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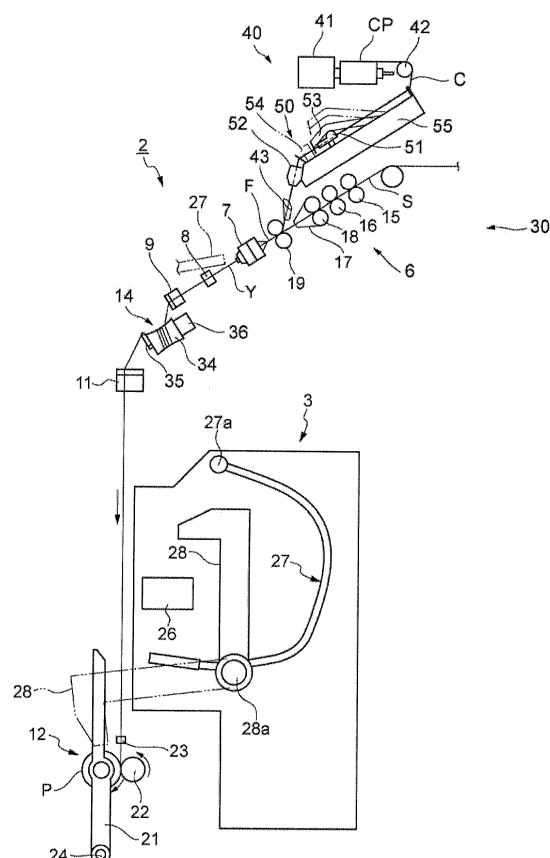
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(54) **Spinning machine, spinning method, and spun yarn**

(57) A spinning machine (1) includes a core yarn supplying device (40) adapted to supply a core yarn (C); a draft device (6) adapted to supply a fiber bundle (F); a pneumatic spinning device (7) adapted to produce a spun yarn (Y) by applying twists to the fiber bundle (F) with the core yarn (C) as a core; a tension sensor (9) adapted to detect tension applied to the spun yarn (Y) produced by the pneumatic spinning device (7); and a monitoring section (71) adapted to monitor a yarn quality of the spun yarn (Y) in accordance with a quality monitor reference range for monitoring the yarn quality of the spun yarn (Y) and a detection result of the tension sensor (9).

FIG. 2



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a spinning machine, a spinning method, and a spun yarn.

2. Description of the Related Art

[0002] Conventionally, there is known a spinning machine including a core yarn supplying device adapted to supply a core yarn, a fiber bundle supplying device adapted to supply a fiber bundle, and a spinning device adapted to produce a spun yarn by applying twists to the fiber bundle with a core yarn as a core (see e.g., Japanese Unexamined Patent Publication No. 2013-049932).

[0003] In the spinning machine described above, the fiber bundle is required to be appropriately twisted around the core yarn to improve a yarn quality of the spun yarn. Thus, in the present technical field, improvement in the yarn quality of the spun yarn is desired.

BRIEF SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a spinning machine that can improve a yarn quality of a spun yarn, a spinning method, and a spun yarn with improved yarn quality.

[0005] A spinning machine according to one aspect of the present invention includes a core yarn supplying device adapted to supply a core yarn; a fiber bundle supplying device adapted to supply a fiber bundle; a spinning device adapted to produce a spun yarn by applying twists to the fiber bundle with the core yarn as a core; a tension detecting section adapted to detect tension applied to the spun yarn produced by the spinning device; and a monitoring section adapted to monitor a yarn quality of the spun yarn in accordance with a quality monitor threshold for monitoring the yarn quality of the spun yarn and a detection result of the tension detecting section.

[0006] Thus, the yarn quality of the spun yarn can be monitored by using the tension (the detection result of the detecting section) applied to the spun yarn having a correlative relationship with the yarn quality of the spun yarn, and the yarn quality of the spun yarn can be improved.

[0007] The quality monitor threshold may be set according to a type of the spun yarn to be monitored by the monitoring section. The yarn quality thus can be appropriately monitored according to the spun yarn to be produced.

[0008] The monitoring section may be adapted to further monitor a presence and/or an absence of the core yarn in accordance with a presence/absence monitoring threshold for monitoring whether or not the core yarn is included in the spun yarn produced by the spinning de-

vice and a detection result of the tension detecting section. The yarn quality of the spun yarn thus can be further improved.

[0009] The core yarn supplying device may include a core yarn detecting section adapted to detect a presence and/or an absence of the core yarn to be supplied, and the monitoring section may be adapted to further monitor the presence and/or the absence of the core yarn in accordance with a detection result of the core yarn detecting section. The yarn quality of the spun yarn thus can be further improved.

[0010] The monitoring section may be adapted to switch between monitoring of the yarn quality and monitoring of the presence and/or the absence of the core yarn. In this case, the monitoring of the yarn quality and the monitoring of the presence and/or the absence of the core yarn can be switched according to a state of the spun yarn, a timing of producing the spun yarn, and the like, whereby necessary monitoring can be appropriately carried out.

[0011] The spinning device may be adapted to stop producing the spun yarn when the monitoring section determines an abnormality in the yarn quality of the spun yarn. In this case, when the yarn quality of the spun yarn has an abnormality, the spinning device can stop producing the spun yarn at an appropriate timing.

[0012] The spinning machine may further include a setting section adapted to set a spinning condition of the spun yarn according to the spun yarn to be produced by the spinning device. Since the spinning machine includes the setting section, the yarn quality of the spun yarn can be changed by changing the spinning condition. Therefore, the spinning condition can be set in accordance with a monitoring result of the monitoring section, and the spun yarn having high yarn quality can be produced.

[0013] The spinning machine may further include a pull-out device adapted to pull out the spun yarn from the spinning device, and a setting section adapted to set a ratio of a speed at which the fiber bundle supplying device supplies the core yarn and the fiber bundle to the spinning device and a speed at which the pull-out device pulls out the spun yarn, in accordance with the spun yarn produced by the spinning device. The yarn quality of the spun yarn can be changed by changing the ratio of the speed at which the core yarn and the fiber bundle are supplied and the speed at which the spun yarn is pulled out. Therefore, the spun yarn having high yarn quality can be produced by changing the ratio of the speed in accordance with the monitoring result of the monitoring section.

[0014] The core yarn supplying device may include a tension applying section adapted to apply tension to the core yarn, wherein the tension applying section may include an adjusting section adapted to adjust setting of the tension to be applied to the core yarn. The yarn quality of the spun yarn can be changed by changing the tension of the core yarn to be supplied. Therefore, the spun yarn having high yarn quality can be produced by changing the tension to be applied to the core yarn in accordance

with the monitoring result of the monitoring section.

[0015] The spinning machine may further include a display section adapted to display the detection result of the tension detecting section. By displaying the detection result, an operator of the spinning machine can easily learn the tension applied to the spun yarn.

[0016] Another aspect of the present invention relates to a spinning method performed by a spinning machine including a spinning device adapted to produce a spun yarn by applying twists to a fiber bundle with a core yarn as a core, the spinning method including a detecting step of detecting tension applied to the spun yarn produced by the spinning device; and a monitoring step of monitoring a yarn quality of the spun yarn in accordance with a quality monitor threshold for monitoring the yarn quality of the spun yarn and a detection result of the tension applied to the spun yarn.

[0017] Thus, the yarn quality of the spun yarn can be monitored by using the tension applied to the spun yarn having a correlative relationship with the yarn quality of the spun yarn, and the yarn quality of the spun yarn can be improved.

