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(71) Applicant: **Murata Machinery, Ltd.**
Minami-ku
Kyoto-shi
Kyoto 601-8326 (JP)

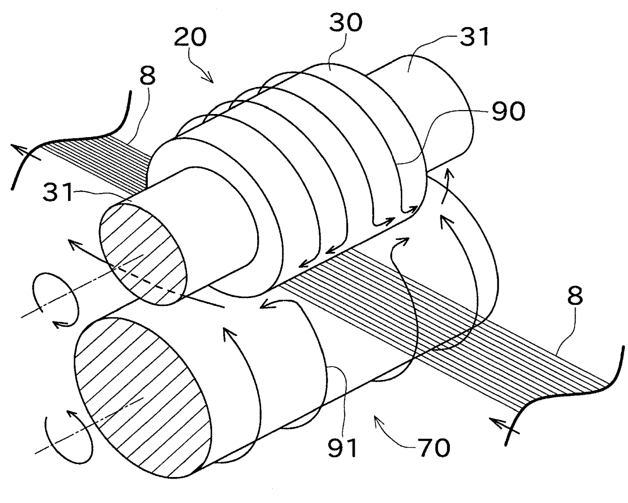
(72) Inventors:
- **Ota, Naritoshi**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Fujita, Manabu**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Mori, Hideshige**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Ikkai, Tomoyuki**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Satomi, Shinichi**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Ikeno, Masayuki**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Morita, Akihiro**
  Kyoto-shi, Kyoto 612-8686 (JP)
- **Hata, Naoki**
  Kyoto-shi, Kyoto 612-8686 (JP)

(74) Representative: **Zimmermann, Tankred Klaus et al**
Patentanwälte Schoppe, Zimmermann,
Stöckeler, Zinkler & Partner
Postfach 246
82043 Pullach (DE)

(54) **Draft roller, draft device, and spinning machine**

(57) A top front roller (20) includes a fiber-contacting portion (30) formed with a substantially uniform diameter and adapted to make a fiber bundle to contact with an outer peripheral surface thereof, and a reduced-diameter portion (31) having a diameter shorter than the fiber-contacting portion (30) at both ends of the fiber-contacting portion in an axial direction. A total width of the fiber-contacting portion (30) and the reduced-diameter portion (31) in the axial direction is 30 mm or longer and 34 mm or shorter, and a width of the fiber-contacting portion (30) in the axial direction is less than 18 mm.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention mainly relates to a shape of a draft roller provided in a draft device.

2. Description of the Related Art

[0002] A spinning machine drafts a fiber bundle (sliver) using a draft device and applies a twist to the fiber bundle with a spinning device to produce a spun yarn. This type of draft device includes a plurality of draft rollers, and drafts the fiber bundle by nipping (sandwiching) the fiber bundle with the draft rollers and rotating each of the draft rollers.

[0003] As a spinning speed of the spinning device is recently increasing, rotating speed of the draft rollers of the draft device is also increasing. As the rotating speed of the draft rollers increases, flow of air flowing along with an outer surface of the draft rollers (hereinafter referred to as "associated air current") also increases. A problem has been pointed out that this associated air current causes fibers constituting the fiber bundle to scatter and deteriorate the evenness of the produced spun yarn.

[0004] Japanese Unexamined Patent Application Publication No. H7-126926 (hereinafter referred to as "Patent Document 1") discloses a top front roller of a draft device (which is located at the most downstream position among other draft rollers) whose effective roller width is narrowed to almost half the standard width by widely cutting off both ends of the top front roller. The Patent Document 1 describes that such a top front roller enables the fiber bundle to be not influenced by the associated air current even if the top front roller rotates at high speed, and almost no fluff scatters from the front of the top front roller to both sides of the top front roller.

[0005] Japanese Unexamined Patent Application Publication No. 2005-113274 (hereinafter referred to as "Patent Document 2") discloses a draft device provided with a clearance, which is formed at both ends between the rollers constituting a roller pair, that passes through an associated air current accompanying rotation of the rollers, and forms an air passage to be an air current that forms a prevention wall for preventing the drafted fiber bundle from being scattered due to the associated air current.

SUMMARY OF THE INVENTION

[0006] An object of the present invention is to provide a draft roller suitable for a fiber bundle for a yarn of a medium yarn count or a fine yarn count.

[0007] This object is achieved by a draft roller of claim 1.

[0008] For textile machines, dimension and shape of each component are extremely essential, and for example, a subtle difference in a shape of a draft roller could often cause a significant impact on yarn quality. This is because, as a fiber constituting a fiber bundle is extremely thin and light, a subtle change in an associated air current generated near the draft roller sensibly affects the degree of fiber scattering. As there are numerous options available for setting a dimension and a shape of the draft roller, improving yarn quality by modifying the dimension and the shape of the known draft roller is one of technical problems.

[0009] However, the Patent Document 1 only describes that the effective roller width of the top front roller is narrowed to nearly half a standard width, and does not describe the degree of "nearly half", being unclear as to whether or not the exact half the standard width is included. Although dimensions are extremely important in developing a draft roller, the Patent Document 1 does not clearly describe as to the effective roller width of "nearly half of the standard" includes dimensions of which range. Therefore, an embodiment describing "an effective roller width after cutting off both ends is 18 mm" could be an only useful reference for a person skilled in the art who would try to devise the top front roller based on the description of the Patent Document 1.

[0010] The Patent Document 2 relates to an invention focusing on height and width of a step portion, and neither describes nor suggests an importance of the effective roller width. The Patent Document 2 merely discloses 18 mm as an example of a width of a nipping portion (the effective roller width described in Patent Document 1) of the top front roller (refer to FIG. 7). The Patent Document 2 neither describes nor suggests how to set the length of the effective roller width in order to improve the yarn quality. Therefore, the person skilled in the art who refers to the Patent Document 2 merely focuses on optimizing the step portion, and would not consider optimizing the effective roller width.

[0011] Meanwhile, it has been known among persons skilled in the art that in a case where the effective roller width of the top front roller of the draft device is less than 18 mm, fibers of the fiber bundle are more likely to protrude from the effective roller width, and as a result, yarn quality becomes unstable. Whether or not the fiber actually protrudes from the effective roller width of the top front roller depends on a drafting condition. However, if the effective roller width of the top front roller is 18 mm or longer, protrusion of the fibers can be prevented under most conditions. In other words, the top front roller whose effective width is 18 mm or longer can be used for many purposes. Therefore, a recent common technical knowledge of the persons skilled in the art is that the effective roller width of the top front roller should be 18 mm or longer. Accordingly, even if a person skilled in the art having this technical knowledge refers to the Patent Documents 1 and 2, such a person skilled in the art would just determine that the effective roller width of the top front roller should be 18 mm as described in the embodiments, and would not try to make the effective roller width to be less than 18 mm, for example.

[0012] Recently, due to improvement in measuring devices, measuring accuracy of the yarn quality has also improved. As a result, an effect of a shape of a draft roller on the yarn quality has also become possible to be accurately evaluated. Under this trend, through many research and developments, inventors of the present invention strived to identify that in a spinning machine having a draft device adopting a top front roller whose effective roller width is 18 mm or longer, yarn quality of coarse yarn count improves, but the yarn quality of medium yarn count and fine yarn count does not improve as expected. The experiments conducted by the inventors of the present invention have suggested that the top front roller whose effective roller width is 18 mm or longer is not necessarily a suitable roller width in order to draft a fiber bundle of yarn counts smaller than the coarse yarn count (the medium yarn count or the fine yarn count).

[0013] Neither the Patent Document 1 nor the Patent Document 2 describes nor suggests an idea of optimizing a dimension and/or a shape of the top front roller according to the yarn count (thickness) or the like. At the time of filing of the Patent Documents 1 and 2, the measuring accuracy of the yarn quality was not high compared to the present technology, and the use of general-purpose draft rollers was of greater importance. Therefore, there was no demand for using a top front roller whose effective roller width is other than 18 mm.

