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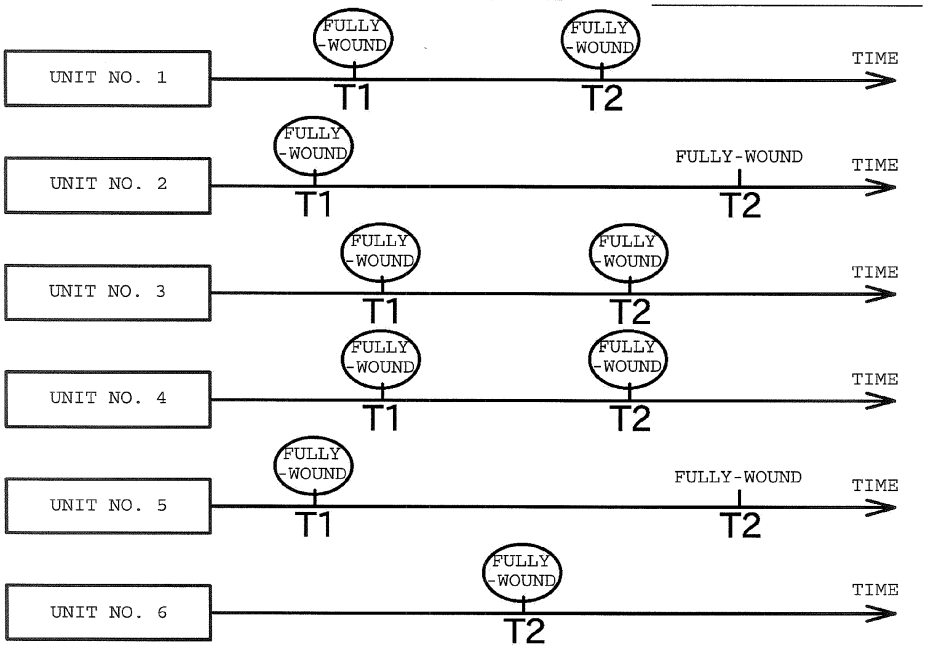
(54) Yarn winding machine

(57) A yarn winding machine (1) includes a plurality of winding units (2) and a control section (30). Each of the plurality of winding units (2) winds a package (45). The control section (30) controls the plurality of the winding units (2). The control section performs a control to calculate a winding-end expected time of the package in each of the winding units. The control section performs a control to store a produced quantity indicating a quantity of the package of which winding has been completed, and when a difference between the produced quantity and an expected production quantity is equal to or less than a predetermined value, to determine whether or not to supply a new bobbin (48) to the winding units in accordance with the winding-end expected time.

FIG. 4A PRESENT EMBODIMENT



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding machine adapted to wind a package in each of a plurality of winding units.

2. Description of the Related Art

[0002] Conventionally, there is known a yarn winding machine including a doffing device adapted to discharge a fully-wound package and the like. Japanese Unexamined Patent Publication No. 8-109527 (Patent Document 1), Japanese Unexamined Patent Publication No. 63-92577 (Patent Document 2), and Japanese Unexamined Patent Publication No. 2011-162351 (Patent Document 3) disclose a yarn winding machine including the doffing device.

[0003] Patent Document 1 discloses a control to efficiently move the doffing device (doffing cart). In the yarn winding machine of Patent Document 1, a timing at which a package becomes fully wound in each winding unit (spinning machine) is predicted, and in accordance with predicted information, for example, the doffing device travels to the winding unit in which the package is immediately before a fully-wound state. Thus, a time during which each winding unit waits for the doffing device can be reduced, and a winding efficiency of the yarn winding machine can be improved.

[0004] Patent Document 2 discloses a yarn winding machine adapted to prevent a large number of packages which are partially wound (partially-wound packages) from remaining upon change of lots. In the yarn winding machine of Patent Document 2, a yarn quantity for one lot and a necessary remaining yarn quantity are obtained, and only a number of the winding units comparable to the remaining yarn quantity is operated. Furthermore, Patent Document 2 describes that a time required for obtaining one fully-wound package differs depending on the number of times of yarn breakages and other troubles.

[0005] Patent Document 3 discloses a control to prevent supplying of a new bobbin to the winding unit after receiving a lot-change signal.

[0006] As described in Patent Document 2, a winding efficiency is known to differ among the winding units. However, Patent Document 1 merely discloses the control for the travelling of the doffing cart, and does not mention about a control that takes into consideration the winding efficiency of the winding unit. Patent Documents 2 and 3 also do not disclose a control for selecting the winding unit to perform the winding operation in accordance with the winding efficiency.

[0007] Thus, the conventional yarn winding machine still requires improvement in the winding efficiency of the entire yarn winding machine.

BRIEF SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a yarn winding machine adapted to efficiently produce packages using the fact that a winding efficiency differs among winding units.

[0009] This object is achieved by a yarn winding machine according to claim 1.

[0010] According to a first aspect of the present invention, a yarn winding machine includes a plurality of winding units and a control section. Each of the winding units is adapted to wind a package. The control section is adapted to control the plurality of the winding units. The control section is adapted to perform a control to calculate a winding-end expected time of the package in each of the winding units. The control section is also adapted to perform a control to store a produced quantity indicating a quantity of the package of which winding has been completed, and when a difference between the produced quantity and an expected production quantity is equal to or less than a predetermined value, to determine whether or not to supply a new bobbin to the winding units in accordance with the winding-end expected time.

[0011] Thus, how many packages are to be wound in which winding unit can be determined in accordance with the winding-end expected time, and the winding efficiency of the entire yarn winding machine can be improved.

[0012] In the yarn winding machine described above, the control section is adapted to calculate a first winding-end expected time and a second winding-end expected time. The first winding-end expected time is an expected time of completion of winding of the package currently being wound in each of the winding units. The second winding-end expected time is an expected time of completion of winding of an additional package if each of the winding units winds the additional package.

[0013] Thus, how many packages are to be wound in which winding unit can be rationally determined in accordance with a specific time of completion of winding of the package, and the winding efficiency of the entire yarn winding machine can be further improved.

[0014] In the yarn winding machine described above, the control section preferably calculates the winding-end expected time in accordance with a winding efficiency of each of the winding units within a predetermined period of time.

[0015] Thus, a highly appropriate winding-end expected time can be obtained, and the winding efficiency of the entire yarn winding machine can be further improved.

[0016] In the yarn winding machine described above, when each of the winding units completes winding of the package, the control section preferably calculates the winding-end expected time of at least such a winding unit.

[0017] Thus, the winding-end expected time can be updated in accordance with the most recent information, and a highly appropriate winding-end expected time can

be calculated.

[0018] The yarn winding machine described above further preferably includes a doffing device adapted to perform a doffing operation to the plurality of the winding units to discharge the package of which the winding has been completed, and to perform a bobbin setting operation to the plurality of the winding units to supply the bobbin.

[0019] Thus, in the yarn winding machine including the doffing device, the efficiency of the entire yarn winding machine can be improved.

[0020] In the yarn winding machine described above, a priority order of the plurality of the winding units is preferably set in accordance with the winding-end expected time of each of the winding units, and the doffing device is preferably controlled to supply the bobbin to the winding units according to the priority order.

[0021] Thus, the bobbin can be supplied in order to the winding units with early winding-end expected time, and the efficiency of the entire yarn winding machine can be further improved.

