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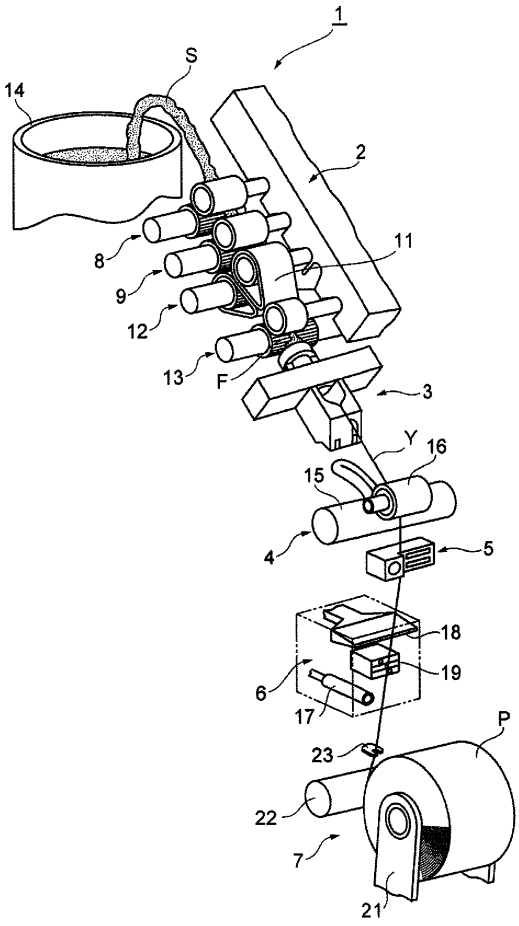
(54) Yarn defect classifying device and method and yarn winding machine

(57) A yarn defect classifying device for a yarn winding machine includes a yarn defect detecting device (5) adapted to detect a yarn defect, a removal determination section (53N, 53S, 53L) adapted to calculate a removal determination value for a set length of the yarn (Y) in accordance with a detected thickness of the yarn defect detected by the yarn defect detecting device (5), and to determine removal of the yarn defect when the removal determination value exceeds a prescribed value, and a calculating section (54N, 54S, 54L) adapted to calculate a display thickness and a display length of the yarn defect in accordance with the detected thickness and a detected length of the yarn defect.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn defect classifying device and method used in a yarn winding machine such as a spinning machine and/or an automatic winder, and the like, for example, and a yarn winding machine.

2. Description of the Related Art

[0002] A conventional yarn winding machine detects a yarn defect while winding a yarn, and removes the yarn defect when the detected yarn defect meets a prescribed condition. With regards to such yarn winding machine, for example, Japanese Unexamined Patent Publication No. 2000-327226 describes providing a sensitivity adjusting function to a yarn defect detecting device adapted to detect the yarn defect at high accuracy.

BRIEF SUMMARY OF THE INVENTION

[0003] The following problems arise when determination information indicating whether or not the yarn defect has been removed, and classification information indicating display length and display thickness of the yarn defect, are displayed on a display device for the yarn defect detected by the yarn defect detecting device. In other words, although non-removal of the yarn defect is indicated as the determination information, the classification information may be indicating that the display thickness of the yarn defect exceeds an upper limit value (upper limit value of the display thickness that can tolerate non-removal of the yarn defect). Although removal of the yarn defect is indicated as the determination information, the classification information may be indicating that the display thickness of the yarn defect does not exceed the upper limit value. That is, the determination information and the classification information may contradict each other.

[0004] It is an object of the present invention to provide a yarn defect classifying device and a yarn winding machine capable of suppressing contradiction from occurring between the determination information indicating whether or not the yarn defect has been removed, and the classification information indicating the display length and the display thickness of the yarn defect.

[0005] A yarn defect classifying device according to an embodiment of the present invention is a yarn defect classifying device used in a yarn winding machine including a yarn supplying device adapted to supply a yarn, a winding device adapted to wind the yarn into a package, and a yarn defect removal device adapted to remove a yarn defect of the yarn between the yarn supplying device and the winding device, the yarn defect classifying device including a yarn defect detecting device adapted to detect the yarn defect between the yarn supplying device and the winding device, a removal determination section adapted to calculate a removal determination value for a set length of the yarn in accordance with a detected thickness of the yarn defect detected by the yarn defect detecting device, and to remove the yarn defect by the yarn defect removal device when the removal determination value exceeds a prescribed value, and a calculating section adapted to calculate a display thickness of the yarn defect and a display length of the yarn defect in accordance with the detected thickness and a detected length of the yarn defect.

[0006] In this yarn defect classifying device, the removal determination value with respect to the set length of the yarn is calculated in accordance with the detected thickness of the yarn defect, and determination is made to remove the yarn defect when the removal determination value exceeds the prescribed value. The display thickness and the display length of the yarn defect are calculated in accordance with the detected thickness of the yarn defect and the detected length of the yarn defect. According to the yarn defect classifying device, contradiction can be suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness of the yarn defect.

[0007] The removal determination section may be arranged in plurals, and the calculating section may be arranged in plurals. According to such configuration, for example, the display thickness and the display length can be appropriately calculated according to the type of yarn defect.

[0008] A different set length may be set for each of the removal determination sections. According to such configuration, for example, the display thickness and the display length can be appropriately calculated by setting different length for each of the plurality of removal determination sections according to the type of yarn defect.

[0009] At least one of a first calculating section, a second calculating section, and a third calculating section is arranged for the calculating section. The first calculating section is adapted to calculate a maximum value of the detected thickness as the display thickness, and to calculate a length of the yarn defect at a thickness of a prescribed percentage value of the maximum value of the detected thickness as the display length. The second calculating section is adapted to calculate

the maximum value of the detected thickness as the display thickness, and to calculate a value obtained by dividing the removal determination value by the maximum value of the detected thickness as the display length. The third calculating section is adapted to calculate a value obtained by dividing the removal determination value by the detected length as the display thickness, and to calculate the detected length as the display length. According to the calculation of the first calculating section, contradiction can be appropriately suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness of the yarn defect for the yarn defect of which the length is relatively short and the thickness is relatively thick like nep, for example. According to the calculation of the second calculating section, contradiction can be appropriately suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness of the yarn defect for the yarn defect of which the length and the thickness are moderate like slub, for example. According to the calculation of the third calculating section, contradiction can be appropriately suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness of the yarn defect for the yarn defect of which the length is relatively long referred to as long yarn defect, for example.

[0010] The calculating section may be adapted to calculate an integrated value of the detected thickness of the yarn defect as a calculated integrated value, to calculate the detected length as the display length, and to calculate a value obtained by dividing the calculated integrated value by the detected length as the display thickness. The calculating section may be adapted to calculate the detected length as the display length according to a comparison of the detected length and a prescribed length, and to calculate a value obtained by dividing the calculated integrated value by the detected length as the display thickness. According to such configuration, the detected thickness of "the portion where the thickness of the yarn defect becomes partially large" that is likely to appear when the detected length becomes large can be effectively prevented from being calculated as the display thickness.

[0011] The calculating section may be adapted to calculate a value obtained by dividing the calculated integrated value by the detected thickness as the display length according to a comparison of the detected thickness and a prescribed thickness, and to calculate the detected thickness as the display thickness. According to such configuration, contradiction can be effectively suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length of the yarn defect.

[0012] The yarn defect classifying device may further include a display device adapted to display determination information indicating whether or not the yarn defect has been removed, the display length, and the display thickness. According to such configuration, the relationship between the determination information, and the display length and the display thickness can be visually recognized.

[0013] A yarn winding machine according to an embodiment of the present invention includes a yarn supplying device adapted to supply a yarn, a winding device adapted to wind the yarn into a package, a yarn defect removal device adapted to remove a yarn defect of the yarn between the yarn supplying device and the winding device, and any yarn defect classifying device described above.

[0014] According to the yarn winding machine, contradiction can be suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness of the yarn defect.

[0015] According to the present invention, the yarn defect classifying device and the yarn winding machine are capable of suppressing contradiction from occurring between the determination information indicating whether or not the yarn defect has been removed, and the classification information indicating the display length and the display thickness of the yarn defect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a perspective view of a spinning unit, which is a yarn winding machine, according to one embodiment of the present invention;
FIG. 2 is a block diagram of a yarn defect detecting device and a control device of the spinning unit of FIG. 1;
FIG. 3A and FIG. 3B are views illustrating a relationship between length and thickness of a yarn;
FIG. 4 is a display example in a display device of the spinning unit of FIG. 1;
FIG. 5 is a view illustrating patterns switched according to the relationship of a defect calculated length and a defect calculated thickness of a yarn defect;
FIG. 6A to FIG. 6C are views illustrating a relationship between length and thickness of the yarn;
FIG. 7A and FIG. 7B are views illustrating a relationship between length and thickness of the yarn; and
FIG. 8 is a block diagram of a yarn defect classifying device of a spinning unit, which is a yarn winding machine, according to another embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] A Preferred embodiment of the present invention will be hereinafter described in detail with reference to the drawings. The same reference numerals are denoted on the same or corresponding portions throughout the drawings, and redundant description will be omitted.

[0018] As illustrated in FIG. 1, a spinning unit (yarn winding machine) 1 is a device adapted to produce a yarn Y and wind the yarn Y into a package P. The spinning unit 1 includes a draft device (yarn supplying device) 2, a spinning device (yarn supplying device) 3, a yarn feeding device 4, a yarn defect detecting device 5, a yarn joining device (yarn defect removal device) 6, and a winding device 7 arranged in order from upstream along a travelling path of a sliver (fiber bundle) S and the yarn Y.

