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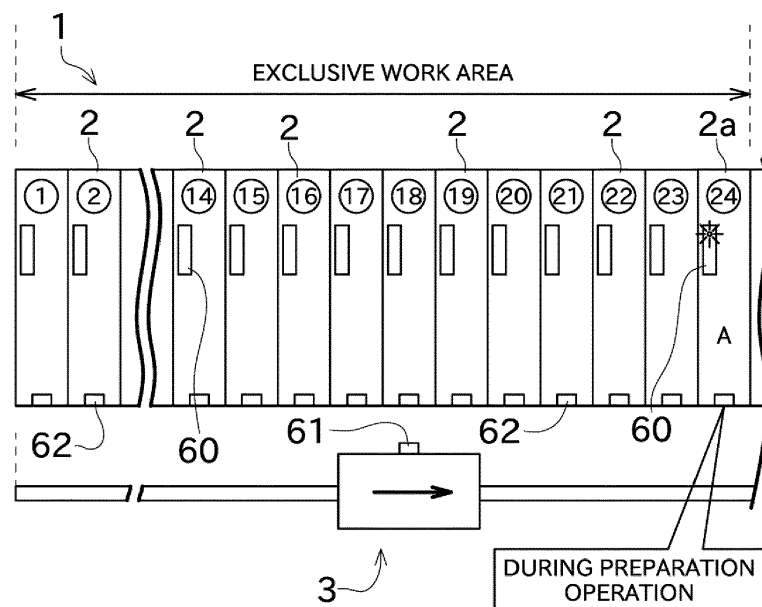
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(54) **YARN WINDING MACHINE AND YARN WINDING METHOD**

(57) A spinning machine (1) includes a plurality of spinning units (2) and at least one yarn joining cart (3). Each of the spinning units (2) winds a spun yarn. The yarn joining cart (3) performs a yarn joining operation with respect to each of the spinning units (2). After occurrence of a yarn breakage, the relevant spinning unit (2) performs a preparation operation to be prepared for the yarn joining operation to be started. The yarn joining

cart (3) performs a yarn joining travel so as to be positioned at the operating position to perform the yarn joining operation with respect to the spinning unit (2) in which the yarn breakage has occurred. If there is no completion spinning unit and if there is a preparation spinning unit (2a), the yarn joining cart (3) performs the yarn joining travel with respect to the preparation spinning unit (2a).

Fig.3



A : YARN JOINING NOTICE

EP 3 566 987 A1

## Description

### TECHNICAL FIELD

**[0001]** The present invention mainly relates to a yarn winding machine having a yarn joining cart capable of traveling with respect to a winding unit.

### BACKGROUND ART

**[0002]** Conventionally, in a yarn winding machine, a configuration in which a yarn joining cart travels and performs a yarn joining operation based on a yarn joining signal outputted by a winding unit has been known. Patent Document 1 (Japanese Patent Application Laid-Open No. 1998-001259) discloses a spinning machine with this type of configuration.

**[0003]** The spinning machine in Patent Document 1 includes a plurality of units (winding units) that wind a yarn spun by an air spinning nozzle into a package.

**[0004]** When a yarn breakage occurs in a unit, such unit sends a signal requiring a yarn joining (yarn joining signal). Upon receipt of the signal, a work cart (yarn joining cart) stops at an operation position with respect to the unit, and performs a yarn joining operation.

### SUMMARY OF THE INVENTION

**[0005]** In the spinning machine, when a yarn breakage occurs, a cleaning operation of a spinning device may be performed for the purpose of removing fiber waste etc. clogged in a spinning nozzle before the yarn joining operation and resumption of winding, but this is not mentioned in Patent Document 1.

**[0006]** Although Patent Document 1 does not disclose it, the spinning machine may include a yarn accumulation device that temporarily accumulates the yarn before winding the yarn into the package. In such spinning machine, when the yarn breakage occurs, it is necessary to remove the yarn remained in the yarn accumulation device before the yarn joining operation and resumption of winding.

**[0007]** Conventionally, when the yarn breakage occurs, each of the winding units sends the yarn joining signal after completion of a preparation operation for joining the yarn (for example, the cleaning operation of the spinning device, and a residual yarn removing operation of the yarn accumulation device). Therefore, a time from occurrence of the yarn breakage to the yarn joining operation and resumption of winding is prolonged, which causes decrease in working efficiency.

**[0008]** An object of the present invention is to provide a yarn winding machine capable of efficiently performing a yarn joining work and reducing a waiting time for the yarn joining.

**[0009]** According to a first aspect of the present invention, a yarn winding machine with the following configuration is provided. That is, the yarn winding machine in-

cludes a plurality of winding units and at least one yarn joining cart. Each of the winding units winds a yarn. The yarn joining cart performs a yarn joining operation with respect to each of the winding units. After occurrence of a yarn breakage, a relevant winding unit performs a preparation operation to be prepared for the yarn joining operation. The yarn joining cart performs a yarn joining travel so as to be positioned at an operating position to perform the yarn joining operation with respect to the winding unit in which the yarn breakage has occurred. The yarn joining travel is to start traveling toward the operating position, to cancel a current traveling and stop at the operating position, or to travel at a decelerated speed from a current traveling speed. If there is no completion winding unit that is the winding unit in which the preparation operation has been completed and if there is a preparation winding unit that is the winding unit during the preparation operation, the yarn joining cart performs the yarn joining travel with respect to the preparation winding unit.

**[0010]** As such, the yarn joining cart performs the yarn joining travel during a time when the winding unit performs the preparation operation. Thereby, a yarn joining work including the yarn joining travel and the yarn joining operation can be more efficiently performed and a waiting time for the yarn joining can be reduced.

**[0011]** In the yarn winding machine, when a current position where the yarn joining cart is stopped coincides with the operating position where the yarn joining operation is to be performed with respect to the winding unit in which the yarn breakage has occurred, it is preferable that the yarn joining cart maintains the current position without performing the yarn joining travel.

**[0012]** Accordingly, a cart positioning in view of the current position and the operating position of the yarn joining cart can be reasonably performed.

**[0013]** In the yarn winding machine, it is preferable that each of the winding units includes a control section for transmitting a yarn joining notice signal after occurrence of the yarn breakage and before completion of the preparation operation.

**[0014]** Accordingly, a start timing of the yarn joining travel of the yarn joining cart with respect to the operating position at which the yarn joining operation is scheduled to be performed can be instructed with a simple configuration.

**[0015]** The yarn winding machine is preferably configured as follows. That is, each of the winding units includes a detection section. The detection section detects success or failure of the preparation operation. The control section cancels the yarn joining notice signal if the detection section detects the failure of the preparation operation after transmission of the yarn joining notice signal.

**[0016]** Accordingly, the yarn joining travel with respect to the preparation winding unit in which the preparation operation has failed after transmission of the yarn joining notice signal can be promptly canceled, and the yarn joining cart can prepare to respond to a yarn joining request from other winding units.

**[0017]** In the yarn winding machine, it is preferable that the control section transmits a preparation completion signal after the preparation operation is completed.

**[0018]** Accordingly, the yarn joining cart can be informed that the yarn joining operation with respect to the winding unit can be started.

**[0019]** In the yarn winding machine, provided that a first preparation winding unit is one of the preparation winding units, and a second preparation winding unit is another one of the preparation winding units that is located in a range, which the yarn joining cart can reach from a current traveling position within a predetermined first traveling time, during the yarn joining travel of the yarn joining cart with respect to the first preparation winding unit, when the second preparation winding unit transmits the yarn joining notice signal, it is preferable that the yarn joining cart cancels the yarn joining travel with respect to the first preparation winding unit and performs the yarn joining travel with respect to the second preparation winding unit.

**[0020]** Accordingly, depending on a situation of each winding unit, the yarn joining cart can preferentially perform the yarn joining work with respect to the winding unit that is located at a position close to the current traveling position. Therefore, the yarn joining work with respect to the plurality of preparation winding units can be more efficiently performed.

**[0021]** In the yarn winding machine, when the preparation winding unit transmits the yarn joining notice signal and the completion winding unit transmits the preparation completion signal, it is preferable that the yarn joining cart preferentially performs the yarn joining travel based on the preparation completion signal.

**[0022]** Accordingly, when the preparation winding unit and the completion winding unit exist at the same time, the yarn joining work by the yarn joining cart can be more efficiently performed for the entire yarn winding machine.

**[0023]** In the yarn winding machine, during the yarn joining travel of the yarn joining cart with respect to the preparation winding unit which has transmitted the yarn joining notice signal, when the completion winding unit, which is located in a range, which the yarn joining cart can reach from the current traveling position within a second traveling time determined based on an operation time of the preparation operation of the preparation winding unit, transmits the preparation completion signal, it is preferable that the yarn joining cart cancels the yarn joining travel with respect to the preparation winding unit and performs the yarn joining travel with respect to the completion winding unit which has transmitted the preparation completion signal.

**[0024]** Accordingly, a priority order of the yarn joining work can be flexibly changed depending on a situation of each winding unit.

**[0025]** The yarn winding machine is preferably configured as follows. That is, the yarn winding machine includes an air spinning device. The air spinning device forms a yarn by applying twists to a fiber bundle by using

a swirling airflow current. During a period after occurrence of the yarn breakage and before the yarn joining operation by the yarn joining cart, the winding unit performs a cleaning operation of the air spinning device as the preparation operation. When the preparation winding unit transmits the yarn joining notice signal, a time interval from start to end of the cleaning operation performed by the preparation winding unit at least partly overlaps a time interval from start to end of the yarn joining travel performed by the yarn joining cart with respect to the preparation winding unit.

**[0026]** Accordingly, the cleaning operation of the air spinning device and the yarn joining travel of the yarn joining cart can be performed concurrently, thereby the yarn joining work can be performed more efficiently.

**[0027]** The yarn winding machine is preferably configured as follows. That is, the yarn winding machine includes a yarn accumulation roller. The yarn accumulation roller temporarily accumulates the yarn. During a period after occurrence of the yarn breakage and before the yarn joining operation to be performed by the yarn joining cart, the winding unit performs a residual yarn removing operation as the preparation operation, for removing the yarn remaining on the yarn accumulation roller from the yarn accumulation roller. When the preparation winding unit transmits the yarn joining notice signal, a time interval from start to end of the residual yarn removing operation performed by the preparation winding unit at least partly overlaps a time interval from start to end of the yarn joining travel performed by the yarn joining cart with respect to the preparation winding unit.

**[0028]** Accordingly, the residual yarn removing operation and the yarn joining travel of the yarn joining cart can be performed concurrently, thereby the yarn joining work can be performed more efficiently.

**[0029]** The yarn winding machine is preferably configured as follows. That is, in occurrence of two preparation winding units, when the yarn is remaining on the yarn accumulation roller of one of the preparation winding units and the yarn is not remaining on the yarn accumulation roller of a different preparation winding unit, the yarn joining cart performs the yarn joining travel with respect to the different preparation winding unit.

