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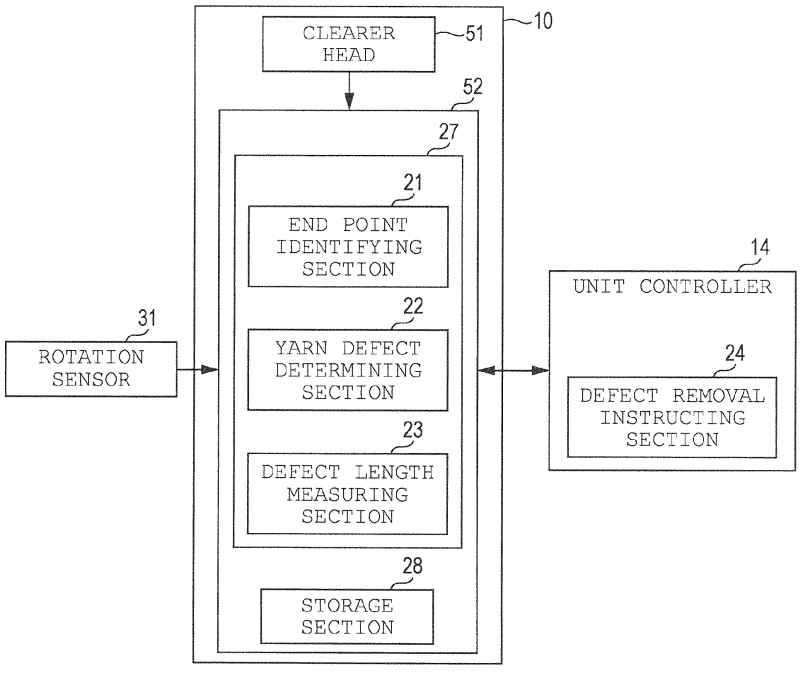
(54) **Yarn defect detecting device and winding device**

(57) A yarn defect detecting device (10) includes a yarn defect determining section (22) that determines, as a defect, a part of a yarn having a thickness falling outside a thickness threshold specified as a determination threshold and having a length equal to or larger than a reference length, an end point identifying section (21) that identifies an end point of the defect in a longitudinal direction when the part of the yarn is determined as the defect by the yarn defect determining section (22), and a cutter (9) that cuts the yarn when the end point identifying section (21) identifies the longitudinal direction end point of the defect.

FIG. 3



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn defect detecting device and a winding device.

2. Description of the Related Art

[0002] Conventionally, a textile machine such as a yarn winding device is provided with a yarn defect detection device that detects a defect included in a yarn (yarn defect) and removes the yarn (see, e.g., JP 4436938). A method described in JP 4436938 monitors a traveling yarn and, when detecting a defect of the yarn, cuts the yarn at a downstream side of the detected yarn defect to interrupt a winding process. In this method, the yarn is removed by a predetermined length.

BRIEF SUMMARY OF THE INVENTION

[0003] In the conventional technology described above, the yarn is removed by a predetermined length, so that if a length of the defect is larger than the predetermined length, the removal process needs to be repeated several times. This deteriorates production efficiency. That is, the repetitive execution of the removal process increases the number of yarn joining points, resulting in deterioration in quality of a yarn product (e.g., yarn package).

[0004] An object of the present invention is to provide a yarn defect detecting device and a winding device capable of detecting a plurality of yarn defects each having a length equal to or larger than a reference length collectively as one defect.

[0005] A yarn defect detecting device of the present invention includes: a yarn thickness detecting section that detects a thickness of a traveling yarn; a yarn defect determining section that determines whether a part of the yarn detected by the yarn thickness detecting section and having a thickness falling outside a thickness threshold specified as a determination threshold of a defect of the yarn has a length equal to or larger than a reference length specified as the determination threshold and determines, when the part of the yarn having the thickness falling outside the thickness threshold specified as the determination threshold has a length equal to or larger than the reference length, the part of the yarn falling outside the thickness threshold specified as the determination threshold as a defect; and an end point identifying section that identifies an end point of the defect in a longitudinal direction when the part is determined as the defect by the yarn defect determining section. The yarn defect detecting device further includes a yarn cutting section that cuts the yarn when the end point identifying section identifies the longitudinal direction end point of the defect.

[0006] In the yarn defect detecting device, when a part of the yarn having a thickness falling outside a thickness threshold specified as a determination threshold has a length equal to or larger than a reference length specified as the determination threshold, an end point of a defect in a longitudinal direction is identified. Thus, it is possible to detect a plurality of defects collectively as one defect longer than in the conventional approach. For example, a length of the yarn to be removed can be determined based on the length of the part of the yarn having the thickness falling outside the thickness threshold specified as the determination threshold, thereby eliminating the need to perform a plurality of times of removal operations as done in the conventional approach. This allows improvement in production efficiency and prevention of quality deterioration. When a required quality level is high, it can be estimated that the length of the defect to be detected is larger. It is possible to detect a plurality of defects collectively as one long defect, thereby allowing achievement of a high quality yarn product.

[0007] The yarn defect detecting device may include a measuring section that measures the length of the defect. Measuring the length of the defect allows collective detection of a long defect, thereby allowing achievement of a high quality yarn product.

[0008] The yarn defect determining section may determine an occurrence of the defect based on a first detection condition, and the end point identifying section may determine the end point of the defect based on a second detection condition different from the first detection condition. With this configuration, detection of the defect can be detected by determining presence/absence of the defect based on the first detection condition, and the end point of the defect can be detected based on the second detection condition. For example, setting the second detection condition that is stricter than the first condition results in measurement of longer defect, thereby ensuring margin of detection error.

[0009] The yarn defect determining section may include a type determining section that determines a type of the yarn defect, and the end point identifying section may determine whether to identify the end point of the defect depending on the defect type. The yarn defect type includes "Nep", "Slub", "Thick place", "Thin place", and the like. The defect such as "Nep" or "Slub" is comparatively small in length and is thus preferably removed without measurement of the length of the defect. The defect such as "Thick place" or "Thin place" may be generated by unevenness of a sliver as a material during fine spinning and may thus be large in length. The length of the defect is measured only for the defect comparatively large in length and whereby defect removal corresponding to the defect length can be performed.

[0010] The measuring section may include a normal length measuring section that measures a length of a normal part of the yarn having a thickness falling within the thickness threshold specified as the determination

threshold. The end point identifying section may identify, when the length of the normal part following the part of the yarn determined by the yarn defect determining section as the defect is equal to or larger than a predetermined length, the end point of the defect. Further, when the yarn sequentially includes the part determined by the yarn defect determining section as the defect, a normal part having a length equal to or smaller than a predetermined length, and another defect part, the measuring section may measure the lengths of the two defect parts and normal part as one continuous defect. Thus, a comparatively long defect is detected. Further, when the length of the normal part following the defect is short, it is possible to collectively measure a plurality of defects as one continuous defect. This reduces the number of times of removal of the defect, allowing improvement in production efficiency and product quality.

[0011] The yarn defect detecting device may further include a control section that controls removal of the defect. After the measuring section measures the length of the defect, the control section may instruct removal of a yarn by a length equal to or larger than that of the measured defect. With this configuration, when the defect has a length smaller than the reference length, the yarn is removed by a previously set length; while when the defect has a length equal to or larger than the reference length, the yarn is removed in accordance with a measured defect length.

[0012] A winding device of the present invention includes: the yarn defect detecting device described above; a yarn winding section that winds a yarn that has passed through the yarn defect detecting device; and a defect removing section that removes a defect of the yarn detected by the yarn defect detecting device.

[0013] The yarn winding unit includes the yarn defect detecting device, by which when the defect of the yarn having a length equal to or larger than the reference length is detected, the length of the defect is measured. Thus, it is possible to detect a plurality of defects collectively as one defect longer than in the conventional approach. The yarn winding unit can determine the length of the yarn to be removed based on the length of the detected defect, thereby eliminating the need to perform a plurality of times of removal operations as done in the conventional approach. This allows improvement in production efficiency and prevention of quality deterioration. When a required quality level is high, it can be estimated that the length of the defect to be detected is larger. The winding device can detect and remove a plurality of defects collectively as one long defect, thereby allowing achievement of a high quality yarn product.

