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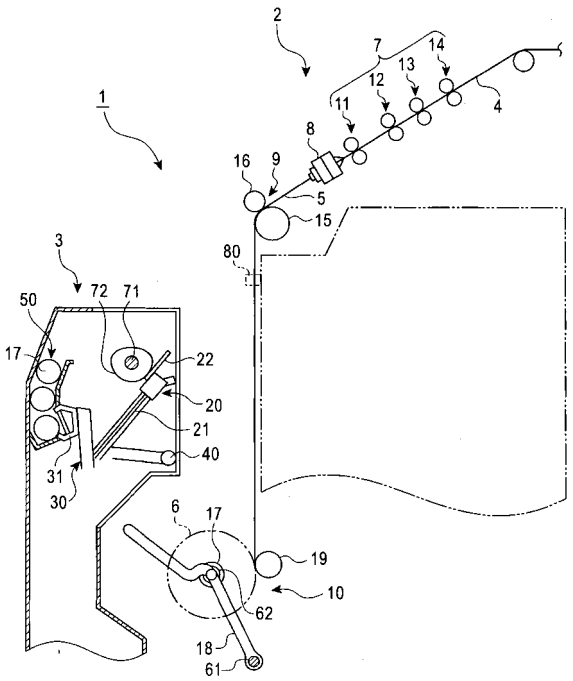
(54) Method for automatic doffing operation and doffing apparatus

(57) The present invention relates to an automatic doffing operation. Conventionally if in spite of a failure in a yarn drawing-out operation, a yarn hooking operation is performed and an empty bobbin is uselessly supplied, an operator is thus forced to remove the bobbin. The present invention includes a full-package taking-out operation step of taking a bobbin (17) with a package (6) out of a cradle, a yarn drawing-out operation step of using a yarn drawing-out device (20) to start drawing out a spun yarn and then catching the spun yarn, and a yarn hooking operation step of supplying an empty bobbin (17) to the cradle and hooking the spun yarn on the bobbin (17) to return a doffing operation to an initial state. If the yarn fails to be caught during the yarn drawing-out operation step, a reverse returning step is executed instead of the yarn hooking operation step to reversely rotate a motor to return the doffing operation to its initial state without executing the yarn hooking operation step.

FIG. 1



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Description

Field of the Invention

[0001] The present invention relates to a technique for a method for an automatic doffing operation performed by a doffing apparatus on a target apparatus comprising a yarn drawing-out device and a winding device comprising a cradle, the doffing apparatus comprising a bobbin transfer device, an air sucking yarn catching device, and a cradle operating device which are driven in unison with one another by a single motor. The present invention also relates to a technique for the doffing apparatus.

Background of the Invention

[0002] A known textile machine comprising a yarn drawing-out device and a winding device includes an apparatus (automatic doffing apparatus) that automatically takes out a fully winding package, supplies an empty bobbin for replacement, and hooks a yarn on the empty bobbin. This corresponds to, for example, the technique disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) 2001-254235.

[0003] The textile machine disclosed in the Unexamined Japanese Patent Application Publication (Tokkai) 2001-254235 is a spinning machine comprising a draft device, a yarn drawing-out device composed of air injecting nozzles, and a winding device comprising a cradle. The spinning machine further comprises a large number of spinning units arranged in a line and a doffing carriage that moves in the direction in which the spinning units are arranged in a line. The doffing carriage performs doffing operations.

[0004] A conventional method for an automatic doffing operation is composed of a cyclic process (cycle). Accordingly, the cycle is ensured to be repeated whether or not it succeeds. Here, the doffing operation method involves performing a series of operations including a full-package taking-out operation of taking out a full package, a yarn drawing-out operation of drawing out a new yarn, and a yarn hooking operation of hooking the taken-out spun yarn on a replaced empty bobbin. Thus, even if the yarn drawing-out operation fails, the doffing operation is not interrupted and the yarn hooking operation is performed. An empty bobbin is thus supplied to the winding device. If no measures are taken for the empty bobbin and a subsequent doffing operation succeeds, it is transferred along the same route as that along which full packages are transferred. Accordingly, an operator must manually remove the empty bobbin.

[0005] Further, the yarn hooking operation requires a relatively long time. If the yarn hooking operation is performed in spite of a failure in the yarn drawing-out operation, the time required for the yarn hooking operation is wasteful. In particular, if the textile machine is configured so that a single doffing apparatus serves a plurality of target apparatuses (for example, spinning apparatuses for a single spinning unit), the production efficiency of the whole textile machine decreases with increasing time for which the doffing apparatus is bound by a particular target apparatus.

[0006] That is, a problem to be solved is that when, during the automatic doffing operation, the yarn hooking operation is continuously performed in spite of a failure in the yarn drawing-out operation, an empty bobbin is uselessly supplied, thus forcing the operator to remove the empty bobbin from the winding device.

Summary of the Invention

[0007] A description has been given of the problem to be solved. Now, a description will be given of means for solving the problem.

[0008] According to Claim 1, the present invention provides a method for an automatic doffing operation performed by a doffing apparatus on a target apparatus comprising a yarn drawing-out device and a winding device comprising a cradle, the method comprising a full-package taking-out operation step of taking a bobbin with a package out of the cradle, a yarn drawing-out operation step of using the yarn drawing-out device to start drawing out a spun yarn and then catching the spun yarn, and a yarn hooking operation step of supplying an empty bobbin to the cradle and hooking the spun yarn on the bobbin to return the doffing operation to an initial state, and wherein when the spun yarn fails to be caught during the yarn drawing-out operation step, a returning step is executed instead of the yarn hooking operation step, the returning step returning the doffing operation to the initial state without executing the yarn hooking operation step.

[0009] According to Claim 2, the doffing apparatus comprises an air sucking yarn catching device, a bobbin transfer device, and a cradle operating device which are driven in unison with one another by a single motor, and in the full-package taking-out operation step, the motor is normally rotated to cause the cradle operating device to take a bobbin with a package out of the cradle, and in the yarn drawing-out operation step, with the motor stopped, the yarn drawing-out device starts drawing out the spun yarn and the air sucking yarn catching device catches the spun yarn, and in the yarn hooking operation step, the motor is further normally rotated to cause the bobbin transfer device to supply an empty bobbin to the cradle, and the spun yarn caught by the air sucking yarn catching device is hooked on the bobbin to return the doffing operation to the initial state, and in the returning step, the motor is reversely rotated to return the doffing operation to the initial state without executing the yarn hooking operation step.

[0010] According to Claim 3, the yarn drawing-out operation step is executed a predetermined plural number of times until the air sucking yarn catching device successfully catches the spun yarn.

[0011] According to Claim 4, the doffing apparatus is configured to be able to travel between a plurality of target

apparatuses, and one doffing apparatus performs a doffing operation in response to a doffing operation request from the target apparatus.

[0012] The present invention exerts the effects described below.

[0013] According to Claim 1, the situation is avoided in which an empty bobbin is supplied to the winding device in spite of a failure in the yarn drawing-out operation, thus forcing an operator to remove the bobbin.

[0014] According to Claim 2, not only the effect of Claim 1 is produced but the same driving source also drives those devices in the doffing apparatus which relate to the full-package taking-out operation, yarn drawing-out operation, and yarn hooking operation. This simplifies the configuration of the apparatus.

[0015] According to Claim 3, no only the effect of Claim 1 or Claim 2 is produced but the rate of success in the automatic doffing operation performed by the doffing apparatus is also improved. If the doffing operation succeeds without any maintenance operation performed by the operator, the operator need not perform any troublesome operations.

[0016] According to Claim 4, no only the effect of any one of Claims 1 to 3 is produced but it is also unnecessary to perform the yarn drawing-out operation when the doffing operation fails; the yarn drawing-out operation accounts for a relatively high rate of the total time required for the process constituting the doffing operation. This reduces the time for which the doffing apparatus is bound by a particular target apparatus. Therefore, the operating efficiency of the whole apparatus is improved.

Brief Description of the Drawings

[0017]

Figure 1 is a side view of a spinning machine in accordance with the present embodiment.

Figure 2 is a side view of a doffing apparatus.

Figure 3 is a schematic diagram showing a driving mechanism for a suction arm, a bobbin chucker, and a cradle operating arm.

Figure 4 is a flowchart showing a schematic procedure of a method for a doffing operation.

Figure 5 is a flowchart of a doffing operation.

Figure 6 is a side view showing a doffing apparatus in a standby state.

Figure 7 is a side view showing the doffing apparatus during a yarn drawing-out operation.

Figure 8 is a side view showing the doffing apparatus during a yarn hooking operation.

Figure 9 is a time chart of the doffing operation, wherein Figure 9(a) shows that the doffing operation has succeeded as a result of the first yarn drawing-out operation, Figure 9(b) shows that the doffing operation has succeeded as a result of the second yarn drawing-out operation, and Figure 9(c) shows that the doffing operation has failed.