[0019] Such spinning unit 1 is arranged in plurals to configure the spinning machine. In this case, the yarn joining device 6 can move among the plurality of spinning units 1 to perform the yarn joining operation at the spinning 1 where the yarn Y is cut. That is, the yarn joining device 6 is shared among the plurality of spinning units 1. However, the yarn joining device 6 may be arranged in each spinning unit 1.

[0020] The draft device 2 includes a back roller pair 8, a third roller pair 9, a middle roller pair 12 provided with apron belts 11, and a front roller pair 13. The draft device 2 draws the sliver S accommodated in a can 14 with each roller pair 8, 9, 12, and 13 to produce the fiber bundle F.

[0021] The spinning device 3 is a pneumatic spinning device adapted to produce the yarn Y by applying twist to the fiber bundle F with a whirling airflow. More specifically (not illustrated), the spinning device 3 has a spinning chamber, a fiber guiding section, a whirling airflow generating nozzle, and a hollow guide shaft body. The fiber guiding section guides the fiber bundle F generated by the draft device 2 into the spinning chamber. The whirling airflow generating nozzle generates the whirling airflow in the spinning chamber to reverse and whirl the fiber end of the fiber bundle F guided into the spinning chamber. The hollow guide shaft body guides the spun yarn Y from the inside of the spinning chamber to outside the spinning device 3.

[0022] The yarn feeding device 4 includes a delivery roller 15 and a nip roller 16. The yarn feeding device 4 nips the yarn Y produced by the spinning device 3 with a pair of rollers 15 and 16 to feed the yarn Y to the winding device 7.

[0023] The yarn defect detecting device 5 is a device referred to as a yarn clearer, and is adapted to detect the yarn defect of the travelling yarn Y between the spinning device 3 and the winding device 7. The yarn defect detecting device 5 has a function of cutting the yarn Y when the detected yarn defect meets a predetermined condition.

[0024] The yarn joining device 6 includes a suction pipe 17, a suction mouth (yarn defect removal device) 18, and a splicer 19. The suction pipe 17 is swingably supported, and is adapted to catch the yarn end of the yarn Y from the spinning device 3 and guide the yarn Y to the splicer 19. The suction mouth 18 removes the yarn defect. The suction mouth 18 is swingably supported, and is adapted to catch the yarn end of the yarn Y from the winding device 7 and to guide the yarn Y to the splicer 19. The splicer 19 performs the yarn joining operation on the yarn ends guided by the suction pipe 17 and the suction mouth 18. The yarn Y from the winding device 7 includes the yarn defect. When the suction mouth 18 sucks and catches the yarn Y from the winding device 7, the yarn defect is taken into the suction mouth 18 and removed. The splicer 19 performs the yarn joining operation on the yarn Y from the winding device 7 in which the yarn defect is removed, and on the yarn Y from the spinning device 3.

[0025] The winding device 7 is a device adapted to wind the yarn Y into the package P, and includes a cradle arm 21, a winding drum 22, and a traverse device 23. The cradle arm 21 brings the surface of the package P into contact with the surface of the winding drum 22 at an appropriate pressure while rotatably supporting the package P. The winding drum 22 rotates the package P brought into contact by the cradle arm 21. The traverse device 23 traverses the yarn Y at a prescribed width with respect to the package P being rotated by the winding drum 22. The spinning unit 1 can wind not only the circular column shaped package P illustrated in FIG. 1, but can also wind a cone shaped package. The shape of the package P wound by the spinning unit 1 is not particularly limited.

[0026] As illustrated in FIG. 2, the yarn defect detecting device 5 includes a yarn defect detecting section 5a and a cutting section 5b. The yarn defect detecting section 5a is, for example, an optical or a capacitance sensor, and outputs a signal indicating thickness of the travelling yarn Y to a control device 24. The cutting section 5b cuts the yarn Y when the control device 24 determines that the yarn defect should be removed on the basis of the signal input from the yarn defect detecting section 5a.

[0027] The control device 24 is a device for controlling the entire spinning unit 1, and includes a central processing device 25, a Read Only Memory (ROM) 26, a Random Access Memory (RAM) 27, and a hard disc 28. A display device 31 and an input device 32 are connected to the control device 24. The display device 31 displays various pieces of information. The input device 32 is, for example, an operation button for the operator to give various instructions to the spinning unit 1. The control device 24 may be arranged in each spinning unit 1, may be arranged one for every group configured by a plurality of spinning units 1, or may be arranged one for all the spinning units 1 arranged in the spinning machine.

[0028] As illustrated in FIG. 3A, the control device 24 calculates an integrated value A1 of the detected thickness of

the yarn Y with respect to a set length LS of the yarn Y based on the signal input from the yarn defect detecting section 5a. The set length LS is a value set in advance by the operator. The integrated value A1 of the detected thickness of the yarn Y with respect to the set length LS of the yarn Y corresponds to a hatched region in FIG. 3A. The control device 24 causes the yarn joining device 6 to remove the yarn defect (removing function) if the integrated value A1 exceeds a prescribed integrated value A(th), and causes the yarn joining device 6 not to remove the yarn defect and to leave the yarn defect if the integrated value A1 does not exceed a prescribed integrated value A(th). The control device 24 adopts the result of determination of whether or not to remove the yarn defect based on the integrated value A1 as the determination information.

[0029] As illustrated in FIG. 3B, the control device 24 calculates the integrated value of the detected thickness of the yarn defect as a calculated integrated value A2 based on the signal input from the yarn defect detecting section 5a, calculates the detected length of the yarn defect as a defect calculated length LA, and calculates the detected thickness of the yarn defect as a defect calculated thickness WA (calculating function). The control device 24 calculates the display length and the display thickness based on the calculated integrated value A2, the defect calculated length LA and the defect calculated thickness WA, and adopts the display length and the display thickness as the classification information. The method of calculating the display length and the display thickness will be described later. The lines indicating the detected thickness in FIG. 3A and FIG. 3B are similarly illustrated, and the integrated value A1 and the calculated integrated value A2 are differently illustrated. However, actually, the lines indicating the detected thickness respectively represent different thickness and the integrated value A1 and the calculated integrated value A2 are values similarly integrated based on the set length.

[0030] The calculated integrated value A2 is an integrated value of the detected thickness of the yarn Y in a region where the detected thickness of the yarn Y exceeds a prescribed thickness WS (normally, a value greater than or equal to 100% and smaller than or equal to 125% of the average thickness W0 of the yarn Y). Therefore, the calculated integrated value A2 corresponds to a hatched region in FIG. 3B. The defect calculated length LA is a detected length of the yarn Y in a region where the detected thickness of the yarn Y exceeds the prescribed thickness W1 (e.g., 165% of the average thickness W0 of the yarn Y). The defect calculated thickness WA is a maximum value of the detected thickness of the yarn Y in a range of the defect calculated length LA. In this case, the detected thickness of the yarn Y is a ratio of the thickness of the yarn Y with respect to the average thickness W0 of the yarn Y in a range in which the detected length of the yarn Y is sufficiently long.

[0031] The control device 24 associates the determination information indicating whether or not the yarn defect has been removed (i.e., whether or not the integrated value A1 exceeded the prescribed integrated value A(th)), with the classification information indicating the display length and the display thickness of the yarn defect, for each yarn defect, and stores the same in the hard disc 28.

[0032] The operation of the spinning unit 1 when the integrated value A1 of the detected thickness of the yarn Y with respect to the set length LS of the yarn Y exceeds the prescribed integrated value A(th) is as follows. First, the control device 24 causes the cutting section 5b of the yarn defect detecting device 5 to cut the yarn Y. Then, the control device 24 causes the yarn joining device 6 (suction mouth 18) to remove the yarn defect from the yarn end of the yarn Y cut by the cutting section 5b, and thereafter, causes the yarn joining device 6 (splicer 19) to perform the yarn joining operation of the yarn ends. When the integrated value A1 exceeds the prescribed integrated value A(th), the yarn joining device 6 thus removes the yarn defect from the yarn Y between the spinning device 3 and the winding device 7.

[0033] As illustrated in FIG. 4, upon receiving a request instruction from the operator through the input device 32, the control device 24 causes the display device 31 to display a two-dimensional field having the yarn defect length on a horizontal axis and the yarn defect thickness on a vertical axis (displaying function). In this case, the control device 24 reads out a clearing limit CL from the hard disc 28, and displays the same on the two-dimensional field as a line. The clearing limit CL is based on the set length LS set by the operator and the removed thickness.

[0034] The clearing limit CL of FIG. 4 is an example of when the set length LS is set to 1.5 cm and the removed thickness is set to 200% by the operator. In this case, in the range in which the set length LS is between 1.0 cm and 1.5 cm, the clearing limit CL is set to satisfy "set thickness WB = prescribed integrated value A(th) / set length LS". In the range in which the set length LS is smaller than or equal to 1.0 cm, the clearing limit CL is set to satisfy "set thickness WB = 280%" to remove a nep as the yarn defect of which the set thickness WB is greater than or equal to 280%. In the range in which the set length LS is greater than or equal to 1.5 cm, the clearing limit CL is set to satisfy "set thickness WB = 200%" to remove a slub as the yarn defect of which the set thickness WB is greater than or equal to 200%.

[0035] Thus, the yarn defect having the yarn defect length and the yarn defect thickness of a point positioned in a region below the clearing limit CL in the two- dimensional field remains in the yarn Y without being removed from the yarn Y. The yarn defect having the yarn defect length and the yarn defect thickness of a point positioned in a region above the clearing limit CL in the two- dimensional field is removed from the yarn Y.

[0036] The control device 24 reads out the determination information and the classification information from the hard disc 28 for each yarn defect, and displays the same on the two-dimensional field as a dot. The control device 24 determines the display length and the display thickness to be displayed as the classification information of the yarn defect in the

following manner.