[0022] In the yarn winding machine described above, when a number of the winding units performing the winding becomes the predetermined number or less, the control section preferably prohibits the doffing device from supplying the bobbin after discharging the package of which winding has been completed from each of the winding units.

[0023] Thus, after reaching the expected production quantity, the winding can be automatically interrupted.

[0024] In the yarn winding machine described above, the control section preferably calculates a winding efficiency of each of the winding units within a predetermined period of time, and prevents the winding unit of which the winding efficiency is a predetermined efficiency or lower from performing the winding of the package.

[0025] By interrupting the winding in the winding unit of which the winding efficiency is low, maintenance and the like can be carried out in such a winding unit.

[0026] The yarn winding machine described above further preferably includes an input section adapted to input the expected production quantity.

[0027] Thus, an operator can easily correct the expected production quantity according to change in production plan and the like.

[0028] According to a second aspect of the present invention, a yarn winding machine includes a plurality of winding units and a control section. Each of the winding units is adapted to wind a package. The control section is adapted to control the plurality of the winding units. The control section is adapted to store a produced quantity indicating a quantity of the package of which winding has been completed, and when a difference between the produced quantity and an expected production quantity becomes equal to or less than a predetermined value, to prevent the winding unit of which has been determined to have a low winding efficiency from winding the new package.

[0029] By prohibiting the winding of the package in the winding unit of which the winding efficiency is low, the package can be preferentially wound in the winding unit of which the winding efficiency is high, and the winding efficiency of the entire yarn winding machine can be improved.

[0030] According to a third aspect of the present invention, a yarn winding machine includes a plurality of winding units, a doffing device, and a control section. Each of the winding units is adapted to wind a package. The doffing device is adapted to perform a doffing operation to the plurality of the winding units to discharge the package of which the winding has been completed, and to perform a bobbin setting operation to the plurality of the winding units to supply the bobbin around which a yarn is to be wound. The control section is adapted to control the plurality of the winding units and the doffing device. Under a state in which at least one of the plurality of the winding units has completed winding of the package and is under standby, the control section is adapted to control the doffing device to supply the bobbin to a different one of the winding units in order to wind a remaining package that is to satisfy an expected production quantity.

[0031] Thus, the package can be preferentially wound in a desired winding unit, and the winding efficiency of the entire yarn winding machine can be improved.

[0032] In the yarn winding machine described above, each of the winding units includes a draft device, a spinning device, and a winding device. The draft device is adapted to draft a fiber bundle. The spinning device is adapted to spin the fiber bundle, drafted by the draft device, by a whirling airflow to produce a spun yarn. The winding device is adapted to wind the spun yarn produced by the spinning device into a package.

[0033] Thus, since an air jet spinning machine can perform spinning at a high-speed, the winding efficiency of the entire yarn winding machine can be further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034]

FIG. 1 is a front view illustrating an overall structure of a fine spinning machine according to one embodiment of the present invention;

FIG. 2 is a longitudinal cross-sectional view of the fine spinning machine;

FIG. 3 is a flowchart illustrating a control in an expected production quantity mode;

FIGS. 4A and 4B are views comparing a winding efficiency of the present embodiment and a winding efficiency of the prior art; and

FIG. 5 is a view describing a winding-end expected time according to an alternative embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0035] A fine spinning machine (yarn winding machine) according to one embodiment of the present invention will be described with reference to the drawings. "Upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of a yarn during spinning.

[0036] A fine spinning machine 1 as a yarn winding machine illustrated in FIG. 1 includes a plurality of winding units 2 arranged in line, a yarn joining cart 3, a doffing cart (doffing device) 4, a blower box 93, and a motor box 5.

[0037] The motor box 5 includes a machine control device (control section) 30. The machine control device 30 controls a plurality of the winding units 2. The machine control device 30 includes a color liquid crystal monitor 31 and an input section 32. When an operator performs an appropriate operation, the color liquid crystal monitor 31 displays information related to an operation status and/or a yarn quality of each of the winding units 2. The input section 32 includes a plurality of input keys. The input section 32 is used such that the operator can select information to be displayed on the color liquid crystal monitor 31. The input section 32 accepts transmission of an appropriate instruction to each of the winding units 2, setting of various types of conditions, and the like.

[0038] As illustrated in FIG. 1, each winding unit 2 includes a draft device 7, a spinning device 9, a yarn accumulating device 12, and a winding device 13 in this order from upstream to downstream. The draft device 7 is arranged in proximity to an upper end of a frame 6 of the fine spinning machine 1. A fiber bundle 8 fed from the draft device 7 is spun by the spinning device 9. A spun yarn 10 fed from the spinning device 9 passes through a yarn clearer 49, to be described later, and further passes through the yarn accumulating device 12. The spun yarn 10 is wound around a bobbin 48 by the winding device 13, and a package 45 is formed.

[0039] The draft device 7 drafts a sliver 15 to obtain the fiber bundle 8. As illustrated in FIG. 2, the draft device 7 includes four roller pairs, i.e., a back roller pair 16, a third roller pair 17, a middle roller pair 19 provided with apron belts 18, and a front roller pair 20.

[0040] Although a detailed structure of the spinning device 9 is not illustrated, the spinning device 9 of the present embodiment uses a whirling airflow to apply twists to the fiber bundle 8 to produce the spun yarn 10.

[0041] The yarn accumulating device 12 is arranged downstream of the spinning device 9. The yarn accumulating device 12 has a function of applying a predetermined tension on the spun yarn 10 to pull out the spun yarn 10 from the spinning device 9, a function of accumulating the spun yarn 10 fed from the spinning device 9 during a yarn joining operation by the yarn joining cart 3 to prevent slackening of the spun yarn 10, and a function of adjusting the yarn tension such that a fluctuation of the yarn tension at the downstream of the yarn accumulating device 12 is not transmitted towards the spinning device 9. As illustrated in FIG. 2, the yarn accumulating device 12 includes a yarn accumulating roller 21, a yarn engagement member 22, an upstream guide 23, and an electric motor 25.

[0042] The yarn engagement member 22 can be engaged with the spun yarn 10, and integrally rotates with the yarn accumulating roller 21 while being engaged with the spun yarn 10 to guide the spun yarn 10 to an outer peripheral surface of the yarn accumulating roller 21.

[0043] The yarn accumulating roller 21 winds the spun yarn 10 around the outer peripheral surface thereof to accumulate the spun yarn 10. The yarn accumulating roller 21 is rotatably driven at a constant rotation speed by the electric motor 25.

[0044] The yarn engagement member 22 is supported in a relatively rotatable manner with respect to the yarn accumulating roller 21. A torque (resistance torque) against a relative rotation with respect to the yarn accumulating roller 21 is applied to the yarn engagement member 22 by a torque generating means including a magnetic means, for example. Thus, when the yarn engagement member 22 is engaged with the spun yarn 10, if a tension applied to the spun yarn 10 is greater than the resistance toque, the yarn engagement member 22 rotates independently from the yarn accumulating roller 21 and the spun yarn 10 is unwound from the yarn accumulating roller 21. If the tension applied to the spun yarn 10 is less than the resistance torque, the yarn engagement member 22 integrally rotates with the yarn accumulating roller 21 and the spun yarn 10 is wound around the yarn accumulating roller 21.