Detailed Description of the Preferred Embodiments

[0018] With reference to the drawings, a description will be given of an embodiment of a method for an automatic doffing operation and a doffing apparatus implementing the method according to the present invention. The present embodiment is a method and apparatus for an automatic doffing apparatus which is applied to a spinning machine 1. The spinning machine 1 is an apparatus comprising a yarn drawing-out device composed of a draft device 7 and a pneumatic spinning device 8, and a winding device 10.

[0019] The spinning machine 1 in accordance with the present embodiment will be described with reference to Figure 1. The spinning machine 1 comprises a large number of spinning units 2 each relating to manufacture of a spun yarn, and a doffing apparatus 3 that performs a doffing operation on each spinning unit 2 and which is shared by a plurality of spinning units 2. Figure 1 is as viewed from the direction in which the spinning units 2 are arranged in a line. A large number of spinning units 2 are arranged in a direction perpendicular to the sheet of the drawing. The doffing device 3 is movable in the direction in which the spinning units 2 are arranged in a line.

[0020] Each spinning unit 2 manufactures a spun yarn 5 using a sliver 4 supplied from a can (not shown in the drawing) and thus manufactures a winding package 6 of the spun yarn 5. The spinning unit 2 comprises a draft device 7, a pneumatic spinning device 8, a yarn feeding device 9, and a winding device 10.

[0021] The draft device 7 is of a four-line type and comprises four pairs of draft rollers that nip and draft (draw) the sliver 4. The four pairs of draft rollers include a front roller pair 11 (first line), a second roller pair 12 (second line), a third roller pair 13 (third line), and a back roller pair 14 (four line).

[0022] The pneumatic spinning device 8 utilizes a whirling air current to generate the spun yarn 5 from fibers constituting the sliver 4.

[0023] The yarn feeding device 9 feeds the spun yarn 5 manufactured by the pneumatic spinning device 8, to the winding device 10, and the yarn feeding device 9 comprises a delivery roller 15 and a nip roller 16 that nip and feed the spun yarn 5.

[0024] The yarn winding device 10 traverses and winds the spun yarn 5 manufactured by the pneumatic spinning device 8, around the bobbin 17 in an axial direction to form a winding package 6. The yarn winding device 10 comprises a cradle arm 18 that holds the bobbin 17, a friction roller 19 that contacts and rotates the package on the bobbin 17, and a traverse device (not shown in the drawing).

[0025] As shown in Figure 2, the cradle arm 18 is supported by the spinning unit 2 so as to be pivotable around a supporting point shaft 61. The cradle arm 18 can be tilted to a start position C1, a full package position C2, a full-package taking-out position C3, and a receiving por-

tion C4. The cradle arm 18 can be moved (tilted) from the start position C1 through the receiving position C4 and the full package position C2 to the full-package taking-out position C3 around the supporting point shaft 61.

[0026] The start position C1 corresponds to the tilting position in which the cradle arm 18 is positioned when the empty bobbin 17 held by the cradle arm 18 contacts with the friction roller 19. The full package position C2 corresponds to the tilting position in which the cradle arm 18 is positioned when the full winding package 6 held by the cradle arm 18 contacts with the friction roller 19. That is, as the winding package 6 on the bobbin 17 grows (the diameter increases), the cradle arm 18 moves within a tilting range CR from the start position C1 to the full package position C2. Further, the full-package taking-out position C3 corresponds to the tilting position in which the cradle arm 18 is positioned when the full winding package 6 held by the cradle arm 18 is taken out. The receiving position C4 corresponds to the tilting position on the course from the full-package taking-out position C3 to the start position which position is very close to the start position C1 and in which the cradle arm 18 is positioned when receiving a new empty bobbin 17. In the start position C1, the empty bobbin 17 held by the cradle arm 18 contacts with the friction roller 19. However, in the receiving position C4, the empty bobbin 17 held by the cradle arm 18 does not contact with the friction roller 19.

[0027] A pair of bobbin holders 62 is provided on the cradle arm 18 to hold the bobbin 17 by sandwiching the opposite shaft ends of the bobbin 17 between the bobbin holders 62. The cradle arm 18 can be opened and closed in the axial direction of the supporting point shaft 61 so that the spacing between the bobbin holders 62, 62 can be increased. When the cradle arm 18 is closed, the pair of bobbin holders 62, 62 sandwiches the bobbin 17 between the bobbin holders 62, 62 to hold the winding package 6 (bobbin 17). On the other hand, when the cradle arm 18 is open, the sandwiching of the bobbin 17 between the paired bobbin holders 62, 62 is cancelled to allow the full winding package 6 (bobbin 17) to be taken out. The cradle arm 18 can be opened and closed in the axial direction of the supporting point shaft 61, in an arbitrary tilting position in a circumferential direction of the supporting point shaft 61. When operated by a cradle operating arm 40, described later, the cradle arm 18 is opened or closed. Further, the operator's operation enables the cradle arm 18 to be opened or closed in an arbitrary tilting position.

[0028] The doffing apparatus 3 will be described with reference to Figures 1 and 2. The doffing apparatus 3 performs an operation of doffing the full winding package 6. The doffing operation refers to a series of operations including a full-package taking-out operation, a yarn drawing-out operation, and a yarn hooking operation. The full-package taking-out operation is the operation that takes out the full winding package 6 from the winding device 10 of the winding unit 2. In the yarn drawing-out operation, the pneumatic spinning device 8 first spins out the spun yarn 5 to be hooked on a new empty bobbin 17 and the doffing apparatus 3 (suction pipe 21) finally catches the new spun yarn 5. The yarn hooking operation involves supplying the new empty bobbin 17 to the winding device 10 and hooking the spun yarn 5 caught during the yarn drawing-out operation, on the bobbin 17. The time required for the doffing operation is basically about 13 seconds in the present embodiment.

[0029] The doffing apparatus 3 comprises a suction arm 20, a bobbin chucker 30, and a cradle operating arm 40 which can move forward and backward with respect to the spinning units 2 side. The suction arm 20 relates to yarn catching in the yarn drawing-out operation and yarn hooking in the yarn hooking operation. The suction arm 20 comprises the suction pipe 21 that sucks and catches an end of the spun yarn 5 and a bunch winding device 22 used to hook the spun yarn 5 on the bobbin 17. The bobbin chucker 30 relates to the supply of the bobbin 17 in the yarn hooking operation, and the bobbin chucker 30 is configured to be a device that can grip and move the bobbin 17. The cradle operating arm 40 relates to taking-out of the full winding package 6 in the doffing operation and the supply of the empty bobbin 17 in the yarn hooking operation, and the cradle operating arm 40 is configured to be device that tilts, opens, and closes the cradle arm 18, provided in the doffing apparatus 10.

[0030] The doffing apparatus 3 is also provided with a bobbin accommodating box 50 in which empty bobbins 17 to be transferred by the bobbin chucker 30 are accommodated.

[0031] The suction arm 20 moves among the following three positions: a standby position S1 in which the suction arm 20 is accommodated in the doffing apparatus 3, a yarn catching position S2 in which the suction arm 20 is located close to the yarn feeding device 9, and a yarn hooking position S3 in which the suction arm 20 is located close to the winding device 10. In short, the suction arm 20 has its operation controlled so as to move between the three positions S1, S2, S3.

[0032] In the standby position S1, the doffing operation stands by (the doffing operation is not performed) and the suction arm 20 is stationary. In the standby position S1, the suction arm 20 is accommodated in the doffing apparatus 3. Consequently, the suction arm 20 is unlikely to interfere with the spinning units 2 and with the movement of the doffing apparatus 3 along the direction in which the spinning units 2 are arranged in a line.

[0033] In the yarn catching position S2, the doffing operation is being performed, and the suction arm 20 is located downstream side (yarn feeding direction) of the yarn feeding device 9 in order to catch the end of the spun yarn 5 to be hooked on the empty bobbin 17 newly supplied to the winding device 10. In the yarn catching position S2, a suction port in the suction pipe 21, comprising the suction arm 20, is directed to a spin-out port in the pneumatic spinning device 8. In the yarn catching position S2, when the suction pipe 21 starts suction, the spun yarn 5 spun out by the pneumatic spinning device

8 is sucked and caught in the suction pipe 21 after having passed between the delivery roller 15 and the nip roller 16.

[0034] In the yarn hooking position S3, the doffing operation is being performed, and the suction arm 20 is located close to the winding device 10 in order to hook the spun yarn 5 caught in the suction pipe 21, on the empty bobbin 17 newly supplied to the winding device 10. In the yarn hooking position S3, the spun yarn 5 caught in the suction pipe 21 is hooked on the bobbin 17 held by the cradle arm 18 of the winding device 10. When the suction arm 20 is in the yarn hooking position S3, the cradle arm 18 is located in the receiving position C4.

