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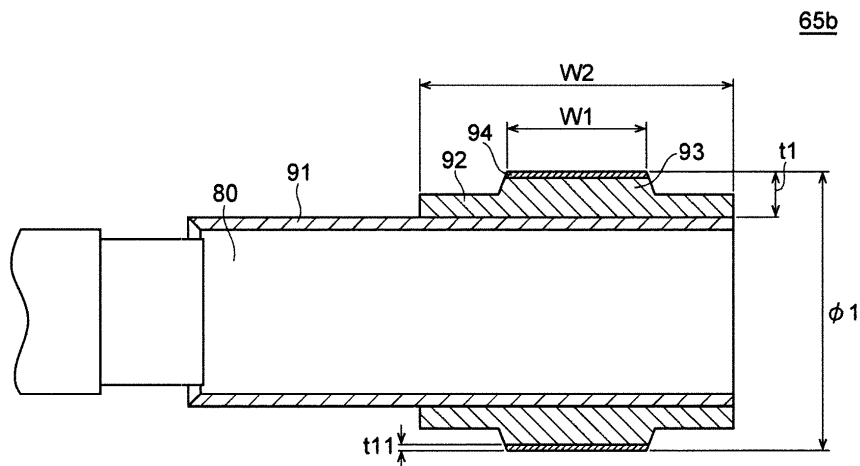
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(54) **DELIVERY ROLLER, DRAFTING DEVICE, AND SPINNING MACHINE**

(57) A front top roller (65b) is a delivery roller arranged in a drafting device (6) to deliver a sliver (S). The front top roller (65b) includes a roller body (92) and a property modified layer (94) formed on an outer peripheral surface of the roller body (92). The roller body (92) is made of a rubber composite of a type A durometer

hardness in the range from 40 to 83. The property modified layer (94) is formed by modifying the rubber composite used for making the roller body (92) such that a microhardness of the property modified layer (94) is greater than that of the roller body (92) by a value in the range from 1 to 15.

FIG.5



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a delivery roller, a drafting device, and a spinning machine.

2. Description of the Related Art

[0002] Textile machines such as air-jet spinning devices, ring spinning frames, and drawing frames are equipped with delivery rollers that deliver a fiber bundle (including a sliver) downstream.

[0003] A spinning roller that can be used as a delivery roller in a drafting device is disclosed in Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. H11-500498.

[0004] The outer peripheral surface of the delivery roller wears with use. Hence, it is desirable that the outer peripheral surface of the delivery roller is resistant to wear.

SUMMARY OF THE INVENTION

[0005] It is an objective of the present invention to provide a delivery roller whose outer peripheral surface is resistant to wear, and a drafting device and a spinning machine that include such a delivery roller.

[0006] According to an aspect of the present invention, a delivery roller arranged in a textile machine for delivering a fiber bundle includes a roller body made of a rubber composite having a Type A durometer hardness in the range from 40 to 83; and a property modified layer formed on an outer peripheral surface of the roller body. The property modified layer is formed by modifying the rubber composite forming the roller body such that a microhardness of the property modified layer is greater than that of the roller body by a value in the range from 1 to 15.

[0007] According to another aspect of the present invention, a drafting device includes a roller pair that drafts a fiber bundle. The above delivery roller is used for at least one roller out of the rollers forming the roller pair.

[0008] According to still another aspect of the present invention, a spinning machine includes the above drafting device; an air-jet spinning device that twists the fiber bundle drafted by the drafting device and produces a yarn; and a winding device that winds the yarn produced by the air-jet spinning device into a package.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a front view of a spinning machine that includes a drafting device that has a top roller according to an embodiment of the present invention.

FIG. 2 is a side view of a spinning unit of the spinning machine shown in FIG. 1.

FIG. 3 is a top view of the drafting device of the spinning unit shown in FIG. 2.

FIG. 4 is a side view of the drafting device of the spinning unit shown in FIG. 2.

FIG. 5 is a cross-sectional view taken along an axial direction of a front top roller arranged in the drafting device shown in FIGS. 2 and 3.

FIG. 6A is a cross-sectional view taken along the axial direction of the front top roller according to one modification.

FIG. 6B is a cross-sectional view taken along the axial direction of the front top roller according to another modification.

DETAILED DESCRIPTION

[0010] Exemplary embodiments of the present invention are explained in detail below with reference to the accompanying drawings. Identical parts or equivalent parts in these drawings are denoted by the same reference symbols, and redundant description is omitted. The dimensions of parts shown in the drawings do not necessarily match with those given in the description.

[0011] As shown in FIG. 1, a spinning machine 1 includes plural spinning units 2, a yarn joining carrier 3, a blower box 4, and a motor box 5. The spinning units 2 are arranged in a line. Each spinning unit 2 produces a yarn Y and winds the yarn Y into a package P. The yarn joining carrier 3 performs yarn joining in the spinning unit 2 in which a breakage of the yarn Y has occurred. The blower box 4 houses an air supplying source, and the like, that generates a suction air current, a swirling air current, and the like, in the component parts of the spinning unit 2. The motor box 5 houses a motor, and the like, that supplies power to the component parts of the spinning unit 2. In the following explanation, on a traveling route of the yarn Y (that is, on a yarn route), the side where the yarn Y is produced shall be referred to as upstream, and the side where the yarn Y is wound shall be referred to as downstream.

[0012] As shown in FIGS. 1 and 2, each of the spinning units 2 includes, sequentially from upstream, a drafting device (textile machine) 6, an air-jet spinning device 7, a yarn monitoring device 8, a tension sensor 9, a yarn pooling device 10, a waxing device 11, and a winding device 12. These devices are directly or indirectly supported by a machine frame 13 such that the upper side of the machine in a height direction corresponds to upstream (that is, the lower side of the machine in the height direction corresponds to downstream).

[0013] The drafting device 6 drafts a sliver (fiber bundle) S. The drafting device 6 includes, sequentially from upstream (the side on a conveyance path of the sliver S from where the sliver S is supplied), a back roller pair 61, a third roller pair 62, a middle roller pair 64 with an apron belt 63 stretched over each roller of the middle roller pair

64, and a front roller pair 65.