[0018] A spun yarn according to still another aspect of the present invention is produced by the spinning method described above. The yarn quality of the spun yarn produced by the spinning method described above is monitored. Thus, the spun yarn having improved yarn quality can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 is a front view of a spinning machine according to one embodiment of the present invention;

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

FIG. 3A is a view illustrating a state in which a tension applying section is applying large tension;

FIG. 3B is a view illustrating a state in which the tension applying section is applying small tension;

FIG. 4 is a block diagram illustrating a function configuration of a unit control device; and

FIG. 5 is a view illustrating a relationship between a feed ratio and tension to be applied to a core yarn, and a yarn quality.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0020] Embodiments of the present invention will be hereinafter described with reference to the drawings. The same reference numerals are denoted on the same components in the description of the drawings, and the redundant description will be omitted.

[0021] As illustrated in FIG. 1, a spinning machine 1 includes a plurality of spinning units 2, a yarn joining cart 3, a blower box 4, and a motor box 5. The plurality of spinning units 2 are arranged in a line. Each spinning

unit 2 produces a spun yarn Y from a sliver S and a core yarn C, and winds the spun yarn Y into a package P. The yarn joining cart 3 performs a yarn joining operation in the spinning unit 2 in which the spun yarn Y is cut. The blower box 4 accommodates an air supply source and the like for generating a suction flow, a whirling airflow, or the like at each section of the spinning unit 2. The motor box 5 accommodates a motor and the like for supplying power to each section of the spinning unit 2.

[0022] In the following description, on a travelling path of the sliver S and the spun yarn Y, a side on which the sliver S is supplied is referred to as upstream, and a side on which the spun yarn Y is wound is referred to as downstream. A side on which the spun yarn Y travels with respect to the yarn joining cart 3 is referred to as a front side, and a side opposite to the front side is referred to as a back side. In the present embodiment, a work passage (not illustrated) extending in a direction in which the plurality of spinning units 2 are arranged is provided on the front side of the spinning machine 1. Therefore, the operator can perform operation, monitoring, and the like of each spinning unit 2 from the work passage.

[0023] As illustrated in FIGS. 1 and 2, each spinning unit 2 includes a draft device (fiber bundle supplying device) 6, a core yarn supplying device 40, a pneumatic spinning device (spinning device) 7, a spun yarn monitoring device 8, a tension sensor (tension detecting section) 9, a yarn storage device (yarn pull-out device, setting section) 14, a waxing device 11, and a winding device 12 in this order from the upstream. These devices are directly or indirectly supported by a machine frame 13 such that the upstream is an upper side in a height direction of the spinning machine 1 (i.e., downstream is a lower side in the height direction).

[0024] The draft device 6 is adapted to draft a sliver S to produce a fiber bundle F. The draft device 6 includes a back roller pair 15, a third roller pair 16, a middle roller pair 18 provided with an apron belt 17 on each roller, and a front roller pair 19 in this order from the upstream. Each of the roller pairs 15, 16, 18, and 19 is driven by power from the motor box 5, or by power of driving sources (not illustrated) arranged individually. Each of the roller pairs 15, 16, 18, and 19 causes the sliver S supplied from a can (not illustrated) to travel from the upstream towards the downstream while drafting.

[0025] The core yarn supplying device 40 unwinds the core yarn C from a core yarn package CP, and supplies the core yarn C to the draft device 6. More specifically, the core yarn supplying device 40 supplies the core yarn C to a travelling path of the fiber bundle F from between the middle roller pair 18 and the front roller pair 19. The core yarn C is thus supplied to the pneumatic spinning device 7 together with the fiber bundle F.

[0026] The pneumatic spinning device 7 produces the spun yarn Y by applying twists to the fiber bundle F with the core yarn C as a core. More specifically (although not illustrated), the pneumatic spinning device 7 includes a spinning chamber, a fiber core yarn guide, a whirling

airflow generating nozzle, and a hollow guide shaft body. The fiber core yarn guide guides the fiber bundle F, which becomes cover fibers, supplied from the draft device 6 and the core yarn C supplied from the core yarn supplying device 40 to the spinning chamber. The whirling airflow generating nozzle is arranged at a periphery of the travelling path of the fiber bundle F and the core yarn C. A whirling airflow is generated in the spinning chamber by injecting air from the whirling airflow generating nozzle. This whirling airflow causes a fiber end of the fiber bundle F guided into the spinning chamber to be reversed and to whirl. The hollow guide shaft body is adapted to guide the spun yarn Y from the spinning chamber to outside the pneumatic spinning device 7.

[0027] The spun yarn monitoring device 8 is adapted to monitor the travelling spun yarn Y between the pneumatic spinning device 7 and the yarn storage device 14. When a yarn defect is detected in the spun yarn Y, the spun yarn monitoring device 8 transmits a yarn defect detection signal to a unit control device 10. The spun yarn monitoring device 8 detects, for example, a thickness abnormality of the spun yarn Y and/or foreign substance contained in the spun yarn Y as the yarn defect.

[0028] The tension sensor 9 measures tension of the travelling spun yarn Y between the pneumatic spinning device 7 and the yarn storage device 14. That is, the tension sensor 9 measures (detects) tension applied to the spun yarn Y produced by the pneumatic spinning device 7. The tension sensor 9 transmits a measured tension value to the unit control device 10. Various sensors can be used for the tension sensor 9 as long as the tension of the spun yarn Y can be measured.

[0029] The waxing device 11 is adapted to apply wax on the travelling spun yarn Y between the yarn storage device 14 and the winding device 12.

[0030] The unit control device 10 is provided for each spinning unit 2, and is adapted to control operation of the spinning unit 2 under control of a machine control device 20, which is a high-order controller.

[0031] The yarn storage device 14 is adapted to store the travelling yarn Y between the pneumatic spinning device 7 and the winding device 12. The yarn storage device 14 has a function of stably pulling out the spun yarn Y from the pneumatic spinning device 7, a function of storing the spun yarn Y fed from the pneumatic spinning device 7 to prevent the spun yarn Y from slackening during the yarn joining operation by the yarn joining cart 3 or the like, and a function of adjusting the tension of the spun yarn Y at the winding device 12 side to prevent a fluctuation in the tension of the spun yarn Y at the winding device 12 side from being transmitted towards the pneumatic spinning device 7.

[0032] The yarn storage device 14 includes a yarn storage roller 34, a yarn hooking member 35, and an electric motor 36. The yarn hooking member 35 can engage with the spun yarn Y and integrally rotate with the yarn storage roller 34 while being engaged with the spun yarn Y to wind the spun yarn Y around an outer circumferential

surface of the yarn storage roller 34. The yarn storage roller 34 winds a prescribed amount of the spun yarn Y around the outer circumferential surface thereof to store the spun yarn Y. The yarn storage roller 34 is rotatably driven by the electric motor 36. When the yarn storage roller 34 is rotated, the spun yarn Y wound around the outer circumferential surface of the yarn storage roller 34 is wound to tighten the yarn storage roller 34, and the spun yarn Y located upstream of the yarn storage device 14 is pulled. In other words, when the yarn storage roller 34 is rotated at a predetermined rotation speed with the spun yarn Y wound around the outer circumferential surface, the yarn storage device 14 can apply predetermined tension to the spun yarn Y, pull out the spun yarn Y at a predetermined speed from the pneumatic spinning device 7, and transport the spun yarn Y towards the downstream at a predetermined speed. The electric motor 36 is controlled by the unit control device 10.

[0033] The winding device 12 is adapted to wind the yarn Y produced by the pneumatic spinning device 7 around a bobbin B 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 supported to be swingable about a supporting shaft 24. The cradle arm 21 causes a surface of the rotatably supported bobbin B or a surface of the package P to make contact with a surface of the winding drum 22 at an appropriate pressure. The winding drum 22 is driven by an electric motor (not illustrated) provided in each spinning unit 2 to rotate the bobbin B or the package P making contact with the winding drum 22. The traverse device 23 is driven by a shaft 25 shared among the plurality of spinning units 2, and traverses the spun yarn Y over a prescribed width with respect to the rotating bobbin B or the package P.