[0045] The upstream guide 23 is arranged slightly upstream of the yarn accumulating roller 21. The upstream guide 23 appropriately guides the spun yarn 10 with respect to the outer peripheral surface of the yarn accumulating roller 21. The upstream guide 23 prevents the twist of the spun yarn 10 propagating from the spinning device 9 from being transmitted downstream of the upstream guide 23.

[0046] The yarn clearer 49 is arranged on a front side of the frame 6 of the fine spinning machine 1 at a position between the spinning device 9 and the yarn accumulating device 12. The spun yarn 10 from the spinning device 9 passes through the yarn clearer 49 before being wound by the yarn accumulating device 12. The yarn clearer 49 monitors a thickness of the travelling spun yarn 10. When a yarn defect of the spun yarn 10 is detected, the yarn clearer 49 transmits a yarn defect detection signal to a unit controller (not illustrated). In addition to thickness abnormality of the spun yarn 10, the yarn clearer 49 may detect presence or absence of foreign substances contained in the spun yarn 10.

[0047] When receiving the yarn defect detection signal from the yarn clearer 49, the unit controller stops the spinning by the spinning device 9 to cut the spun yarn 10, and also stops the draft device 7 and the like. The unit

controller also transmits a control signal to the yarn joining cart 3, and the yarn joining cart 3 travels to front of the relevant winding unit 2. Thereafter, the unit controller drives the spinning device 9 and the like again, the yarn joining cart 3 performs a yarn joining operation, and winding is resumed.

[0048] As illustrated in FIG. 1 and FIG. 2, the yarn joining cart 3 includes a splicer (yarn joining device) 43, a suction pipe 44, a suction mouth 46, and travel wheels 42. When yarn breakage or yarn cut occurs in a winding unit 2, the yarn joining cart 3 drives the travel wheels 42 and travels on a travelling rail 41. The travelling rail 41 is fixed to the frame 6. The yarn joining cart 3 stops in front of the winding unit 2 in which the yarn breakage or the yarn cut occurred, and performs the yarn joining operation.

[0049] The suction pipe 44 can swing vertically with an axis as a center. The suction pipe 44 sucks and catches a yarn end (upper yarn) from the spinning device 9, and guides the yarn end to the splicer 43. The suction mouth 46 can swing vertically with an axis as a center. The suction mouth 46 sucks and catches a yarn end (lower yarn) from the package 45 supported by the winding device 13, and guides the yarn end to the splicer 43. Although a description on a detailed configuration of the splicer 43 will be omitted, the upper yarn and the lower yarn are joined by applying twists to the yarn ends by the whirling airflow.

[0050] The winding device 13 includes a cradle 70. The cradle 70 includes a supporting shaft 73, a cradle arm 71, and bobbin holders. The cradle arm 71 can swing with the supporting shaft 73 as the center. The bobbin holders can hold both ends of the bobbin 48.

[0051] The winding device 13 includes a winding drum 74, and a traverse guide 76 capable of being engaged with the spun yarn 10. The winding drum 74 is driven while making contact with an outer peripheral surface of the bobbin 48 or an outer peripheral surface of the package 45. The winding device 13 drives the winding drum 74 with an electric motor (not illustrated) to rotate the package 45 making contact with the winding drum 74 while reciprocating the traverse guide 76 with a driving means (not illustrated), and the spun yarn 10 is wound while being traversed.

[0052] As illustrated in FIG. 1 and FIG. 2, the doffing cart 4 includes a bobbin setting device 60. The bobbin setting device 60 performs a bobbin setting operation of supplying the bobbin 48 to the cradle 70 to prepare for the winding of the spun yarn 10, and a doffing operation of detaching the fully-wound package (the package of which the winding has been completed) 45 from the cradle 70. Travel wheels 92 are provided in a lower portion of the doffing cart 4. When receiving an instruction to perform the bobbin setting operation and/or the doffing operation with respect to a certain winding unit 2, the doffing cart 4 travels along a travelling path 91 to the relevant winding unit 2. The travelling path 91 is formed on the frame 6. The doffing cart 4 stops in front of the instructed winding unit 2 and performs the bobbin setting operation or the doffing operation (or the both operations).

[0053] The bobbin setting device 60 includes a bobbin supply section 50 and a suction pipe 88 for performing the bobbin setting operation.

[0054] The suction pipe 88 is capable of swinging, and extending and contracting. The suction pipe 88 sucks and catches the spun yarn 10 from the spinning device 9, and guides the caught spun yarn 10 to the winding device 13.

[0055] The bobbin supply section 50 can swing with a swing shaft 111 as a center, and can grip the bobbin 48 with a bobbin gripping section 52. The doffing cart 4 swings the bobbin supply section 50 with the gripped bobbin 48, and supplies the bobbin 48 to the cradle 70.

[0056] The bobbin setting device 60 includes a transporting section 61 illustrated in FIG. 2 for performing the doffing operation. The transporting section 61 guides the fully-wound package 45 discharged from the cradle 70 to a receiving section 82 via an inclined section 81. The transporting section 61 includes a guiding plate 69 and a bobbin guiding cylinder 62.

[0057] The guiding plate 69 guides the package 45 while making contact with the outer peripheral surface of the fully-wound package 45 received from the cradle 70.

[0058] The bobbin guiding cylinder 62 can vertically swing the guiding plate 69 by extending and contracting the cylinder. The transporting section 61 can adjust a position of the guiding plate 69 when guiding the package 45, and stop rotation of the package 45 that continues to rotate due to inertia even after the winding of the package 45 has been completed.

[0059] Next, a description will be made on a control for producing the packages 45 in accordance with the winding efficiency of the winding unit 2.

[0060] In the present embodiment, a continuous production mode and an expected production quantity mode can be set. The continuous production mode is a mode in which the packages 45 are continuously produced until a predetermined instruction is given. The expected production quantity mode is a mode in which the packages 45 of a quantity specified in advance are produced. In the expected production quantity mode, the mode shifts to a normal mode, a unit selection mode, and a lot-change mode according to a progress status of the winding. In the following description, expressions such as a quantity of the package 45, a total quantity, an expected production quantity, and the like are concepts including the number, a weight, a total length, and the like of the package 45.

[0061] The operator operates the input section 32 to input or change the expected production quantity in the expected production quantity mode.

[0062] As illustrated in FIG. 3, the normal mode is set first. In the normal mode, the machine control device 30 controls each of the winding units 2 to perform the winding operation of the package 45 (step S101).

[0063] When the package 45 is fully wound in a certain winding unit 2, the machine control device 30 controls the doffing cart 4 to discharge the relevant package 45 from the winding unit 2 (step S102). Thereafter, the machine control device 30 updates and stores the produced quantity (step S103). The produced quantity is the total amount of packages 45 produced after the start of the present lot.

[0064] Next, the machine control device 30 calculates the winding efficiency of the winding unit 2 (step S104). The winding efficiency is the quantity of the packages 45 that can be produced per unit time, for example. The winding efficiency is calculated in accordance with the quantity of the packages 45 produced in each of the winding units 2 in the predetermined period of time. In order to calculate an accurate winding efficiency, the winding efficiency is calculated in a period of time excluding the time in which the winding is stopped. A specific example of the time in which the winding is stopped includes a time during maintenance, and a time during standby in the unit selection mode and the lot-change mode.

[0065] The machine control device 30 calculates the winding efficiency and also calculates the winding-end expected time (step S104).