[0014] The air-jet spinning device 7 twists a fiber bundle F drafted by the drafting device 6 using swirling air currents to produce the yarn Y. More specifically, the air-jet spinning device 7 includes, although not shown specifically, a spinning chamber, a fiber guiding section, a swirling air current generating nozzle, and a hollow guide shaft. The fiber guiding section guides the fiber bundle F supplied from the upstream drafting device 6 into the spinning chamber. The swirling air current generating nozzle is arranged in the periphery of the traveling route of the fiber bundle F and generates the swirling air current inside the spinning chamber. The swirling air current causes fiber ends of the fiber bundle F guided into the spinning chamber to be reversed and whirled. The hollow guide shaft guides the spun yarn Y from inside the spinning chamber to outside of the air-jet spinning device 7.

[0015] The yarn monitoring device 8 monitors the traveling yarn Y at a location between the air-jet spinning device 7 and the yarn pooling device 50, and on detecting a yarn defect, transmits a yarn defect detection signal to a unit controller 10. The yarn monitoring device 8 detects, for example, any thickness abnormality of the yarn Y and/or presence of foreign substance in the yarn Y as yarn defects. The tension sensor 9 measures a tension of the traveling yarn Y between the air-jet spinning device 7 and the yarn pooling device 50, and transmits the measured tension as a tension measurement signal to the unit controller 10. The waxing device 11 applies wax to the traveling yarn Y at a location between the yarn pooling device 50 and the winding device 12. The unit controller 10 is arranged for each spinning unit 2 and controls the operation of the spinning unit 2. One unit controller 10 can also be shared by plural spinning units 2.

[0016] The yarn pooling device 50 pools the traveling yarn Y at a location between the air-jet spinning device 7 and the winding device 12. The yarn pooling device 50 has the functions of stably drawing the yarn Y from the air-jet spinning device 7, pooling the yarn Y drawn from the air-jet spinning device 7 and preventing the yarn Y from slackening during a yarn joining operation performed by the yarn joining carrier 3, and adjusting the tension on the yarn Y in the winding device 12 and preventing any change in the tension on the yarn Y in the winding device 12 from being conveyed to the air-jet spinning device 7.

[0017] The winding device 12 winds the yarn Y produced in the air-jet spinning device 7 to form the package P. The winding device 12 includes a cradle arm 21, a winding drum 22, and a traverse device 23. The cradle arm 21 is swingably supported by a shaft 24 and brings a surface of a rotatably supported bobbin B or package P (that is, the bobbin B with the yarn Y wound thereon) into contact with a surface of the winding drum 22 with an appropriate pressure. The winding drum 22 is driven by a not shown electric motor arranged for each spinning unit 2. The bobbin B or the package P that is in contact with the winding drum 22 rotates following the rotation of

the winding drum 22. The traverse device 23 is driven by a shaft 25 that is shared by plural spinning units 2, and traverses the yarn Y within a given width over the rotating bobbin B or the package P.

[0018] The yarn joining carrier 3 moves to the spinning unit 2 in which a breakage of the yarn Y has occurred and performs the yarn joining operation in that spinning unit 2. The yarn joining carrier 3 includes a yarn joining device 26, a first yarn catching device 27, and a second yarn catching device 28. The first yarn catching device 27 is swingably supported by a shaft 31, and sucks and catches a yarn end of the yarn Y from the air-jet spinning device 7 and guides the caught yarn end to the yarn joining device 26. The second yarn catching device 28 is swingably supported by a shaft 32, and sucks and catches a yarn end of the yarn Y from the winding device 12 and guides the caught yarn end to the yarn joining device 26. The yarn joining device 26 is, for example, a splicer, and joins the two yarn ends that are guided thereto.

[0019] The drafting device 6 is explained below in greater detail. As shown in FIGS. 3 and 4, the back roller pair 61 includes a back bottom roller 61a and a back top roller 61b that are arranged opposite to each other sandwiching a traveling route R1 over which the sliver S travels. The third roller pair 62 includes a third bottom roller 62a and a third top roller 62b that are arranged opposite to each other sandwiching the traveling route R1. The middle roller pair 64 includes a middle bottom roller 64a and a middle top roller 64b that are arranged opposite to each other sandwiching the traveling route R1. An apron belt 63a is stretched over the middle bottom roller 64a and an apron belt 63b is stretched over the middle top roller 64b. The front roller pair 65 includes a front bottom roller 65a and a front top roller (delivery roller) 65b arranged opposite to each other sandwiching the traveling route R1. The roller pairs 61, 62, 64, and 65 draft and deliver the sliver S that is supplied from a not shown can and guided by a fiber bundle guide 77 from upstream to downstream.

[0020] The back bottom roller 61a is rotatably supported by a back roller housing 66. The third bottom roller 62a is rotatably supported by a third roller housing 67. The middle bottom roller 64a is rotatably supported by a middle roller housing 68. The front bottom roller 65a is rotatably supported by a front roller housing 69. Each of the bottom rollers 61a, 62a, 64a, and 65a is rotated at a different rotational speed by power from the motor box 5 in such a way that a rotational speed of a given bottom roller is greater than that of the bottom roller immediately upstream to it. In an alternative arrangement, at least some of or all the bottom rollers 61a, 62a, 64a, and 65a can be rotated by a driving motor arranged in each of the spinning units 2.

[0021] The back top roller 61b, the third top roller 62b, the middle top roller 64b, and the front top roller 65b are rotatably supported by a draft cradle 71. Each of the top rollers 61b, 62b, 64b, and 65b is made to come into contact with each of the bottom rollers 61a, 62a, 64a, and

65a, respectively, with a predetermined pressure, and thereby driven to rotate.

[0022] The draft cradle 71 is pivotable about a shaft 72 between a position where each of the top rollers 61b, 62b, 64b, and 65b comes into contact with each of the bottom rollers 61a, 62a, 64a, and 65a, respectively, with the predetermined pressure, and a position where each of the top rollers 61b, 62b, 64b, and 65b separates from each of the bottom rollers 61a, 62a, 64a, and 65a, respectively. The draft cradle 71 is pivoted with a not shown handle arranged in the draft cradle 71. The draft cradle 71 rotatably supports each of the top rollers 61b, 62b, 64b, and 65b of the respective drafting devices 6 of two adjacent spinning units 2. That is, one draft cradle 71 is shared by the drafting devices 6 of two adjacent spinning units 2.