[0034] The yarn joining cart 3 travels to the spinning unit 2 in which the spun yarn Y is disconnected to perform the yarn joining operation in the target spinning unit 2. The yarn joining cart 3 includes a yarn joining device 26, a first yarn catching and guiding device 27, and a second yarn catching and guiding device 28. The first yarn catching and guiding device 27 is swingably supported by a supporting shaft 27a, and is adapted to suck and catch a yarn end of the spun yarn Y from the pneumatic spinning device 7 to guide the yarn end to the yarn joining device 26. The second yarn catching and guiding device 28 is swingably supported by a supporting shaft 28a, and is adapted to suck and catch a yarn end of the spun yarn Y from the winding device 12 to guide the yarn end to the yarn joining device 26. The yarn joining device 26 is a splicer, for example, and joins the guided yarn ends.

[0035] As illustrated in FIG. 2, the core yarn supplying device 40 includes a core yarn package holding section 41, a core yarn supplying unit 50, and a core yarn guiding section 43. The core yarn package holding section 41 holds the core yarn package CP with a center line of the core yarn package CP extended in a horizontal and front-back direction. A mono-filament yarn or a false-twisted yarn, for example, is wound as the core yarn C in the

core yarn package CP. The mono-filament yarn is a yarn having high rigidity. The false-twisted yarn is a yarn having high stretchability. The core yarn supplying unit 50 has a function of applying tension to the core yarn C supplied from the core yarn package CP through a guide roller 42, a function of applying slackening to the core yarn C, and a function of feeding the core yarn C. The core yarn guiding section 43 is a tubular member adapted to guide the core yarn C to the draft device 6. On an inner side of the core yarn guiding section 43, a travel region of the core yarn C is formed to include a straight line.

[0036] The core yarn supplying unit 50 includes a tension applying section 51, a core yarn feeding section 52, and a slackening applying section 53. The tension applying section 51, the core yarn feeding section 52, and the slackening applying section 53 are attached to a unit base 55.

[0037] The tension applying section 51 applies tension to the core yarn C guided to the core yarn supplying unit 50 at the time of producing the spun yarn Y by the pneumatic spinning device 7. As illustrated in FIGS. 3A and 3B, the tension applying section 51 includes an adjustment dial (setting section) 62, a fixed piece 63, and a movable piece 64. The tension applying section 51 applies tension to the core yarn C by guiding the core yarn C in a zigzag manner. The fixed piece 63 is fixed to the unit base 55. A plurality of shafts 63a, on which the core yarn C is to be hooked, is arranged on the fixed piece 63.

[0038] The movable piece 64 is supported to be openable/closable with respect to the fixed piece 63 by a supporting shaft (not illustrated) arranged on the fixed piece 63. A plurality of protrusions 64a are arranged on the movable piece 64 so as to project out towards the plurality of shafts 63a. As illustrated in FIG. 3B, each protrusion 64a is arranged on the movable piece 64 so as to be alternately positioned with each shaft 63a. A hole 64b, through which the core yarn C is inserted, is formed at a distal end of each protrusion 64a.

[0039] The adjustment dial 62 is a dial for adjusting an open/close position of the movable piece 64 with respect to the fixed piece 63. For example, as illustrated in FIGS. 3A and 3B, the operator operates the adjustment dial 62 to adjust the open/close position of the movable piece 64.

[0040] The tension to be applied to the core yarn C can be adjusted by adjusting the open/close position of the movable piece 64 with the core yarn C passed through the hole 64b of the movable piece 64 and the core yarn C hooked to each shaft 63a. As illustrated in FIG. 3A, if the movable piece 64 is greatly opened with respect to the fixed piece 63, the travelling core yarn C is guided in a large zigzag manner, and thus the tension applied to the core yarn C becomes large. As illustrated in FIG. 3B, if an opening of the movable piece 64 with respect to the fixed piece 63 is smaller than the case illustrated in FIG. 3A, the travelling core yarn C is guided in a small zigzag manner, and thus the tension applied to the core yarn C becomes small compared to the case illustrated in FIG. 3A.

[0041] The slackening applying section 53 applies slackening to the core yarn C between the tension applying section 51 and the core yarn feeding section 52. As illustrated in FIG. 2, the slackening applying section 53 is formed in an arm shape. A basal end of the slackening applying section 53 is swingably supported by a supporting shaft fixed to the unit base 55. The distal end extending from the basal end of the slackening applying section 53 engages with the core yarn C between the tension applying section 51 and the core yarn feeding section 52. The distal end of the slackening applying section 53 is movable to a position (position of solid line of FIG. 2) along the travelling path of the core yarn C, and a position on the upper side (position of chain double dashed line of FIG. 2). When the distal end of the slackening applying section 53 is swung to the position on the upper side with the distal end of the slackening applying section 53 engaged with the core yarn C and the core yarn C clamped by the core yarn feeding section 52, the core yarn C is pulled out from the core yarn package CP and the slackening is applied to the core yarn C. The slackening is applied by the slackening applying section 53 before the core yarn C is fed by the core yarn feeding section 52.

[0042] The core yarn feeding section 52 has a function of feeding a yarn end of the core yarn C to the draft device 6 by action of the compressed air when starting the production of the spun yarn Y, a function of clamping the core yarn C when stopping the production of the spun yarn Y, and a function of cutting the core yarn C when stopping the production of the spun yarn Y.

[0043] The unit control device 10 controls the operation of each section of the spinning unit 2. The unit control device 10 has a function of monitoring the yarn quality of the spun yarn Y to be produced. The monitoring function of the yarn quality in the unit control device 10 will be mainly described below. As illustrated in FIG. 4, the unit control device 10 is functionally configured to include a monitoring section 71, a stop instructing section 72, and a display control section 73 to monitor the yarn quality.

[0044] There is a correlative relationship between the yarn quality of the spun yarn Y produced by the pneumatic spinning device 7, and the tension applied to the spun yarn Y produced by the pneumatic spinning device 7. The yarn quality refers to a covered state of the core yarn C by cover fibers. In other words, the yarn quality of the spun yarn Y is the yarn quality in a state where the spun yarn Y includes the core yarn C.

[0045] A description will be made on the yarn quality of when the tension value measured by the tension sensor 9 is appropriate. If appropriate tension is applied to the core yarn C and the fiber bundle F, the core yarn C is appropriately covered by the cover fibers. Such a spun yarn Y has the following properties. For example, a portion of the core yarn C and a portion of the cover fibers are broken at the same time (almost at the same time) when the spun yarn Y is pulled. Thus, a breaking strength

of the spun yarn Y is strong. A surface of the spun yarn Y is uniform, and a degree of uniformity of the spun yarn Y is satisfactory. If the degree of uniformity is satisfactory, the cover fibers are less likely to be stripped from the core yarn C, and are less likely to be broken when the spun yarn Y is rubbed by a testing machine or the like.

[0046] A description will be made on the yarn quality of the spun yarn Y of when the tension value measured by the tension sensor 9 is lower than a tension value measured when the spun yarn is produced with only the fiber bundle F. In such a spun yarn Y, the core yarn C is loosened, and the core yarn C tends to project out from the cover fibers in a loop form. When such a spun yarn Y is pulled, the core yarn C and the cover fibers are broken at an individual timing. Thus, the breaking strength of the spun yarn Y is weak. Furthermore, the surface of the spun yarn Y other than the portion where the core yarn C projects out is uniform, and degradation in the degree of uniformity of the spun yarn Y is small. Since the degradation in the degree of uniformity is small, the cover fibers are less likely to be stripped from the core yarn C and are less likely to be broken when the spun yarn Y is rubbed by the testing machine or the like.

