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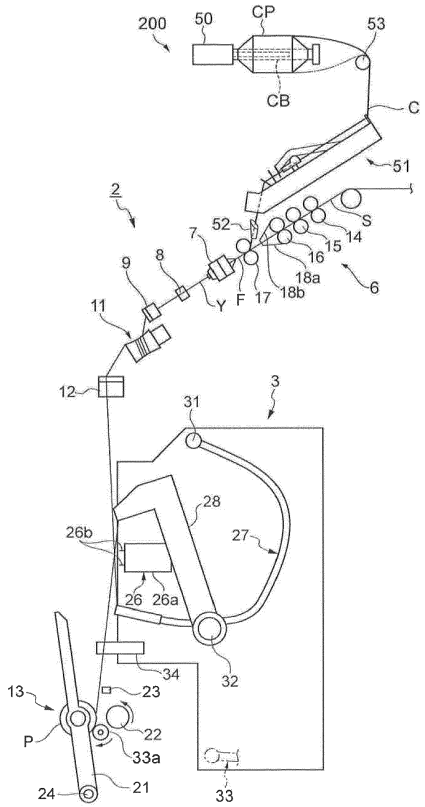
## (54) YARN WINDING MACHINE

(57) A spinning unit (2) includes a draft device (6), a pneumatic spinning device (7), a core yarn supplying device (200), a winding device (13), a splicer (26), and a suction mouth (28). The winding device (13) is adapted to perform a first unwinding operation to unwind a spun yarn (Y) having a core yarn (C) from a package (P) by reversely rotating the package (P) when the suction mouth (28) is performing a yarn guiding operation. The winding device (13) is adapted to perform a second unwinding operation to unwind the spun yarn (Y) from the package (P) by reversely rotating the package (P) after the suction mouth (28) finishes the yarn guiding operation and before the splicer (26) starts the yarn joining operation. The suction mouth (28) sucks the spun yarn (Y) from the package (P) while a reverse rotation mechanism (33) is performing the second unwinding operation.

FIG. 7

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## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to a yarn winding machine.

#### 2. Description of the Related Art

**[0002]** As a conventional yarn winding machine, there is known a yarn winding machine including a yarn supplying device adapted to supply a yarn having a core yarn, a winding device adapted to wind the yarn into a package, and a yarn joining device adapted to perform a yarn joining operation to join the yarn from the yarn supplying device and the yarn from the package upon disconnection of the yarn (see e.g., Japanese Unexamined Patent Publication No. H11-200165). Such a yarn winding machine may include a yarn guiding device adapted to perform a yarn guiding operation to guide the yarn from the package to the yarn joining device.

### BRIEF SUMMARY OF THE INVENTION

**[0003]** However, in the yarn winding machine described above, a portion where the core yarn is exposed may be mixed in the yarn wound into the package.

**[0004]** It is an object of the present invention to provide an improved yarn winding machine.

**[0005]** This object is achieved by a yarn winding machine according to claim 1.

**[0006]** Embodiments provide a yarn winding machine capable of preventing a portion where a core yarn is exposed from mixing into a package.

**[0007]** A yarn winding machine of the present invention includes a yarn supplying device adapted to supply a yarn having a core yarn; a winding device adapted to wind the yarn into a package by forwardly rotating the package; a yarn joining device adapted to perform a yarn joining operation to join the yarn from the yarn supplying device and the yarn from the package upon disconnection of the yarn; and a yarn guiding device adapted to perform a yarn guiding operation to guide the yarn from the package to the yarn joining device while sucking the yarn from the package upon disconnection of the yarn; wherein the winding device is adapted to perform a first unwinding operation to unwind the yarn from the package by reversely rotating the package when the yarn guiding device is performing the yarn guiding operation, and to perform a second unwinding operation to unwind the yarn from the package by reversely rotating the package after the yarn guiding device finishes the yarn guiding operation and before the yarn joining device starts the yarn joining operation, and the yarn guiding device is adapted to suck the yarn from the package when the winding device is performing the second unwinding operation.

**[0008]** In the above-described yarn winding machine, when the yarn is disconnected, the guiding operation is performed by the yarn guiding device, and thereafter the yarn joining operation is performed by the yarn joining device. If high tension is applied on the yarn from the package when the guiding operation is being performed, possibility of the core yarn being exposed from a surface of the yarn may increase. However, in the above-described yarn winding machine, the second unwinding operation is performed by the winding device after the yarn guiding operation is finished and before the yarn joining operation is started. Furthermore, the yarn from the package is sucked by the yarn guiding device when the second unwinding operation is being performed. Thus, even if the core yarn is exposed when the yarn guiding operation is being performed, for example, the portion where the core yarn is exposed is sucked by the yarn guiding device. Therefore, the portion where the core yarn is exposed can be prevented from being mixed into the package.

**[0009]** An embodiment of the yarn winding machine of the present invention may further include a yarn moving device adapted to perform a yarn moving operation to move the yarn from the package after the yarn guiding device finishes the yarn guiding operation and before the winding device starts the second unwinding operation. Thus, the yarn from the package can be moved to a desired position before the yarn joining operation, and the yarn joining operation can be more reliably performed.

**[0010]** In an embodiment of the yarn winding machine of the present invention, the yarn moving device may be adapted to move the yarn from the package towards center of a wound width of the package by the yarn moving operation. Thus, the yarn joining operation can be more reliably performed.

**[0011]** In an embodiment of the yarn winding machine of the present invention, the winding device may be adapted to stop reverse rotation of the package between the first unwinding operation and the second unwinding operation. Thus, the package can be reliably reversely rotated by the desired reverse rotation amount in the second unwinding operation.

**[0012]** In an embodiment of the yarn winding machine of the present invention, a length of the yarn unwound by the winding device by the second unwinding operation may be equal to or longer than a length of the yarn from the winding device to the yarn joining device. Thus, the portion where the core yarn may be exposed can be reliably collected.

**[0013]** An embodiment of the yarn winding machine of the present invention may further include a setting section adapted to set a period of time in which the winding device performs the second unwinding operation. Thus, the length of the yarn unwound by the second unwinding operation can be adjusted.

**[0014]** In an embodiment of the yarn winding machine of the present invention, the yarn joining device includes a yarn joining section adapted to join the yarn from the

yarn supplying device and the yarn from the package, and a yarn gathering section adapted to gather the yarn from the yarn supplying device and the yarn from the package, and the winding device is adapted to perform the second unwinding operation after the yarn guiding device finishes the yarn guiding operation and before the yarn gathering section gathers the yarn from the yarn supplying device and the yarn from the package to the yarn joining section. Thus, the yarns can be joined in a state where the portion where the core yarn is exposed is removed.

**[0015]** In an embodiment of the yarn winding machine of the present invention, the yarn supplying device may include a core yarn supplying device adapted to supply the core yarn; a draft device adapted to draft a fiber bundle; and a pneumatic spinning device adapted to form the yarn by applying twists to the fiber bundle with the core yarn as a core. Thus, the yarn having the core yarn can be appropriately formed.

**[0016]** An embodiment of the yarn winding machine of the present invention may further include a control section adapted to control the winding device to perform the second unwinding operation and the yarn guiding device to suck the yarn from the package while the second unwinding operation is being performed by the winding device. Thus, the second unwinding operation, the operation of causing the yarn guiding device to suck the yarn, and the like can be reliably performed.

**[0017]** In an embodiment of the yarn winding machine of the present invention, the yarn guiding device is adapted to suck and remove a defective portion of the yarn during the second unwinding operation. The defective portion of the yarn may be a portion where the core yarn is exposed.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]**

FIG. 1 is a front view of a spinning machine, which is a yarn winding machine, according to one embodiment of the present invention;

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

FIG. 3 is a timing chart illustrating an operation of the spinning unit from middle of a yarn guiding operation to end of a yarn joining operation;

FIG. 4 is a side view of the spinning unit at the time of yarn disconnection;

FIG. 5 is a side view of the spinning unit at the time of the yarn guiding operation;

FIG. 6 is a side view of the spinning unit at the time of a yarn moving operation;

FIG. 7 is a side view of the spinning unit at the time of a second unwinding operation; and

FIG. 8 is a side view of the spinning unit at the time of the yarn joining operation.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0019]** An embodiment of the present invention will be hereinafter described in detail with reference to the accompanying drawings. The same reference numerals are denoted on the same or corresponding portions throughout the drawings, and redundant description will be omitted.

**[0020]** As illustrated in FIG. 1, a spinning machine (yarn winding machine) 1 includes a plurality of spinning units 2, a yarn joining cart 3, a doffing cart (not illustrated), a first end frame 4, and a second end frame 5. The plurality of spinning units 2 are arranged in a row. Each spinning unit 2 is adapted to form a spun yarn (yarn) Y and wind the spun yarn Y into a package P. The yarn joining cart 3 is adapted to perform a yarn joining operation in a spinning unit 2, after the spun yarn Y is cut, or is broken for some reason in such a spinning unit 2. The doffing cart is adapted to doff the package P and to supply a new bobbin B to the spinning unit 2 when the package P is fully-wound in a spinning unit 2. The first end frame 4 accommodates, for example, a collecting device adapted to collect fiber waste, yarn waste, and the like generated in the spinning units 2.