[0023] A regulating member 74, called a sliver guide or a condenser, for example, is arranged between the third roller pair 62 and the middle roller pair 64. A through hole 74a for passing the sliver S is formed in the regulating member 74. A width of the sliver S in a direction in which a rotational axis of each of the rollers 61a, 61b, 62a, 62b, 64a, 64b, 65a, and 65b extends (hereinafter, "rotational axis direction") is regulated by a width of the through hole 74a in the rotational axis direction. Hence, the regulating member 74 regulates the traveling route of the sliver S over the traveling route R1 and also regulates the width of the sliver S in the rotational axis direction to the width of the through hole 74a in the rotational axis direction. The regulating member 74 is supported by a supporting member 75. The supporting member 75 is located below the traveling route R1 in the height direction of the machine and is fixed to the middle roller housing 68 that rotatably supports the middle bottom roller 64a. With this arrangement, the position of the regulating member 74 is maintained uncharged relative to the middle roller pair 64. The regulating member 74 and the supporting member 75 are not shown in FIGS. 1 and 2.

[0024] The fiber bundle guide 77 is supported by a supporting member 79. As shown in FIG. 4, the fiber bundle guide 77 is tubular-shaped and guides the sliver S along a guiding route R2 over which the sliver S should be guided.

[0025] The top rollers 61b, 62b, 64b, and 65b are explained in detail below. The front top roller 65b that is arranged on the extreme downstream side of the drafting device 6 will be explained first.

[0026] As shown in FIG. 5, the front top roller 65b includes a roller tube 91, a roller body 92, and a property modified layer 94.

[0027] The roller tube 91 is made of aluminum, for example, and is cylindrical. The roller tube 91 is externally fitted over a shaft 80 via a not shown bearing. Thus, the front top roller 65b is rotatably fixed to the shaft 80. The shaft 80 is made of iron or resin.

[0028] The roller body 92 is arranged on the outer peripheral surface of the roller tube 91. The roller body 92 is made of a rubber composite having a type A durometer

hardness in the range from 40 to 83, preferably, in the range from 45 to 78. The above mentioned rubber composite can include those solely formed from raw rubber (for example, hydrogenated nitrile butadiene rubber) or can include those formed by combining other rubber raw materials and/or additives.

[0029] The roller body 92 can be made of, for example, a rubber composite made by incorporating zinc methacrylate in hydrogenated nitrile butadiene rubber (H-NBR). The roller body 92 that has superior wear resistance can be realized by incorporating zinc methacrylate in the hydrogenated nitrile butadiene rubber. The rubber composite that is used for making the roller body 92 can also have incorporated therein, for example, ethylene propylene diene rubber (EPDM), styrene butadiene rubber (SBR), acrylonitrile butadiene rubber (NBR), and the like.

[0030] The Type A durometer hardness of the roller body 92 is the Type A durometer hardness defined in the JIS K 6253-3:2012 (Japan Industrial standards corresponding to ISO7619). The Type A durometer hardness can be a hardness measured with, for example, a durometer -ASKER Rubber Hardness Tester Model A (made by Kobunshi Keiki Co. Ltd.) in accordance with a measurement method of the Type A durometer defined in the JIS K 6253-3:2012.

[0031] A protrusion 93, which is convex outwardly in a radial direction, is formed along the circumferential direction near the mid portion of the roller body 92 in an axial direction. The protrusion 93 need not necessarily be continuous along the circumferential direction (that is, the protrusion 93 need not be annular). The protrusion 93 is formed so as to cover the traveling route R1 of the sliver S. That is, the protrusion 93 is formed on that part of the roller body 92 that grips the sliver S.

[0032] The property modified layer 94 is formed on the outer peripheral surface of the roller body 92 in a part of the roller body 92 in the axial direction. Specifically, the property modified layer 94 is formed on the outer peripheral surface of the protrusion 93 on the roller body 92. The property modified layer 94 is formed by modifying the rubber composite that forms the roller body 92 such that a microhardness of the rubber composite forming the property modified layer 94 is greater than that of the roller body 92 by a value in the range from 1 to 15, preferably, in the range from 4 to 13. The property modified layer 94 is formed such that a static friction coefficient of the outer peripheral surface thereof is less than or equal to 0.3, preferably, less than or equal to 0.1.

[0033] The microhardness of the roller body 92 and the property modified layer 94 are measured with a Type A (Indenter design) micro durometer (MD-1 capa: made by Kobunshi Keiki Co. Ltd.). Specifically, the microhardness of the roller body 92 and the property modified layer 94 are obtained under identical temperature and humidity testing conditions as prescribed in "6. Standard conditions of testing chamber" of "Rubber-General procedures for preparing and conditioning test pieces for physical test methods" of JIS K 6250 (Japan Industrial Standards

corresponding to ISO 23529), by preparing the front top roller 65b in which the property modified layer 94 is formed on the outer peripheral surface of the roller body 92, and measuring the hardness of the property modified layer 94 by pressing down the above-mentioned durometer such that the durometer becomes perpendicular to a tangent passing through the measurement point on the property modified layer 94. The measurement mode of the micro durometer is set to a normal mode.

[0034] The static friction coefficient of the property modified layer 94 is measured with a friction meter (Portable friction meter Type 94 I-II: made by Shinto Kagaku Co. Ltd.). Specifically, the static friction coefficient is measured by mounting the friction meter on the test piece fixed to a jig and pressing the switch of the friction meter.

[0035] The property modified layer 94 is formed by coating the rubber composite forming the roller body 92 with a surface modifying agent. The surface modifying agent, for example, is a coating material of an isocyanate-group compound. The property modified layer 94 is not merely a layer of surface modifying agent formed on the roller body 92 by coating the surface modifying agent over the outer peripheral surface of the roller body 92 but is a layer formed by the surface modifying agent permeating and modifying the rubber composite. Hence, the layer of surface modifying agent differs from a coating layer formed by simply coating and covering the surface of the rubber composite with a coating material, and the like. It is preferable that the surface modifying agent is coated in a uniform thickness as far as possible. When the surface modifying agent is coated in a uniform thickness, uniform hardness of the property modified layer 94 and the static friction coefficient of the outer peripheral surface of the property modified layer 94 can be realized.

