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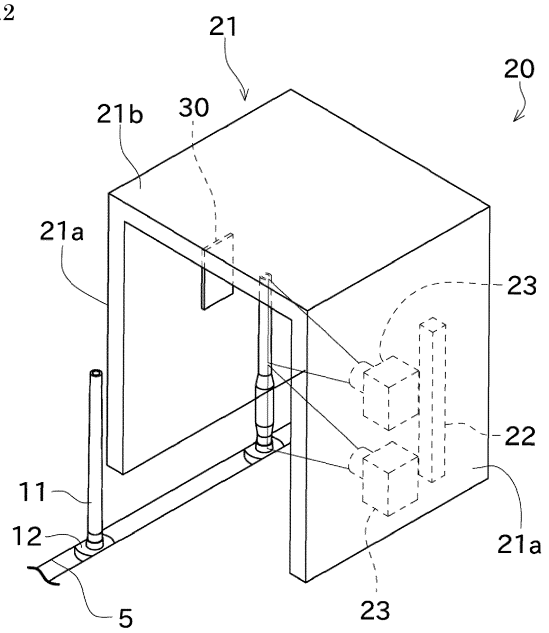
(54) **TRANSPORT SYSTEM**

(57) A transport system includes a transport path 5, a line sensor unit 20, and a CPU. The transport path 5 transports bobbins 11 to and from an automatic winder that winds up a yarn to produce a package. The line sensor unit 20 includes a light source 22 and line sensors 23. The line sensors 23, which are arranged such that their detection direction is coincident with the axial direction of the bobbin 11, detect a bobbin being transported on the transport path 5. The CPU controls the line sensor unit 20.

Fig.2



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a transport system for transporting a bobbin to an automatic winder.

2. Description of the Related Art

[0002] Japanese Patent Application Laid-Open No. 2016-88660 discloses a remaining yarn processing system that detects and processes a yarn remaining on a bobbin being transported on a tray. The remaining yarn processing system is provided in a bobbin transport route that connects a fine spinning machine to an automatic winder. The remaining yarn processing system includes a first yarn amount detection device, a second yarn amount detection device, and a third yarn amount detection device.

[0003] The first yarn amount detection device brings a brush into following contact with an outer circumferential surface of a bobbin in the vertical direction, and if a yarn is caught on the brush, determines that the bobbin has a remaining yarn. The second yarn amount detection device brings a bobbin into contact with a feeler, which rotates about an up-down direction, and if the feeler is pushed by the bobbin, determines that there is a remaining yarn. The third yarn amount detection device includes a photoelectric sensor having a light receiver and a light emitter. The positions of the light emitter and light receiver are adjusted in advance such that the optical axis extending therebetween passes through a portion that is a slight distance apart from a surface of the bobbin. If the bobbin has a remaining yarn, therefore, the yarn interrupts the light. Accordingly, the position of the remaining yarn can be detected based on the light detected by the light receiver.

SUMMARY OF THE INVENTION

[0004] The third yarn amount detection device of Japanese Patent Application Laid-Open No. 2016-88660 can detect a remaining yarn only at a location where the light emitter and light receiver are disposed. Even though the bobbin has an abnormality, the third yarn amount detection device in Japanese Patent Application Laid-Open No. 2016-88660 may not be able to detect the abnormality.

[0005] The present invention has been accomplished in view of the circumstances described above, and primarily aims to provide a transport system capable of detecting detailed information about a bobbin.

[0006] The foregoing has described problems to be solved by the present invention. The following will describe solutions to the problems and advantageous effects thereof.

[0007] An aspect of the present invention provides a transport system having the following configuration. The transport system includes a transport path, a line sensor unit, and a control section. The transport path transports a bobbin placed on a tray in an upright position. A transport direction is perpendicular to the axial direction of the bobbin. The transport path transports the bobbin to and from an automatic winder that winds up a yarn to produce a package. The line sensor unit includes a line sensor and a light source. The line sensor detects a bobbin being transported on the transport path. The line sensor has a detection direction coincident with the axial direction of the bobbin. The light source emits light. The control section controls the transport path and the line sensor.

[0008] Since the detection direction is coincident with the axial direction of the bobbin, a wide range in the axial direction of the bobbin can be detected by the line sensor. Consequently, detailed information about the bobbin can be detected.

[0009] In the transport system, it is preferable that: a result of detection by the line sensor is composed of detection values at plural points arranged in the detection direction; and the number of detection values in the transport direction of the bobbin is one.

[0010] Accordingly, the bobbin can be detected with the line sensor having a simple configuration.

[0011] Preferably, the transport system is configured as follows. The transport system further includes a reference information storage section that stores reference information for comparison against a result of detection by the line sensor. The control section compares against the reference information a result of detection obtained when the line sensor detects the bobbin being transported on the transport path while the bobbin is out of a detection range of the line sensor.

[0012] Accordingly, the accuracy of the result of detection by the line sensor can be grasped.

[0013] In the transport system, it is preferable that the line sensor comprises at least two line sensors that are arranged in the detection direction.

[0014] This allows the line sensor to be closer to the bobbin, and thus a high resolving power can be achieved.

[0015] Preferably, the transport system is configured as follows. The light source is composed of LEDs that emit visible light to the bobbin. The line sensor detects light that is visible light emitted from the light source and reflected by the bobbin.

[0016] Since the light source is composed of the LEDs, power saving can be achieved, and moreover incorporation into a substrate can be easy.

[0017] Preferably, the transport system is configured as follows. The transport system further includes a covering that covers the light source and the line sensor. A direction perpendicular to the transport direction of the bobbin in a horizontal plane is defined as a first perpendicular direction. The covering includes a pair of wall portions and a ceiling portion. The pair of wall portions are disposed so as to face the transport path in the first per-

pendicular direction. The ceiling portion connects upper portions of the pair of wall portions to each other.

[0018] This can reduce an influence of light from the outside, so that the accuracy of detection by the line sensor can be increased.

[0019] In the transport system, the control section preferably controls the transport path and the line sensor unit such that the line sensor detects the bobbin in movement while the bobbin is being transported on the transport path.

[0020] This configuration can shorten the time required for detection of a remaining yarn as compared to a configuration that stops the bobbin for detection by the line sensor.

[0021] In the transport system, the control section preferably determines the presence or absence of a remaining yarn on the bobbin based on a result of detection of the bobbin by the line sensor, and in a case of any remaining yarn being present on the bobbin, finds a range where the remaining yarn is present.

[0022] Accordingly, by using the line sensor, the bobbin can be detected entirely, so that the remaining yarn can be detected with an increased accuracy.

[0023] Preferably, the transport system is configured as follows. The transport system further includes a removal apparatus that removes a remaining yarn of the bobbin, the removal apparatus being disposed downstream of the line sensor in the transport direction of the bobbin. The control section transmits range information about a range of the remaining yarn on the bobbin to the removal apparatus. The removal apparatus removes the remaining yarn based on the range information about the range of the remaining yarn received from the control section.

[0024] Accordingly, the removal apparatus can remove the remaining yarn with an increased reliability.

[0025] In the transport system, the light source may be capable of emitting visible light beams of different colors to the bobbin.

[0026] With this configuration, the accuracy of detection of the remaining yarn can be increased by emitting a light beam of an appropriate color in accordance with the color of the bobbin, the color of the yarn, or the like.

[0027] In the transport system, the control section preferably controls the line sensor unit so as to perform a first detection and a second detection, the first detection being implemented by the line sensor detecting a visible light beam of a first color emitted to the bobbin, the second detection being implemented by the line sensor detecting a visible light beam of a second color emitted to the bobbin.

[0028] With this configuration, even if the color of the bobbin or the color of the yarn is similar to the first color, a result of detection obtained by emitting the visible light beam of the second color is used, which allows the remaining yarn to be detected with an increased accuracy.

[0029] In the transport system, the control section preferably performs the first detection and the second detection successively.

[0030] Accordingly, results of detection obtained by emission of light beams of different colors can be acquired successively.

[0031] In the transport system, the control section preferably compares a color of an outer circumferential surface of a portion of the bobbin where the yarn is not wound against a color of a yarn wound on the outer circumferential surface of the bobbin, to calculate the presence or absence of a remaining yarn on the bobbin and, in a case of the remaining yarn being present on the bobbin, a range where the remaining yarn is present.

[0032] Information about the bobbin can be acquired in this manner.

[0033] In the transport system, the control section preferably uses a color of an end portion of the bobbin in the axial direction as the color of the outer circumferential surface of the bobbin.

[0034] Accordingly, the color of the outer circumferential surface of the bobbin can be acquired substantially without fail.

[0035] Preferably, the transport system is configured as follows. The transport system further includes a bobbin information storage section that stores bobbin information, the bobbin information being information about the bobbin. The control section compares bobbin information calculated based on a result of detection by the line sensor against the bobbin information stored in the bobbin information storage section.

[0036] Information about the bobbin being transported can be acquired in this manner.

[0037] Preferably, the transport system is configured as follows. The bobbin information is information about a color of the bobbin, or a height of the bobbin. The control section determines the presence or absence of an abnormality based on a result of the comparison.

[0038] An abnormality of the bobbin being transported can be detected in this manner.

[0039] Preferably, the transport system is configured as follows. The bobbin information includes information about a color of the bobbin, and a color of a yarn wound on the bobbin. The control section determines whether or not the bobbin and the yarn wound on the bobbin are appropriate, based on a result of the comparison.

[0040] In this manner, whether or not a combination of the bobbin being transported and the yarn is appropriate can be determined.

[0041] Preferably, the transport system is configured as follows. A first automatic winder and a second automatic winder are provided as the automatic winder. The transport path transports the bobbins to a first transport route and a second transport route that is a transport route different from the first transport route. The first transport route transports the bobbin to the first automatic winder. The second transport route transports the bobbin to the second automatic winder. The control section selects to which of the first transport route and the second transport route the bobbin should be sent, based on the

bobbin information calculated based on a result of detection by the line sensor.

[0042] Accordingly, the bobbins can be sorted to be transported to an appropriate transport route.

[0043] In the transport system, the control section preferably sends the bobbin having the bobbin information satisfying a first reference condition to the first transport route, while sending the bobbin having the bobbin information not satisfying the first reference condition to the second transport route.

[0044] Accordingly, bobbins can be distributed to two paths by using the single reference condition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045]

FIG. 1 is a plan view of a transport system according to an embodiment of the present invention.

FIG. 2 is a perspective view showing a configuration of a line sensor unit.

FIG. 3 is a block diagram of the line sensor unit.

FIG. 4 shows a result of detection by the line sensor unit.

FIG. 5 is a flowchart showing a process that the line sensor unit performs.