[0035] The bobbin chucker 30 moves among the following three positions: a standby position B1 in which the bobbin chucker 30 is accommodated in the doffing apparatus 3, a bobbin taking-out position B2 in which the bobbin chucker 30 is projected into the bobbin accommodating box 50, and a bobbin supply position B3 in which the bobbin chucker 30 is located close to the winding device 10. In short, the bobbin chucker 30 has its operation controlled so as to move between the three positions B1, B2, B3.

[0036] In the standby position B1, the doffing operation stands by (the doffing operation is not performed) and the bobbin chucker 30 is stationary.

[0037] In the bobbin taking-out position B2, the doffing operation is being performed, and the bobbin chucker 30 is projected into the bobbin accommodating box 50 to grip one of the bobbins 17 in the bobbin accommodating box 50; the new empty bobbin 17 is supplied to the winding device 10. In the bobbin taking-out position B2, a hand 31 is driven to allow the bobbin 17 to be gripped by the bobbin chucker 30; the hand 17 is provided in the bobbin chucker 30 to grip the bobbin 17.

[0038] In the bobbin supply position B3, while the doffing operation is being performed, the bobbin chucker 30 is located close to the cradle arm 18 in order to deliver the empty bobbin 17 to the cradle arm 18 in the winding device 10. In the bobbin supply position B3, the gripping of the bobbin 17 by the bobbin chucker 30 is cancelled. The bobbin 17 is then delivered to the cradle arm 18. When the bobbin chucker 30 is in the bobbin supply portion B3, the cradle arm 18 is in the receiving position C4.

[0039] The cradle operating arm 40 moves among the following three positions: a standby position M1 in which the cradle operating arm 40 is accommodated in the doffing apparatus 3, a supply position M2 in which the empty bobbin 17 is supplied to the cradle arm 18, and a taking-out position M3 in which the cradle arm 18 takes out the full winding package 6. First, the cradle operating arm 40 is means for tilting the cradle arm 18 by contacting with the cradle arm 18 in a circumferential direction of the supporting point shaft 61. Second, the cradle operating arm 40 is means for opening and closing the cradle arm 18 by pushing the cradle arm 18 in an axial direction of the supporting point shaft 61. The cradle operating arm 40 is controlled so as to move between the three positions M1, M2, M3. The cradle operating arm 40 thus tilts, opens, or closes the cradle arm 18.

[0040] In the standby position M1, the doffing operation stands by (the doffing operation is not performed) and the cradle operating arm 40 stationary.

[0041] In the supply position M2, the empty bobbin 17 is supplied to the cradle arm 18. In this case, the cradle arm 18 is in the receiving position C4. Further, when the cradle arm 18, pushed by the cradle operating arm 40, tilts the cradle arm 18 located in the start position C1 or full package position C2, toward the full-package taking-out position C3, the cradle operating arm 40 is moved toward the taking-out position M3 via the supply position M2. Here, when the empty bobbin 17 is supplied to the cradle arm 18, the cradle operating arm 40 is moved, in the supply position M2, in the axial direction of the supporting point shaft 61 to open the cradle arm 18. The bobbin chucker 30 can thus supply the empty bobbin 17 to the cradle arm 18. While the doffing operation is being performed, when the cradle arm 18 is tilted toward the full-package taking-out position C3, the cradle operating arm 40 does not open the cradle arm 18 upon passing through the supply position M2.

[0042] While the doffing operation is being performed, the cradle operating arm 40 is placed in the taking-out position M3 after pushing and swinging the cradle arm 18 to the full-package taking-out position C3. In the taking-out position M3, the cradle operating arm 40 also moves in the axial direction of the supporting point shaft 61 to open the cradle arm 18. As a result, the full winding package 6 held by the cradle arm 18 is taken out. The cradle operating arm 40 opens the cradle arm 18 only when the cradle operating arm 40 is in the supply position M2 and in the taking-out position M3. In the other positions, the cradle arm 18 is closed.

[0043] As shown in Figure 3, the three driving members, that is, the suction arm 20, the bobbin chucker 30, and the cradle operating arm 40 provided in the doffing apparatus 3 receive power from a single motor 70 provided in the doffing apparatus 3 and are driven in unison with one another. An output shaft of the motor 70 is connected to a main driving shaft 71 that diverges power to the suction arm 20, the bobbin chucker 30, and the cradle operating arm 40 to drive them. The motor 70 can be normally and reversely rotated. The main driving shaft 71 is normally and reversely rotated as required to drive the cradle operating arm 40 forward and backward.

[0044] Further, a cam and a cam follower are provided on a power transmission path from the motor 70, as a driving source, to each of the driving members so that the cam is in contact with the follower of the cam. The cam is connected to the motor 70 via a link so that power from the motor 70 can be transmitted to the cam. The follower is connected to each driving member so that power from the follower can be transmitted to the driving member. A cam 72 for suction arm 20 and a follower 29 for suction arm 20 are provided on the power transmission path from the motor 70 to the suction arm 20. Spe-

cifically, the follower 29 for suction arm 20 is a member such as an arm which is placed at the terminal or in the middle of a link to support and drive the suction arm 20. A cam 73 for bobbin chucker 30 and a follower 39 for bobbin chucker 30 are provided on the power transmission path from the motor 70 to the bobbin chucker 30. A cam 74 for cradle operating arm 40 and a follower 49 for cradle operating arm 40 are provided on the power transmission path from the motor 70 to the credle operating arm 40.

[0045] The cams can be utilized to intermittently drive the suction arm 20, the bobbin chucker 30, and the cradle operating arm 40. These driving members can be driven in unison with one another but have different actual driving timings and different time intervals at which they are driven.

[0046] Here, the bobbin chucker 30 and the cradle operating arm 40 are driven using only the motor 70 as a driving source. In contrast, the suction arm 20 is provided with an air cylinder 75 as a driving source, in addition to the motor 70. The air cylinder 75 is driven by air supplied by an air compressor 76 that is an air supply source provided in the doffing apparatus 3. The air cylinder 75 performs control such that a leading end of the suction arm 20 moves forward and backward with respect to its trailing end (such that the leading end of the suction arm 20 can extend further). The air compressor 76 also serves as a driving source for the suction pipe 21, provided in the suction arm 20.

[0047] The main driving shaft 71 is fixed to the cam 72 for suction arm 20. One rotation of the main driving shaft 71 rotates the cam 72 for suction arm 20 once. Driving the suction arm 20 by rotating the cam 72 for suction arm 20 once means one cycle in the doffing operation during which the suction arm 20 is driven. Similarly, one rotation of the main driving shaft 71 rotates the cam 73 for bobbin chucker 30 and the cam 74 for cradle operating arm 40 once. One rotation of the main driving shaft 71 corresponds to one cycle in the doffing operation during which the bobbin chucker 30 and the cradle operating arm 40 is driven.

[0048] As previously described, the main driving shaft 71 is rotated once during one doffing operation. However, the main driving shaft 71 is halted a number of times during one doffing operation; the main driving shaft 71 itself is intermittently driven. The main driving shaft 71 is principally stopped during a full-package taking-out cradle open period and during the yarn drawing-out operation. During the full-package taking-out cradle open period and during the yarn drawing-out operation, an apparatus located outside the doffing apparatus 3 performs a time-consuming operation. Accordingly, the doffing apparatus 3 is stopped to provide a sufficient time for the operation. Rotational positions of the main driving shaft 71 include a standby rotational position R1 in which the main driving shaft 71 is placed when the doffing operation is started, a doffing rotational position R2 in which the main driving shaft 71 is placed while the full-package taking-out cradle is open, and a yarn drawing-out rotational position R3 in which the main driving shaft 71 is placed during the yarn drawing-out operation.

[0049] The full-package taking-out cradle open period has the meaning described below. The cradle arm 18 is opened twice during the doffing operation; the cradle arm 18 is open in the full-package taking-out position C3, in which it takes out the full winding package 6, and in the receiving position C4, in which it is supplied with a new empty bobbin 17. Specifically, the cradle arm 18 is initially in the full package position C2, in which it holds the full winding package 6. The cradle arm 18 is then moved to the full-package taking-out position C3, in which it takes out the full winding package 6. Subsequently, when returned to the start position C1, the cradle arm 18 is supplied with the empty bobbin 17 in the receiving position C4, located before the start position C1. That is, the full-package taking-out cradle open period means the period during which the cradle arm 18 takes out the full winding package 6 (full-package taking-out position C3), one of the two periods during which the cradle arm 18 is open. The period during which the empty bobbin 17 is received (receiving position C4) corresponds to a bobbin supply cradle open period.

[0050] During the full-package taking-out cradle open period, a transfer device (not shown in the drawings) transfers the full winding package 6. This requires a longer time than the supply of the bobbin 17 carried out by the bobbin chucker 30 (bobbin supply cradle open period). Thus, during the full-package taking-out cradle open period, the main driving shaft 71 itself is stopped to keep the cradle arm 18 open longer than during the bobbin supply cradle open period. This provides a sufficient time to allow the transfer device to perform its operation.