**[0030]** Accordingly, the priority order of the yarn joining work can be flexibly determined depending on a residual state of the yarn on the yarn accumulation roller of the preparation winding unit.

**[0031]** The yarn winding machine is preferably configured as follows. That is, each of the winding units further includes a detection device for detecting the length of a yarn defect included in the yarn. In occurrence of the two preparation winding units, the yarn joining cart performs the yarn joining travel with respect to the preparation winding unit in which the detected length of the yarn defect is shorter.

**[0032]** Accordingly, the priority order of the yarn joining work can be flexibly determined depending on the length of the yarn defect in the preparation winding unit.

**[0033]** In the yarn winding machine, each of the winding units preferably has a display for displaying that the yarn joining notice signal has been transmitted.

**[0034]** Accordingly, an operator can easily identify the winding unit which has transmitted the yarn joining notice signal.

**[0035]** According to a second aspect of the present invention, the following yarn winding method is provided. That is, in the yarn winding method, a package is formed by winding the yarn while traversing the yarn in each of a plurality of winding units. The yarn winding method includes a preparation step and a yarn joining travel step. In the preparation step, the winding unit is prepared to be ready for the yarn joining operation after occurrence of the yarn breakage in the winding unit. In the yarn joining travel step, in order to position the yarn joining cart, which performs the yarn joining operation with respect to the winding unit, at an operating position where the yarn joining cart performs the yarn joining operation with respect to the winding unit in which the yarn breakage has occurred, the yarn joining cart starts traveling toward the operating position, cancels the current traveling and stops at the operating position, or travels at a decelerated speed from the current traveling speed. If there is no completion winding unit that is the winding unit in which the preparation step is completed and if there is the preparation winding unit that is the winding unit during the preparation step, the yarn joining travel step with respect to the preparation winding unit is performed.

**[0036]** Accordingly, the yarn joining travel step is performed during the period of the preparation step in the winding unit, thereby shortening the waiting time for the yarn joining.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### **[0037]**

Fig. 1 is a front view showing an overall configuration of a spinning machine according to one embodiment of the present invention.

Fig. 2 is a side view showing a spinning unit and a yarn joining cart.

Fig. 3 is a schematic view showing a travel of the yarn joining cart with respect to a yarn joining notice signal.

Fig. 4 is a schematic view showing a state in which two preparation spinning units appeared at different timings.

Fig. 5 is a schematic view showing a state in which the preparation spinning unit and a completion spinning unit exist at the same time.

Fig. 6 is a schematic view showing a state in which the preparation spinning unit and the completion spinning unit appeared at different timings.

Fig. 7 is a schematic view showing a variation of work areas of yarn joining carts.

#### EMBODIMENT FOR CARRYING OUT THE INVENTION

**[0038]** Next, a spinning machine (yarn winding machine) 1 according to one embodiment of the present invention will be described with reference to the drawings. In the following description, the terms "upstream" and "downstream" refer to upstream and downstream, in a traveling direction of a sliver 15, a fiber bundle 8, and a spun yarn 10, at a time of winding the spun yarn (yarn) 10.

**[0039]** The spinning machine 1 shown in Fig. 1 includes a blower box 80, a motor box 5, a plurality of spinning units (winding units) 2 arranged side by side in one line, and a yarn joining cart 3.

**[0040]** The spinning machine 1 includes a central control device 4 which controls each component. The central control device 4 is connected to a unit control section 50 (see Fig. 2), which will be described later, provided in each of the spinning units 2 via a signal line (not shown). One unit control section 50 may be provided for every predetermined number of spinning units 2, and may not be provided for every single spinning unit 2.

**[0041]** A negative pressure source, etc. for supplying negative pressure to each spinning unit 2 is arranged inside the blower box 80 shown in Fig. 1. A common driving source for each of the spinning units 2 is arranged in the motor box 5.

**[0042]** In the spinning machine 1 of this embodiment, a unit number as an identifier is assigned to each of the spinning units 2 so as to identify each of the spinning units 2. Specifically, as indicated by circled numbers in Fig. 3, the unit numbers 1, 2, 3, ... are assigned to each of the spinning units 2 from one end of a machine frame of the spinning machine 1. Although not all the spinning units 2 are shown in the drawings, the spinning machine 1 of this embodiment has ninety-six spinning units 2, for example.

**[0043]** As shown in Fig. 1, each of the spinning units 2 mainly includes a spinning device 9 and a winding device 13, which are arranged in order from upstream to downstream.

**[0044]** Each of the spinning units 2 further includes a draft device 7 and a yarn accumulation device 12.

**[0045]** The draft device 7 is provided near an upper end of a frame 6 of the spinning machine 1. As shown in Fig. 2, the draft device 7 has four pairs of draft rollers, which are a pair of back rollers 16, a pair of third rollers 17, a pair of middle rollers 19, and a pair of front rollers 20, in order from an upstream side. An apron belt 18 is provided with respect to each roller in the pair of middle rollers 19.

**[0046]** The draft device 7 transports the sliver 15 that is supplied from a sliver case (not shown) while sandwiching the sliver 15 between the rollers included in the pair of draft rollers. Thereby, the sliver 15 is stretched (drafted) to a predetermined fiber amount (or thickness) and the fiber bundle 8 is formed. The fiber bundle 8 formed by the draft device 7 is supplied to the spinning

device 9.

**[0047]** The spinning device (air spinning device) 9 includes a spinning nozzle (not shown) and forms the spun yarn (yarn) 10 by applying twists to the fiber bundle 8 that is supplied from the draft device 7 by using a swirling airflow current that is generated by injecting compressed

**[0048]** In this embodiment, the spinning device 9 includes a nozzle block (not shown) and a hollow guide shaft (not shown). The nozzle block has a fiber guide section, the spinning nozzle, and a spinning chamber. The hollow guide shaft has a yarn passage and a second nozzle. An operation of the spinning device 9 is controlled by the unit control section 50.

**[0049]** The fiber guide section is a member for guiding the drafted fiber bundle 8 into the spinning device 9 (spinning chamber). The spinning device 9 injects the air from the spinning nozzle into the spinning chamber and makes the swirling airflow current to act on the fiber bundle 8 inside the spinning chamber. As a result of the action of such swirling airflow current, each fiber end of the plurality of fibers that constitute the fiber bundle 8 is reversed and swirled. The hollow guide shaft is a cylindrical member. A yarn passage is formed inside the hollow guide shaft. The hollow guide shaft guides the spun yarn 10 from the inside of the spinning chamber to the outside of the spinning device 9.

**[0050]** When performing a yarn discharge spinning for starting a spinning operation, the spinning device 9 injects the air from the second nozzle into the yarn passage to generate a swirling airflow current inside the yarn passage. A direction of the swirling airflow current generated inside the yarn passage at this time is opposite to the direction of the swirling airflow current in the spinning chamber. Accordingly, the fiber bundle 8 is introduced from the draft device 7 into the spinning device 9, and then forming of the spun yarn 10 is started.

**[0051]** If the spinning unit 2 is configured to join the spun yarn 10 by piecing, the hollow guide shaft does not have the second nozzle, but has another nozzle. The air is injected from such another nozzle in order to reversely feed the spun yarn 10 from a package 45 back into the spinning device 9.

**[0052]** A yarn accumulation device 12 is provided downstream of the spinning device 9. As shown in Fig. 2, the yarn accumulation device 12 has a yarn accumulation roller 14, a motor 25 for rotationally driving the yarn accumulation roller 14, a first accumulated yarn detection sensor 21, and a second accumulated yarn detection sensor 22.

**[0053]** The yarn accumulation roller 14 temporarily accumulates the spun yarn 10 by winding a certain amount of the spun yarn 10 on an outer peripheral surface thereof. The yarn accumulating roller 14 pulls the spun yarn 10 from the spinning device 9 and transports the spun yarn 10 to the downstream side at a predetermined speed by being rotated at a predetermined rotational speed with the spun yarn 10 wound on the outer peripheral surface

thereof.

**[0054]** As such, since the yarn accumulating device 12 can temporarily accumulate the spun yarn 10 on the outer peripheral surface of the yarn accumulating roller 14, the yarn accumulating device 12 can function as a kind of buffer of the spun yarn 10. The buffering function of the yarn accumulating device 12 avoids troubles (for example, slackening and the like of the spun yarn 10) caused by a mismatch in a spinning speed of the spinning device 9 and a winding speed (a traveling speed of the spun yarn 10 being wound into the package 45 which will be described later) due to some reason.

**[0055]** Each of the first accumulated yarn detection sensor 21 and the second accumulated yarn detection sensor 22 includes a reflective type of photo sensor with a light emitting element and a light receiving element. The first accumulated yarn detection sensor 21 detects whether an accumulated amount of the spun yarn 10 accumulated on the yarn accumulation roller 14 is equal to or more than a predetermined amount or not. The second accumulated yarn detection sensor 22 that is arranged downstream than the first accumulated yarn detection sensor 21, detects whether the accumulated amount of the spun yarn 10 accumulated on the yarn accumulation roller 14 is equal to or less than a limit value (predetermined maximum amount) or not.

**[0056]** The first accumulated yarn detection sensor 21 and the second accumulated yarn detection sensor 22 have a function as a detection section for detecting success or failure of a preparation operation which will be described later, performed after the yarn breakage occurs.

**[0057]** A yarn monitoring device 59 is provided between the spinning device 9 and the yarn accumulation device 12. The spun yarn 10 that is formed by the spinning device 9 passes through the yarn monitoring device 59 before being wound by the yarn accumulation device 12.

**[0058]** The yarn monitoring device (detection device) 59 monitors the quality (thickness and the like) of the traveling spun yarn 10 by a light transmission sensor, and detects a yarn defect included in the spun yarn 10 (portions having abnormality in the thickness and the like of the spun yarn 10, foreign matters etc.) and the length of the yarn defect. The yarn monitoring device 59 transmits a yarn defect detection signal to the unit control section 50 when the yarn defect of the spun yarn 10 is detected. The yarn monitoring device 59 may monitor the quality of the spun yarn 10 by using a capacitance sensor, for example, not limited to the light transmission sensor.

**[0059]** Upon receipt of the yarn defect detection signal from the yarn monitoring device 59, the unit control section 50 causes the spun yarn 10 to be cut by stopping the drive of the spinning device 9. That is, the spinning device 9 has the function as a cutting section for cutting the spun yarn 10 when the yarn monitoring device 59 detects a yarn defect. The spun yarn 10 may be cut by using a cutter.