FIG. 6 is a perspective view showing a configuration of a yarn amount detection device.

FIG. 7 is a side view showing a configuration of a removal apparatus.

FIG. 8 is a flowchart showing an inspection of the line sensor unit.

FIG. 9 is a plan view of a transport system that supplies bobbins to a first automatic winder and a second automatic winder.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0046] An embodiment of the present invention will now be described with reference to the drawings.

[0047] As shown in FIG. 1, a fine spinning winder 1 includes a fine spinning machine 2, an automatic winder 3, and a transport system 4.

[0048] The transport system 4 has a transport path 5 for transporting a tray 12 on which a bobbin 11 is set. The transport path 5, which connects the fine spinning machine 2 to the automatic winder 3, is configured as a loop, and the tray 12 is configured to circulate through the transport path 5 while having the bobbin 11 placed thereon. In the following descriptions, focusing on a flow of the bobbin 11 in the transport path 5, the upstream and downstream sides in a transport direction of the bobbin 11 may sometimes be referred to as "upstream side" and "downstream side", respectively. As used herein, the term "perpendicular" is intended to mean not only a state where the angle formed between two directions is exactly 90 degrees, but also a state where the angle is slightly different from 90 degrees (i.e., substantially perpendicular).

[0049] In the following descriptions, as shown in FIG. 1, a bobbin 11 on which no yarn is wound will be called an empty bobbin 11a, a bobbin 11 on which a yarn is sufficiently wound will be called a loaded bobbin 11b, and a bobbin 11 that is the loaded bobbin 11b from which the yarn has been unwound to leave some yarn thereon will be called a remaining yarn bobbin 11c.

[0050] Now, referring to FIG. 1, etc., the fine spinning machine 2 and the automatic winder 3 included in the fine spinning winder 1 will be described.

[0051] The fine spinning machine 2 includes plural fine spinning units (not shown) arranged side by side. Each of the fine spinning units performs spinning to produce a yarn, forms a loaded bobbin 11b by winding the yarn onto an empty bobbin 11a supplied, and discharges the loaded bobbin 11b. The fine spinning machine 2 receives empty bobbins 11a from the transport system 4, and delivers loaded bobbins 11b to the transport system 4. An apparatus that delivers loaded bobbins 11b to the transport system 4 is not limited to the fine spinning machine 2, and may be a parts feeder, for example.

[0052] The automatic winder 3 includes plural winder units (not shown) arranged side by side. Each of the winder units unwinds a yarn from a bobbin 11 supplied from the transport system 4, monitors the presence or absence of a defect, and upon detecting a defect, removes the defect while winding up the yarn to form a package with a predetermined length. The bobbin 11 from which the yarn has been unwound by the automatic winder 3 is discharged to the transport system 4.

[0053] In the fine spinning winder 1 having the above-described configuration, a loaded bobbin 11b on which a yarn has been wound by the fine spinning machine 2 is supplied from the fine spinning machine 2 to the automatic winder 3, and an empty bobbin 11a from which a yarn has been unwound by the automatic winder 3 is supplied from the automatic winder 3 to the fine spinning machine 2. With this configuration, the fine spinning winder 1 is able to complete a series of steps from yarn spinning to package formation in a self-contained manner, with bobbins 11 circulating between the fine spinning machine 2 and the automatic winder 3.

[0054] A configuration of the transport system 4 will now be described.

[0055] The transport system 4 has the transport path 5 for transporting bobbins 11. The transport system 4 includes a conveyor mechanism (not shown), and can transport a bobbin 11 placed on the tray 12 along the transport path 5.

[0056] The transport path 5 includes a first transport path 51, a second transport path 52, a reprocessing transport path 53, a post-process transport path 54, a return transport path 55, a remaining yarn transport path 56, and a stagnation transport path 57.

[0057] The first transport path 51 has its upstream end connected to the fine spinning machine 2, and its down-

stream end connected to the automatic winder 3. Connected to a downstream portion of the first transport path 51 is the upstream end of the reprocessing transport path 53.

[0058] A first yarn end preparation device 61 is disposed slightly upstream of a location where the reprocessing transport path 53 branches from the first transport path 51. The first yarn end preparation device 61 performs an operation of unwinding a yarn end from a bobbin 11, and placing the yarn end at the inside of a bobbin tube (hereinafter, pick-finding).

[0059] A first switching device 63 is disposed at the location where the reprocessing transport path 53 branches from the first transport path 51. The first switching device 63 switches a transport destination of the bobbin 11 in accordance with whether or not the aforementioned pick-finding is successful. To be specific, a bobbin 11 having successfully undergone the pick-finding is transported to the automatic winder 3, and a bobbin 11 having failed in the pick-finding is transported to the reprocessing transport path 53.

[0060] The reprocessing transport path 53 has its downstream end connected to the post-process transport path 54 and the return transport path 55. The post-process transport path 54 is connected to the automatic winder 3. A second yarn end preparation device 62 and a second switching device 66 are disposed slightly upstream of a location where the reprocessing transport path 53 branches into the post-process transport path 54 and the return transport path 55.

[0061] The transport path 5 also includes the stagnation transport path 57 arranged so as to connect the first transport path 51 to the reprocessing transport path 53. A stagnation switching device 68 is disposed at a location where the stagnation transport path 57 branches from the first transport path 51. If the stagnation switching device 68 detects, by a sensor (not shown), that the amount of bobbins 11 that are stagnant because of a pick-finding process being delayed for some reason is equal to or more than a predetermined amount, the stagnation switching device 68 switches a transport destination of a bobbin 11 to the stagnation transport path 57, to make the bobbin 11 undergo pick-finding by the second yarn end preparation device 62.

[0062] The second switching device 66 transports a bobbin 11 having successfully undergone pick-finding to the automatic winder 3 via the post-process transport path 54, and transports a bobbin 11 having failed in pick-finding to the return transport path 55. The second transport path 52 has its upstream end connected to the automatic winder 3, and its downstream end connected to the fine spinning machine 2. The return transport path 55 has its downstream end connected to the second transport path 52.

[0063] The second transport path 52 mainly transports bobbins 11 that have become empty bobbins 11a after their yarns were fully unwound by the automatic winder 3. The second transport path 52 transports not only the empty bobbins 11a but also, for example, a bobbin 11 that has failed in yarn drawing by the automatic winder 3, a bobbin 11 from which yarn unwinding has become impossible for some reason during winding by the automatic winder 3, and a bobbin 11 that has failed in pick-finding and thus is returned via the return transport path 55.

[0064] The fine spinning machine 2 cannot wind a yarn to a remaining yarn bobbin 11c because a yarn remains thereon. This is why the remaining yarn transport path 56 for detecting and processing the remaining yarn bobbin 11c is connected to a downstream portion of the second transport path 52. A line sensor unit 20 and a third switching device 67 are disposed slightly upstream of a location where the remaining yarn transport path 56 branches from the second transport path 52.

[0065] The line sensor unit 20 detects a bobbin 11 by using a line sensor, and calculates the presence or absence of a remaining yarn, and a remaining yarn range. The remaining yarn range refers to a range where a remaining yarn is present on the bobbin 11. As the remaining yarn range, a specific range where the remaining yarn is present may be identified in the form of a numerical value, or a region where the remaining yarn is present may be identified from among plural regions into which the bobbin 11 is divided. As shown in FIG. 2, the line sensor unit 20 includes a covering 21, a light source 22, two line sensors 23, and a reference plate 30.

[0066] The covering 21 is a tunnel-like member that covers the transport path 5. The covering 21 reduces an influence of extraneous light when the line sensors 23 detect the bobbin 11. The covering 21 is made of a light-shielding material, therefore. The covering 21 includes a pair of wall portions 21a arranged opposed to each other across the transport path 5, and a ceiling portion 21b. The wall portions 21a are disposed such that they face the transport path 5 in a direction (first perpendicular direction) perpendicular to the transport direction in a horizontal plane. The ceiling portion 21b connects upper portions of the two wall portions 21a to each other. One of the wall portions 21a has, on its inside surface, the light source 22 and the two line sensors 23, while the other of the wall portions 21a has, on its inside surface, the reference plate 30. The shape of the covering 21 is just an example, and another example may further provide an additional wall portion that covers a part of a plane vertical to the transport direction.

[0067] The light source 22 includes an LED substrate having one or more LEDs, and a diffuser. The diffuser is an acrylic board for example, which diffuses light emitted from the LEDs in a height direction. In this manner, the light source 22 can emit light spreading in the height direction. The light source 22 includes a red LED, a green LED, and a blue LED. Accordingly, the light source 22 can emit visible light spreading in the height direction toward the entire bobbin 11 passing through the covering 21, the visible light having a color of red, green, blue, or a mixture of them. Instead of having LEDs of plural colors,

a white light source and a color filter may be used to provide a configuration capable of emitting plural colors. Instead of LEDs, a light source of another type such as a fluorescent lamp may be adoptable. Although the light source 22 is separate from the line sensors 23 which will be described later, the light source 22 may be incorporated in the line sensors 23.

[0068] Each of the line sensors 23 has a linear-shaped detection region. A detection direction of the line sensor 23 is the height direction, and in other words is the axial direction of the bobbin 11. The detection direction of the line sensor 23 is a direction in which light receiving elements of an image sensor 25 which will be described later are arranged. Ideally, the detection direction of the line sensor 23 is coincident with the axial direction of the bobbin 11, but strictly they may sometimes be non-coincident because of backlash, dimensional accuracy, or the like. Description herein considers that the detection direction of the line sensor 23 is coincident with the axial direction of the bobbin 11 even when the detection direction of the line sensor 23 is slightly different (by about several degrees) from the axial direction of the bobbin 11. The axial direction of the bobbin 11 refers to the direction of a straight line that passes through the center of a core tube of the bobbin 11. The bobbin 11 intersects at right angles the transport direction on the transport path 5.

[0069] The line sensors 23 are juxtaposed to each other in the detection direction. This allows the line sensors 23 to be closer to the bobbin 11 as compared to a configuration having a single line sensor 23. As a consequence, an increased resolving power and a reduced size of the covering 21 can be achieved as compared to the configuration having a single line sensor 23. As for how the line sensors 23 are arranged, it may be possible that the line sensors 23 are arranged such that only end portions of their respective detection regions overlap each other. It may also be possible that the line sensors 23 are arranged such that end portion sides of their respective detection regions partially overlap each other.