[0051] In the present embodiment, the full-package taking-out cradle open period lasts about 4.5 seconds, whereas the bobbin supply cradle open period lasts about 3.5 seconds. The difference between these periods, about 1 second, corresponds to the time for which the main driving shaft 71 is stopped.

[0052] Further, the yarn drawing-out operation period corresponds to the period during which the suction arm 20 is in the yarn catching position S2 so that the suction pipe 21 catches the spun yarn 5 spun out by the pneumatic spinning device 8. In the present embodiment, the time for which the main driving shaft 71 is stopped during the yarn drawing-out operation is about 1.5 to 3.0 seconds.

[0053] The doffing apparatus 3 comprises the yarn catching device 20, which catches the taken-out spun yarn, the bobbin transfer device 30, the cradle operating device 40, and a yarn detecting sensor 23 that detects whether or not the yarn catching device has caught the taken-out spun yarn. The doffing apparatus 3 also has a control device (not shown in the drawings) that, when the yarn detecting sensor 23 has not detected the spun yarn, performs control such that the process returns immediately to its initial state without performing the operations

following the bobbin transfer operation.

[0054] Now, with reference to Figure 4, a brief description will be given of a method for an automatic doffing operation in accordance with the present embodiment. The method for the automatic doffing operation is a cyclic process of sequentially executing a full-package taking-out operation step 1000, a yarn drawing-out operation step 2000, and a yarn hooking operation step 3000 to return to the initial state again. That is, the state observed after the yarn hooking operation step is finished corresponds to the state observed when the full-package taking-out operation step is started. With the method for the automatic doffing operation, when the yarn drawing-out operation step is defective, the process returns to its initial state (the state observed when the full-package taking-out operation step is started) without executing the yarn hooking operation step. The step of returning to the initial state is called a reverse returning step 4000. The word "reverse" is used because the direction in which the main driving shaft 71 (motor 70), which drives the driving members (suction arm 20 and the like) of the doffing apparatus 3, is reversed during the reverse returning step 4000.

[0055] Two stages are used to determine whether or not to suspend the yarn hooking operation step 3000 and then proceed to the reverse returning step 4000. If the yarn drawing-out operation succeeds, the process proceeds directly to the yarn hooking operation step 3000. If the yarn drawing-out operation fails, the process determines whether or not the number of failures has reached a predetermined plural times (in the present embodiment, two). For the first failure, the process executes the yarn drawing-out operation step 2000 again. For the second failure, the process proceeds to the reverse returning step 4000.

[0056] The procedure of the doffing operation will be described in detail with reference to Figure 5 and Figures 6 to 8. Figure 5 shows the flow of the doffing operation. Figures 6 and 7 shows how the doffing operation progresses and how the doffing apparatus 3 operates at a particular point in time. Thus, the doffing operation will be described while comparing Figure 5 with Figures 6 to 8, showing the state observed depending on the progress of the flow.

[0057] The doffing apparatus 3 can run between a plurality of spinning units 2. The doffing apparatus 3 stops at a front surface of a spinning unit 2 having made a doffing operation request. The doffing apparatus 3 then performs a doffing operation on that spinning unit 2. The doffing operation request is made by a spinning unit 2 having a full winding package 6.

[0058] Figure 6 shows how the doffing apparatus 3 operates when the doffing operation is started. On this occasion, the suction arm 20 is in the standby position S1, the bobbin chucker 30 is in the standby position B1, and the cradle operating arm 40 is in the standby position M1. The doffing operation is started when a control section of the spinning machine 1 sends a doffing operation start signal to a control section of the doffing apparatus 3 (step 101 in Figure 5).

[0059] The yarn drawing-out operation (spinning-out of the spun yarn 5 by the pneumatic spinning device 8) is already finished before the doffing operation is started. The spinning unit 2 on which the doffing operation is to be performed is at a stop.

[0060] Figure 7 shows how the doffing apparatus 3 operates during the yarn drawing-out operation. The operations in steps 102 to 110 (all the serial numbers 102 to 110) are performed between the state shown in Figure 6 and the state shown in Figure 7.

[0061] The control section receives a doffing operation start signal (step 101). Then, the main driving shaft 71 is rotatively driven (step 102). During the full-package taking-out operation, the main driving shaft 71 rotates from the standby rotational position R1 (step 101) through the full-package taking-out rotational position R2 (step 103) to the yarn drawing-out rotational position R3 (step 106). In response to this, the suction arm 20, the bobbin chucker 30, and the cradle operating arm 40 start to be driven.

[0062] The suction arm 20 is driven toward the yarn catching position S2 when the main driving shaft 71 starts rotating (step 102). Before reaching the yarn catching position S2, the suction arm 20 is halted in response to halting of the main driving shaft 71 (step 103). The suction arm 20 is extended when the air cylinder 75 starts to be driven (step 104). After steps 103 and 104, the suction arm 20 reaches the yarn catching position S2 (step 105) and then waits for the yarn drawing-out operation (step 106). On this occasion (step 106), the main driving shaft 71 is in the yarn drawing-out rotational position R3, in which its rotation is halted.

[0063] After the main driving shaft 71 starts to be rotated (step 102) and after the main driving shaft 71 is halted (step 103), the bobbin chucker 30 starts to be driven and then reaches the bobbin taking-out position B2 (step 107).

[0064] After the main driving shaft 71 starts to be rotated (step 102), the cradle operating arm 40 is driven to move from the standby position M1 through the supply position M2 to the taking-out position M3 (step 108). The cradle operating arm 40 remains stopped in the taking-out position M3 in response to halting of the main driving shaft 71 (step 103). As previously described, when the cradle operating arm 40 is in the taking-out position M3, the cradle arm 18 is open. The purpose of halting main driving shaft 71 (step 103) is to increase the duration of the open state so as to avoid interfering with taking-out of the full package 6 (full-package taking-out cradle open period).

[0065] Further, the spinning unit 2 performs a yarn drawing-out preparing operation in response to the start of rotation of the main driving shaft 71 (step 110). Specifically, the yarn drawing-out preparing operation means causing the pneumatic spinning device 8 to, for example, clean nozzles by air injection so as to allow the spun yarn 5 to be spun out.

[0066] The main driving shaft 71 reaches the yarn

drawing-out rotational position R3 and has its rotation halted (step 106). Then, the process can change to the yarn drawing-out operation. In this state, the yarn drawing-out operation is performed, that is, the pneumatic spinning device 8 spins out the spun yarn 5 and the suction pipe 21 catches the spun yarn 5.

[0067] Up to two yarn drawing-out operations are performed during one doffing operation. When no defect occurs, that is, the suction pipe 21 successfully catches the spun yarn 5, during the first doffing operation, the second yarn drawing-out operation is omitted. On the other hand, if the second yarn drawing-out operation also fails, the doffing operation is suspended. The process then returns to its initial state (standby state).

[0068] Thus, first, the pneumatic spinning device 8 performs the first yarn drawing-out operation (spins out the spun yarn 5) (step 111). On this occasion, the suction pipe 21 sucks air so that the suction arm 20 in the yarn catching position S2 can catch the spun yarn 5.

[0069] The suction pipe 21 is provided with the yarn detecting sensor 23 (Figure 3), which can detect whether the spun yarn 5 has been sucked into the suction pipe 21.

[0070] In response to the first yarn drawing-out operation, the yarn detecting sensor 23 determines whether or not the spun yarn is detected in the suction pipe 21 (step 112). If the sensor determines that the yarn drawing-out operation has succeeded, the process proceeds to step 113. If the sensor determines that the yarn drawing-out operation has failed, the process proceeds to step 114.

[0071] Here, a success in the detection of the spun yarn 5 in the suction pipe 21 means a success in both the operation performed by the pneumatic spinning device 8 to spin out the spun yarn 5 and the operation performed by the suction pipe 21 to catch the spun-out yarn 5. That is, the success in the detection of the spun yarn 5 in the suction pipe 21 means that the spun yarn 5 suitable for being hooked on the bobbin 17 is sucked into the suction pipe 21 without being cut prematurely or undergoing any other defects. On the other hand, a failure to detect the spun yarn in the suction pipe 21 corresponds to a failure to spin out or catch the spun yarn 5.

[0072] If the yarn detection fails, the main driving shaft 71 in the yarn drawing-out rotational position R3 is rotatively driven (step 113) to return to the standby rotational position R1, which is initially taken (step 115). The main driving shaft 71 located in the standby rotational position R1 in step 101 rotates once. Then, in step 115, the doffing operation is completed.

[0073] Here, a normal rotating direction is the direction in which the main driving shaft 71 rotates when the doffing operation is performed without presenting any problems. A problem occurs when, for example, during the yarn drawing-out operation, the yarn detection finally fails (in the present embodiment, the second detection fails), thus preventing the yarn hooking operation from being performed. Accordingly, the following are both normal rotating directions: the direction in which the main driving shaft 71 rotates between steps 102 and 106 and the direction in which the main driving shaft 71 rotates between steps 113 and 115.