[0014] However, as described above, the measuring accuracy of the yarn quality has highly improved recently. Thus, yarn with higher quality has been required compared to the time of filing of the Patent Documents 1 and 2. Therefore, providing a draft roller optimized according to a yarn count (thickness) can be considered reasonable and proper rather than providing general-purpose draft rollers.

[0015] According to a first aspect of the present invention, a draft roller of a draft device includes a fiber-contacting portion, which is formed with a substantially uniform diameter and adapted to make a fiber bundle to contact with an outer peripheral surface thereof, and a reduced-diameter portion having a diameter shorter than the fiber-contacting portion and provided at both ends of the fiber-contacting portion in an axial direction. A total width of the fiber-contacting portion and the reduced-diameter portion in the axial direction is 30 mm or longer and 34 mm or shorter, and the width of the fiber-contacting portion in the axial direction is less than 18 mm.

[0016] By forming the reduced-diameter portion at both ends of the fiber-contacting portion, an associated air current, which is generated accompanying rotation of the draft roller, can be released. Accordingly, scattering of a fiber bundle can be prevented. By configuring the width of the fiber-contacting portion to be less than 18 mm, an influence of the associated air current on the fiber bundle can be reduced when the width of the fiber bundle to be drafted is narrow (when drafting a fiber bundle for a yarn that is finer than the yarn of coarse yarn count). Yarn quality can be thus improved.

[0017] According to a second aspect of the present invention, the draft device includes the draft roller and an opposed roller arranged opposing the draft roller and adapted to nip the fiber bundle between the opposed roller and the fiber-contacting portion of the draft roller. The width of the fiber-contacting portion in the axial direction is longer than the width of the fiber bundle nipped between the fiber-contacting portion and the opposed roller within a range of 7 mm or longer and 11 mm or shorter.

[0018] In this manner, by allowing a margin of the width of the fiber-contacting portion with respect to the nipped fiber bundle nipped, protrusion of the fiber bundle from the fiber-contacting portion can be prevented. In a case where the width of the fiber-contacting portion is much wider than the width of the nipped fiber bundle, the fiber bundle is more likely to spread due to an increasing influence of the associated air current. By allowing the margin of the width of the fiber-contacting portion with respect to the width of the fiber bundle within the above-described range, the spreading of the fiber bundle due to the associated air currents can be prevented. By determining the width of the fiber-contacting portion of the draft roller according to the width of the fiber bundle to be drafted, an optimized draft device can be provided.

[0019] The draft device preferably drafts the fiber bundle such that the width of the fiber bundle nipped between the fiber-contacting portion and the opposed roller is 7 mm or narrower.

[0020] The draft roller of the present invention is suitable for drafting a fiber bundle for a yarn finer than the coarse yarn count (yarn of a medium yarn count or a fine yarn count). Accordingly, by providing the width of the fiber bundle nipped by the draft rollers to be 7 mm or narrower (which corresponds to a yarn of a medium yarn count, approximately Ne30), the draft device can draft the fiber bundle with good quality.

[0021] In the above-described draft device, the draft roller is preferably a top front roller.

[0022] As the top front roller is located at the most downstream position in the feeding direction of the fiber bundle among other draft rollers of the draft device and rotated at the highest speed, the influence caused by the associated air current is the greatest. Therefore, by adopting the draft roller of the present invention as a top front roller, the top front roller can achieve outstanding performance in preventing scattering of fibers by releasing the associated air current.

[0023] According to a third aspect of the present invention, a spinning machine includes a plurality of spinning units having the above-described draft device and a spinning device adapted to produce a spun yarn by spinning the fiber bundle drafted by the draft device.

[0024] The draft device of the present invention is especially suitable for a fiber bundle for a yarn of the medium yarn count or the fine yarn count. Therefore, the spinning machine configured as described above can improve yarn quality of yarn of the medium yarn count or the fine yarn count produced by the spinning device.

[0025] In the spinning machine, the spinning device is preferably an air-jet spinning device.

[0026] As the air-jet spinning machine spins yarn at high speed, the draft rollers also rotate at high speed and the influence of the associated air current is apt to be greater. By adopting the draft roller of the present invention that can release the associated air current in the spinning machine, the quality of the spun yarn can be highly improved.

[0027] In the above-described the spinning machine, the spinning device preferably includes a nozzle holder, a hollow guide shaft, and a fiber guiding section adapted to guide the fiber bindle into a spinning chamber formed between the nozzle holder and the hollow guide shaft.

[0028] In the air-jet spinning device in which accuracy is required for a state of the fiber bundle to be guided into the spinning chamber, the fiber bundle drafted by the draft device is guided by the fiber guiding section under a stable condition. Accordingly, the spinning machine can produce a spun yarn with stable quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a front view illustrating an overall structure of a spinning machine according to one embodiment of the present invention.

FIG.2 is a side view illustrating a spinning unit.

FIG.3 is a sectional view illustrating a spinning device.

FIG.4 is a perspective view illustrating a pair of front rollers.

FIG.5 is a plan view illustrating a pair of front rollers.

FIG.6 is a table indicating results of measurement of a yarn quality of a spun yarn that has been spun when a nipped width the fiber bundle by a front roller pair is 6 mm.

FIG.7 is a table indicating results of measurement of a yarn quality of a spun yarn that has been spun when a nipped width of the fiber bundle by a front roller pair is 10 mm.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0030] Next, a fine spinning machine (spinning machine) according to one embodiment of the present invention will be described with reference to the drawings. The fine spinning machine 1 illustrated in FIG. 1 as a spinning machine includes a plurality of spindles (spinning units 2) arranged in a line. The fine spinning machine 1 includes a yarn joining cart 3, a blower box 80 and a motor box 5.

[0031] As illustrated in FIG. 1, each spinning unit 2 mainly includes a draft device 7, a spinning device 9, a yarn slack eliminating device (yarn accumulating device) 12, and a winding device 13, all of which are arranged in this order from upstream to downstream. Herein, "upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of a spun yarn at the time of spinning. Each spinning unit 2 spins a fiber bundle 8 fed from the draft device 7 with the spinning device 9, and winds a spun yarn 10 with the winding device 13 to form a package 45.

[0032] The draft device 7 is positioned close to the top end of a housing 6 of the fine spinning machine 1. The draft device 7 drafts (draws) the fiber bundle (sliver) 8 fed from a sliver case (not illustrated) through a sliver guide into a prescribed width. The fiber bundle 8 drafted by the draft device 7 is supplied to the spinning device 9.

[0033] The spinning device 9 applies a twist to the fiber bundle 8 supplied from the draft device 7 to produce the spun yarn 10. An air-jet spinning device that twists the fiber bundle 8 using a whirling airflow is adopted in the present embodiment. As illustrated in FIG. 3, the spinning device 9 mainly includes a nozzle holder 34, a hollow guide shaft 23, and a fiber guiding section 22.

[0034] A spinning chamber 26 is formed between the nozzle holder 34 and the hollow guide shaft 23. The nozzle holder 34 is provided with an air injecting nozzle 27 adapted to eject air to the spinning chamber 26. The fiber guiding section 22 is provided with a yarn introducing opening 21 adapted to introduce the fiber bundle 8 into the spinning chamber 26. The air injecting nozzle 27 is configured to eject air into the spinning chamber 26 so as to generate the whirling airflow. This configuration enables the fiber guiding section 22 having the yarn introducing opening 21 to guide the fiber bundle 8 supplied from the draft device 7 to the spinning chamber 26. In the spinning chamber 26, the fiber bundle 8 is swung around the hollow guide shaft 23 by the whirling airflow. As a result, a twist is given to the fiber bundle 8, and the spun yarn 10 is produced. The twisted spun yarn 10 passes through a yarn passage 29 formed at the axial center of the hollow guide shaft 23, and is transported out from a downstream yarn outlet (not illustrated) of spinning device 9.