[0070] Referring to FIG. 3, the line sensor unit 20 includes the two line sensors 23, a CPU 26, an image memory 27, a communication section 28, and a storage section (a reference information storage section, a bobbin information storage section) 29. Each of the line sensors 23 includes a lens 24 and the image sensor 25. Light incident through the lens 24 is detected by the image sensor 25, and changed into an electrical signal. Specifically, the image sensor 25 detects light that has been emitted from the light source 22 and reflected by the bobbin 11. More specifically, light that the image sensor 25 detects is light that is reflected by a portion of the bobbin 11 where no yarn is would, and/or is light that is reflected by the yarn would on the bobbin 11. The image sensor 25 is configured to have light receiving elements arranged in a line along the detection direction. In this embodiment, light receiving elements are not arranged in a direction (the width direction, the transport direction on the transport path 5) perpendicular to the detection direction. Accordingly, a result of detection by the line sensor 23 is composed of detection values at plural points arranged in the detection direction, and the number of detection values in the width direction is one. It however may be acceptable that plural light receiving elements are arranged in the width direction so that plural detection values are obtained in the width direction, as long as a substantially linear-shaped detection region is formed (this configuration also corresponds to a line sensor). The line sensor unit 20 may be configured to include a single line sensor 23, or may be configured to include three or more line sensors 23.

[0071] By the CPU 26, an electrical signal outputted from the image sensor 25 is, as image data, deployed to the image memory 27, and image processing is executed. The CPU 26 outputs a result of the image processing to the outside (such as a control device for controlling the transport path 5) via the communication section 28. The communication section 28 is a connector for wired communication, or an antenna for wireless communication, for example. The storage section 29, which is a flash memory, an SSD, or the like, stores information relating to controls that the line sensor unit 20 performs. The control device for controlling the transport path 5 and the CPU 26 constitutes a control section.

[0072] The CPU 26 executes a process shown in FIG. 5, to calculate the presence or absence of a remaining yarn on the bobbin 11, and a remaining yarn range. The CPU 26 firstly reads out settings related to the bobbin 11 and the yarn, and determines a light source pattern (S101). To be specific, the CPU 26 communicates with a control device for controlling the fine spinning winder 1, to read out information (bobbin information) on the bobbin 11. The bobbin information, specifically, contains the color and height of the bobbin 11. The CPU 26 further communicates with the control device for controlling the fine spinning winder 1, to receive and store another bobbin information (which specifically is information on a yarn wound around the bobbin). The information on the yarn, specifically, contains the color of the yarn.

[0073] The CPU 26 further determines a light source pattern based on the color of the bobbin 11 and the color of the yarn. The light source pattern refers to a color pattern of light that illuminates in detecting the bobbin 11. In a case of detecting the bobbin 11 one time, a color of the light source at that time defines the light source pattern. In a case of detecting the bobbin 11 plural times, colors of the light source used in the plural-times detections as well as a sequence of the colors define the light source pattern. The most appropriate light source color varies depending on a combination of the color of the bobbin 11 and the color of the yarn. For example, it is conceivable that appropriate light source colors in accordance with combinations of the color of the bobbin 11 and the color of the yarn are preliminarily obtained and stored, and based on this information, a light source pattern is determined. In this embodiment, the light source

pattern is constituted by light of a first color in first emission and light of a second color in second emission.

[0074] The number of times light is emitted may be either one, or three or more. In a case of emitting light more than one time, light of the same color may be emitted more than one time. The light intensity may be varied instead of or in addition to a color hue. The number of types of colors included in the light source pattern is not limited to two, and may be one, or three or more. The light source patterns are set in accordance with the color of the bobbin and the color of the yarn, but instead the same light source pattern may be always used. Alternatively, it may be possible that light of a first color is emitted to determine whether or not the presence or absence of a remaining yarn and/or a remaining yarn range can be found, and if it cannot be found, light of a second color is emitted to calculate the presence or absence of a remaining yarn, and/or a remaining yarn range. Thus, the presence or absence of the remaining yarn and/or the remaining yarn range can be found by using an appropriate color, without the need to preliminarily set light source patterns. The light source 22 of this embodiment includes LEDs of three primary light colors, which can provide various colors by varying the light intensity of each color.

[0075] Then, the CPU 26 determines whether or not a bobbin detection timing has come (S102). A bobbin detection sensor (not shown) is disposed in an end portion of the covering 21 on the upstream side in the transport direction, or is disposed on the upstream side of the line sensor unit 20 in the transport direction. The bobbin detection sensor is an optical sensor, for example. Based on a result of detection by the bobbin detection sensor, the CPU 26 calculates a timing (i.e., the bobbin detection timing) at which the bobbin 11 arrives at the line sensors 23.

[0076] Upon determining that the bobbin detection timing has come, the CPU 26 controls the light source 22 to emit light of the first color, and controls the line sensors 23 to detect the bobbin 11 (S103, first detection). Then, the CPU 26 controls the light source 22 to emit light of the second color, and controls the line sensors 23 to detect the bobbin 11 (S104, second detection). In this embodiment, the line sensors 23 detect the bobbin 11 while the bobbin 11 is being transported on the transport path 5. This allows the bobbin 11 to be detected without the need to stop the bobbin 11 (that is, the bobbin 11 in movement is detected). It however is also possible that the bobbin 11 is stopped before the line sensors 23, and then the bobbin 11 is detected.

[0077] Then, the CPU 26 performs image analysis on a result of the detection obtained in steps S103, S104, to calculate the presence or absence of a remaining yarn, and a remaining yarn range (S105). The line sensors 23 are monochrome sensors, and a detection result they generate is at a gray-scale level. Then, the CPU 26 performs image processing by using a known process such as gamma correction, to thereby obtain data associating positions of the bobbin 11 in the axial direction with detection values (e.g., luminances) at the respective positions. For example, when the color of an outer circumferential surface of the bobbin 11 is a dark color while the yarn has a light color, a portion where the yarn is present has a higher detection value than the luminance of the outer circumferential surface of the bobbin, as shown in FIG. 4. It is possible that, for example, a threshold value is set, to determine that the yarn is present in a portion having a detection value equal to or higher than the threshold value. Here, the color of the outer circumferential surface of the bobbin 11 is the color of a portion of the bobbin 11 where the yarn is not wound (that is, the color of the core tube itself).

[0078] The threshold value used to determine the yarn position may either be a preset value, or be changed in accordance with the detection value at the outer circumferential surface of the bobbin 11. The yarn is not wound on the opposite ends of the bobbin 11 in the axial direction. It therefore can be presumed that detection values at the opposite ends of the bobbin 11 in the axial direction are equal to the detection value at the outer circumferential surface of the bobbin 11. Thus, it may be conceivable that a value obtained by adding a predetermined value to the detection value at the outer circumferential surface of the bobbin 11 is set as the threshold value.

[0079] When the color of the outer circumferential surface of the bobbin 11 is a light color while the yarn has a dark color, it can be determined that the yarn is present in a portion having a detection value equal to or lower than the threshold value. In this case, the color of the outer circumferential surface of the bobbin 11 and the color of the yarn have different lightnesses, and therefore they can be distinguished from each other based on detection values obtained by the monochrome sensors. A color sensor may be used instead of the monochrome sensor.

[0080] The line sensor unit 20 calculates the presence or absence of a remaining yarn on the bobbin 11, and a remaining yarn range. If no remaining yarn is present on the bobbin 11, the CPU 26 controls the third switching device 67, to transport the bobbin 11 to the fine spinning machine 2 (S107). If a remaining yarn is present on the bobbin 11, the CPU 26 controls the third switching device 67, to transport the bobbin 11 to the remaining yarn transport path 56 (S108), and transmits the remaining yarn range to a removal apparatus 73 (S109).

[0081] The remaining yarn transport path 56 has its downstream end connected to an upstream portion of the first transport path 51. Thus, a remaining yarn bobbin 11c transported to the remaining yarn transport path 56 undergoes the pick-finding operation as described above.

[0082] Here, remaining yarn bobbins 11c transported to the remaining yarn transport path 56 include a remaining yarn bobbin 11c having an amount of remaining yarn too small to be wound by the automatic winder 3. If such a remaining yarn bobbin 11c from which winding is im-

possible is supplied to the automatic winder 3 via the first transport path 51, the efficiency of production of packages by the automatic winder 3 is reduced. To prevent this, the remaining yarn transport path 56 is provided with a yarn amount detection device 72 for detecting the amount of yarn on a remaining yarn bobbin 11c, and the removal apparatus 73 for removing a remaining yarn. Here, the yarn amount detection device 72 may be omitted, and the line sensor unit 20 may be used to detect the amount of yarn on a remaining yarn bobbin 11c as follows: the remaining yarn bobbin 11c is detected intermittently in a short time by using the line sensor unit 20, which makes it possible to detect a yarn alone while not detecting the outer circumferential surface of the bobbin 11 if the bobbin 11 has any remaining yarn. For example, the line sensor unit 20 performs detection in a period from when no bobbin 11 is present in the detection region to when the outer circumferential surface of the bobbin 11 is detected. In a case of the bobbin 11 having any remaining yarn, there is a time lag between a time of detection of the remaining yarn and a time of detection of the outer circumferential surface of the bobbin 11. As the amount of yarn is larger, detection of the yarn alone continues in a longer period. The specific amount of yarn can be calculated based on a transport speed of the bobbin 11 and a time length from when detection of the yarn alone is started to when the yarn becomes no longer detected.

[0083] The yarn amount detection device 72 includes a rotation shaft 72a, an arm 72b, and a contact portion 72c.

[0084] The rotation shaft 72a is a member like a round bar arranged in an up-down direction, and is supported rotatably. The arm 72b is a rod-like member attached to the rotation shaft 72a so as to protrude from the rotation shaft 72a. The arm 72b has the contact portion 72c which is bent upward so as to extend along the longitudinal direction of the remaining yarn bobbin 11c. The contact portion 72c is formed with its length fixed in the up-down direction. A spring (not shown) is attached to the rotation shaft 72a, and the spring biases the contact portion 72c of the arm 72b in a direction toward the remaining yarn bobbin 11c. A stopper (not shown) is also attached to the rotation shaft 72a. The stopper is capable of regulating rotation of the rotation shaft 72a caused by a biasing force of the spring so as to make the contact portion 72c stop at a position where the contact portion 72c has a slight gap with a surface of the bobbin tube of the remaining yarn bobbin 11c being transported to the removal apparatus 73.

[0085] The yarn amount detection device 72 has a sensor (not shown) capable of detecting rotation of the rotation shaft 72a. With this configuration, if the amount of remaining yarn wound on the remaining yarn bobbin 11c is equal to or larger than a predetermined amount, a yarn layer of the remaining yarn pushes the contact portion 72c in the middle of transport of the remaining yarn bobbin 11c. This causes the rotation shaft 72a to rotate in a direction against the biasing force of the spring, and this rotation is detected by the sensor.