[0047] A description will be made on the yarn quality of when an excessive tension value is measured by the tension sensor 9. In such a spun yarn Y, tension more than necessary is applied to the core yarn C, and thus the cover fibers cannot withstand stretching of the core yarn C and the cover fibers tend to be stripped (lifted). In the case of the spun yarn Y in which the cover fibers have been stripped, the core yarn C and the cover fibers are broken at the individual timing when the spun yarn Y is pulled. Thus, the breaking strength of the spun yarn Y is weak. Since the cover fibers are stripped, the surface of the spun yarn Y is not uniform, and the degree of uniformity is not satisfactory. Since the degree of uniformity is not satisfactory, the cover fibers tend to be easily stripped from the core yarn C and tend to be easily broken when the spun yarn Y is rubbed by the testing machine or the like.

[0048] Thus, the yarn quality of the spun yarn Y can be monitored by checking the tension value measured by the tension sensor 9. The monitoring section 71 determines whether or not the tension value measured by the tension sensor 9 is within a quality monitor reference range set in advance to monitor the yarn quality. The quality monitor reference range is a range of the tension value applied to the spun yarn Y produced by the pneumatic spinning device 7, and is the range of the tension value at which the core yarn C can be appropriately covered by the cover fibers. The quality monitor reference range is set according to the type of spun yarn Y monitored by the monitoring section 71. An upper limit value (quality monitor threshold) and a lower limit value (quality monitor threshold) of the quality monitor reference range may be determined based on the result of actually producing the spun yarn Y while changing the tension applied to the spun yarn Y. For example, the lower limit of

the quality monitor reference range may be determined based on the tension value measured when the spun yarn is produced with only the fiber bundle F.

[0049] The tension applied to the spun yarn Y produced by the pneumatic spinning device 7 is changed by changing a feed ratio and the tension to be applied to the core yarn C by the tension applying section 51 of the core yarn supplying device 40. The feed ratio is a ratio of a rotation speed of the front roller pair 19 of the draft device 6 and a rotation speed of the yarn storage roller 34 of the yarn storage device 14. For example, when the feed ratio is "1", the rotation speed of the front roller pair 19 and the rotation speed of the yarn storage roller 34 are the same. When the feed ratio is "1.01", the rotation speed of the yarn storage roller 34 is faster than the rotation speed of the front roller pair 19, and the yarn storage roller 34 pulls out the spun yarn Y from the pneumatic spinning device 7 while slightly pulling the spun yarn Y.

[0050] The tension value measured by the tension sensor 9 becomes a high value by setting the feed ratio high, and becomes a high value by setting the tension to be applied to the core yarn C high. On the other hand, the tension value measured by the tension sensor 9 becomes a low value by setting the feed ratio low, and becomes a low value by setting the tension to be applied to the core yarn C low.

[0051] If the tension value measured by the tension sensor 9 is smaller than the quality monitor reference range, the monitoring section 71 determines the abnormality in the yarn quality of the spun yarn Y such as the projection of the core yarn C from the cover fibers in a loop form. If the tension value measured by the tension sensor 9 is greater than the quality monitor reference range, the monitoring section 71 determines the abnormality in the yarn quality of the spun yarn Y such as the stripping (floating) of the cover fibers, and the like. If the tension value measured by the tension sensor 9 is within the quality monitor reference range, the monitoring section 71 determines that the yarn quality of the spun yarn Y is appropriate.

[0052] A plurality of quality monitor reference ranges may be stored in advance in the monitoring section 71 for each type of spun yarn Y, and the operator may select the necessary reference range. The quality monitor reference range may be set each time by having the operator input a value.

[0053] In addition to the monitoring of the yarn quality, the monitoring section 71 monitors whether or not the spun yarn Y produced by the pneumatic spinning device 7 includes the core yarn C. The monitoring section 71 determines whether or not the tension value measured by the tension sensor 9 is greater than or equal to a presence/absence monitoring threshold set in advance to monitor a presence and/or an absence of the core yarn C. The presence/absence monitoring threshold is the tension value applied to the spun yarn Y produced by the pneumatic spinning device 7, and is the threshold for determining the presence and/or the absence of the core

yarn C. The presence/absence monitoring threshold is set according to the type of spun yarn Y monitored by the monitoring section 71. For example, the presence/absence monitoring threshold may be determined based on the tension value measured when the spun yarn is produced with only the fiber bundle F.

[0054] If the spun yarn Y does not include the core yarn C, the tension value measured by the tension sensor 9 becomes low. Thus, if the tension value measured by the tension sensor 9 is smaller than the presence/absence monitoring threshold, the monitoring section 71 determines that the spun yarn Y does not include the core yarn C. If the tension value measured by the tension sensor 9 is greater than or equal to the presence/absence monitoring threshold, the monitoring section 71 determines that the spun yarn Y includes the core yarn C.

[0055] The monitoring section 71 can switch between the monitoring of the yarn quality and the monitoring of the presence and/or the absence of the core yarn C. The presence and/or the absence of the core yarn C can be monitored by the monitoring section 71 at the start of production of the spun yarn Y, for example. Thus, whether or not the core yarn C is normally supplied from the core yarn supplying device 40 can be monitored. The monitoring of the yarn quality by the monitoring section 71 can be carried out during the production of the spun yarn Y, after the monitoring of the presence and/or the absence of the core yarn C is finished. Thus, the monitoring section 71 can monitor the yarn quality and monitor the presence and/or the absence of the core yarn C at an appropriate timing.

[0056] If an abnormality in the yarn quality is determined by the monitoring section 71 at the time of the monitoring of the yarn quality, the stop instructing section 72 stops the operation of each section of the spinning unit 2 such as the pneumatic spinning device 7 and the like to stop the production of the spun yarn Y. If determination is made by the monitoring section 71 at the time of monitoring of the presence and/or the absence of the core yarn C that the core yarn C is not included, the stop instructing section 72 stops the operation of each section of the spinning unit 2 such as the pneumatic spinning device 7 and the like.

[0057] The display control section 73 displays the monitoring result of the monitoring section 71 on the display section 74 (see FIG. 1). For example, the display control section 73 displays the determination result of the yarn quality, the tension value of the spun yarn Y measured by the tension sensor 9, and the like on the display section 74. The operator thus can learn the yarn quality of the spun yarn Y, the presence and/or the absence of the core yarn C, the tension value of the spun yarn Y, and the like. The position to arrange the display section 74 is not limited to the motor box 5 as illustrated in FIG. 1. The display section 74 may be arranged at a place other than the motor box 5.

[0058] The operator sets the spinning condition of the spun yarn Y such that the tension value measured by the

tension sensor 9 falls within the quality monitor reference range based on the determination result of the yarn quality displayed on the display section 74. In the present embodiment, the tension value measured by the tension sensor 9 can be changed by changing at least one of the feed ratio and the tension to be applied to the core yarn C, as described above. In other words, the operator can change the yarn quality of the spun yarn Y such that an appropriate yarn quality is obtained by changing the feed ratio and the tension to be applied to the core yarn C to change the tension value measured by the tension sensor 9.

[0059] The relationship between the feed ratio and the tension to be applied to the core yarn C, and the yarn quality will be described with reference to FIG. 5. If the feed ratio is low and the tension to be applied to the core yarn C is low (region of "NG1" of FIG. 5), the tension value measured by the tension sensor 9 is low. In this case, the spun yarn Y in which the core yarn C projects out from the cover fibers in a loop form tends to be produced. If the feed ratio is high and the tension to be applied to the core yarn C is high (region of "NG2" of FIG. 5), the tension value measured by the tension sensor 9 is high. In this case, the spun yarn Y in which the cover fibers are stripped from the core yarn C tends to be produced. The region of "OK" in FIG. 5 represents the relationship between the feed ratio and the tension to be applied to the core yarn C when the tension value of the spun yarn Y is within the quality monitor reference range and the yarn quality is appropriate.