**[0060]** The winding device 13 includes a cradle arm

71, a winding drum 72, and a traverse guide 76. The cradle arm 71 is swingably supported around a supporting shaft 73. The cradle arm 71 can rotatably support a bobbin 48 (that is, the package 45) for winding the spun yarn 10. The winding drum 72 is rotated in contact with the outer peripheral surface of the bobbin 48 or the package 45, and thereby the package 45 is rotationally driven in a winding direction. The winding device 13 drives the winding drum 72 by an electric motor (not shown) while causing the traverse guide 76 to reciprocatingly move by using a driving member (not shown). As a result, the spun yarn 10 is wound into the package 45 while being traversed.

**[0061]** As shown in Fig. 1, a rail 41 is provided on the frame 6 of the spinning machine 1 along the direction in which the spinning units 2 are arranged side by side. The yarn joining cart 3 is configured to travel on the rail 41.

**[0062]** In the spinning machine 1 of this embodiment, four yarn joining carts 3 are provided for ninety-six spinning units 2. Each of the four yarn joining carts 3 has an exclusive work area. For example, the exclusive work area of the yarn joining cart 3 shown in Fig. 3 is an area where the spinning units 2 having each unit number of 1 to 24 are arranged. If there is no yarn joining request from the spinning units 2, each of the yarn joining carts 3 stands by at a center position of the respective work area. However, each of yarn joining carts 3 may stand by at a position where the yarn joining operation has just been completed. Alternatively, each of the yarn joining carts 3 may stand by at a position moved for a predetermined distance from the position where the yarn joining operation has just been completed.

**[0063]** Each of the yarn joining carts 3 performs a yarn joining work with respect to the spinning unit 2 in which the yarn breakage has occurred. For example, when a yarn traveling sensor (not shown) that is arranged downstream of the yarn accumulation device 12 detects that there is no spun yarn 10, the unit control section 50 determines that the yarn breakage has occurred. Other sensors may detect occurrence of the yarn breakage. The yarn joining work includes a cart positioning and a yarn joining operation. The cart positioning includes a current position maintenance for a case where the current position where the yarn joining cart 3 under a stopped state coincides with an operating position where the yarn joining operation is to be performed, and a yarn joining travel for cases other than such a case where the current position coincides with the operating position. The current position maintenance is to maintain the current position of the yarn joining cart 3 under the stopped state. The yarn joining travel is to travel from a position where a signal related to the yarn joining has been received to the operating position where the yarn joining operation is to be performed. The yarn joining operation is an operation for catching a yarn end and performing yarn joining.

**[0064]** As shown in Fig. 1 etc., the yarn joining cart 3 includes a traveling wheel 42, a yarn joining device 43,

a yarn catching section (a suction pipe 44 and a suction mouth 46), a cart control section 70, and a position detection section (a signal transmitter 61 and a not-shown dock sensor).

**[0065]** The traveling wheel 42 is rotationally driven by a motor (not shown). By driving the traveling wheel 42, the yarn joining cart 3 can travel along the rail 41 with respect to the plurality of spinning units 2.

**[0066]** The suction pipe 44 generates a suction air stream at its tip, which can suck and catch the spun yarn 10 from the spinning device 9. The suction mouth 46 generates a suction air stream at its tip, which can suck and catch the spun yarn 10 from the package 45 that is supported by the winding device 13. The suction pipe 44 and the suction mouth 46 are swung with the caught spun yarn 10, and thereby guide the spun yarn 10 to a position where the spun yarn 10 can be introduced into the yarn joining device 43.

**[0067]** The yarn joining device 43 joins the spun yarn 10 from the spinning device 9 that is guided by the suction pipe 44 and the spun yarn 10 from the package 45 that is guided by the suction mouth 46. In this embodiment, the yarn joining device 43 is a splicer device in which the yarn ends are twisted by using the swirling airflow current. The yarn joining device 43 is not limited to the above-described splicer device. For example, a mechanical knitter etc. may be adopted.

**[0068]** In a case where the yarn joining cart 3 has the yarn joining device 43, the yarn joining operation includes an operation in which the spun yarn 10 from the spinning device 9 is guided to the yarn joining device 43 by the suction pipe 44, an operation in which the spun yarn 10 from the package 45 is guided to the yarn joining device 43 by the suction mouth 46, and an operation in which the spun yarns 10 are joined by the yarn joining device 43.

**[0069]** The yarn joining cart 3 may be configured to join the spun yarn 10 by performing piecing as the yarn joining operation. In this case, the yarn joining cart 3 does not have the yarn joining device 43.

**[0070]** The cart control section 70 is configured as a known computer having a CPU (Central Processing Unit), a ROM (Read Only Memory), and a RAM (Random Access Memory), etc. (not shown). The cart control section 70 controls the operations of each component included in the yarn joining cart 3, and thereby controls the yarn joining work performed by the yarn joining cart 3.

**[0071]** The signal transmitter 61 wirelessly transmits a predetermined position confirmation signal to the spinning unit 2 that is located at a position facing the signal transmitter 61. As shown in Fig. 3, each of the spinning units 2 has a receiving section 62 for receiving the position confirmation signal.

**[0072]** When the yarn joining cart 3 stops traveling, the cart control section 70 transmits the position confirmation signal from the signal transmitter 61 with respect to the spinning unit 2 facing the signal transmitter 61 at such stopped position of the yarn joining cart 3. When the receiving section 62 receives the position confirmation sig-

nal from the yarn joining cart 3, the unit control section 50 of the spinning unit 2 transmits a response signal including the unit number of such spinning unit 2 to the yarn joining cart 3. Accordingly, the yarn joining cart 3 obtains its current position. The unit control section 50 may transmit the response signal including the unit number of the spinning unit 2 to the yarn joining cart 3 via the central control device 4.

**[0073]** The dock sensor detects a dock (not shown) provided in each of the spinning units 2. When the yarn joining cart 3 travels on the rail 41, the cart control section 70 counts the number of docks detected by the dock sensor, thereby obtaining a distance corresponding to the number of units through which the yarn joining cart 3 has moved. Accordingly, the yarn joining cart 3 can obtain its position (traveling position).

**[0074]** Next, the yarn joining travel (yarn joining travel step) that is performed by the yarn joining cart 3 will be described with reference to drawings. The yarn joining travel that is performed by the yarn joining cart 3 is traveling performed in the following cases, for example.

**[0075]** As a first example, while the yarn joining cart 3 is under standby, when the signal related to the yarn joining is received from the spinning unit 2 that is located at a position away from the standby position, the yarn joining travel that is performed by the yarn joining cart 3 is to travel from the current position to the operating position with respect to the spinning unit 2 which has transmitted the signal related to the yarn joining.

**[0076]** As a second example, during a time when the yarn joining cart 3 is traveling toward one of the spinning units 2 (that is, during a time when the yarn joining cart 3 is traveling based on a certain predetermined plan), when another spinning unit 2 with a higher priority order appeared, the yarn joining cart 3 cancels the traveling toward the spinning unit 2 of the initial destination, and travels toward the spinning unit 2 with the higher priority order.

**[0077]** As a third example, during a time when the yarn joining cart 3 is traveling toward one of the spinning units 2 (that is, during a time when the yarn joining cart 3 is traveling based on the certain predetermined plan), when another spinning unit 2 with a higher priority order appeared near the current traveling position and ahead of the current traveling direction, the yarn joining cart 3 travels at a decelerated speed from the current traveling speed so as to be able to stop at an operating position with respect to the spinning unit 2 with the higher priority order.

**[0078]** When the yarn joining cart 3 is under standby at a position associated with one of the spinning units 2, and when the signal related to the yarn joining is received from such one of the spinning units 2, the yarn joining cart 3 does not perform the yarn joining travel and maintains the current position. That is, the yarn joining cart 3 does not travel and stands by as it is.

**[0079]** Although three examples of the yarn joining travel have been described above, the yarn joining cart

3 may merely perform at least one of three examples. In other words, the yarn joining cart 3 may be configured so as to perform only one example of three examples as the yarn joining travel.

**[0080]** The signal related to the yarn joining includes a yarn joining notice signal for notifying that the yarn joining operation will be required soon, and a preparation completion signal for indicating that the preparation operation is completed and the yarn joining operation can be started.

**[0081]** In the spinning machine 1 of this embodiment, when the yarn breakage occurs in the spun yarn 10 between the spinning device 9 and the package 45 due to some reason, the unit control section 50 performs the preparation operation (preparation step) as a pre-operation of the yarn joining operation that is performed by the yarn joining cart 3. The unit control section 50 transmits the yarn joining notice signal to the cart control section 70 of the yarn joining cart 3, during the preparation operation. The unit control section 50 may transmit the yarn joining notice signal to the cart control section 70 of the yarn joining cart 3 before performing the preparation operation.

**[0082]** The preparation operation includes a cleaning operation performed by the spinning nozzle of the spinning device 9, and a residual yarn removing operation for removing the spun yarn 10 remaining on the yarn accumulation roller 14. In this embodiment, the cleaning operation and the residual yarn removing operation are started at the same time. However, either one of the preparation operations may be started in advance.

**[0083]** One example of the cleaning operation will be described in more detail. When the unit control section 50 determines that the yarn breakage has occurred, the unit control section 50 stops the spinning operation of the draft device 7 and the spinning device 9. Then, the spinning chamber is opened by separating the hollow guide shaft from the nozzle block. In this state, the cleaning operation is performed by injecting air from the spinning nozzle for a predetermined time. When such air injection from the spinning nozzle is stopped and the cleaning operation ends, the hollow guide shaft returns to its original position.

**[0084]** One example of the residual yarn removing operation will be described in more detail. When the yarn breakage occurs, the spun yarn 10 located downstream of the yarn accumulation device 12 is wound into the package 45. However, the spun yarn 10 that is wound on the yarn accumulation roller 14 is not wound into the package 45 and remains on the yarn accumulation roller 14. In this embodiment, the yarn accumulation device 12 has a residual yarn removing device (not shown) that is arranged so as to face a downstream end portion of the yarn accumulation roller 14. The yarn accumulation device 12 rotates the yarn accumulation roller 14 in a direction opposite to the direction in which the yarn accumulation roller 14 is rotated during winding of the package 45, and a suction flow is generated in a suction port of a

suction pipe of the residual yarn removing device. Accordingly, the residual yarn on the yarn accumulation roller 14 can be sucked and removed by means of the residual yarn removing device.

**[0085]** After completion of the cleaning operation and the residual yarn removing operation, when the yarn joining cart 3 reached the operating position, the unit control section 50 restarts the operation of the draft device 7 and the spinning device 9, catches the spun yarn 10 from the spinning device 9 by the suction pipe 44, and guides the spun yarn 10 to a position where the yarn joining can be performed by the yarn joining device 43. The yarn joining device 43 joins the spun yarn 10 from the spinning device 9 guided by the suction pipe 44 and the spun yarn 10 from the package 45 guided by the suction mouth 46. After the yarn joining is completed by the yarn joining device 43, the yarn winding operation is restarted in the spinning unit 2.