**[0021]** The second end frame 5 accommodates an air supplying section adapted to adjust air pressure of compressed air (air) to be supplied to the spinning machine 1 and to supply the air to each section of the spinning machine 1, a drive motor adapted to supply power to each section of the spinning unit 2, and the like. The second end frame 5 is provided with a machine control device (setting section) 41, a display screen 42, and an input key 43. The machine control device 41 is adapted to intensively manage and control each section of the spinning machine 1. The display screen 42 is capable of displaying information relating to set contents and/or status, or the like of the spinning units 2. An operator can perform a setting operation of the spinning units 2 by performing an appropriate operation with the input key 43.

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

**[0023]** As illustrated in FIGS. 1 and 2, each spinning unit 2 includes a draft device (yarn supplying device) 6 and a core yarn supplying device (yarn supplying device)

200, a pneumatic spinning device (yarn supplying device) 7, a yarn monitoring device 8, a tension sensor 9, a yarn storage device 11, a waxing device 12, and a winding device 13 in this order from upstream in a travelling direction of the spun yarn Y. A unit controller (control section) 10 is provided for every predetermined number of the spinning units 2 and is adapted to control operations of the spinning units 2.

**[0024]** The draft device 6 is adapted to draft a sliver (fiber bundle) S. The draft device 6 includes a pair of back rollers 14, a pair of third rollers 15, a pair of middle rollers 16, and a pair of front rollers 17 in this order from upstream in a travelling direction of the sliver S. Each pair of rollers 14, 15, 16, and 17 includes a bottom roller and a top roller. The bottom roller is rotationally driven by the drive motor provided in the second end frame 5 or by a drive motor provided in each spinning unit 2. An apron belt 18a is provided with respect to the bottom roller of the middle rollers 16. An apron belt 18b is provided with respect to the top roller of the middle rollers 16.

**[0025]** The core yarn supplying device 200 unwinds a core yarn C from a core yarn package CP, and supplies the core yarn C to the pneumatic spinning device 7. The core yarn supplying device 200 includes a package supporting section 50, a core yarn supplying unit 51, and a core yarn guiding section 52. The package supporting section 50 supports the core yarn package CP with a center line of the core yarn package CP, which is formed by winding the core yarn C around a core yarn bobbin CB, extending in a horizontal and front-back direction. The core yarn supplying unit 51 applies tension to the core yarn C unwound from the core yarn package CP and guided via a guide roller 53. The core yarn guiding section 52 guides the core yarn C supplied from the core yarn supplying unit 51 to a position between the pair of middle rollers 18 and the pair of front rollers 19 of the draft device 6. The core yarn supplying device 200 thereby supplies the core yarn C to the pneumatic spinning device 7.

**[0026]** The pneumatic spinning device 7 is adapted to form the spun yarn Y having the core yarn C by applying twists to the fiber bundle F, which has been drafted by the draft device 6, with a whirling airflow, with the core yarn C supplied from the core yarn supplying device 200 as the core. More specifically (however, not illustrated), the pneumatic spinning device 7 includes a spinning chamber, a fiber guiding section, a whirling airflow generating nozzle, and a hollow guide shaft body. The fiber guiding section is adapted to guide the core yarn C supplied from the upstream core yarn supplying device 200 and the fiber bundle F supplied from the upstream draft device 6 into the spinning chamber. The whirling airflow generating nozzle is arranged at a periphery of a travelling path of the core yarn C and the fiber bundle F, and a whirling airflow is generated in the spinning chamber by the air being injected from the whirling airflow generating nozzle. With the whirling airflow, each fiber end of a plurality of fibers that form the fiber bundle F is reversed and whirled. The hollow guide shaft body is adapted to guide the spun yarn Y from the spinning chamber to an outside of the pneumatic spinning device 7.

**[0027]** The yarn monitoring device 8 is adapted to monitor information on the travelling spun yarn Y between the pneumatic spinning device 7 and the yarn storage device 11, and to detect presence or absence of a yarn defect based on the information acquired by the monitoring. When detecting the yarn defect, the yarn monitoring device 8 transmits a yarn defect detection signal to the unit controller 10. The yarn monitoring device 8 detects a thickness abnormality of the spun yarn Y, a foreign substance included in the spun yarn Y, and/or exposure of the core yarn C, for example, as the yarn defect. The yarn monitoring device 8 also detects yarn breakage or the like. The tension sensor 9 is adapted to measure tension of the travelling spun yarn Y between the pneumatic spinning device 7 and the yarn storage device 11, and to transmit a tension measurement signal to the unit controller 10. When the unit controller 10 determines presence of an abnormality based on a detection result of the yarn monitoring device 8 and/or the tension sensor 9, the spun yarn Y is cut in the spinning unit 2. Specifically, by stopping air supply to the pneumatic spinning device 7 to interrupt forming of the spun yarn Y, the spun yarn Y is cut. Alternatively, the spun yarn Y may be cut with a cutter separately provided.

**[0028]** The waxing device 12 is adapted to apply wax to the spun yarn Y between the yarn storage device 11 and the winding device 13.

**[0029]** The yarn storage device 11 is adapted to eliminate slack of the spun yarn Y between the pneumatic spinning device 7 and the winding device 13. The yarn storage device 11 has a function of stably pulling out the spun yarn Y from the pneumatic spinning device 7, a function of preventing the spun yarn Y from slackening by accumulating the spun yarn Y fed from the pneumatic spinning device 7 at the time of the yarn joining operation or the like by the yarn joining cart 3, and a function of preventing variation in the tension of the spun yarn Y at downstream of the yarn storage device 11 from being propagated to the pneumatic spinning device 7.

**[0030]** The winding device 13 is adapted to forwardly rotate the package P to wind the spun yarn Y around the bobbin B or the package P. The winding device 13 includes a cradle arm 21, a winding drum 22, a traverse guide 23, and a reverse rotation mechanism 33. The cradle arm 21 rotatably supports the bobbin B. The cradle arm 21 is swingably supported by a supporting shaft 24, and is adapted to bring a surface of the bobbin B or a surface of the package P into contact with a surface of the winding drum 22 under appropriate pressure. A drive motor (not illustrated) provided in the second end frame 5 is adapted to simultaneously drive the winding drums 22 each provided in the plurality of the spinning units 2. Accordingly, in each spinning unit 2, the bobbin B or the package P is rotated in a winding direction.

**[0031]** The traverse guide 23 of each spinning unit 2

is provided on a shaft 25 shared by the plurality of the spinning units 2. By the drive motor in the second end frame 5 driving the shaft 25 to reciprocate in a direction of a rotational axis of the winding drum 22, the traverse guide 23 traverses the spun yarn Y in a predetermined width with respect to the rotating bobbin B or package P. When the cradle arm 21 is moved by an air cylinder (not illustrated) such that the package P moves away from the winding drum 22, the reverse rotation mechanism 33 brings a surface of a reverse rotation roller 33a into contact with the surface of the package P under an appropriate pressure to reversely rotate the package P. The reverse rotation mechanism 33 is provided in the yarn joining cart 3.

**[0032]** After the spun yarn Y is cut, or is broken for some reason in a spinning unit 2, the yarn joining cart 3 travels to such a spinning unit 2 to perform the yarn joining operation. The yarn joining cart 3 includes a splicer (yarn joining device) 26, a suction pipe 27, a suction mouth (yarn guiding device) 28, and a yarn moving device 34.

**[0033]** The suction pipe 27 is swingably supported by a supporting shaft 31, and is adapted to suck the spun yarn Y from the pneumatic spinning device 7 and to guide the sucked spun yarn Y to the splicer 26. The suction mouth 28 is swingably supported by a supporting shaft 32, and is adapted to suck the spun yarn Y from the winding device 13 and to guide the sucked spun yarn Y to the splicer 26.

**[0034]** The yarn moving device 34 is adapted to perform a yarn moving operation to move the spun yarn Y from the winding device 13 guided to the splicer 26 by a yarn guiding operation towards the center of the wound width of the package P. Specifically, the yarn moving device 34 includes a pair of yarn guide members (not illustrated) that can be opened and closed. During the yarn guiding operation, the pair of yarn guide members is held in the opened state. In other words, the two yarn guide members are held at positions spaced apart from each other, and are located on both sides of the spun yarn Y from the winding device 13. After the yarn guiding operation is finished, the pair of yarn guide members is driven to the closed state, thus moving the spun yarn Y towards the center of the wound width of the package P.