[0036] Alternatively, the property modified layer 94 can include a first property modified layer that is formed by coating the surface modifying agent over the outer peripheral surface of the roller body 92 thereby modifying the rubber composite forming the roller body 92, and a second property modified layer that is formed by the surface modifying agent itself that remains over the outer peripheral surface of the first property modified layer without contributing to the modification of the rubber composite.

[0037] A length W2 of the roller body 92 in the axial direction can be, for example, in the range from 30 millimeters (mm) to 34 mm. A length W1 of the protrusion 93 in the axial direction can be, for example, in the range from 12 mm to 32 mm. An outer diameter $\phi 1$ of the protrusion 93 of the roller body 92 can be, for example, in the range from 12 mm to 40 mm, preferably, in the range from 25 mm to 35 mm. A thickness t1 of the roller body 92 in the portion where the protrusion 93 is formed can be, for example, in the range from 2.0 mm to 7.0 mm.

[0038] A thickness t11 of the property modified layer 94 can be, for example, less than or equal to 200 micrometers (μm), preferably, in the range from 10 μm to 50 μm .

[0039] The other top rollers 61b, 62b, and 64b aside from the front top roller 65b can have a structure similar to that of the front top roller 65b or can have a different structure. Each of the top rollers 61b, 62b, and 64b can have a structure that includes, for example, a roller tube made of aluminum, and the like, and a roller body (whose hardness is immaterial) made of the rubber composite and arranged around the outer peripheral surface of the roller tube.

[0040] With the front top roller 65b having the above structure, the Type A durometer hardness of the roller body 92 is in the range from 40 to 83 and the microhardness of the property modified layer 94 forming the outer side of the roller body 92 is greater than that of the roller body 92 by a value in the range from 1 and to 15. With this structure, a gripping strength (nipping strength) of the front top roller 65b and the front bottom roller 65a on the sliver S is maintained, and at the same time, the wear of the outer peripheral surface of the front top roller 65b can be suppressed.

[0041] The above-described front top roller 65b is formed by coating the rubber composite forming the roller body 92 with a surface modifying agent in the form of an isocyanate group compound. With this structure, the inner hardness of the front top roller 65b is maintained while the hardness of the outer peripheral surface is enhanced and the static friction coefficient is reduced. As a result, the gripping strength of the opposing front top roller 65b and the front bottom roller 65a on the sliver S is maintained while the wear of the outer peripheral surface of the front top roller 65b is suppressed. Furthermore, damage to the outer peripheral surface of the front top roller 65b is suppressed.

[0042] In the conventional UV process, only a very thin surface layer can be formed, and as a result, the desired level of wear resistance is difficult to obtain. In contrast, in the front top roller 65b according to the present embodiment, the property modified layer 94 is formed by coating the surface modifying agent over the rubber composite. With this structure, the wear of and damage to the outer peripheral surface of the front top roller 65b can be suppressed.

[0043] Exemplary embodiments of the present invention are explained above; however, the present invention is not limited to the above embodiments.

First modification

[0044] In the front top roller 65b according to the above embodiment, an example is presented in which the property modified layer 94 is formed on the outer peripheral surface of only the protrusion 93 on the roller body 92. However, the present invention is not limited to the above embodiment. For example, in a front top roller (delivery roller) 165b shown in FIG. 6A, a property modified layer 194 is formed not just on an outer peripheral surface of a protrusion 193 but also on the outer peripheral surface of the entire roller body 192.

Second modification

[0045] As shown in FIG. 6B, a front top roller (delivery roller) 265b has no protrusion on a roller body 292. In this front top roller 265b, a property modified layer 294 can be formed on the outer peripheral surface of the entire roller body 292. Alternatively, instead of along the outer peripheral surface of the entire roller body 292, the property modified layer 294 can be formed along a circumferential direction of the roller body 292 near the mid portion of the roller body 292 (the area that includes the traveling route R1 of the sliver S) along the axial direction of the roller body 292.

Third modification

[0046] In the front top roller 65b according to the above embodiment, an example is presented in which an isocyanate-group compound is used as the surface modifying agent. However, the present invention is not limited to the above embodiment. Epoxy-based or urea-based surface modifying agents are also included as surface modifying agents that modify the rubber composite. A single modifying agent or a mixture of plural modifying agents can be used as the surface modifying agent. In the front top roller 65b, plural layers can be modified.

Other modifications

[0047] To prevent the twist of the fiber bundle from being conveyed upstream in the air-jet spinning device, the air-jet spinning device can further include a needle that is held by the fiber guiding section so as to protrude into the spinning chamber. Instead of the needle, the air-jet spinning device can prevent the twist of the fiber bundle from being conveyed upstream in the air-jet spinning device by a downstream end of the fiber guiding section. Furthermore, the air-jet spinning device can also include a pair of air-jet nozzles that can twist the fiber bundle in mutually opposite directions.

[0048] In the spinning machine 1, the yarn pooling device 50 has the function of drawing the yarn Y from the air-jet spinning device 7. Alternatively, in the spinning machine according to the present invention, the yarn can be drawn by using a delivering roller and a nip roller. The delivery roller having a similar structure as that of the front top roller 65b according to the present embodiment or the front top rollers 165b, and 265b according to the modifications can be used as the nip roller.

[0049] In this explanation, the delivery roller according to the present invention is adapted to the front top rollers 65b, 165b, and 265b used in the drafting device 6 or the nip roller. The present invention is not limited to the above, and can be adapted to a roller used in a textile machine such as a ring spinning frame or a drawing frame.

[0050] According to an aspect of the present invention, a delivery roller arranged in a textile machine for deliv-

ering a fiber bundle includes a roller body made of a rubber composite having a Type A durometer hardness in the range from 40 to 83; and a property modified layer formed on an outer peripheral surface of the roller body.

The property modified layer is formed by modifying the rubber composite forming the roller body such that a microhardness of the property modified layer is greater than that of the roller body by a value in the range from 1 to 15.

