



(11)

EP 4 450 442 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.10.2024 Bulletin 2024/43

(51) International Patent Classification (IPC):
B65H 69/06 (2006.01) **B65H 63/06** (2006.01)
D01H 13/22 (2006.01)

(21) Application number: **24166946.4**

(52) Cooperative Patent Classification (CPC):
B65H 63/064; B65H 63/06; B65H 63/065;
B65H 69/06; D01H 13/22; B65H 2701/319

(22) Date of filing: **27.03.2024**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

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

(72) Inventor: **SAWADA, Akira**
Kyoto-shi, Kyoto 612-8686 (JP)

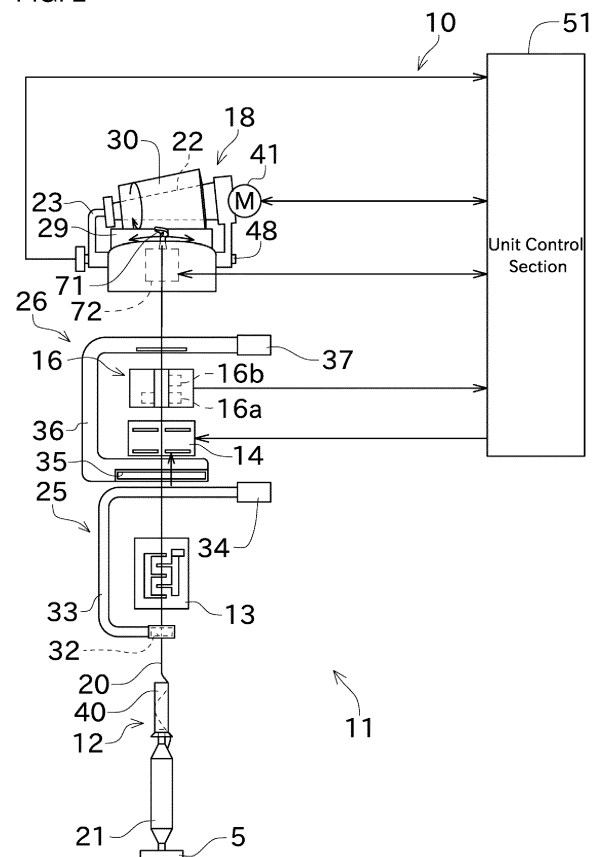
(74) Representative: **Stöckeler, Ferdinand et al**
Schoppe, Zimmermann, Stöckeler
Zinkler, Schenk & Partner mbB
Patentanwälte
Radtkoferstrasse 2
81373 München (DE)

(30) Priority: **21.04.2023 JP 2023069714**

(54) **YARN WINDING MACHINE**

(57) An automatic winder includes a monitoring section 16, a yarn splicing section 14, a winding section 18, and a unit control section 51. The monitoring section 16 monitors a state of the yarn 20. The yarn splicing section 14 is arranged upstream of the monitoring section 16 in a running direction of the yarn 20, and splices the yarn 20 on a tray 5 side and the yarn 20 on a package 30 side. The winding section 18 winds the yarn 20 to form a package 30. The monitoring section 16 includes at least one of an optical sensor 16a and a capacitance sensor 16b. The optical sensor 16a detects the thickness of the yarn 20. The capacitance sensor 16b detects the mass of the yarn 20. The unit control section 51 determines the presence or absence of the core fiber in the seam region, based on a detection result of the monitoring section 16 for a seam region where the yarn is spliced by the yarn splicing section 14.

FIG. 2



Description

Technical field

[0001] The present invention mainly relates to a winding machine for winding a yarn including a core fiber and a cover fiber.

Background Art

[0002] Patent Document 1 is JP H03-167330A.

[0003] Patent Document 1 discloses a method for detecting an abnormality in a yarn (core yarn) in which a cover fiber (binding yarn) is wound around a core fiber (core). In such a method, the yarn is passed between a light source and a light receiver, and light is radiated from the light source toward the light receiver. An amount of light received by the light receiver changes depending on a thickness of the yarn. Therefore, it is possible to detect yarn unevenness, based on the amount of light received by the light receiver. In Patent Document 1, yarn abnormality, in particular, missing of a cover fiber, is detected based on the yarn unevenness.

Summary of Invention

[0004] If a cover fiber is missing, an outer shape of the yarn changes, and thus, it is possible to detect such a missing by using the method described in Patent Document 1. However, if a core fiber is missing, the outer shape of the yarn does not change much, and thus, it is difficult to detect the missing by using such a method. The core fiber may be missing in a seam region formed by yarn splicing.

[0005] The present invention has been made in view of the above circumstances, and a primary object thereof is to provide a yarn winding machine capable of detecting missing of a core fiber in a seam region.

Means for Solving Problems and Effects Thereof

[0006] The problem to be solved by the present invention is thus described, and next, the means for solving such a problem and the effects thereof will be described.

[0007] According to an aspect of the present invention, a yarn winding machine having the following configuration is provided. That is, the yarn winding machine includes a yarn supplying section, a monitoring section, a yarn splicing section, a winding section, and a control section. The yarn supplying section supplies a yarn including a core fiber formed of an elastic yarn and a cover fiber wound around the core fiber. The monitoring section monitors a state of the yarn. The yarn splicing section is arranged upstream of the monitoring section in a running direction of the yarn, and splices a yarn on a yarn supplying section side and a yarn on a package side. The winding section winds the yarn to form a package. The monitoring section includes at least one of an optical sen-

sor and a capacitance sensor. The optical sensor detects a thickness of the yarn. The capacitance sensor detects a mass of the yarn. The control section determines the presence or absence of the core fiber in the seam region, based on a detection result of the monitoring section for the seam region where the yarn is spliced by the yarn splicing section.

[0008] As a result, it is possible to detect the presence or absence of the core fiber in the seam region, based on the detection result of the monitoring section.

[0009] In the yarn winding machine, the control section preferably controls the winding section so that a yarn winding speed, when the seam region passes through the monitoring section, is less than a yarn winding speed during a steady state.

[0010] As a result, a detection accuracy of the monitoring section is increased, and thus, it is possible to detect the presence or absence of the core fiber with even greater accuracy.

[0011] The yarn winding machine described above preferably has the following configuration. That is, the monitoring section includes the optical sensor and the capacitance sensor. The control section preferably determines the presence or absence of the core fiber in the seam region, based on a difference between the detection result of the optical sensor and the detection result of the capacitance sensor, and a threshold value previously determined, according to yarn information of the yarn that is being wound, for the difference.

[0012] When the threshold value is determined, it is possible to determine, with a simple method, the presence or absence of the core fiber. When the threshold value according to the yarn information is set, it is possible to accurately detect the presence or absence of the core fiber.

[0013] The yarn winding machine described above preferably has the following configuration. That is, the monitoring section includes the optical sensor including a reflection type sensor configured to detect reflected light reflected by the yarn. The control section determines the presence or absence of protrusion of the core fiber from the cover fiber, based on a detection result of the reflection type sensor.

[0014] As a result, it is possible to further detect the protrusion of the core fiber without adding a sensor.

[0015] The yarn winding machine described above preferably has the following configuration. That is, the monitoring section includes the optical sensor and the capacitance sensor. The optical sensor includes a transmission type sensor configured to detect transmitted light transmitting a region where the yarn is located, and a reflection type sensor configured to detect reflected light reflected by the yarn. The control section determines the presence or absence of the protrusion of the core fiber from the cover fiber, based on the detection result of the transmission type sensor, the detection result of the reflection type sensor, and the detection result of the capacitance sensor.

[0016] As a result, when the two types of sensors, that is, the optical sensor and the capacitance sensor, are used, it is possible to accurately detect the protrusion of the core fiber.

[0017] The yarn winding machine described above preferably has the following configuration. That is, the yarn winding machine includes a tension applying section capable of switching between a first state in which tension is applied to the yarn and a second state in which the tension applied to the yarn is smaller than in the first state. The control section sets the tension applying section to the second state and controls so that the seam region passes through the monitoring section.

[0018] If the core fiber in the seam region is missing, shrinkage in the seam region is unlikely to occur even if the tension is reduced. As a result, when information about the seam region is detected in a state where the tension is small, it is possible to accurately detect the presence or absence of the core fiber in the seam region.

[0019] In the yarn winding machine, it is preferable that the control section controls so that the tension applying section is set to the second state and the seam region passes through the monitoring section, and subsequently, controls so that a position of the seam region is returned to upstream of the monitoring section, the tension applying section is set to the first state, and the seam region passes through the monitoring section.

[0020] As a result, it is possible to change the tension and detect information about the seam region without providing the two monitoring sections.

[0021] The yarn winding machine described above preferably has the following configuration. That is, the yarn winding machine includes a second monitoring section arranged downstream of the monitoring section in a running direction of the yarn, the second monitoring section configured to monitor a state of the yarn. The control section controls so that the tension applying section is set to the second state and the seam region passes through the monitoring section, and controls so that the tension applying section is set to the first state and the seam region passes through the second monitoring section.

[0022] As a result, it is possible to detect the information about the seam region by changing the tension without moving the yarn in an opposite direction.

[0023] The yarn winding machine described above preferably has the following configuration. That is, the yarn winding machine is arranged upstream of the monitoring section in the running direction of the yarn, and includes an expansion contraction detection section configured to detect expansion and contraction of the yarn. The control section determines the presence or absence of the core fiber in the seam region, based on the detection result of the monitoring section for the seam region and a detection result of the expansion contraction detection section for the yarn.

[0024] As a result, it is possible to utilize a low-cost sensor as long as it is possible to detect the expansion

and contraction of the yarn.

[0025] The yarn winding machine described above preferably has the following configuration. That is, the yarn winding machine includes a tension applying section capable of switching between a first state in which tension is applied to the yarn and a second state in which the tension applied to the yarn is smaller than the first state. The control section determines the presence or absence of the core fiber in the seam region, based on the detection result of the expansion contraction detection section when the tension applying section is in the first state and the detection result of the expansion contraction detection section when the tension applying section is in the second state.

[0026] When the tension applying section is provided, it is possible to intentionally generate the expansion and contraction of the yarn, and thus, it is possible to accurately detect the expansion and contraction of the seam region.

[0027] In the yarn winding machine described above, it is preferable that the control section changes an operation setting of the yarn splicing section at the time of yarn splicing, based on the detection result of the monitoring section.

[0028] As a result, it is possible to change the operation setting of the yarn splicing so that a yarn abnormality is less likely to occur.

[0029] The yarn winding machine described above preferably has the following configuration. That is, the yarn winding machine includes an imaging device configured to image the seam region. The control section determines the presence or absence of the protrusion of the core fiber from the cover fiber, based on an imaging result of the imaging device.

[0030] As a result, it is possible to detect the protrusion of the core fiber.

Brief Description of Drawings

[0031]

FIG. 1 is a front view of an automatic winder according to a first embodiment.

FIG. 2 is a front view and a block diagram of a winding unit.

FIG. 3 is a cross-sectional view illustrating a configuration of a yarn.

FIG. 4 is a graph showing a difference in detection result between a normal state and a state where a core fiber is missing.

FIG. 5 is a flowchart illustrating a process of determining the presence or absence of a core fiber in a seam region.

FIG. 6 is a flowchart illustrating a process of determining the presence or absence of a core fiber in a seam region according to a second embodiment.

FIG. 7 is a flowchart illustrating a flow of an operation of a winding unit according to the second embodi-

ment.

FIG. 8 is a flowchart illustrating a process of determining the presence or absence of a core fiber in a seam region according to a third embodiment.

FIG. 9 is a front view of a winding unit according to the third embodiment.

FIG. 10 is a flowchart illustrating a process of detecting protrusion of a core fiber according to a fourth embodiment.

FIG. 11 is a front view of a winding unit according to the fourth embodiment.

FIG. 12 is a front view of a winding unit according to a fifth embodiment.

Description of Embodiments

[0032] Next, with reference to the drawings, an embodiment of the present invention will be described. It is noted that "upstream" and "downstream" as used herein mean an upstream and a downstream in a running direction of a yarn during winding the yarn.

[0033] As illustrated in FIG. 1, an automatic winder (yarn winding machine) 1 of a first embodiment includes a plurality of winding units 10 arranged side by side, a doffing apparatus 60, and a machine control apparatus 90.