**[0035]** The splicer 26 performs the yarn joining operation to join the guided spun yarn Y from the pneumatic spinning device 7 and the spun yarn Y from the package P. The splicer 26 is positioned with respect to a central region of the wound width of the package P. The splicer 26 includes a splicer head (yarn joining section) 26a and a yarn gathering lever (yarn gathering section) 26b. In the present embodiment, the splicer head 26a is arranged to be movable forward and backward with respect to a yarn path. The splicer head 26a is held at a standby position away from the yarn path when the yarn joining operation is not being performed. To perform the yarn joining operation, after the splicer head 26a is moved forward, the yarn gathering lever 26b gathers the spun yarn Y from the pneumatic spinning device 7 and the spun yarn Y from the package P towards the splicer head 26a. The splicer head 26a joins the two gathered spun yarns Y with compressed air.

**[0036]** Next, a description will be made on an operation of the spinning unit 2 when the spun yarn Y is cut, with reference to a timing chart of FIG. 3. The timing chart of FIG. 3 illustrates a timing at which the unit controller 10 transmits a control signal to each device.

**[0037]** A case where the spun yarn Y is cut includes a case where the spun yarn Y is cut to remove the yarn defect, and a case where the spun yarn Y is unexpectedly cut. When the spun yarn Y is cut to remove the yarn defect, the unit controller 10 determines that the spun yarn Y is cut by the unit controller 10 itself performing a control to cut the spun yarn Y. More specifically, the unit controller 10 stops the operations of the draft device 6 and the pneumatic spinning device 7 to cut the spun yarn Y upon receiving the yarn defect detection signal from the yarn monitoring device 8 while the spun yarn Y is being formed and wound into the package P. At this timing, the unit controller 10 determines that the spun yarn Y is cut. When the spun yarn Y is unexpectedly cut, the unit controller 10 determines that the spun yarn Y is cut based on a yarn detection signal transmitted from a yarn travelling sensor (not illustrated) arranged at a predetermined position on the travelling path of the spun yarn Y. In this case as well, the unit controller 10 stops the operations of the draft device 6 and the pneumatic spinning device 7.

**[0038]** When determining that the spun yarn Y is cut, the unit controller 10 swings the cradle arm 21 and operates a brake mechanism (not illustrated) arranged on the cradle arm 21 after the spun yarn Y from the package P is wound into the package P, as illustrated in FIG. 4. The forward rotation of the package P is thereby stopped with the package P spaced apart from the winding drum 22. Then, the unit controller 10 transmits a control signal indicating the spinning unit 2, in which the spun yarn Y is determined to be cut, to the yarn joining cart 3. The yarn joining cart 3 thus travels to the spinning unit 2 and stops.

**[0039]** Then, as illustrated in FIG. 5, the unit controller 10 swings the suction pipe 27 such that a suction port of the suction pipe 27 is located downstream of the pneumatic spinning device 7 and performs a control to generate a suction flow in the suction pipe 27. At this time, since the unit controller 10 resumes the operations of the draft device 6 and the pneumatic spinning device 7, the suction pipe 27 can suck the spun yarn Y from the pneumatic spinning device 7 into a suction path (not illustrated) of the suction pipe 27 (i.e. , the suction pipe 27 catches the spun yarn Y). Then, the unit controller 10 swings the suction port of the suction pipe 27 towards the splicer 26. The suction pipe 27 thus sucks the spun yarn Y from the pneumatic spinning device 7 and guides the spun yarn Y to the splicer 26.

**[0040]** Meanwhile, as illustrated in FIG. 5, the unit controller 10 brings the reverse rotation roller 33a of the re-

verse rotation mechanism 33 into contact with the package P, and rotates the reverse rotation roller 33a (period to T1 of FIG. 3). By frictional force between the package P and the reverse rotation roller 33a, the package P starts to reversely rotate accompanying rotation of the reverse rotation roller 33a. Then, the unit controller 10 swings the suction mouth 28 such that a suction port of the suction mouth 28 is located in proximity to the surface of the package P and performs a control to generate a suction flow at the suction mouth 28 (time point of T1 of FIG. 3). The suction mouth 28 thereby sucks a yarn end of the spun yarn Y unwound from the package P and sucks the spun yarn Y into a suction path (not illustrated) of the suction mouth 28 (i.e., the suction mouth 28 catches the spun yarn Y).

**[0041]** The unit controller 10 then performs a control of moving the suction port of the suction mouth 28 towards the splicer 26 while continuing to generate of the suction flow of the suction mouth 28 (period from T1 to T2 of FIG. 3). The suction mouth 28 performs the yarn guiding operation to suck the spun yarn Y from the package P and guide the sucked spun yarn Y to the splicer 26 in the above manner.

**[0042]** While the suction mouth 28 is performing the yarn guiding operation, the unit controller 10 controls the reverse rotation mechanism 33 so as to continue the rotation of the reverse rotation roller 33a. Accordingly, the reverse rotation roller 33a reversely rotates the package P to unwind the spun yarn Y from the package P. As described above, the reverse rotation mechanism 33 (the winding device 13) performs the first unwinding operation of reversely rotating the package P to unwind the spun yarn Y from the package P while the suction mouth 28 is performing the yarn guiding operation (the period from T1 to T2 of FIG. 3).

**[0043]** After the suction mouth 28 finishes the yarn guiding operation, the unit controller 10 stops the rotation of the reverse rotation roller 33a (period from T3 to T6 of FIG. 3), as illustrated in FIG. 6. The reverse rotation of the package P is thereby stopped. As described above, the reverse rotation mechanism 33 (the winding device 13) stops the reverse rotation of the package P between the first unwinding operation and the second unwinding operation, to be described later.

**[0044]** After the suction mouth 28 finishes the yarn guiding operation, the unit controller 10 causes the yarn moving device 34 to perform the yarn moving operation (period from T4 to T5 of FIG. 3). The spun yarn Y from the package P is thereby moved towards the center of the wound width of the package P. The yarn moving device 34 performs the yarn moving operation of moving the spun yarn Y from the package P after the suction mouth 28 finishes the yarn guiding operation and before the reverse rotation mechanism 33 starts the second unwinding operation.

**[0045]** After the yarn moving device 34 finishes the yarn moving operation, the unit controller 10 again starts the rotation of the reverse rotation roller 33a, as illustrated in FIG. 7. Accordingly, the reverse rotation roller 33a reversely rotates the package P to unwind the spun yarn Y from the package P. As described above, the reverse rotation mechanism 33 (the winding device 13) performs the second unwinding operation of reversely rotating the package P to unwind the spun yarn Y from the package P after the suction mouth 28 finishes the yarn guiding operation (more specifically, after the yarn moving device 34 finishes the yarn moving operation) and before the splicer 26 starts the yarn joining operation (more specifically, before the yarn gathering lever 26b gathers the spun yarn Y from the pneumatic spinning device 7 and the spun yarn Y from the package P to the splicer head 26a).

**[0046]** The unit controller 10 performs the control of continuing to generate the suction flow of the suction mouth 28 while the reverse rotation mechanism 33 is performing the second unwinding operation. The suction mouth 28 thus can suck the spun yarn Y from the package P and suck the spun yarn Y into the suction path of the suction mouth 28 while the reverse rotation mechanism 33 is performing the second unwinding operation. Thus, even when the core yarn C of the spun yarn Y from the package P is exposed by the yarn guiding operation performed by the suction mouth 28 and/or the yarn moving operation performed by the yarn moving device 34, such a spun yarn Y is sucked into the suction path of the suction mouth 28.

**[0047]** A length of the spun yarn Y unwound in the second unwinding operation is longer than or equal to a length of the spun yarn Y from the winding device 13 to the splicer 26. More specifically, the length of the spun yarn Y is longer than or equal to a length from a separation point of the outer peripheral surface of the package P and the spun yarn Y unwound from the outer peripheral surface to a point where the splicer head 26a performs the yarn joining operation. The length of the spun yarn Y can be changed by the operator. Specifically, the operator selects desired conditions with the input key 43 from a plurality of "times for performing the second unwinding operation" displayed on the display screen 42. The selected condition is set (stored) in the machine control device 41. For example, when the operator sets the time for performing the second unwinding operation to be relatively long, the time of reversely rotating the package P becomes long, and hence the length of the spun yarn Y unwound from the package P also becomes long. When the time for performing the second unwinding operation is set to be relatively short, the time of reversely rotating the package P becomes short, and hence the length of the spun yarn Y unwound from the package P also becomes short. The unit controller 10 rotates the reverse rotation roller 33a at a constant speed regardless of which condition is selected. However, the rotation speed of the reverse rotation roller 33a may be differed according to a diameter of the package P.

**[0048]** Then, as illustrated in FIG. 8, the unit controller 10 stops the rotation of the reverse rotation mechanism

33 (time point of T7 of FIG. 3). The reverse rotation of the package P is thereby stopped. Then, the unit controller 10 stops the suction flow of the suction mouth 28 (time point of T8 of FIG. 3). Thus, after such a time point, the spun yarn Y from the package P is not sucked into the suction path of the suction mouth 28.