[0051] The Type A durometer hardness of the roller body mentioned here is the Type A durometer hardness defined in the JIS K 6253-3:2012 (Japan Industrial Standards corresponding to ISO7619). The microhardness of the roller body and the property modified layer are measured with a micro durometer (MD-1 capa: made by Kobunshi Keiki Co. Ltd.), obtained under identical temperature and humidity testing conditions as prescribed in "6. Standard conditions of testing chamber" of "Rubber-General procedures for preparing and conditioning test pieces for physical test methods" of JIS K 6250 (Japan Industrial Standards corresponding to ISO 23529). The MD-1 capa is a durometer (a hardness tester) that measures the microhardness that cannot be measured by a regular durometer. A difference in the microhardness between the property modified layer and the roller body before modification is measured with the MD-1 capa.

[0052] In the delivery roller with the above structure, the property modified layer is made harder than the roller body. With this structure, the wear of the outer peripheral surface of the delivery roller can be suppressed. The roller body is an inner part of the delivery roller in the radial direction and the property modified layer is an outer part of the delivery roller in the radial direction, and is the part that comes into contact with the fiber bundle.

[0053] According to another aspect of the present invention, in the delivery roller, the Type A durometer hardness of the roller body is in the range from 45 to 78.

[0054] According to still another aspect of the present invention, in the delivery roller, the microhardness of the property modified layer is greater than that of the roller body by a value in the range from 4 to 13.

[0055] According to still another aspect of the present invention, in the delivery roller, a static friction coefficient of the outer peripheral surface of the property modified layer is less than or equal to 0.3.

[0056] According to the delivery roller having the above structure, the damage to the outer peripheral surface of the property modified layer that occurs with use can be suppressed. The term damage does not refer to the (shallow) recesses that gradually form on the outer peripheral surface of the delivery roller by the abrasion due to friction with the fiber bundle but to the (deeper) recesses formed by the flaking off of the rubber composite in lumps from the outer peripheral surface of the delivery roller due to friction with the fiber bundle.

[0057] According to still another aspect of the present invention, in the delivery roller, the static friction coefficient of the outer peripheral surface of the property mod-

ified layer is less than or equal to 0.1.

[0058] According to the delivery roller having the above structure, the damage to the outer peripheral surface of the property modified layer that occurs with use can be further suppressed.

[0059] According to still another aspect of the present invention, in the delivery roller, the property modified layer of a predetermined width in an axial direction is formed along a circumferential direction of the roller body.

[0060] According to the delivery roller having the above structure, the hardness of the part of the outer peripheral surface that comes into contact with the fiber bundle, that is, the part of the outer peripheral surface that grips the fiber bundle can be relatively increased.

[0061] According to still another aspect of the present invention, in the delivery roller, the rubber composite forming the roller body includes hydrogenated nitrile butadiene rubber.

[0062] According to the delivery roller having the above structure, a roller body of desired hardness can be easily formed.

[0063] According to still another aspect of the present invention, in the delivery roller, the rubber composite forming the roller body includes zinc methacrylate.

[0064] According to the delivery roller having the above structure, a roller body that has superior wear resistance can be formed.

[0065] According to still another aspect of the present invention, in the delivery roller, the property modified layer is formed by coating a surface modifying agent on the rubber composite.

[0066] According to the delivery roller having the above structure, the rubber composite on the outer peripheral surface of the roller body can be easily modified.

[0067] According to still another aspect of the present invention, in the delivery roller, the property modified layer includes a first property modified layer formed by modification of the rubber composite by the surface modifying agent, and a second property modified layer that is a layer of the surface modifying agent covering the first modified layer.

[0068] According to still another aspect of the present invention, in the delivery roller, a thickness of the roller body is in the range from 2.0 mm to 7.0 mm.

[0069] According to still another aspect of the present invention, in the delivery roller, a thickness of the property modified layer is less than or equal to 200 μm .

[0070] According to still another aspect of the present invention, a drafting device includes a roller pair that drafts a fiber bundle. The above delivery roller is used for at least one roller out of the rollers forming the roller pair.

[0071] According to the drafting device having the above structure, a gripping strength (nipping strength) of the roller pair on the fiber bundle is maintained, and at the same time, the wear of the outer peripheral surface of the delivery roller can be suppressed. The delivery rollers that form the roller pair arranged at the extreme

downstream of the drafting device rotate at a greater speed than the delivery rollers that form the roller pair arranged upstream to it, and therefore needs to be even more durable. Accordingly, using the delivery roller having the above structure as the delivery roller forming the roller pair arranged at the extreme downstream of the drafting device is particularly effective.

[0072] According to still another aspect of the present invention, a spinning machine includes the above drafting device; an air-jet spinning device that twists the fiber bundle drafted by the drafting device and produces a yarn; and a winding device that winds the yarn produced by the air-jet spinning device into a package.

[0073] According to the spinning machine having the above structure, the gripping strength of the roller pair constituting the drafting device on the fiber bundle is maintained, and at the same time, the wear of the outer peripheral surface of the delivery roller out of the roller pair can be suppressed. With this structure, a yarn with higher quality can be obtained.

[0074] According to the present invention, a delivery roller having an outer peripheral surface that has improved wear resistant, and a drafting device and a spinning device that include such a delivery roller can be realized.

Claims

1. A delivery roller (65b;165b;265b) arranged in a textile machine (6) for delivering a fiber bundle (S), comprising:

a roller body (92;192;292) made of a rubber composite having a Type A durometer hardness in the range from 40 to 83; and

a property modified layer (94;194;294) formed on an outer peripheral surface of the roller body (92;192;292),

wherein the property modified layer (94;194;294) is formed by modifying the rubber composite forming the roller body (92;192;292) such that a microhardness of the property modified layer (94;194;294) is greater than that of the roller body (92;192;292) by a value in the range from 1 to 15.

2. The delivery roller (65b;165b;265b) as claimed in Claim 1, wherein the Type A durometer hardness of the roller body (92;192;292) is in the range from 45 to 78.
3. The delivery roller (65b;165b;265b) as claimed in Claim 1 or 2, wherein the microhardness of the property modified layer (94;194;294) is greater than that of the roller body (92;192;292) by a value in the range from 4 to 13.

4. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 3, wherein a static friction coefficient of the outer peripheral surface of the property modified layer (94;194;294) is less than or equal to 0.3. 5
5. The delivery roller (65b;165b;265b) as claimed in Claim 4, wherein the static friction coefficient of the outer peripheral surface of the property modified layer (94;194;294) is less than or equal to 0.1. 10
6. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 5, wherein the property modified layer (94;194;294) of a predetermined width in an axial direction is formed along a circumferential direction of the roller body (92;192;292). 15
7. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 6, wherein the rubber composite forming the roller body (92;192;292) includes hydrogenated nitrile butadiene rubber. 20
8. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 7, wherein the rubber composite forming the roller body (92;192;292) includes zinc methacrylate. 25
9. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 8, wherein the property modified layer (94;194;294) is formed by coating a surface modifying agent on the rubber composite. 30
10. The delivery roller (65b;165b;265b) as claimed in Claim 9, wherein the property modified layer (94;194;294) includes a first property modified layer formed by modification of the rubber composite by the surface modifying agent, and a second property modified layer that is a layer of the surface modifying agent covering the first modified layer. 35
40
11. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 10, wherein a thickness of the roller body (92;192;292) is in the range from 2.0 mm to 7.0 mm. 45
12. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 11, wherein a thickness of the property modified layer (94;194;294) is less than or equal to 200 μ m. 50
13. The delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 12, wherein the delivery roller (65b;165b;265b) is a draft roller that is used for drafting the fiber bundle (S). 55
14. A drafting device (6) comprising a roller pair (61, 62, 64, 65) that drafts a fiber bundle (S), wherein at least one roller out of the rollers forming the roller pair (61,

62, 64, 65) is the delivery roller (65b;165b;265b) as claimed in any one of Claims 1 to 13.

15. A spinning machine (1) comprising:

the drafting device (6) as claimed in Claim 14; an air-jet spinning device (7) that twists the fiber bundle (S) drafted by the drafting device (6) and produces a yarn (Y); and a winding device (12) that winds the yarn (Y) produced by the air-jet spinning device (7) into a package (P).