[0014] According to the present invention, it is possible to detect a plurality of yarn defects each having a length equal to or larger than a reference length collectively as one defect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 is a front view of a yarn winding unit serving as a winding device according to an embodiment of the present invention;

FIG. 2 is a side view of the yarn winding unit according to the embodiment of the present invention;

FIG. 3 is an example of a block configuration diagram of a unit controller;

FIG. 4 is another example of a block configuration diagram of a unit controller;

FIGS. 5A and 5B are each a schematic view illustrating a reference length and a defect length at a detection time of a yarn defect;

FIGS. 6A and 6B are each a schematic view illustrating a length of a normal part and a defect length at the yarn defect detection time;

FIG. 7 is a graph illustrating a temporal change of a yarn thickness;

FIG. 8 is a table illustrating a type of the yarn defect; and

FIG. 9 is a flowchart illustrating a procedure of processing to be performed by a control section.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0016] As illustrated in FIGS. 1 and 2, a yarn winding unit 1 is a unit that winds a yarn Y into a package P. For example, a plurality of the yarn winding units 1 are arranged in parallel to each other to constitute an automatic winder. The yarn winding unit 1 includes, sequentially from an upstream side (lower side, in FIG. 1) along a traveling path (i.e., yarn passage) of the yarn Y, a bobbin supporting section 2 serving as a yarn supplying section, a yarn unwinding assisting device 3, a pre-clearer 4, a gate type tension control member 5, a tension sensor 6, a lower yarn catching device 7, a splicer 8 (yarn joining device), a cutter 9 (yarn cutting section), a yarn clearer 10 (yarn defect detecting device) capable of detecting a defect of the yarn Y, an upper yarn catching device 11 (winding side yarn catching section), and a yarn winding section 12. Each of the above components is attached to a frame 13. The yarn winding unit 1 further includes a unit controller (control section) 14 and a display 15 serving as a notifying section.

[0017] The bobbin supporting section 2 is a section that supplies a yarn and supports a yarn supplying bobbin B in an upright state. The yarn supplying bobbin B is formed by a fine spinning machine in a pre-step and is transported from the fine spinning machine while being set in a tray, for example. The yarn unwinding assisting device 3 controls a balloon of the yarn Y unwound from the yarn supplying bobbin B by a tubular member arranged above the yarn supplying bobbin B. The gate type tension control member 5 applies a predetermined ten-

sion on the travelling yarn Y by holding the yarn Y in a zigzag form with a pair of gates including a fixed gate and a movable gate of comb teeth shape. The tension sensor 6 measures a tension of the yarn Y traveling along the yarn passage. The unit controller 14 feedback-controls the gate-type tension control member 5 such that a predetermined tension is applied to the traveling yarn Y based on the tension of the yarn Y measured by the tension sensor 6.

[0018] The pre-clearer 4 regulates in advance passing of the yarn defect greater than a defined value by a pair of regulating members arranged at a predetermined interval with a yarn passage interposed therebetween.

[0019] The yarn clearer 10 detects the yarn defect such as "Slub" (see FIG. 8) during winding of the yarn Y. As illustrated in FIG. 3, the yarn clearer 10 includes a clearer head 51 (yarn thickness detecting section) that detects a thickness of the yarn Y passing therethrough and an analyzer 52 (details of which will be described later) that determines presence/absence of the defect of the yarn Y based on the thickness of the yarn Y detected by the clearer head 51. The yarn clearer 10 may detect a yarn traveling speed of the yarn Y traveling between the bobbin supporting section 2 and yarn winding section 12.

[0020] The cutter 9 cuts the yarn Y upon issuance of a yarn joining instruction from the unit controller 14 after the yarn clearer 10 detects the yarn defect. The splicer 8 joins a yarn end on the yarn supplying bobbin B side and yarn end on the package P side when the yarn Y is cut by the cutter 9 or when the yarn Y is disconnected.

[0021] The lower yarn catching device 7 is configured to be vertically swingable about an axis line α, where a suction port 7a is arranged at a swinging end thereof. The suction port 7a is swung between an upper part of the splicer 8 and a lower part of the pre-clearer 4. The upper yarn catching device 11 is configured to be vertically swingable about an axis center β, where a suction port 11a is arranged at a swinging end thereof. The suction port 11a is swung between a lower part of the splicer 8 and the yarn winding section 12. With the above configuration, the lower yarn catching device 7 is swung in a downward direction so as to suck the yarn end on the yarn supplying bobbin B side with the suction port 7a, and thereafter, swung in an upward direction to pass the yarn end on the yarn supplying bobbin B side to the splicer 8. On the other hand, the upper yarn catching device 11 is swung in an upward direction to suck the yarn end on the package P side with the suction port 11a, and thereafter, swung in a downward direction to pass the yarn end on the package P side to the splicer 8.

[0022] The yarn winding section 12 winds the yarn Y unwound from the yarn supplying bobbin B into the package P to form a fully-wound package P while performing traversing to reciprocate the yarn in a left-right direction (in an axial direction of a winding drum 16). The yarn winding section 12 includes a winding drum 16 and a cradle 17 serving as a supporting mechanism.

[0023] The winding drum 16 rotates the package P while making contact with the package P to wind the yarn Y into the package P. The winding drum 16 has, formed therein, a drum grove 16a for the traversing.

[0024] The winding drum 16 is attached with a rotation sensor 31. The rotation sensor 31 is electrically connected to the analyzer 52, etc. , of the yarn clearer 10. The rotation sensor 31 is configured as, e.g. , a rotary encoder and transmits a pulse signal to the analyzer 52 every time the winding drum 16 is rotated at a predetermined angle. The pulse signal output from the rotation sensor 31 is referred to as a rotation pulse signal.

[0025] A cradle 17 rotatably supports the package P. As the package P, a cone-shaped package, a pillar-shaped package, or the like may be used. The cradle 17 can control an angle γ formed by an axial line of the winding drum 16 and axial line of the package P. The control of the angle γ allows a position of a contact point (hereinafter, referred to as "driving point") between the winding drum 16 and package P to be controlled. Further, the cradle 17 brings a surface of the package P into contact with a surface of the winding drum 16 with an appropriate contact pressure. The winding drum 16 is driven and rotated by a motor to rotate the package P, whereby the yarn winding section 12 winds the yarn Y into the package P while traversing the yarn Y at a predetermined width. An outer circumference surface of the winding drum 16 and an outer circumferential surface of the package P make contact with each other at the driving point, whereby a rotary driving force of the winding drum 16 is transmitted to the package P.

[0026] The unit controller 14 controls each of the components constituting the yarn winding unit 1. The unit controller 14 includes a CPU (Central Processing Unit) that performs computations, and a ROM (Read Only Memory) and a RAM (Random Access Memory) each of which serve as a storage section. The unit controller 14 receives, from each of the components of the yarn winding unit 1, information required for control operation.

[0027] When the automatic winder is constituted by a plurality of the yarn winding units 1, the unit controller 14 exchanges various information concerning winding operation with a controller that controls the entire operation of the automatic winder. The unit controller 14 is electrically connected to the yarn clearer 10, rotation sensor 31, display 15, splicer 8, lower yarn catching device 7, and upper yarn catching device 11.

[0028] The display 15 displays operating conditions and the like of the yarn winding unit 1. When the yarn defect is detected by the yarn clearer 10, the display 15 may display the detection of the yarn defect.