[0060] The operator views the determination result displayed on the display section 74 and sets the feed ratio and the tension to be applied to the core yarn C such that the spun yarn Y of an appropriate yarn quality is produced. The feed ratio can be set by having the operator operate the operation section of the machine control device 20, for example. For example, the feed ratio can be changed by changing the rotation speed of the electric motor 36 adapted to drive the yarn storage roller 34 with respect to the rotation speed of the front roller pair 19. If the front roller pair 19 is driven by the driving source arranged individually, the rotation speed of this driving source may be changed. The tension to be applied to the core yarn C can be set by having the operator operate the adjustment dial 62 of the tension applying section 51 arranged in the core yarn supplying device 40. The yarn storage device 14 and the tension applying section 51 function as a setting section adapted to set the spinning condition of the spun yarn Y.

[0061] The unit control device 10 physically includes, for example, a Central Processing Unit (CPU), a Read Only Memory (ROM), and a Random Access Memory (RAM).

[0062] A description will be made on the operation of monitoring the yarn quality. The tension sensor 9 detects the tension applied to the spun yarn Y while the spun yarn Y is being produced by the pneumatic spinning device 7 (step of detecting tension). The monitoring section

71 then compares the tension value measured by the tension sensor 9 and the quality monitor reference range, and monitors the yarn quality (step of monitoring a yarn quality of the spun yarn Y). The operator changes at least one of the feed ratio and the tension to be applied to the core yarn C such that the tension value measured by the tension sensor 9 falls within the quality monitor reference range based on the monitoring result.

[0063] The present embodiment is configured as described above, and the tension sensor 9 detects the tension applied to the spun yarn Y produced by the pneumatic spinning device 7 in the spinning machine 1. The monitoring section 71 monitors the yarn quality of the spun yarn Y based on the quality monitor reference range for monitoring the yarn quality of the spun yarn Y and the measurement result of the tension sensor 9. Thus, the yarn quality of the spun yarn Y can be monitored by using the tension (measurement result of the tension sensor 9) applied to the spun yarn Y having a correlative relationship with the yarn quality of the spun yarn Y, and the yarn quality of the spun yarn Y can be improved.

[0064] The quality monitor reference range is set according to the type of spun yarn monitored by the monitoring section 71. Thus, the yarn quality can be appropriately monitored according to the spun yarn Y to be produced.

[0065] The monitoring section 71 monitors the presence and/or the absence of the core yarn C based on the presence/absence monitoring threshold and the measurement result of the tension sensor 9. Thus, the yarn quality of the spun yarn Y can be further improved.

[0066] The monitoring section 71 can switch between the monitoring of the yarn quality and the monitoring of the presence and/or the absence of the core yarn C. The monitoring of the yarn quality and the monitoring of the presence and/or the absence of the core yarn C can be switched according to the state of the spun yarn Y, the timing of producing the spun yarn Y, and the like, and the necessary monitoring can be appropriately carried out.

[0067] When the monitoring section 71 determines the abnormality in the yarn quality of the spun yarn Y, the pneumatic spinning device 7 stops the production of the spun yarn Y. The spun yarn Y having an abnormality in the yarn quality thus can be prevented from being continuously wound into the package P.

[0068] The spinning machine 1 can change the feed ratio by changing the rotation speed of the yarn storage roller 34 of the yarn storage device 14, and the like. The yarn quality of the spun yarn Y can be changed by changing the feed ratio. Therefore, the spun yarn Y having high yarn quality can be produced by changing the feed ratio based on the monitoring result of the monitoring section 71.

[0069] The core yarn supplying device 40 includes the tension applying section 51 adapted to apply tension to the core yarn C to be supplied. The yarn quality of the spun yarn Y can be changed by changing the tension of

the core yarn C. Therefore, the spun yarn Y having high yarn quality can be produced by changing the tension to be applied to the core yarn C based on the monitoring result of the monitoring section 71.

[0070] The spinning machine 1 includes the display section 74 adapted to display the determination result of the yarn quality by the monitoring section 71 and the measurement result of the tension sensor 9. The operator thus can easily learn the determination result of the yarn quality and the measurement result of the tension sensor 9. The operator can set the feed ratio, the tension to be applied to the core yarn C, and the like based on the obtained measurement result.

[0071] The spinning machine 1 carries out a step of measuring the tension applied to the spun yarn Y produced by the pneumatic spinning device 7 by the tension sensor 9, and a step of monitoring the yarn quality of the spun yarn Y based on the quality monitor reference range and the measurement result of the tension sensor 9. The yarn quality of the spun yarn Y can be monitored by using the tension applied to the spun yarn Y having a correlative relationship with the yarn quality of the spun yarn Y, and the yarn quality of the spun yarn Y can be improved.

[0072] The spun yarn Y produced by the spinning machine 1 has a high yarn quality since the yarn quality is managed.

[0073] One embodiment of the present invention has been described above, but the present invention is not limited to the above embodiment. For example, the monitoring section 71 is not limited to monitoring the presence and/or the absence of the core yarn C based on the detection result of the tension sensor 9. For example, a core yarn detecting section 54 adapted to detect the presence and/or the absence of the core yarn C may be arranged, as illustrated with a chain double dashed line in FIG. 2. The core yarn detecting section 54, for example, detects the presence and/or the absence of the core yarn C between the slackening applying section 53 and the core yarn feeding section 52. In this case as well, the monitoring section 71 can monitor the presence and/or the absence of the core yarn C based on the detection result of the core yarn detecting section 54, and the yarn quality of the spun yarn Y can be further improved.

[0074] The tension applying section 51 that causes the core yarn C to travel in a zigzag manner is used to apply tension to the core yarn C, but a mechanism for applying tension to the core yarn C is not limited thereto. The present invention is not limited to carrying out both the changing of the feed ratio and the applying of the tension to the core yarn C, and only one of the above may be carried out. In the embodiment described above, the feed ratio and the tension to be applied to the core yarn C by the tension applying section 51 are changed to change the tension to be applied to the spun yarn Y produced by the pneumatic spinning device 7. However, the tension applied to the spun yarn Y may be changed by factors other than the feed ratio and the tension applying section 51.

[0075] The type of the core yarn C may be other than the mono-filament yarn or the false-twisted yarn. For example, the core yarn C may be a multi-filament yarn having lower rigidity than the mono-filament yarn or may be a yarn having lower crimping property than the false-twisted yarn. Furthermore, a textured yarn, an air textured yarn (e.g., yarn in which spandex and textured yarn are interlaced, yarn having similar crimping property as the textured yarn), or a spun yarn (generally-used spun yarn) may be used for the core yarn C.

[0076] In the spinning machine 1, each device is arranged such that the spun yarn Y supplied on the upper side is wound on the lower side, but each device may be arranged such that the yarn supplied on the lower side is wound on the upper side. Furthermore, in the spinning machine 1, each roller pair of the draft device 6 and the traverse mechanism of the traverse device 23 are driven by the power from the motor box 5 (i.e., commonly driven for the plurality of spinning units 2). However, each section of the spinning unit 2 (e.g., the draft device 6, the pneumatic spinning device 7, or the like) may be independently driven for each spinning unit 2.

[0077] The pneumatic spinning device 7 may further include a needle held by the fiber core yarn guide and arranged to project out into a spinning chamber to prevent the twists of the fiber bundle F from being propagated towards the upstream of the pneumatic spinning device 7. In place of the needle, the pneumatic spinning device 7 may prevent the twists of the fiber bundle F from being propagated towards the upstream of the pneumatic spinning device 7 by a downstream end of the fiber core yarn guide. Moreover, the pneumatic spinning device 7 may include a pair of air jet nozzles adapted to apply twists in opposite directions from each other.

