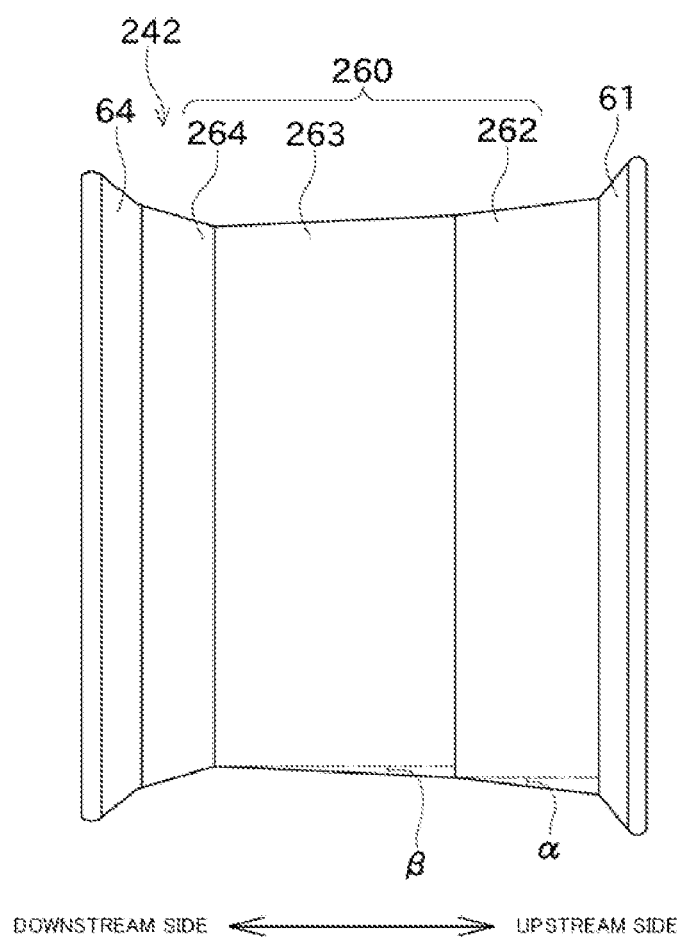


FIG. 6





EUROPEAN SEARCH REPORT

Application Number
EP 09 17 1582

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Place of search Munich		Date of completion of the search 14 April 2010	Examiner Dreyer, Claude
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