**[0086]** After the start of the spinning operation of the spinning device 9, the unit control section 50 determines success or failure of the cleaning operation (preparation operation) based on the detection result of the yarn monitoring device 59, for example. If the spun yarn 10 is not detected by the yarn monitoring device 59 despite starting the spinning operation of the spinning device after the preparation operation, the unit control section 50 determines that the cleaning operation has failed. The unit control section 50 may determine success or failure of the cleaning operation based on a detection result of a sensor (not shown) that is provided inside the suction pipe 44 and/or a sensor that is provided in the spinning device 9, in addition to or instead of the yarn monitoring device 59.

**[0087]** The unit control section 50 determines success or failure of the residual yarn removing operation (preparation operation) based on the detection result of the first accumulated yarn detection sensor 21 and/or the second accumulated yarn detection sensor 22. If the first accumulated yarn detection sensor 21 and the second accumulated yarn detection sensor 22 detect that the spun yarn 10 is remaining on the yarn accumulation roller 14 despite the residual yarn removing operation, the unit control section 50 determines that the residual yarn removing operation has failed.

**[0088]** If the preparation operation has failed, the unit control section 50 transmits a notice cancellation signal that is a signal for canceling the yarn joining notice signal to the cart control section 70. In this case, the yarn joining cart 3 may stop and stand by at the current traveling position, or may return to and stand by at the center position in the work area.

**[0089]** The unit control section 50 transmits the preparation completion signal to the cart control section 70 after completion of the preparation operation for the yarn joining operation (after success of the preparation operation).

**[0090]** As shown in Fig. 3, each of the spinning units 2 has a display 60 for displaying that the yarn joining

notice signal or the preparation completion signal has been transmitted. When the yarn joining notice signal or the preparation completion signal is transmitted by the unit control section 50, the display 60 lights up an LED (lamp) provided in each of the spinning units 2. When the yarn joining notice signal is canceled by the unit control section 50 or when the yarn joining operation is completed, the display 60 turns off the LED. Accordingly, the operator can easily check the state of each of the spinning units 2.

**[0091]** In the following description, after occurrence of the yarn breakage, the spinning unit 2 which is performing the preparation operation is referred to as a preparation spinning unit (preparation winding unit) 2a, and the spinning unit 2 in which the preparation operation has been completed and which is ready for the yarn joining operation is referred to as a completion spinning unit (completion winding unit) 2b.

**[0092]** As shown in Fig. 3, when there is no completion spinning unit 2b which has transmitted the preparation completion signal and when the yarn joining notice signal is received from the preparation spinning unit 2a, the cart control section 70 controls the yarn joining cart 3 to start the yarn joining travel toward the operating position with respect to the preparation spinning unit 2a. That is, the yarn joining cart 3 starts the yarn joining travel before completion of the preparation operation of the preparation spinning unit 2a.

**[0093]** In other words, the yarn joining cart 3 starts the yarn joining travel before the preparation spinning unit 2a starts the preparation operation or during the preparation operation. As such, the time interval from the start to the end of the preparation operation in the preparation spinning unit 2a at least partly overlaps the time interval from the start to the end of the yarn joining travel performed by the yarn joining cart 3 with respect to the preparation spinning unit 2a.

**[0094]** As such, in the spinning machine 1, the preparation operation of the preparation spinning unit 2a and the yarn joining travel of the yarn joining cart 3 can be performed concurrently. The yarn joining cart 3 starts traveling toward the operating position with respect to the preparation spinning unit 2a before completion of the preparation operation in such preparation spinning unit 2a. When the yarn joining cart 3 reaches the operating position, if the preparation operation has not been completed yet, the yarn joining cart 3 stops and stands by at the operating position. When the yarn joining cart 3 reaches the operating position, if the preparation operation has already been completed, the yarn joining cart 3 immediately starts the yarn joining operation. As such, the preparation step and the yarn joining travel step are performed at the same time, thereby the yarn joining work can be efficiently performed and the time of a yarn joining cycle from occurrence of the yarn breakage to completion of the yarn joining can be shortened.

**[0095]** With reference to Fig. 4, a description will be made on a case where the preparation spinning unit 2a



having the unit number 24 firstly transmits the yarn joining notice signal and the preparation spinning unit 2a having the unit number 20 transmits the yarn joining notice signal at a later timing. Although the yarn joining cart 3 starts traveling toward the preparation spinning unit 2a having the unit number 24, the yarn joining cart 3 receives the yarn joining notice signal from the preparation spinning unit 2a having the unit number 20 before reaching the preparation spinning unit 2a having the unit number 24. In this situation, the cart control section 70 determines whether or not to change a target spinning unit based on whether or not the preparation spinning unit 2a having the unit number 20 is located in a range in which the yarn joining cart 3 can reach from a current traveling position within a first traveling time.

**[0096]** When the preparation spinning unit 2a having the unit number 20 is located in the range in which the yarn joining cart 3 can reach from the current traveling position within the first traveling time, the cart control section 70 changes the target spinning unit for the yarn joining cart 3, from the preparation spinning unit 2a having the unit number 24 to the preparation spinning unit 2a having the unit number 20. The yarn joining cart 3 cancels the yarn joining travel with respect to the preparation spinning unit 2a having the unit number 24, and starts the yarn joining travel with respect to the preparation spinning unit 2a having the unit number 20.

**[0097]** When the preparation spinning unit 2a having the unit number 20 is not located in the range in which the yarn joining cart 3 can reach from the current traveling position within the first traveling time, the cart control section 70 does not change the target spinning unit of the yarn joining cart 3, and the yarn joining cart 3 continues to travel to the preparation spinning unit 2a having the unit number 24.

**[0098]** The first traveling time is preferably defined based on an operation time of the preparation operation of the preparation spinning unit 2a which has firstly transmitted the yarn joining notice signal, and based on the operation time of the preparation operation of the preparation spinning unit 2a which has transmitted the yarn joining notice signal at a later timing. The first traveling time is preferably defined in view of a time required for the yarn joining cart 3 to travel from the current traveling position to the operating position with respect to the preparation spinning unit 2a which has firstly transmitted the yarn joining notice signal.

**[0099]** As such, when the plurality of preparation spinning units 2a has transmitted the yarn joining notice signal, the cart control section 70 of this embodiment controls the yarn joining travel of the yarn joining cart 3 so as to prioritize the yarn joining operation of the preparation spinning unit 2a capable of firstly starting the yarn joining operation, regardless of whether any one of the preparation spinning units 2a has firstly transmitted the yarn joining notice signal.

**[0100]** With reference to Fig. 5, a description will be made on a case where both the completion spinning unit

2b and the preparation spinning unit 2a appeared during the yarn joining operation with respect to one of the spinning units 2. In this case, after completion of the yarn joining operation of the spinning unit 2, the cart control section 70 controls the yarn joining travel of the yarn joining cart 3 so as to prioritize the yarn joining operation of the completion spinning unit 2b which has transmitted the preparation completion signal, over the preparation spinning unit 2a which has transmitted the yarn joining notice signal. That is, after completion of the current yarn joining operation, the yarn joining cart 3 starts the yarn joining travel to the completion spinning unit 2b.

**[0101]** However, this embodiment is not limited to the above-described example. For example, when the time of the yarn joining travel with respect to the completion spinning unit 2b is longer than the operation time of the preparation operation of the preparation spinning unit 2a, and when the yarn joining cart 3 can reach the operating position with respect to the preparation spinning unit 2a before completion of the preparation operation of the preparation spinning unit 2a, the yarn joining work with respect to the preparation spinning unit 2a may be preferentially performed.

**[0102]** With reference to Fig. 6, a description will be made on a case where the preparation spinning unit 2a having the unit number 24 firstly transmits the yarn joining notice signal and then the completion spinning unit 2b having the unit number 2 transmits the preparation completion signal at a later timing. Although the yarn joining cart 3 starts traveling to the preparation spinning unit 2a having the unit number 24 which has firstly transmitted the yarn joining notice signal, the yarn joining cart 3 receives the preparation completion signal from the completion spinning unit 2b having the unit number 2 before reaching the preparation spinning unit 2a. In this situation, the cart control section 70 determines whether or not to change the target spinning unit based on whether or not the completion spinning unit 2b having the unit number 2 is located in a range in which the yarn joining cart 3 can reach from the current traveling position within a second traveling time.

**[0103]** When the completion spinning unit 2b having the unit number 2 is located in the range in which the yarn joining cart 3 can reach from the current traveling position within the second traveling time, the cart control section 70 changes the target spinning unit of the yarn joining cart 3, from the preparation spinning unit 2a having the unit number 24 to the completion spinning unit 2b. The yarn joining cart 3 travels to the completion spinning unit 2b having the unit number 2.

**[0104]** When the completion spinning unit 2b having the unit number 2 is not located in the range in which the yarn joining cart 3 can reach from the current traveling position within the second traveling time, the cart control section 70 does not change the target spinning unit of the yarn joining cart 3, and the yarn joining cart 3 continues to travel to the preparation spinning unit 2a having the unit number 24.

**[0105]** The second traveling time is preferably defined based on the operation time of the preparation operation of the preparation spinning unit 2a. The second traveling time is preferably defined in view of a time required for the yarn joining cart 3 to travel from the current traveling position of the yarn joining cart 3 to the operating position with respect to the preparation spinning unit 2b. Accordingly, even if a completion spinning unit 2b to be basically prioritized appeared, from the viewpoint of shortening the time of the yarn joining cycle, the yarn joining work can be performed by the yarn joining cart 3 while appropriately prioritizing each of the spinning units 2, based on the current traveling position of the yarn joining cart 3 and each position of the preparation spinning unit 2a and the completion spinning unit 2b.

**[0106]** A textile machinery such as the spinning machine 1 may include a doffing cart for doffing the fully wound package 45. Therefore, as with the case of the yarn joining cart 3, the unit control section 50 may transmit a doffing notice signal to the doffing cart at a timing to some extent before the package 45 is fully wound, and then transmit the preparation completion signal to the doffing cart at a timing when the package 45 is actually fully wound.

**[0107]** In case of the doffing cart, since the operation from the doffing notice signal to the preparation completion signal has less fluctuating elements, the order of the spinning units 2 which transmit the doffing notice signal may be almost same as that of the spinning units 2 which transmit the preparation completion signal. However, in case of the yarn joining cart 3, the order of the spinning units 2 which transmit the yarn joining notice signal does not match frequently with the order of the spinning units 2 which transmit the preparation completion signal, due to failure of the preparation operation or the like. Therefore, the above-described control of the cart is more effective to be applied to the yarn joining cart 3 as in this embodiment.