**[0049]** Then, the unit controller 10 causes the splicer 26 to perform the yarn joining operation (period from T9 to T12 of FIG. 3). More specifically, the unit controller 10 first moves the splicer head 26a forward, and thereafter, operates the yarn gathering lever 26b. Accordingly, the spun yarn Y from the pneumatic spinning device 7 and the spun yarn Y from the package P are gathered to the splicer head 26a (period from T9 to T10 of FIG. 3). After the gathering of the spun yarn Y is finished (time point of T10 of FIG. 3), the unit controller 10 controls the splicer 26 to cut the two spun yarns Y at a predetermined position and perform the yarn joining operation of the yarn ends of the two spun yarns Y with action of the whirling airflow (period from T10 to T11 of FIG. 3). After the yarn joining operation is finished (time point of T11 of FIG. 3), the unit controller 10 operates the yarn gathering lever 26b to release the gathering of the joined spun yarn Y (period from T11 to T12 of FIG. 3).

**[0050]** After the yarn joining operation of the splicer 26 is finished (time point of T12 of FIG. 3), the unit controller 10 operates the suction pipe 27, the suction mouth 28, the reverse rotation mechanism 33, and the yarn moving device 34 so as to return to the original position in the yarn joining cart 3. The unit controller 10 then swings the cradle arm 21 to the position illustrated in FIG. 2 to bring the package P into contact with the winding drum 22, and restarts the winding by the winding device 13.

**[0051]** As described above, in the spinning machine 1, when the spun yarn Y is cut, the guiding operation to guide the spun yarn Y from the package P to the splicer 26 is performed by the suction mouth 28, and the yarn joining operation to join the spun yarn Y from the pneumatic spinning device 7 and the spun yarn Y from the package P is performed by the splicer 26. When a high tension is applied to the spun yarn Y from the package P during the guiding operation to guide the spun yarn Y from the package P to the splicer 26, the possibility of the core yarn C being exposed increases. In the spinning machine 1, however, the second unwinding operation of reversely rotating the package P and unwinding the spun yarn Y from the package P is performed by the winding device 13 after the yarn guiding operation is finished and before the yarn joining operation is started. Furthermore, the spun yarn Y from the package P is sucked by the suction mouth 28 while the second unwinding operation is being performed. Thus, even if the core yarn C is exposed while the yarn guiding operation is being performed, for example, the portion where the core yarn C is exposed is sucked by the suction mouth 28. Therefore, the portion where the core yarn C is exposed can be prevented from being mixed into the package P.

**[0052]** The spinning machine 1 includes the yarn moving device 34. Thus, the spun yarn Y from the package P can be moved to the desired position before the yarn joining operation. More specifically, the yarn moving device 34 moves the spun yarn Y from the package P towards the center of the wound width of the package P. Thus, the yarn joining operation can be more reliably performed.

**[0053]** The reverse rotation mechanism 33 stops the reverse rotation of the package P between the first unwinding operation and the second unwinding operation. The second unwinding operation thus can be performed after resetting (cancelling) accumulation of a reverse rotation amount of the first unwinding operation. Thus, the package P can be reliably reversely rotated at the desired reverse rotation amount in the second unwinding operation. Furthermore, since the reverse rotation of the package P is stopped during the yarn moving operation, friction on the spun yarn Y from the package P by the yarn moving device 34 can be reduced.

**[0054]** In the spinning machine 1, the length of the spun yarn Y unwound by the winding device 13 in the second unwinding operation is longer than or equal to the length of the spun yarn Y from the winding device 13 to the splicer 26. More specifically, the length of the spun yarn Y is longer than or equal to the length from the separation point of the outer peripheral surface of the package P and the spun yarn Y unwound from the outer peripheral surface to the point where the splicer head 26a performs the yarn joining operation. Thus, the portion where the core yarn C may be exposed can be reliably collected.

**[0055]** The spinning machine 1 includes the machine control device 41 adapted to set the period of time for performing the second unwinding operation. The length of the spun yarn Y unwound by the second unwinding operation thus can be adjusted.

**[0056]** The spinning machine 1 includes the core yarn supplying device 200, the draft device 6, and the pneumatic spinning device 7, and hence can appropriately form the spun yarn Y having the core yarn C.

**[0057]** The spinning machine 1 includes the unit controller 10, and thus can reliably perform the second unwinding operation, the operation to cause the suction mouth 28 to suck the spun yarn Y, and the like.

**[0058]** One embodiment of the present invention has been described above, but the present invention is not limited to the above embodiment.

**[0059]** The spinning machine 1 stops the reverse rotation of the package P between the first unwinding operation and the second unwinding operation, but the spinning machine 1 may perform, as a series of unwinding operations, the operation from the first unwinding operation to the second unwinding operation without stopping the reverse rotation of the package P.

**[0060]** A splicer 26 using the compressed air is used as the yarn joining device, but the yarn joining device may be a knotter that mechanically joins the spun yarn Y, or the like. In the above-described embodiment, the splicer head 26a can move forward and backward with

respect to the yarn path, but the splicer head 26a may not move forward and backward.

**[0061]** The yarn moving device 34 moves the spun yarn Y towards the center in the wound width of the package P, but the yarn moving device 34 may move the spun yarn Y towards a region other than the center according to a yarn joining position of the splicer 26.

**[0062]** In the spinning machine 1, the splicer 26, the suction pipe 27, the suction mouth 28, the reverse rotation mechanism 33, and the yarn moving device 34 are provided in the yarn joining cart 3, but at least one of the sections may not be provided in the yarn joining cart 3, and may be directly arranged in each spinning unit 2.

**[0063]** The winding device 13 includes the reverse rotation mechanism 33, but the winding device 13 may not include the reverse rotation mechanism 33 and may drive the winding drum 22 of each spinning unit 2 independently. Thus, when the spun yarn Y of a spinning unit 2 is cut, the spun yarn Y can be unwound from the package P by reversely rotating the winding drum 22 of the spinning unit 2. The winding device 13 includes the winding drum 22 and the reverse rotation mechanism 33, but the winding device 13 may not include the winding drum 22 and the reverse rotation mechanism 33, and a drive mechanism adapted to directly rotate a supporting body that supports the bobbin B may be arranged in each winding device. In this case, the driving mechanism forwardly rotates the package P to wind the spun yarn Y into the package P, and when the spun yarn Y of a spinning unit 2 is cut, the drive mechanism reversely rotates the package P of the spinning unit 2 to unwind the spun yarn Y.

**[0064]** In the spinning machine 1, a brake mechanism arranged on the cradle arm 21 is used to stop the forward rotation of the package P, but a package stopping mechanism arranged in the yarn joining cart 3 may be used. In this case, the cradle arm 21 is first swung and the package P is moved away from the winding drum 22 in the spinning unit 2. At this time, the package P continues to forwardly rotate with inertia. The yarn joining cart 3 then travels to the relevant spinning unit 2 and stops. The yarn joining cart 3 swings the package stopping mechanism so as to bring the package stopping mechanism into contact with the package P, and stops the forward rotation of the package P.

**[0065]** In the spinning machine 1, the unit controller 10 performs the control of the yarn joining cart 3, but a cart controller (control section) arranged separately from the unit controller 10 may perform the control of the yarn joining cart 3. In this case, a yarn joining request signal is first transmitted to the machine control device 41, which is a high order controller, from the unit controller 10. The machine control device 41 that received the yarn joining request signal instructs the cart controller to perform the yarn joining operation in the spinning unit 2 including the unit controller 10 that transmitted the yarn joining request signal. The cart controller thus controls the suction pipe 27, the suction mouth 28, the splicer 26, and the like so as to perform the yarn joining operation in the spinning unit 2.

**[0066]** In the above-described embodiment, the spinning machine 1, which is a yarn winding machine of one embodiment of the present invention, has been described, but the present invention may be applied to other yarn winding machines. For example, the present invention may be applied to an automatic winder configured by arranging a plurality of winding units side by side. The plurality of winding units wind the spun yarn unwound from a yarn supplying bobbin while traversing the spun yarn to form a package.

**[0067]** The pneumatic spinning device 7 may further include a needle held by the fiber guiding section and arranged so as to protrude into the spinning chamber to prevent twists of the fiber bundle F from being propagated to upstream of the pneumatic spinning device 7. Alternatively, such a needle may be omitted, and the pneumatic spinning device 7 may prevent the twists of the fiber bundle F from being propagated to upstream of the pneumatic spinning device 7 by a downstream end portion of the fiber guiding section. Furthermore, instead of the above-described configuration, the pneumatic spinning device 7 may include a pair of air-jet nozzles respectively adapted to twist the fiber bundle F in directions opposite from each other.