[0034] As illustrated in FIG. 2, each winding unit 10 traverses a yarn 20 unwound from a yarn supplying bobbin 21 set on a tray (yarn supplying section) 5 while winding the yarn 20 on a cone-shaped winding tube 22 supported by a cradle 23, to form a cone-shaped package 30. It is noted that the winding unit 10 may be configured to wind the yarn 20 around the winding tube 22 having a cylindrical shape to form the package 30 having a cheese shape.

[0035] As illustrated in FIG. 3, the yarn 20 wound by the winding unit 10 includes a core fiber 20a and a cover fiber 20b. The core fiber 20a is an elastic yarn or a synthetic yarn. Examples of the core fiber 20a includes polyurethane, nylon, or acrylic. The core fiber 20a has elasticity. The elasticity means that a high elasticity is provided as compared to the cover fiber 20b or a typical natural fiber yarn. The cover fiber 20b is wound around an outer periphery of the core fiber 20a. The cover fiber 20b may be a natural fiber yarn, an elastic yarn, or a synthetic yarn.

[0036] The doffing apparatus 60 runs to a position of the winding unit 10 where the package 30 is fully wound, and removes the fully wound package 30 of the winding unit 10 from the cradle 23. The doffing apparatus 60 further supplies the winding tube 22 around which the yarn 20 is not wound yet, to the winding unit 10.

[0037] The machine control apparatus 90 includes a machine input section 91 and a machine display unit 92. In the machine input section 91, an operator inputs a predetermined setting value or selects an appropriate control method, and thus, it is possible to perform setting on each winding unit 10. The operator sets, for example, information about the yarn 20 to be wound (yarn infor-

mation). The yarn information includes at least one of a material (type), a thickness (count), and the number of twists of each of the core fiber 20a and the cover fiber 20b.

[0038] Next, with reference to FIG. 2, a configuration of the winding unit 10 will be specifically described. As illustrated in FIG. 2, each winding unit 10 includes a winding unit main body 11 and a unit control section (control section) 51.

[0039] The unit control section 51 includes, for example, an arithmetic apparatus such as a CPU, a RAM, a ROM, an I/O port, and a communication port. The ROM is recorded thereon with a program for controlling each component of the winding unit main body 11. The I/O port and the communication port are connected with each component provided in the winding unit main body 11 and the machine control apparatus 90, as a result of which it is possible to perform communication of control information and the like. As a result, the unit control section 51 is capable of controlling an operation of each component included in the winding unit main body 11.

[0040] The winding unit main body 11 includes, in order from the upstream side, a yarn unwinding auxiliary device 12, a tension applying section 13, a yarn splicing section 14, a monitoring section 16, and a winding section 18.

[0041] The yarn unwinding auxiliary device 12 lowers a regulating member 40 covering a core tube of the yarn supplying bobbin 21 in conjunction with unwinding of the yarn 20 from the yarn supplying bobbin 21 to assist with unwinding the yarn 20 from the yarn supplying bobbin 21. The regulating member 40 contacts a balloon formed on an upper part of the yarn supplying bobbin 21 due to rotation of the yarn 20 unwound from the yarn supplying bobbin 21 and a centrifugal force, and controls such a balloon to an appropriate size to assist with unwinding the yarn 20.

[0042] The tension applying section 13 applies a predetermined tension to the running yarn 20. The tension applying section 13 is of a gate type in which movable comb teeth are arranged relative to fixed comb teeth. The movable comb teeth are capable of rotation by a rotary solenoid. As a result, it is possible to change the tension to be applied by the tension applying section 13 to the yarn 20. It is noted that in addition to the gate type described above, for example, it is possible to adopt a disk type as the tension applying section 13.

[0043] The yarn splicing section 14 splices a lower yarn on a yarn supplying bobbin 21 side (yarn on a yarn supplying section side) and an upper yarn on a package 30 side (yarn on a package side), when the monitoring section 16 cuts a yarn after detecting a yarn defect or when a yarn unwound from the yarn supplying bobbin 21 is cut, for example. Specifically, when the yarn splicing section 14 splices a lower yarn and an upper yarn which have been first untwisted, overlapped, and twisted again. In the following description, a location where a yarn is spliced will be referred to as a seam region. It is possible to adopt a mechanical configuration or a configuration using a fluid such as compressed air for the yarn splicing

section 14.

[0044] The monitoring section 16 monitors a state of the yarn 20. In detecting an abnormality in the yarn 20, the monitoring section 16 cuts the yarn 20 using an unillustrated cutter. The monitoring section 16 includes an optical sensor 16a and a capacitance sensor 16b. The optical sensor 16a and the capacitance sensor 16b are fixed to one case. However, the optical sensor 16a and the capacitance sensor 16b may be fixed to separate cases and placed apart from each other. The monitoring section 16 may include only one of the optical sensor 16a and the capacitance sensor 16b.

[0045] The optical sensor 16a is a transmission type sensor and includes a light source and a light receiving section. The light source and the light receiving section are arranged on one side and the other side across a yarn path. The light source radiates light toward the yarn path (towards the light receiving section). The light receiving section receives the light radiated by the light source and transmitted through the yarn 20. As a result, as the yarn 20 becomes thicker, an amount of light received by the light receiving section decreases. As described above, the optical sensor 16a is capable of detecting a thickness of the yarn 20. A detection result of the optical sensor 16a is output to the unit control section 51. The detection result as used herein includes not only a value directly detected by a sensor (detected value), but also a value obtained by converting the detected value, and a value calculated based on the detected value.

[0046] The capacitance sensor 16b detects a change in capacitance caused by the presence or absence of the yarn 20. A mass of the yarn 20 (in other words, an amount of fibers) is calculated from the detected change in capacitance. A thickness of the yarn 20 is determined based on the mass of the yarn 20. However, if the core fiber 20a is missing, the mass of the yarn 20 is lower than the thickness of the yarn 20 in appearance. A detection result of the capacitance sensor 16b is output to the unit control section 51.

[0047] On the downstream and upstream sides of the yarn splicing section 14, a lower yarn catching member 25 configured to catch a yarn end of the lower yarn on the yarn supplying bobbin 21 side and guide the caught yarn end to the yarn splicing section 14, and an upper yarn catching member 26 configured to catch a yarn end of the upper yarn on the package 30 side and guide the caught yarn end to the yarn splicing section 14 are arranged, respectively. The lower yarn catching member 25 includes a lower yarn pipe arm 33 and a lower yarn suction port 32 formed at a distal end of the lower yarn pipe arm 33. The upper yarn catching member 26 includes an upper yarn pipe arm 36 and an upper yarn suction port 35 formed at a distal end of the upper yarn pipe arm 36.

[0048] The lower yarn pipe arm 33 and the upper yarn pipe arm 36 are rotatable about shafts 34 and 37, respectively. The lower yarn pipe arm 33 and the upper yarn pipe arm 36 are connected with appropriate suction

sources (not illustrated), respectively. As a result, suction flows are generated in the lower yarn suction port 32 and the upper yarn suction port 35, and thus, it is possible to suction and catch the yarn ends of the upper yarn and the lower yarn, respectively, by the lower yarn pipe arm 33 and the upper yarn pipe arm 36.

[0049] The winding section 18 includes the cradle 23 configured to detachably support the winding tube 22, a contact roller 29 capable of rotation in contact with an outer peripheral surface of the winding tube 22 or an outer peripheral surface of the package 30, a traverse arm 71, and a traverse drive motor 72.

[0050] The cradle 23 is rotatable about a rotation shaft 48. When a yarn layer widens along with the yarn 20 wound around the winding tube 22, the cradle 23 rotates accordingly. As a result, it is possible to eliminate an influence of a shape change due to the widening of the yarn layer.

[0051] The cradle 23 is attached with a package drive motor 41. When the winding tube 22 is rotationally driven by the package drive motor 41, the yarn 20 is wound around the winding tube 22. When the winding tube 22 is supported on the cradle 23, a motor shaft of the package drive motor 41 is connected so as not to rotate relative to the winding tube 22 (so-called direct drive system). An operation of the package drive motor 41 is controlled by the unit control section 51 via a motor driver (not illustrated). It is noted that instead of the direct drive method, the package 30 may be rotationally driven by rotating a contact roller brought into contact with the package 30.

[0052] The traverse arm 71 engages with the yarn 20 to traverse the yarn 20. The traverse arm 71 is driven by the traverse drive motor 72. Specifically, the traverse arm 71 is provided to continuously reciprocate in a package width direction (axial direction of the winding tube 22 and the package 30) in conjunction with the rotation of a rotor of the traverse drive motor 72. An operation of the traverse drive motor 72 is controlled by the unit control section 51 via an unillustrated motor driver. For example, a distal end of the traverse arm 71 is formed with a hook-shaped yarn guide section, for example. When the traverse arm 71 is reciprocated and turned in a state where the yarn 20 is held by the yarn guide section, it is possible to traverse the yarn 20. It is noted that, instead of the traverse arm 71, a traverse groove formed on the contact roller may be used to traverse the yarn 20.

[0053] When the package 30 is rotationally driven while the yarn is traversed by the traverse arm 71, the yarn 20 is wound around the winding tube 22 to realize formation of the package 30.

[0054] Next, with reference to FIG. 4 and FIG. 5, a process for determining the presence or absence of the core fiber 20a in the seam region will be described.

[0055] When the yarn splicing section 14 performs yarn splicing, the core fiber 20a may miss in the seam region due to an elasticity of the core fiber 20a. In a conventional configuration, it is difficult to detect whether the core fiber

20a is missing. For example, the optical sensor 16a detects an external appearance of the yarn 20, and thus, it is not possible to detect an internal state of the yarn 20. The capacitance sensor 16b detects the mass of the yarn 20, and thus, a value in which the internal state of the yarn 20 is taken into account is detected, but it is not possible to determine whether the mass is small due to the missing of the core fiber 20a, or whether the mass is small due to the yarn 20 itself being thin.

[0056] In this regard, in the present embodiment, when the both optical sensor 16a and capacitance sensor 16b are provided, it is possible to detect the missing of the core fiber 20a. Specifically, a difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b is used. The detection result of the optical sensor 16a is a thickness of the yarn 20, and the detection result of the capacitance sensor 16b is a mass of the yarn 20. Therefore, in order to calculate the difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b, it is necessary to use a comparable unit for the two detection results. Here, based on the yarn information input by the operator to the machine control apparatus 90, it is possible to know a density of the yarn 20. Based on the thickness of the yarn 20 and the density of the yarn 20, it is possible to calculate the mass of the yarn 20. Therefore, it is possible to convert the thickness of the yarn 20 detected by the optical sensor 16a into the mass of the yarn 20. As a result, when the mass of the yarn 20 is used, it is possible to calculate the difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b. Further, based on the mass of the yarn 20 and the density of the yarn 20, it is possible to calculate the thickness of the yarn 20. Therefore, it is possible to convert the mass of the yarn 20 detected by the capacitance sensor 16b into the thickness of the yarn 20. As a result, when the thickness of the yarn 20 is used, it is also possible to calculate the difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b.

[0057] A graph in the upper part of FIG. 4 shows the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b for the yarn 20 in a normal state (that is, the yarn 20 including the core fiber 20a and the cover fiber 20b). A graph in the lower part of FIG. 4 shows the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b for the yarn 20 with the core fiber 20a missing (that is, the cover fiber 20b). A difference in detection result for the yarn 20 with the core fiber 20a missing is larger than a difference in detection result for the yarn 20 in the normal state. This is because, in the normal state and in the state where the core fiber 20a is missing, the detection result of the optical sensor 16a does not change significantly, but the detection result of the capacitance sensor 16b changes greatly. Taking advantage of such a feature, in the present embodiment, the difference be-

tween the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b for the seam region is used to determine the presence or absence of the missing of the core fiber 20a in the seam region.

[0058] With reference to a flowchart in FIG. 5, such a process will be described in detail below. The flowchart illustrated in FIG. 5 is executed by the unit control section 51. After starting a yarn splicing (S101), the unit control section 51 reads threshold value information (S102). The threshold value information is information in which yarn information and a threshold value are associated with each other, and is previously stored in the unit control section 51. The unit control section 51 selects and reads a corresponding threshold value, based on the yarn information input by the operator to the machine control apparatus 90. It is noted that a timing at which the threshold value information is read is just one example, and the threshold information may be read before the start of the yarn splicing. Instead of the process of reading the threshold value every time the yarn is spliced, the unit control section 51 may continue to store the same threshold value until the yarn information is changed, for example.