[0037] That is, as illustrated in FIG. 5, when the defect calculated length LA is smaller than a prescribed length L(th) and the defect calculated thickness WA is greater than a prescribed thickness W(th), the control device 24 determines the display length and the display thickness to be displayed as the classification information in pattern A. When the defect calculated length LA is smaller than the prescribed length L(th) and the defect calculated thickness WA is smaller than the prescribed thickness W(th), the control device 24 determines the display length and the display thickness to be displayed as the classification information in pattern B. When the defect calculated length LA is greater than the prescribed length L(th), the control device 24 determines the display length and the display thickness to be displayed as the classification information in pattern C regardless of the size of the defect calculated thickness WA. The prescribed length L(th) is a value greater than or equal to 5 mm and smaller than or equal to 30 mm. The prescribed thickness W (th) is a value greater than or equal to 150% and smaller than or equal to 200% of the average thickness W0 of the yarn Y.

[0038] More specifically, as illustrated in FIG. 6A, when the defect calculated length LA is smaller than the prescribed length L(th) and the defect calculated thickness WA is greater than the prescribed thickness W(th), a "changing profile of the thickness of the yarn defect with respect to the length of the yarn defect" in the yarn defect is likely to become triangular. In this case, the control device 24 adopts the "defect calculated length LA" as the display length and adopts the "defect calculated thickness WA" as the display thickness for the classification information of the yarn defect.

[0039] As illustrated in FIG. 6B, when the defect calculated length LA is smaller than the prescribed length L (th) and the defect calculated thickness WA is smaller than the prescribed thickness W(th), the "changing profile of the thickness of the yarn defect with respect to the length of the yarn defect" in the yarn defect is likely to become rectangular. In this case, the control device 24 adopts the "value obtained by dividing the calculated integrated value A2 by the defect calculated thickness WA" as the display length and adopts the "defect calculated thickness WA" as the display thickness for the classification information of the yarn defect.

[0040] As illustrated in FIG. 6C, when the defect calculated length LA is greater than the prescribed length L(th), the "changing profile of the thickness of the yarn defect with respect to the length of the yarn defect" in the yarn defect is likely to become horizontally long and elliptical although a portion where the thickness of the yarn defect becomes partially large tends to appear. In this case, the control device 24 adopts the "defect calculated length LA" as the display length and adopts the "value W(avg) obtained by dividing the calculated integrated value A2 by the defect calculated length LA" as the display thickness for the classification information of the yarn defect.

[0041] The defect calculated length LA and the defect calculated thickness WA of when determining the display length and the display thickness to be displayed as the classification information of the yarn defect may be values multiplied with a defect shape coefficient according to the shape of the yarn defect. This is because, since the shape of the yarn defect may be an ellipse or a triangle, the value obtained by multiplying the display length and the display thickness may not correspond to the integrated value A1. The defect shape coefficient is a value smaller than one and is, for example, 7/8.

[0042] The control device 24 displays, as a dot, the classification information determined as above and the determination information indicating whether or not the yarn defect has been removed on the two-dimensional field. As illustrated in FIG. 4, each yarn defect is displayed as a black dot or a white dot. The display length and the display thickness (classification information) are shown by the position of the dot. The black dot indicates that the yarn defect has been removed (determination information). The white dot indicates that the yarn defect has not been removed (determination information).

[0043] The operator then can check the distribution state of the yarn defect, and change the setting of the clearing limit CL according to the distribution state. For example, in FIG. 4, 50 times is displayed at the upper right of the display device 31 to indicate the number of times the yarn defect has been removed. When the operator determines to reduce the number of times from a standpoint of enhancing the productivity of the yarn Y, the operator can change the clearing limit so that the clearing limit CL moves to the upper side in the two-dimensional field. When the operator determines to increase the number of times from the standpoint of improving the quality of the yarn Y, the operator can change the clearing limit so that the clearing limit CL moves to the lower side in the two-dimensional field. In this case, since the number of times the yarn defect is removed is changed to the number of times when the changed clearing limit CL is applied, the operator can adjust the clearing limit CL while referencing such number of times.

[0044] As described above, in the spinning unit 1, the integrated value A1 of the detected thickness W of the yarn Y with respect to the set length LS of the yarn Y is calculated, and the yarn defect is removed when the integrated value A1 exceeds the prescribed integrated value A(th). If the defect calculated length LA is smaller than the prescribed length L(th), the defect calculated thickness WA is displayed as the display thickness with the determination information indicating whether or not the yarn defect has been removed on the display device 31. If the defect calculated length LA is greater than the prescribed length L(th), the value W(avg) obtained by dividing the calculated integrated value A2 by the defect calculated length LA is displayed as the display thickness with the determination information indicating whether or not the yarn defect has been removed on the display device 31. The defect calculated thickness WA of the "portion where the thickness of the yarn defect becomes partially large" that is likely to appear when the defect calculated length LA becomes greater than the prescribed length L (th) can be prevented from being displayed as the display thickness on

the display device 31.

[0045] If the defect calculated thickness WA of the "portion where the thickness of the yarn defect becomes partially large" is adopted as the display thickness, the white dot corresponding to the non-removed yarn defect of which the integrated value A1 did not exceed the prescribed integrated value A(th) may be displayed in the region above the clearing limit CL in the two-dimensional field in FIG. 4. According to the spinning unit 1, such contradiction can be suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the classification information indicating the display length and the display thickness of the yarn defect.

[0046] If the prescribed length L(th) is a value greater than or equal to 5 mm and smaller than or equal to 30 mm, the defect calculated thickness WA of the "portion where the thickness of the yarn defect becomes partially large" that is likely to appear when the defect length L becomes large is more effectively prevented from being displayed on the display device 31 as the display thickness.

[0047] In the spinning unit 1, when the defect calculated length LA is greater than the prescribed length L(th), the defect calculated length LA is displayed as the display length with the determination information indicating whether or not the yarn defect has been removed, on the display device 31. Thus, when the defect calculated length LA is greater than the prescribed length L(th), the contradiction can be suppressed from occurring between the display length of the yarn defect and the determination information.

[0048] In the spinning unit 1, when the defect calculated length LA is smaller than the prescribed length L(th), if the defect calculated thickness WA is greater than the prescribed thickness W(th), the defect calculated length LA is displayed as the display length with the determination information indicating whether or not the yarn defect has been removed, on the display device 31. When the defect calculated length LA is smaller than the prescribed length L(th), if the defect calculated thickness WA is smaller than the prescribed thickness W(th), the value obtained by dividing the calculated integrated value A2 by the defect calculated thickness WA is displayed as the display length with the determination information indicating whether or not the yarn defect has been removed, on the display device 31. Thus, when the defect calculated length LA is smaller than the prescribed length L(th), the contradiction can be suppressed from occurring between the display length of the yarn defect and the determination information.

[0049] If the prescribed thickness W(th) is a value greater than or equal to 150% and smaller than or equal to 200% of the average thickness W0 of the yarn Y, when the defect calculated length LA is smaller than the prescribed length L(th), the contradiction can be more effectively suppressed from occurring between the display length of the yarn defect and the determination information.

[0050] Therefore, according to the spinning unit 1, the contradiction can be suppressed from occurring between the actually measured length of the removed yarn defect and the display length of the classification information, or between the actually measured thickness of the removed yarn defect and the display thickness of the classification information.

[0051] The control device 24 may change the prescribed thickness W1, which is a threshold value for measuring the defect calculated length LA, according to the defect calculated thickness WA of the yarn defect. More specifically, when the defect calculated thickness WA of the yarn defect exceeds the prescribed thickness W2 (> prescribed thickness Wl) as illustrated in FIG. 7A, the control device 24 may increase the prescribed thickness W1, which is a threshold value for measuring the defect calculated length LA as illustrated in FIG. 7B. Accordingly, the contradiction can be suppressed from occurring between the display length of the yarn defect and the determination information.

[0052] One embodiment of the present invention has been described above, but the present invention is not limited to the embodiment described above. For example, the yarn winding machine according to an embodiment of the present invention is not limited to the spinning unit configuring the spinning machine, and may be other yarn winding machines such as a winder unit configuring an automatic winder.

[0053] In the spinning unit 1 described above, the yarn supplying device for supplying the yarn is configured by the draft device 2 and the spinning device 3, but the yarn supplying device according to an embodiment of the present invention may be other yarn supplying devices such as a device configured to supply the yarn from a bobbin around which the yarn is wound.

[0054] The yarn winding machine according to an embodiment of the present invention may include a display device, as with the spinning unit 1 described above, or may be connected with a display device of a personal computer, and the like.

[0055] If the yarn winding machine according to an embodiment of the present invention is a spinning unit, the yarn is not limited to being pulled out from the spinning device with the delivery roller and the nip roller, and the yarn may be pulled out from a spinning device by a yarn accumulating roller adapted to accumulate yarn at downstream of the spinning device. Furthermore, when the yarn defect is detected, the yarn may be cut with a cutter other than the cutting section of the yarn defect detecting device or may be cut by stopping the whirling airflow in the spinning device.

[0056] The control device 24 and the yarn defect detecting device 5 are described to be individually configured, but may be integrally configured.

[0057] The hard disc 28 may be a large-capacity RAM. The hard disc 28 may be mounted on the display device 31, and information may be stored in or read out from the hard disc 28 through communication with the control device 24.

[0058] The defect calculated thickness WA has been described as a maximum value of the detected thickness of the

yarn Y corresponding to the defect calculated length LA, but may be an average value of a predetermined range as a value corresponding to the maximum value. The predetermined range is desirably a range of greater than or equal to 2 mm and smaller than or equal to 10 mm, which is the length of an extent that the thickness of the yarn Y can be visually determined.