[0035] The yarn introducing opening 21 is provided with a guide needle 22a whose tip end is positioned towards the spinning chamber 26. The fiber bundle 8 introduced from the yarn introducing opening 21 is guided into the spinning chamber 26 in such a manner so as to be wound around the guide needle 22a. This winding movement stabilizes a state of the fiber bundle 8 to be introduced into the spinning chamber 26. Since the fiber bundle 8 is guided while being wound around the guide needle 22a, even if twists are applied to the fibers in the spinning chamber 26, the twists are prevented from propagating upstream of the fiber guide 22. Accordingly, the twisting by the spinning device 9 can be prevented from exerting an influence on the draft device 7.

[0036] The yarn accumulating device 12 is provided downstream of the spinning device 9. As illustrated in FIG. 2, the yarn accumulating device 12 includes a yarn accumulating roller 14 and an electronic motor 25 adapted to drive and rotate the yarn accumulating roller 14.

[0037] The yarn accumulating roller 14 can wind and temporarily accumulate a certain amount of the spun yarn 10 on its outer peripheral surface. Thus, by rotating the yarn accumulating roller 14 at a prescribed speed with the spun yarn 10 being wound around the outer peripheral surface of the yarn accumulating roller 14, the spun yarn 10 can be pulled out from the spinning device 9 at the prescribed speed and transported towards downstream.

[0038] The winding device 13 includes a cradle arm 71 that is supported capable of swinging around a supporting axis 73. The cradle arm 71 can rotationally support a bobbin 48 used to wind the spun yarn 10.

[0039] The winding device 13 includes a winding drum 72 and a traverse device 75. The winding drum 72 rotates in contact with an outer peripheral surface of the bobbin 48 or the package 45, which is produced by winding the spun yarn 10 around the bobbin 48. The traverse device 75 includes a traverse guide 76 that can engage with the spun yarn 10. By driving the winding drum 72 with an electric motor (not illustrated) while reciprocating the traverse guide 76 a driving means (not illustrated), the package 45 is wound by rotating the package 45 in contact with the winding drum 72 and traversing the spun yarn 10.

[0040] As illustrate in FIG. 1 and FIG.2, the yarn joining cart 3 includes a splicer (yarn-joining device) 43, a suction pipe 44, and a suction mouth 46. When a yarn breakage or a yarn cut occurs in one spinning unit 2, the yarn jointing cart 3 runs on the rail 41 to such a spinning unit 2 and stops thereat. While swinging vertically with an axis as a center, the suction pipe 44 sucks and catches a yarn end fed from the spinning device 9, and guides the yarn end to the splicer 43. While swinging vertically with an axis as a center, the suction mouth 46 sucks and catches a yarn end from the package 45 supported by the winding device 13, and guides the yarn end to the splicer 43. The splicer 43 joins the guided yarn ends.

[0041] A yarn clearer 52 is arranged between the spinning device 9 and the yarn accumulating device 12. The spun yarn 10 spun by the spinning device 9 passes the yarn clearer 52 before being wound by the yarn accumulating device 12. The yarn clearer 52 monitors the travelling spun yarn 10 with a sensor (not illustrated). When the sensor detects defects in the spun yarn 10 (for example, a portion having abnormal yarn thickness, or a foreign particle included in the spun yarn 10), the yarn clearer 52 transmits a yarn defect detection signal to a unit controller (not illustrated).

[0042] When receiving the yarn defect detecting signal, the unit controller immediately directs a cutter 57 to cut off the spun yarn 10 and to stop the draft device 7, the spinning device 9, and the like. The unit controller also stops winding in the winding device 13. The unit controller transmits a control signal to the yarn-joining cart 3, and the yarn-joining cart 3 travels to the front of such a spinning unit 2. The yarn-joining cart 3 respectively guides the yarn end from the spinning device 9 and the yarn end from the package 45 to the splicer 43 with the suction pipe 44 and the suction mouth 46, and joins the yarn ends with the splicer 43. The yarn joining operation described above eliminates the defective portion of the spun yarn 10, and the winding of the spun yarn 10 into the package 45 can be restarted. Further, the cutter 57 may be omitted, and by stopping the draft device 7 while the winding device 13 is operating, the spun yarn 10 may be torn and cut.

[0043] Next, the draft device 7 will be described in detail.

[0044] The draft device 7 includes a plurality of draft rollers. Two draft rollers constitute one draft roller pair. The draft device 7 of the present embodiment is configured as a four-line draft device that includes four roller pairs, i.e., a back roller pair including draft rollers 16 and 66, a third roller pair including draft rollers 17 and 67, a middle roller pair including draft rollers 19 and 69, and a front roller pair including draft rollers 20 and 70, which are arranged in this order from the upstream side. A condenser 28 adapted to control the width of the fiber bundle 8 is arranged between the third roller pair and the middle roller pair.

[0045] In each draft roller pair, a draft roller located at the front side of the fine spinning machine 1 is referred to as a "top roller", and a draft roller located at the back side of the fine spinning machine 1 is referred to as a "bottom roller". The top rollers are the top back roller 16, the top third roller 17, the top middle roller 19 provided with an apron belt 18, and the top front roller 20, which are arranged in this order from the upstream side. The bottom rollers are the bottom back roller 66, the bottom third roller 67, the bottom middle roller 69 provided with an apron belt 68, and the bottom front roller (opposed roller) 70, which are arranged in this order from the upstream side.

[0046] Each of the top rollers 16, 17, 19, and 20 is a roller whose peripheral surface is covered with an elastic material such as rubber. Each of the top rollers 16, 17, 19 and 20 is rotatably supported with its axial line as a center via a bearing (not illustrated). Each of the bottom rollers 66, 67, 69 and 70 is a metallic roller, and is rotationally driven with its axial line as the center by a driving source (not illustrated). In each draft roller pair, a top roller and a bottom roller are arranged facing one another. The draft device 7 has an urging means (not illustrated) to urge the top rollers 16, 17, 19 and 20 towards the opposing bottom rollers 66, 67, 69 and 70. Accordingly, the outer peripheral surface of the top rollers 16, 17, 19 and 20 elastically makes contact with the outer peripheral surface of the bottom rollers 66, 67, 69 and 70. By rotating the bottom rollers 66, 67, 69 and 70, the top rollers 16, 17, 19, and 20 which are in contact with the bottom rollers 66, 67, 69 and 70, also rotate.

[0047] The draft device 7 transports the fiber bundle 8 downstream by nipping (sandwiching) the fiber bundle 8 between the rotating top rollers 16, 17, 19 and 20 and the rotating bottom rollers 66, 67, 69 and 70. The draft device 7 is configured such that the draft roller pair located further downstream rotates faster. Therefore, the fiber bundle 8 is drafted while being transported between the draft roller pairs, and accordingly the width of the fiber bundle 8 becomes narrower as the fiber bundle 8 is transported further downstream. By appropriately setting the rotating speed of each of the bottom rollers 66, 67, 69 and 70 and controlling the width of the fiber bundle 8 with the condenser 28, a drafting state of the fiber bundle 8 can be changed. The draft device 7 thus can supply the fiber bundle 8 drafted to be a desired width to the spinning device 9. Accordingly, the spinning device 9 can spin the spun yarn 10 with the desired count (thickness).

[0048] As described above, since the rotating speed of the draft roller pair that is located further downstream in the draft device 7 is faster, the rotating speed of the front roller pair, which is located at the most downstream position, is extremely fast. Therefore, the associated air current that generates near the front roller pair gains strength, and an impact of the associated air current on yarn quality also increases. In the draft device 7 according to the present embodiment, in order to reduce the impact of the associated air current that generates near the front roller pair, a reduced-diameter portion 31 is formed on the top front roller 20.

[0049] The structure of the top front roller 20 will be described hereafter in detail. As illustrated in FIG. 4 and FIG. 5, the top front roller 20 includes a fiber-contacting portion 30, which is formed cylindrical having an approximately uniform diameter, and cylindrical reduced-diameter portions 31 whose diameter is smaller than the fiber-contacting portion 30 and are formed at the both ends in the axial direction of the fiber-contacting portion 30.