FIG.1

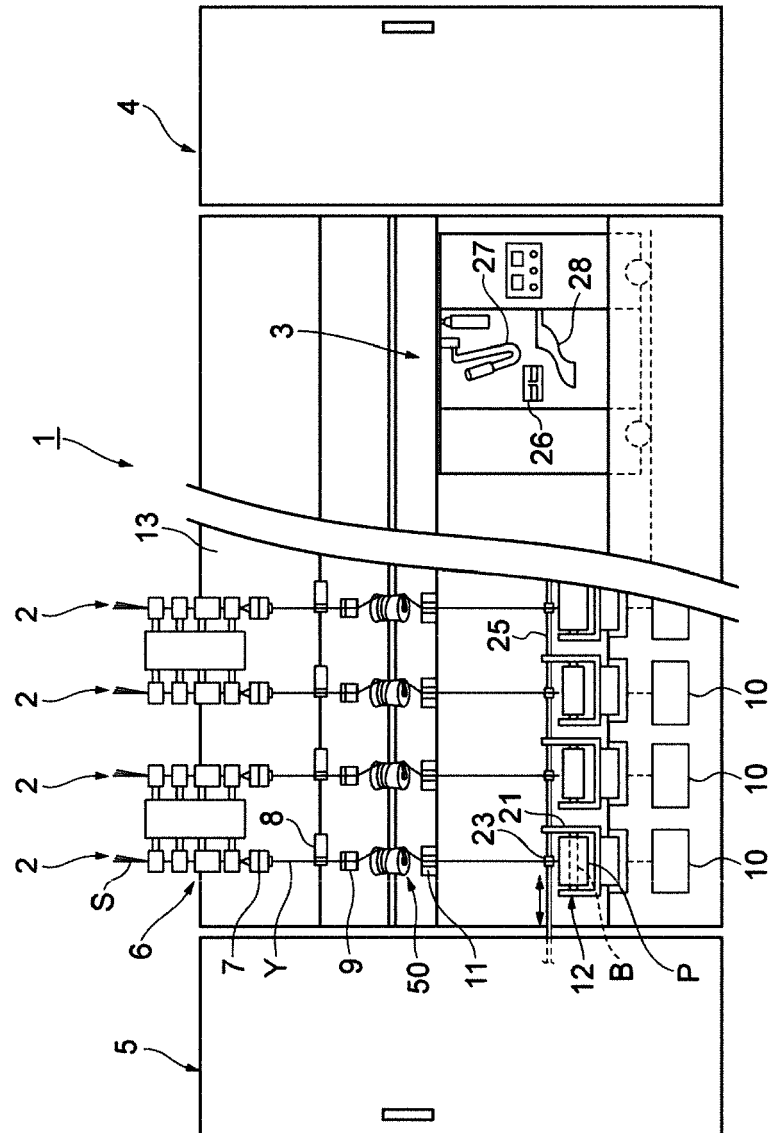


FIG.2

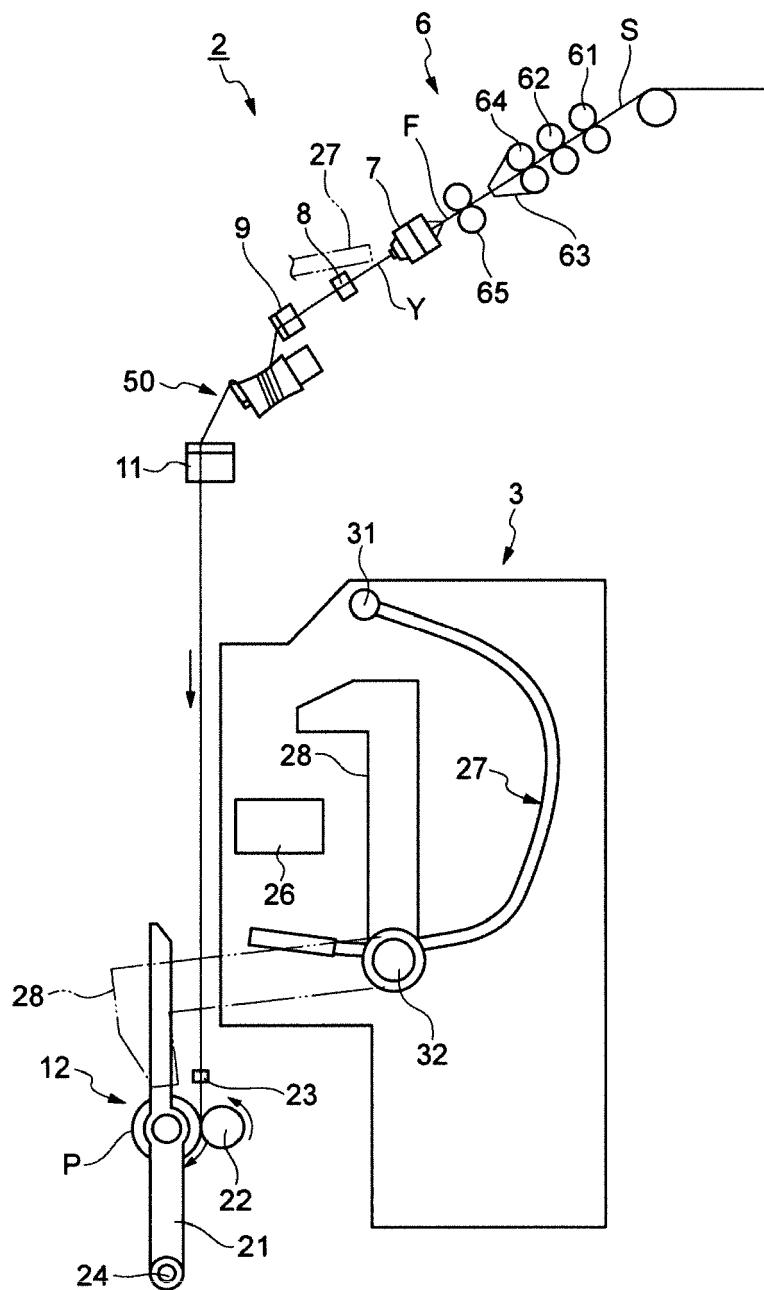


FIG.3

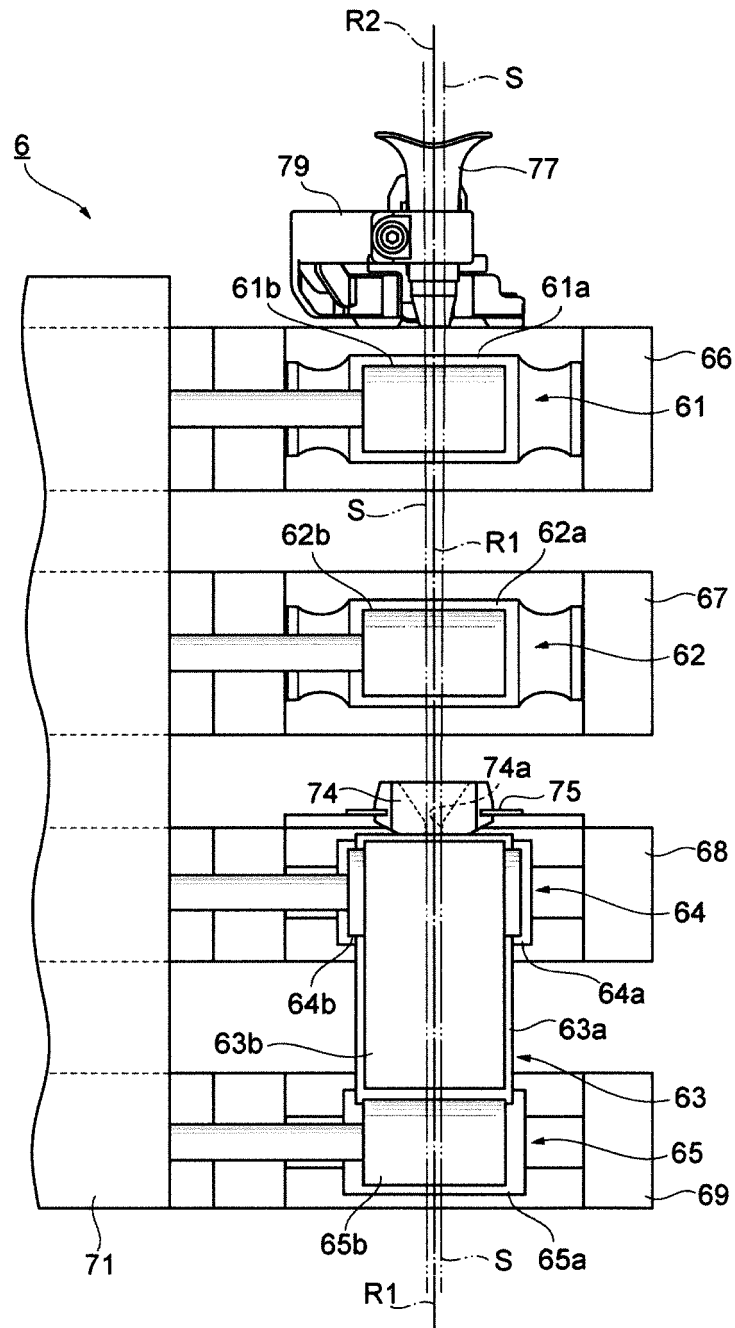


FIG.4