**[0068]** In the spinning unit 2, the yarn storage device 11 has a function of pulling out the spun yarn Y from the pneumatic spinning device 7, but the spun yarn Y may be pulled out from the pneumatic spinning device 7 with a delivery roller and a nip roller. In a case of pulling out the spun yarn Y from the pneumatic spinning device 7 with the delivery roller and the nip roller, a slack tube adapted to absorb the slack of the spun yarn Y with suction airflow, a mechanic compensator, or the like may be provided instead of the yarn storage device 11.

**[0069]** In the spinning machine 1, each device is arranged such that the spun yarn Y supplied at an upper side is wound at a lower side in a direction of a machine height. However, each device may be arranged such that the spun yarn Y supplied at the lower side is wound at the upper side.

**[0070]** In the spinning machine 1, at least one of the bottom rollers in the draft device 6, and the traverse guide 23 are driven by power from the second end frame 5 (that is, in common with the plurality of spinning units 2). However, each section (for example, the draft device 6, the pneumatic spinning device 7, the winding device 13, or the like) of the spinning unit 2 may be driven independently for each spinning unit 2.

**[0071]** In the travelling direction of the spun yarn Y, the tension sensor 9 may be arranged upstream of the yarn monitoring device 8. The unit controller 10 may be provided for every spinning unit 2. In the spinning unit 2, the waxing device 12, the tension sensor 9, and the yarn monitoring device 8 may be omitted.

**[0072]** FIG. 1 illustrates that the spinning machine 1 winds a cheese package P, but the spinning machine 1 can also wind a conical package P. In a case of the conical

package P, a slack of the spun yarn Y occurs by traversing the spun yarn Y, but the slack can be absorbed with the yarn storage device 11.

## Claims

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

a yarn supplying device (6, 7, 200) adapted to supply a yarn (Y) having a core yarn (C);
a winding device (13) adapted to wind the yarn (Y) into a package (P) by forwardly rotating the package (P);
a yarn joining device (26) adapted to perform a yarn joining operation to join the yarn (Y) from the yarn supplying device (6, 7, 200) and the yarn (Y) from the package (P) upon disconnection of the yarn (Y);
a yarn guiding device (28) adapted to perform a yarn guiding operation to guide the yarn (Y) from the package (P) to the yarn joining device (26) while sucking the yarn (Y) from the package (P) upon disconnection of the yarn (Y);
wherein the winding device (13) is adapted to perform a first unwinding operation to unwind the yarn (Y) from the package (P) by reversely rotating the package (P) when the yarn guiding device (28) is performing the yarn guiding operation, and to perform a second unwinding operation to unwind the yarn (Y) from the package (P) by reversely rotating the package (P) after the yarn guiding device (28) finishes the yarn guiding operation and before the yarn joining device (26) starts the yarn joining operation, and
the yarn guiding device (28) is adapted to suck the yarn (Y) from the package (P) when the winding device (13) is performing the second unwinding operation.

**2.** The yarn winding machine (1) according to claim 1, further comprising a yarn moving device (34) adapted to perform a yarn moving operation to move the yarn from the package (P) after the yarn guiding device (28) finishes the yarn guiding operation and before the winding device (13) starts the second unwinding operation.

**3.** The yarn winding machine (1) according to claim 2, wherein the yarn moving device (34) is adapted to move the yarn (Y) from the package (P) towards center of a wound width of the package (P) by the yarn moving operation.

**4.** The yarn winding machine (1) according to any one of claim 1 through claim 3, wherein the winding device (13) is adapted to stop reverse rotation of the package (P) between the first unwinding operation and the second unwinding operation.

**5.** The yarn winding machine (1) according to any one of claim 1 through claim 4, wherein a length of the yarn (Y) unwound by the winding device (13) by the second unwinding operation is equal to or longer than a length of the yarn (Y) from the winding device (13) to the yarn joining device (26).

**6.** The yarn winding machine (1) according to any one of claim 1 through claim 5, further comprising a setting section (41) adapted to set a period of time in which the winding device (13) performs the second unwinding operation.

**7.** The yarn winding machine (1) according to any one of claim 1 through claim 6, wherein the yarn joining device (26) includes a yarn joining section (26a) adapted to join the yarn (Y) from the yarn supplying device (6, 7, 200) and the yarn (Y) from the package (P), and a yarn gathering section (26b) adapted to gather the yarn (Y) from the yarn supplying device (6, 7, 200) and the yarn (Y) from the package (P), and the winding device (13) is adapted to perform the second unwinding operation after the yarn guiding device (28) finishes the yarn guiding operation and before the yarn gathering section (26b) gathers the yarn (Y) from the yarn supplying device (6, 7, 200) and the yarn (Y) from the package (P) to the yarn joining section (26a).

**8.** The yarn winding machine (1) according to any one of claim 1 through claim 7, wherein the yarn supplying device (6, 7, 200) includes:

a core yarn supplying device (200) adapted to supply the core yarn (C);
a draft device (6) adapted to draft a fiber bundle (F); and
a pneumatic spinning device (7) adapted to form the yarn (Y) by applying twists to the fiber bundle (F) with the core yarn (C) as a core.

**9.** The yarn winding machine (1) according to any one of claim 1 through claim 8, further comprising a control section (10) adapted to control the winding device (13) to perform the second unwinding operation and the yarn guiding device (28) to suck the yarn (Y) from the package (P) while the second unwinding operation is being performed by the winding device (13).

**10.** The yarn winding machine (1) according to any one of claim 1 to claim 9, wherein the yarn guiding device (28) is adapted to suck and remove a defective portion of the yarn (Y) during the second unwinding operation.