[0050] The outer peripheral surface of the fiber-contacting portion 30 of the top front roller 20 makes contact with the outer peripheral surface of the bottom front roller 70 arranged facing the top front roller 20. As illustrated in FIG. 5, the fiber bundle 8 is nipped between the fiber-contacting portion 30 and the bottom front roller 70. Meanwhile, clearance is formed between the reduced-diameter portion 31 and the bottom roller 70.

[0051] Next, a description will be made on the associated air current generated near the top front roller 20 having the structure described above. As described above, the top front roller 20 is rotated accompanying the rotation of the bottom front roller 70 provided facing the top front roller 20. Therefore, the top front roller 20 and the bottom front roller 70 rotate in opposite directions from one another. Therefore, as illustrated in FIG. 4, the associated air current 90 that generates accompanying the rotation of the top front roller 20 and the associated air current 91 that generates accompanying the rotation of the bottom front roller 70 become opposing currents. The opposed air currents collide with one another at a position near an entrance of the fiber bundle 8 into the front roller pair.

[0052] The collided associated air currents 90 and 91 become air currents flowing into the direction parallel to a roller axis of the top front roller 20 and the bottom front roller 70 (hereinafter simply referred to as "axial direction"). The air currents flow towards the axial direction ends of the top front roller 20 and the bottom front roller 70. In other words, the air currents flow so as to spread outward. After reaching the axial direction ends of the fiber-contacting portion 30, the associated air currents 90 and 91 pass through the clearance formed between the reduced-diameter portion 31s and the bottom front roller 70, and flow towards the direction parallel to the direction in which the fiber bundle 8 travels. As described above, the flow of the associated air currents 90 and 91 flowing in the axial direction can be released via the clearance formed between the reduced-diameter portions 31 and the bottom front roller 70. As a result, the flow of the associated air currents 90 and 91 flowing in the axial direction is weakened, and spreading of the fiber bundle 8 along with the associated air currents 90 and 91 can be prevented.

[0053] It has been conventionally considered that the shape of the reduced-diameter portion 31 is essential to control the associated air currents 90 and 91 as described above. The Patent Document 2, for example, describes how to optimize the width of the reduced-diameter portion or the shape of the clearance. For example, the Japanese Unexamined Patent Publication No.2010-163702, describes various examples of the shape of the reduced-diameter portion. However, the shape and the dimension of the fiber-contacting portion have not been considered important. This is due to the fact that according to the common technological knowledge, the width of the fiber-contacting portion 30 should be 18 mm or longer, and there was no room for consideration on the dimension and the shape of the fiber contacting portion.

[0054] However, as described above, as a result of research and developments by the inventors, in the spinning machine having the conventional top front roller 20, whose width of the fiber-contacting portion 30 in the axial direction is 18 mm or longer, when spinning a yarn of a medium yarn count or a fine yarn count, a sufficient advantage in improvement of the yarn quality cannot be achieved. The inventors of the present invention conducted the following experiments in order to search an influence of a shape of the fiber-contacting portion 30 on the yarn quality.

[0055] The inventors of the present invention prepared three kinds of top front rollers 20 having the width of the fiber-contacting portion 30 in the roller axial direction being 18 mm, 17 mm, and 16 mm. The inventors conducted experimental spinning to produce the spun yarn 10 with the spinning machine 1 using each top front roller 20. FIG. 6 indicates results of measurements of quality of spun yarn 10 produced in the experimental spinning. "A1" and "A2" in FIG. 6 refer to yarn defects classified by the publicity known classimat classification. FIG.6 also indicates the number of yarn defects detected per 100 km of the spun yarn 10. Lower number of detected defects implies that the quality of the spun yarn 10 is higher. In the experiments indicated in FIG. 6, the width of the fiber bundle 8 being nipped by the fiber-contacting portion 30 was 6 mm. This width is correspondent to the spun yarn 10 of approximately Ne. 30. Ne 30 is generally considered as a medium yarn count.

[0056] As indicated in FIG.6, compared with a case in which the width of the fiber-contacting portion 30 is 18 mm, the number of yarn defects (in particular, classimat A1) decreased in cases in which the width of the fiber-contacting portion 30 is 17 mm or 16 mm. In particular, in the case in which the width of the fiber-contacting portion 30 is 16 mm, the number of yarn defects significantly decreased. As described above, by adopting the top front rollers 20 whose width of the fiber-contacting portion 30 in the axial direction is less than 18 mm (for example, 17 mm or 16 mm), the quality of the spun yarn 10 of the medium yarn count improved. The top front roller 20 whose fiber-contacting portion 30 is 16 mm is especially effective for the spun yarn 10 of the medium yarn count.

[0057] As described above, conventionally, a consideration has been made that since the fibers are more likely to protrude when the width of the fiber-contacting portion 30 is less than 18mm, a top draft roller whose width of the fiber-contacting portion 30 is less than 18 mm has not been used. However, the above-described experiments revealed that even when the width of the fiber-contacting portion 30 is less than 18 mm, the fibers do not protrude, but the yarn quality improves. In other words, the experiments conducted by the inventors of the present invention have proved for the first time that the top front roller 20 whose width of the fiber-contacting portion 30 is less than 18 mm can be put into practical use.

[0058] After having performed various experiments, the inventors of the present invention have also found that the width of a non-nipping portion is essential in optimizing the shape of the top front roller 20. The non-nipping portion refers to a portion of the fiber-contacting portion 30 where the fiber bundle 8 is not nipped. As illustrated in FIG. 5, the width of the fiber bundle 8 which is nipped at the fiber-contacting portion 30 is SW, and the width of the fiber-contacting portion in the axial direction is W1. The width of the non-nipping portions 32 and 33 formed outside the both ends of the fiber bundle 8 in the width direction are W2 and W3, respectively. As described above, since the non-nipping portions 32 and 33 are formed at both ends of the fiber-contacted portion 30, an expression of "width of the non-nipping portions" in this description refers to a total width (W2 + W3) of both non-nipping portions 32 and 33 at both ends of the fiber-contacting portion 30.

[0059] The importance of the width of the non-nipping portions revealed by the inventors will be briefly described hereinafter. A fact that the width of the non-nipping portions (W2 + W3) is long means that that the fiber bundle 8 nipped at the fiber-contacting portion 30 is located away from the reduced-diameter portions 31 in the axial direction. The reduced-diameter portions 31 are formed in order to release the associated air currents 90 and 91. Therefore, if the fiber bundle 8 is located away from the reduced-diameter portions 31, the associated air currents 90 and 91 generated close to the fiber bundle 8 cannot be released. Therefore, by narrowing the width of the non-nipping portions (W2 + W3) to some extent, the associated air currents 90 and 91 generated close to the fiber bundle 8 is more likely released via the reduced-diameter portions 31. As a result, the fiber bundle 8 is less likely to scatter, and the yarn quality improves. However, if the width of the non-nipping portions (W2 + W3) is narrowed too much, the fiber bundle 8 is more likely to protrude from the fiber-contacting portion 30, and the yarn quality deteriorates.

[0060] FIG.6 indicates results of experiments conducted with the fiber bundle 8 whose width SW is 6 mm. Thus, when the width W1 of the fiber-contacting portion 30 of the top front roller 20 is 18 mm, the width of the non-nipping portions (W2 + W3) is 12 mm. When the width W1 of the fiber-contacting portion 30 is 17 mm, the width of the non-nipping portions (W2 + W3) is 11 mm. When the width W1 of the fiber-contacting portion 30 is 16 mm, the width of the non-nipping portions (W2 + W3) is 10 mm. When looking at the experimental results in FIG. 6 based on the width of the non-nipping portions, compared with a case in which the width of the non-nipping portions is 12 mm, the yarn quality improved in a case in which the width of the non-nipping portions is 11 mm, and the yarn quality further improved in a case in which the width of the non-nipping portions is 10 mm. That is, in cases in which the width W1 of the fiber-contacting portion 30 of the top front roller 20 is 17 mm or shorter, the yarn quality improved.