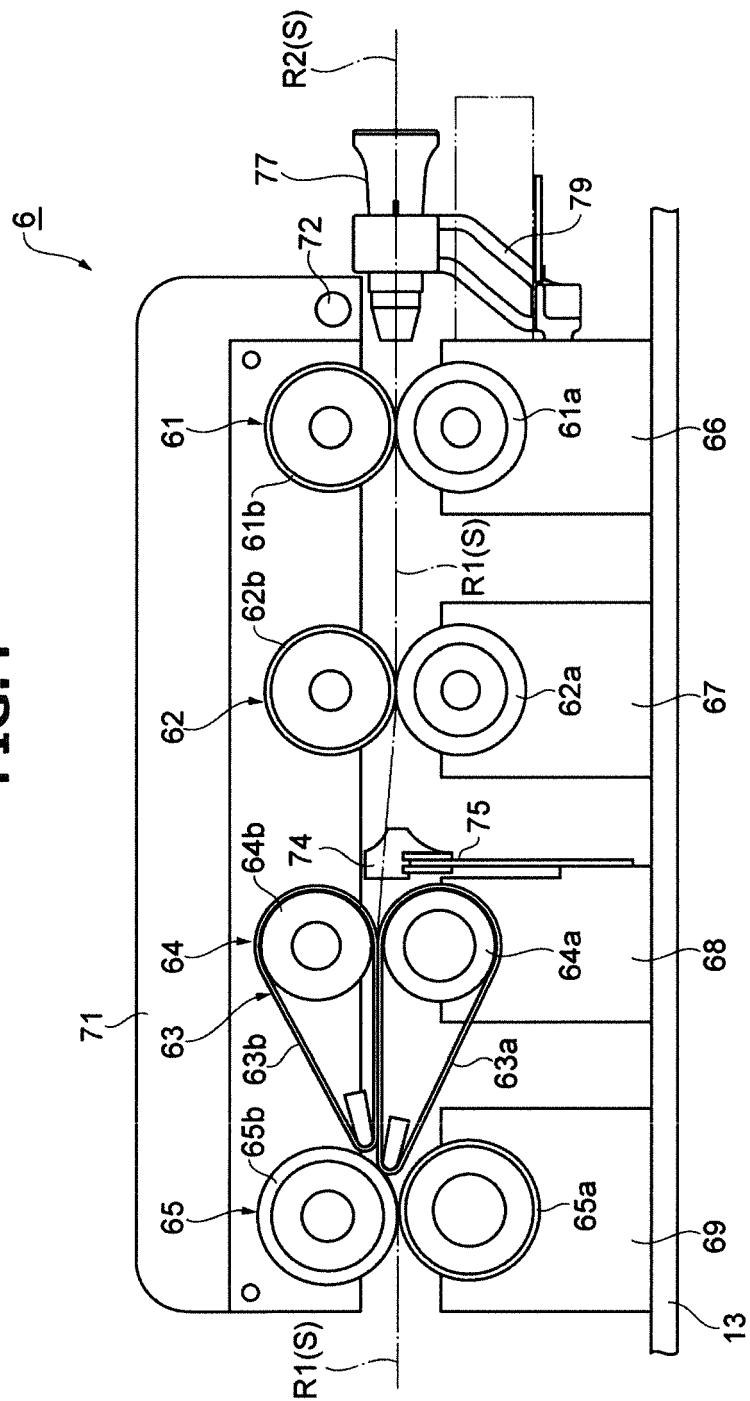


FIG.5

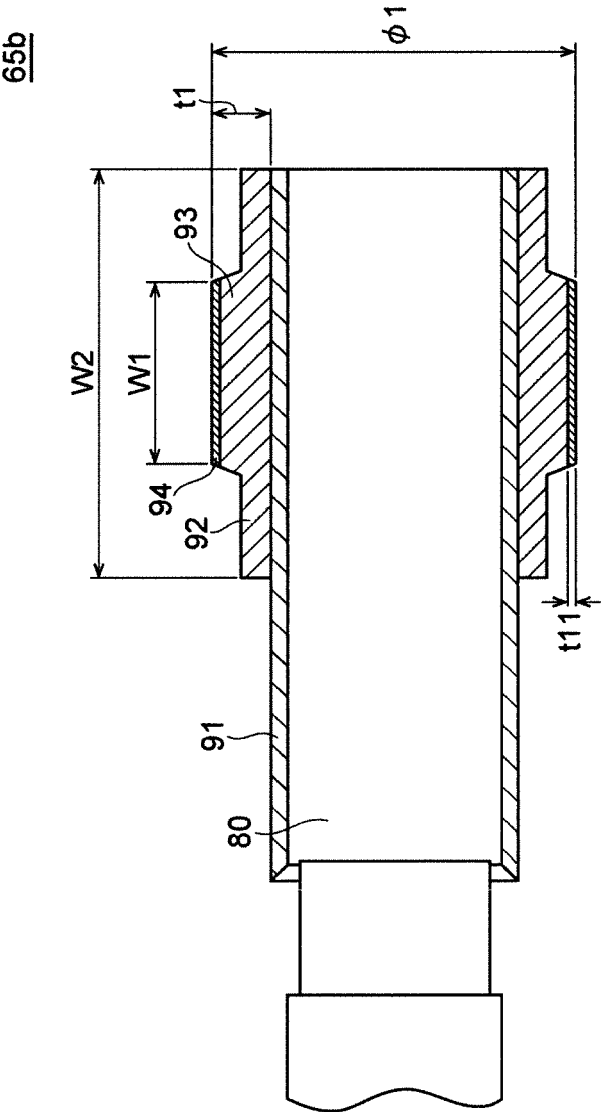


FIG.6A

165b

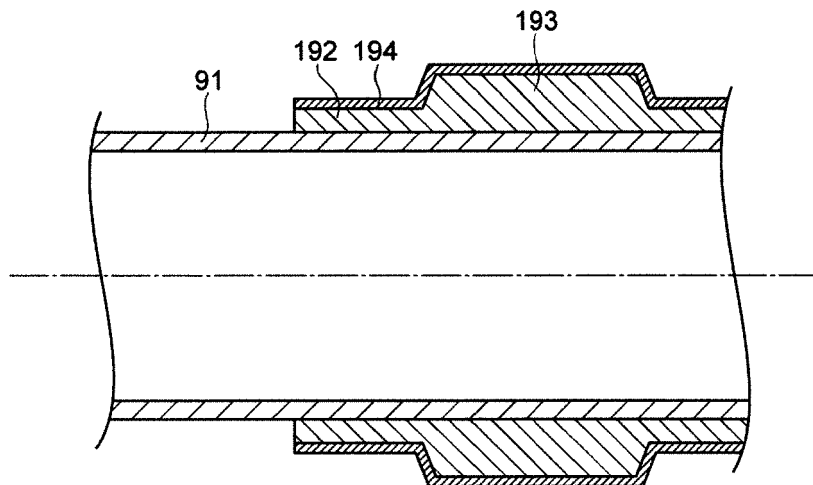


FIG.6B

265b