[0074] Figure 8 shows how the doffing apparatus 3 operates during the yarn hooking operation. The yarn hooking operation is performed between steps 113 and 115, that is, while the main driving shaft 71 returns from the yarn drawing-out rotational position R3 to the standby rotational position R1.

[0075] The operations described below are preformed during the yarn hooking operation. First, the cradle operating arm 40 is returned from the taking-out position M3 to the supply position M2 to open the cradle arm 18 placed in the receiving position C4. Correspondingly, the bobbin chucker 30 approaches the cradle arm 18 to supply an empty bobbin 17 to the cradle arm 18. The empty bobbin 17 is then held by the.cradle arm 18. Further, the suction arm 20 approaches the cradle arm 18 to hook the yarn on the bobbin 17 held by the cradle arm 18 placed in the receiving position C4. The yarn hooking operation is performed by utilizing the bunch winding device 22 provided in the suction arm 20 and by rotating the bobbin 17, held by the cradle arm 18, by a friction roller (not shown in the drawings) provided in the doffing apparatus 3.

[0076] After the yarn is completely hooked on the bobbin 17 newly held by the cradle arm 18, when the main driving shaft 71 returns to the standby rotational position R1, the suction arm 20, the bobbin chucker 30, and the cradle operating arm 40 return to the standby positions S1, B1, M1, respectively. The suction arm 20 returns to the standby position S1 after the yarn hooking operation has been finished to stop driving the air cylinder 75 to contract the suction arm 20. Further, when the cradle operating arm 40 returns to the standby position M1, the cradle arm 18 returns to the start position C1. As described above, the doffing operation is finished.

[0077] Then, a description will be the case where the process fails to detect the yarn when determining whether or nor the first yarn drawing-out operation has succeeded (step 112). In this case, the second yarn drawing-out operation is performed. During the time corresponding to the performance of the second yarn drawing-out operation, the main driving shaft 71 remains stationary in the yarn drawing-out rotational position. The yarn drawing-out preparing operation is performed as in step 110 (step 114).

[0078] Then, the second yarn drawing-out operation (spinning out the spun yarn 5) is preformed (step 116) in the same manner as the first yarn drawing-out operation in step 111.

[0079] In response to the second yarn drawing-out operation, the process determines whether the spun yarn 5 has been successfully detected in the suction pipe 21 (step 117), in the same manner as the determination in step 112. When the process determines that the spun yarn has been successfully taken out, it proceeds to step 113. When the process determines that the yarn drawing-

out operation has failed, it proceeds to step 118. If the process proceeds to step 113, the yarn hooking operation is performed in the same manner as that previously described. The doffing operation is thus finished.

[0080] If the second yarn drawing-out operation fails, the yarn hooking operation is given up for the current doffing operation. The doffing apparatus 3 is then returned to its initial state. That is, the main driving shaft 71 in the yarn drawing-out rotational position R3 is reversed (step 118) to return to the standby rotational position R1 (step 115). In this case, the rotating direction of the main driving shaft 71 is opposite to the direction in which the shaft 71 is rotated when the doffing operation, that is, the yarn hooking operation, is successfully performed.

[0081] In the present embodiment, the main driving shaft 71 rotates by an amount equal to about one-third of one rotation between the standby rotational position R1 and the yarn drawing-out rotational position R3 during normal rotation.

[0082] Thus, when the yarn drawing-out operation fails and the doffing apparatus 3 is returned to the doffing operation standby state without performing the yarn hooking operation, the amount of rotation of the main driving shaft 71 can be reduced by rotating the main driving shaft 71 located in the yarn drawing-out rotational position R3, reversely rather than normally to return it. This is more efficient. For the spinning machine 1, which carries out high-speed spinning, performance can be a significantly improved by reducing the time required for the returning operation by several seconds

[0083] Further, when the main driving shaft 71 is normally rotated to return the doffing apparatus 3 to the doffing operation standby state, the procedure of the yarn drawing-out operation is uselessly executed. Then, the bobbin chucker 30 supplies an empty bobbin 17 to the winding device 10 in spite of a failure in the yarn drawing-out operation. Consequently, before the doffing operation is subsequently performed again, the empty bobbin 17 must have been removed from the winding device 10. When the bobbin 17 is not removed, when the doffing operation is subsequently performed again, the empty bobbin 17 will be conveyed similarly to normal full winding packages 6.

[0084] Even if the main driving shaft 71 is reversely rotated, once the main driving shaft 71 reaches the standby rotational position R1 (step 115), the suction arm 20, the bobbin chucker 30, and the cradle operating arm 40 return to the standby positions S1, B1, M1. The cradle arm 18 also returns to the start position C1. The doffing apparatus 3 returns to its initial state.

[0085] Now, with reference to Figure 9, a description will be given of the difference in required time depending on whether or not the doffing operation has succeeded. Figure 9(a) is a time chart showing that the first yarn drawing-out operation and thus the doffing operation have succeeded. In the present embodiment, the time required for the doffing operation is 13 seconds provided that the time required for the yarn drawing-out operation is 2.0 seconds. The doffing operation is composed of the full-package taking-out operation, the yarn drawing-out operation, and the yarn hooking operation as previously described. The full-package taking-out operation requires 4. 5 seconds, the yarn drawing-out operation requires 2.0 seconds, and the yarn hooking operation requires 6.5 seconds.

[0086] Figure 9(b) is a time chart showing that the second yarn drawing-out operation and thus the doffing operation have succeeded; the first yarn drawing-out operation has failed. In the present embodiment, if the doffing operation succeeds as a result of the successful second yarn drawing-out operation, the time required for the doffing operation is 15 seconds. In this case, the full-package taking-out operation requires 4.5 seconds and the first yarn drawing-out operation requires 2.5 seconds. The second yarn drawing-out operation requires 2.0 seconds and the yarn hooking operation requires 6.5 seconds. That is, one extra yarn drawing-out operation increases the time required for the doffing operation; the time required for the doffing operation is longer than that required for the doffing operation having succeeded as a result of the successful first yarn drawing-out operation, by the time required for the second yarn drawing-out operation.

[0087] Figure 9(c) is a time chart showing that the doffing operation has failed; both the first and second yarn drawing-out operations have failed. In the present embodiment, if the doffing operation fails, the time required to return to the initial state (standby state) is 12 seconds. In this case, the full-package taking-out operation requires 4.5 seconds and the first yarn drawing-out operation requires 2.0 seconds. The second yarn drawing-out operation requires 2.0 seconds and the return to the initial state requires 3.5 seconds. The time required to return to the initial state is equal to that required for the doffing operation. However, in the present embodiment, the doffing operation involves the time for which the main driving shaft 71 is stopped. Consequently, the time required to return to the initial state is shorter than that required for the doffing operation. As previously described, during the full-package taking-out cradle open period, an extra time is allowed during which the main driving shaft 71 is stopped, in order to provide a sufficient time to take out the full winding package 6.

[0088] A comparison of the above three time charts indicates the following. First, if the doffing operation fails (Figure 9(c)), the doffing apparatus 3 reversely rotates the main driving shaft 71 to return to its initial state without performing the yarn hooking operation. Accordingly, the time required in this case is shorter than the time required if the doffing operation succeeds as a result of the successful second yarn drawing-out operation (Figure 9(b)). When the main driving shaft 71 is normal ly rotated to return the doffing operation to its initial state as in the case where the yarn hooking operation is performed without reversely rotating the main driving shaft 71, then the

time required when the doffing operation fails is equal to the time required if the doffing operation succeeds as a result of the successful second yarn drawing-out operation. That is, the required time decreases by an amount equal to the difference between the time required for the yarn hooking operation and the time required to return the doffing operation to its initial state by reversely rotating the main driving shaft 71.

[0089] Further, in the present embodiment, owing to the time required for the doffing operation (including the time required for the full-package taking-out operation), the time (12 seconds) required if the doffing operation fails (Figure 9(c)) is shorter than the time (13 seconds) required if the doffing operation succeeds as a result of the successful first yarn drawing-out operation.

[0090] Now, a description will be given of a process executed if the doffing operation fails. When an automatic doffing operation fails which is performed on a spinning unit 2 by the doffing apparatus 3, then an external maintenance operation must be preformed on that spinning unit 2 by an operator or the like. Thus, each spinning unit 2 has an alarm lamp 80 attached to a front surface of a main body as means for, if the spinning unit 2 cannot perform an automatic doffing operation, alarming the operator for this state. When the spinning unit 2 to which the alarm lamp 80 is attached cannot perform a doffing operation, the alarm lamp 80 lights in, for example, red to given an alarm to the operator.

[0091] Means for displaying the disability to perform a doffing operation is not limited to the alarm lamp 80. A tiltable plate-like member attached to the main body of the spinning unit 2 may be normally maintained at such an angle that it extends along the main body and may be tilted from the main body when the doffing operation cannot be performed. Further, the alarm lamp 80 may be disposed at the highest position of the main body of the spinning unit 2. The position of the alarm lamp 80 is not limited. Furthermore, the display color of the alarm lamp 80 is not limited to red. In addition, the alarm lamp 80 may be normally extinguished or lighted in a display color such as green which means a normal state.