[0086] As shown in FIG. 7, the removal apparatus 73 includes a bobbin gripping device 91 and a bobbin fixing device 94. The removal apparatus 73 is capable of removing a remaining yarn of the remaining yarn bobbin 11c that is detected by the line sensor unit 20.

[0087] The bobbin gripping device 91 includes an extraction head 92 which is supported by a cylinder (not shown) such that the extraction head 92 can move up and down. The extraction head 92 has a recess 92a capable of receiving the remaining yarn bobbin 11c inserted therein.

[0088] The extraction head 92 has three gripping claws 93 capable of protruding toward the center side (i.e., toward the remaining yarn bobbin 11c received in the recess 92a). The extraction head 92 includes a cylinder 95, and the cylinder 95 is capable of switching the state between a state where the three gripping claws 93 protrude inward and a state where the protrusion is cancelled. The extraction head 92 is moved downward, then the three gripping claws 93 are made protrude inward, and then the extraction head 92 is moved upward. Thereby, the remaining yarn can be extracted from the bobbin tube while the remaining yarn bobbin 11c is gripped from three directions.

[0089] The bobbin fixing device 94 includes a cylinder 96 and a fixing member 97. The bobbin fixing device 94 drives the cylinder 96 so that the fixing member 97 holds down the upper end of the remaining yarn bobbin 11c from above, to fix it.

[0090] The transport system 4 causes the remaining yarn bobbin 11c from which the remaining yarn is to be removed to stop at a stop position 101 located below the removal apparatus 73. To remove the remaining yarn from the remaining yarn bobbin 11c positioned at the stop position 101, the removal apparatus 73 lowers the extraction head 92 down to a height corresponding to the remaining yarn range that the CPU 26 has transmitted in step S109. At this time, the bobbin fixing device 94 lowers the fixing member 97 to hold down a distal end portion of the bobbin 11 from above, for fixing it.

[0091] Then, the removal apparatus 73 actuates the cylinder 95 of the bobbin gripping device 91, to thereby make the gripping claws 93 protrude inward. Here, the extraction head 92 has been lowered to the height corresponding to the remaining yarn range, and therefore the gripping claws 93 can grip a portion of the remaining yarn bobbin 11c, the portion being located below where the remaining yarn is present. Particularly, since the diameter of the bobbin 11 varies depending on the height, lowering the extraction head 92 to the height suitable for removal of the remaining yarn allows precise removal of the remaining yarn. The removal apparatus 73 raises the extraction head 92 while keeping the distal end portion of the remaining yarn bobbin 11c held down by the fixing member 97. Thus, the remaining yarn of the remaining yarn bobbin 11c is removed.

[0092] The process of the line sensor unit 20 transmit-

ting the remaining yarn range to the removal apparatus 73 may be omitted. In such a case, the removal apparatus 73 makes the gripping claws 93 positioned at a lower end portion of the remaining yarn bobbin 11c, and then raises the extraction head 92 to remove the remaining yarn. Alternatively, the line sensor unit 20 may transmit the number of times the remaining yarn should be extracted, instead of the remaining yarn range, to the removal apparatus 73. For example, in a case of a remaining yarn being present at two positions apart from each other, extraction of the remaining yarn can likely be failed. The CPU 26, therefore, transmits an instruction to perform extraction of the remaining yarn twice, to the removal apparatus 73. Here, in a case of a remaining yarn being present throughout the bobbin 11 for example, extraction of the remaining yarn can likely be difficult. In this case, the CPU 26 may perform such a control that extraction of the remaining yarn is skipped, and the bobbin 11 is, as an unprocessable bobbin 11, transported to a predetermined position.

[0093] Next, how to inspect the line sensor unit 20 will be described with reference to FIG. 8.

[0094] The CPU 26 determines whether or not an inspection timing comes (S201), and upon determining that the inspection timing has come, determines whether or not it is the bobbin detection timing mentioned above (S202). The line sensor unit 20 cannot be inspected during bobbin detection.

[0095] If it is not the bobbin detection timing, the CPU 26 detects the reference plate 30 while emitting predetermined light (S203). Then, the CPU 26 compares a result of detecting the reference plate 30 against reference information (S204). The reference information refers to a result of detection obtained when the line sensor unit 20 in a normal state detects the reference plate 30. The reference information is prepared in advance, and is stored in the storage section 29. Since the reference plate 30 is a white-color plate, the reference information is data having a substantially constant luminance. The CPU 26 outputs a difference between the result of detection of the reference plate 30 and the reference information. If the difference is large (for example, when a luminance value in any pixel is different from that of the reference information by a threshold value or more), it is determined that there is an abnormality (S205). Examples of the abnormality that can be detected include contamination of the lenses of the line sensors 23, adhering of dust, etc. to the lenses of the line sensors 23, and a failure to light by the light source 22. Upon determining that there is an abnormality, the CPU 26 notifies the presence of the abnormality. The notification is implemented through, for example, sound generation, lamp lighting, notification to an operator's terminal, notification to a manager's terminal, or the like. If the difference between the result of detection of the reference plate 30 and the reference information is small (when it is determined that there is no abnormality), the CPU 26 corrects the setting of the line sensor unit 20 (performs a zero-point correction) so as to reduce the difference between the result of detection and the reference information. In this embodiment, the difference that is outputted from the comparison between the result of detection of the reference plate 30 and the reference information is used for both the abnormality determination and correction, but alternatively it may be used for either one of them.

[0096] In this embodiment, the line sensor unit 20 is used to detect the presence or absence of the remaining yarn on the bobbin 11, and the remaining yarn range. Instead of or in addition to this, the following information may be detected. For example, the length, color, inclination angle, and upper and lower directions of the bobbin 11 can be calculated based on information acquired by the line sensor unit 20. A result of detection by the line sensor unit 20 includes results concerning the bobbin 11 and the covering 21. The bobbin 11 and the covering 21 have different colors, and, therefore, it is possible to detect the length of the bobbin 11 based on this result of detection. Moreover, it is possible to detect the color of the bobbin 11 based on this result of detection. In a case of the line sensors 23 being monochrome sensors, the line sensors 23 cannot identify a specific color in detail, but can determine whether the color of the bobbin 11 is identical to or different from the color of another bobbin 11 by comparison against a result of detection of the other bobbin 11. When the bobbin 11 is inclined, the length of the bobbin 11 successively detected by the line sensors 23 varies gradually. Based on this information, the inclination angle of the bobbin 11 can be detected. The bobbin 11 has its diameter increasing toward the lower end. If the upper and lower directions of the bobbin 11 are correct, there should be a timing when a lower portion of the bobbin 11 is detected while an upper portion of the bobbin 11 is not detected, during successive detections by the line sensors 23. If this timing is not present, it can be presumed that the upper and lower directions of the bobbin 11 are incorrect. Successive detection by the line sensors 23 enables detection of the lengths of the lower and upper portions of the bobbin 11 in the transport direction. Based on a result of this detection, the upper and lower directions of the bobbin 11 can be presumed.

[0097] An abnormality of the bobbin 11 may be determined through the above-described process. To be specific, it may be possible that: the length and color of the bobbin 11 are preset, and stored as bobbin information in the storage section 29; and if a bobbin 11 not corresponding to the bobbin information is detected, the bobbin 11 is processed as an abnormal bobbin 11. Instead of or in addition to an abnormality of the bobbin 11, an abnormality of the yarn wound on the bobbin 11 may be determined. As described above, the line sensor unit 20 stores the color of the yarn wound on the bobbin 11. The line sensor unit 20 compares a result of the line sensors 23 detecting a portion of the bobbin 11 where the yarn is present (i.e., a portion, such as a middle portion, excluding the upper and lower ends) against the stored yarn color. In this manner, whether or not the preset yarn is

wound can be determined. The line sensor unit 20 also compares a result of the line sensors 23 detecting a portion of the bobbin 11 where the yarn is not present (i.e., the upper or lower end) against the preset color of the bobbin 11. In this manner, whether or not the preset bobbin 11 is used can be determined. If the inclination angle of a bobbin 11 exceeds a threshold value, too, the bobbin 11 may be processed as an abnormal bobbin 11.

[0098] Another example using the line sensor unit 20 will now be described with reference to FIG. 9.

[0099] A transport path 5 shown in FIG. 9 transports bobbins 11 to a first automatic winder 3a and a second automatic winder 3b. The first automatic winder 3a and the second automatic winder 3b produce different kinds of packages. Therefore, bobbins 11 supplied to the first automatic winder 3a and bobbins 11 supplied to the second automatic winder 3b are different from each other (more specifically, different in the length of a bobbin 11, the color of a bobbin 11, the color of a yarn wound on a bobbin 11, and the like).

[0100] The line sensor unit 20 is disposed near and upstream of a branch portion where a first transport route 58 for supplying bobbins 11 to the first automatic winder 3a and a second transport route 59 for supplying bobbins 11 to the second automatic winder 3b diverge from each other. The line sensor unit 20 performs the process as described in the embodiment above, and thereby can calculate bobbin information (the length of a bobbin 11, the color of a bobbin 11, the color of a yarn wound on a bobbin 11, and the like). Bobbin information on a bobbin 11 to be supplied to the first automatic winder 3a and bobbin information on a bobbin 11 to be supplied to the second automatic winder 3b are set in advance, and stored in the storage section 29 or the like.

[0101] Based on the bobbin information detected by the line sensor unit 20, the transport system 4 determines to which of the first transport route 58 and the second transport route 59 the bobbin 11 should be sent. Herein, a condition for determining whether or not a bobbin 11 is a bobbin 11 to be supplied to the first automatic winder 3a will be referred to as a first reference condition.

[0102] The line sensor unit 20 controls a switching device 69 based on a result of detection of a bobbin 11, to thereby transport a bobbin 11 that satisfies the first reference condition to the first transport route 58 while transporting a bobbin 11 that does not satisfy the first reference condition (i.e., a bobbin 11 to be used in the second automatic winder 3b) to the second transport route 59. Accordingly, bobbins 11 suited to each automatic winder can be transported even though the transport path 5 are transporting two or more kinds of bobbins 11.

[0103] A second reference condition as well as the first reference condition may further be set. The second reference condition is a condition for identifying a bobbin 11 to be used in the second automatic winder 3b. The line sensor unit 20 sends a bobbin 11 that satisfies the first reference condition to the first transport route 58, and sends a bobbin 11 that satisfies the second reference condition to the second transport route 59.