[0061] FIG. 6 indicates results of experiments conducted with the fiber bundle 8 whose width SW is 6 mm. However, having repeatedly performed experiments, the inventors of the present invention confirmed that if the width SW of the fiber bundle 8 is 7 mm or narrower, the yarn quality improves by providing the width of the non-nipping portions to be 11 mm or shorter.

[0062] Meanwhile, when the width SW of the fiber bundle 8 is 7 mm or thicker (in case of a coarse yarn count, for example, SW = 8 mm), the fibers are more like to protrude from the top front roller 20 of the present invention (the top front roller 20 whose width W1 of the fiber-contacting portion 30 is less than 18 mm), and that the yarn quality may deteriorate. Accordingly, the top front roller 20 of the present invention is preferable for a case in which the width SW of the fiber bundle 8 is 7 mm or less (corresponds to a yarn finer than a coarse yarn count, i.e., a yarn of a medium yarn count or a fine yarn count). When the width SW of the fiber bundle 8 is thicker than 7 mm, the conventional top front roller (front top roller whose width W1 of the fiber-contacting portion 30 is 18mm or thicker) may be used.

[0063] In order to investigate a correlation between fiber protrusion and the width of the non-nipping portions (W2 + W3), the inventors of the present invention conducted experiments in which the spun yarn 10 is spun with the width SW of the fiber bundle 8 being 10 mm. Results of the experiments are indicted in FIG. 7. When the width SW of the fiber bundle 8 is 10 mm as in the experiments, since the SW is thicker than 7 mm, fibers are more likely to protrude from the width of the fiber-contacting portion 30 and the yarn quality deteriorates with the top roller 20 of the present invention. Therefore, by examining the relations between a deteriorated level of the yarn quality in the experiments (the number of yarn defects) and the width of the non-nipping portions (W2 + W3), relations between likelihood of the fiber protrusion and the width of the non-nipping portions (W2 + W3) can be clarified. When looking at the results indicated in FIG. 7 from this aspect, the number of yarn defects is relatively few in cases where the width of the non-nipping portions (W2 + W3) is 7 mm or 8mm, and the number of yarn defects (in particular, classimat A2) is relatively large in a case where the width of the non-nipping portions (W2 + W3) is 6 mm. According to the results of the experiments, in a case where the width of the non-nipping portions (W2 + W3) is 6 mm, the fibers of the fiber bundle 8 is likely to protrude from the fiber-contacting portion 30. Accordingly, if the width of the non-nipping portions (W2 + W3) is 7 mm or longer, the prevention of the fiber protrusion can be considered to be achieved.

[0064] By summarizing the above descriptions, in a case where the non-nipping portions of the top front roller 20 (W2 + W3) is within a range of 7 mm or longer to 11 mm or shorter, the fiber bundle 8 can be prevented from protruding from the fiber-contacting portion 30. Further, the fiber bundle 8 is unlikely to scatter due to the associated air currents 90 and 91, and as a result, yarn quality can be improved. In other words, by configuring the width W1 of the fiber-contacting portion 30 within the range indicated below, the spun yarn 10 with high quality can be produced:

$$SW + 7\ \mathrm{mm} \leqq W1 \leqq SW + 11\ \mathrm{mm}$$

[0065] The width SW when the fiber bundle 8 is nipped by the fiber-contacting portion 30 of the top front roller 20 is determined by setting of the draft device 7, such as a rotating speed of each draft rollers pair. In the fine spinning machine 1 according to the embodiments of the present invention, a plurality of the top front rollers 20 whose fiber-contacting portions 30 are set to various width W1 are prepared, and an appropriate top front roller 20 is used depending on the width SW of the fiber bundle 8 supplied to the draft device 7. Accordingly, even when the setting is changed, the width W1 of the fiber-contacting portion 30 can be preferably kept within the range described above. The above embodiment describes spinning of a yarn of a medium yarn count (in particular, in a case where the width SW of the fiber bundle 8 is 6 mm). However, the top front roller 20 according to the present embodiment also has similar effect when spinning a yarn of a fine yarn count. In other words, the top front roller 20 of the present embodiment can improve the yarn quality when the width SW of the fiber bundle 8 is 7 mm or less (that is, SW =7 mm, 6 mm, 5 mm, 4 mm, 3 mm, 2 mm, etc.)

[0066] Since the surface of the top rollers is covered with elastic materials such as rubber, abrasion occurs accompanying use. Since the top rollers are consumables, the top rollers are configured to be replaced in the draft device 7. Accordingly, the top front roller 20 can be replaced easily according to the offsetting of the draft device 7.

[0067] If the entire width W4 of the top front roller 20 (a total width of the fiber-contacting portion 30 and the reduced-diameter portions 31 in the axial direction) is too wide, the roller may deflect, and nipping of the fiber bundle 8 might become unstable. Meanwhile, if the entire width W4 of the top front roller 20 is too narrow, the width of the reduced-diameter portions 31 cannot be sufficiently provided. Therefore, the associated air currents 90 and 91 cannot be sufficiently released.. In this respect, according to the experiments conducted by the inventors of the present invention, if the entire width W4 of the top front roller 20 is provided within a range of 30 mm or longer to 34 mm or shorter, problems do not arise in particular. Therefore, the entire width W4 of the top front roller 20 of the present embodiment is 30 mm or longer and 34 mm or shorter. FIG. 6 and FIG. 7 indicate experimental results that were obtained by using the top front roller 20 whose entire width W4 is 32 mm.

[0068] As described above, the top front roller 20 of the present embodiment includes the fiber-contacting portion 30 that is formed with substantially constant diameter and adapted to make the fiber bundle 8 to contact with the outer peripheral surface thereof, and the reduced-diameter portion 31, whose diameter is shorter than the fiber-contacting portion 30 and provided at the both ends of the fiber-contacting portion 30 in the axial direction. The total width W4 of the fiber-contacting portion 30 and the reduced-diameter portion 31 in the axial direction is 30 mm or longer and 34 mm or shorter. The width W1 of the fiber-contacting portion 30 in the axial direction is less than 18 mm.

[0069] By forming the reduced-diameter portion 31 at the both ends of the fiber-contacting portion 30, the associated air currents 90 and 91, which are generated accompanying rotation of the top front roller 20, can be released. Accordingly, scattering of the fiber bundle 8 can be prevented. By configuring the width of the fiber-contacting portion 30 to less than 18 mm, the influence caused by the associated air current can be reduced when the width of the fiber bundle 8 to be drafted is narrow (when drafting the fiber bundle 8 for the spun yarn which is finer than a coarse yarn count) , and accordingly yarn quality can be improved.

[0070] The draft device 7 of the present embodiment includes the top front roller 20 and the bottom front roller 70, which is arranged opposing the top front roller 20 and adapted to nip the fiber bundle 8 with the fiber-contacting portion 30 of the top front roller 20. The width W1 of the fiber-contacting portion 30 in the axial direction is longer than the width SW of the fiber bundle 8 that is nipped between the fiber-contacting portion 30 and the bottom front roller 70. More specifically, the width W1 is within the range of 7 mm or longer to 11 mm or shorter.

[0071] In this manner, by allowing a margin of the width W1 of the fiber-contacting portion 30 with respect to the width S1 of the nipped fiber bundle 8, the fibers can be prevented from protruding from the fiber-contacting portion 30. If the width of the fiber-contacting portion 30 is too wide compared with the width of the nipped fiber bundle 8, the fiber bundle 8 is more likely to spread out due to an increasing impact of the associated air currents 90 and 91. By setting the margin of the width W1 of the fiber-contacting portion 30 with respect to the width SW of the fiber bundle 8, that is, the width of the non-nipping portion, within the above-mentioned range, the spreading of the fiber bundle 8 by the associated air current can be prevented. As described above, by determining the width of the fiber-contacting portion 30 of the top front roller 20 according to the width of the fiber bundle 8 to be drafted, an optimized draft device 7 can be provided.