**[0108]** As described above, the spinning machine 1 of this embodiment includes the plurality of spinning units 2, and at least one yarn joining cart 3. Each of the spinning units 2 winds the spun yarn 10. The yarn joining cart 3 performs the yarn joining operation with respect to the spinning units 2. After occurrence of a yarn breakage, the spinning unit 2 performs the preparation operation to be prepared for the yarn joining operation. The yarn joining cart 3 performs the yarn joining travel so as to be positioned at the operating position to perform the yarn joining operation with respect to the spinning unit 2 in which the yarn breakage has occurred. The yarn joining travel is to start traveling toward the operating position, to cancel a predetermined scheduled traveling and stop at the operating position, or to travel at a decelerated speed from the predetermined scheduled traveling speed. If there is no completion spinning unit 2b that is the spinning unit 2 in which the preparation operation has been completed and if there is the preparation spinning unit 2a that is the spinning unit 2 during the preparation

operation, the yarn joining cart 3 performs the yarn joining travel with respect to the preparation spinning unit 2a.

**[0109]** As such, the yarn joining cart 3 performs the yarn joining travel during a time when the spinning unit 2 performs the preparation operation. Thereby, the yarn joining work including the yarn joining travel and the yarn joining operation can be efficiently performed and a waiting time for the yarn joining in the spinning unit 2 can be reduced.

**[0110]** In the spinning machine 1, when the current position where the yarn joining cart 3 is stopped coincides with the operating position where the yarn joining operation is performed with respect to the spinning unit 2 in which the yarn breakage has occurred, the yarn joining cart 3 maintains the current position without performing the yarn joining travel.

**[0111]** Accordingly, a cart positioning in view of the current position and the operating position of the yarn joining cart 3 can be reasonably performed.

**[0112]** In the spinning machine 1, the spinning unit 2 includes the unit control section 50 for transmitting the yarn joining notice signal after occurrence of the yarn breakage and before completion of the preparation operation.

**[0113]** Accordingly, a start timing of the yarn joining travel of the yarn joining cart 3 with respect to the operating position at which the yarn joining operation is scheduled to be performed can be instructed with a simple configuration.

**[0114]** In the spinning machine 1, the spinning unit 2 includes the first accumulated yarn detection sensor 21 and the second accumulated yarn detection sensor 22. The first accumulated yarn detection sensor 21 and the second accumulated yarn detection sensor 22 detect success or failure of the preparation operation. The unit control section 50 cancels the yarn joining notice signal if the first accumulated yarn detection sensor 21 and the second accumulated yarn detection sensor 22 detect the failure of the preparation operation after transmission of the yarn joining notice signal.

**[0115]** Accordingly, the yarn joining travel with respect to the preparation spinning unit 2a in which the preparation operation has failed after transmission of the yarn joining notice signal can be promptly canceled, and the yarn joining cart 3 can prepare to respond to the yarn joining requests from the other spinning units 2.

**[0116]** In the spinning machine 1, the unit control section 50 transmits the preparation completion signal after completion of the preparation operation.

**[0117]** Accordingly, the yarn joining cart 3 can be informed that the yarn joining operation with respect to the spinning unit 2 can be started.

**[0118]** In the spinning machine 1, provided that a first preparation winding unit is one preparation spinning unit 2a, and a second preparation winding unit is another preparation spinning unit 2a that is positioned in a range, which the yarn joining cart 3 can reach from the current traveling position within a predetermined first traveling

time, during the yarn joining travel with respect to the first preparation winding unit, when the second preparation winding unit transmits the yarn joining notice signal, the yarn joining cart 3 cancels the yarn joining travel with respect to the first preparation spinning unit 2a and performs the yarn joining travel with respect to the second preparation spinning unit 2a.

**[0119]** Accordingly, depending on a situation of each spinning unit 2, the yarn joining cart 3 can preferentially perform the yarn joining work with respect to the spinning unit 2 that is located at a position close to the current traveling position. Therefore, the yarn joining work with respect to the plurality of preparation spinning units 2a can be more efficiently performed.

**[0120]** In the spinning machine 1, when the preparation spinning unit 2a transmits the yarn joining notice signal and the completion spinning unit 2b transmits the preparation completion signal, the yarn joining cart preferentially performs the yarn joining travel based on the preparation completion signal.

**[0121]** Accordingly, when the preparation spinning unit 2a and the completion spinning unit 2b exist at the same time, the yarn joining work of the yarn joining cart 3 can be more efficiently performed for the entire spinning machine 1.

**[0122]** In the spinning machine 1, during the yarn joining travel of the yarn joining cart 3 with respect to the preparation spinning unit 2a which has transmitted the yarn joining notice signal, when the completion spinning unit 2b, which is located in the range, which the yarn joining cart 3 can reach from the current traveling position within a second traveling time determined based on an operation time of the preparation operation of the preparation spinning unit 2a, transmits the preparation completion signal, the yarn joining cart 3 cancels the yarn joining travel with respect to the preparation spinning unit 2a and performs the yarn joining travel with respect to the completion spinning unit 2b which has transmitted the preparation completion signal.

**[0123]** Accordingly, the priority order of the yarn joining work can be flexibly changed depending on a situation of each spinning unit 2.

**[0124]** The spinning machine 1 includes the spinning device 9. The spinning device 9 forms the spun yarn 10 by applying twists to the fiber bundle 8 by using the swirling airflow current. During the period after occurrence of the yarn breakage and before the yarn joining operation by the yarn joining cart, the spinning unit 2 performs the cleaning operation of the spinning device 9 as the preparation operation. When the preparation spinning unit 2a transmits the yarn joining notice signal, a time interval from the start to the end of the cleaning operation performed by the preparation spinning unit 2a at least partly overlaps the time interval from the start to the end of the yarn joining travel performed by the yarn joining cart 3 with respect to the preparation spinning unit 2a.

**[0125]** Accordingly, the cleaning operation of the spinning device 9 and the yarn joining travel of the yarn joining

cart 3 can be performed concurrently, thereby the yarn joining work can be performed more efficiently.

**[0126]** The spinning machine 1 includes the yarn accumulation roller 14. The yarn accumulation roller 14 temporarily accumulates the spun yarn 10. During the period after occurrence of the yarn breakage and before the yarn joining operation to be performed by the yarn joining cart 3, the spinning unit 2 performs the residual yarn removing operation as the preparation operation, for removing the spun yarn 10 remaining on the yarn accumulation roller 14 from the yarn accumulation roller 14. When the preparation spinning unit 2a transmits the yarn joining notice signal, the time interval from the start to the end of the residual yarn removing operation performed by the preparation spinning unit 2a at least partly overlaps the time interval from the start to the end of the yarn joining travel performed by the yarn joining cart 3 with respect to the preparation spinning unit 2a.

**[0127]** Accordingly, the residual yarn removing operation and the yarn joining travel of the yarn joining cart 3 can be performed concurrently, thereby the yarn joining work can be performed more efficiently.

**[0128]** In the spinning machine 1, each of the spinning units 2 has the display 60 for displaying that the yarn joining notice signal has been transmitted.

**[0129]** Accordingly, the operator can easily identify the spinning unit 2 which has transmitted the yarn joining notice signal.

**[0130]** Although a preferred embodiment of the present invention has been described above, the above-described configuration can be modified, for example, as follows. Even when any one of the following examples is adopted, the yarn joining cart 3 performs the above-described yarn joining travel. The following examples can be appropriately combined.

**[0131]** The cleaning operation and the residual yarn removing operation are examples of the preparation operation. Alternately, the spinning unit 2 may perform an operation other than the above-described operations, as the preparation operation. The spinning unit 2 may not perform at least any one of the cleaning operation and the residual yarn removal operation as the preparation operation. If the spinning unit 2 does not perform the cleaning operation, the hollow guide shaft may not be provided to be movable away from the nozzle block.

**[0132]** Each device may be arranged in each of the winding units such that a yarn path where the spun yarn 10 travels is oriented from bottom to top with respect to the machine frame. In this case, the yarn joining cart 3 travels while being guided by a rail provided in an upper portion of the spinning machine 1.

**[0133]** The spinning machine 1 may be configured as an open end spinning machine which applies twists to fibers by using a rotor, etc. In this case, when the yarn breakage occurs, the yarn joining cart 3 performs the yarn joining operation by reversely feeding the yarn from the package 45 to the rotor and then restarting a spinning operation by the rotor.

**[0134]** If there is no yarn joining request from the spinning units 2, the yarn joining cart 3 may perform the predetermined scheduled traveling for reciprocatingly traveling at a predetermined speed between both ends of the work area. In this case, when the yarn joining cart 3 receives the yarn joining notice signal or the preparation completion signal, the yarn joining cart 3 cancels the predetermined scheduled traveling and stops at the operating position with respect to the spinning unit 2 which has transmitted the signal.

**[0135]** The unit control section 50 may be provided for each group of the plurality of spinning units 2. The unit control section 50 may be omitted, and the central control device 4 may directly control each configuration of each of the spinning units 2.

**[0136]** The unit control section 50 may be configured to transmit the yarn joining notice signal, the preparation completion signal, and the notice cancellation signal to the central control device 4, for example. In this case, the central control device 4 transmits the information on which spinning unit 2 has transmitted which signal, to the cart control section 70 of the yarn joining cart 3.

**[0137]** The unit control section 50 may determine success or failure of the preparation operation only based on the detection result of the first accumulated yarn detection sensor 21.

**[0138]** Each of the spinning units 2 may pull out the spun yarn 10 from the spinning device 9 by using a pair of delivery rollers. In this case, the yarn accumulation device 12 may be provided downstream of the pair of delivery rollers. Alternately, instead of the yarn accumulation device 12, a slack tube using the suction air stream and/or a mechanical compensator for absorbing slackening in the spun yarn 10 may be provided downstream of the pair of delivery rollers. When the yarn accumulation device 12 is not provided, for example, the cleaning operation is performed as the preparation operation without performing the residual yarn removing operation.

**[0139]** In the display 60, the LED may emit different colors, or LEDs may be arranged at different positions and each LED may emit light such that transmission of the yarn joining notice signal and transmission of the preparation completion signal can be distinguished. The display 60 may be, instead of the LED, a liquid crystal panel capable of displaying a message, and may be a seven-segment indicator showing a state with alphanumeric characters.

**[0140]** At least one and three or less, or five or more yarn joining carts 3 may be provided. The yarn joining cart 3 may have a doffing function to doff the package 45 and a supplying function to supply a new bobbin 48 when the package 45 is fully wound in the spinning unit 2.

**[0141]** The yarn joining carts 3 may stand by in a state where the plurality of yarn joining carts 3 are equally arranged in a direction of the length of the machine frame of the spinning machine 1.

**[0142]** When two preparation spinning units 2a have transmitted the yarn joining notice signal, there is a case

where the spun yarn 10 is remaining on the yarn accumulation roller 14 provided in one of the preparation spinning units 2a and the spun yarn 10 is not remaining on the yarn accumulation roller 14 provided in the other preparation spinning unit 2a. When the spun yarn 10 is not remaining on the yarn accumulation roller 14, it can be predicted that the preparation operation can be completed earlier than the case where the spun yarn 10 is remaining on the yarn accumulation roller 14. Therefore, the cart control section 70 can control the yarn joining cart 3 to perform the yarn joining travel with respect to the preparation spinning unit 2a in which the spun yarn 10 is not remaining on the yarn accumulation roller 14. Such control enables the yarn joining work to be more efficiently performed as a whole.