[0104] As thus far described, the transport system 4 includes the transport path 5, the line sensor unit 20, and the control section (the CPU 26 and the control device for controlling the transport path 5). The transport path 5 transports the bobbin 11 placed on the tray 12 in an upright position. The transport direction is perpendicular to the axial direction of the bobbin 11. The transport path 5 transports the bobbin 11 to and from the automatic winder 3 that winds up a yarn to produce a package. The line sensor unit 20 includes the line sensors 23 and the light source 22. The line sensors 23, whose detection direction is coincident with the axial direction of the bobbin 11, detect a bobbin being transported on the transport path 5. The light source 22 emits light. The control section controls the transport path 5 and the line sensors 23.

[0105] Since the detection direction is coincident with the axial direction of the bobbin 11, a wide range in the axial direction of the bobbin 11 can be detected by the line sensors 23. Consequently, detailed information about the bobbin 11 can be detected.

[0106] In the transport system 4 according to the above-described embodiment, a result of detection by the line sensors 23 is composed of detection values at plural points arranged in the detection direction, and the number of detection values in the transport direction of the bobbin 11 is one.

[0107] Accordingly, the bobbin 11 can be detected with the line sensors 23 having a simple configuration.

[0108] The transport system 4 according to the above-described embodiment further includes the storage section 29 that stores reference information for comparison against a result of detection by the line sensors 23. The control section compares against the reference information a result of detection obtained when the line sensors 23 detect the bobbin 11 being transported on the transport path 5 while the bobbin 11 is out of a detection range of the line sensors 23.

[0109] Accordingly, the accuracy of the result of detection by the line sensors 23 can be grasped.

[0110] In the transport system 4 according to the above-described embodiment, the line sensors 23 comprise at least two line sensors 23 that are arranged in the detection direction.

[0111] This allows the line sensors 23 to be closer to the bobbin 11, and thus a high resolving power can be achieved.

[0112] In the above-described embodiment, the light source 22 is composed of the LEDs that emit visible light to the bobbin 11. The line sensors 23 detect light that has been visible light emitted from the light source 22 and reflected by the bobbin 11.

[0113] Since the light source 22 is composed of the LEDs, power saving can be achieved, and moreover incorporation into a substrate can be easy.

[0114] The transport system 4 according to the above-described embodiment further includes the covering 21 that covers the light source 22 and the line sensors 23.

The direction perpendicular to the transport direction of the bobbin 11 in a horizontal plane is defined as the first perpendicular direction. The covering 21 includes the pair of wall portions 21a and the ceiling portion 21b. The pair of wall portions 21a are disposed so as to face the transport path 5 in the first perpendicular direction. The ceiling portion 21b connects the upper portions of the pair of wall portions 21a to each other.

[0115] This can reduce an influence of light from the outside, so that the accuracy of detection by the line sensors 23 can be increased.

[0116] In the transport system 4 according to the above-described embodiment, the control section controls the transport path 5 and the line sensor unit 20 such that the line sensors 23 detect the bobbin 11 in movement while the bobbin 11 is being transported on the transport path 5.

[0117] This configuration can shorten time required for detection of a remaining yarn as compared to a configuration that stops the bobbin 11 for detection by the line sensors 23.

[0118] In the transport system 4 according to the above-described embodiment, the control section determines the presence or absence of a remaining yarn on the bobbin 11 based on a result of detection of the bobbin 11 by the line sensors 23, and in a case of any remaining yarn being present on the bobbin 11, finds a range where the remaining yarn is present.

[0119] Accordingly, by using the line sensors 23, the bobbin 11 can be detected entirely, so that the remaining yarn can be detected with an increased accuracy.

[0120] The transport system 4 according to the above-described embodiment further includes the removal apparatus 73 that removes a remaining yarn of the bobbin 11. The removal apparatus 73 is disposed downstream of the line sensors 23 in the transport direction of the bobbin 11. The control section transmits range information about a range of the remaining yarn on the bobbin 11 to the removal apparatus 73. The removal apparatus 73 removes the remaining yarn based on the range information about the range of the remaining yarn received from the control section.

[0121] Accordingly, the removal apparatus 73 can remove the remaining yarn with an increased reliability.

[0122] In the above-described embodiment, the light source 22 is capable of emitting visible light beams of different colors to the bobbin 11.

[0123] With this configuration, the accuracy of detection of the remaining yarn can be increased by emitting a light beam of an appropriate color in accordance with the color of the bobbin 11, the color of the yarn, or the like.

[0124] In the transport system 4 according to the above-described embodiment, the control section controls the line sensor unit 20 so as to perform the first detection and the second detection. The first detection is implemented by the line sensors 23 detecting a visible light beam of a first color emitted to the bobbin 11. The second detection is implemented by the line sensors 23 detecting a visible light beam of a second color emitted to the bobbin 11.

[0125] With this configuration, even if the color of the bobbin 11 or the color of the yarn is similar to the first color, a result of detection obtained by emitting the visible light beam of the second color is used, which allows the remaining yarn to be detected with an increased accuracy.

[0126] In the transport system 4 according to the above-described embodiment, the control section performs the first detection and the second detection successively.

[0127] Accordingly, results of detection obtained by emission of light beams of different colors can be acquired successively.

[0128] In the transport system 4 according to the above-described embodiment, the control section compares a color of an outer circumferential surface of a portion of the bobbin 11 where the yarn is not wound against a color of a yarn wound on the outer circumferential surface of the bobbin 11, to calculate the presence or absence of a remaining yarn on the bobbin 11 and, in a case of the remaining yarn being present on the bobbin 11, a range where the remaining yarn is present.

[0129] Information about the bobbin can be acquired in this manner.

[0130] In the transport system 4 according to the above-described embodiment, the control section uses a color of an end portion of the bobbin 11 in the axial direction as the color of the outer circumferential surface of the bobbin 11.

[0131] Accordingly, the color of the outer circumferential surface of the bobbin 11 can be acquired substantially without fail.

[0132] The transport system 4 according to the above-described embodiment further includes the storage section 29 that stores the bobbin information, which is information about the bobbin 11. The control section compares bobbin information calculated based on a result of detection by the line sensors 23 against the bobbin information stored in the storage section 29.

[0133] Information about the bobbin 11 being transported can be acquired in this manner.

[0134] In the transport system 4 according to the above-described embodiment, the bobbin information includes information about the color of the bobbin 11, or the height of the bobbin 11. The control section determines the presence or absence of an abnormality based on a result of the comparison.

[0135] An abnormality of the bobbin 11 being transported can be detected in this manner.

[0136] In the transport system 4 according to the above-described embodiment, the bobbin information includes information about the color of the bobbin 11, and the color of the yarn wound on the bobbin 11. The control section determines whether or not the bobbin 11 and the yarn wound on the bobbin 11 are appropriate, based on a result of the comparison.

[0137] In this manner, whether or not a combination of the bobbin 11 being transported and the yarn is appropriate can be determined.

[0138] The transport system 4 shown in FIG. 9 transports the bobbins 11 to the first automatic winder 3a and the second automatic winder 3b. The transport path 5 transports the bobbins 11 to the first transport route 58 and the second transport route 59 that is a transport route different from the first transport route 58. The first transport route 58 transports the bobbins 11 to the first automatic winder 3a. The second transport route 59 transports the bobbins 11 to the second automatic winder 3b. The CPU 26 selects to which of the first transport route 58 and the second transport route 59 the bobbin 11 should be sent, based on the bobbin information calculated based on a result of detection by the line sensors 23.

[0139] Accordingly, the bobbins 11 can be sorted to be transported to an appropriate transport route.

[0140] In the transport system 4 shown in FIG. 9, the control section sends the bobbin 11 having the bobbin information satisfying the first reference condition to the first transport route 58, while sending the bobbin 11 having the bobbin information not satisfying the first reference condition to the second transport route 59.

[0141] Accordingly, bobbins can be distributed to two paths by using the single reference condition.

[0142] While a preferred embodiment of the present invention has been described above, the foregoing configurations may be modified, for example, as follows.

[0143] The flowchart shown in the above-described embodiment is just an example. A part of the process may be omitted, the contents of a part of the process may be changed, or a new process may be added. For example, in the flowchart shown in FIG. 5, the determination of whether or not it is the bobbin detection timing may be omitted. In such a case, the line sensors 23 perform detection at predetermined intervals, and upon detection of a bobbin 11, the process of step S105 and subsequent steps are executed.

[0144] The line sensor unit 20 of the above-described embodiment detects an abnormality of the bobbin 11 in addition to detecting the presence or absence of the remaining yarn on the bobbin 11, and the remaining yarn range. Alternatively, the line sensor unit 20 may be configured to only detect an abnormality of the bobbin 11. In such a case, the line sensor unit 20 may be disposed in a region of the fine spinning machine 2 or the automatic winder 3.

Claims

1. A transport system (4) comprising:

a transport path (5) configured to transport a bobbin (11) placed on a tray (12) in an upright position, the transport path (5) having a transport direction perpendicular to the axial direction of the bobbin (11), the transport path (5) being configured to transport the bobbin (11) to and from an automatic winder (3) that is configured to wind up a yarn to produce a package;

a line sensor unit (20) including a line sensor (23) and a light source, the line sensor (23) being configured to detect a bobbin (11) being transported on the transport path (5), the line sensor (23) having a detection direction coincident with the axial direction of the bobbin (11), the light source (22) being configured to emit light; and

a control section (26) that is configured to control the transport path (5) and the line sensor unit (20).

2. The transport system (4) according to claim 1, wherein

a result of detection by the line sensor (23) is composed of detection values at plural points arranged in the detection direction, and the number of detection values in the transport direction of the bobbin (11) is one.

3. The transport system (4) according to claim 1 or 2,

further comprising a reference information storage section (29) that stores reference information for comparison against a result of detection by the line sensor (23), wherein

the control section (26) is configured to compare against the reference information a result of detection obtained when the line sensor (23) detects the bobbin (11) being transported on the transport path (5) while the bobbin (11) is out of a detection range of the line sensor (23).

4. The transport system (4) according to any one of claims 1 to 3, wherein

the light source (22) is composed of LEDs that are configured to emit visible light to the bobbin (11), and

the line sensor (23) is configured to detect light that is visible light emitted from the light source (22) and reflected by the bobbin (11).

5. The transport system (4) according to claim 4, further comprising a covering (21) that covers the light source (22) and the line sensor (23), the covering (21) including:

a pair of wall portions (21a) disposed so as to face the transport path (5) in a first perpendicular direction, the first perpendicular direction being a direction that is perpendicular to the transport direction of the bobbin (11) in a horizontal plane; and

a ceiling portion (21b) that connects upper por-

tions of the pair of wall portions (21a) to each other.