[0059] The switch among the pattern A, the pattern B, and the pattern C in the embodiment described above is merely an example, and the switch among the pattern A, the pattern B, and the pattern C may be appropriately changed to determine the display length and the display thickness to be displayed as the classification information. For example, when the defect calculated length LA is smaller than the prescribed length L(th), the display length and the display thickness to be displayed as the classification information may be determined by the pattern A regardless of the size of the defect calculated thickness WA. Alternatively, the display length and the display thickness to be displayed as the classification information may be determined by the pattern C in all cases.

[0060] In the embodiment described above, the yarn defect classifying device is configured at least by the yarn defect detecting device 5 and the control device 24. In the embodiment described above, the control device 24 includes the removal determination section and the calculating section. In the embodiment described above, the integrated value A1 corresponds to a removal determination value, the defect calculated length LA corresponds to the detected length, and the defect calculated thickness WA corresponds to the detected thickness.

[0061] Next, other embodiments of the yarn winding machine will be described. As illustrated in FIG. 8, in the yarn defect classifying device 100 of the present embodiment, a control device 24B includes a central processing device 25B in addition to the central processing device 25. The central processing device 25B includes a first determination channel 50N, a second determination channel 50S, and a third determination channel 50L to execute the determination on whether or not to remove the yarn defect, and the calculation of the display length and the display thickness according to the type of yarn defect.

[0062] The first determination channel 50N determines the yarn defect (nep) that is short and thick, for example. For instance, the yarn defect having a length of smaller than or equal to 10 mm can be classified as the nep. The first determination channel 50N includes a first thickness detecting section 51N, a first length detecting section 52N, a first removal determination section 53N, and a first calculating section 54N.

[0063] The second determination channel 50S determines the yarn defect (slub) of a type that is longer than the nep and has a change in the thickness of the yarn, which is more gradual than the nep, for example. For instance, the yarn defect having a length of greater than 10 mm and smaller than or equal to 80 mm can be classified as the slub. The second determination channel 50S includes a second thickness detecting section 51S, a second length detecting section 52S, a second removal determination section 53S, and a second calculating section 54S.

[0064] The third determination channel 50L determines the yarn defect (long) of a type longer than the slub, for example. For instance, the yarn defect having a length of greater than 80 mm can be classified as the long. The third determination channel 50L includes a third thickness detecting section 51L, a third length detecting section 52L, a third removal determination section 53L, and a third calculating section 54L.

[0065] Each of the first to third thickness detecting sections 51N, 51S, and 51L detects the thickness (detected thickness) of the yarn Y at an interval of the yarn length of 1 mm, for example, based on the information from the yarn defect detecting device 5. Each of the first to third length detecting sections 52N, 52S, and 52L detects the length (detected length) of the yarn defect based on the information from the yarn defect detecting device 5. The detected length can be detected in a similar manner as the above-described defect calculated length LA, for example.

[0066] The first removal determination section 53N calculates the removal determination value An with respect to the prescribed set length dn based on the detected thickness from the first thickness detecting section 51N. The removal determination value An is a value in which the detected thicknesses of the yarn defect are integrated at an interval of the yarn length of 1 mm at a prescribed set length dn, for example. The set length dn can be set to about 2 mm, for example. When the removal determination value An exceeds a prescribed threshold value Nth, the first removal determination section 53N determines to have the yarn joining device 6 remove the yarn defect. Such calculation and determination are repeated at an interval of the yarn length of 1 mm, for example.

[0067] When the first removal determination section 53N determines whether or not to remove the yarn defect, the first calculating section 54N calculates the display thickness and the display length of the yarn defect. The first calculating section 54N calculates the maximum value of the detected thickness as a display thickness, and calculates the length of the yarn defect at the thickness of the value of a prescribed percentage of the maximum value of the detected thickness as the display length. The maximum value of the detected thickness is the maximum value of the detected thickness in one detected yarn defect (similarly hereinafter). The prescribed percentage is, for example, 0.5 (i.e., in this case, the display length is half value full width in the yarn defect). The prescribed percentage may be other than 0.5, and may be for example, 0.6. The first determination channel 50N transmits the calculated display length and the display thickness as the classification information with the determination information indicating whether or not the yarn defect has been removed to the display device 31.

[0068] The second removal determination section 53S calculates the removal determination value As with respect to

the prescribed set length ds based on the detected thickness from the second thickness detecting section 51S. The removal determination value As is a value in which the detected thicknesses of the yarn defect are integrated at an interval of the yarn length of 1 mm at a prescribed set length ds, for example. The set length ds can be set to about 20 mm, for example. When the removal determination value As exceeds the prescribed threshold value Sth, the second removal determination section 53S determines to have the yarn joining device 6 remove the yarn defect. Such calculation and determination are repeated at an interval of the yarn length of 1 mm, for example.

[0069] When the second removal determination section 53S determines whether or not to remove the yarn defect, the second calculating section 54S calculates the display thickness and the display length of the yarn defect. The second calculating section 54S calculates the maximum value of the detected thickness as the display thickness, and calculates a value obtained by dividing the removal determination value A2 by the maximum value of the detected thickness as the display length. The second calculating section 54S executes the calculation using moving average. The second determination channel 50S transmits, to the display device 31, the calculated display length and the display thickness as the classification information with the determination information indicating whether or not the yarn defect has been removed.

[0070] The third removal determination section 53L calculates the removal determination value A1 with respect to the prescribed set length dl based on the detected thickness from the third thickness detecting section 51L. The removal determination value A1 is a value calculated by weighted average of the detected thickness of the yarn defect at the prescribed set length dl, for example. In other words, A1 is calculated with the following equation (1).

$$Al_k = [Al_{k-1} \cdot (dl-1) \cdot W_k \cdot 1]/dl \cdots (1)$$

Al_k is the removal determination value calculated this time. Al_{k-1} is the removal determination value calculated the previous time. W_k is the detected thickness detected this time.

[0071] The amount of information to be stored in the RAM 27 can be reduced and the load of the RAM 27 can be reduced by calculating the removal determination value A1 by weighted average. The removal determination value A1 may be a value obtained by integrating the detected thicknesses of the yarn defect at an interval of the yarn length of 1 mm at the prescribed set length dl. The removal determination values An and As may be calculated by weighted average. The set length dl can be set to about 120 mm, for example. When the removal determination value A1 exceeds the prescribed threshold value Lth, the third removal determination section 53L determines to cause the yarn joining device 6 to remove the yarn defect. The calculation and determination are repeated at an interval of the yarn length of 1 mm, for example.

[0072] When the third removal determination section 53L determines whether or not to remove the yarn defect, the third calculating section 54L calculates the display thickness and the display length of the yarn defect. The third calculating section 54L calculates the value obtained by dividing the removal determination value A1 by the detected length as the display thickness, and calculates the detected length as the display length. The third determination channel 50L transmits, to the display device 31, the calculated display length and the display thickness as the classification information with the determination information indicating whether or not the yarn defect has been removed.

[0073] When one of the first removal determination section 53N, the second removal determination section 53S, and the third removal determination section 53L determines to remove the yarn defect, the cutting section 5b cuts the yarn Y. The control device 24 stops the drafting operation of the draft device 2, the spinning operation of the spinning device 3, and the winding operation of the winding device 7. The control device 24 causes the suction mouth 18 to catch the yarn end of the package P and guide the yarn end to the splicer 19. At the same time as or temporally before or after the catching and guiding of the yarn end by the suction mouth 18, the control device 24 resumes the drafting operation of the draft device 2 and the spinning operation of the spinning device 3, and causes the suction pipe 17 to catch the yarn Y spun out from the spinning device 3 and guide the yarn Y to the splicer 19. The splicer 19 performs the yarn joining operation. The control device 24 causes the winding device 7 to rotate the package P in the winding direction. The winding of the package P is thereby resumed.

[0074] In the yarn defect classifying device 100 and the yarn winding machine including the same according to the present embodiment, the removal determination values An, As, and Al with respect to the set lengths dn, ds, and dl of the yarn are respectively calculated based on the detected thickness of the yarn defect. When the removal determination value An exceeds the prescribed value Nth, when the removal determination value As exceeds the prescribed value Sth, or when the removal determination value Al exceeds the prescribed value Lth, determination is made to remove the yarn defect. The display thickness and the display length of the yarn defect are calculated based on the detected thickness of the yarn defect and the detected length of the yarn defect. Therefore, according to the yarn defect classifying device 100, contradiction can be suppressed from occurring between the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness of the yarn defect.

[0075] The first to third removal determination sections 53N, 53S, and 53L are provided as the removal determination

section, and the first to third calculating sections 54N, 54S, and 54L are provided as the calculating section. The first to third removal determination sections 53N, 53S, and 53L are set with different set lengths according to the type of yarn defect. Therefore, the display thickness and the display length can be appropriately calculated according to the type of yarn defect.

[0076] The first calculating section 54N calculates the maximum value of the detected thickness as the display thickness and calculates the length of the yarn defect at the thickness of the value of a prescribed percentage of the maximum value of the detected thickness as the display length. The calculation performed by the first calculating section 54N can suitably suppress contradiction from occurring in the determination information and the classification information indicating the display length and the display thickness of the yarn defect, with respect to the relatively short yarn defect such as the nep, for example.

[0077] The second calculating section 54S calculates the maximum value of the detected thickness as the display thickness and calculates the value obtained by dividing the removal determination value As by the maximum value of the detected thickness as the display length. The calculation performed by the second calculating section 54S can suitably suppress contradiction from occurring in the determination information and the classification information indicating the display length and the display thickness of the yarn defect, with respect to the yarn defect having a moderate length such as the slub, for example.

[0078] The third calculating section 54L calculates the value obtained by dividing the removal determination value Al by the detected length as the display thickness and calculates the detected length as the display length. The calculation performed by the third calculating section 54L can suitably suppress contradiction from occurring in the determination information and the classification information indicating the display length and the display thickness of the yarn defect, with respect to the relatively long yarn defect such as the long, for example.