**[0143]** In a case where each of the two preparing spinning units 2a detects a yarn defect by using the yarn monitoring device 59 and thereby transmits the yarn joining notice signal, the cart control section 70 can determine the priority order for performing the yarn joining operation based on the length of the yarn defect detected by the yarn monitoring device 59 provided in each preparation spinning unit 2a. Specifically, if the length of the yarn defect is short, the time required for removing the yarn defect is also short, and a prediction can be made that the preparation operation would be completed earlier. Therefore, the cart control section 70 controls the yarn joining cart 3 to perform the yarn joining travel with respect to the preparation spinning unit 2a which has detected the yarn defect having a relatively short length. Such control enables the yarn joining operation to be more efficiently performed as a whole.

**[0144]** As with a spinning machine 1x shown in Fig. 7, both the exclusive work area and the overlapping work area may be provided with respect to the plurality of yarn joining carts 3.

**[0145]** Specifically, as shown in Fig. 7, a first yarn joining cart 3a is assigned with the exclusive work area where the spinning units 2 having the unit number 1 to 16 are arranged and the overlapping work area where the spinning units 2 having the unit number 17 to 24 are arranged.

**[0146]** A second yarn joining cart 3b is assigned with the exclusive work area where the spinning units 2 having the unit number 25 to 40 are arranged and the overlapping area where the spinning units 2 having the unit number 17 to 24 are arranged.

**[0147]** Both the first yarn joining cart 3a and the second yarn joining cart 3b can perform the yarn joining work with respect to the spinning units 2 arranged in the overlapping work area. When receiving the yarn joining notice signal or the preparation completion signal from the spinning units 2 arranged in the overlapping work area, the cart control section 70 of each of the yarn joining carts 3 determines whether the relevant yarn joining cart 3 should perform the yarn joining work or whether another yarn joining cart 3 should perform the yarn joining work, based on the current position of the relevant yarn joining cart 3, and based on the current position of other yarn

joining carts 3 and a working state of other yarn joining carts 3 (whether or not such other yarn joining carts 3 are in operation).

Claims

1. A yarn winding machine (1) comprising:

a plurality of winding units (2) adapted to wind a yarn (10); and at least one yarn joining cart (3) adapted to perform a yarn joining operation with respect to each of the winding units (2), wherein after occurrence of a yarn breakage, a relevant winding unit (2) is adapted to perform a preparation operation to be started, the yarn joining cart (3) is adapted to perform a yarn joining travel so as to be positioned at an operating position appropriate to perform the yarn joining operation with respect to the winding unit (2) in which the yarn breakage has occurred, the yarn joining travel being starting traveling toward the operating position, canceling a current traveling and stopping at the operating position, or traveling at a decelerated speed from a current traveling speed, characterized in that if there is no completion winding unit (2b) that is the winding unit (2) in which the preparation operation has been completed and if there is a preparation winding unit (2a) that is the winding unit (2) during the preparation operation, the yarn joining cart (3) is adapted to perform the yarn joining travel with respect to the preparation winding unit (2a).

2. The yarn winding machine (1) according to claim 1, wherein if a current position where the yarn joining cart (3) is stopped coincides with the operating position where the yarn joining operation is to be performed with respect to the winding unit (2) in which the yarn breakage has occurred, the yarn joining cart (3) is adapted to maintain the current position without performing the yarn joining travel.

3. The yarn winding machine (1) according to claim 1 or 2, wherein each of the winding units (2) includes a control section (50) adapted to transmit a yarn joining notice signal after occurrence of the yarn breakage and before completion of the preparation operation.

4. The yarn winding machine (1) according to claim 3, wherein each of the winding units (2) includes a detection section (21, 22) adapted to detect success or failure

of the preparation operation, and the control section (50) is adapted to cancel the yarn joining notice signal if the detection section (21, 22) detects failure of the preparation operation after transmission of the yarn joining notice signal.

5. The yarn winding machine (1) according to claim 3 or 4, wherein the control section (50) is adapted to transmit a preparation completion signal after the preparation operation is completed.

6. The yarn winding machine (1) according to claim 5, wherein provided that a first preparation winding unit (2a) is one of preparation winding units (2a), and a second preparation winding unit (2b) is another one of the preparation winding units (2a) that is located in a range, which the yarn joining cart (3) can reach from a current traveling position within a predetermined first traveling time, during the yarn joining travel of the yarn joining cart (3) with respect to the first preparation winding unit (2a), when the second preparation winding unit (2a) transmits the yarn joining notice signal, the yarn joining cart (3) is adapted to cancel the yarn joining travel with respect to the first preparation winding unit (2a) and performs the yarn joining travel with respect to the second preparation winding unit (2b).

7. The yarn winding machine (1) according to claim 5 or 6, wherein when the preparation winding unit (2a) transmits the yarn joining notice signal and when the completion winding unit (2b) transmits the preparation completion signal, the yarn joining cart (3) is adapted to preferentially perform the yarn joining travel based on the preparation completion signal.

8. The yarn winding machine (1) according to any one of claims 5 to 7, wherein during the yarn joining travel of the yarn joining cart (3) with respect to the preparation winding unit (2a) which has transmitted the yarn joining notice signal, when the completion winding unit (2b), which is located in a range, which the yarn joining cart (3) can reach from the current traveling position within a second traveling time determined based on an operation time of the preparation operation of the preparation winding unit (2a), transmits the preparation completion signal, the yarn joining cart (3) is adapted to cancel the yarn joining travel with respect to the preparation winding unit (2a) and to perform the yarn joining travel with respect to the completion winding unit (2b) which has transmitted the preparation completion signal.

9. The yarn winding machine (1) according to any one

of claims 3 to 8, comprising an air spinning device (9) adapted to form a yarn (10) by applying twists to a fiber bundle (8) by using a swirling airflow current, wherein each of the winding units (2) is adapted to perform a cleaning operation of the air spinning device (9) as the preparation operation, during a period after occurrence of the yarn breakage and before the yarn joining operation by the yarn joining cart (3), and when the preparation winding unit (2a) transmits the yarn joining notice signal, a time interval from start to end of the cleaning operation performed by the preparation winding unit (2a) at least partly overlaps a time interval from start to end of the yarn joining travel performed by the yarn joining cart (3) with respect to the preparation winding unit (2a).

10. The yarn winding machine (1) according to any one of claims 3 to 9, comprising a yarn accumulation roller (14) adapted to temporarily accumulate the yarn (10), wherein each of the winding units (2) is adapted to perform a residual yarn removing operation as the preparation operation, for removing the yarn (10) remaining on the yarn accumulation roller (14) from the yarn accumulation roller (14), during a period after occurrence of the yarn breakage and before the yarn joining operation to be performed by the yarn joining cart (3), when the preparation winding unit (2a) transmits the yarn joining notice signal, a time interval from start to end of the residual yarn removing operation performed by the preparation winding unit (2a) at least partly overlaps a time interval from start to end of the yarn joining travel performed by the yarn joining cart (3) with respect to the preparation winding unit (2a).

11. The yarn winding machine (1) according to claim 10, wherein in occurrence of two preparation winding units (2a), when the yarn (10) is remaining on the yarn accumulation roller (14) of one of the preparation winding units (2a) and the yarn (10) is not remaining on the yarn accumulation roller (14) of a different preparation winding unit (2a), the yarn joining cart (3) is adapted to perform the yarn joining travel with respect to the different preparation winding unit (2).

12. The yarn winding machine (1) according to any one of claims 3 to 11, wherein each of the winding units (2) further includes a detection device (59) adapted to detect a length of a yarn defect included in the yarn (10), and in occurrence of two preparation winding units (2a), the yarn joining cart (3) is adapted to perform the yarn joining travel with respect to the preparation winding unit (2a) in which the detected length of the yarn defect is shorter.

13. The yarn winding machine (1) according to any one of claims 3 to 12, wherein each of the winding units (2) includes a display (60) adapted to display that the yarn joining notice signal has been transmitted.

14. A yarn winding method for forming a package (45) by winding a yarn (10) while traversing the yarn (10) in each of a plurality of winding units (2), the method comprising:

a preparation step for preparing the winding unit (2) to be ready for a yarn joining operation after occurrence of a yarn breakage; and  
 a yarn joining travel step for positioning a yarn joining cart (3), which performs the yarn joining operation with respect to each of the winding units (2), at an operating position where the yarn joining cart (3) performs the joining operation with respect to the winding unit (2) in which the yarn breakage has occurred, by having the yarn joining cart (3) to start traveling toward the operating position, to cancel a current traveling and stop at the operating position, or to travel at a decelerated speed from a current traveling speed, **characterized in that** if there is no completion winding unit (2b) that is the winding unit (2) in which the preparation step is completed and if there is a preparation winding unit (2a) that is the winding unit (2) during the preparation step, the yarn joining travel step with respect to the preparation winding unit (2a) is performed.