[0059] The threshold value is used to determine whether the core fiber 20a is missing in the seam region. Therefore, the threshold value indicated by the threshold value information is larger than a value (average value of the differences, for example) based on the difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b in the normal state. The threshold value indicated by the threshold value information is smaller than a value (average value of the differences, for example) based on the difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b in a state where the core fiber 20a in the seam region is missing.

[0060] Next, the unit control section 51 specifies the timing at which the seam region passes through the monitoring section 16, and reduces a winding speed at such a timing (S103). Here, the unit control section 51 performs control regarding the yarn splicing, and thus, the timing at which the yarn splicing is completed is known. The unit control section 51 controls the winding section 18, and thus, the winding speed of the yarn 20 is known. A distance from the yarn splicing section 14 to the monitoring section 16 is known. Thus, the unit control section 51 is capable of specifying the timing at which the seam region passes through the monitoring section 16. Alternatively, the unit control section 51 may estimate that the seam region passes through the monitoring section 16 at a timing when a predetermined period of time elapses since the completion of the yarn splicing. The predetermined time may be evaluated in advance experimentally or by simulation and stored in the unit control section 51.

[0061] The winding speed is decreased by the unit control section 51 controlling the winding section 18. When

the winding speed is decreased, the winding speed at the timing when the seam region passes through the monitoring section 16 is less than the winding speed during a steady state. The winding speed during a steady state is a winding speed set as a winding condition. In other words, such a winding speed is a winding speed while the yarn 20 is wound to form the package 30 (excluding when the yarn is spliced). It is noted that as a result of the decrease in winding speed, the winding speed obtained when the seam region is located at the monitoring section 16 may be 0. Instead of the process of decreasing the winding speed, the winding may be restarted at a winding speed less than the winding speed during a steady state after the yarn splicing, and in such a state, the seam region may pass through the monitoring section 16.

[0062] Next, the unit control section 51 obtains the detection result of the seam region (hereinafter referred to as a first detection result) by the optical sensor 16a at the timing when the seam region passes through the monitoring section 16 (S104). The unit control section 51 obtains the detection result (hereinafter referred to as a second detection result) of the seam region by the capacitance sensor 16b at the timing when the seam region passes through the monitoring section 16 (S105). The winding speed is decreased at the timing when the seam region passes through the monitoring section 16, and thus, the optical sensor 16a and the capacitance sensor 16b are capable of accurately detecting the state of the yarn 20.

[0063] Next, the unit control section 51 compares the difference between the first detection result and the second detection result with a threshold value (S106). Such a process is performed by making the units of the first detection result and the second detection result comparable, as described above. A method for calculating the difference includes, for example, calculating a difference between an average value of the detection results of the optical sensor 16a and an average value of the detection results of the capacitance sensor 16b. Alternatively, another method may include calculating the difference between the first detection result and the second detection result.

[0064] The unit control section 51 determines whether the difference is less than or equal to the threshold value (S107). As described above, when the core fiber 20a is missing, the second detection result is larger than the first detection result. That is, when the difference is less than or equal to the threshold value, the unit control section 51 determines that the core fiber 20a is present in the seam region (S108). On the other hand, if the difference exceeds the threshold value, the unit control section 51 determines that there is no core fiber 20a in the seam region, and notifies as such (S109). In a notification method, for example, the machine control apparatus 90 or the unit control section 51 may light or blink an alarm lamp, or may generate an alarm sound. Alternatively, the unit control section 51 may transmit a message to an operator

terminal or an administrator terminal.

[0065] Thus, when the detection results of the optical sensor 16a and the capacitance sensor 16b are used, it is possible to accurately detect whether or not the core fiber 20a is missing in the seam region of the yarn 20.

[0066] If there is no core fiber 20a in the seam region, there may be room for improvement in an operation setting of the yarn splicing section 14. For example, if an overlapping length of the lower yarn on a yarn supplying bobbin 21 side and an upper yarn on the package 30 side is short, the core fiber 20a may be missing. Therefore, when an amount of operation of a yarn pulling lever that pulls a yarn is increased, the core fiber 20a may be less likely to be missing. Alternatively, when a time for untwisting or twisting is lengthened, the core fiber 20a may be less likely to be missing. In the present embodiment, in determining that there is no core fiber 20a in the seam region, the unit control section 51 changes the operation setting of the yarn splicing section 14 (S110). As a result, during a subsequent yarn splicing, it is possible to reduce a probability that the core fiber 20a is missing. It is noted that the process in step S110 is not essential and may be omitted or executed once every three times, for example.

[0067] In the present embodiment, when the core fiber 20a is missing, a notification to such an effect is applied and the process is continued. Instead of such a process, the yarn splicing may be attempted again. The attempting again of the yarn splicing means that the monitoring section 16 cuts the yarn 20, and the yarn splicing section 14 performs the yarn splicing between the lower yarn on the yarn supplying bobbin 21 side and the upper yarn on the package 30 side again. In the attempting again of the yarn splicing, the change in the operation setting of the yarn splicing section 14 set in step S 110 is applied, and thus, the core fiber 20a is less likely to be missing.

[0068] Next, with reference to FIG. 6 and FIG. 7, a second embodiment will be described. It is noted that in the following description, a configuration other than the explicitly stated parts has the same configuration as the automatic winder 1 of the first embodiment. The same steps as those in the first embodiment are allotted the same step numbers, and the description thereof will be omitted.

[0069] In the second embodiment, the presence or absence of the core fiber 20a is determined by changing a tension of the yarn 20. As described above, the unit control section 51 controls the tension applying section 13 to change an amount of operation of the movable comb teeth to thereby change the tension of the yarn 20. Hereinafter, a state where the tension applying section 13 applies a first tension to the yarn 20 is called a first tension and a state where the tension applying section 13 applies a second tension (tension smaller than the first tension) to the yarn 20 is called a second state. When the tension applying section 13 is switched from the first state to the second state, the yarn 20 is loosened, and thus, the yarn 20 is likely to shrink.

[0070] A method of reducing the tension of the yarn 20 to shrinking the yarn 20 is not limited to using the tension applying section 13. For example, the unit control section 51 is capable of shrinking the yarn 20 by controlling the winding section 18 to decrease the winding speed. In such a case, the winding section 18 (more specifically, the package drive motor 41) corresponds to the "tension applying section". For example, the unit control section 51 is capable of increasing the tension by the yarn splicing section 14 (more specifically, the yarn pulling lever that pulls the yarn 20) coming into contact with the yarn 20, after the yarn splicing by the yarn splicing section 14, and capable of shrinking the yarn 20 by reducing the tension by releasing the contact of the yarn 20 by the yarn splicing section 14. In such a case, the yarn splicing section 14 (more specifically, the yarn pulling lever) corresponds to the "tension applying section". For example, the unit control section 51 is capable of increasing the tension applied to the yarn 20 by injecting a cleaning compressed air of the monitoring section 16 to the yarn 20, and capable of shrinking the yarn 20 by reducing the tension by releasing the injection of the compressed air. In such a case, the monitoring section 16 (more specifically, a compressed air injection section) corresponds to the "tension applying section". When the compressed air is injected to the yarn 20, it is possible to influence a tension change locally applied to the yarn 20 to other parts of the yarn 20.

[0071] When the core fiber 20a is included in the seam region, the seam region and other parts shrink to the same extent. When there is no core fiber 20a in the seam region, expansion and contraction is less likely to occur due to the absence of the core fiber 20a, and thus, an amount of shrinkage in the seam region is smaller than an amount of shrinkage in other parts. That is, the amount of shrinkage in the seam region differs depending on the tension applied to the yarn 20, and thus, the detection results of the seam regions with different tension application conditions are compared, so that it is possible to determine the presence or absence of the core fiber 20a in the seam region. When the amounts of shrinkage between the seam region and the other parts are compared, it is also possible to determine the presence or absence of the core fiber 20a in the seam region.

[0072] In the second embodiment, after the yarn splicing (S101, upper left in FIG. 7), the unit control section 51 sets the tension applying section 13 to the second state (S201). The unit control section 51 obtains the detection results of the optical sensor 16a and the capacitance sensor 16b at the timing when the seam region (reference numeral 20c in FIG. 7) passes through the monitoring section 16 (S202, upper right in FIG. 7).

[0073] Next, after the seam region passes through the monitoring section 16, the unit control section 51 returns the yarn 20 to the upstream side of the monitoring section 16 (S203, lower left in FIG. 7). Specifically, the unit control section 51 suctions the yarn 20 by using an auxiliary nozzle 81 while controlling the winding section 18 to reverse

the package 30. As a result, the seam region is sent back to the upstream side. It is noted that instead of the auxiliary nozzle 81, the lower yarn catching member 25 may be used to suction the yarn 20. Alternatively, the yarn pulling lever of the yarn splicing section 14 may be used to move the yarn 20 to the upstream side.

[0074] Next, the unit control section 51 sets the tension applying section 13 to the first state (S204). As a result, the tension of the yarn 20 is increased. The unit control section 51 obtains the detection results of the optical sensor 16a and the capacitance sensor 16b at the timing when the seam region passes through the monitoring section 16 again (S205, lower right in FIG. 7).

[0075] Next, the unit control section 51 compares the first and second detection results (S206). Specifically, the unit control section 51 compares a degree of shrinkage in the seam region between the first and second times. At the first time, the tension of the yarn 20 is small, and thus, the yarn 20 is likely to shrink. However, if there is no core fiber 20a in the seam region, the seam region shrinks only little. On the other hand, at the second time, the tension of the yarn 20 is large, and thus, the yarn 20 does not shrink, and the yarn 20 is likely to be straight. That is, when the core fiber 20a is present in the seam region, a difference in degree of shrinkage between the first and second times is large. On the other hand, if there is no core fiber 20a in the seam region, the difference in degree of shrinkage between the first and second times is small. The unit control section 51 compares the first-time degree of shrinkage in the seam region with the second-time degree of shrinkage in the seam region. When the degree of shrinkage is large, an amount of fibers in the yarn 20 per unit length increases, and thus, the thickness of the yarn 20 detected by the optical sensor 16a and the thickness of the yarn 20 detected by the capacitance sensor 16b increase, and therefore, it is possible to detect the degree of shrinkage by using these sensors. The unit control section 51 compares the threshold value in much the same way as in the first embodiment, based on a comparison value obtained by such a comparison. Subsequent processes are the same as those in the first embodiment.

[0076] As described above, based on the degree of shrinkage obtained when the tensions are differed, it is possible to determine the presence or absence of the core fiber 20a in the seam region. In the second embodiment, the first-time detection result is obtained with the tension applying section 13 being in the second state, and next, the second-time detection result is acquired with the tension applying section 13 being in the first state. In other words, a state where the tension is small is changed to a state where the tension is large. Therefore, a level of tension applied to the yarn 20 is not likely to spread in the running direction of the yarn 20, and thus, it is possible to obtain a more appropriate detection result.

[0077] It is noted that in the second embodiment, the seam region is measured twice. Alternatively, the seam region may be measured only once with a small change

in tension. In such a case, the unit control section 51 compares the degree of shrinkage in the seam region with the degree of shrinkage in regions other than in the seam region. When the core fiber 20a is present in the seam region, the degree of shrinkage is the same in the seam region and other regions. When there is no core fiber 20a in the seam region, the degree of shrinkage in the seam region is smaller than the degree of shrinkage in the other regions. Thus, even if the seam region is measured only once, it is possible to determine the presence or absence of the core fiber 20a in the seam region, based on the degree of shrinkage.

[0078] It is noted that instead of the processes of the second embodiment, it may be possible that firstly, the tension applying section 13 is set in the first state and the first detection result by the monitoring section 16 is obtained, and next, the tension applying section 13 is set to the second state and the second detection result by the monitoring section 16 is obtained.

[0079] The processes of the first embodiment and the second embodiment may be combined. That is, if it is determined that in the process of the first embodiment, the core fiber 20a is present in the seam region and it is further determined that in the process of the second embodiment, the core fiber 20a is present in the seam region, it may be determined that the core fiber 20a is present in the seam region.

[0080] Next, with reference to FIG. 8 and FIG. 9, a third embodiment will be described.

[0081] In the second embodiment, the yarn 20 is returned and passed through the same monitoring section 16 twice, whereas in the third embodiment, the yarn 20 is not returned but passed through two monitoring sections in order. Therefore, as illustrated in FIG. 9, the winding unit 10 of the third embodiment further includes a second monitoring section 17. The second monitoring section 17 is arranged downstream of the monitoring section 16. Similarly to the monitoring section 16, the second monitoring section 17 includes an optical sensor 17a and a capacitance sensor 17b.