[0092] Here, the spinning machine 1 in accordance with the present embodiment comprises the large number of spinning units 2 and the doffing apparatus 3 that travels between the spinning units 2 to perform doffing operations. Thus, when a doffing operation performed on a particular spinning unit 2 fails, it is suspended. However, the doffing operation can be continuously performed on the other spinning units.

[0093] A brief description will be given of the method for the automatic doffing operation in accordance with the present invention. The first invention is a method for an automatic doffing operation performed by a doffing apparatus on a target apparatus comprising a yarn drawing-out device and a winding device comprising a cradle. The method comprises a full-package taking-out operation step of taking a bobbin with a package out of the cradle, a yarn drawing-out operation step of using the yarn drawing-out device to start drawing out a yarn and then catching the yarn, and a yarn hooking operation step of supplying an empty bobbin to the cradle and hooking the yarn on the bobbin to return to an initial state. If the spun yarn fails to be caught during the yarn drawing-out operation step, a returning step of returning to the initial state without executing the yarn hooking operation step is executed.

[0094] The spinning machine 1 in accordance with the present embodiment is configured as described below. The spinning machine 1 comprises the doffing apparatus 3 and the large number of spinning units 2, serving as target apparatuses for the doffing apparatus 3. Each of the spinning units 2 comprises the yarn drawing-out device composed of the draft device 7 and the pneumatic spinning device 8, and the winding device 10 comprising the cradle arm 18 (the above described cradle). The target apparatus for the doffing apparatus 3 has only to comprise a yarn drawing-out device and a winding device and may be an automatic winder that rewinds a apun yarn from a supplying package. In the automatic winder, the yarn drawing-out device corresponds to a device that draws a yarn out from a supplying package.

[0095] The doffing apparatus 3 comprises the suction arm 20, the bobbin chucker 30, that is, a bobbin transfer device, and the cradle operating arm 40, that is, a cradle operating device. The suction arm 20 comprises the suction pipe 21, that is, an air sucking yarn catching device. During the full-package taking-out operation step, the cradle operating arm 40 causes the cradle arm 18 to take out the bobbin 17 with the winding package 6. During the yarn drawing-out operation step, the pneumatic spinning device 8 spins out the spun yarn 5, and the suction pipe 21, provided in the suction arm 20, catches the spun yarn 5. During the yarn hooking operation step, the bobbin chucker 30 supplies an empty bobbin 17 to the cradle arm 18. The spun yarn 5 caught by the suction pipe 21 is then hooked on the bobbin 17 to return to its initial state.

[0096] The above configuration omits the yarn drawing-out operation step of supplying an empty bobbin for replacement when the yarn drawing-out operation fails. This avoids the situation in which even though the yarn drawing-out operation has failed, an empty bobbin is supplied to the winding device, thus forcing the operator to remove the bobbin.

[0097] The method for the automatic doffing operation in accordance with the second invention is the first invention configured as described below. The doffing apparatus comprises an air sucking yarn catching device, a bobbin transfer device, and a cradle operating device which are driven in unison with one another by a single motor. In the full-package taking-out operation step, the motor is normally rotated to cause the cradle operating device to take a bobbin with a package out of the cradle. In the yarn drawing-out operation step, with the motor stopped, the yarn drawing-out device starts drawing out the spun yarn and the air sucking yarn catching device catches the yarn. In the yarn hooking operation step, the

motor is further normally rotated to cause the bobbin transfer device to supply an empty bobbin to the cradle, and the yarn caught by the air sucking yarn catching device is hooked on the bobbin to return to the initial state. In the returning step, the motor is reversely rotated to return to the initial state without executing the yarn hooking operation step.

[0098] In the spinning machine 1 in accordance with the present embodiment, the following devices provided in the doffing apparatus 3 are driven in unison with one another by the single motor 70: the suction arm 20, comprising the suction pipe 21, the bobbin chucker 30, that is, a bobbin transfer device, and the cradle operating arm 40, that is, a cradle operating device.

[0099] With this configuration, normal rotation of the motor allows the sequential progress of the steps constituting the present method for the automatic doffing operation. Reverse rotation of the motor allows the operation to return to its initial state without the need to execute all the steps constituting the present method for the automatic doffing operation. Thus, the same driving source drives those devices in the doffing apparatus which relate to the full-package taking-out operation, yarn drawing-out operation, and yarn hooking operation. This simplifies the configuration of the apparatus.

[0100] The method for the automatic doffing operation in accordance with the third invention is the first or second invention configured as described below. The yarn drawing-out operation step is executed a predetermined plural number of times until the air sucking yarn catching device successfully catches the yarn.

[0101] In the present embodiment, during the yarn drawing-out operation step, the suction arm 20, comprising the suction pipe 21, catches the spun yarn 5 twice.

[0102] This improves the rate of success in the automatic doffing operation performed by the doffing apparatus. If the doffing operation succeeds without any maintenance operation performed by the operator, the operator need not perform any troublesome operations.

[0103] The method for the automatic doffing operation in accordance with the fourth invention is any of the first to third inventions configured as described below. The doffing apparatus is configured to be able to travel between a plurality of target apparatuses, and one doffing apparatus performs a doffing operation in response to a doffing operation request from the target apparatus.

[0104] This eliminates the need to perform the yarn drawing-out operation when the doffing operation fails; the yarn drawing-out operation accounts for a relatively high rate of the total time required for the process constituting the doffing operation. This reduces the time for which the doffing apparatus is bound by a particular target apparatus. Therefore, the operating efficiency of the whole apparatus is improved.

Claims

1. A method for an automatic doffing operation performed by a doffing apparatus on a target apparatus comprising a yarn drawing-out device and a winding device comprising a cradle, the method being **characterized by** comprising a full-package taking-out operation step of taking a bobbin with a package out of the cradle, a yarn drawing-out operation step of using the yarn drawing-out device to start drawing out a spun yarn and then catching the spun yarn, and a yarn hooking operation step of supplying an empty bobbin to the cradle and hooking the spun yarn on the bobbin to return the doffing operation to an initial state, and in that if the spun yarn fails to be caught during the yarn drawing-out operation step, a returning step is executed instead of the yarn hooking operation step, the returning step returning the doffing operation to the initial state without executing the yarn hooking operation step.

2. A method for an automatic doffing operation according to Claim 1, **characterized in that** the doffing apparatus comprises an air sucking yarn catching device, a bobbin transfer device, and a cradle operating device which are driven in unison with one another by a single motor, **in that** in the full-package taking-out operation step, the motor is normally rotated to cause the cradle operating device to take a bobbin with a package out of the cradle, **in that** in the yarn drawing-out operation step, with the motor stopped, the yarn drawing-out device starts drawing out the spun yarn and the air sucking yarn catching device catches the spun yarn, **in that** in the yarn hooking operation step, the motor is further normally rotated to cause the bobbin transfer device to supply an empty bobbin to the cradle, and the spun yarn caught by the air sucking yarn catching device is hooked on the bobbin to return the doffing operation to the initial state, and **in that** in the returning step, the motor is reversely rotated to return the doffing operation to the initial state without executing the yarn hooking operation step.

3. A method for an automatic doffing operation according to Claim 1 or Claim 2, **characterized in that** the yarn drawing-out operation step is executed a predetermined plural number of times until the air sucking yarn catching device successfully catches the spun yarn.