Fig.1

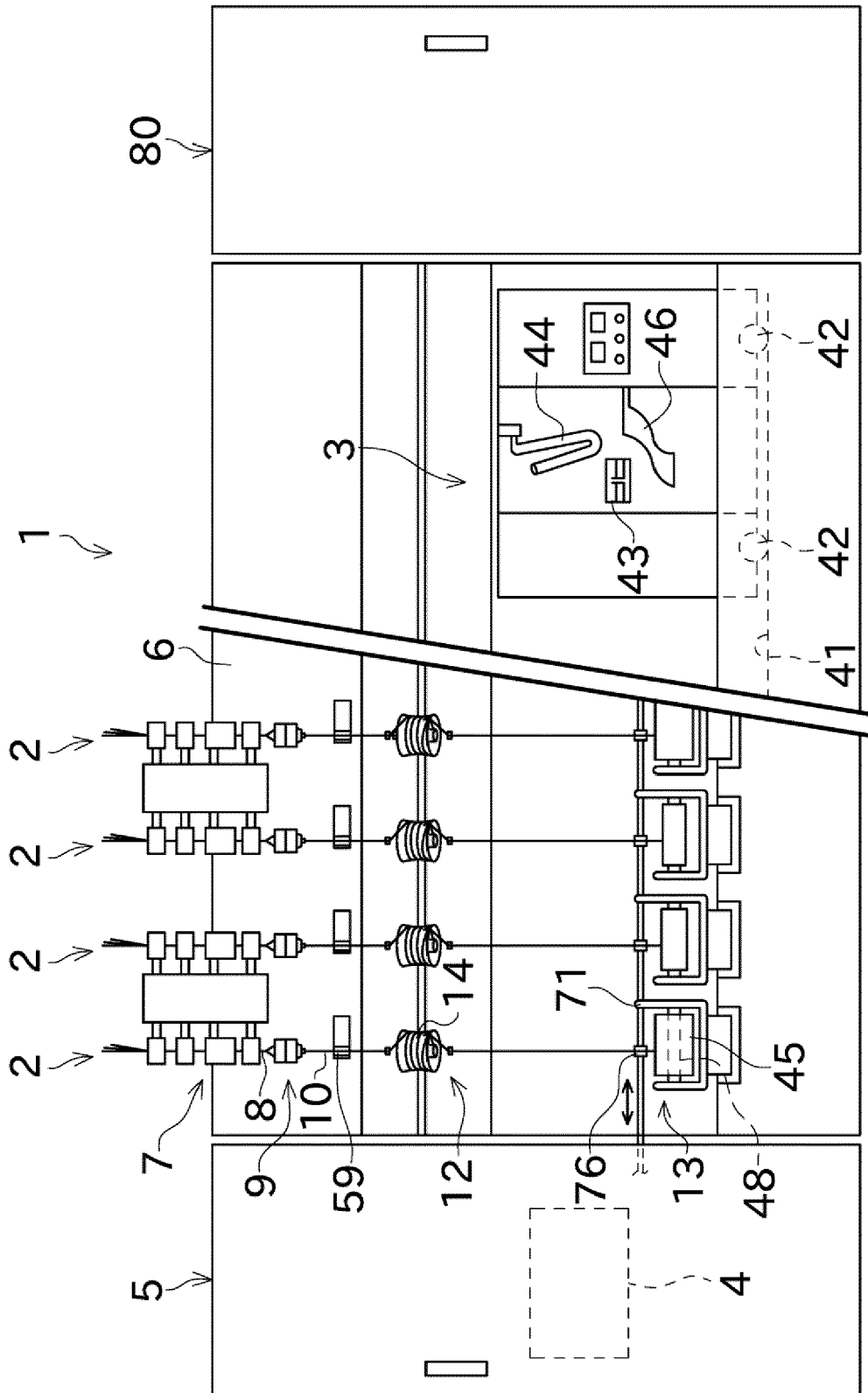


Fig.2

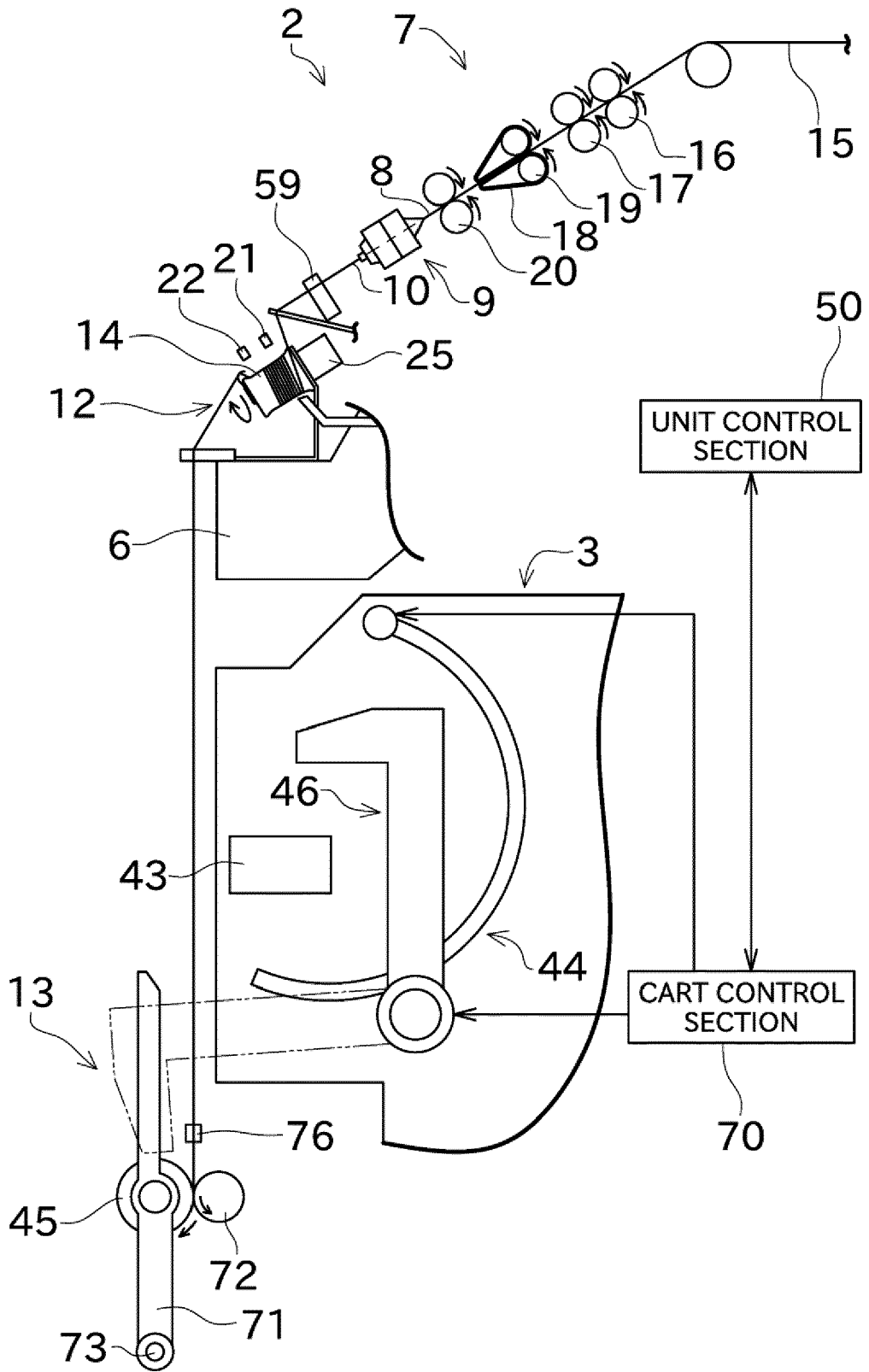
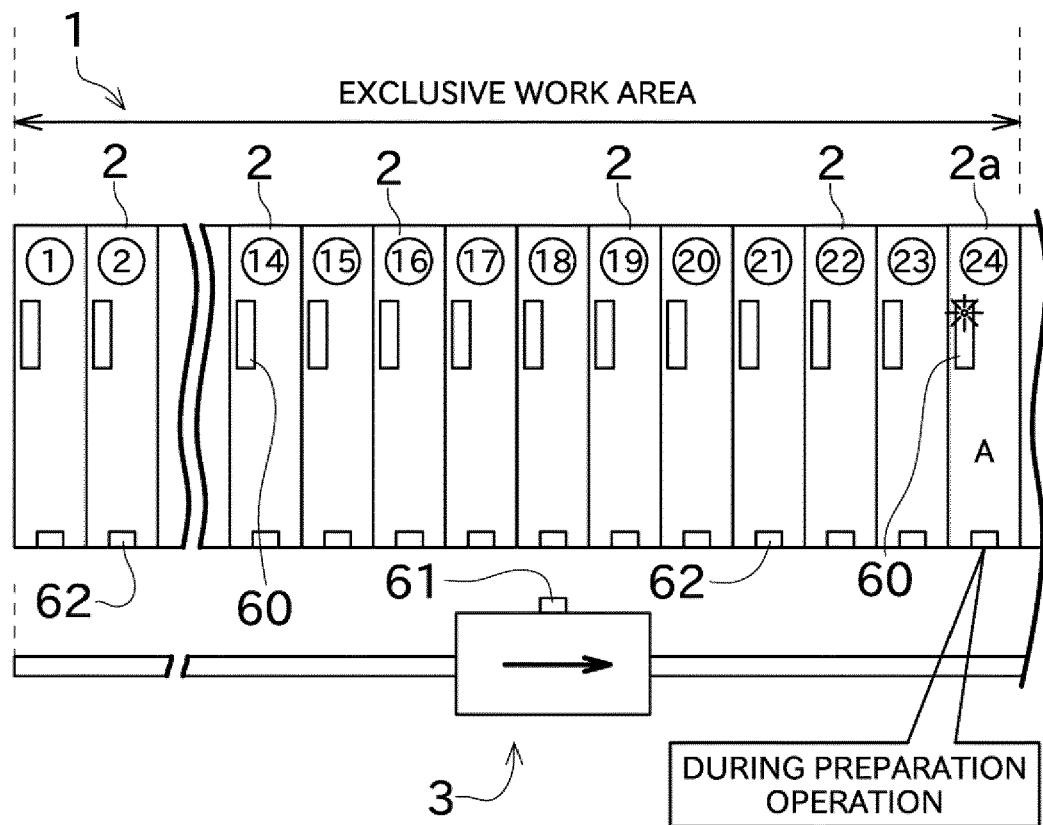