[0082] The unit control section 51 sets the tension applying section 13 to the second state (S401), passes the seam region through the monitoring section 16, and obtains the detection results in the seam region by the optical sensor 16a and the capacitance sensor 16b (S402). Next, after the seam region passes through the monitoring section 16, the unit control section 51 sets the tension applying section 13 to the first state (S403), passes the seam region through the second monitoring section 17, and obtains the detection results of the seam region by the optical sensor 17a and the capacitance sensor 17b (S404).

[0083] As a result, in the third embodiment, it is possible to obtain a similar detection result to that of the second embodiment without a need of returning the yarn 20. Subsequent processes are the same as those in the second embodiment.

[0084] In the third embodiment, the monitoring section

16 and the second monitoring section 17 have the same configuration. Instead, the monitoring section 16, and an expansion contraction detection section which is a simpler sensor than the monitoring section 16, may be provided. The simpler sensor is, for example, an optical sensor or a capacitance sensor having lower accuracy than the monitoring section 16. Alternatively, the simpler sensor may be an image capturing apparatus. In such a case, the expansion contraction detection section is arranged upstream of the monitoring section 16. The expansion contraction detection section measures the seam region when the tension applying section 13 is in the second state, and thereafter, the monitoring section 16 measures the seam region when the tension applying section 13 is in the first state. Although it is preferable that the expansion contraction detection section measures the seam region, the expansion contraction detection section may measure regions other than the seam region.

[0085] Next, with reference to FIG. 10 and FIG. 11, a fourth embodiment will be described.

[0086] The automatic winder 1 of the fourth embodiment further includes a function of detecting protrusion of the core fiber 20a in the seam region. Specifically, as illustrated in FIG. 11, the winding unit 10 includes an imaging device 19. The imaging device 19 is arranged downstream of the yarn splicing section 14. In the present embodiment, in the vicinity of the yarn splicing section 14, in particular, in the running direction of the yarn, the imaging device 19 is arranged between the yarn splicing section 14 and the monitoring section 16. When the imaging device 19 is arranged at such a position, it is possible to image the yarn 20 after the yarn splicing is performed and in a state where the yarn 20 stops running. It is noted that the imaging device 19 may be arranged downstream of the monitoring section 16. The imaging device 19 images the yarn and outputs an imaging result to the unit control section 51.

[0087] The unit control section 51 obtains the result of (an image obtained by imaging) the seam region imaged by the imaging device 19 (S501). The unit control section 51 determines the presence or absence of the protrusion of the core fiber 20a in the seam region, based on the imaging result of the seam region (S502). The unit control section 51 analyzes the imaging result of the seam region, and if it is possible to identify the core fiber 20a protruded from the cover fiber 20b, it determines that the core fiber 20a is protruded. In determining that there is protrusion of the core fiber 20a in the seam region (S503), the unit control section 51 notifies that the core fiber 20a is protruded (S504). The notification method is the same as in the first embodiment.

[0088] Next, with reference to FIG. 12, a fifth embodiment will be described.

[0089] The automatic winder 1 of the fifth embodiment differs from the automatic winder 1 of the fourth embodiment in the method of detecting the protrusion of the core fiber 20a in the seam region. Specifically, in addition to the capacitance sensor 16b, the monitoring section 16

of the automatic winder 1 of the fifth embodiment further includes two types of optical sensors, in particular, a transmission type sensor 16c and a reflection type sensor 16d. The transmission type sensor 16c has the same configuration as the optical sensor 16a of the first embodiment. The reflection type sensor 16d includes a light source and a light receiving section. The light source irradiates the yarn 20 with light. The light receiving section receives light irradiated by the light source and then reflected by the yarn 20. Therefore, as the yarn 20 is thicker, an amount of light detected by the light receiving section increases. The amount of light detected by the light receiving section changes depending on a state of the cover fiber 20b in the yarn 20 (that is, depending on the presence or absence of the protrusion of the core fiber 20a). It is noted that the light source may be common to the transmission type sensor 16c and the reflection type sensor 16d, or separate light sources may be provided.

[0090] In the fifth embodiment, the unit control section 51 mainly uses the reflection type sensor 16d to determine the presence or absence of the protrusion of the core fiber 20a in the seam region. That is, if the core fiber 20a protrudes in the seam region, light is reflected at such a protruded portion. Therefore, the unit control section 51 is capable of determining the presence or absence of the protrusion of the core fiber 20a in the seam region, based on the detection result of the reflection type sensor 16d.

[0091] It is noted that in order to accurately determine the presence or absence of the protrusion of the core fiber 20a in the seam region, the detection results of the capacitance sensor 16b and the transmission type sensor 16c may be further used. That is, when the amount of light detected by the reflection type sensor 16d is corrected with the amount of light detected by the transmission type sensor 16c, it is possible to accurately determine the presence or absence of the protrusion of the core fiber 20a. It is possible to use the detection result of the capacitance sensor 16b to accurately identify the position of the seam region. That is, the yarns 20 are twisted in an overlapping manner in the seam region, and thus, the mass (fiber amount) in the seam region is larger than in other locations. The capacitance sensor 16b detects the mass of the yarn 20, and thus, it is possible to identify a location where the detection result is large as the seam region. With the reflection type sensor 16d only, the light may be reflected by a foreign matter attached to the yarn 20. In such a regard, in addition to the detection result of the reflection type sensor 16d, when the detection result of the transmission type sensor 16c is used, it is possible to reduce the influence of the foreign matter and determine the presence or absence of the protrusion of the core fiber 20a in the seam region.

[0092] Although the monitoring section 16 of the above embodiment includes both the optical sensor 16a and the capacitance sensor 16b, the monitoring section 16 may include only one of the optical sensor 16a and the capacitance sensor 16b. Even with such a configuration,

it is possible to detect the missing of the core fiber 20a in the seam region by performing the following process. That is, under an influence of the presence or absence of the core fiber 20a, the detection result of the optical sensor 16a in the normal state is slightly larger than the detection result of the optical sensor 16a in the state where the core fiber 20a is missing. As described above, the detection results of the capacitance sensor 16b are significantly different between the normal state and the state where the core fiber 20a is missing. Therefore, if a threshold value having a size between such detection results is set and if the detection result is smaller than the threshold value, it is possible to determine that the core fiber 20a is missing.

[0093] As described above, the automatic winder 1 of the above embodiment includes a tray 5, the monitoring section 16, the yarn splicing section 14, the winding section 18, and the unit control section 51. The tray 5 supplies the yarn 20 including the core fiber 20a formed of an elastic yarn and the cover fiber 20b wound around the core fiber 20a. The monitoring section 16 monitors a state of the yarn 20. The yarn splicing section 14 is arranged upstream of the monitoring section 16 in the running direction of the yarn 20, and performs the yarn splicing between the yarn 20 on a tray 5 side and the yarn 20 on a package 30 side. The winding section 18 winds the yarn 20 to form the package 30. The monitoring section 16 includes at least one of the optical sensor 16a and the capacitance sensor 16b. The optical sensor 16a detects the thickness of the yarn 20. The capacitance sensor 16b detects the mass of the yarn 20. The unit control section 51 determines the presence or absence of the core fiber 20a in the seam region, based on the detection result of the monitoring section 16 for the seam region where the yarn is spliced by the yarn splicing section 14.

[0094] As a result, based on the detection result of the monitoring section 16, it is possible to detect the presence or absence of the core fiber 20a in the seam region.

[0095] In the automatic winder 1 of the above embodiment, the unit control section 51 controls the winding section 18 so that the winding speed of the yarn 20 when the seam region passes through the monitoring section 16 is less than the winding speed of the yarn 20 during a steady state.

[0096] As a result, the detection accuracy of the monitoring section 16 is increased, and thus, it is possible to further accurately detect the presence or absence of the core fiber 20a.

[0097] In the automatic winder 1 of the above embodiment, the monitoring section 16 includes the optical sensor 16a and the capacitance sensor 16b. The unit control section 51 determines the presence or absence of the core fiber 20a in the seam region, based on a difference between the detection result of the optical sensor 16a and the detection result of the capacitance sensor 16b, and a threshold value previously determined, according to the yarn information of the yarn 20 that is being wound, for the difference.

[0098] When the threshold value is determined, it is possible to determine the presence or absence of the core fiber 20a with a simpler method. When the threshold value according to the yarn information is set, it is possible to accurately detect the presence or absence of the core fiber 20a.

[0099] In the automatic winder 1 of the embodiment described above, the monitoring section 16 includes the optical sensor 16a including the reflection type sensor 16d configured to detect reflected light reflected by the yarn 20. The unit control section 51 determines the presence or absence of the protrusion of the core fiber 20a from the cover fiber 20b, based on the detection result of the reflection type sensor 16d.

[0100] As a result, it is possible to further detect the protrusion of the core fiber 20a without adding a sensor.

[0101] In the automatic winder 1 of the above embodiment, the monitoring section 16 includes the optical sensor 16a and the capacitance sensor 16b. The optical sensor 16a includes the transmission type sensor 16c configured to detect the transmitted light transmitting through the region where the yarn 20 is positioned, and the reflection type sensor 16d configured to detect the reflected light reflected by the yarn 20. The unit control section 51 determines the presence or absence of the protrusion of the core fiber 20a from the cover fiber 20b, based on the detection result of the transmission type sensor 16c, the detection result of the reflection type sensor 16d, and the detection result of the capacitance sensor 16b.

[0102] As a result, when the two types of sensors, that is, the optical sensor and the capacitance sensor 16b, are used, it is possible to accurately detect the protrusion of the core fiber 20a.

[0103] The automatic winder 1 of the above embodiment includes the tension applying section 13 capable of switching between the first state in which the tension is applied to the yarn 20 and the second state in which the tension applied to the yarn 20 is smaller than in the first state. The unit control section 51 controls so that the tension applying section 13 is set to the second state and the seam region passes through the monitoring section 16.

[0104] If the core fiber 20a in the seam region is missing, shrinkage in the seam region is unlikely to occur even if the tension is reduced. Therefore, when the information on the seam region in a state where the tension is small is detected, it is possible to accurately detect the presence or absence of the core fiber 20a in the seam region.

[0105] In the automatic winder 1 of the above embodiment, the unit control section 51 controls so that after the tension applying section 13 is set to the second state and the seam region passes through the monitoring section 16, the position of the seam region is returned to the upstream of the monitoring section 16, and the tension applying section 13 is set to the first state and the seam region passes through the monitoring section 16.

[0106] As a result, it is possible to change the tension and detect the information about the seam region without

providing the two monitoring sections 16.

[0107] The automatic winder 1 of the above embodiment includes the second monitoring section 17 arranged downstream of the monitoring section 16 in the running direction of the yarn 20 and configured to monitor the state of the yarn 20. The unit control section 51 controls so that the tension applying section 13 is set to the second state and the seam region thereafter passes through the monitoring section 16, and after the tension applying section 13 is set to the first state and the seam region thereafter passes through the second monitoring section 17.

[0108] As a result, it is possible to detect the information about the seam region by changing the tension without moving the yarn 20 in an opposite direction.

[0109] The automatic winder 1 of the above embodiment includes the expansion contraction detection section arranged upstream of the monitoring section 16 in the running direction of the yarn 20 and configured to detect the expansion and contraction of the yarn 20. The unit control section 51 determines the presence or absence of the core fiber 20a in the seam region, based on the detection result of the monitoring section 16 for the seam region and the detection result of the expansion contraction detection section for the yarn 20.

[0110] As a result, it is possible to utilize a low-cost sensor as long as it is possible to detect the expansion and contraction of the yarn 20.

[0111] The automatic winder 1 of the present embodiment includes the tension applying section 13 capable of switching between the first state in which the tension is applied to the yarn 20 and the second state in which the tension applied to the yarn 20 is smaller than in the first state. The unit control section 51 determines the presence or absence of the core fiber 20a in the seam region, based on the detection result of the expansion contraction detection section when the tension applying section 13 is in the first state and the detection result of the monitoring section 16 when the tension applying section 13 is in the second state.

[0112] When the tension applying section 13 is provided, it is possible to intentionally generate the expansion and contraction of the yarn 20, and thus, it is possible to accurately detect the expansion and contraction of the seam region.

[0113] In the automatic winder 1 of the embodiment described above, the unit control section 51 changes the operation setting of the yarn splicing section 14 at the time of yarn splicing, based on the detection result of the monitoring section 16.