FIG. 1

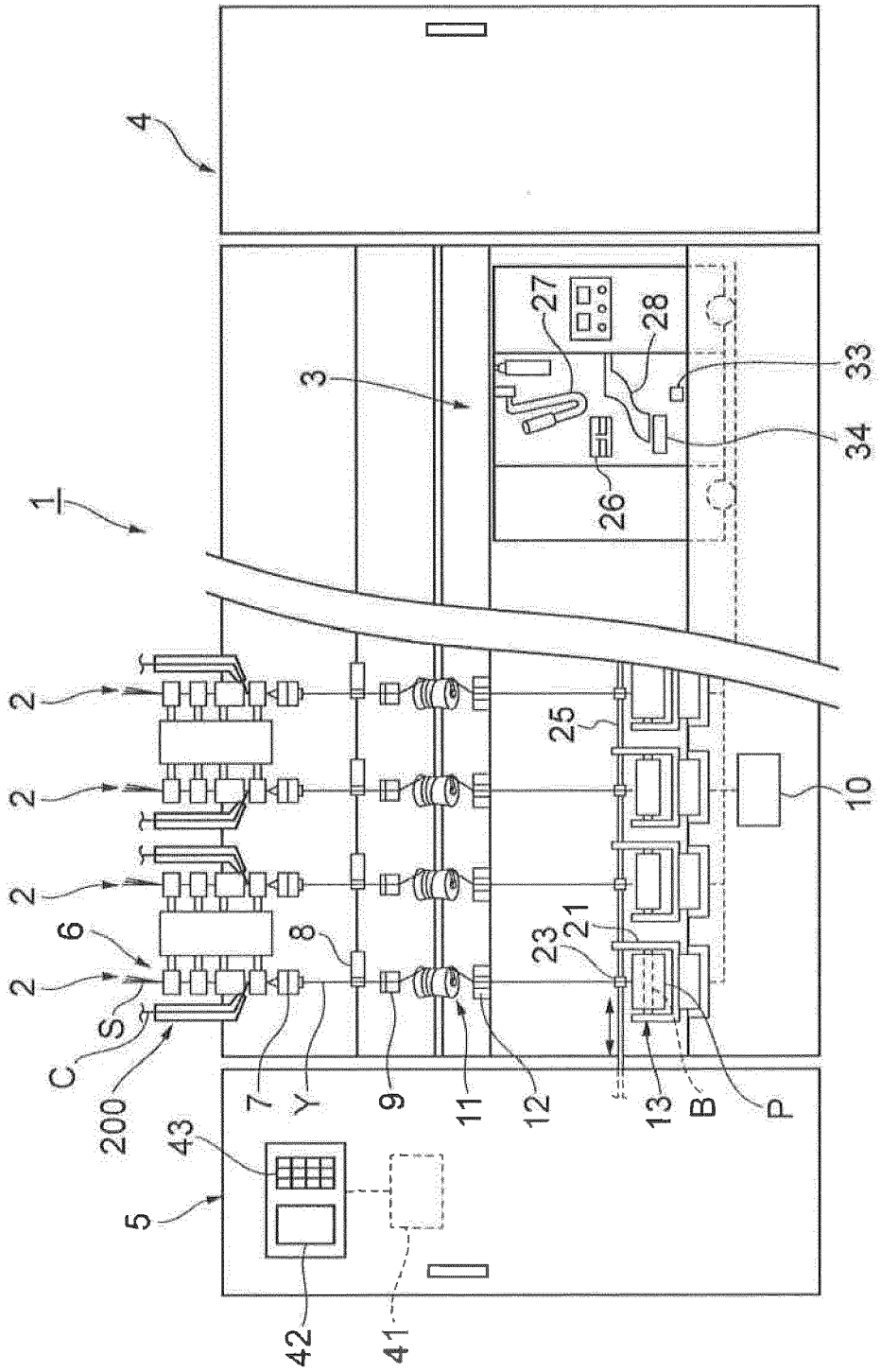

FIG. 2

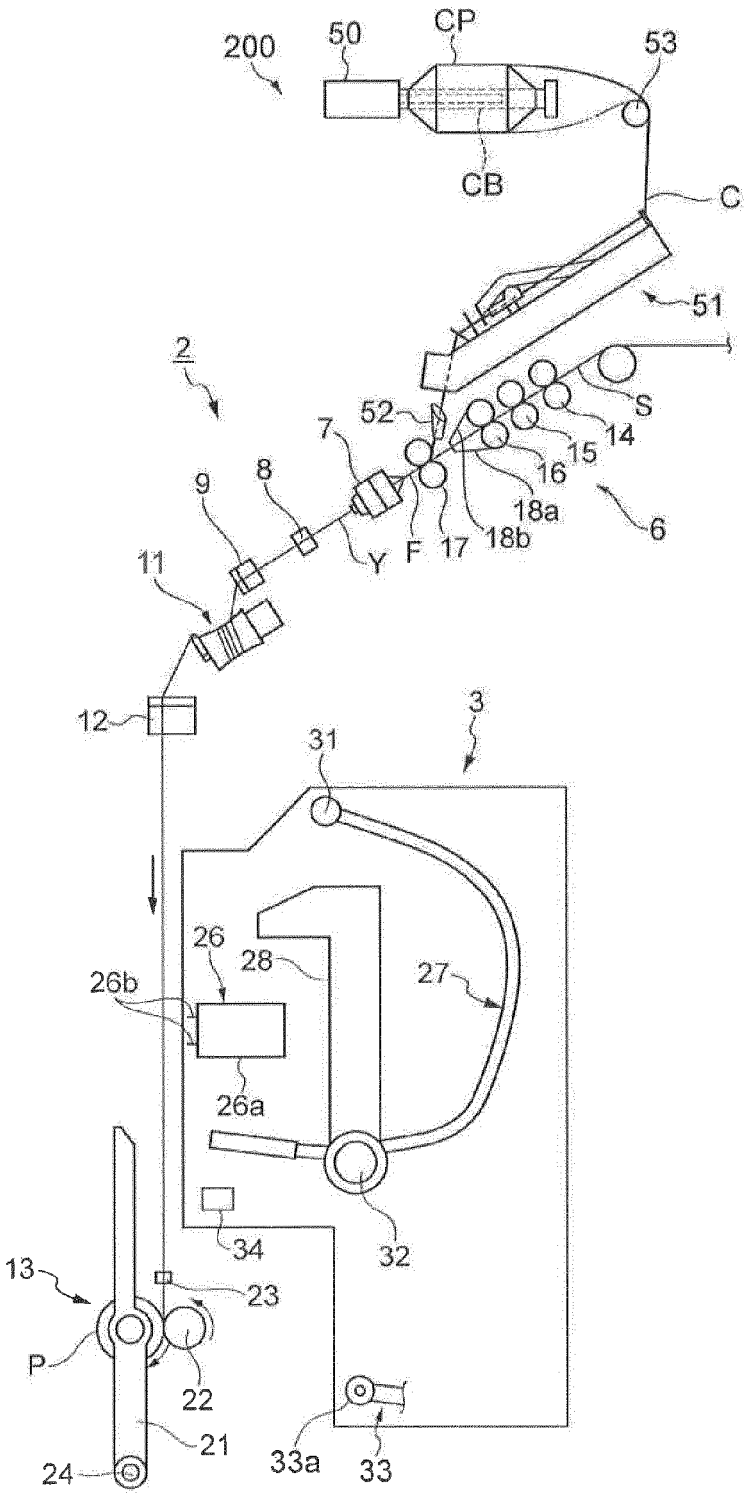
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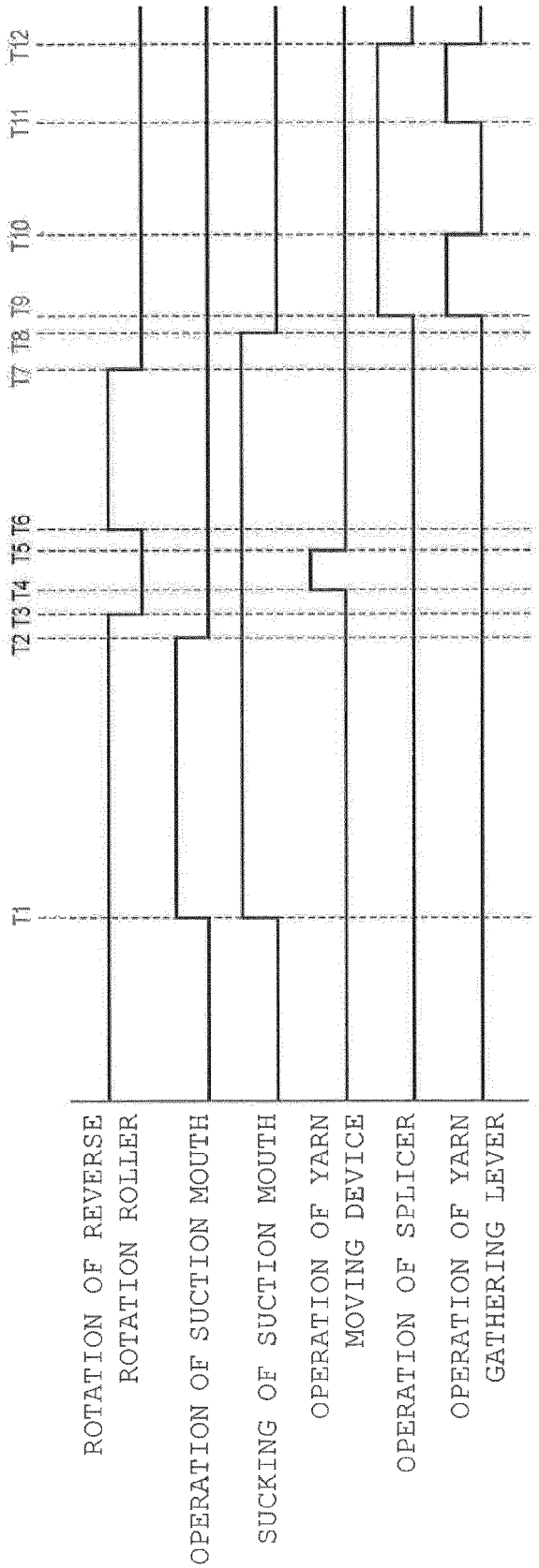
FIG. 3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ROTATION OF REVERSE ROTATION ROLLER
OPERATION OF SUCTION MOUTH
SUCKING OF SUCTION MOUTH
OPERATION OF YARN MOVING DEVICE
OPERATION OF SPLICER
OPERATION OF YARN GATHERING LEVER