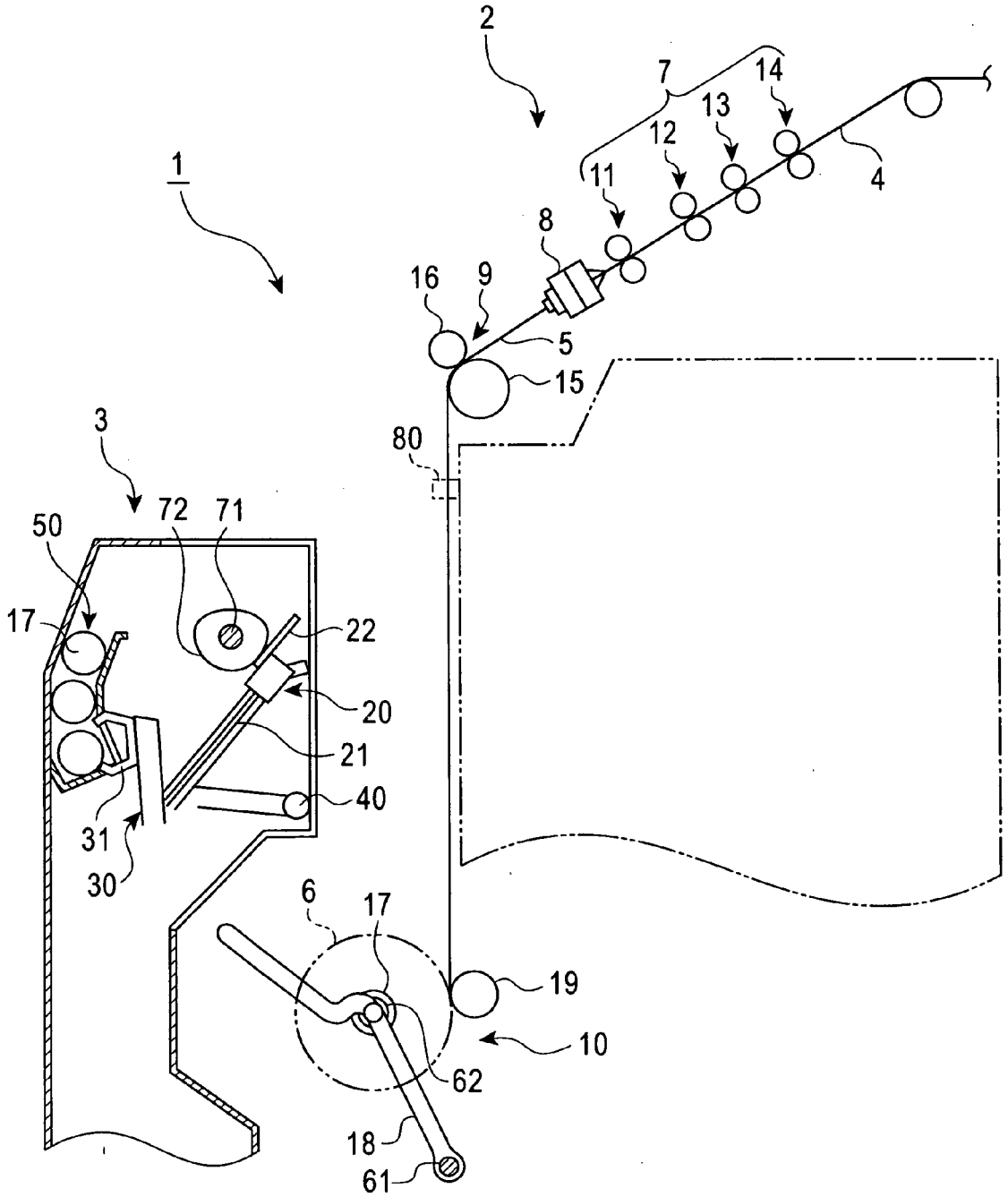
4. A method for an automatic doffing operation according to any one of Claims 1 to 3, **characterized in that** the doffing apparatus is configured to be able to travel between a plurality of target apparatuses, and one doffing apparatus performs a doffing operation in response to a doffing operation request from the target apparatus.

5. A doffing apparatus which takes a full package out of a spinning unit, and which supplies an empty bobbin to the spinning unit, and which hooks a spun yarn spun out by the spinning unit on the empty bobbin, the doffing apparatus being **characterized by** comprising a yarn catching device that catches the drawn-out spun yarn, a bobbin transfer device, a cradle operating device, and a yarn detecting sensor that detects whether or not the spun yarn catching device has caught the drawn-out spun yarn, and in that the doffing apparatus further comprises a control device that, when the detecting sensor has not detected the spun yarn, performs control such that the doffing operation returns to an initial state without performing operations following the bobbin transfer operation.

6. A doffing apparatus according to Claim 5, **characterized in that** the yarn catching device is a suction arm, and a yarn detecting sensor is provided which detects whether or not the spun yarn has been sucked into the suction arm.

7. A doffing apparatus according to Claim 6, **characterized in that** power from a main driving shaft driven by a single driving motor provided in the doffing apparatus is diverged to the yarn catching device, bobbin transfer device, and cradle operating device so that each of the yarn catching device, bobbin transfer device, and cradle operating device is driven to rotate normally or reversely.

FIG. 1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31
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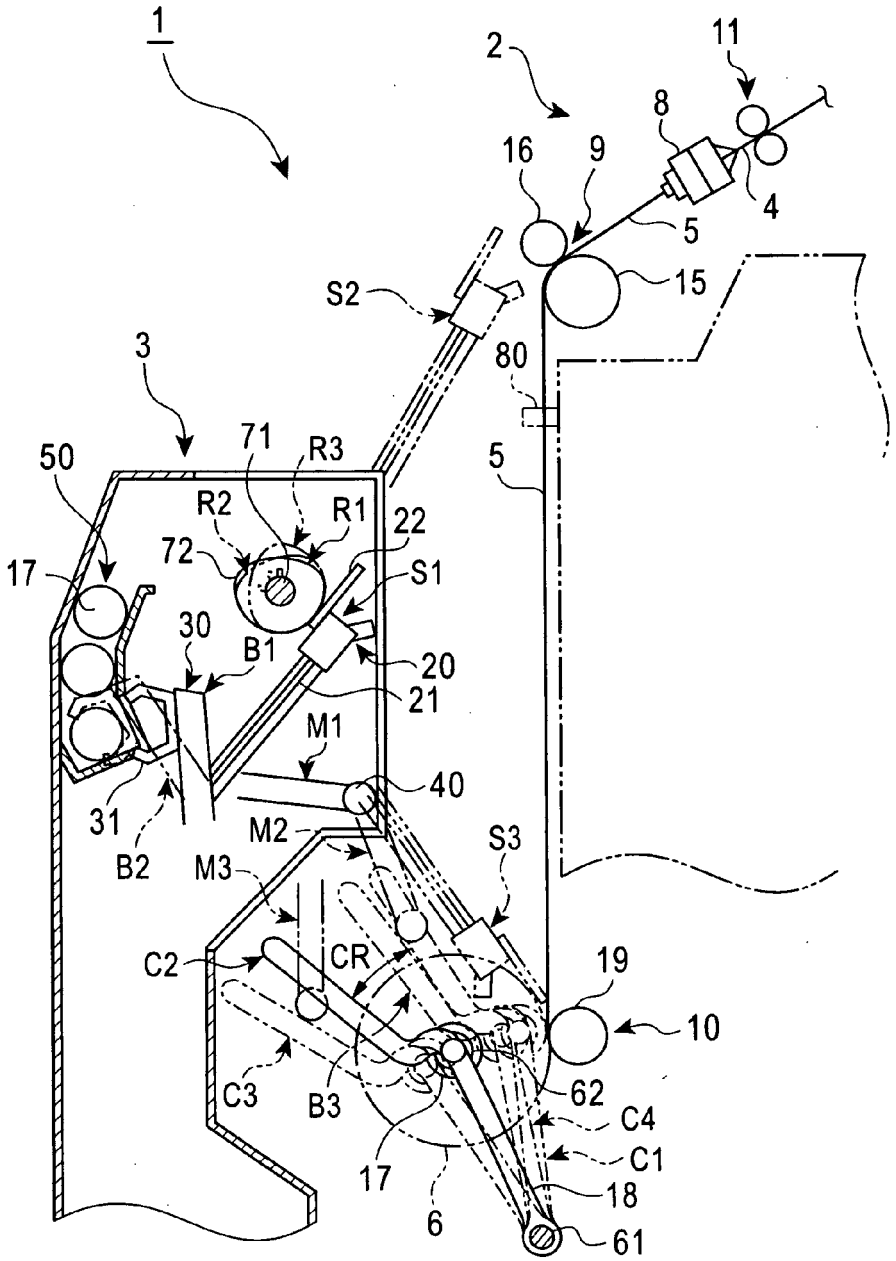
FIG. 2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B2
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C4
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FIG. 3