[0114] As a result, it is possible to change the operation setting of the yarn splicing so that an abnormality of the yarn 20 is less likely to occur.

[0115] The automatic winder 1 of the above embodiment includes the imaging device 19 configured to image the seam region. The unit control section 51 determines the presence or absence of the protrusion of the core fiber 20a from the cover fiber 20b, based on the imaging result of the imaging device 19.

[0116] As a result, it is possible to detect the protrusion of the core fiber 20a.

[0117] Although the preferred embodiments of the present invention have been described above, the above configuration may be modified as follows, for example.

[0118] The optical sensor 16a of the first embodiment, which is a transmission type sensor, may be replaced with a reflection type sensor. The optical sensor 16a may be configured to include at least one light emitting element and two light receiving elements in which one light receiving element detects reflected light and the other light receiving element detects transmitted light.

[0119] The flowchart illustrated in the above embodiment is an example, and some processes may be omitted, the contents of such processes may be changed, or a new process may be added.

[0120] Although the embodiment described above provides an example in which the present invention is applied to the automatic winder, the present invention may also be applied to other yarn winding machines such as a spinning machine instead of the automatic winder.

Claims

1. A yarn winding machine (1), comprising:

a yarn supplying section (5) configured to supply a yarn (20) including a core fiber (20a) formed of an elastic yarn and a cover fiber (20b) wound around the core fiber (20a);

a monitoring section (16) configured to monitor a state of the yarn (20);

a yarn splicing section (14) arranged upstream of the monitoring section (16) in a running direction of the yarn (20), the yarn splicing section (14) configured to splice the yarn (20) on a yarn supplying section (5) side and the yarn (20) on a package side;

a winding section (18) configured to wind the yarn (20) to form a package; and

a control section (51), wherein the monitoring section (16) includes at least one of an optical sensor (16a) configured to detect a thickness of the yarn (20) and a capacitance sensor (16b) configured to detect a mass of the yarn (20), and

the control section (51) is configured to determine, based on a detection result of the monitoring section (16) for a seam region where the yarn (20) is spliced by the yarn splicing section (14), presence or absence of the core fiber (20a) in the seam region.

2. The yarn winding machine (1) according to claim 1, wherein

the control section (51) is configured to control the winding section (18) so that a winding speed of the

yarn (20) obtained when the seam region passes through the monitoring section (16) is less than a winding speed of the yarn (20) during a steady state.

3. The yarn winding machine (1) according to claim 1 or 2, wherein

the monitoring section (16) includes the optical sensor (16a) and the capacitance sensor (16b), and

the control section (51) is configured to determine presence or absence of the core fiber (20a) in the seam region, based on a difference between a detection result of the optical sensor (16a) and a detection result of the capacitance sensor (16b) and based on a threshold value previously defined according to yarn information of the yarn (20) that is being wound for the difference.

4. The yarn winding machine (1) according to any one of claims 1 to 3, wherein

the monitoring section (16) includes the optical sensor (16a) including a reflection type sensor (16d) configured to detect reflected light reflected by the yarn (20), and

the control section (51) is configured to determine presence or absence of protrusion of the core fiber (20a) from the cover fiber (20b), based on a detection result of the reflection type sensor (16d).

5. The yarn winding machine (1) according to any one of claims 1 to 3, wherein

the monitoring section (16) includes the optical sensor (16a) and the capacitance sensor (16b), the optical sensor (16a) includes a transmission type sensor (16c) configured to detect transmitted light transmitting a region where the yarn (20) is located, and a reflection type sensor (16d) configured to detect reflected light reflected by the yarn (20), and

the control section (51) is configured to determine presence or absence of a protrusion of the core fiber (20a) from the cover fiber (20b), based on a detection result of the transmission type sensor (16c), a detection result of the reflection type sensor (16d), and a detection result of the capacitance sensor (16b).

6. The yarn winding machine (1) according to any one of claims 1 to 5, comprising:

a tension applying section (13) capable of switching between a first state in which a tension

- is applied to the yarn (20) and a second state in which a tension applied to the yarn (20) is smaller than in the first state, wherein the control section (51) is configured to control so that the tension applying section (13) is set to the second state and the seam region thereafter passes through the monitoring section (16). 5
7. The yarn winding machine (1) according to claim 6, wherein the control section (51) is configured to control so that the tension applying section (13) is set to the second state and the seam region thereafter passes through the monitoring section (16), and thereafter, control so that a position of the seam region is returned to upstream of the monitoring section (16), the tension applying section (13) is set to the first state, and the seam region thereafter passes through the monitoring section (16). 10 15 20
8. The yarn winding machine (1) according to claim 6, comprising:
- a second monitoring section (17) arranged downstream of the monitoring section (16) in the running direction of the yarn (20), the second monitoring section (17) configured to monitor a state of the yarn (20), wherein the control section (51) is configured to control so that the tension applying section (13) is set to the second state and the seam region thereafter passes through the monitoring section (16), and control so that the tension applying section (13) is set to the first state and the seam region thereafter passes through the second monitoring section (17). 25 30 35
9. The yarn winding machine (1) according to any one of claims 1 to 5, comprising:
- an expansion contraction detection section arranged upstream of the monitoring section (16) in the running direction of the yarn (20), the expansion contraction detection section being configured to detect expansion and contraction of the yarn (20), wherein the control section (51) is configured to determine presence or absence of the core fiber (20a) in the seam region, based on a detection result of the monitoring section (16) for the seam region and a detection result of the expansion contraction detection section for the yarn (20). 40 45 50
10. The yarn winding machine (1) according to claim 9, comprising:
- a tension applying section (13) capable of switching between a first state in which a tension is applied to the yarn (20) and a second state in which a tension applied to the yarn (20) is smaller than in the first state, wherein the control section (51) is configured to determine presence or absence of the core fiber (20a) in the seam region, based on a detection result of the expansion contraction detection section when the tension applying section (13) is in the first state and a detection result of the monitoring section (16) when the tension applying section (13) is in the second state. 55
11. The yarn winding machine (1) according to any one of claims 1 to 10, wherein the control section (51) is configured to change an operation setting of the yarn splicing section (14) during a yarn splicing, based on the detection result of the monitoring section (16).
12. The yarn winding machine (1) according to any one of claims 1 to 11, comprising:
- an imaging device (19) configured to image the seam region, wherein the control section (51) is configured to determine presence or absence of a protrusion of the core fiber (20a) from the cover fiber (20b), based on an imaging result of the imaging device (19).