[0029] Next, a description will be made on the yarn clearer 10 with reference to FIG. 3. The analyzer 52 of the yarn clearer 10 includes a CPU 27 that performs computations and a ROM/RAM serving as a storage section 28. The analyzer 52 includes as a processing section, an end point identifying section 21, a yarn defect determining section 22, a defect length measuring section (measuring section) 23, and a defect removal instructing

section 24. In the analyzer 52, a program stored in the ROM is loaded onto the RAM and executed by the CPU, whereby each of the processing sections is implemented as software. However, each of the processing sections may be implemented as hardware. Further, as illustrated in FIG. 4, the analyzer 52 may be installed in the frame 13.

[0030] The yarn defect determining section 22 acquires information concerning the thickness of the yarn Y from the clearer head 51 and determines whether there is any defect of the yarn Y.

[0031] The yarn defect determining section 22 may include a type determining section that determines a type of the defect of the yarn Y and determine whether to measure a length of the defect depending on the defect type. The yarn defect determining section 22 determines the defect type based on the information concerning to the yarn thickness.

[0032] FIG. 8 is a table illustrating the type (determination threshold) of the yarn defect. The defect type includes, e.g., "Nep", "Slub", "Thick place", "Thin place", and the like. When detecting a thickness larger by 200% or more than an average thickness (reference thickness) of the yarn Y, the yarn defect determining section 22 determines that the defect type is the "Nep". Then, the yarn defect determining section 22 executes removal of the yarn defect immediately without considering the defect length.

[0033] The "Nep" is a knot of entangled thin fibers. For example, the "Nep" occurs when a fiber aggregation exists in a spun fiber bundle. Such a defect is comparatively small in length. In general, the "Nep" is about 5 mm in length.

[0034] When detecting a thickness larger by 150% or more and less than 200% than the average thickness, the yarn defect determining section 22 determines that the defect type is the "Slub". Then, the yarn defect determining section 22 executes removal of the yarn defect immediately without measuring the defect length.

[0035] The "Slub" is a state where a yarn has an abnormal thickness compared to the other part and has little twist. This is caused by presence of a defect part or impurities in the spun yarn. Such a defect is comparatively small in length. In general, the "Nep" is about 10 mm to 30 mm in length.

[0036] When detecting a thickness larger by 110% or more and less than 150% than the average thickness, the yarn defect determining section 22 determines that the defect type is the "Thick place". Then, the yarn defect determining section 22 determines to measure the defect length. When determining that the defect type is the "Thick place", the yarn defect determining section 22 determines that the defect length is equal to or larger than the reference length.

[0037] The "Thick place" is a state where a thick part in a sliver, from which the yarn is to be spun by a spinning machine, is spun as a yarn. Such a defect is likely to be large in length since the thick part of the sliver is extended by the spinning machine. The "thick part" may have a length of 30 m or more.

[0038] When detecting a thickness smaller by 90% or less than the average thickness, the yarn defect determining section 22 determines that the defect type is the "Thin place". Then, the yarn defect determining section 22 determines to measure the defect length. When determining that the defect type is the "Thin place", the yarn defect determining section 22 determines that the defect length is equal to or larger than the reference length.

[0039] The "Thin place" is a state where a thin part in a sliver, from which the yarn is to be spun by a spinning machine, is spun as a yarn. Such a defect is likely to be large in length. The "thin part" may have a length of 30 m or more.

[0040] The yarn defect determining section 22 determines a thickness unevenness of the yarn based on a determination threshold set with respect to a reference length L1 (see FIG. 5) of the defect of the yarn Y. When a yarn meeting the detection condition of the "Thick place" or "Thin place" has a length equal to or larger than the reference length L1, the yarn defect determining section 22 detects an occurrence of a defect corresponding to a yarn unevenness corresponding to the "Thick place" or "Thin place" and then determines to measure the defect length. The determination threshold set with respect to the reference length L1 is stored in, e.g., the storage section 28.

[0041] The defect length measuring section 23 measures the defect length based on the defect determined by the yarn defect determining section 22 and an end point of the thickness unevenness identified by the end point identifying section 21.

[0042] FIG. 5A illustrates a case where a defect having a length equal to or larger than the reference length L1 exists in the yarn Y. The clearer head 51 detects an occurrence of the thickness unevenness (a part of the yarn having a thickness falling outside the thickness threshold specified as the determination threshold) of the yarn Y. The yarn defect determining section 22 determines whether the length of the thickness unevenness of the yarn is equal to or larger than the reference length L1 based on information on the thickness of the yarn Y. In FIGS. 5 and 6, an area where the thickness unevenness of the yarn exists is indicated by hatching.

[0043] In the example of FIG. 5A, the thickness unevenness exceeds the reference length L1 and, accordingly, the yarn defect determining section 22 determines the occurrence of the defect and then determines to measure the defect length to the end point of the thickness unevenness. The end point identifying section 21 identifies the end point of the defect in a longitudinal direction based on the information on the thickness of the yarn Y. Then, the defect length measuring section 23 measures a length L2 of the defect.

[0044] In the example of FIG. 5B, the thickness unevenness (having a thickness larger by 110% or more and less than 150% than the average thickness) corresponding to the "Thick place" has a length smaller than

the reference length L1 in the yarn Y. In this case, the thickness unevenness does not exceed the reference length L1, so that the yarn defect determining section 22 of the yarn clearer 10 does not recognize this thickness unevenness as the defect.

[0045] A start point of the defect to be used in the measurement of the defect length L2 may be a point at which the yarn defect determining section 22 determines that the defect meeting the detection condition exists or a point at which an actual thickness unevenness starts. The end point of the defect may be a point at which it is determined that the thickness unevenness meeting the detection condition dos not exists or a point at which the actual thickness unevenness ends.

[0046] The defect length can be calculated based on a traveling speed of the yarn Y and a time elapsing before detection of the end point of the thickness unevenness. The traveling speed of the yarn Y may be calculated based on information from the clearer head 51, based on the rotation pulse signal from the rotation sensor 31, or based on a signal from another sensor.

[0047] The defect length measuring section 23 may include a normal length measuring section that measures, after the end point identifying section 21 identifies the end point of the defect (first defect), a length of a normal part L4 (see FIG. 6) having a thickness falling within the thickness threshold specified as the determination threshold. When the length of the normal part is smaller than a predetermined value, the end point identifying section 21 identifies the end point of the defect once again after passing of the normal point, and the normal length measuring section measures the first and second defects as one continuous defect. When detecting the length of the normal part that is smaller than a predetermined value, the normal length measuring section detects the end point of the subsequently detected thick unevenness of the yarn after passing of the normal point, and measures the length as one continuous defect.

[0048] FIG. 6A illustrates a case where a defect corresponding to the "Thick place" or "Thin place" having a length equal to or larger than the reference length L1 exists in the yarn Y and where the length L4 of the normal part is smaller than a predetermined value. After detection of the end point of the thickness unevenness of the yarn, the defect length measuring section 23 measures the length L4 of the normal part where the thickness unevenness has not been detected. The defect length measuring section 23 refers to a predetermined value stored in the storage section 28 and determines whether the length L4 of the normal part is smaller or not than the predetermined value. In the example of FIG. 6A, the length L4 of the normal part is smaller than the predetermined value, so that, after passing of the normal part, the end point identifying section 21 identifies the end point of the subsequently detected thickness unevenness of the yarn once again, and the defect length measuring section 23 measures a length L5 of the defect.

[0049] FIG. 6B illustrates a case where a defect corresponding to the "Thick place" or "Thin place" having a length equal to or larger than the reference length L1 exists in the yarn Y and where a length L6 of the normal part is larger than the predetermined value. In the example of FIG. 6B, the length L6 of the normal part is equal to or larger than the predetermined value, so that the defect length measuring section 23 measures a length L7 of the defect.

[0050] The predetermined value for use in determination of the length of the normal part may be a fixed value or may be changed according to, e.g., the length L7 of the defect immediately before the normal part. The predetermined value may be set to, e.g., 10% of the length L7 of the defect immediately before the normal part.