[0072] The draft device 7 of the present embodiment preferably drafts the fiber bundle 8 such that the width of the fiber bundle 8 nipped between the fiber-contacting portion 30 and the bottom front roller 70 is 7 mm or narrower.

[0073] The top front roller 20 of the present embodiment is suitable for drafting the fiber bundle 8 for a spun yarn 10that is finer than a coarse yarn count, that is, a spun yarn 10 of a medium or a fine yarn count. Accordingly, by providing the width SW of the fiber bundle 8 nipped by the top front roller 20 to be 7 mm or narrower (substantially equivalent to the spun yarn 10 of a medium yarn count, approximately Ne30), the draft device 7 can draft the fiber bundle 8 with good quality.

[0074] The top front roller 20 is arranged most downstream among other rollers included in the draft device 7, and rotates at the highest speed. The top front roller 20 is thus most likely to be affected by the influence of the associated air currents 90 and 91. Accordingly, by adopting the draft roller of the present embodiment as the top front roller 20, the scattering of the fibers can be prevented by releasing the associated air currents 90 and 91.

[0075] The fine spinning machine 1 according to the present embodiment includes a plurality of spinning units 2 having the draft device 7 and the spinning device 9 that produces the spun yarn 10 by spinning the fiber bundle 8 drafted by the draft device 7.

[0076] The draft device 7 according to the present embodiment is suitable to draft the fiber bundle 8 for the spun yarn 10 of a medium yarn count or a fine yarn count. Accordingly, the fine spinning machine 1 with the structure described above can improve quality of the spun yarn 10 of a medium yarn count or a fine yarn count produced by the spinning device 9.

[0077] In the fine spinning machine 1 according to the present embodiment, the spinning device 9 is an air-jet spinning device.

[0078] As the air-jet spinning device can perform high-speed spinning, the draft rollers also rotate at high speed and an effect of the associate air currents 90 and 91 is apt to be greater. By adopting the draft roller of the present invention that can release the associated air currents 90 and 91, the quality of the spun yarn 10 can be highly improved.

[0079] In the above-described the fine spinning machine 1 according to the present embodiment, the spinning device 9 includes the nozzle holder 34, the hollow guide shaft 23, and the fiber guiding section 22 that guides the fiber bundle 8 into the spinning chamber 26 formed between the nozzle holder 34 and the hollow guide shaft 23.

[0080] In the air-jet spinning device in which accuracy is required for a state of the fiber bundle 8 to be guided into the spinning chamber 26, the fiber bundle 8 is guided by the fiber guiding section 22 under a stable condition. As a result, the fine spinning machine 1 can produce the spun yarn 10 with stable quality.

[0081] The preferred embodiments of the present invention have been described. However, the configurations can be modified as described hereinafter, for example.

[0082] The present invention can be applied to a draft device of other types of spinning machines, such as a ring spinning machine.

[0083] In the embodiment described above, the fine spinning machine 1 winds the spun yarn 10 around the rotating yarn accumulating roller 14 to pull out the spun yarn 10 from the spinning device 9. Further, instead of the yarn accumulating device 12, a delivery roller and a nip roller, both of which can rotate, may be arranged in the fine spinning machine 1 in order to nip and pull out the spun yarn 10 from the spinning device 9. In this case, the yarn accumulating roller 14 may be arranged downstream of the delivery roller and the nip roller to eliminate slack of the spun yarn 10, which generates during a winding operation or a yarn joining operation.

[0084] The guide needle 22a of the fiber guide 22 can be omitted. In this case, a downstream edge of the fiber guide

22 may be used to carry out a function of the guide needle 22a.

[0085] The shape of the reduced-diameter portion 31 is not limited to a cylindrical shape illustrated in FIG. 4 and FIG. 5. As disclosed in Japanese Unexamined Patent Publication No. 2010-163702, for example, the reduced-diameter portion 31 may be formed in an oblique shape or a curved shape.

[0086] In the above described embodiments of the present invention, descriptions have been made with regard to the structure in which the draft roller of the present invention is used as the top front roller. However, the draft roller of the present invention is not limited to such embodiments, and may be adopted for the bottom front roller. Further, not limited to the front roller pair, the draft roller of the present invention may be adopted as other draft rollers.

Claims

1. A draft roller (20) for a draft device (7), the draft roller (20) comprising:

a fiber-contacting portion (30) formed with a substantially uniform diameter and adapted to make a fiber bundle to contact with an outer peripheral surface thereof, and
a reduced-diameter portion (31) having a diameter smaller than the fiber-contacting portion (30) and provided at both ends of the fiber-contacting portion (30) in an axial direction,
wherein a total width of the fiber-contacting portion (30) and the reduced-diameter portion (31) in the axial direction is 30 mm or longer and 34 mm or shorter, and a width of the fiber-contacting portion (30) in the axial direction is less than 18 mm.

2. A draft device (7) comprising:

the draft roller (20) according to claim 1, and
an opposed roller (70) arranged opposing the draft roller (20) and adapted to nip a fiber bundle between the opposed roller (70) and the fiber-contacting portion (30) of the draft roller (20),
wherein the width of the fiber-contacting portion (30) in the axial direction is longer than a width of the fiber bundle nipped between the fiber-contacting portion (30) and the opposed roller (70) within a range of 7 mm or longer and 11 mm or shorter.

3. The draft device (7) according to claim 2, wherein the fiber bundle is drafted such that the width of the fiber bundle nipped between the fiber-contacting portion (30) and the opposed roller (70) is 7 mm or narrower.

4. The draft device (7) according to claim 2 or claim 3, wherein the draft roller (20) is a top front roller.

5. A spinning machine (1) comprising:

the draft device (7) according to one of claim 2 through claim 4, and
a spinning device (9) adapted to produce spun yarn by spinning the fiber bundle drafted by the draft device (7).

6. The spinning machine (1) according to claim 5, wherein the spinning device (9) is an air-jet spinning device.

7. The spinning machine (1) according to claim 6, wherein the spinning device (9) includes a nozzle holder (34), a hollow guide shaft (23), and a fiber guiding section (22) adapted to guide the fiber bundle into a spinning chamber (26) formed between the nozzle holder (34) and the hollow guide shaft (23).