[0066] The winding-end expected time is an expected time at which the winding unit 2 completes the winding of the package 45. In the present embodiment, the machine control device 30 calculates a first winding-end expected time and a second winding-end expected time. The first winding-end expected time is a time of completion of winding of the package 45 currently being wound. The second winding-end expected time is a time of completion of winding of the package 45 when an additional bobbin 48 is supplied.

[0067] For calculation of the first winding-end expected time, the progress status of the winding of the package 45 that is currently being wound, the quantity of the fully-wound packages 45, and the calculated winding efficiency are used. For calculation of the second winding-end expected time, the quantity of the fully-wound packages 45 and the winding efficiency are used.

[0068] FIG. 4A illustrates an example in which the winding-end expected time is calculated for the winding units 2 with unit Nos. 1 to 6. The arrow extending horizontally from the unit No. indicates time. A time denoted with reference numeral T1 or T2 below "fully-wound" written above the arrow indicates the winding-end expected time. Specifically, the time denoted with the reference numeral T1 is the first winding-end expected time, and the time denoted with the reference numeral T2 is the second winding-end expected time. With respect to the unit No. 6, since the illustrated state is a state after the discharge of the package 45 and before the supply of the bobbin 48, only the second winding-end expected time is illustrated. The machine control device 30 calculates the winding efficiency and the winding-end expected time in the above manner.

[0069] When the fully-wound package 45 is discharged from a certain winding unit 2, the winding efficiency and the winding-end expected time of only the relevant winding unit 2 may be updated, or the winding efficiency and the winding-end expected time of all the winding units 2 may be updated.

[0070] As a result of calculating the winding efficiency, for the winding unit 2 of which the winding efficiency is significantly low, the machine control device 30 immediately stops the winding of the package 45, and instructs the operator to perform maintenance. The instruction for maintenance may not be made immediately and may be made after the package 45 currently being wound is fully wound.

[0071] Next, the machine control device 30 determines whether or not a difference between the produced quantity and the expected production quantity (hereinafter referred to as a remaining package quantity) is equal to or less than a predetermined value (step S105). If the remaining package quantity is greater than the predetermined value, the machine control device 30 supplies a new bobbin 48 to the winding unit 2 from which the package 45 has been discharged, and again returns to the process of step S101 to continue the winding of the package 45.

[0072] If the remaining package quantity is equal to or less than the predetermined value, the machine control device 30 shifts from the normal mode to the unit selection mode. The unit selection mode is a mode in which the winding efficiency of the entire fine spinning machine 1 is improved by selecting the winding unit 2 to perform the winding (determining whether or not to supply a new bobbin 48) in accordance with the winding efficiency and the winding-end expected time.

[0073] Any value can be specified for the "predetermined value" in the determination of step S105. When variation in the winding efficiency of the winding unit 2 is large, the winding efficiency of the entire fine spinning machine 1 can be improved if the mode is shifted to the unit selection mode at an early stage, and thus the "predetermined value" may be set according to the variation in the winding efficiency.

[0074] After being shifted to the unit selection mode, the machine control device 30 selects the winding unit 2 to which a new bobbin 48 is to be supplied (step S106). This selection is carried out in accordance with the remaining package quantity and the winding-end expected time of each of the winding units 2.

[0075] The machine control device 30 of the present embodiment selects the winding unit 2 to which a new bobbin 48 is to be supplied in accordance with the first winding-end expected time and the second winding-end expected time. Specifically, if the remaining package quantity is nine in the example of FIG. 4A, since the winding of five packages 45 has already started, another four packages 45 is required to be produced. Thus, the machine control device 30 selects four winding units 2 in the order the second winding-end expected time is reached earlier. Accordingly, the winding units 2 with the unit Nos.

1, 3, 4, and 6 are selected. In this manner, the winding unit 2 to be supplied with a new bobbin 48 can be determined.

[0076] If the control based on the winding efficiency of the winding units 2 is not carried out, as is done in the prior art, a new bobbin 48 is supplied when the package 45 is fully wound and the expected production quantity is not yet reached. Therefore, as illustrated in FIG. 4B, the new bobbin 48 is supplied even after the package 45 is fully wound in the unit No. 2 and 5 of which the winding efficiency is low. As a result, the timing of reaching the expected production quantity becomes later than that in the present embodiment. In other words, by performing the control of the present embodiment, the winding efficiency of the entire fine spinning machine 1 can be improved as compared to the prior art.

[0077] Next, the machine control device 30 controls such that a new bobbin 48 is supplied to the winding unit 2 selected in step S106 to continue the production of the package 45 (step S107). Meanwhile, the machine control device 30 determines whether or not the remaining package quantity is equal to or less than the number of winding units 2 performing winding (step S108).

[0078] If the remaining package quantity is greater than the number of winding units 2 performing winding, a new bobbin 48 is required to be supplied. If the remaining package quantity is equal to or less than the number of winding units 2 performing winding, the expected production quantity can be reached without supplying a new bobbin 48. Therefore, in this case, the machine control device 30 shifts to the lot-change mode, and stops the supply of a new bobbin 48 (step S109).

[0079] Thereafter, the machine control device 30 controls such that the winding is performed in the winding unit 2, to which the bobbin 48 has already been supplied, to produce the packages 45 (step S110). The packages 45 of the expected production quantity are thereby produced.

[0080] Therefore, the present embodiment differs from the prior art in predicting the timing at which the winding is completed and determining whether or not to supply the bobbin 48 in accordance with the prediction. Therefore, in the present embodiment, as illustrated in Fig. 4A, the control which has not been possible in the prior art is carried out, e.g., a new bobbin 48 is supplied to the winding units 2 with the unit Nos. 1, 3, and 4 after the winding units 2 with the unit Nos. 2 and 5 complete the winding and start to be under standby.

[0081] As described above, the fine spinning machine 1 of the present embodiment includes a plurality of the winding units 2 and the machine control device 30. Each of the plurality of the winding units 2 is adapted to wind the package 45. The machine control device 30 controls the plurality of the winding units 2. The machine control device 30 performs a control to calculate a winding-end expected time of the package 45 in each of the winding units 2. The machine control device 30 stores the produced quantity indicating the quantity of the packages 45 of which the winding has been completed. When a difference between the produced quantity and the expected production quantity becomes equal to or less than a predetermined value, the machine control device 30 determines whether or not to supply a new bobbin 48 to the winding units 2 in accordance with the winding-end expected time.

[0082] Thus, how many packages 45 is to be wound in which winding unit 2 can be determined in accordance with the winding-end expected time, and the winding efficiency of the entire fine spinning machine 1 can be improved.

[0083] In the fine spinning machine 1 of the present embodiment, the machine control device 30 calculates the first winding-end expected time and the second winding-end expected time. The first winding-end expected time is an expected time of completion of winding of the package 45 currently being wound in each of the winding units 2. The second winding-end expected time is an expected time of completion of winding of an additional package 45 if each of the winding units 2 winds the additional package 45.

[0084] Thus, how many packages 45 is to be wound in which winding unit 2 can be rationally determined in accordance with the specific time of completion of winding of the package 45, and the winding efficiency of the entire fine spinning machine 1 can be further improved.

[0085] In the fine spinning machine 1 of the present embodiment, the machine control device 30 calculates the winding-end expected time in accordance with the winding efficiency of each of the winding units 2 within a predetermined period of time.