[0079] The yarn defect classifying device 100 further includes the display device 31 for displaying the determination information indicating whether or not the yarn defect has been removed, and the display length and the display thickness. Therefore, the relationship between the determination information, and the display length and the display thickness can be visually recognized.

[0080] The first to third removal determination sections 53N, 53S, and 53L all do not need to be provided, and at least one of the first to third removal determination sections 53N, 53S, and 53L may be provided. The first to third calculating sections 54N. 54S, and 54L all do not need to be provided, and at least one of the first to third calculating sections 54N, 54S, and 54L may be provided in correspondence with the removal determination section. In other words, the yarn defect classifying device 100 may execute the determination on whether or not to remove the yarn defect, and the calculation of the display length and the display thickness for a specific type of yarn defect. In addition to at least one of the first to third removal determination sections 53N, 53S, and 53L, and at least one of the first to third calculating sections 54N, 54S, and 54L, the removal determination section and the calculating section for another type of yarn defect may be provided.

[0081] The first to third thickness detecting sections 51N, 51S, and 51L, the first to third length detecting sections 52N, 52S, and 52L, the first to third removal determination sections 53N, 53S, and 53L, and the first to third calculating sections 54N, 54S, and 54L may be configured with software or may be configured with hardware. The control device for the yarn defect detecting device 5, and the control device for another element of the spinning unit 1 other than the yarn defect detecting device 5 may be separately provided.

[0082] The yarn winding machine according to an embodiment of the present invention includes a yarn supplying device adapted to supply a yarn, a winding device adapted to wind the yarn into a package, a yarn defect detecting device adapted to detect the yarn defect between the yarn supplying device and the winding device, a yarn defect removal device adapted to remove a yarn defect of the yarn between the yarn supplying device and the winding device, and a control device. The control device has a removing function, a calculating function, and a display function. The removing function is a function of calculating the integrated value of the thickness of the yarn with respect to the set length of the yarn for the yarn defect detected by the yarn defect detecting device, and causing the yarn defect removal device to remove the yarn defect when the integrated value exceeds the prescribed integrated value. The calculating function is a function of calculating the integrated value of the thickness of the yarn of the yarn defect as the calculated integrated value, calculating the length of the yarn defect as the defect calculated length, and calculating the thickness of the yarn defect as the defect calculated thickness. The display function is a function of causing the display device to display the display length and the display thickness, which are obtained based on the calculated integrated value, the defect calculated length, and the defect calculated thickness, as the classification information along with the determination information indicating whether or not the yarn defect has been removed.

[0083] In such a yarn winding machine, the integrated value of the thickness of the yarn with respect to the set length of the yarn is calculated, and the yarn defect is removed when the integrated value exceeds the prescribed integrated value. The integrated value of the thickness of the yarn of the yarn defect, the length of the yarn defect, and the thickness of the yarn defect are each calculated as a calculated value, and the display length and the display thickness obtained based on such calculated values are displayed on the display device as the classification information. Therefore, according

to the yarn winding machine, the contradiction can be suppressed from occurring in the determination information indicating whether or not the yarn defect has been removed, and the classification information indicating the display length and the display thickness of the yarn defect.

[0084] The display function may be a function of displaying the defect calculated length as the display length and the value obtained by dividing the calculated integrated value by the defect calculated length as the display thickness. The display function may be a function of displaying the defect calculated length as the display length according to a comparison of the defect calculated length and the prescribed length, and to display the value obtained by dividing the calculated integrated value by the defect calculated length as the display thickness. The prescribed length may be a value of greater than or equal to 5 mm and smaller than or equal to 30 mm. In such cases, the defect calculated thickness of the "portion where the thickness of the yarn defect becomes partially large" that is likely to appear when the defect calculated length becomes large can be effectively prevented from being displayed on the display device as the display thickness.

[0085] The display function may be a function of displaying the value obtained by dividing the calculated integrated value by the defect calculated thickness as the display length according to a comparison of the defect calculated thickness and the prescribed thickness, and to display the defect calculated thickness as the display thickness. The prescribed thickness may be a value of greater than or equal to 150% and smaller than or equal to 200% of the average thickness of the yarn. In such cases, the contradiction can be effectively suppressed from occurring between the determination information and the display length of the yarn defect.

Claims

1. A yarn defect classifying device used in a yarn winding machine (1) including a yarn supplying device (2, 3) adapted to supply a yarn (Y), a winding device (7) adapted to wind the yarn (Y) into a package (P), and a yarn defect removal device (6) adapted to remove a yarn defect of the yarn (Y) between the yarn supplying device (2, 3) and the winding device (7), the yarn defect classifying device comprising:

   a yarn defect detecting device (5) adapted to detect the yarn defect between the yarn supplying device (2, 3) and the winding device (7); **characterized by**:

   a removal determination section (24; 53N, 53S, 53L) adapted to calculate a removal determination value for a set length of the yarn (Y) in accordance with a detected thickness of the yarn defect detected by the yarn defect detecting device (5), and to remove the yarn defect by the yarn defect removal device (6) when the removal determination value exceeds a prescribed value; and
   a calculating section (24; 54N, 54S, 54L) adapted to calculate a display thickness of the yarn defect and a display length of the yarn defect in accordance with the detected thickness and a detected length of the yarn defect.

2. The yarn defect classifying device according to claim 1, **characterized by** a plurality of the removal determination section (24; 53N, 53S, 53L) and a plurality of the calculating section (24; 54N, 54S, 54L).

3. The yarn defect classifying device according to claim 2, **characterized in that** a different set length is set for each of the removal determination sections (24; 53N, 53S, 53L).

4. The yarn defect classifying device according to any one of claim 1 through claim 3, **characterized in that** at least one of a first calculating section (54N), a second calculating section (54S) and a third calculating section (54L) is provided as the calculating section (24; 54N, 54S, 54L),
   the first calculating section (54N) is adapted to calculate a maximum value of the detected thickness as the display thickness, and to calculate a length of the yarn defect at a thickness of a prescribed percentage value of the maximum value of the detected thickness as the display length,
   the second calculating section (54S) is adapted to calculate the maximum value of the detected thickness as the display thickness, and to calculate a value obtained by dividing the removal determination value by the maximum value of the detected thickness as the display length, and
   the third calculating section (54L) is adapted to calculate a value obtained by dividing the removal determination value by the detected length as the display thickness, and to calculate the detected length as the display length.

5. The yarn defect classifying device according to claim 1, **characterized in that** the calculating section (24; 54N, 54S, 54L) is adapted to calculate an integrated value of the detected thickness of the yarn defect as a calculated integrated

value, to calculate the detected length as the display length, and to calculate a value obtained by dividing the calculated integrated value by the detected length as the display thickness.

6. The yarn defect classifying device according to claim 5, **characterized in that** the calculating section (24; 54N, 54S, 54L) is adapted to calculate the detected length as the display length according to a comparison of the detected length and a prescribed length, and to calculate a value obtained by dividing the calculated integrated value by the detected length as the display thickness.

7. The yarn defect classifying device according to claim 5 or claim 6, **characterized in that** the calculating section (24; 54N, 54S, 54L) is adapted to calculate a value obtained by dividing the calculated integrated value by the detected thickness as the display length according to a comparison of the detected thickness and a prescribed thickness, and to calculate the detected thickness as the display thickness.

8. The yarn defect classifying device according to any one of claim 1 through claim 7, **characterized by** a display device (31) adapted to display determination information indicating whether or not the yarn defect has been removed, the display length, and the display thickness.

9. A yarn winding machine comprising:

a yarn supplying device (2, 3) adapted to supply a yarn (Y);
a winding device (7) adapted to wind the yarn (Y) into a package (P);
a yarn defect removal device (6) adapted to remove a yarn defect of the yarn (Y) between the yarn supplying device (2, 3) and the winding device (7); **characterized by**
the yarn defect classifying device according to any one of claim 1 through claim 8.

10. A yarn defect classifying method used in a yarn winding machine (1) including a yarn supplying device (2, 3) supplying a yarn (Y), a winding device (7) winding the yarn (Y) into a package (P), and a yarn defect removal device (6) adapted to remove a yarn defect of the yarn (Y) between the yarn supplying device (2, 3) and the winding device (7), with the following steps:

detecting the yarn defect between the yarn supplying device (2, 3) and the winding device (7); **characterized by**:

calculating a removal determination value for a set length of the yarn (Y) in accordance with a detected thickness of the yarn defect, and removing the yarn defect when the removal determination value exceeds a prescribed value; and
calculating a display thickness of the yarn defect and a display length of the yarn defect in accordance with the detected thickness and a detected length of the yarn defect.

11. The yarn defect classifying method according to claim 10, **characterized in that** a maximum value of the detected thickness is calculated as the display thickness, and a length of the yarn defect at a thickness of a prescribed percentage value of the maximum value of the detected thickness is calculated as the display length,
the maximum value of the detected thickness is calculated as the display thickness, and a value obtained by dividing the removal determination value by the maximum value of the detected thickness is calculated as the display length, and
a value obtained by dividing the removal determination value by the detected length is calculated as the display thickness, and the detected length is calculated as the display length.

12. The yarn defect classifying method according to claim 10, **characterized in that** an integrated value of the detected thickness of the yarn defect is used as a calculated integrated value, the detected length is calculated as the display length, and a value obtained by dividing the calculated integrated value by the detected length is used as the display thickness.

13. The yarn defect classifying method according to claim 12, **characterized in that** the detected length is calculated as the display length according to a comparison of the detected length and a prescribed length, and a value obtained by dividing the calculated integrated value by the detected length is used as the display thickness.