FIG. 1

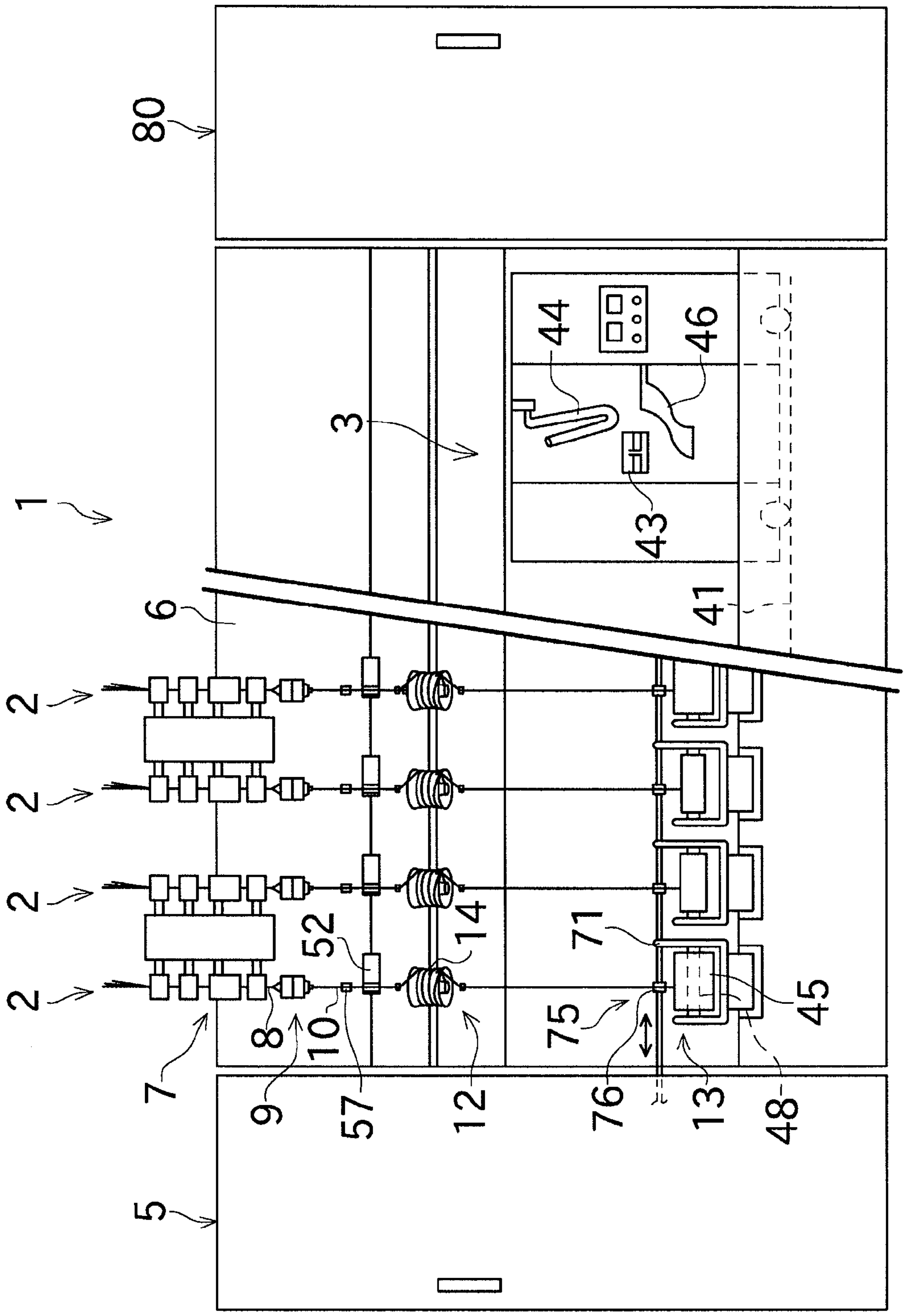

FIG. 2

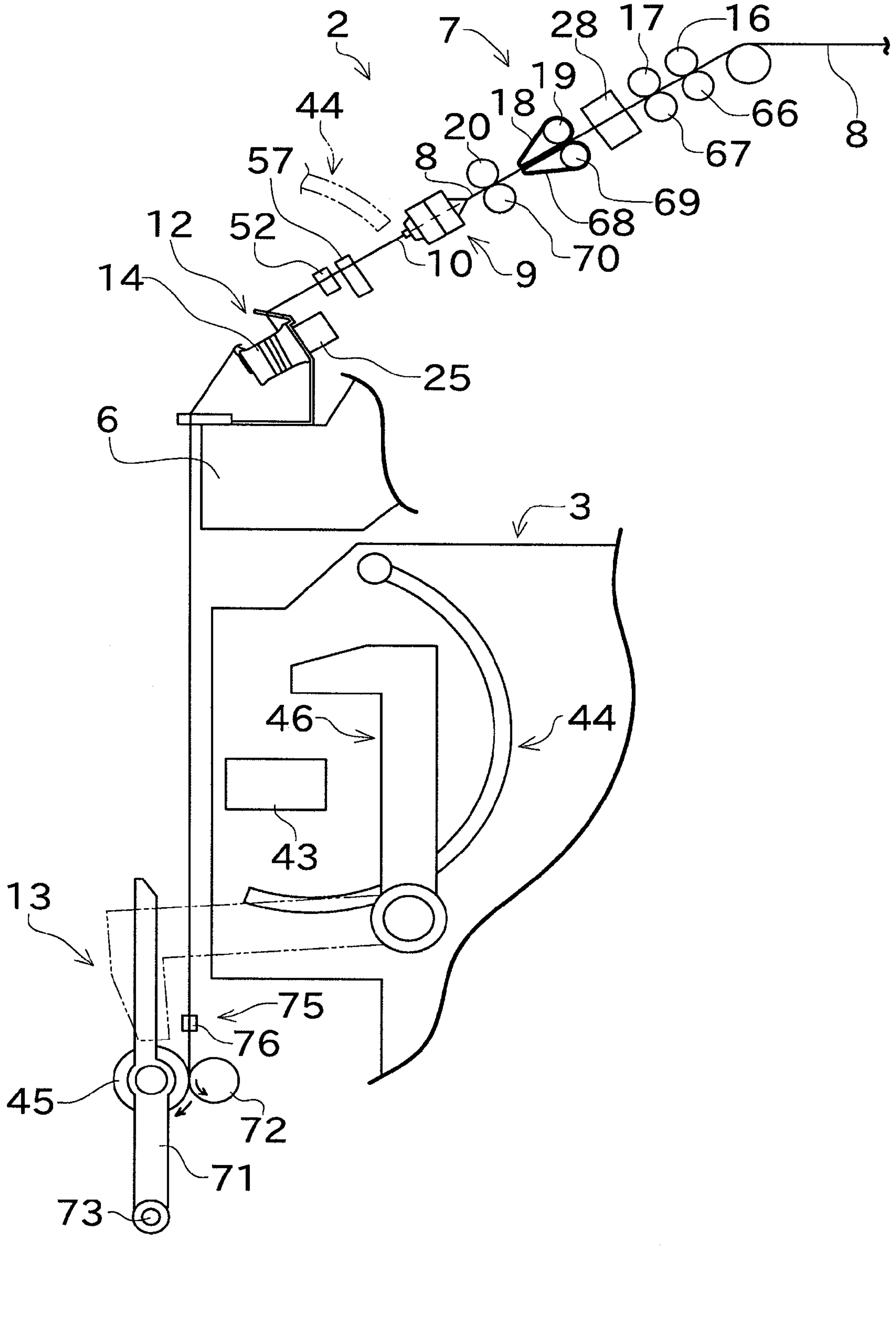
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FIG. 3