[0086] Thus, the highly appropriate winding-end expected time is obtained, and the winding efficiency of the entire fine spinning machine 1 can be further improved.

[0087] The preferable embodiments of the present invention have been described above, but the configuration described above can be modified as below, for example.

[0088] As described above, the timing to shift to the unit selection mode is arbitrary. If shifted to the unit selection mode at an early stage, a third winding-end expected time may be obtained as illustrated in FIG. 5. In this case, the winding unit 2 (unit No. 4) to which the new bobbin 48 is not supplied, the winding units 2 (unit Nos. 2, 3, 5) to which a new bobbin 48 is supplied only once, and the winding units 2 (unit Nos. 1, 6) to which a new bobbin 48 is supplied only twice may be generated.

[0089] If the bobbin 48 can be supplied to any winding unit 2, the doffing cart 4 is not essential and may be omitted.

[0090] In the above description, the example has been described in which the calculation of the winding efficiency and the winding-end expected time is performed in advance in the normal mode, but such calculation may be carried out after the shift to the unit selection mode. After the shift to the unit selection mode, the winding efficiency and the winding-end expected time may be calculated and updated each time the package 45 becomes

fully wound in a certain winding unit 2. In this case, for example, when the winding efficiency of a certain winding unit 2 has decreased, the winding unit 2 under standby may be newly operated.

[0091] The winding unit 2 that performs the winding in the unit selection mode may be changed according an input to the input section 32 made by the operator.

[0092] An application range of the present invention is not limited to the fine spinning machine, and may be applied to other yarn winding machines (automatic winder, open end fine spinning machine, and the like) as long as such yarn winding machines have a configuration of discharging and supplying the bobbin.

Claims

1. A yarn winding machine (1) comprising:

a plurality of winding units (2), each being adapted to wind a package (45); and
a control section (30) adapted to control the plurality of the winding units (2), the control section (30) being adapted to calculate a winding-end expected time of the package (45) in each of the winding units (2), to store a produced quantity indicating a quantity of the packages (45) of which winding has been completed, and, when a difference between the produced quantity and an expected production quantity is equal to or less than a predetermined value, to determine whether or not to supply a new bobbin (48) to the winding units (2) in accordance with the winding-end expected time.

2. The yarn winding machine (1) according to claim 1, wherein as the winding-end expected time, the control section (30) is adapted to calculate a first winding-end expected time, which is an expected time of completion of winding of the package (45) currently being wound in each of the winding units (2), and a second winding-end expected time, which is an expected time of completion of winding of an additional package (45) if each of the winding units (2) winds the additional package (45).

3. The yarn winding machine (1) according to claim 1 or claim 2, wherein the control section (30) is adapted to calculate the winding-end expected time in accordance with a winding efficiency of each of the winding units (2) within a predetermined period of time.

4. The yarn winding machine (1) according to any one of claim 1 through claim 3, wherein when each of the winding units (2) completes winding of the package (45), the control section (30) is adapted to calculate the winding-end expected time of at least such a winding unit (2).

5. The yarn winding machine (1) according to any one of claim 1 through claim 4, further comprising a doffing device (4) adapted to perform a doffing operation to the plurality of the winding units (2) to discharge the package (45) of which the winding has been completed, and to perform a bobbin setting operation to the plurality of the winding units (2) to supply the bobbin (48).

6. The yarn winding machine (1) according to claim 5, wherein the control section (30) is adapted to set a priority order of the plurality of the winding units (2) in accordance with the winding-end expected time of each of the winding units (2), and to control the doffing device (4) to supply the bobbin (48) to the winding units (2) according to the priority order.

7. The yarn winding machine (1) according to claim 5 or claim 6, wherein when a number of the winding units (2) performing the winding becomes the predetermined number or less, the control section (30) is adapted to prohibit the doffing device (4) from supplying the bobbin (48) after discharging the package (45) of which winding has been completed from each of the winding units (2).

8. The yarn winding machine (1) according to any one of claim 1 through claim 7, wherein the control section (30) is adapted to calculate a winding efficiency of each of the winding units (2) within a predetermined period of time, and to prevent the winding unit (2) of which the winding efficiency is a predetermined efficiency or lower from performing the winding.

9. The yarn winding machine (1) according to any one of claim 1 through claim 8, further comprising an input section (32) adapted to input the expected production quantity.

10. The yarn winding machine (1) according to any one of claim 1 through claim 9, wherein:

the control section (30) is adapted to prevent the winding unit (2) of which has been determined to have a low winding efficiency from winding the new package (45), when a difference between the produced quantity and the expected production quantity becomes equal to or less than a predetermined value.

11. A yarn winding machine (1) according to any one of claim 1 through claim 9, comprising:

a doffing device (4) adapted to perform a doffing operation to the plurality of the winding units (2) to discharge the package (45) of which the wind-

ing has been completed, and to perform a bobbin setting operation to the plurality of the winding units (2) to supply the bobbin (48) around which a yarn (10) is to be wound;
wherein under a state in which at least one of the plurality of the winding units (2) has completed winding of the package (45) and is under standby, the control section (3) is adapted to control the doffing device (4) to supply the bobbin (48) to a different one of the winding units (2) in order to wind a remaining package (45) that is to satisfy an expected production quantity.

12. The yarn winding machine (1) according to any one of claim 1 through claim 11, wherein each of the winding units (2) includes:

a draft device (7) adapted to draft a fiber bundle (15);
a spinning device (9) adapted to spin the fiber bundle (15), drafted by the draft device (7), by a whirling airflow to produce a spun yarn (10); and
a winding device (13) adapted to wind the spun yarn (10) produced by the spinning device (9) into a package (45).