[0051] The yarn defect determining section 22 may detect the defect based on a first detection condition and detect the end point of the defect based on a second detection condition different from the first detection condition. FIG. 7 is a graph illustrating a temporal change of the thickness of the yarn Y. In FIG. 7, a vertical axis represents the thickness of the yarn Y and a horizontal axis represents an elapsed time. A curve K in FIG. 7 represents the thickness of the yarn Y, which becomes thicker as it goes upward and becomes thinner as it goes downward.

[0052] When a first detection condition G1 is met, the yarn defect determining section 22 determines that the thickness unevenness exists in the yarn Y. More specifically, the yarn defect determining section 22 determines that the thickness unevenness exists when the curve K is above the first detection condition G1 in Fig. 7.

[0053] When a second detection condition G2 is met, the end point identifying section 21 determines that the end point of the thickness unevenness of the yarn Y has been identified. More specifically, the end point identifying section 21 determines that the thickness unevenness does not exist when the curve K is below the second detection condition G2 in Fig. 7. Thus, the thickness unevenness of the yarn ends is finished, and the end point of the defect is identified. The defect length measuring section 23 measures the length L2 of the defect based on the end point of the thickness unevenness of the yarn identified by the end point identifying section 21.

[0054] In the example of FIG. 7, after the curve K exceeds the first detection condition G1 (that is, after it is determined that a defect in which the thickness of the yarn is larger than the detection condition of "Thick place" exists), the curve K has parts C1 and C2 each having a thickness equal to or smaller than the first detection condition G1 and a thickness equal to or larger than the second detection condition G2. In the present embodiment, the thickness unevenness of the yarn is not determined to end until the thickness becomes equal to or smaller than the second detection condition G2, so that, in this case, the length L2 is detected as one continuous defect. Thus, it is possible to reduce the number of times of removal of the defect. The first and second detection conditions G1 and G2 to be set in the end point identifying

section 21 and yarn defect determining section 22 may have the same thickness value.

[0055] The defect removal instructing section 24 instructs removal of the yarn as the defect when the length of the thickness unevenness of the yarn is measured and the thickness unevenness of the measured yarn is equal to or larger than the specified length. The defect removal instructing section 24 transmits, to the unit controller 14, an instruction signal instructing removal of the yarn by a set amount when the yarn defect determining section 22 detects the yarn defect as the "slut" of "Nep" and determines not to consider the length of the defect.

[0056] The defect removal instructing section 24 of the unit controller 14 instructs the yarn winding section 12 to stop winding of the yarn Y. The yarn Y is cut by the cutter 9, and the yarn end on the yarn supplying bobbin B side is sucked to the suction port 7a of the lower yarn catching device 7, and the package P side end of the yarn the including the yarn defect is sucked to the suction port 11a of the upper yarn catching device 11. At this time, in a case where the length of the defect has been measured, the upper yarn catching device 11 sucks the yarn Y in accordance with the measured defect length. In a case where the length of the defect has not been measured, the upper yarn catching device 11 sucks the yarn Y by a previously set length. For example, it is possible to provide, in the suction port 11a, a sensor capable of detecting the length of the yarn Y passing therethrough and to measure the length of the sucked yarn Y using this sensor. Alternatively, it is possible to provide a simple ON/OFF sensor in the suction port 12a and to reverse-rotate the winding drum 16 by a rotation angle corresponding to the length of the yarn Y sucked when the sensor turns ON by detecting the yarn end to feed the yarn Y. Another method may be used to measure the length of the sucked yarn Y.

[0057] The upper yarn catching device 11 passes the package P side end of the sucked yarn Y to the splicer 8. The lower yarn catching device 7 passes the yarn supplying bobbin B side end of the sucked yarn Y to the splicer 8. The yarn end on the package P side and yarn end on the yarn supplying bobbin B side are joined by the splicer 8. In the yarn joining, the yarn Y including the sucked defect is cut for removal. That is, the lower yarn catching device 7, splicer 8, and upper yarn catching device 11 constitute a defect removing section. After the yarn joining, the winding drum 16 is driven to resume winding of the yarn Y.

[0058] Next, a description will be made on processing to be performed by the analyzer 52 of the yarn clearer 10 with reference to FIG. 9.

[0059] The yarn defect determining section 22 of the analyzer 52 determines whether to have detected the thickness unevenness of the yarn (step S1). The yarn defect determining section 22 determines to have detected the thickness unevenness of the yarn based on the information indicating the thickness of the yarn Y input from the clearer head 51. When determining that the thickness of the yarn Y meets the detection condition based on the defect determination threshold, the yarn defect determining section 22 determines to start detection of the yarn defect (YES in step S1), and the processing flow proceeds to step S2. When determining that the thickness of the yarn Y does not meet the detection condition as illustrated in FIG. 5B, the yarn defect determining section 22 determines not to detect the yarn defect (NO in step S1) and continues the processing of step S1.

[0060] In step S2, the yarn defect determining section 22 of the analyzer 52 determines whether to consider the length of the defect (step S2). When the thickness unevenness of the yarn meeting the detection condition of the "Thick place" or "Thin place" exceeds the reference length L1 as illustrated in FIG. 5A, the yarn defect determining section 22 determines to consider the length of the defect (YES in step S2), and the processing flow proceeds to step S3. When detecting that the thickness unevenness of the yarn meeting the detection condition of the "Nep" or "Slub", the yarn defect determining section 22 recognizes an occurrence of the "Nep" or "Slub" and determines not to consider the length of the defect (NO in step S2), and the processing flow proceeds to step S5.

[0061] In step S3, the defect length measuring section 23 of the analyzer 52 measures the length L2 of the defect until identification of the end point of the thickness unevenness of the yarn as illustrated in FIG. 5A, and the processing flow proceeds to step S4.

[0062] In step S4, the defect removal instructing section 24 of the unit controller 14 sets the length of the measured defect as a length of the yarn to be removed, and the processing flow proceeds to step S6.

[0063] In step S5, the defect removal instructing section 24 of the unit controller 14 sets a preset length as the length of the yarn to be removed, and the processing flow proceeds to step S6.

[0064] In step S6, the defect removal instructing section 24 of the unit controller 14 instructs removal of the defect, and this routine ends.

[0065] The yarn winding unit 1 of the present embodiment includes the yarn clearer 10 as the yarn defect detecting device, by which when the thickness unevenness of the yarn having a length equal to or larger than the reference length L1 is detected, the length of the defect is measured. According to the yarn winding unit 1, it is possible to detect a plurality of defects collectively as one defect longer than in the conventional approach. The yarn winding unit 1 can determine the length of the yarn to be removed based on the length of the detected defect, thereby eliminating the need to perform a plurality of times of removal operations as done in the conventional approach. This allows improvement in production efficiency and prevention of quality deterioration.

[0066] Although the embodiment of the present invention has been described, the present invention is not limited to the above embodiment. For example, in the above embodiment, the yarn Y is traversed onto the surface of the package being rotated by the rotating winding drum

16. However, the present invention is not limited to this but may be applied to a yarn winding device having a configuration in which drive of the package and traversing are performed independently of each other. An example of such yarn winding device includes, e. g. , an automatic winder provided with an arm-type traverse device that traverses the yarn Y with a swinging arm or a belt-type traverse device that traverses the yarn Y with a yarn hooking member that reciprocates to the left and the right by a belt.

[0067] The yarn defect detecting device of the present invention may be applied not only to the automatic winder but also to another type of a yarn processing device such as a fine spinning machine.

[0068] The yarn defect detecting device of the present invention may be incorporated in the yarn clearer 10 or unit controller 14, or may be configured as an independent device.

Claims

1. A yarn defect detecting device (10) comprising:

a yarn thickness detecting section (51) that detects a thickness of a traveling yarn;
a yarn defect determining section (22) that determines whether a part of the yarn detected by the yarn thickness detecting section (51) and having a thickness falling outside a thickness threshold specified as a determination threshold of a defect of the yarn has a length equal to or larger than a reference length specified as the determination threshold and determines, when the part of the yarn having the thickness falling outside the thickness threshold specified as the determination threshold has a length equal to or larger than the reference length, the part of the yarn falling outside the thickness threshold specified as the determination threshold as a defect; and
an end point identifying section (21) that identifies an end point of the defect in a longitudinal direction when the part is determined as the defect by the yarn defect determining section (22).