14. The yarn defect classifying method according to claim 12 or claim 13, **characterized in that** a value obtained by dividing the calculated integrated value by the detected thickness is used as the display length according to a

comparison of the detected thickness and a prescribed thickness, and the detected thickness is used as the display thickness.

15. The yarn defect classifying method according to any one of claim 10 through claim 14, **characterized by** further comprising the step of displaying determination information indicating whether or not the yarn defect has been removed, the display length, and the display thickness..

FIG. 1

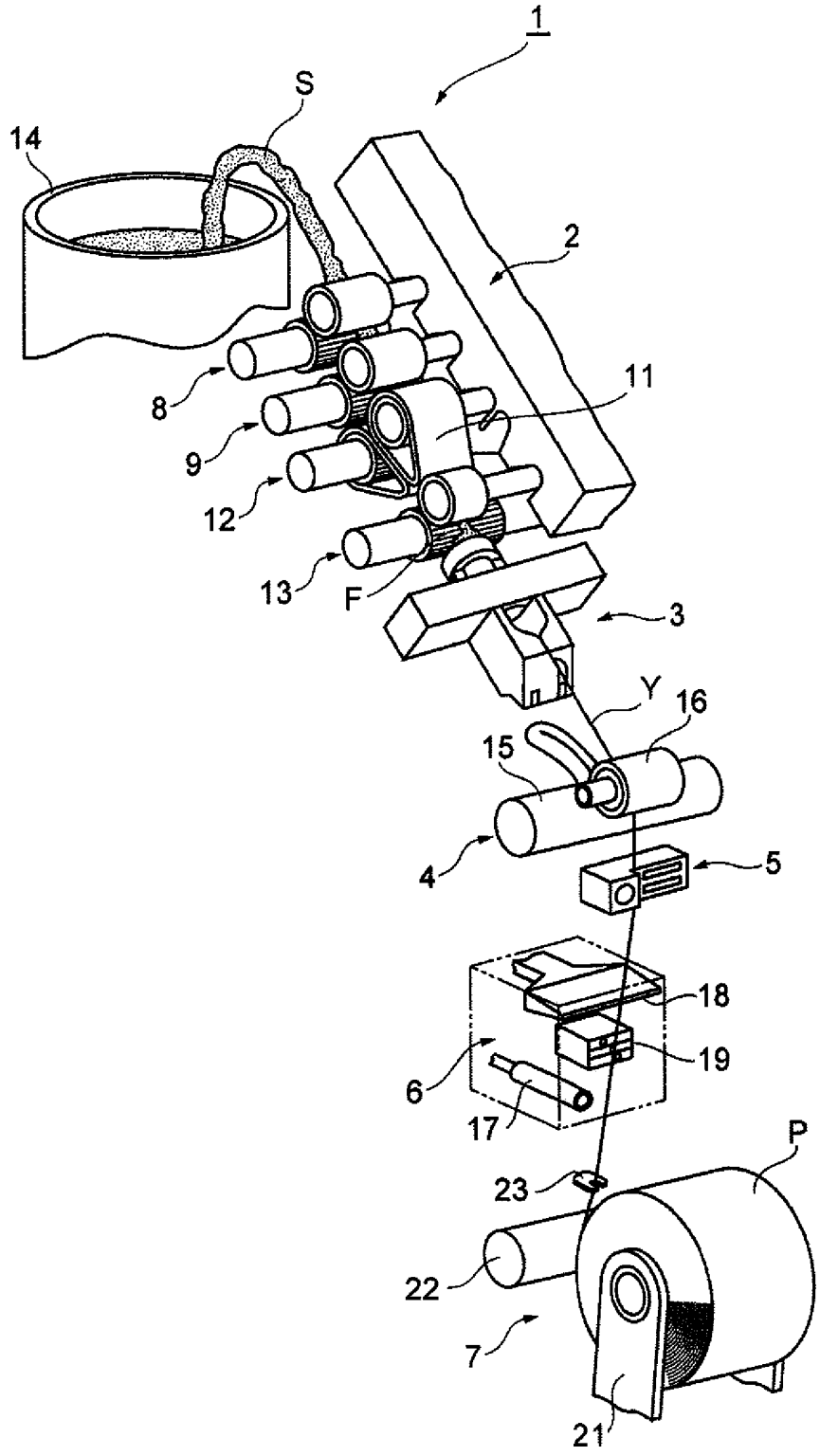


FIG. 2

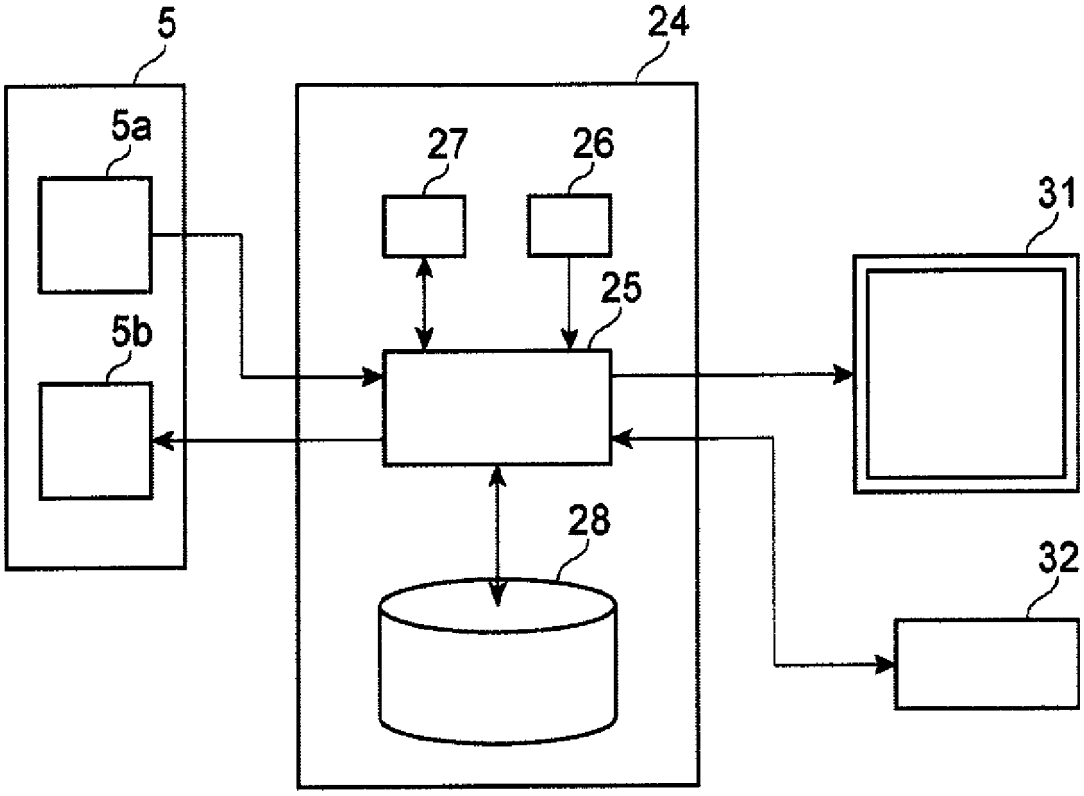


FIG. 3A

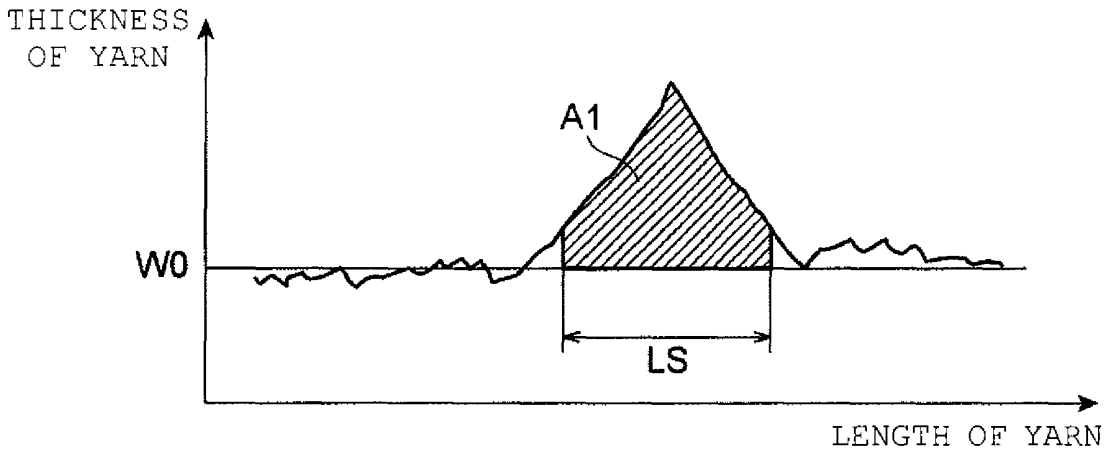

THICKNESS
OF YARN
A1
W0
LS
LENGTH OF YARN

FIG. 3B

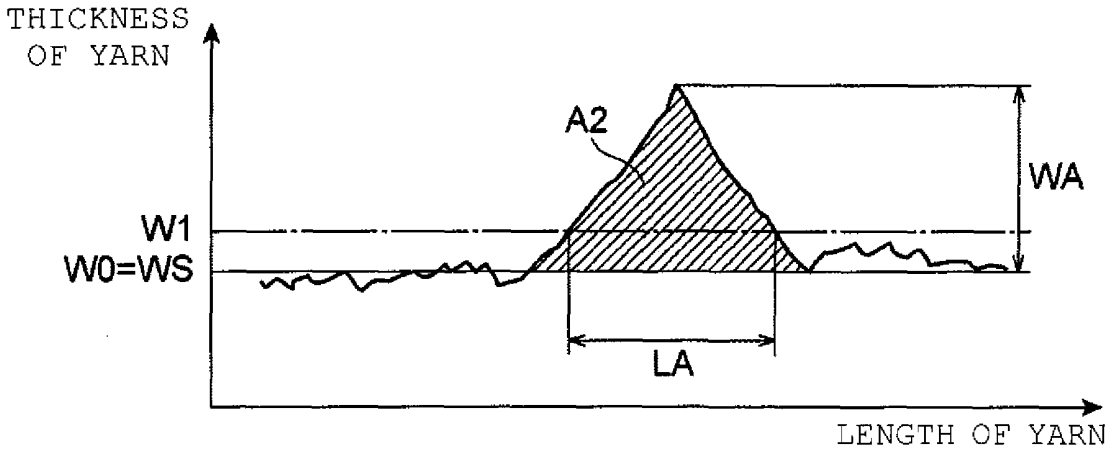

THICKNESS
OF YARN
A2
WA
W1
W0=WS
LA
LENGTH OF YARN

FIG. 4

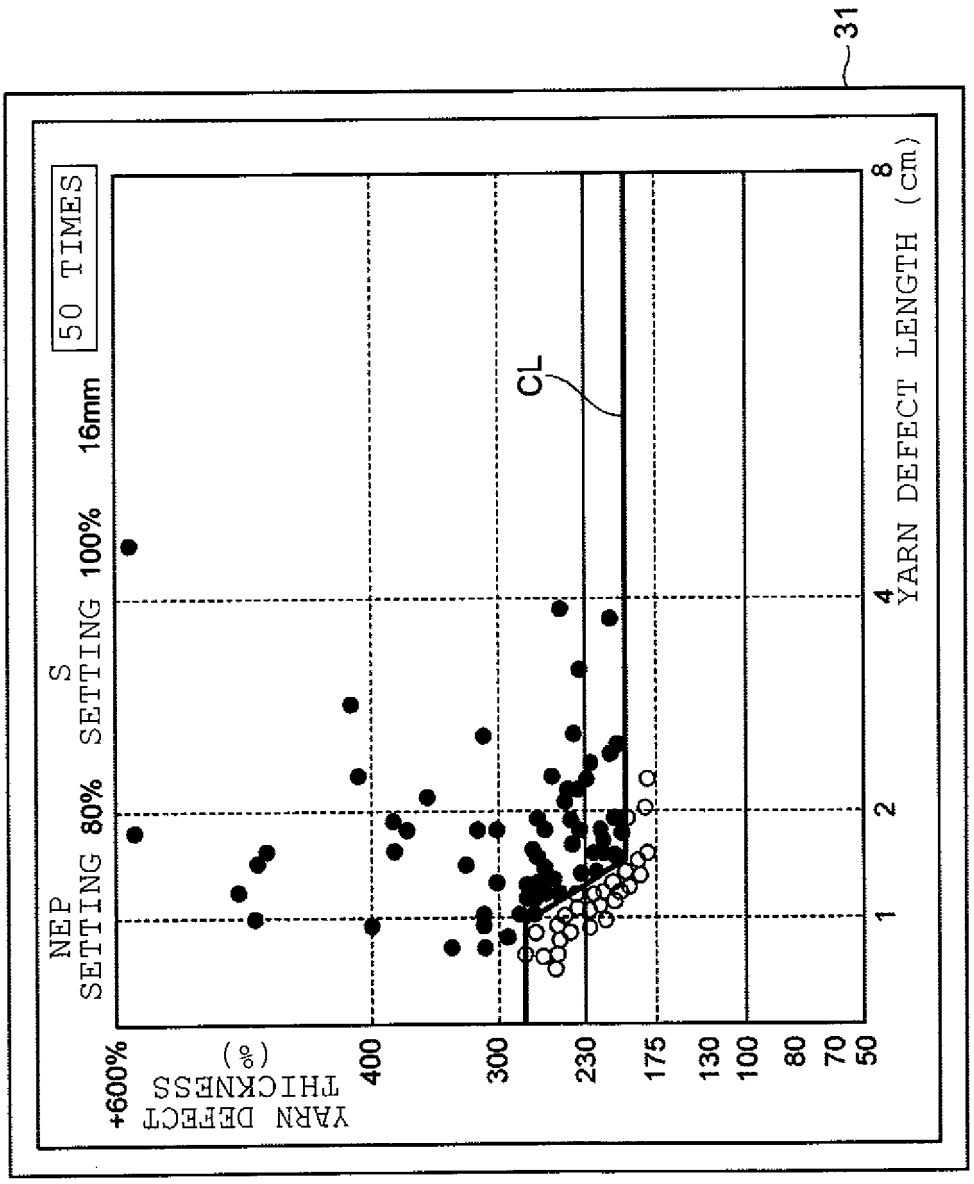

31
NEP SETTING 80% S SETTING 100% 16mm 50 TIMES
YARN DEFECT THICKNESS (%)
+600%
400
300
230
175
130
100
80
70
50
CL
YARN DEFECT LENGTH (cm)
1
2
4
8