FIG. 4

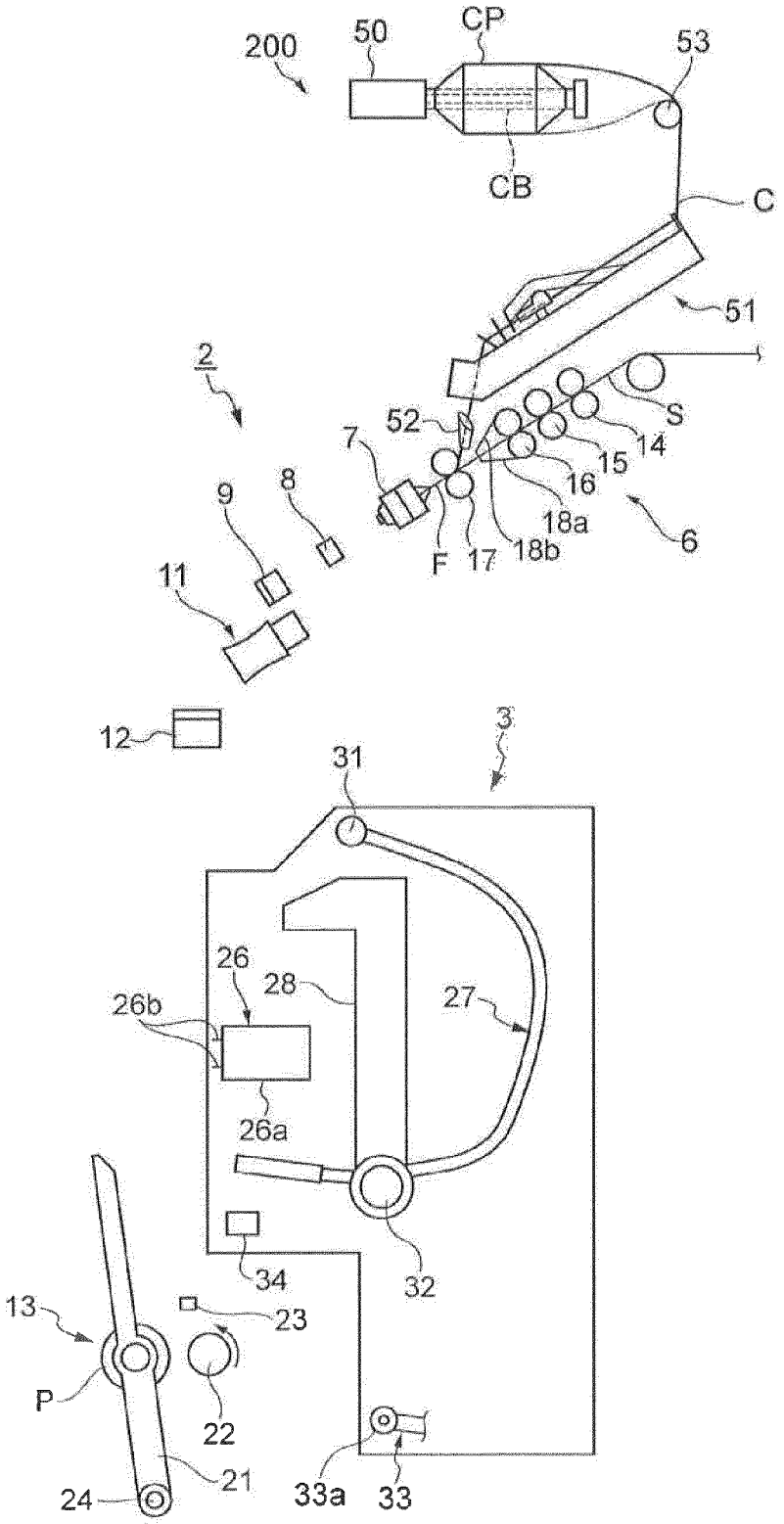
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FIG. 5

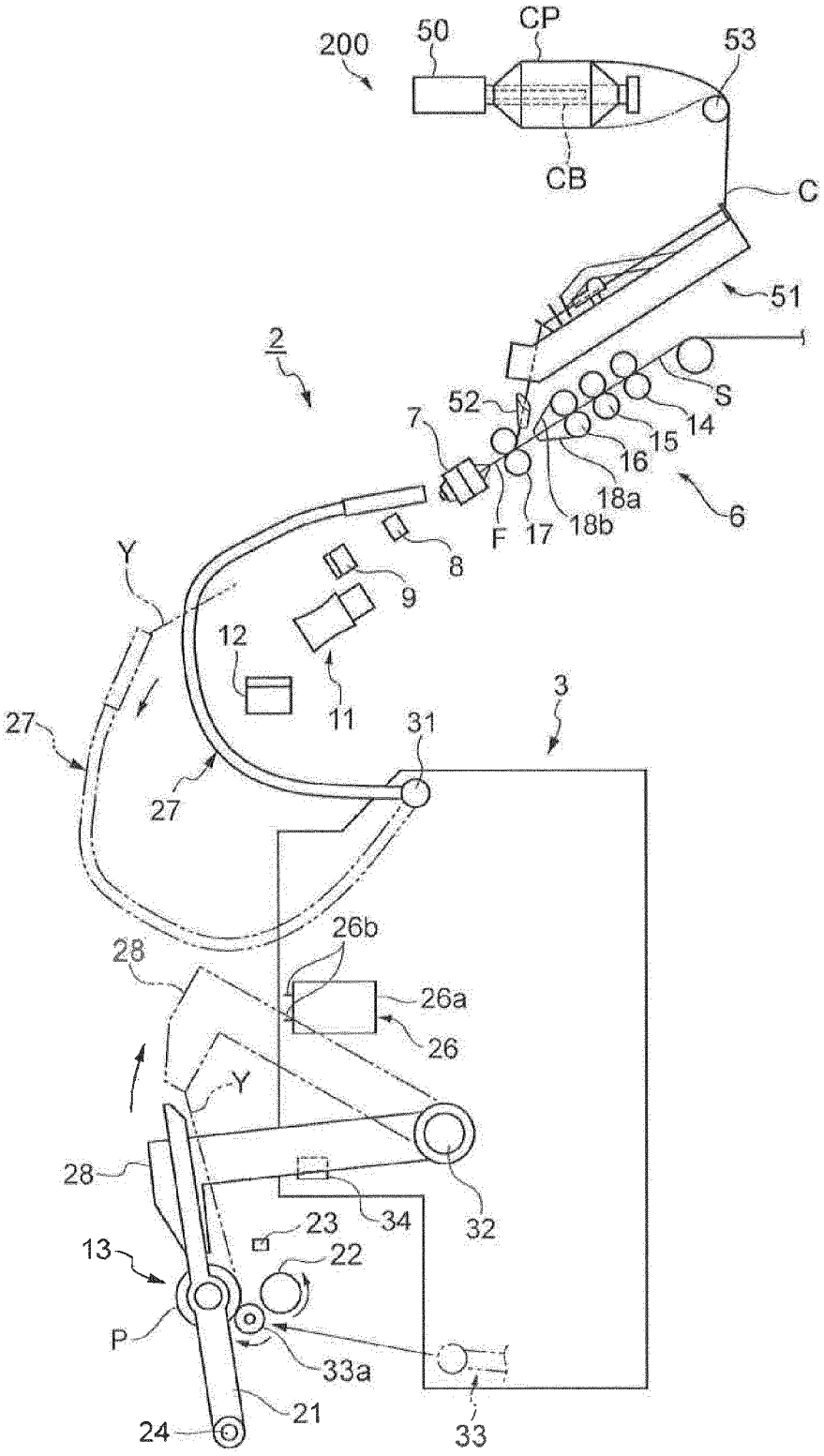
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FIG. 6

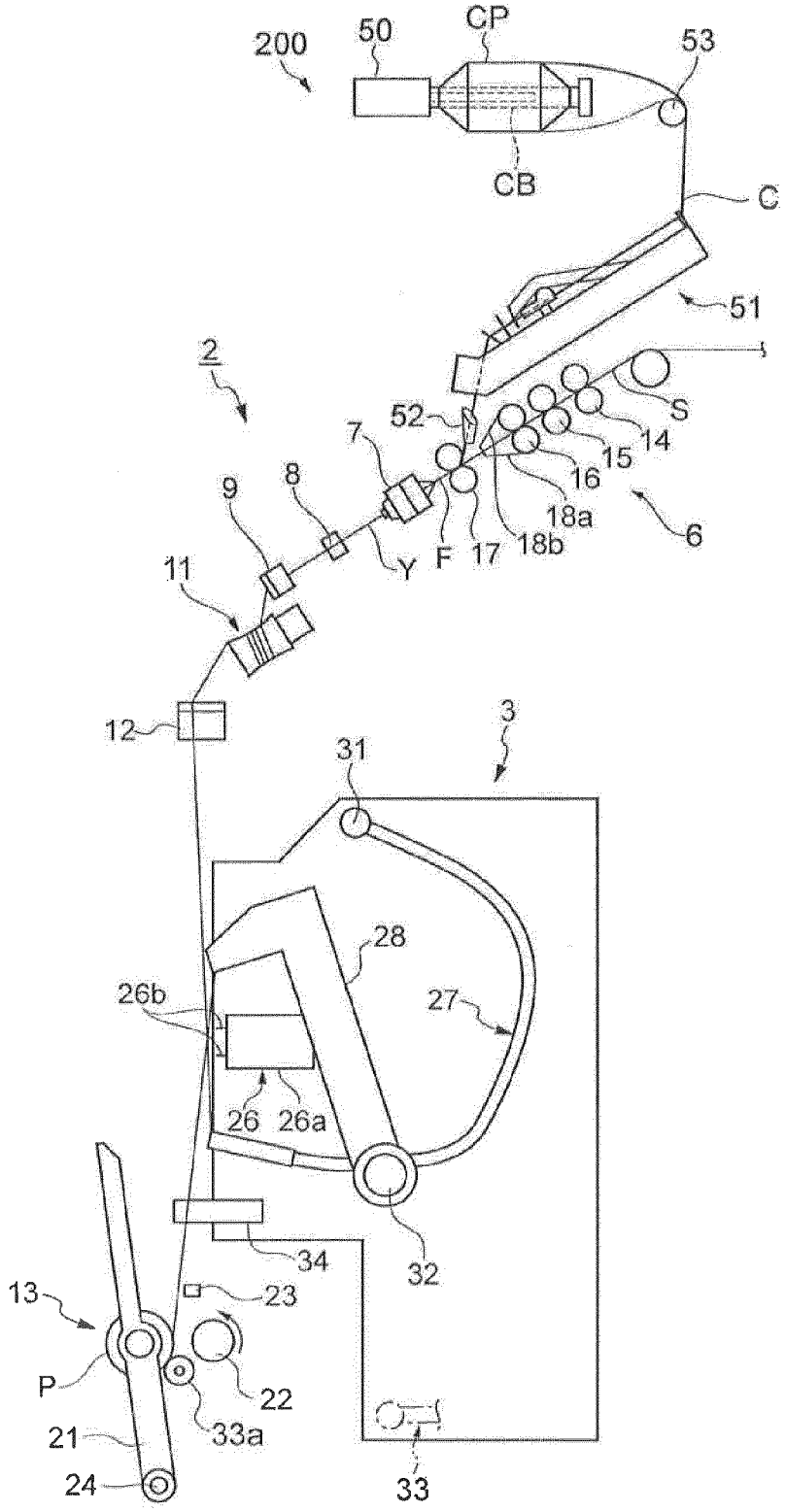
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FIG. 7