FIG. 1

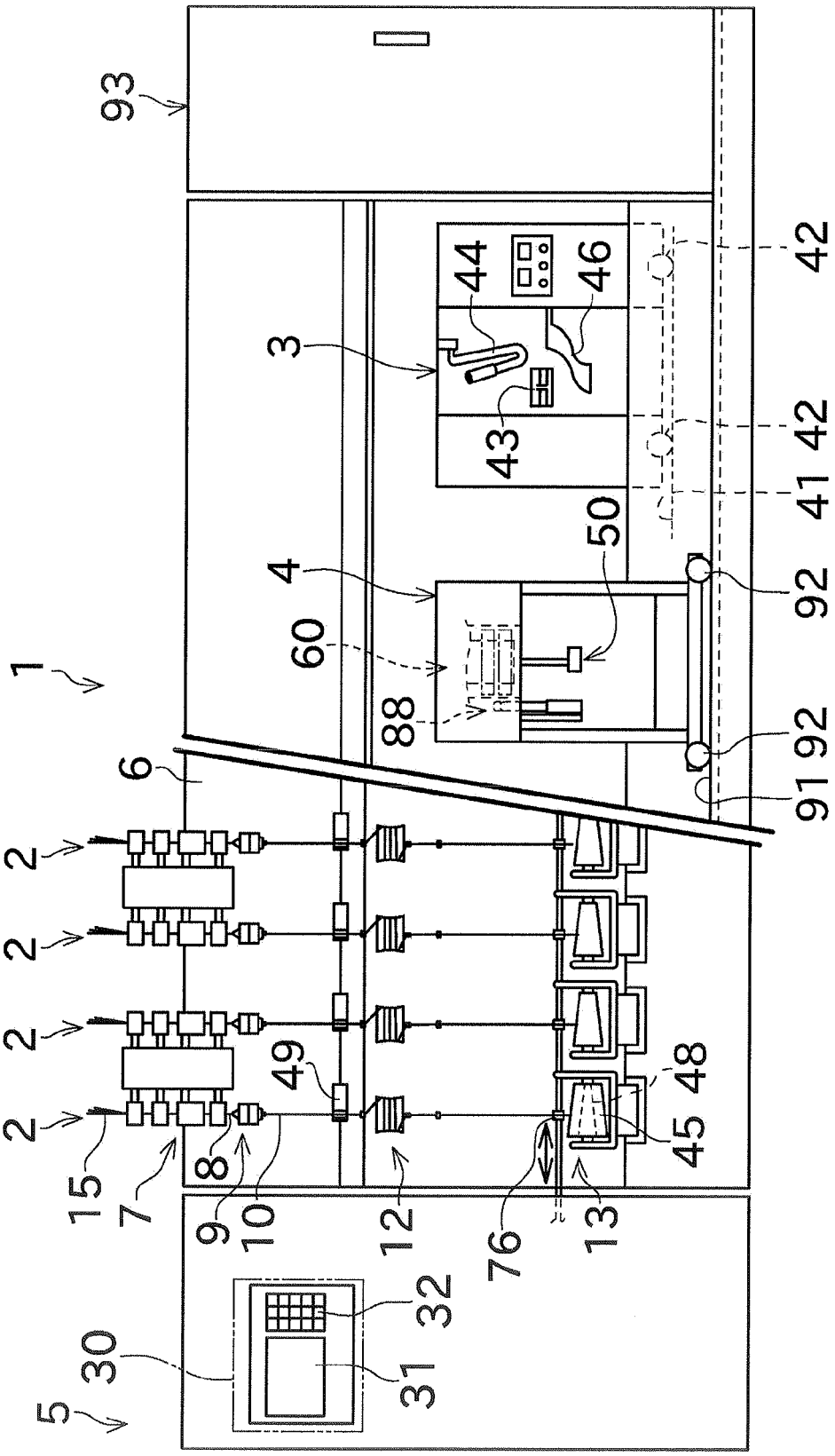
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FIG. 2

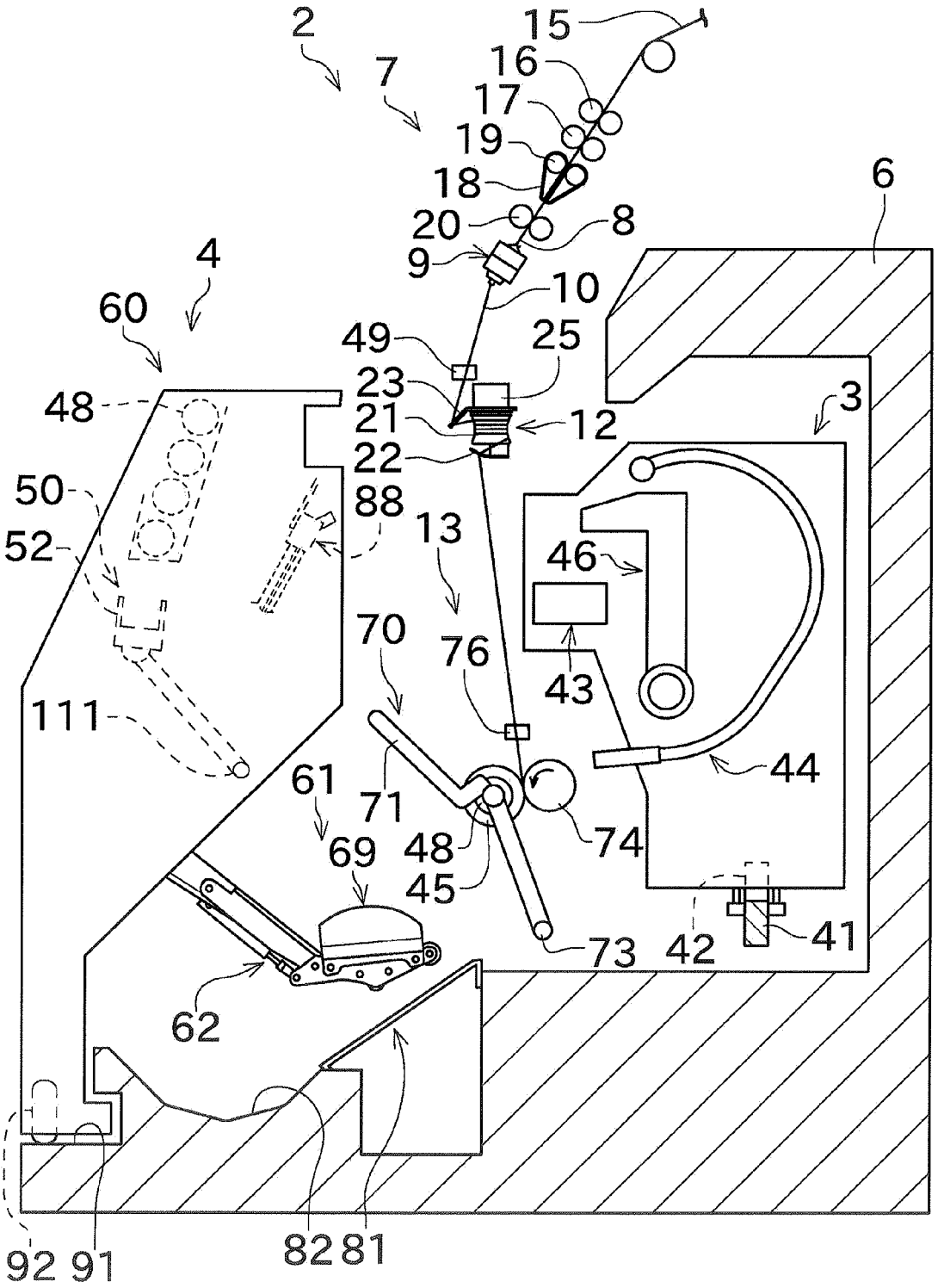
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FIG. 3 EXPECTED PRODUCTION QUANTITY MODE