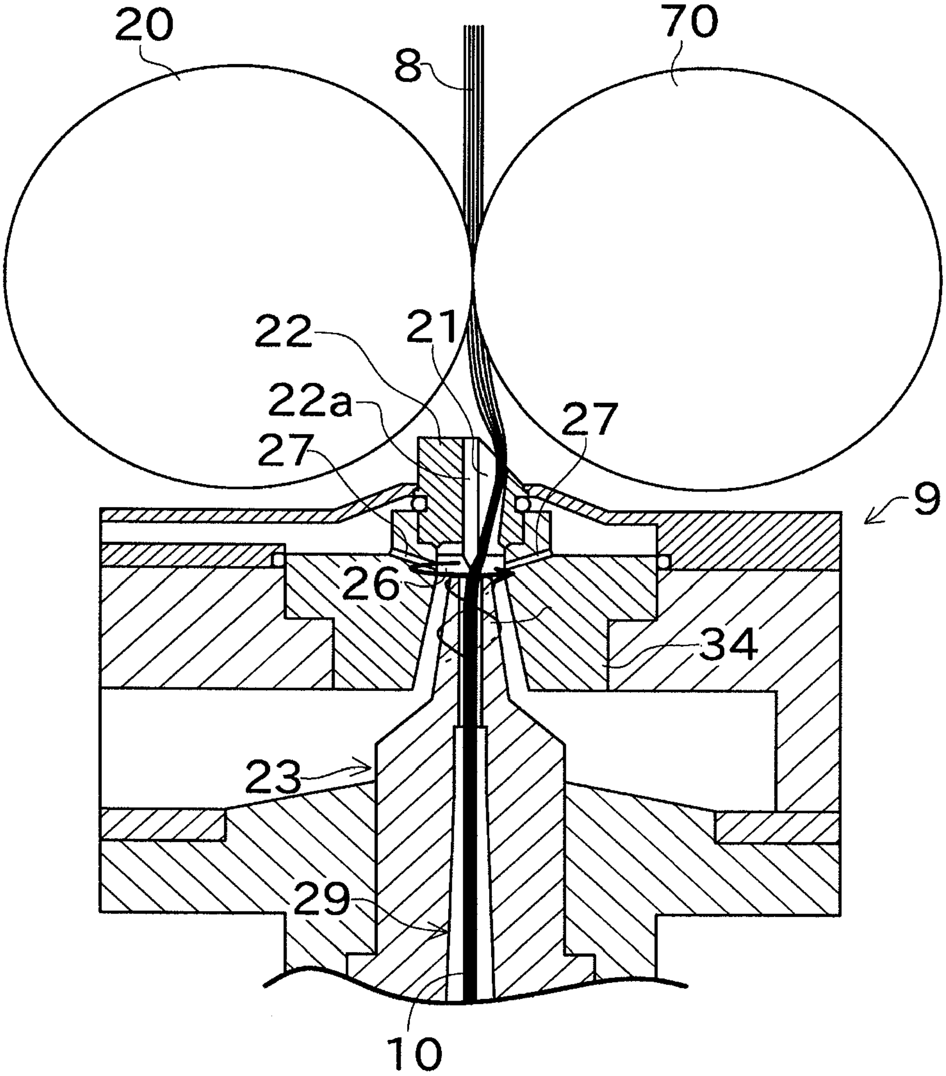

FIG. 4

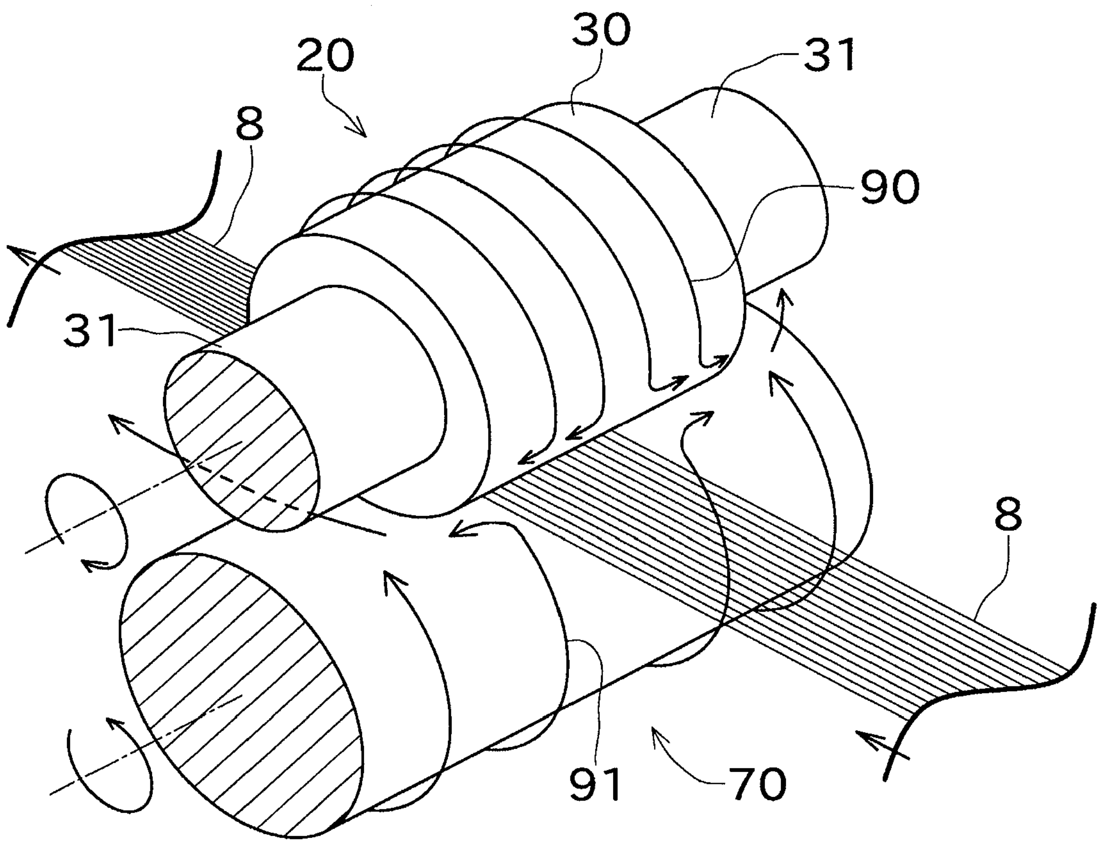

FIG. 5

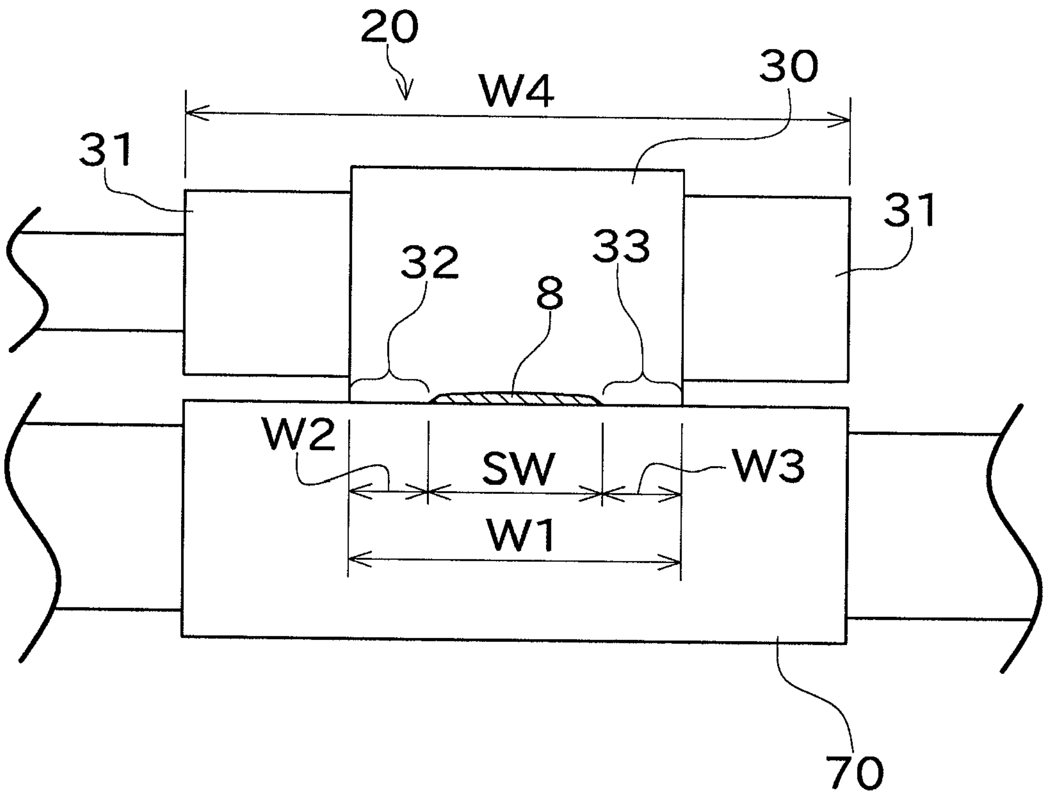

FIG. 6

WIDTH OF FIBER BUNDLE (SW)	6 mm		
WIDTH OF FIBER-CONTACTING PORTION (W1)	18 mm	17 mm	16 mm
WIDTH OF NON-NIPPING PORTION (W2 + W3)	12mm	11 mm	10 mm
CLASSIMAT A1/100km	359	150	27
CLASSIMAT A2/100km	17	10	4

FIG. 7

WIDTH OF FIBER BUNDLE (SW)	10 mm		
WIDTH OF FIBER-CONTACTING PORTION (W1)	18 mm	17 mm	16 mm
WIDTH OF NON-NIPPING PORTION (W2 + W3)	8 mm	7 mm	6 mm
CLASSIMAT A1/100km	32	39	43
CLASSIMAT A2/100km	4	3	13

REFERENCES CITED IN THE DESCRIPTION

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- JP 2005113274 A **[0005]**
- JP 2010163702 A **[0053] [0085]**