[0078] In the travelling direction of the spun yarn Y, the tension sensor 9 may be arranged upstream of the spun yarn monitoring device 8. In the spinning machine 1, the yarn storage device 14 has a function of pulling out the spun yarn Y from the pneumatic spinning device 7, but the spun yarn Y may be pulled out by a delivery roller and a nip roller. The waxing device 11 and the spun yarn monitoring device 8 may not be arranged in the spinning unit 2.

[0079] Instead of being driven by a driving motor arranged for each spinning unit 2, the winding device 12 may be driven by a common driving source for the plurality of spinning units 2. In this case, when reversely rotating the package P, the cradle arm 21 is moved by an air cylinder (not illustrated) such that the package P moves away from the winding drum 22, and the package P is reversely rotated by a reverse rotation roller (not illustrated) arranged in the yarn joining cart 3.

Claims

1. A spinning machine (1) comprising:

a core yarn supplying device (40) adapted to supply a core yarn (C) ;
a fiber bundle supplying device (6) adapted to supply a fiber bundle (F);
a spinning device (7) adapted to produce a spun yarn (Y) by applying twists to the fiber bundle (F) with the core yarn (C) as a core;
a tension detecting section (9) adapted to detect tension applied to the spun yarn (Y) produced by the spinning device (7); **characterized by**
a monitoring section (71) adapted to monitor a yarn quality of the spun yarn (Y) in accordance with a quality monitor threshold for monitoring the yarn quality of the spun yarn (Y) and a detection result of the tension detecting section (9).

2. The spinning machine (1) according to claim 1, **characterized in that** the quality monitor threshold is set according to a type of the spun yarn (Y) to be monitored by the monitoring section (71).
3. The spinning machine (1) according to claim 1 or claim 2, **characterized in that** the monitoring section (71) is adapted to further monitor a presence and/or an absence of the core yarn (C) in accordance with a presence/absence monitoring threshold for monitoring whether or not the core yarn (C) is included in the spun yarn (Y) produced by the spinning device (7) and a detection result of the tension detecting section (54).
4. The spinning machine (1) according to claim 1 or claim 2, **characterized in that** the core yarn supplying device (40) includes a core yarn detecting section (54) adapted to detect a presence and/or an absence of the core yarn (C) to be supplied, and wherein the monitoring section (71) is adapted to further monitor the presence and/or the absence of the core yarn (C) in accordance with a detection result of the core yarn detecting section (54).
5. The spinning machine (1) according to claim 3 or claim 4, **characterized in that** the monitoring section (71) is adapted to switch between monitoring of the yarn quality and monitoring of the presence and/or the absence of the core yarn (C).
6. The spinning machine (1) according to any one of claim 1 through claim 5, **characterized in that** the spinning device (7) is adapted to stop producing the spun yarn (Y) when the monitoring section (71) determines an abnormality in the yarn quality of the spun yarn (Y).
7. The spinning machine (1) according to any one of claim 1 through claim 6, **characterized by** a setting section (14, 51) adapted to set a spinning condition of the spun yarn (Y) according to the spun yarn (Y)

to be produced by the spinning device (7).

8. The spinning machine (1) according to any one of claim 1 through claim 6, further comprising:

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a pull-out device (14) adapted to pull out the spun yarn (Y) from the spinning device (7), **characterized by**:

a setting section (14, 51) adapted to set a ratio of a speed at which the fiber bundle supplying device (6) supplies the core yarn (Y) and the fiber bundle (F) to the spinning device (7) and a speed at which the pull-out device (14) pulls out the spun yarn (Y), in accordance with the spun yarn (Y) produced by the spinning device (7).

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9. The spinning machine (1) according to any one of claim 1 through claim 6 or claim 8, wherein the core yarn supplying device (40) comprises a tension applying section (51) adapted to apply tension to the core yarn (C), **characterized in that** the tension applying section (51) includes an adjusting section (62) adapted to adjust setting of the tension to be applied to the core yarn (C).

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10. The spinning machine (1) according to any one of claim 1 through claim 9, **characterized by** a display section (74) adapted to display the detection result of the tension detecting section (9).

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11. A spinning method performed by a spinning machine (1) including a spinning device (7) adapted to produce a spun yarn (Y) by applying twists to a fiber bundle (F) with a core yarn (C) as a core, the spinning method being **characterized by** the following steps:

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a detecting step of detecting tension applied to the spun yarn (Y) produced by the spinning device (7); and

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a monitoring step of monitoring a yarn quality of the spun yarn (Y) in accordance with a quality monitor threshold for monitoring the yarn quality of the spun yarn (Y) and a detection result of the tension applied to the spun yarn (Y).

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12. A spun yarn (Y) produced by the spinning method according to claim 11.