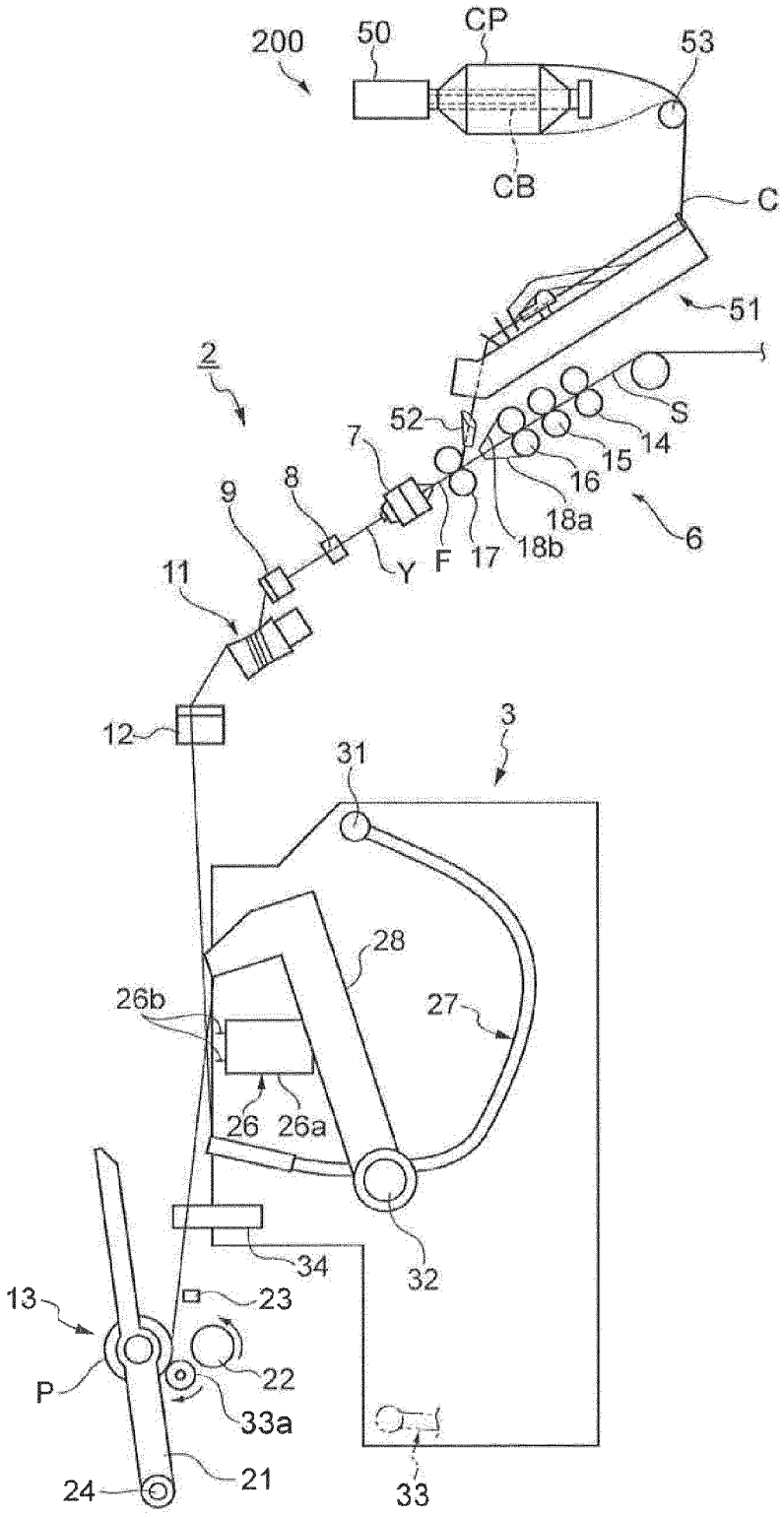
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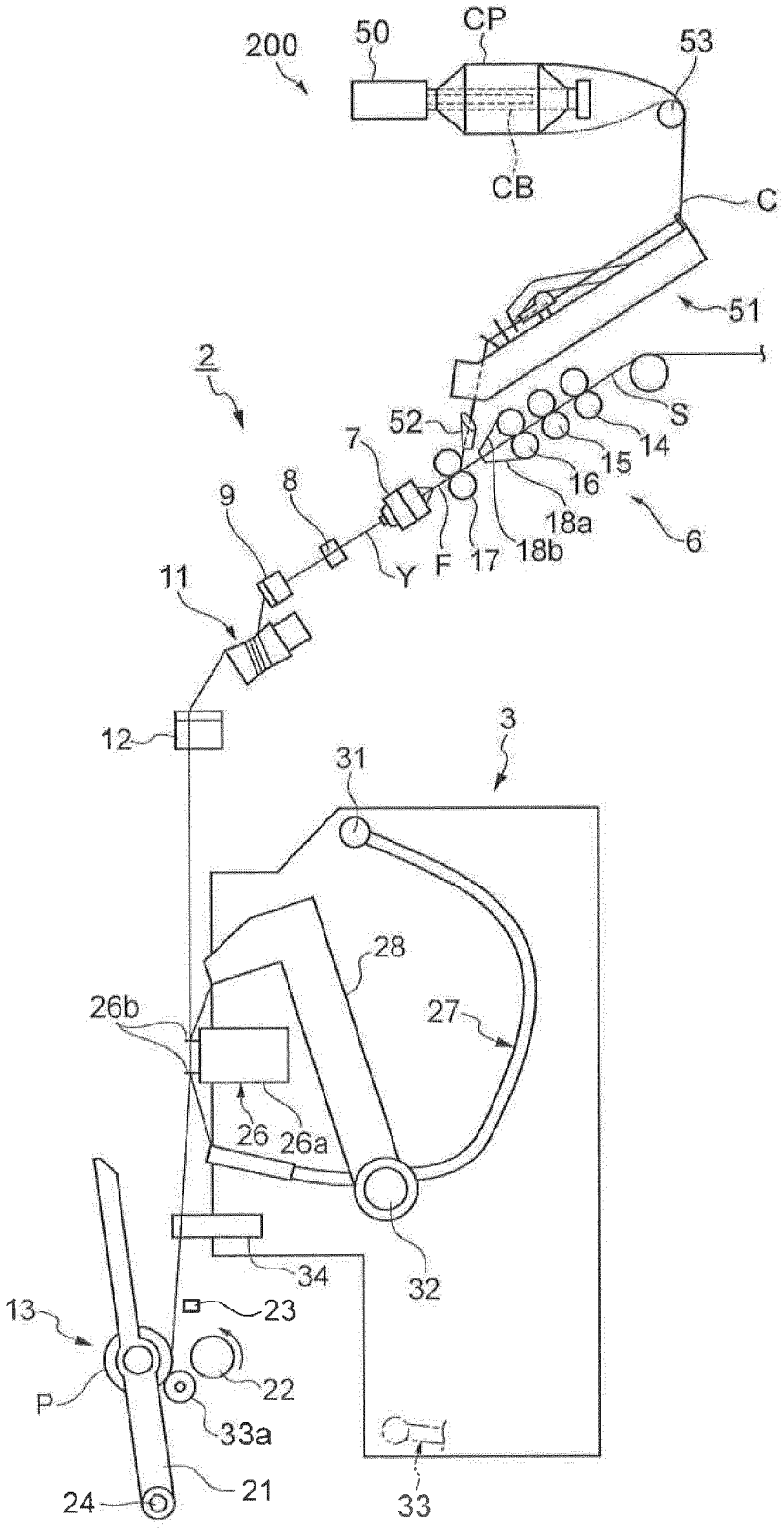
FIG. 8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# EUROPEAN SEARCH REPORT

Application Number
EP 15 18 8743

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| Place of search | Date of completion of the search | Examiner |
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| The Hague | 26 April 2016 | Lemmen, René |

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