2. The yarn defect detecting device (10) according to claim 1, **characterized by** further comprising a yarn cutting section (9) that cuts the yarn when the end point identifying section (21) identifies the longitudinal direction end point of the defect.

3. The yarn defect detecting device (10) according to claim 1 or claim 2, comprising a measuring section (23) that measures the length of the defect.

4. The yarn defect detecting device (10) according to claim 3, wherein
the yarn defect determining section (22) determines an occurrence of the defect based on a first detection condition, and the end point identifying section (21) determines the end point of the defect based on a second detection condition different from the first detection condition.

5. The yarn defect detecting device (10) according to any one of claims 1 to 4, wherein
the yarn defect determining section (22) includes a type determining section that determines a type of the yarn defect, and
the end point identifying section (21) determines whether to identify the end point of the defect depending on the defect type.

6. The yarn defect detecting device (10) according to any one of claims 3 to 5, wherein
the measuring section (23) includes a normal length measuring section that measures a length of a normal part of the yarn having a thickness falling within the thickness threshold specified as the determination threshold, and
the end point identifying section (21) identifies, when the length of the normal part following the part of the yarn determined by the yarn defect determining section (22) as the defect is equal to or larger than a predetermined length, the end point of the defect.

7. The yarn defect detecting device (10) according to any one of claims 3 to 6, wherein
when the part determined by the yarn defect determining section (22) is determined as the defect, a normal part having a length equal to or smaller than a predetermined length is included, and another defect part is determined, the measuring section (23) measures the lengths of the two defect parts and normal part as one continuous defect.

8. The yarn defect detecting device (10) according to any one of claims 3 to 7, further comprising a control section (14) that controls removal of the defect, wherein
after the measuring section (23) measures the length of the defect, the control section (14) instructs removal of a yarn by a length equal to or larger than that of the measured defect.

9. A winding device (1) comprising:

the yarn defect detecting device (10) as claimed in any one of claims 1 to 8;
a yarn winding section (12) that winds a yarn that has passed through the yarn defect detecting device (10); and
a defect removing section that removes a defect of the yarn detected by the yarn defect detecting device (10).