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FIG. 1

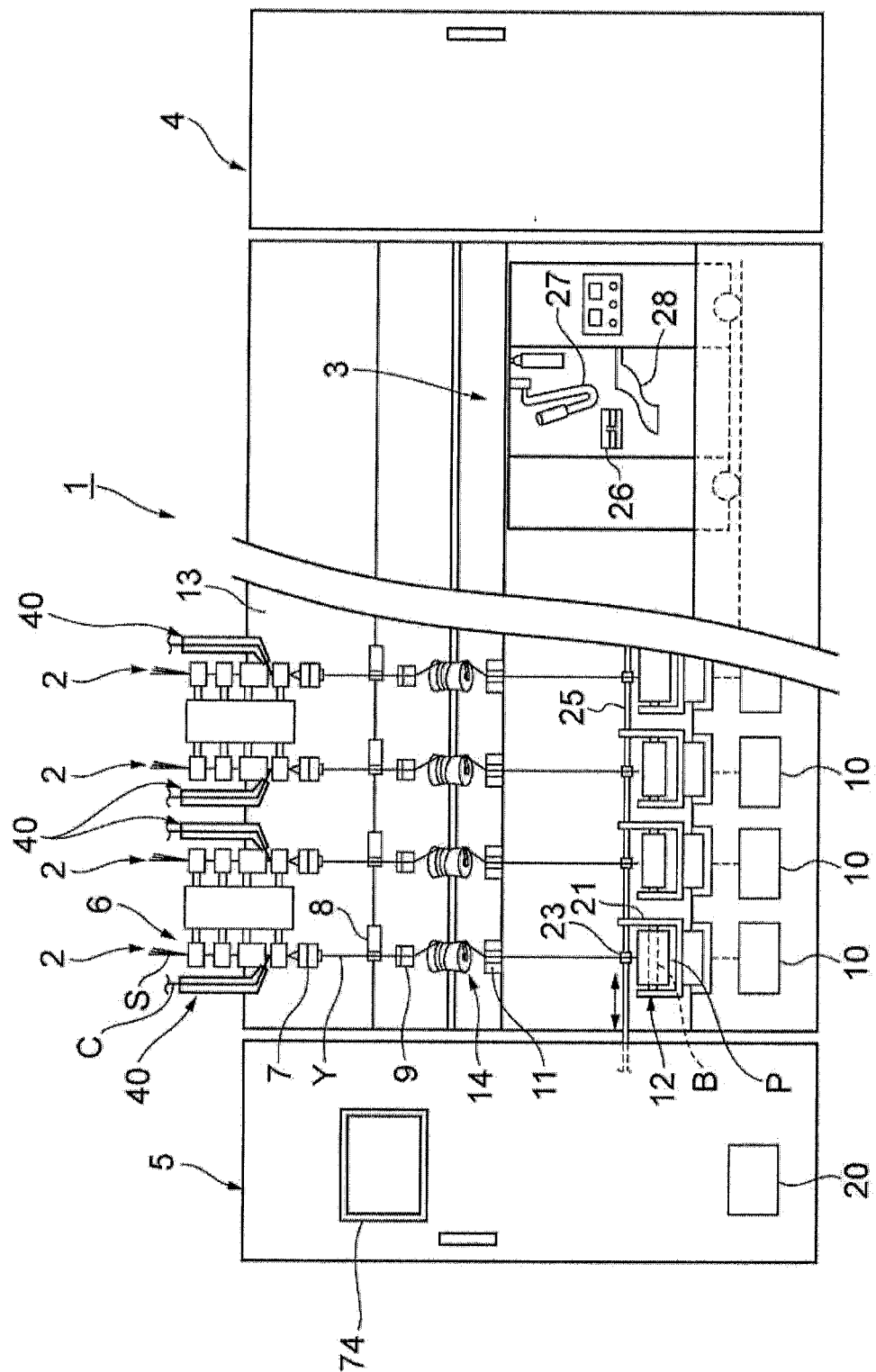


FIG. 2

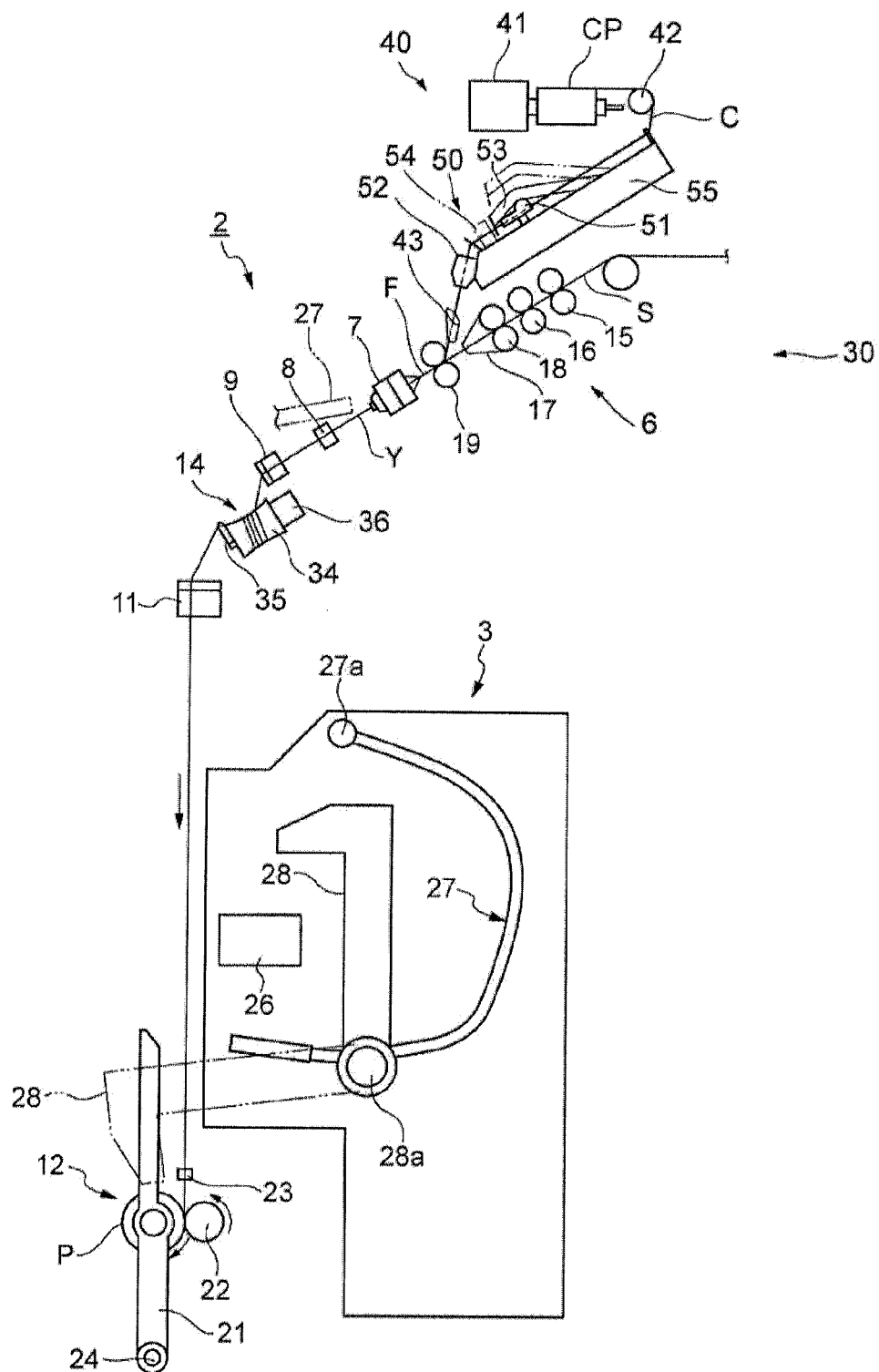


FIG. 3A

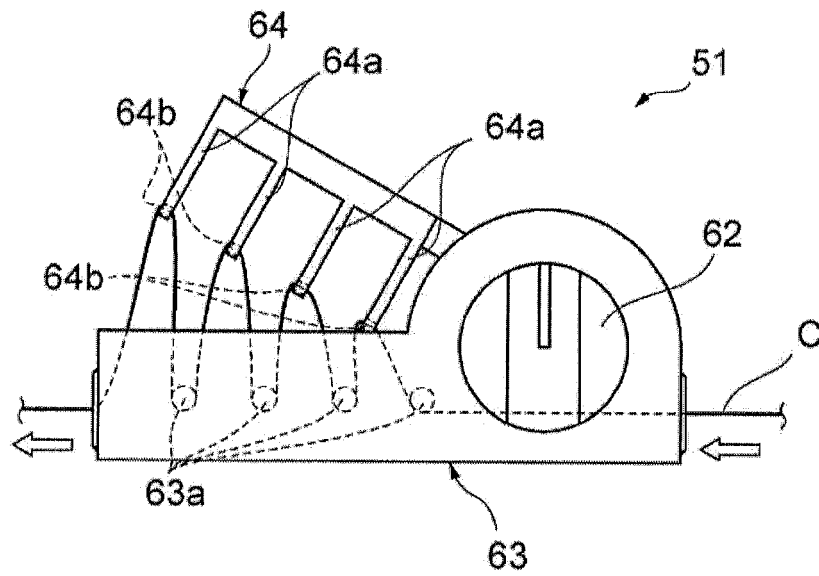


FIG. 3B