FIG. 1

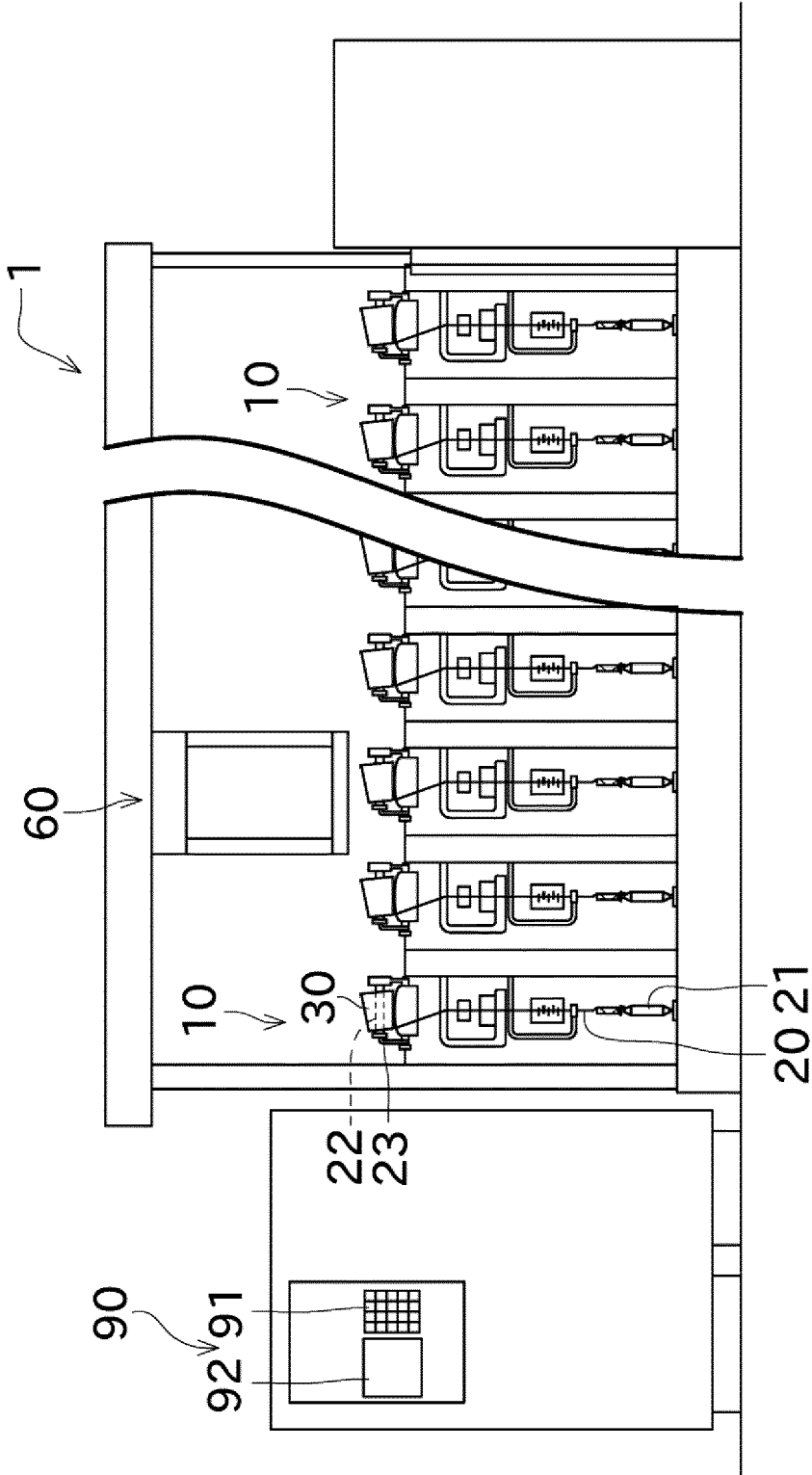


FIG. 2

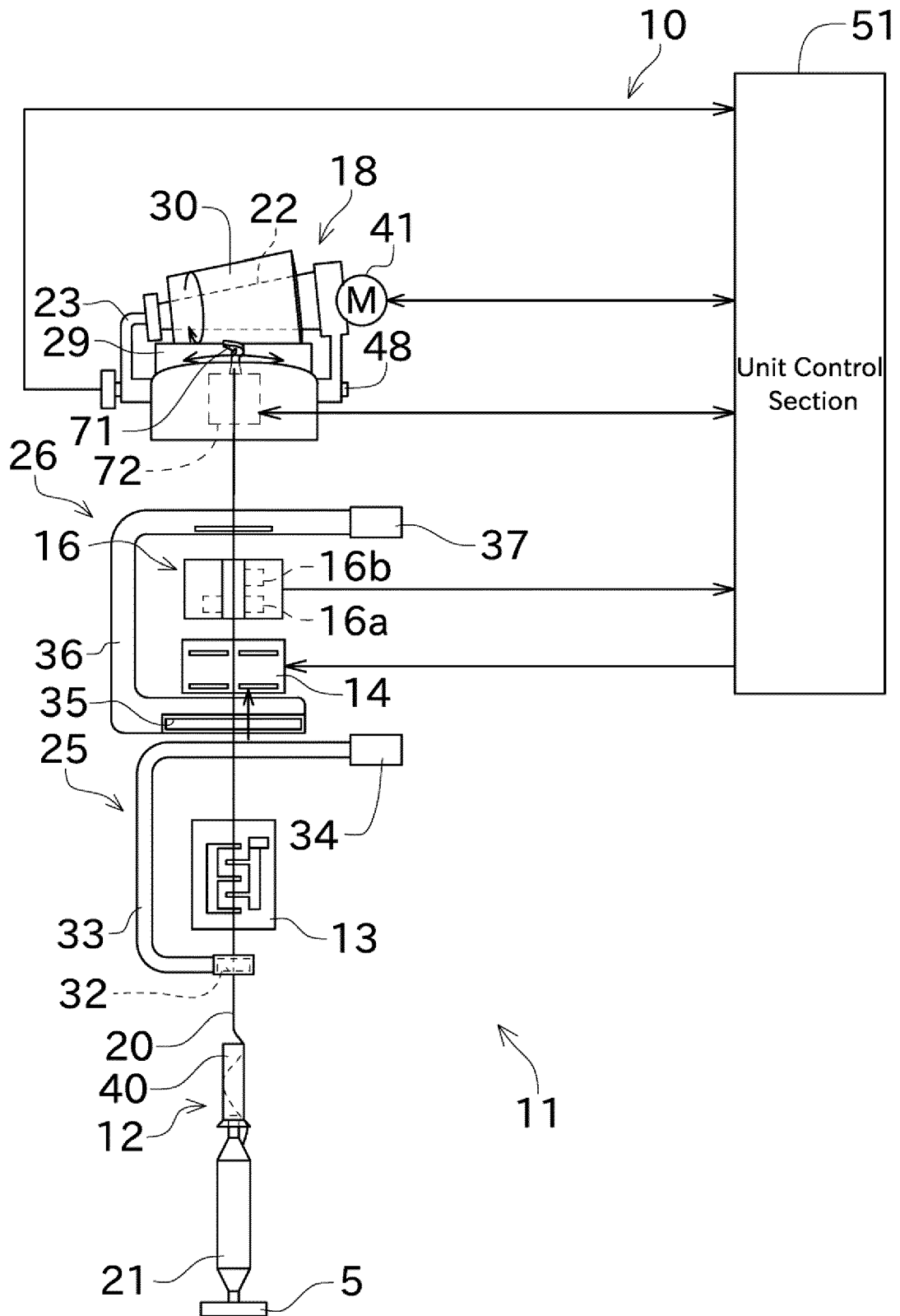


FIG. 3

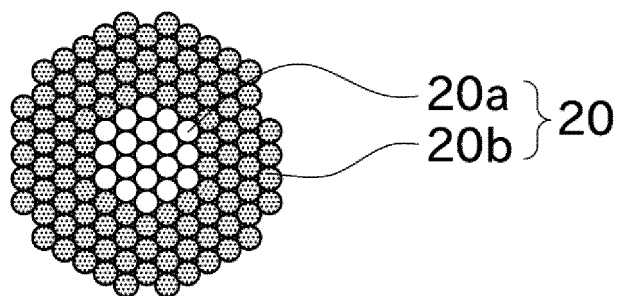


FIG. 4

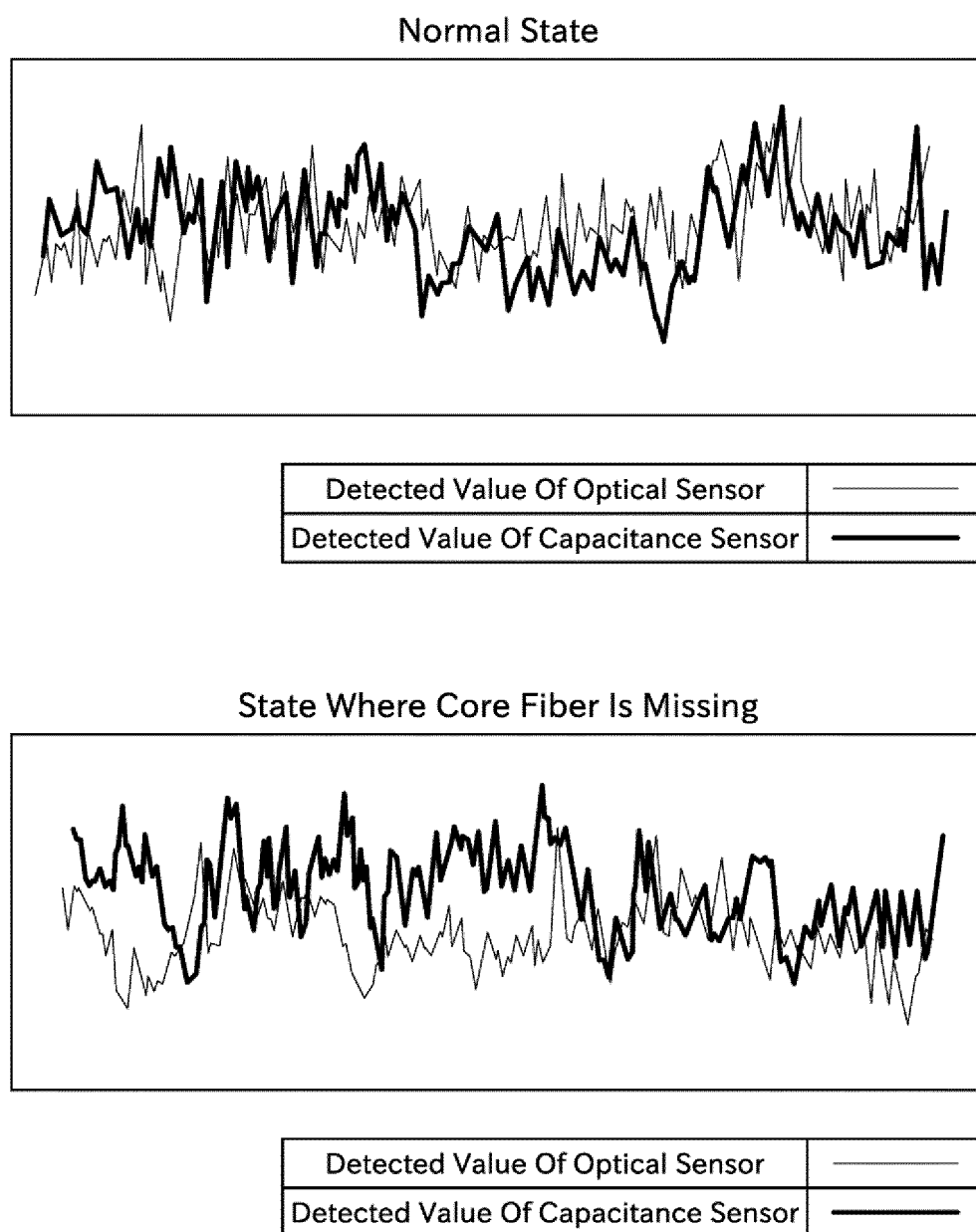


FIG. 5

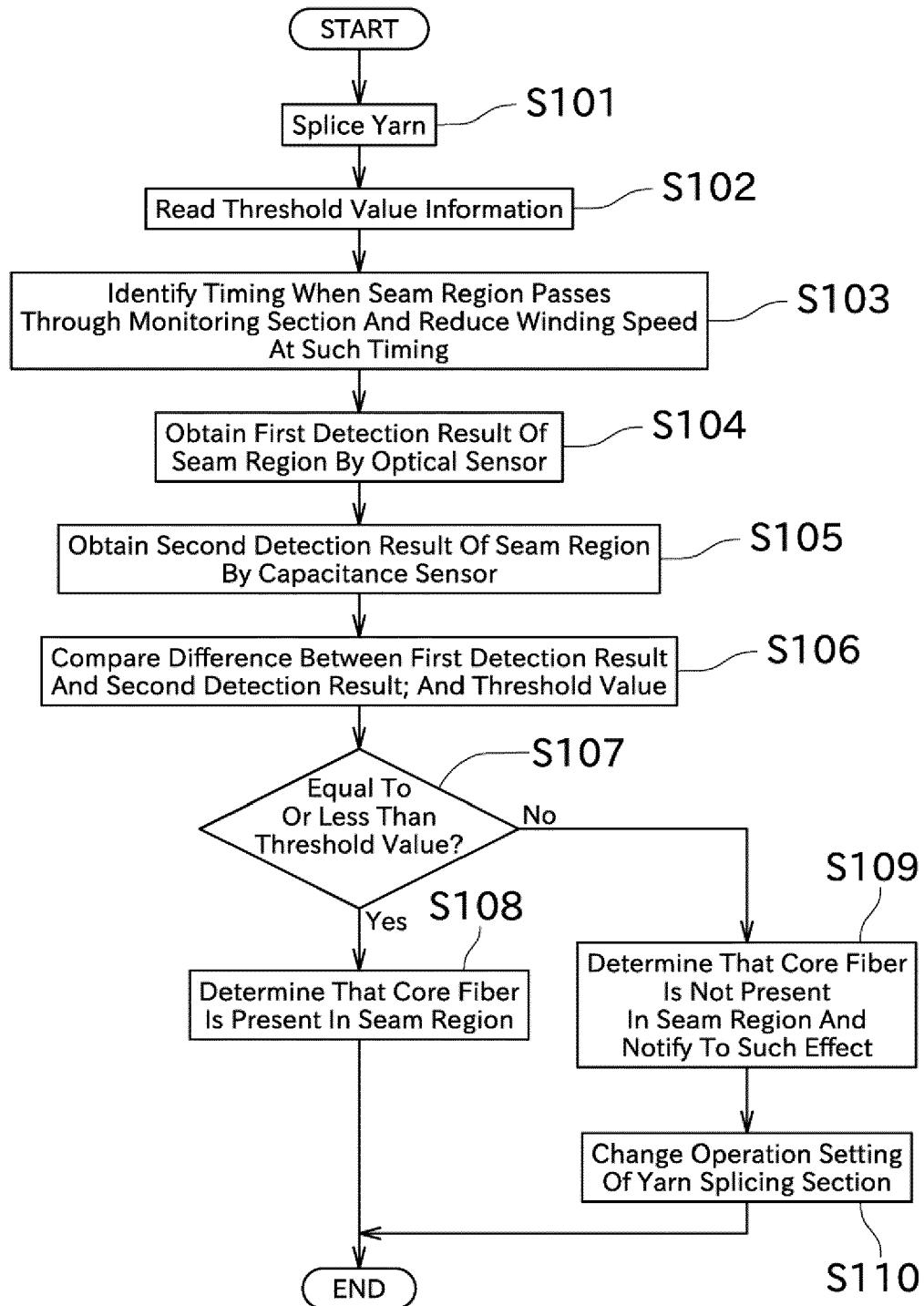


FIG. 6

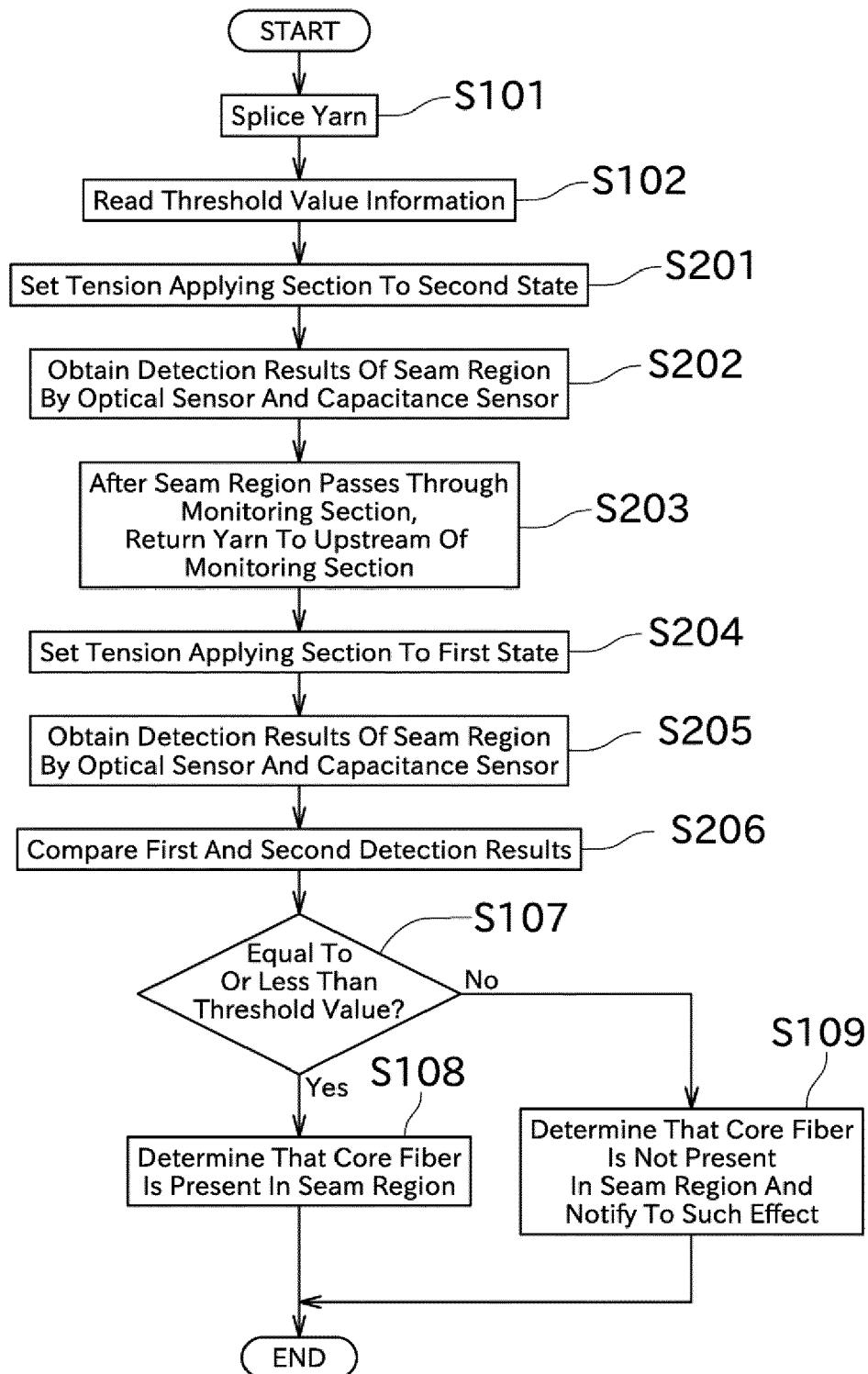


FIG. 7

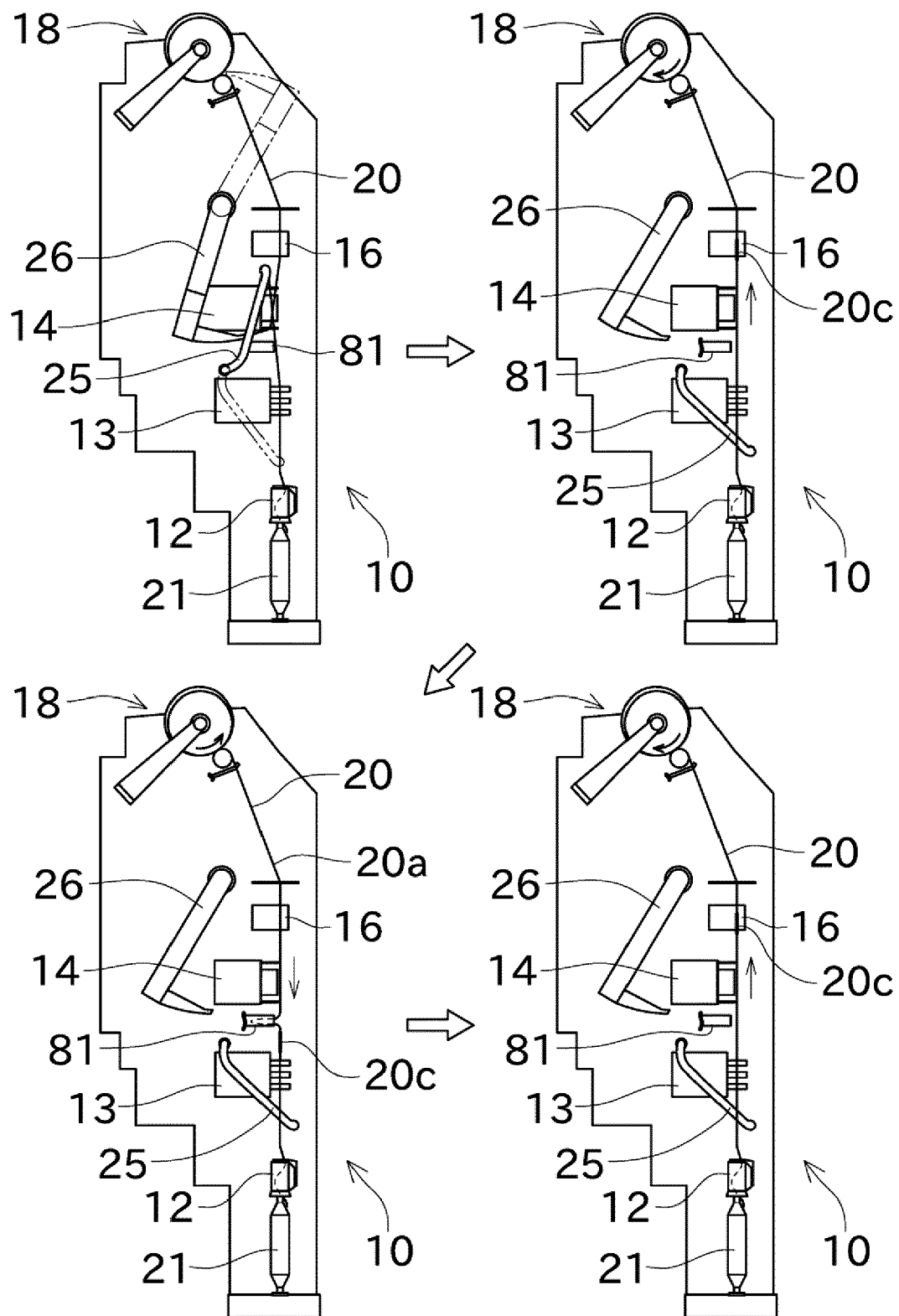


FIG. 8

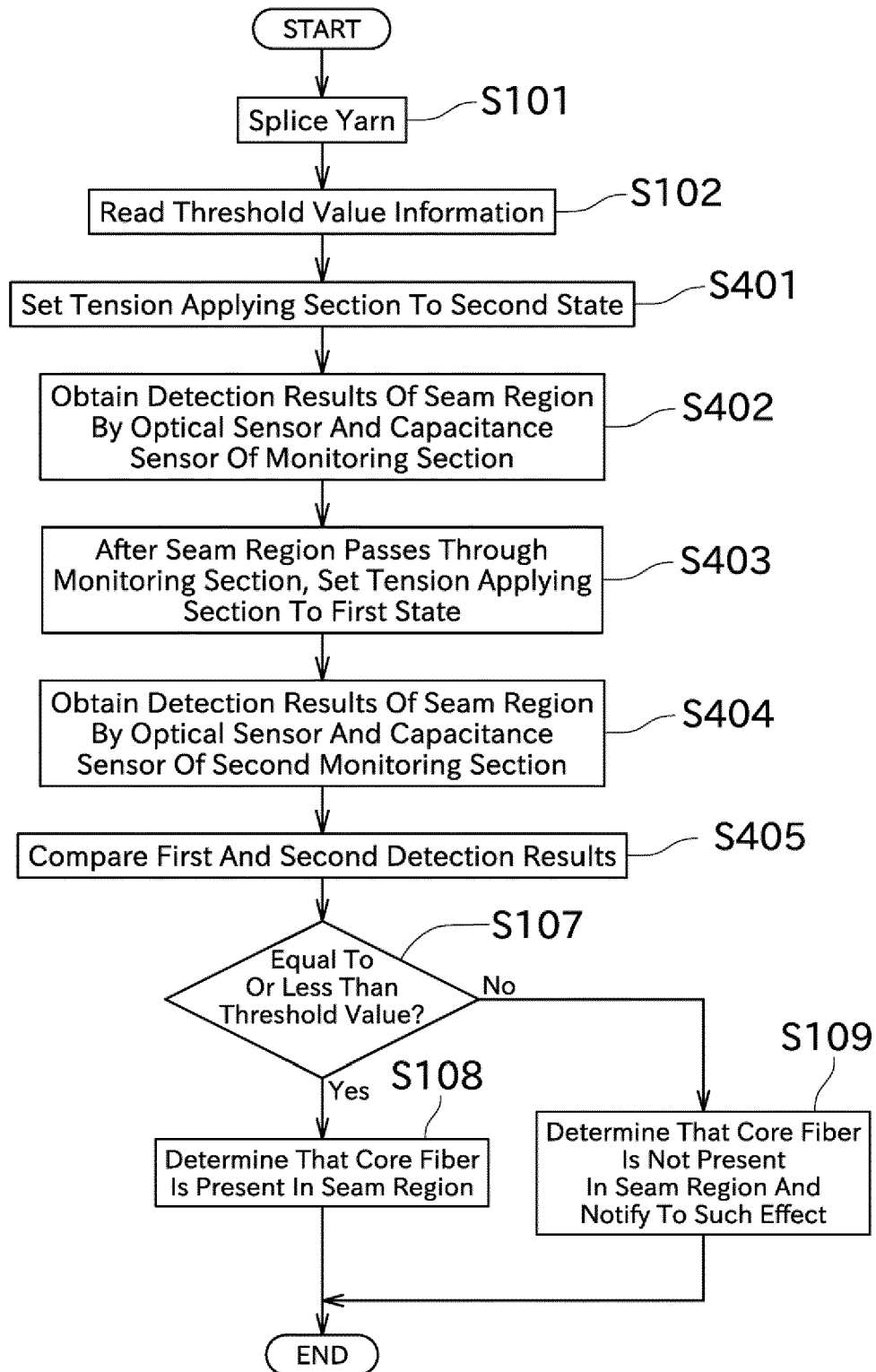


FIG. 9

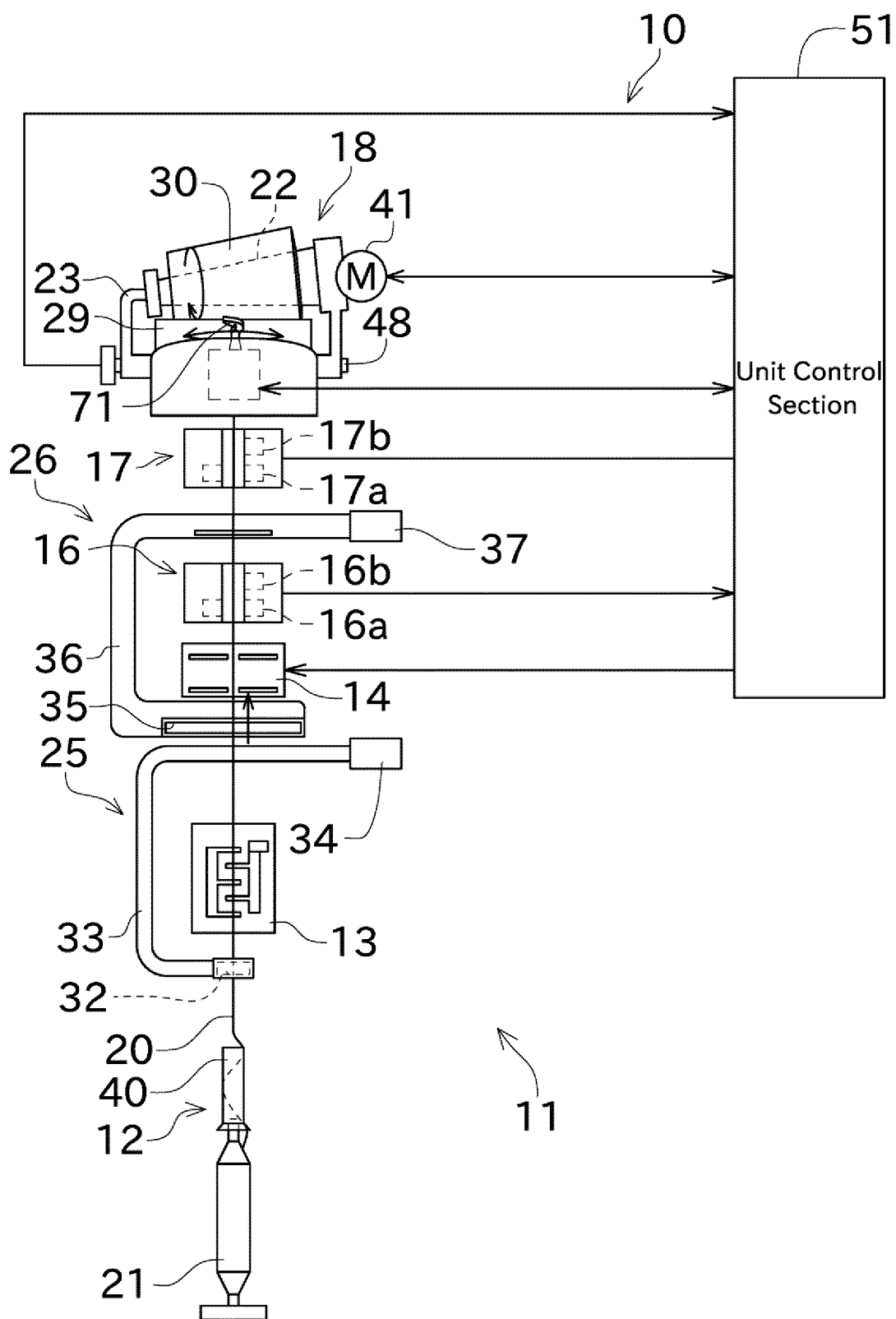


FIG. 10

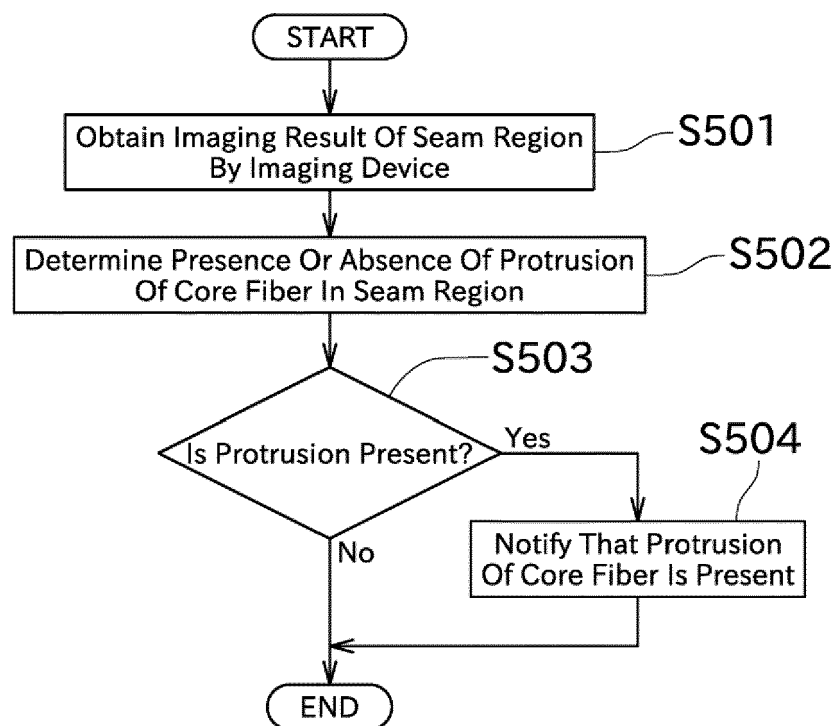


FIG. 11

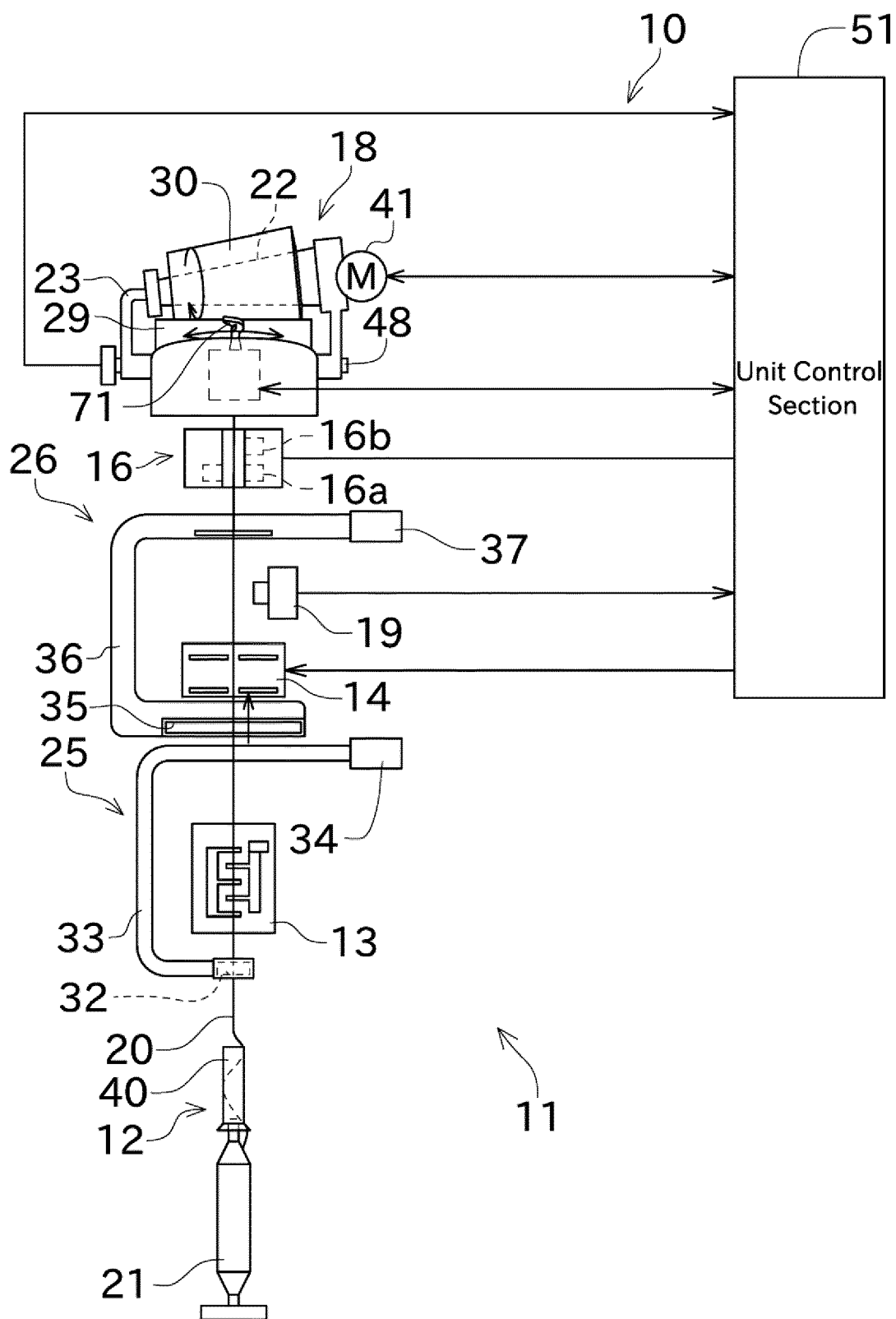
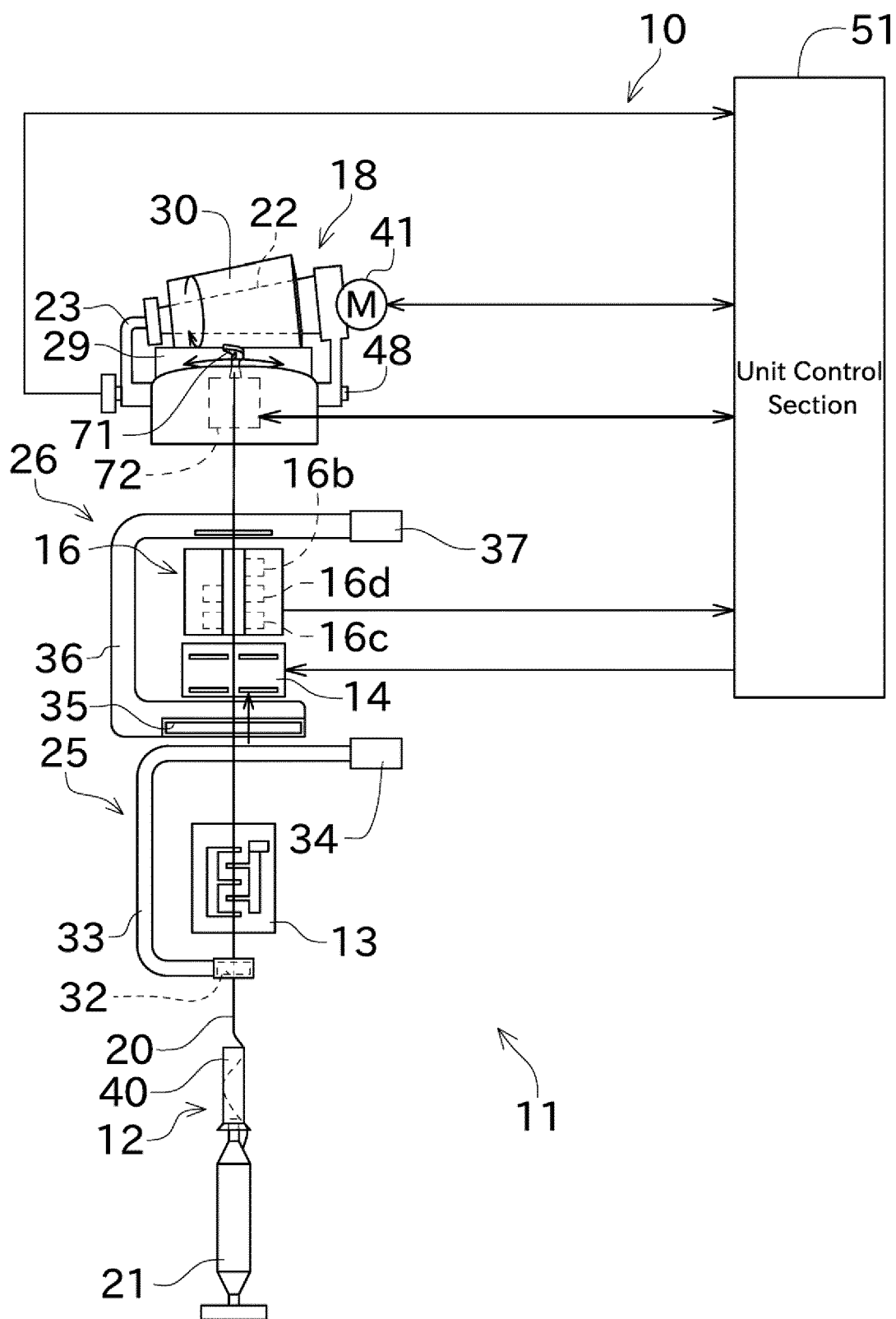


FIG. 12





EUROPEAN SEARCH REPORT

Application Number

EP 24 16 6946

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2020 125938 A1 (SAURER SPINNING SOLUTIONS GMBH & CO KG [DE]) 7 April 2022 (2022-04-07)	1,11,12	INV. B65H69/06 B65H63/06 D01H13/22