FIG. 1

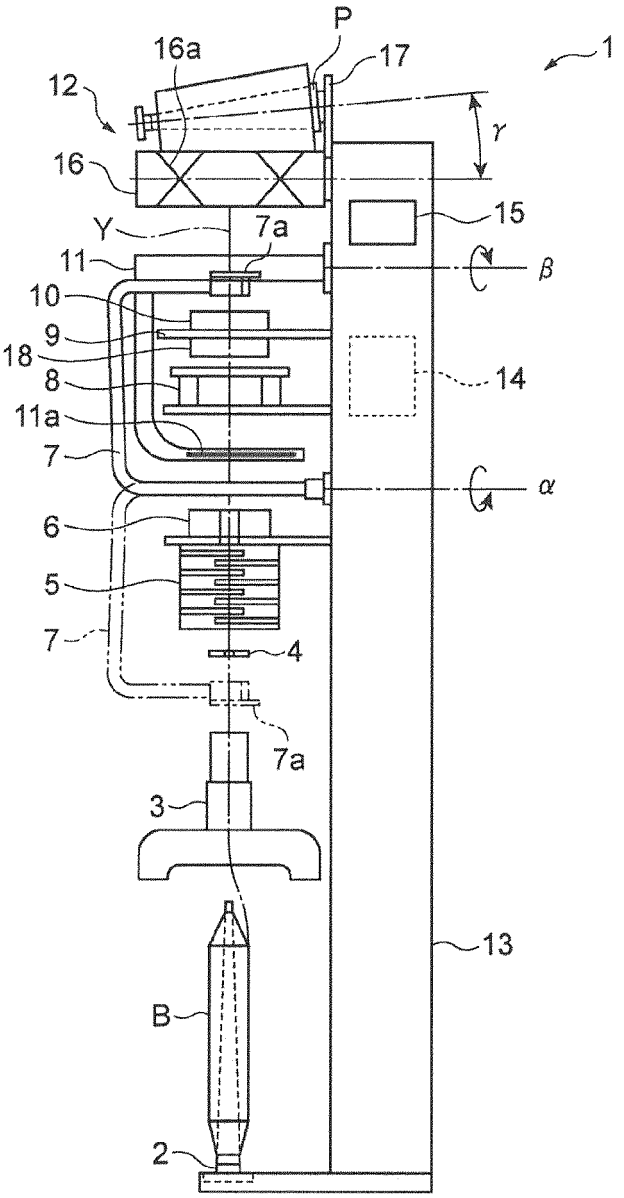


FIG. 2

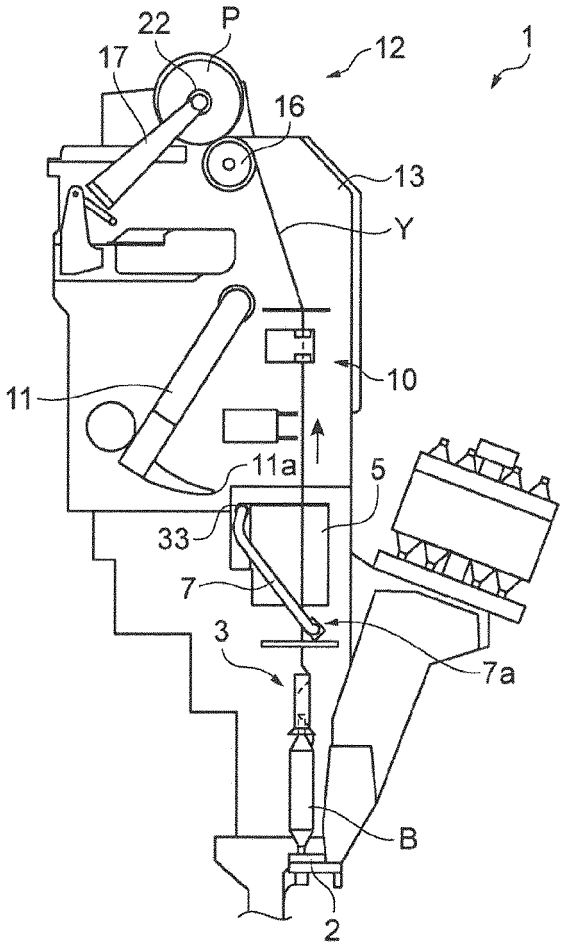


FIG. 3

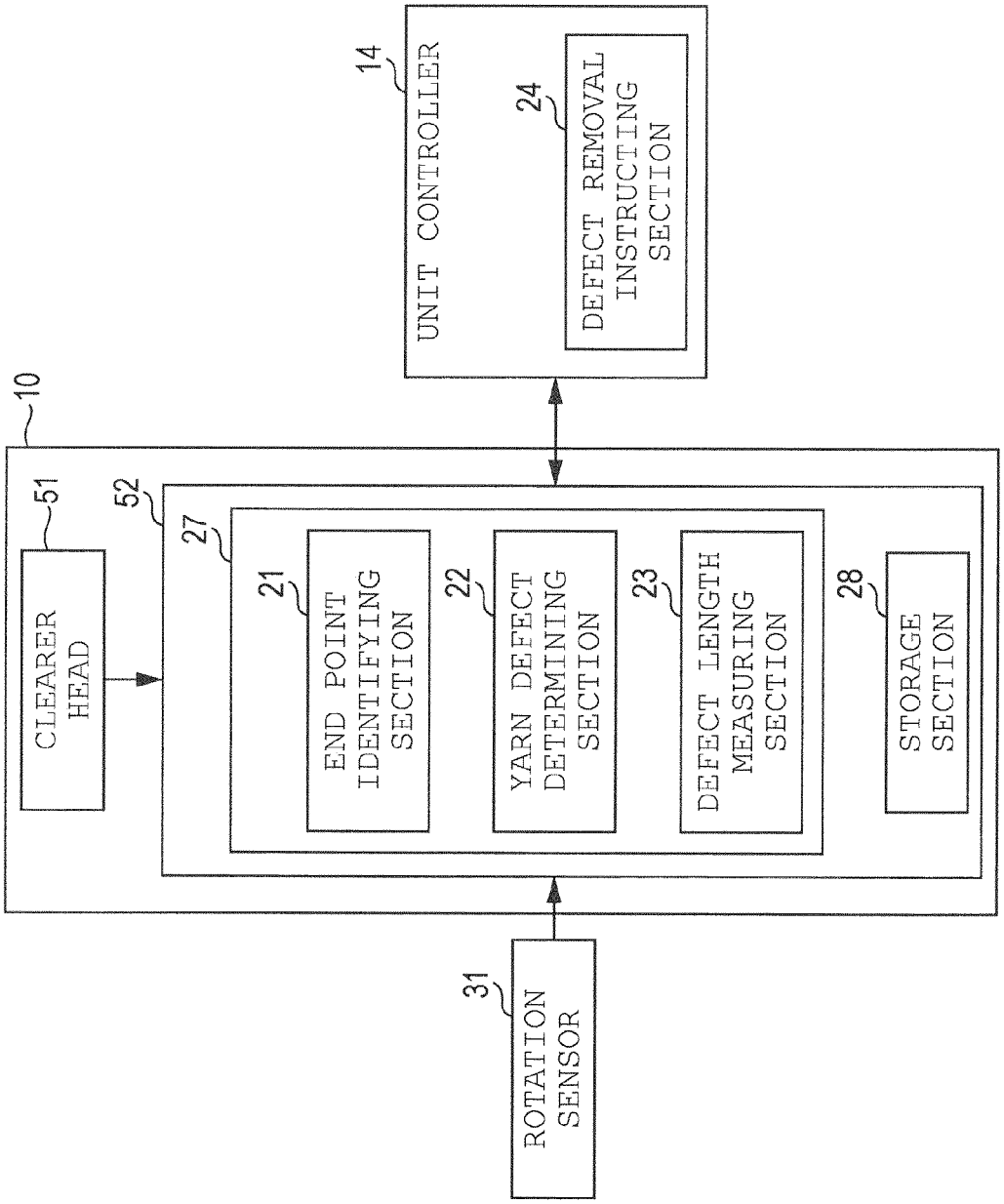
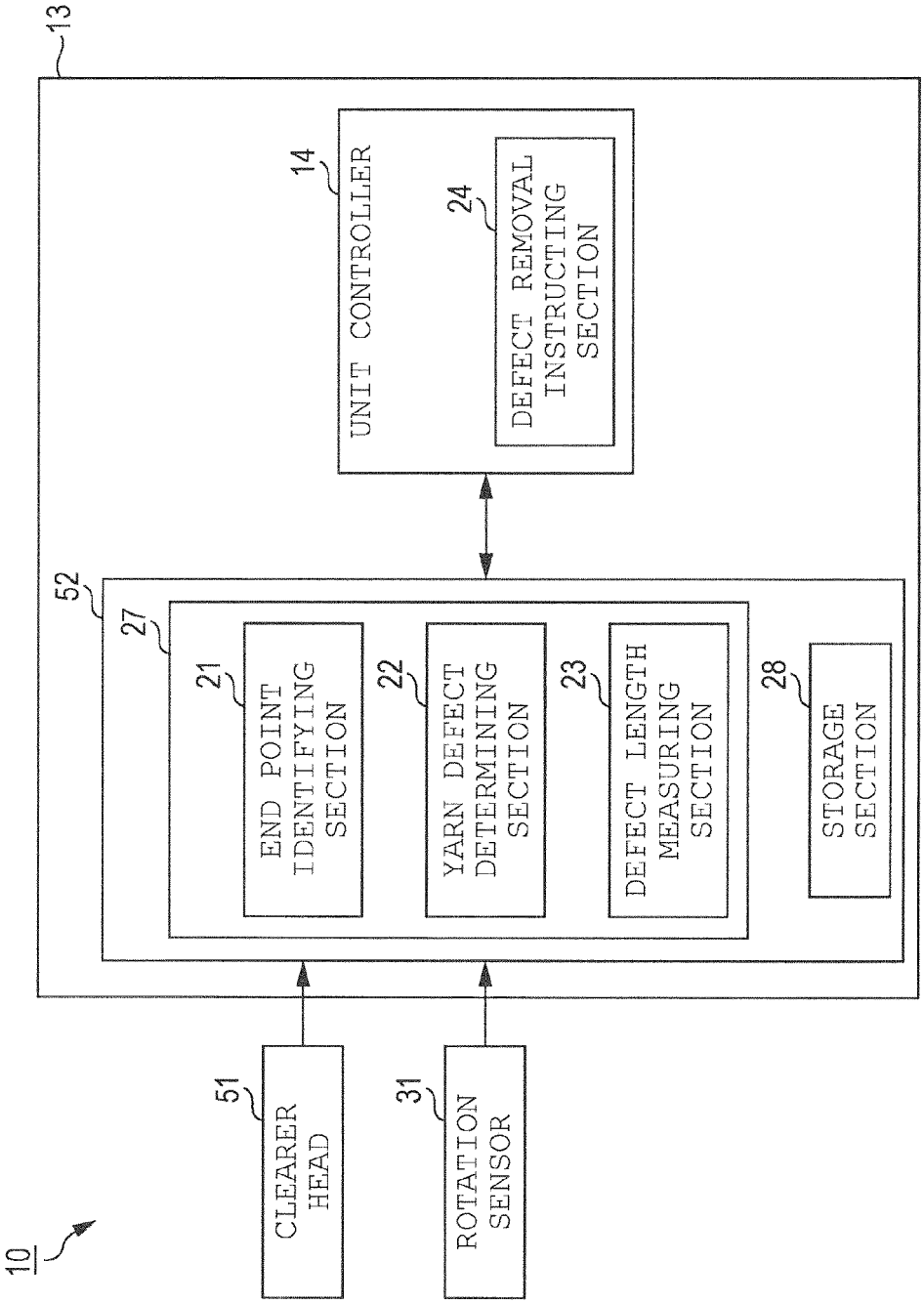

14
UNIT CONTROLLER
24
DEFECT REMOVAL INSTRUCTING SECTION
10
51
CLEARER HEAD
52
27
21
END POINT IDENTIFYING SECTION
22
YARN DEFECT DETERMINING SECTION
23
DEFECT LENGTH MEASURING SECTION
28
STORAGE SECTION
31
ROTATION SENSOR

FIG. 4


13
14
UNIT CONTROLLER
24
DEFECT REMOVAL INSTRUCTING SECTION
52
27
21
END POINT IDENTIFYING SECTION
22
YARN DEFECT DETERMINING SECTION
23
DEFECT LENGTH MEASURING SECTION
28
STORAGE SECTION
51
CLEARER HEAD
31
ROTATION SENSOR
10