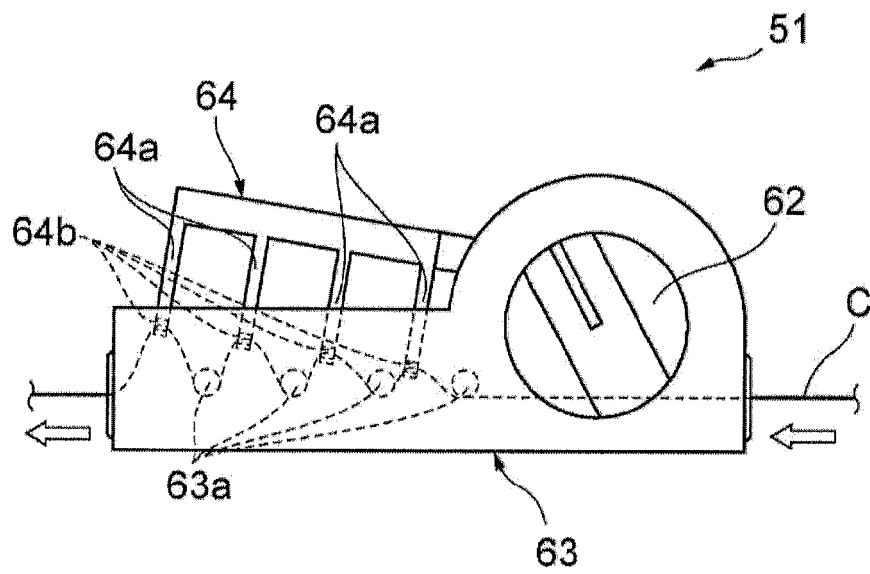


FIG. 4

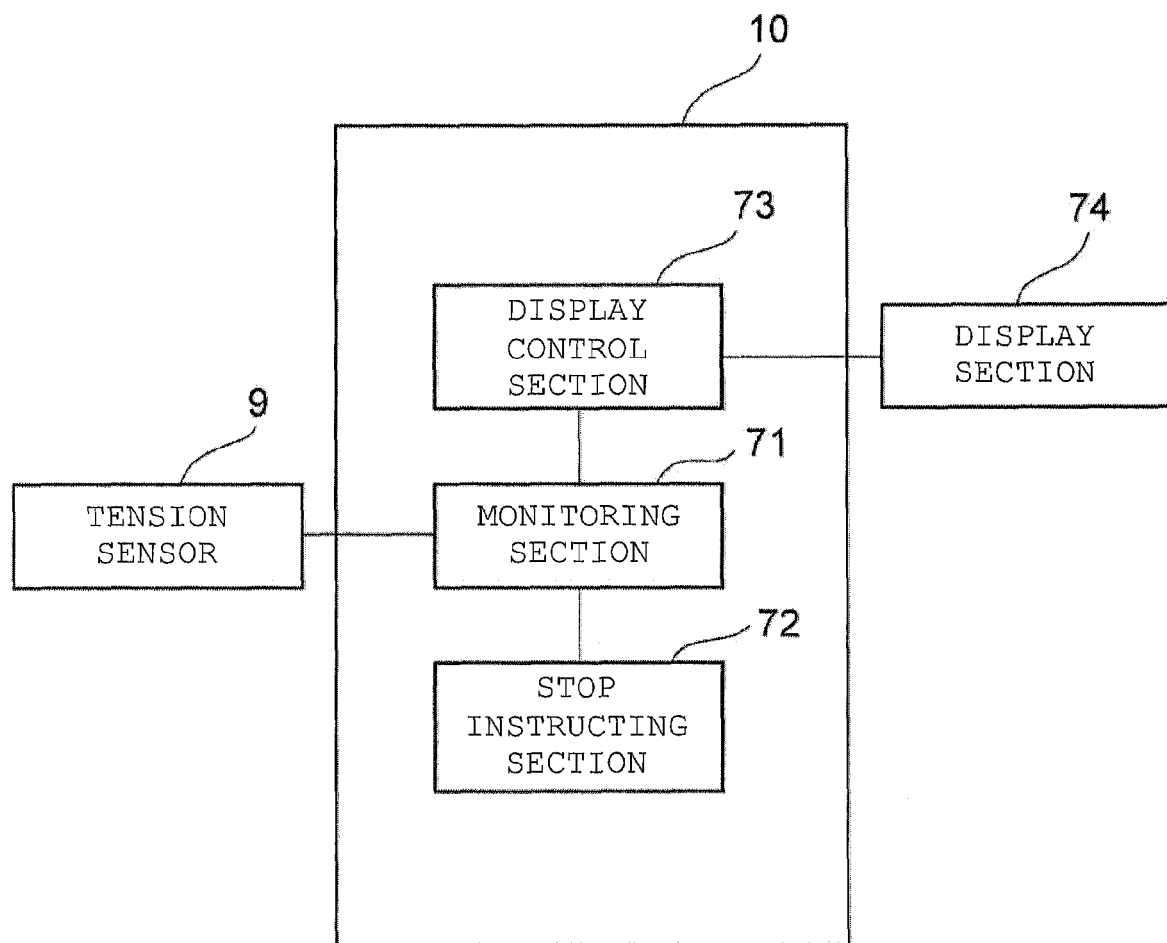
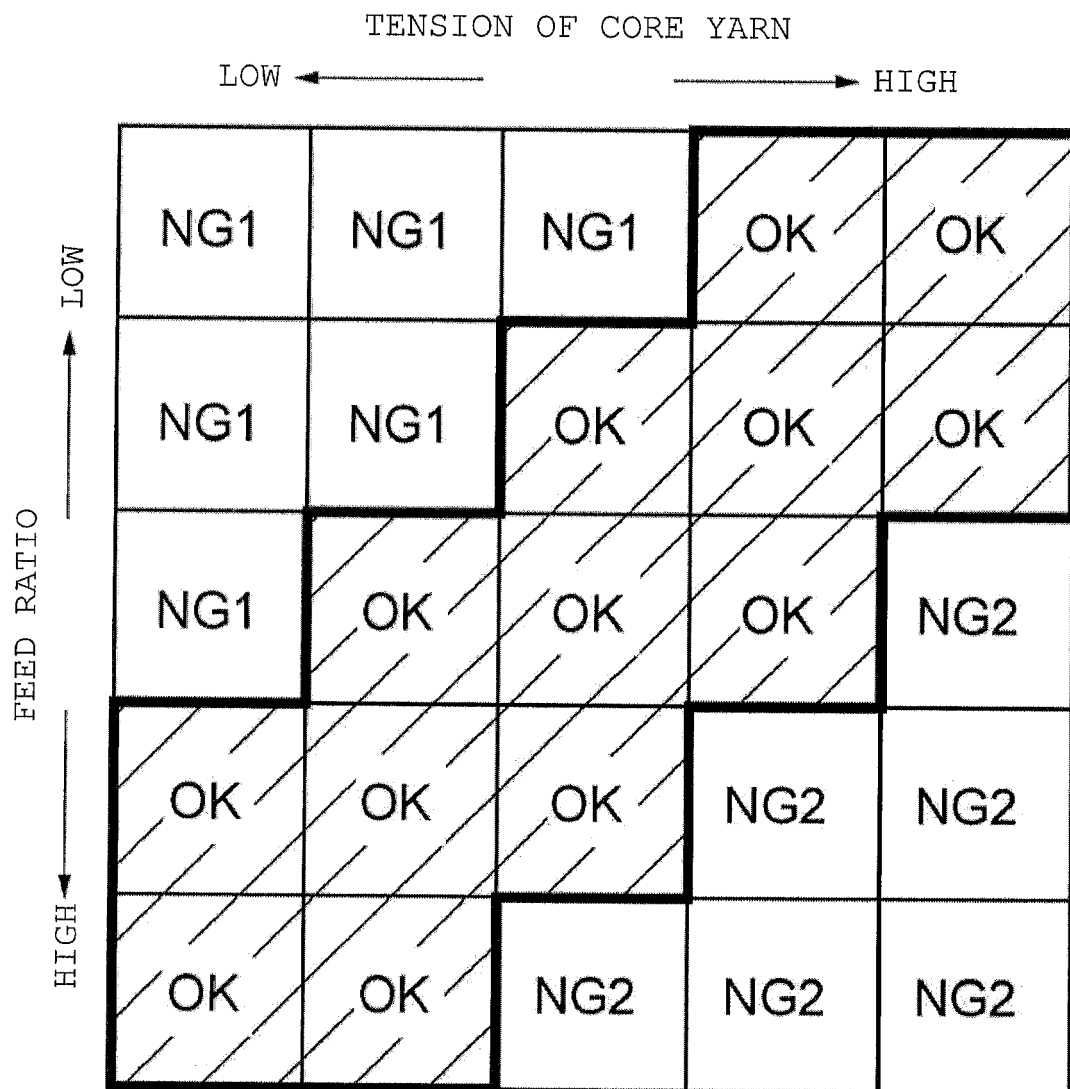


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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