FIG. 5

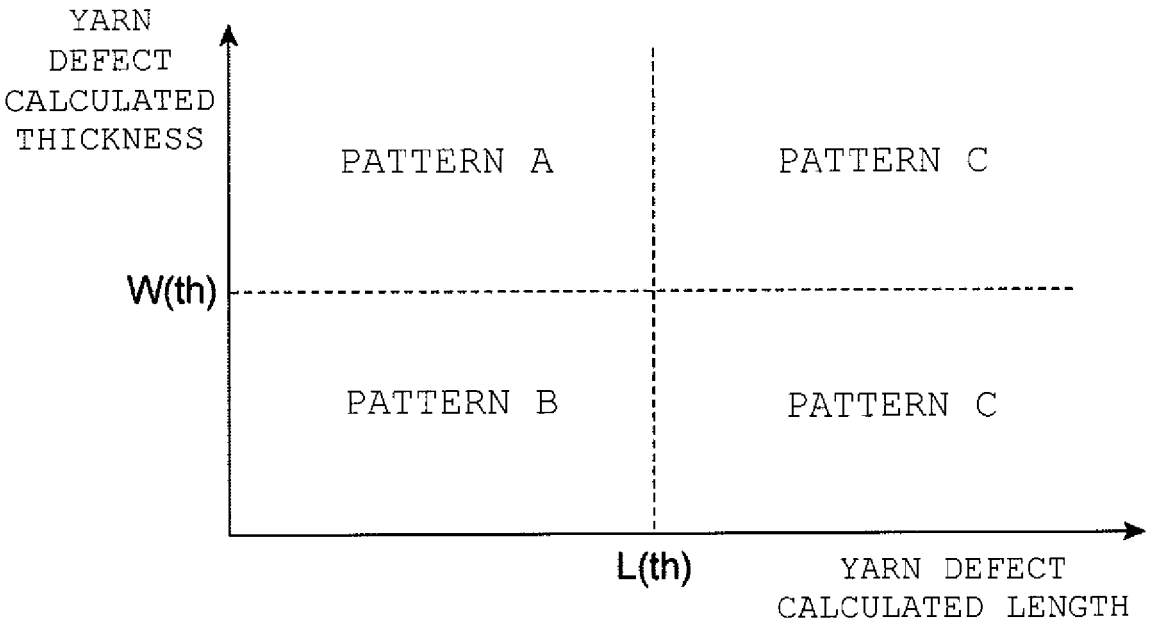

YARN
DEFECT
CALCULATED
THICKNESS
PATTERN A
PATTERN C
W(th)
PATTERN B
PATTERN C
L(th)
YARN DEFECT
CALCULATED LENGTH

FIG. 6A

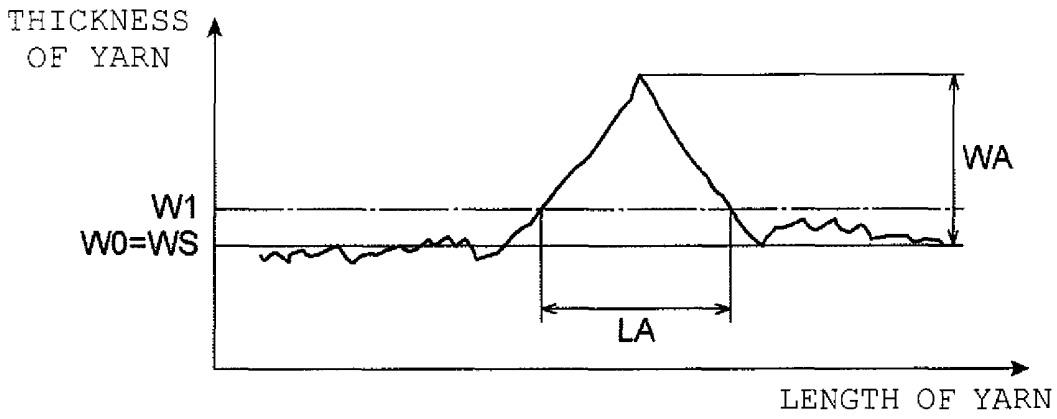


FIG. 6B

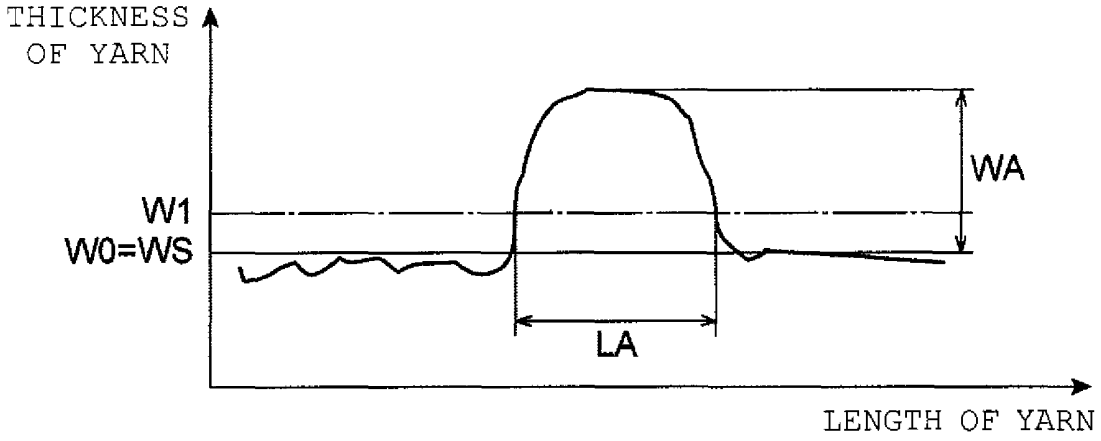


FIG. 6C

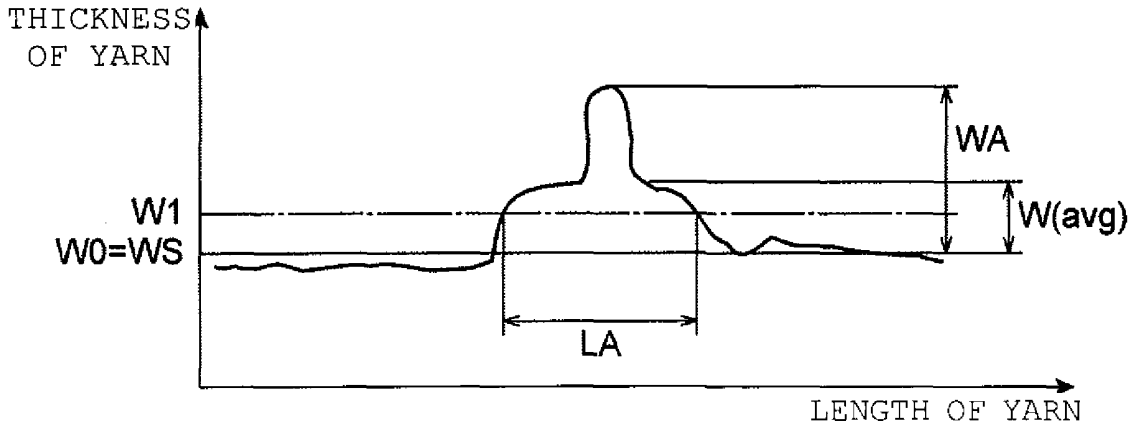


FIG. 7A

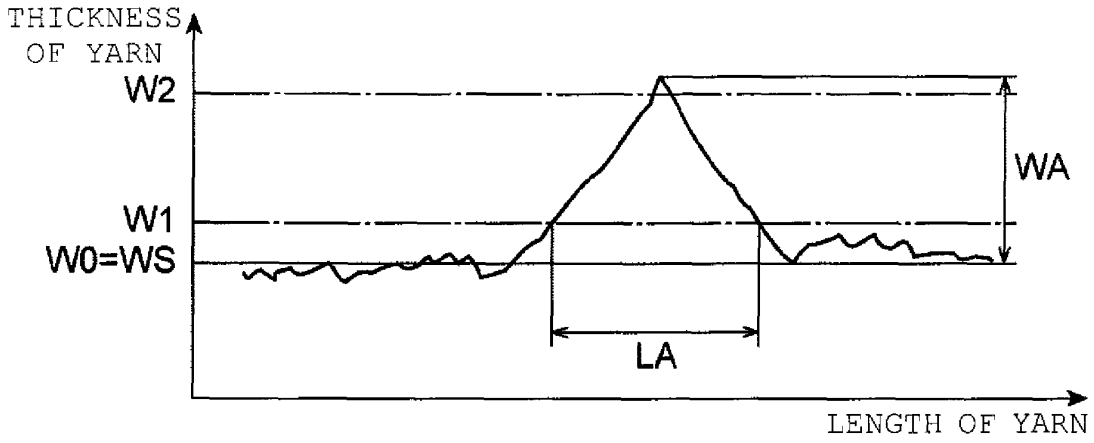

THICKNESS
OF YARN
W2
W1
W0=WS
WA
LA
LENGTH OF YARN

FIG. 7B

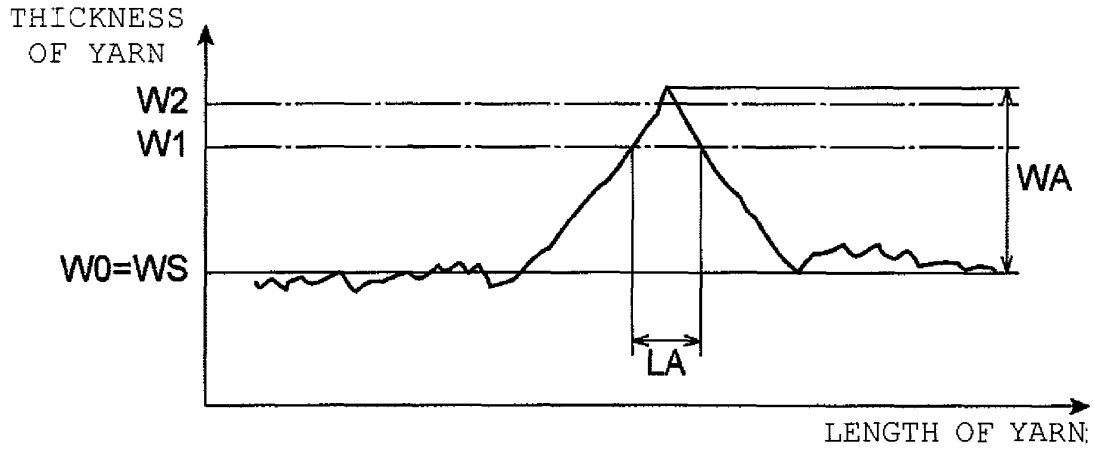
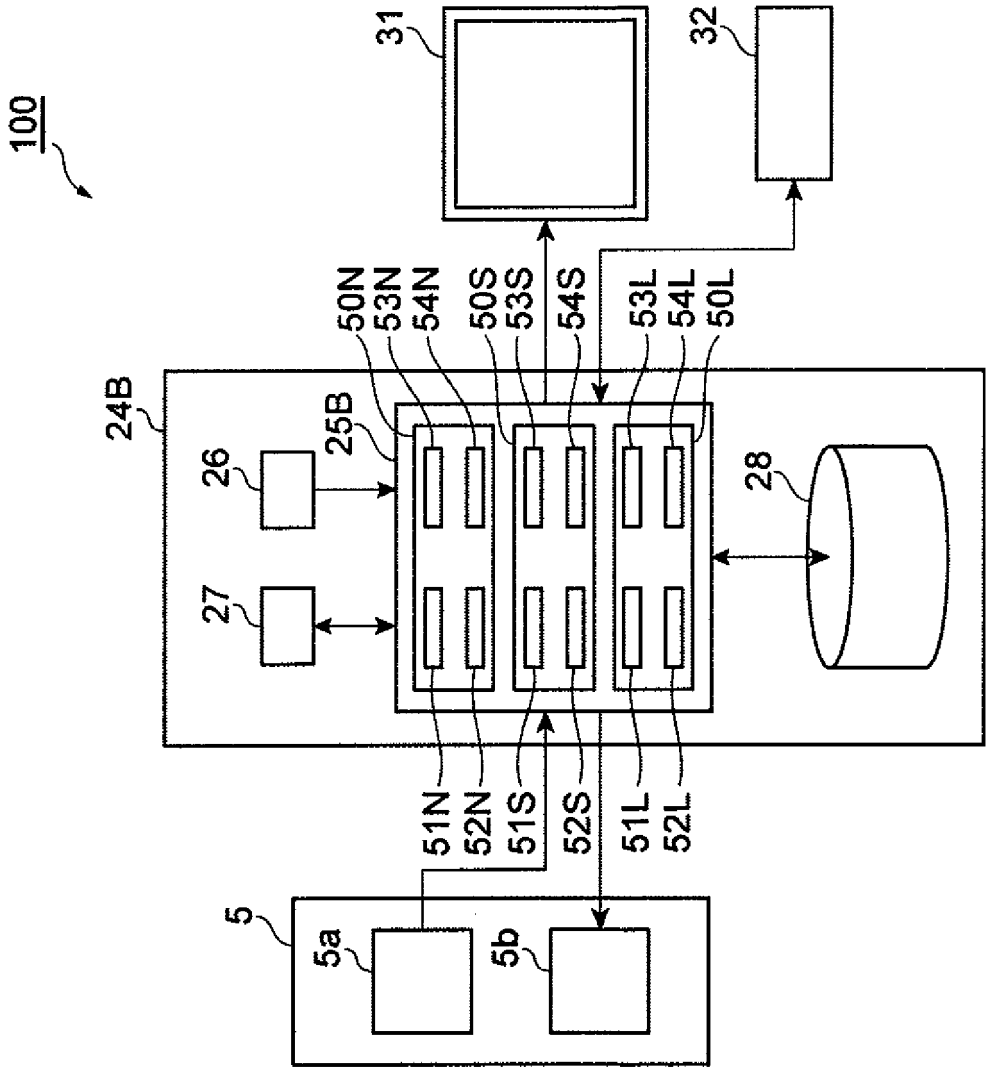

THICKNESS
OF YARN
W2
W1
W0=WS
WA
LA
LENGTH OF YARN

FIG. 8


100
31
32
50N
53N
54N
50S
53S
54S
53L
54L
50L
24B
25B
26
27
28
51N
52N
51S
52S
51L
52L
5
5a
5b

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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