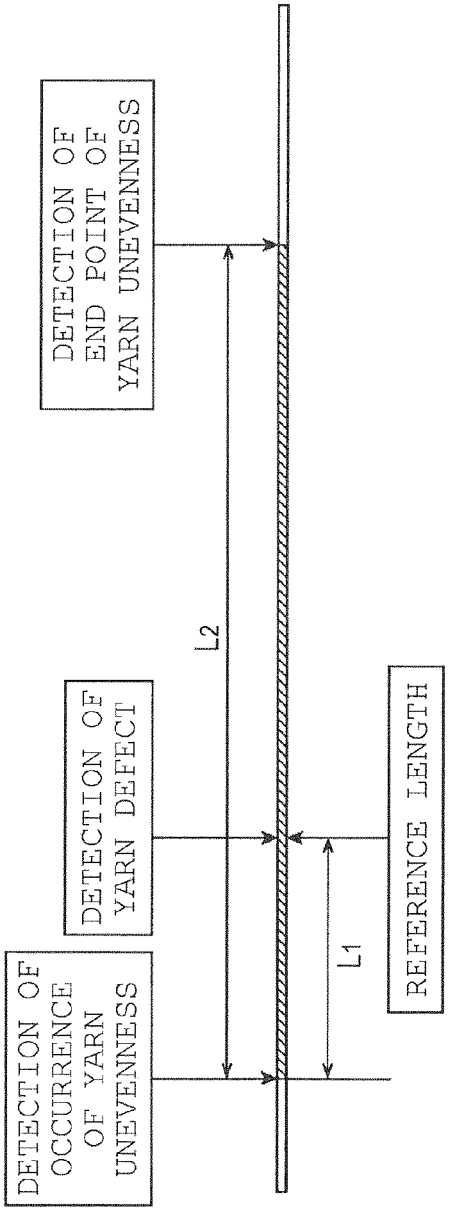

DETECTION OF OCCURRENCE OF YARN UNEVENNESS
DETECTION OF YARN DEFECT
DETECTION OF END POINT OF YARN UNEVENNESS
L1
L2
REFERENCE LENGTH

FIG. 5A

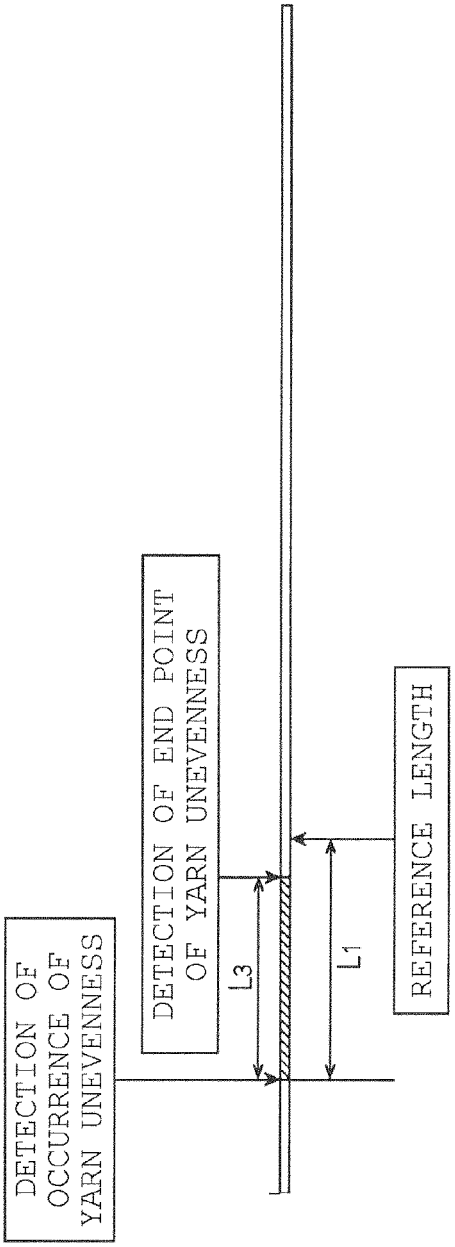

DETECTION OF OCCURRENCE OF YARN UNEVENNESS
DETECTION OF END POINT OF YARN UNEVENNESS
L3
L1
REFERENCE LENGTH

FIG. 5B

FIG. 6A

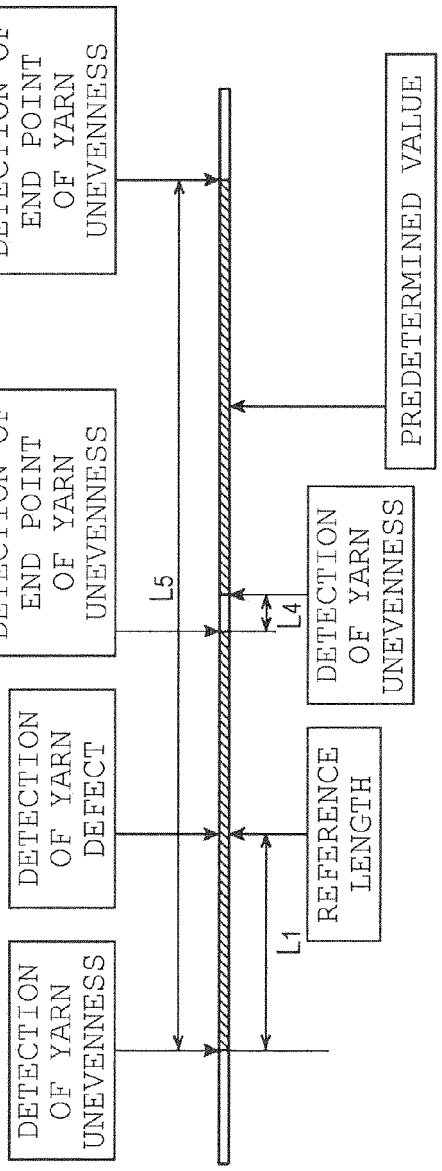

DETECTION OF YARN UNEVENNESS
DETECTION OF YARN DEFECT
DETECTION OF END POINT OF YARN UNEVENNESS
DETECTION OF END POINT OF YARN UNEVENNESS
L1
REFERENCE LENGTH
L4
DETECTION OF YARN UNEVENNESS
L5
PREDETERMINED VALUE

FIG. 6B

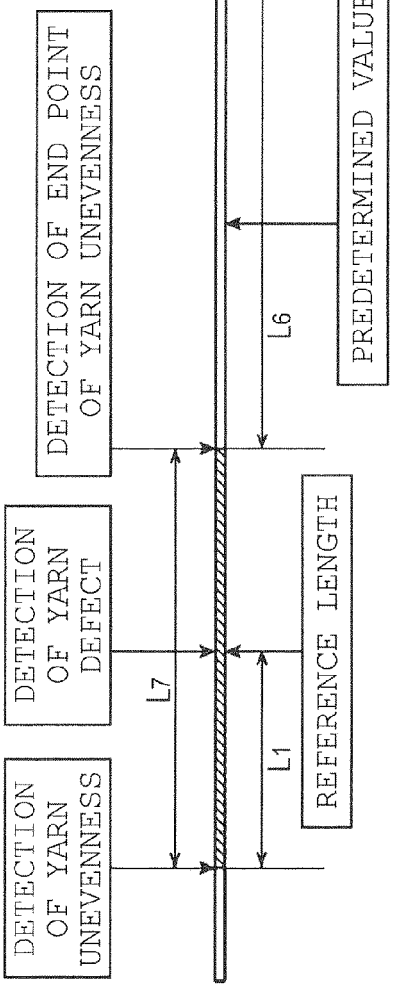

DETECTION OF YARN UNEVENNESS
DETECTION OF YARN DEFECT
DETECTION OF END POINT OF YARN UNEVENNESS
L7
L1
REFERENCE LENGTH
L6
PREDETERMINED VALUE