6. The transport system (4) according to any one of claims 1 to 5, wherein
the control section (26) is configured to control the transport path (5) and the line sensor unit (20) such that the line sensor (23) detects the bobbin (11) in movement while the bobbin (11) is being transported on the transport path (5).

7. The transport system (4) according to any one of claims 1 to 6, wherein
the control section (26) is configured to determine the presence or absence of a remaining yarn on the bobbin (11) based on a result of detection of the bobbin (11) by the line sensor (23), and in a case of any remaining yarn being present on the bobbin (11), is configured to find a range where the remaining yarn is present.

8. The transport system (4) according to claim 7,

further comprising a removal apparatus (73) that is configured to remove a remaining yarn of the bobbin (11), the removal apparatus (73) being disposed downstream of the line sensor (23) in the transport direction of the bobbin (11), wherein
the control section (26) is configured to transmit range information about a range of the remaining yarn on the bobbin (11) to the removal apparatus (73), and
the removal apparatus (73) is configured to remove the remaining yarn based on the range information about the range of the remaining yarn received from the control section (26).

9. The transport system (4) according to claim 7 or 8, wherein
the light source (22) is capable of emitting visible light beams of different colors to the bobbin (11).

10. The transport system (4) according to any one of claims 7 to 9, wherein
the control section (26) is configured to control the line sensor unit (20) so as to perform a first detection and a second detection, the first detection being implemented by the line sensor (23) detecting a visible light beam of a first color emitted to the bobbin (11), the second detection being implemented by the line sensor (23) detecting a visible light beam of a second color emitted to the bobbin (11).

11. The transport system (4) according to claim 10, wherein
the control section (26) is configured to perform the first detection and the second detection successively.

12. The transport system (4) according to any one of claims 7 to 11, wherein
the control section (26) is configured to compare a color of an outer circumferential surface of a portion of the bobbin (11) where the yarn is not wound against a color of a yarn wound on the outer circumferential surface of the bobbin (11), to calculate the presence or absence of a remaining yarn on the bobbin (11) and, in a case of the remaining yarn being present on the bobbin (11), a range where the remaining yarn is present.

13. The transport system (4) according to claim 12, wherein
the control section (26) uses a color of an end portion of the bobbin (11) in the axial direction as the color of the outer circumferential surface of the bobbin (11).

14. The transport system (4) according to any one of claims 1 to 13,

further comprising a bobbin information storage section (29) that stores bobbin information, the bobbin information being information about the bobbin (11), wherein
the control section (26) is configured to compare bobbin information calculated based on a result of detection by the line sensor (23) against the bobbin information stored in the bobbin information storage section (29).

15. The transport system (4) according to claim 14, wherein

the bobbin information includes information about a color of the bobbin (11), or a height of the bobbin (11), and
the control section (26) is configured to determine the presence or absence of an abnormality based on a result of the comparison.

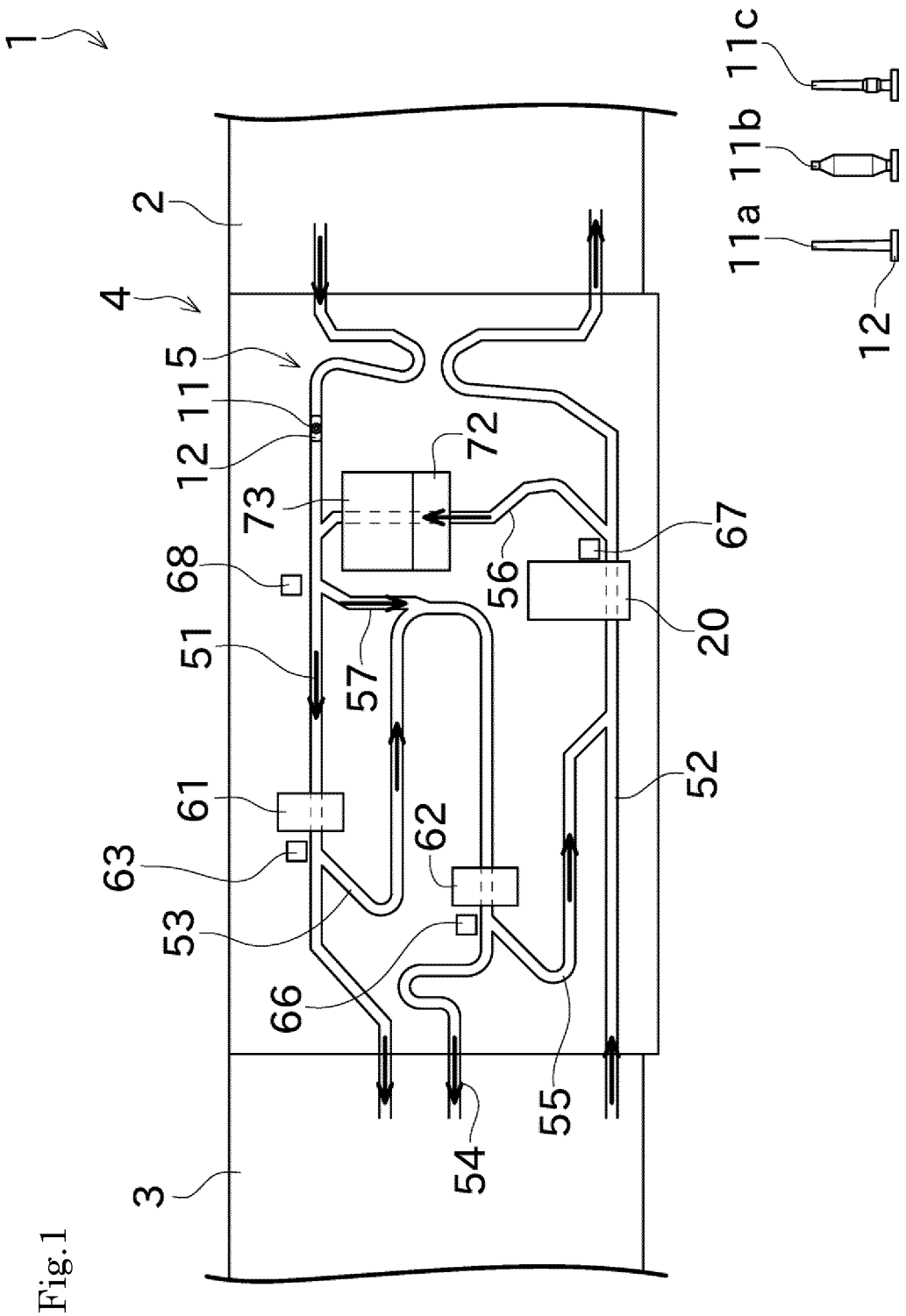
16. The transport system (4) according to claim 14 or 15, wherein

the bobbin information includes information about a color of the bobbin (11), and a color of a yarn wound on the bobbin (11), and
the control section (26) is configured to determine whether or not the bobbin (11) and the yarn wound on the bobbin (11) are appropriate, based on a result of the comparison.

17. The transport system (4) according to any one of claims 14 to 16, wherein

a first automatic winder (3a) and a second automatic winder (3b) are provided as the automatic winder (3),
the transport path (5) transports the bobbins (11) to a first transport route (58) and a second transport route (59) that is a transport route different from the first transport route (58), the first transport route (58) being configured to transport the bobbin (11) to the first automatic winder (3a), the second transport route (59) being configured to transport the bobbin (11) to the second automatic winder (3b), and
the control section (26) is configured to select to which of the first transport route (58) and the second transport route (59) the bobbin (11) should be sent, based on the bobbin information calculated based on a result of detection by the line sensor (23).

18. The transport system (4) according to claim 17, wherein
the control section (26) is configured to send the bobbin (11) having the bobbin information satisfying a first reference condition to the first transport route (58), while sending the bobbin (11) having the bobbin information not satisfying the first reference condition to the second transport route (59).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72
73