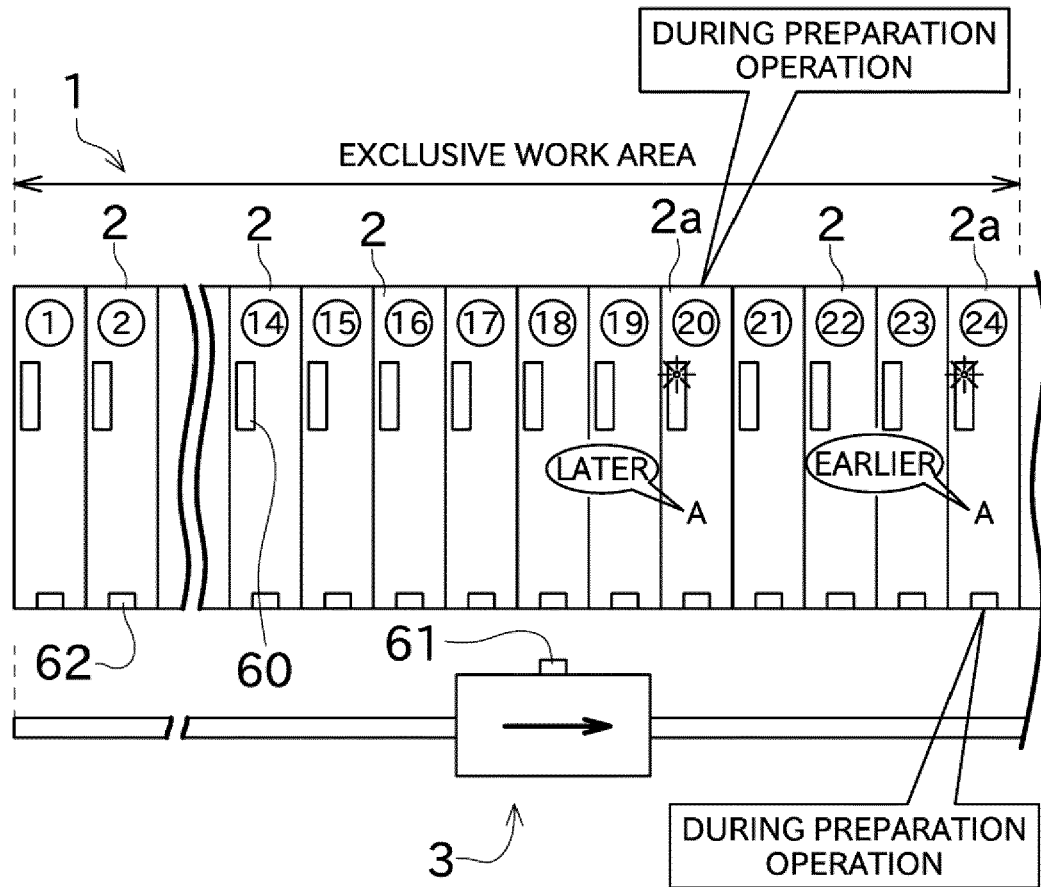


Fig.3



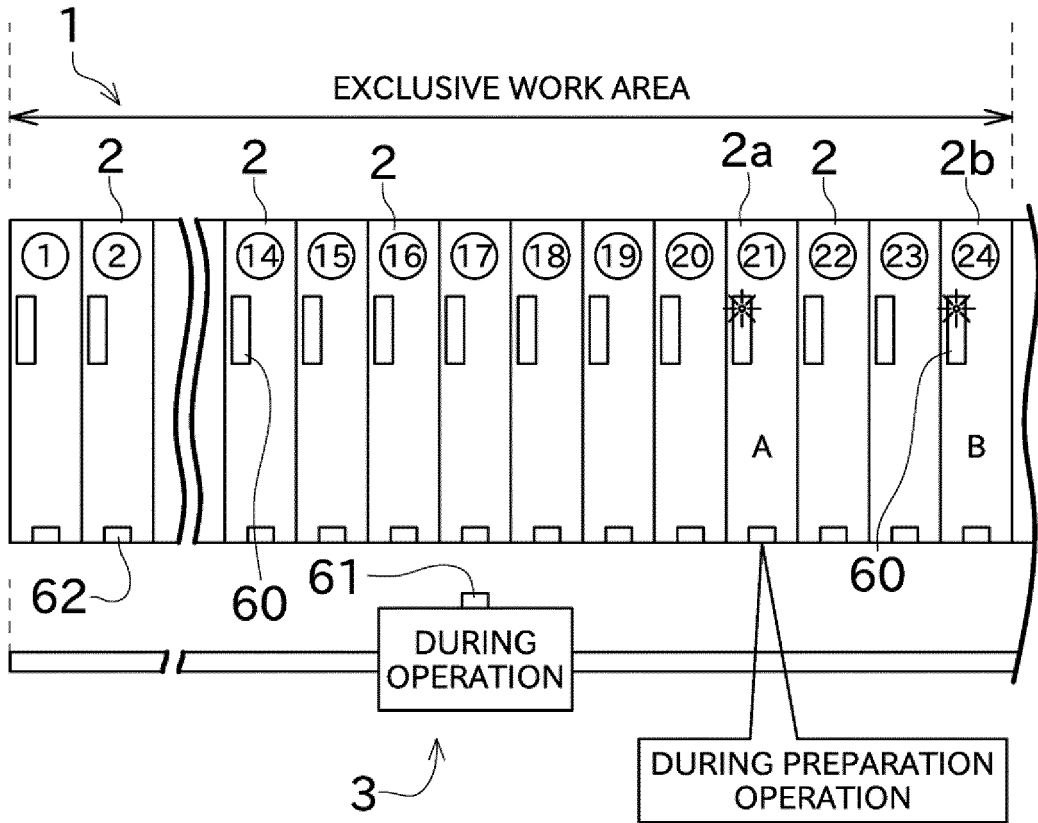
A : YARN JOINING NOTICE

Fig.4



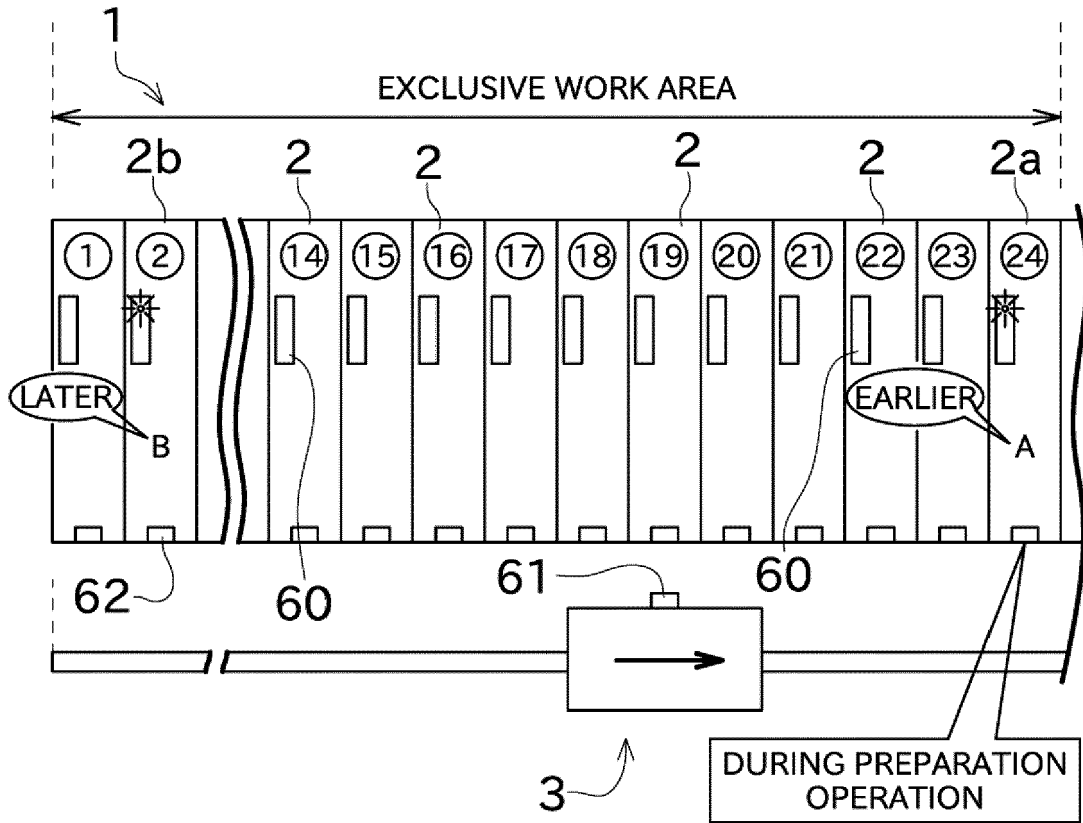
A : YARN JOINING NOTICE

Fig.5



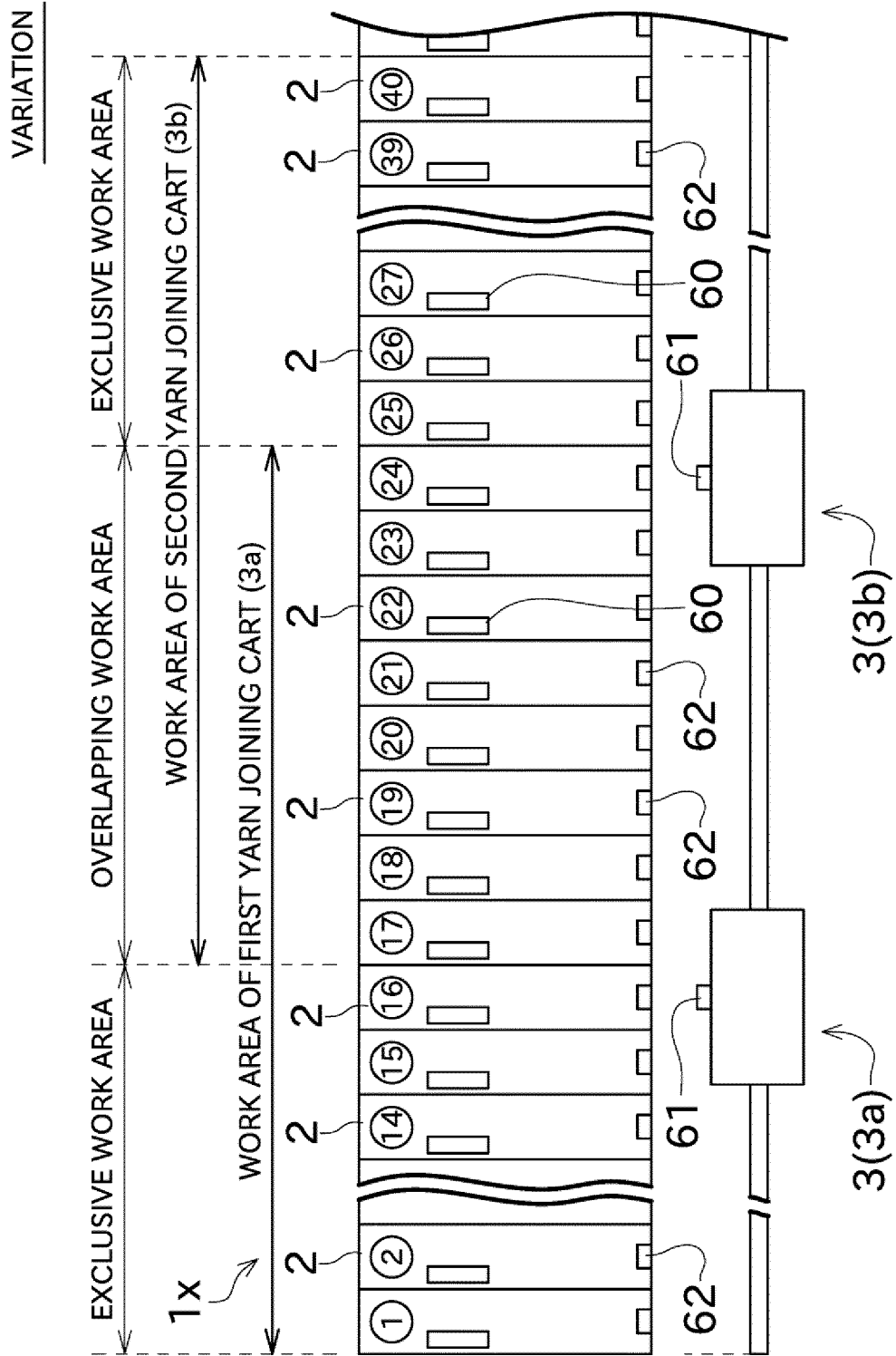
A : YARN JOINING NOTICE  
B : PREPARATION COMPLETED

Fig.6



A : YARN JOINING NOTICE  
B : PREPARATION COMPLETED

Fig.7





EUROPEAN SEARCH REPORT

Application Number  
EP 19 17 1007

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 18 September 2019	Examiner Pussemier, Bart
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