FIG. 7

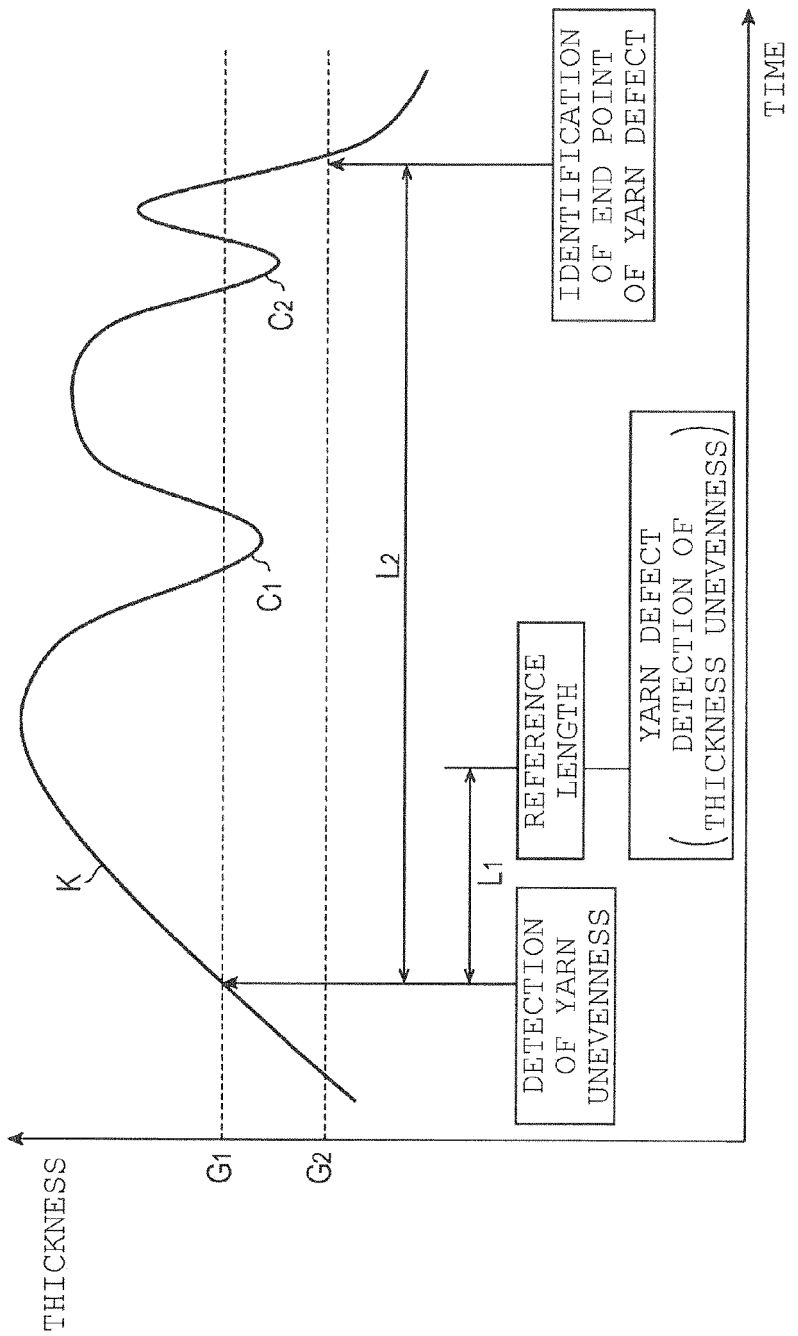
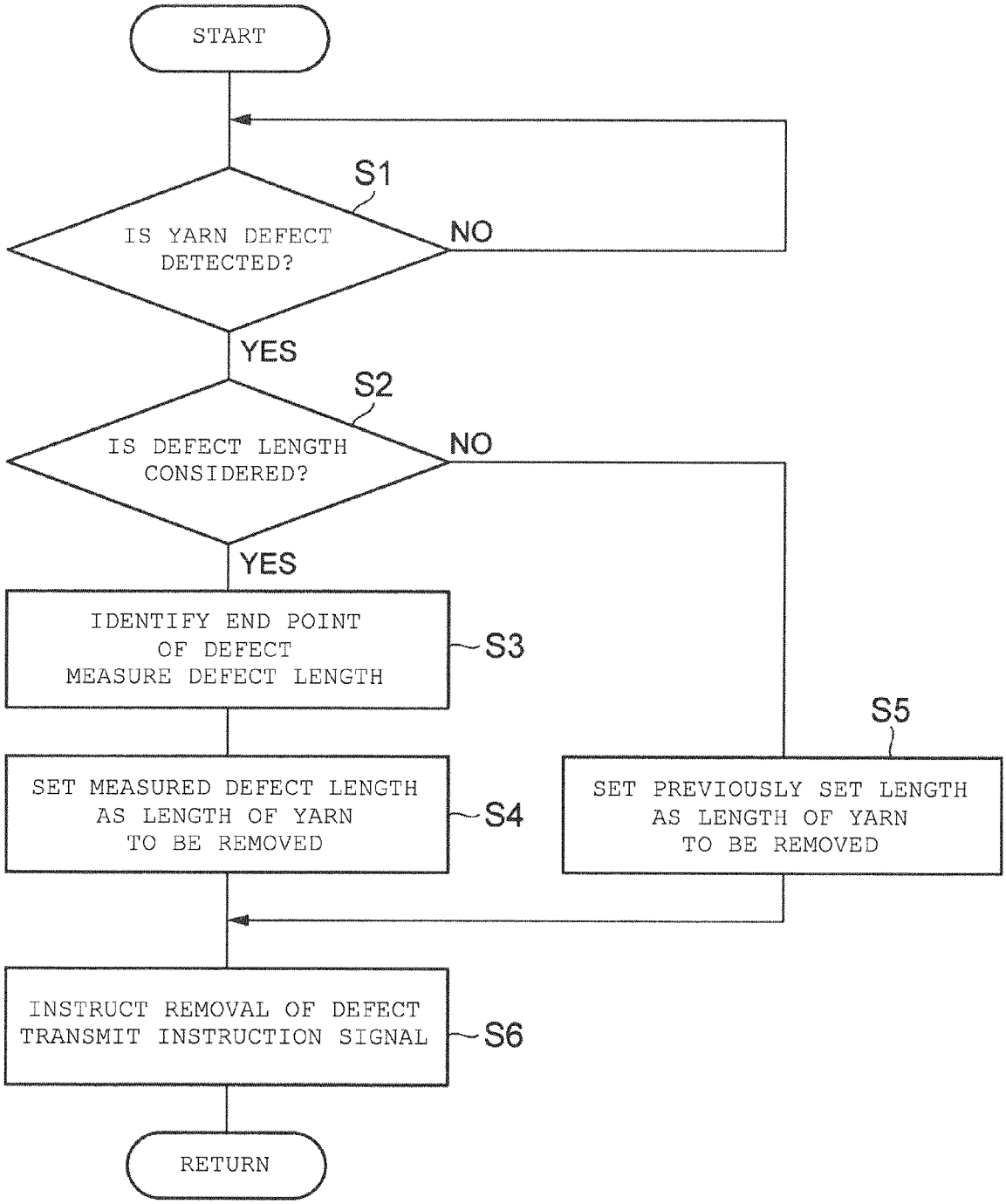

THICKNESS
TIME
G1
G2
K
C1
C2
L1
L2
DETECTION OF YARN UNEVENNESS
REFERENCE LENGTH
YARN DEFECT DETECTION OF (THICKNESS UNEVENNESS)
IDENTIFICATION OF END POINT OF YARN DEFECT

FIG. 8

DEFECT TYPE	DETECTION CONDITION (THICKNESS)	DEFECT LENGTH	SCHEMATIC VIEW OF DEFECT
NEP	200% OR MORE	NOT CONSIDERED	
SLUB	150% OR MORE AND LESS THAN 200%	NOT CONSIDERED	
THICK PLACE	110% OR MORE AND LESS THAN 150%	TO BE MEASURED	
THIN PLACE	EQUAL TO OR LESS THAN 90%	TO BE MEASURED	

FIG. 9


START
S1
IS YARN DEFECT DETECTED?
NO
YES
S2
IS DEFECT LENGTH CONSIDERED?
NO
YES
IDENTIFY END POINT OF DEFECT MEASURE DEFECT LENGTH
S3
S5
SET MEASURED DEFECT LENGTH AS LENGTH OF YARN TO BE REMOVED
S4
SET PREVIOUSLY SET LENGTH AS LENGTH OF YARN TO BE REMOVED
INSTRUCT REMOVAL OF DEFECT TRANSMIT INSTRUCTION SIGNAL
S6
RETURN

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4436938 B **[0002]**