Fig.1

Fig.2

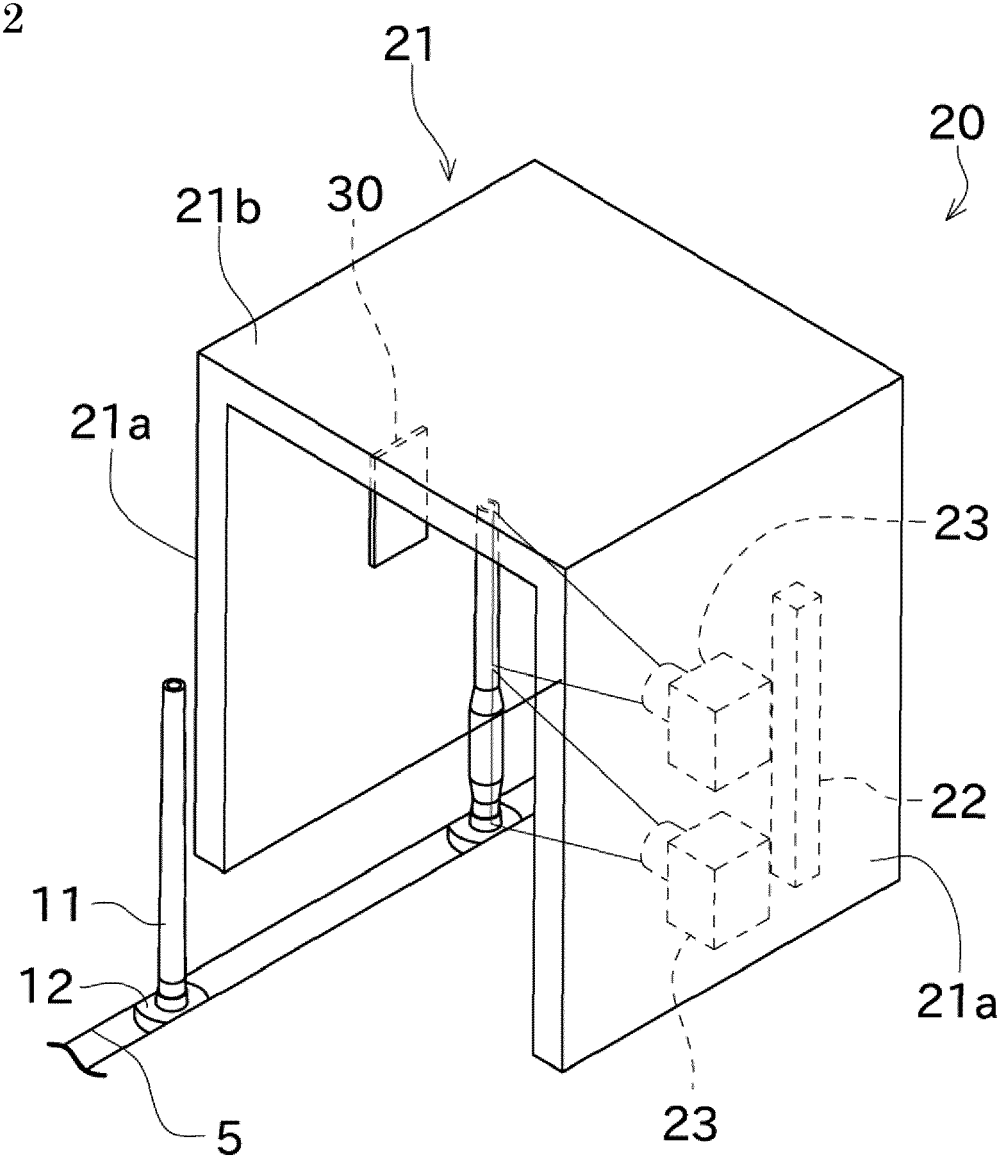


Fig.3

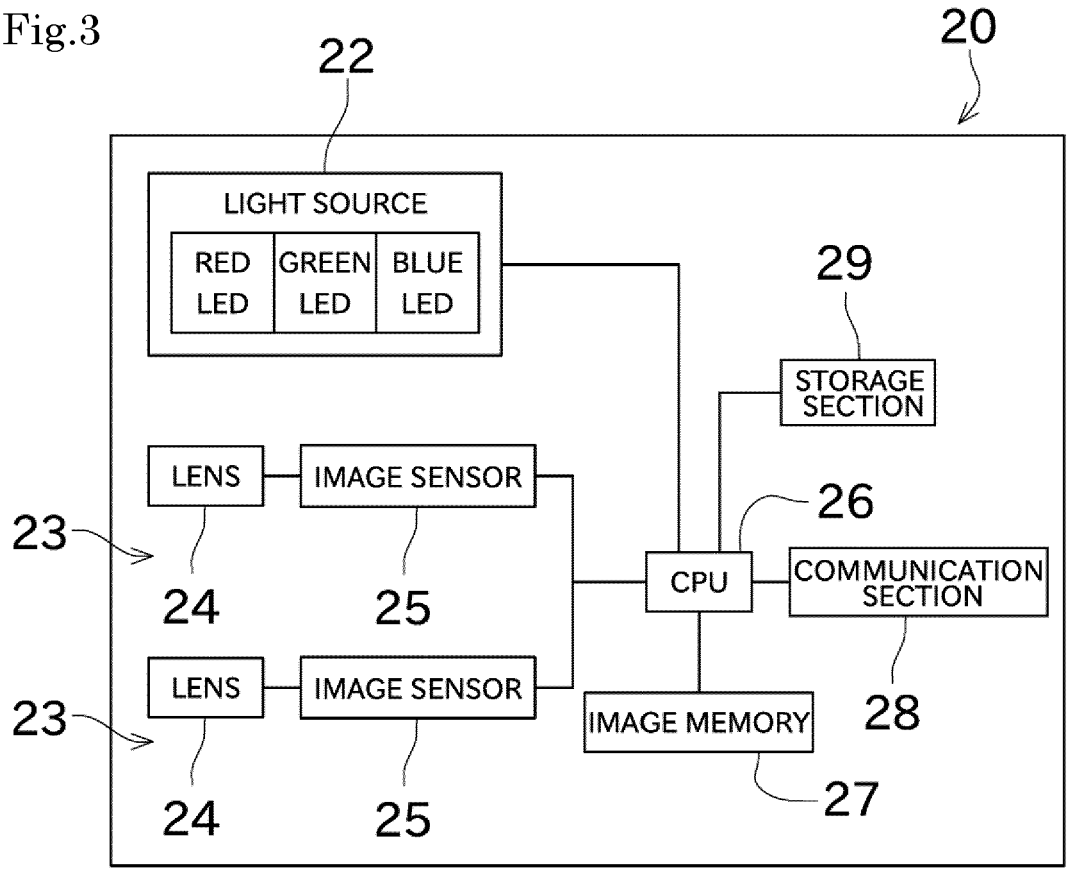

20
22
LIGHT SOURCE
RED LED
GREEN LED
BLUE LED
29
STORAGE SECTION
LENS
IMAGE SENSOR
23
24
25
26
CPU
COMMUNICATION SECTION
28
LENS
IMAGE SENSOR
23
IMAGE MEMORY
27
24
25

Fig.4

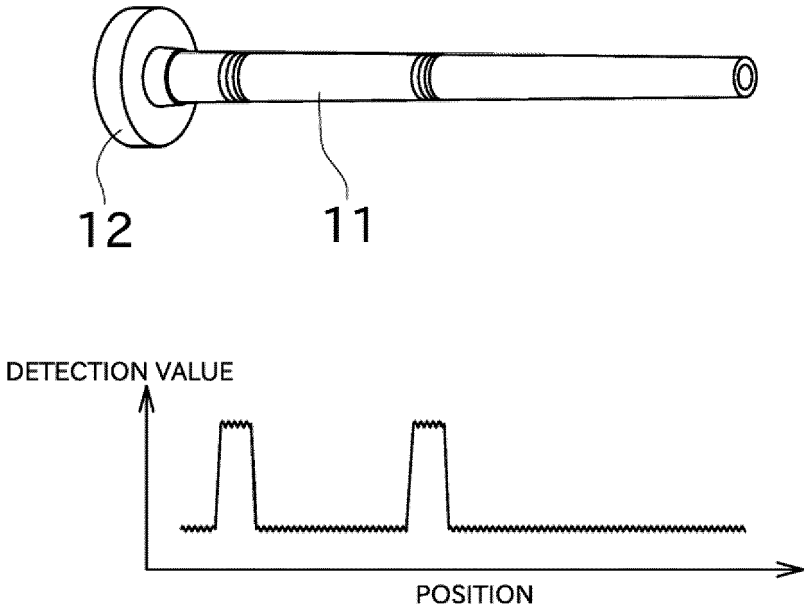


Fig.5

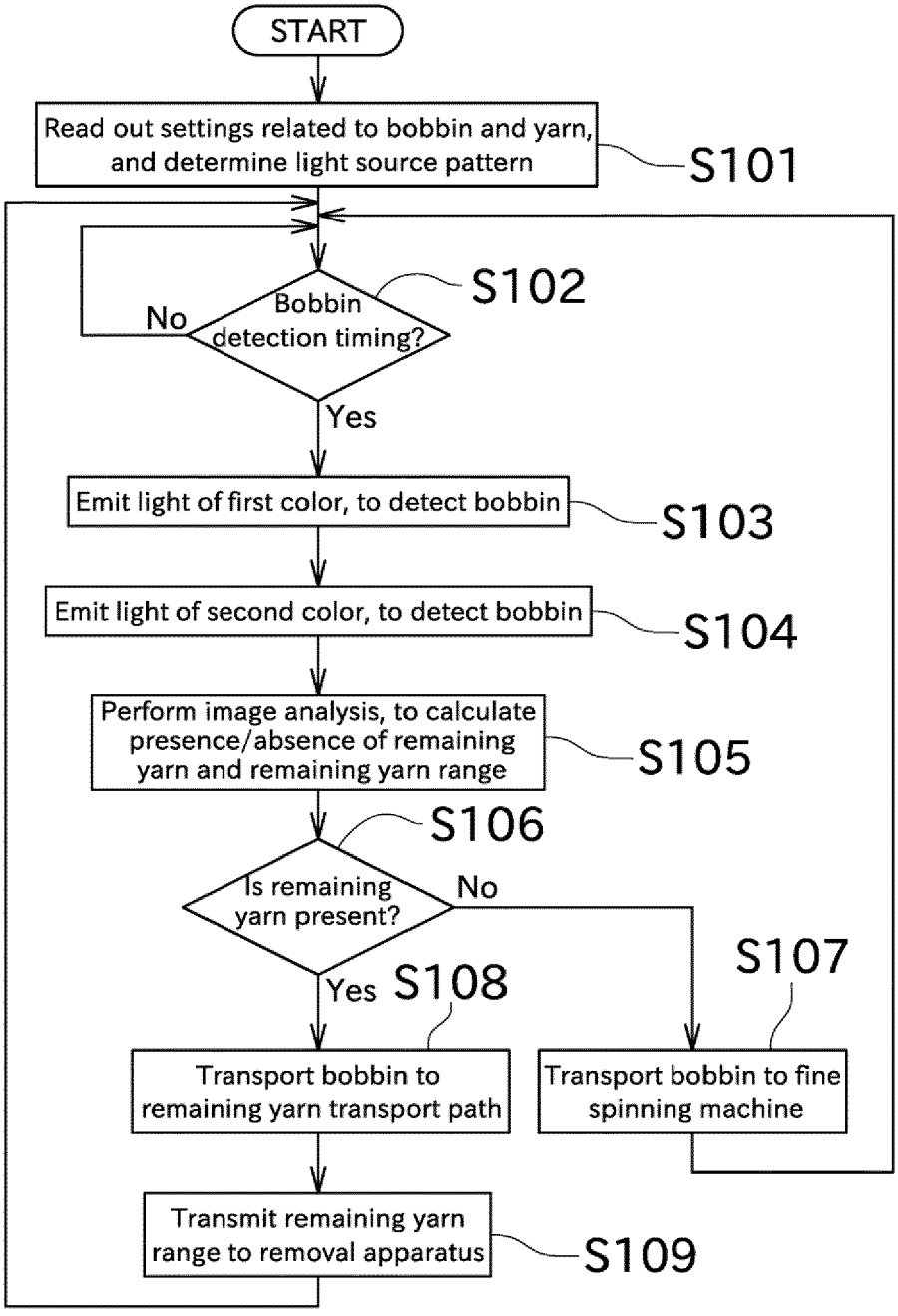

START
Read out settings related to bobbin and yarn, and determine light source pattern
S101
Bobbin detection timing?
No
S102
Yes
Emit light of first color, to detect bobbin
S103
Emit light of second color, to detect bobbin
S104
Perform image analysis, to calculate presence/absence of remaining yarn and remaining yarn range
S105
S106
Is remaining yarn present?
No
S107
Yes
S108
Transport bobbin to remaining yarn transport path
Transport bobbin to fine spinning machine
Transmit remaining yarn range to removal apparatus
S109