Y	* paragraphs [0001], [0007], [0008], [0009], [0010], [0012]; figures *	2,4,6,9,10	
A	-----	3,5,7,8	
Y	WO 2006/030661 A1 (MURATA MACHINERY LTD [JP]; SATOMI SHINICHI [JP]; INOUE KEI [JP]) 23 March 2006 (2006-03-23) * paragraphs [0001], [0003], [0004], [0006], [0008], [0009], [0012], [0013], [0038], [0040] - [0055], [0059], [0062]; figures *	2,4,6,9,10	
A	WO 2006/123454 A1 (MURATA MACHINERY LTD [JP]; SAWADA HARUTOSHI [JP]) 23 November 2006 (2006-11-23) * paragraphs [0001], [0004], [0008], [0018], [0031], [0037] - [0039]; figures *	1-12	
A	WO 2007/140639 A1 (USTER TECHNOLOGIES AG [CH]; HALDEMANN PETER [CH] ET AL.) 13 December 2007 (2007-12-13) * page 8, line 29 - page 9, line 28; figures *	1-12	TECHNICAL FIELDS SEARCHED (IPC) B65H D01H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		13 August 2024	Lemmen, René
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

EPO FORM 1503 03/82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 24 16 6946

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13 - 08 - 2024

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102020125938 A1	07-04-2022	CN 114381835 A	22-04-2022
		DE 102020125938 A1	07-04-2022

WO 2006030661 A1	23-03-2006	CN 101018900 A	15-08-2007
		EP 1801271 A1	27-06-2007
		JP 4529977 B2	25-08-2010
		JP WO2006030661 A1	15-05-2008
		WO 2006030661 A1	23-03-2006

WO 2006123454 A1	23-11-2006	CN 101175878 A	07-05-2008
		EP 1889956 A1	20-02-2008
		JP 4367647 B2	18-11-2009
		JP 2006348456 A	28-12-2006
		US 2009044510 A1	19-02-2009
		WO 2006123454 A1	23-11-2006

WO 2007140639 A1	13-12-2007	CN 101460842 A	17-06-2009
		WO 2007140639 A1	13-12-2007

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H03167330 A [0002]