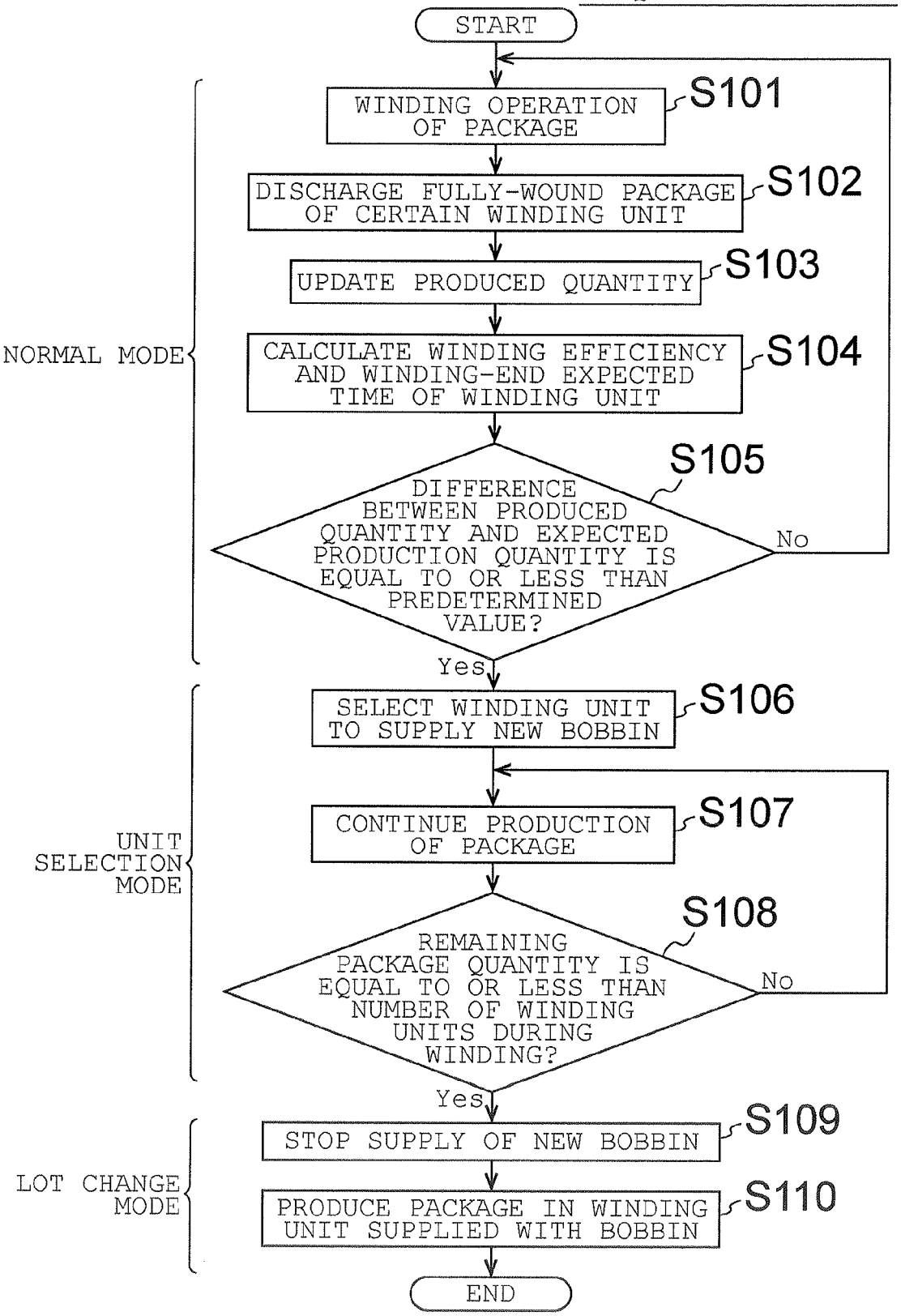


FIG. 4A PRESENT EMBODIMENT

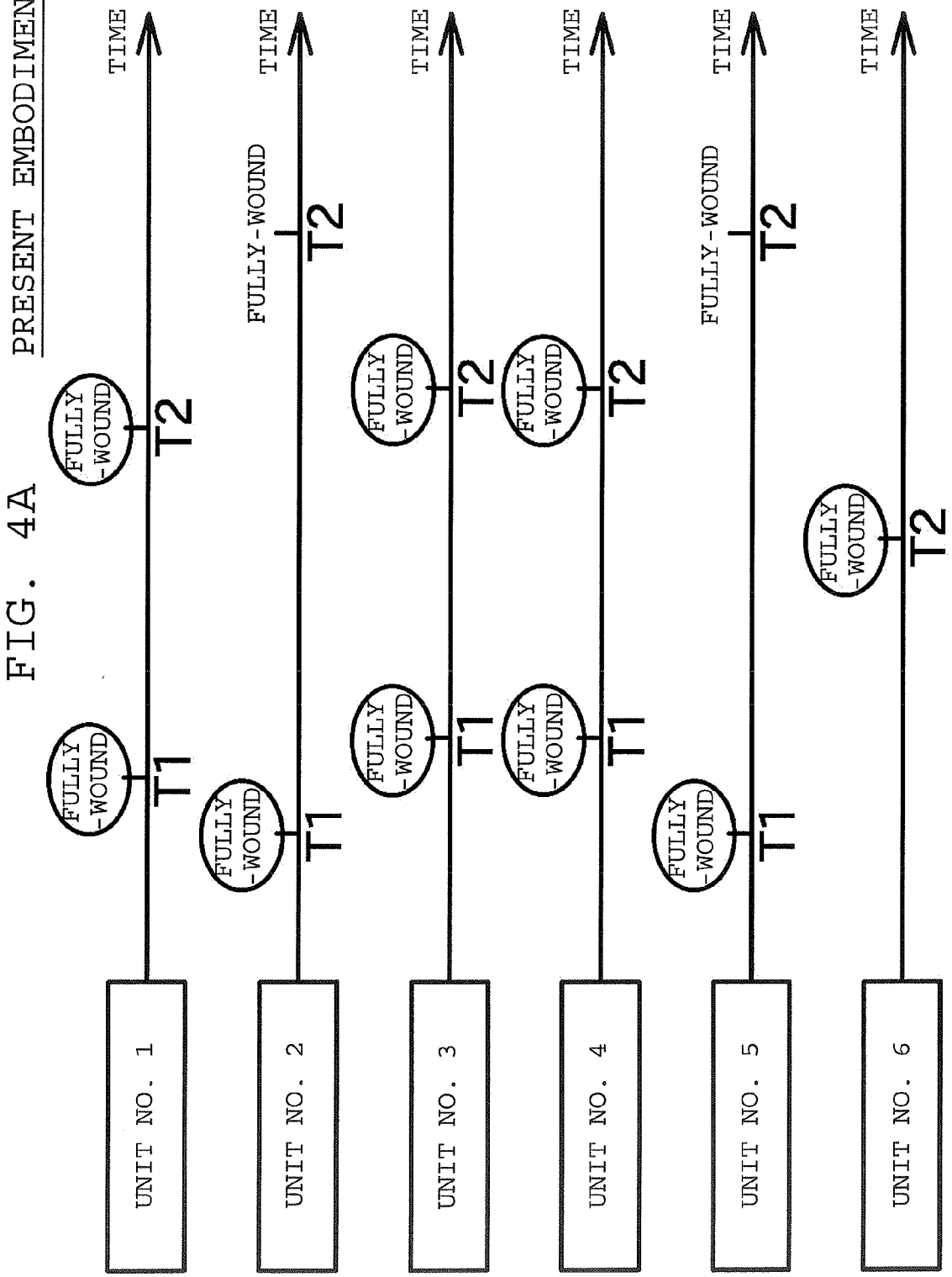


FIG. 4B

PRIOR ART EXAMPLE

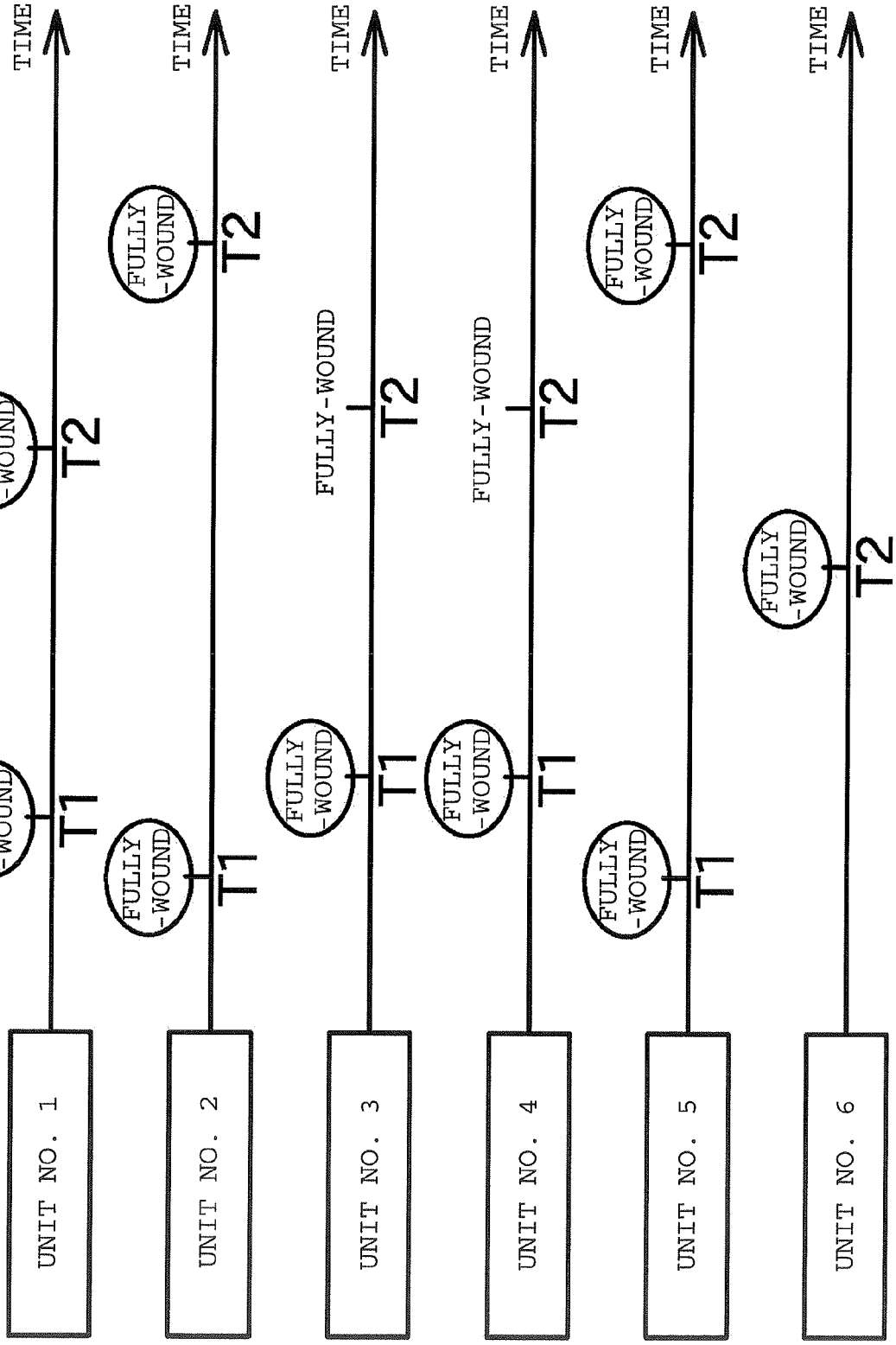
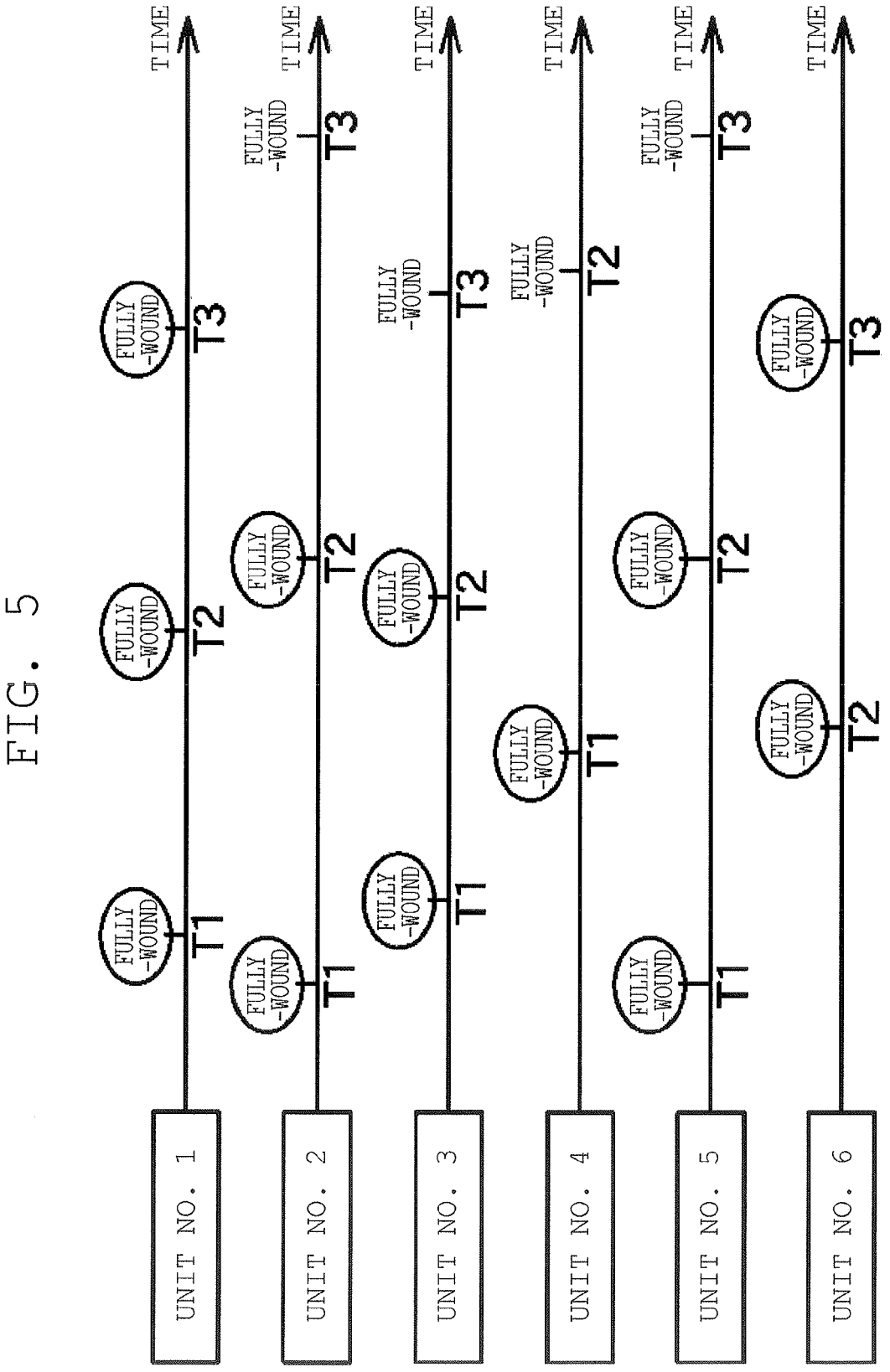


FIG. 5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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 2429

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 September 2014	Pussemier, Bart

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