Fig.6

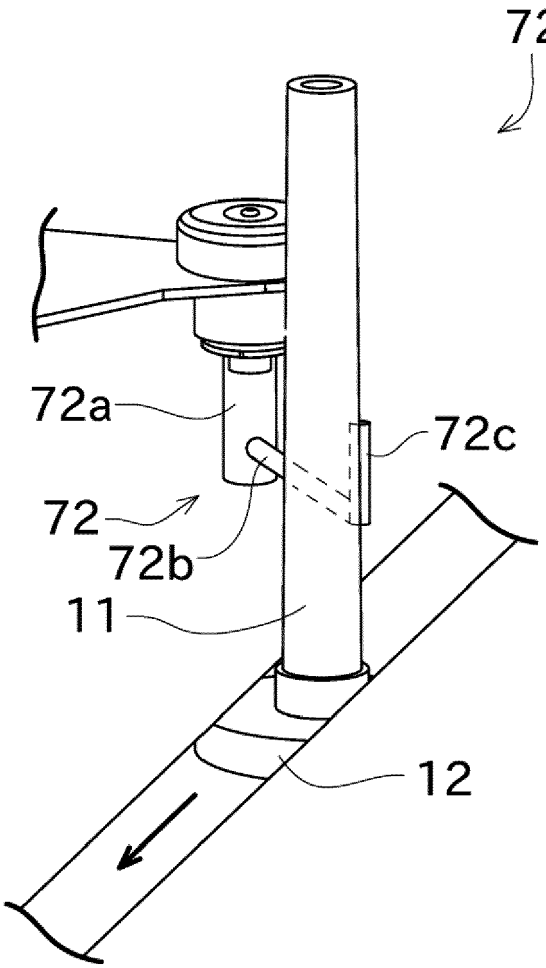


Fig.7

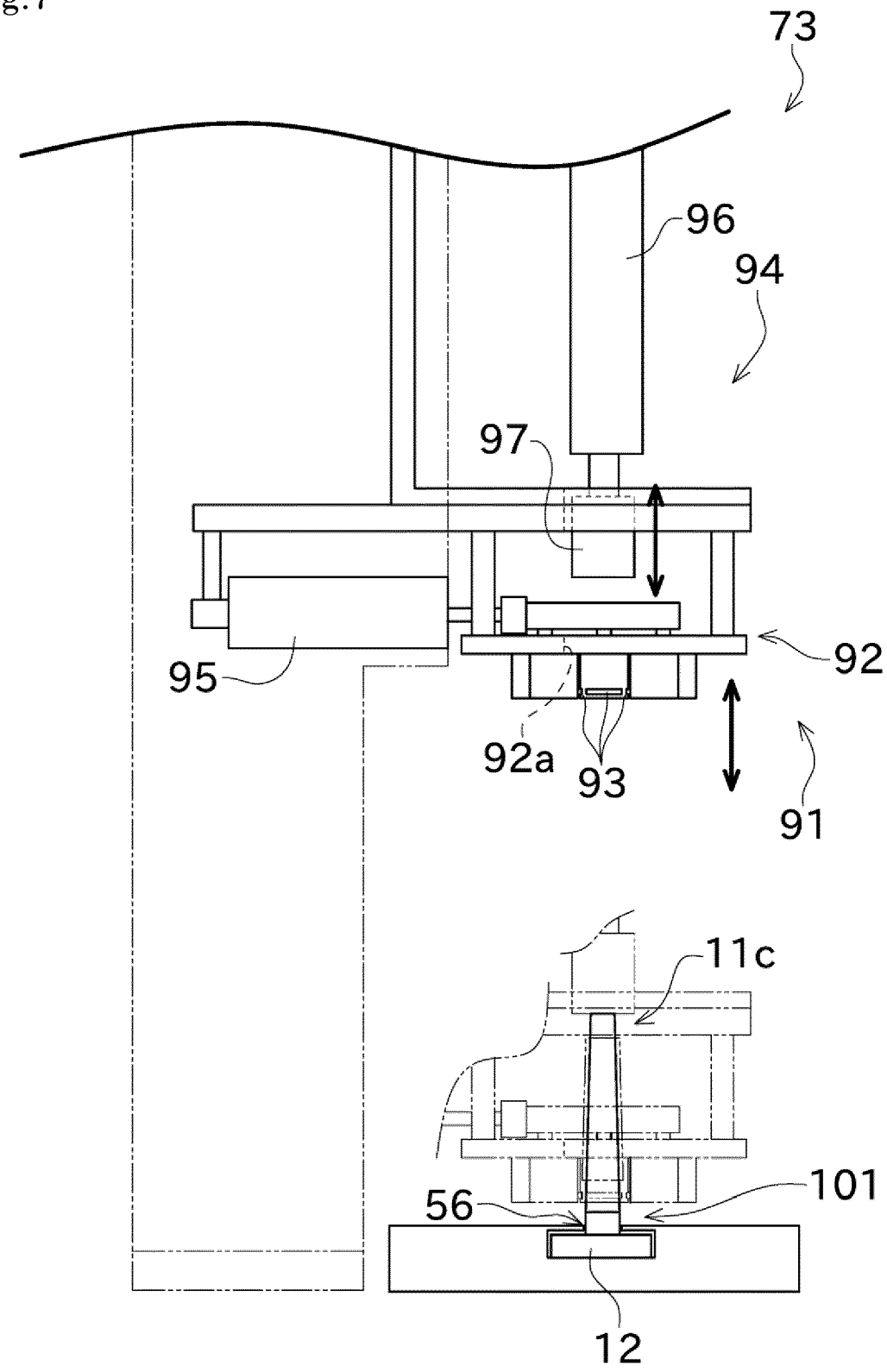


Fig.8

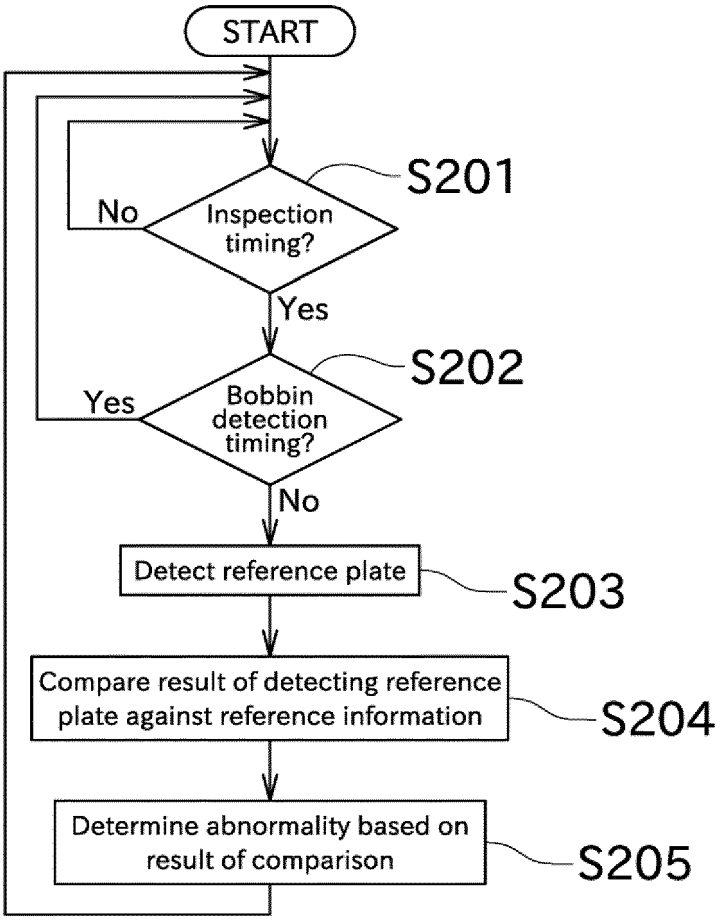
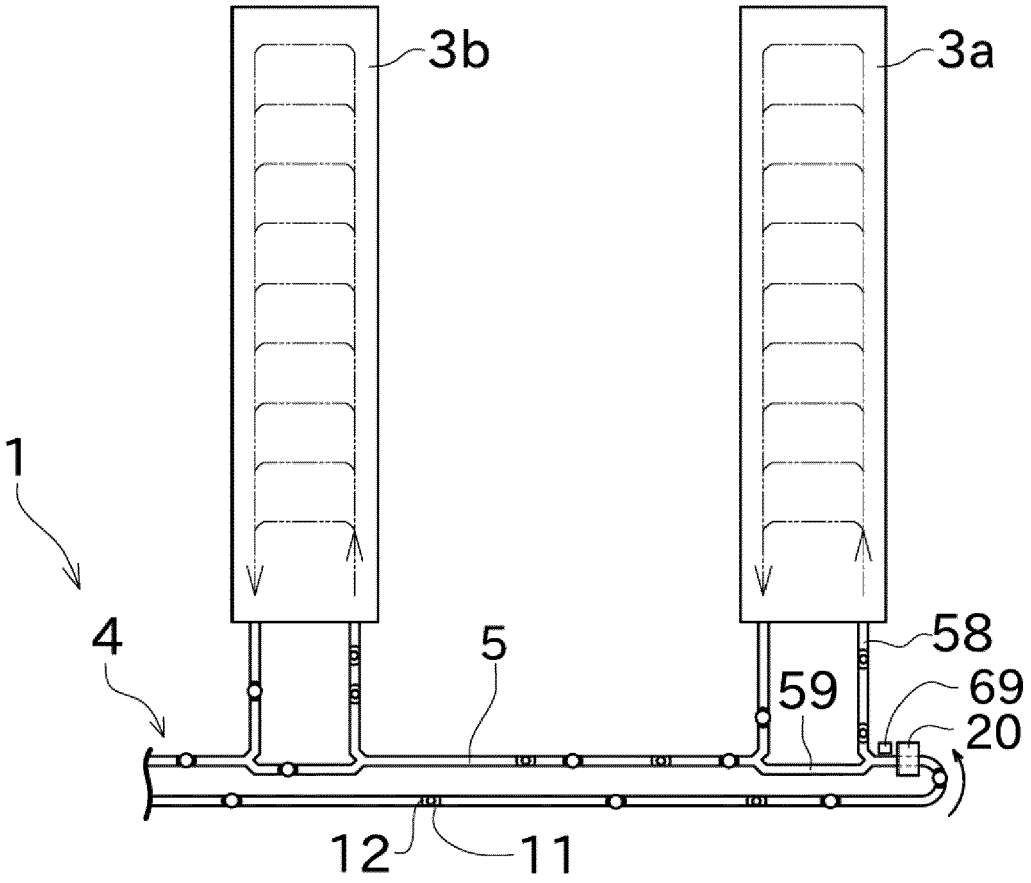

START
S201
No
Inspection timing?
Yes
S202
Yes
Bobbin detection timing?
No
Detect reference plate
S203
Compare result of detecting reference plate against reference information
S204
Determine abnormality based on result of comparison
S205

Fig.9



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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 1260

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Place of search	Date of completion of the search	Examiner
The Hague	9 January 2023	Pussemier, Bart

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