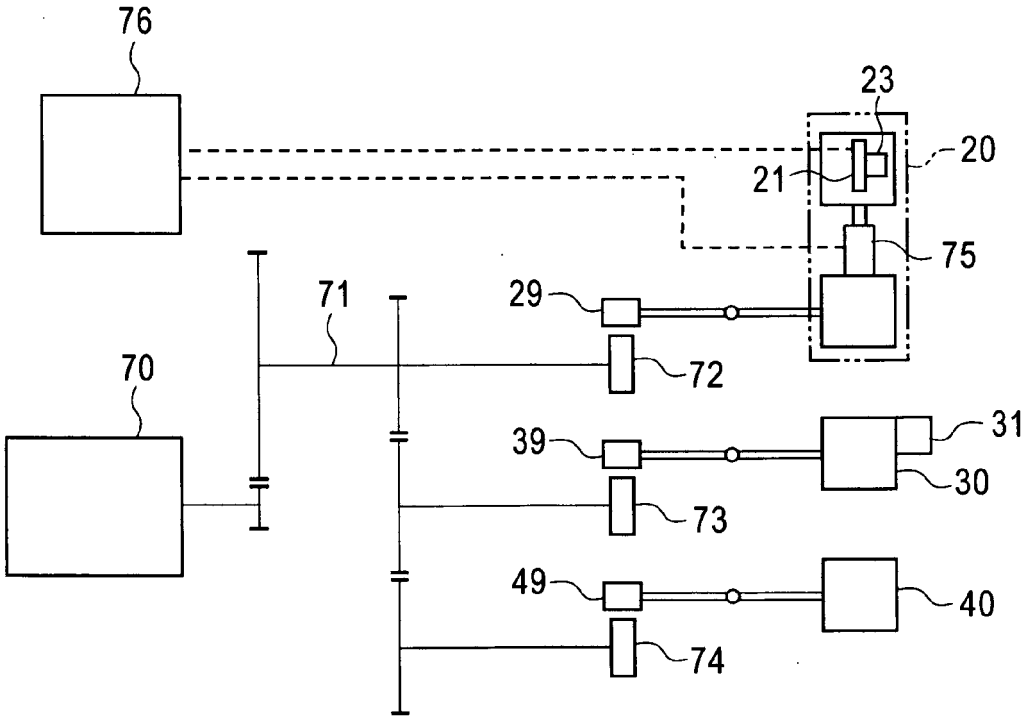


FIG. 4

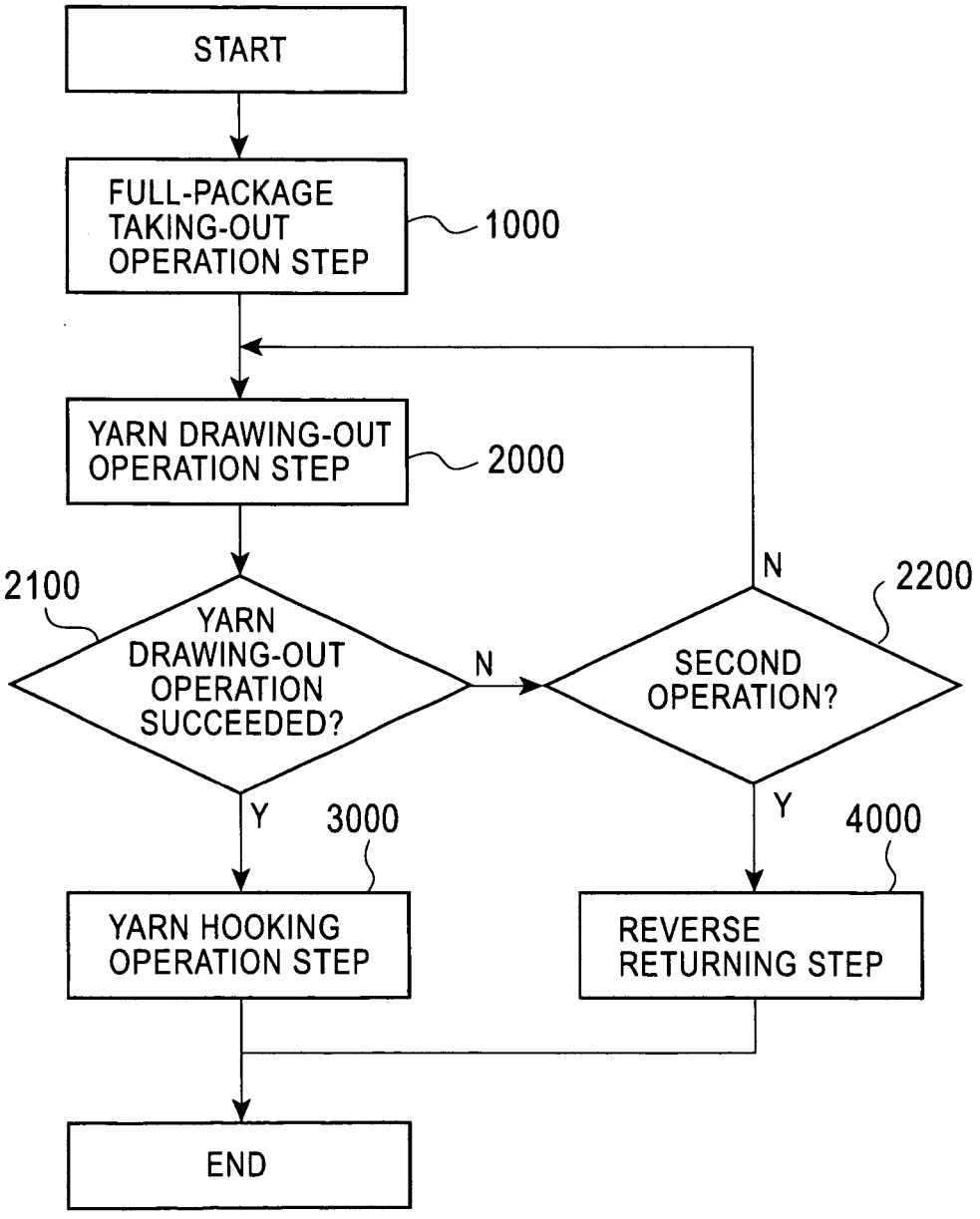

START
FULL-PACKAGE TAKING-OUT OPERATION STEP
1000
YARN DRAWING-OUT OPERATION STEP
2000
2100
YARN DRAWING-OUT OPERATION SUCCEEDED?
N
2200
SECOND OPERATION?
N
Y
3000
YARN HOOKING OPERATION STEP
Y
4000
REVERSE RETURNING STEP
END

FIG. 5

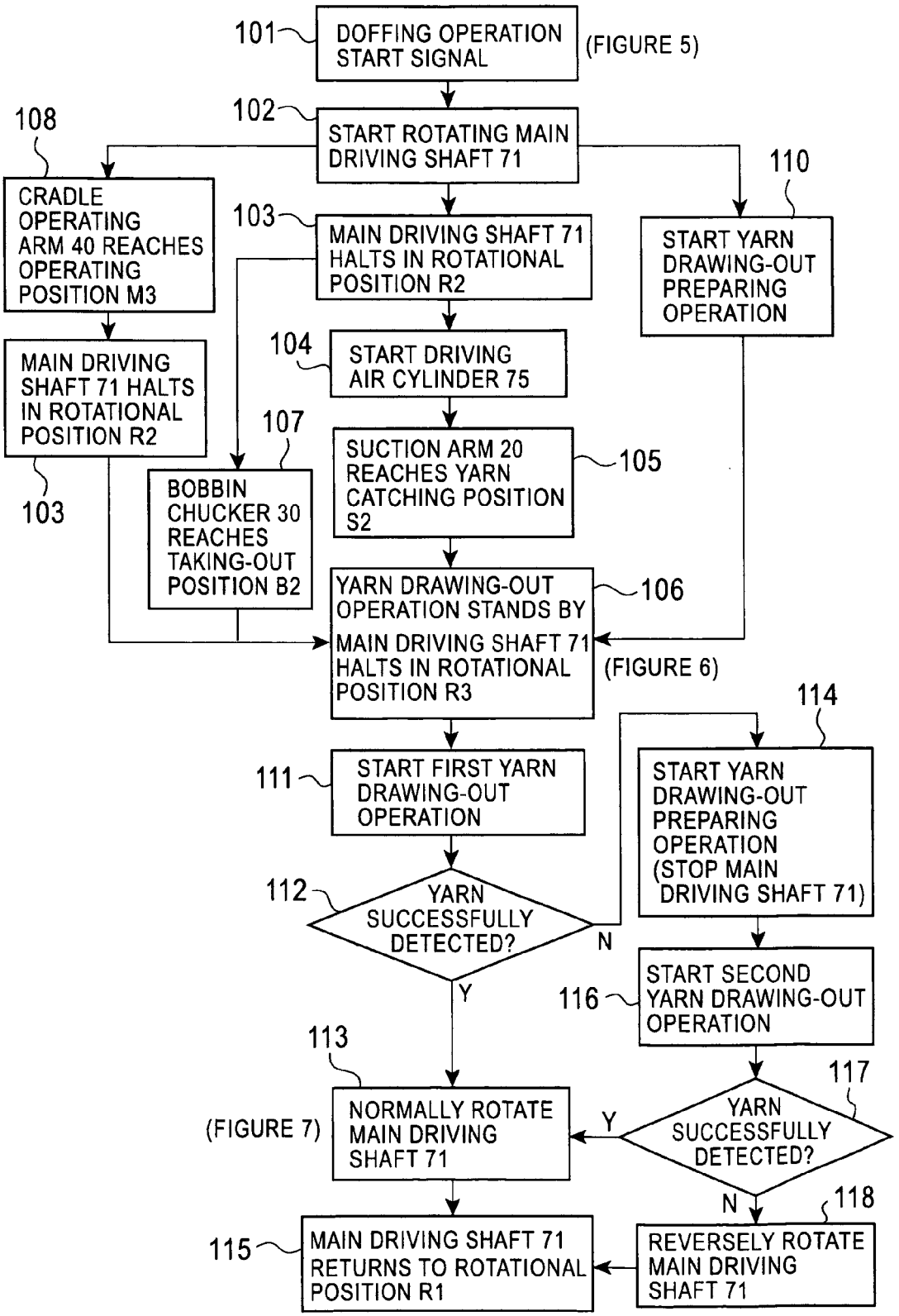
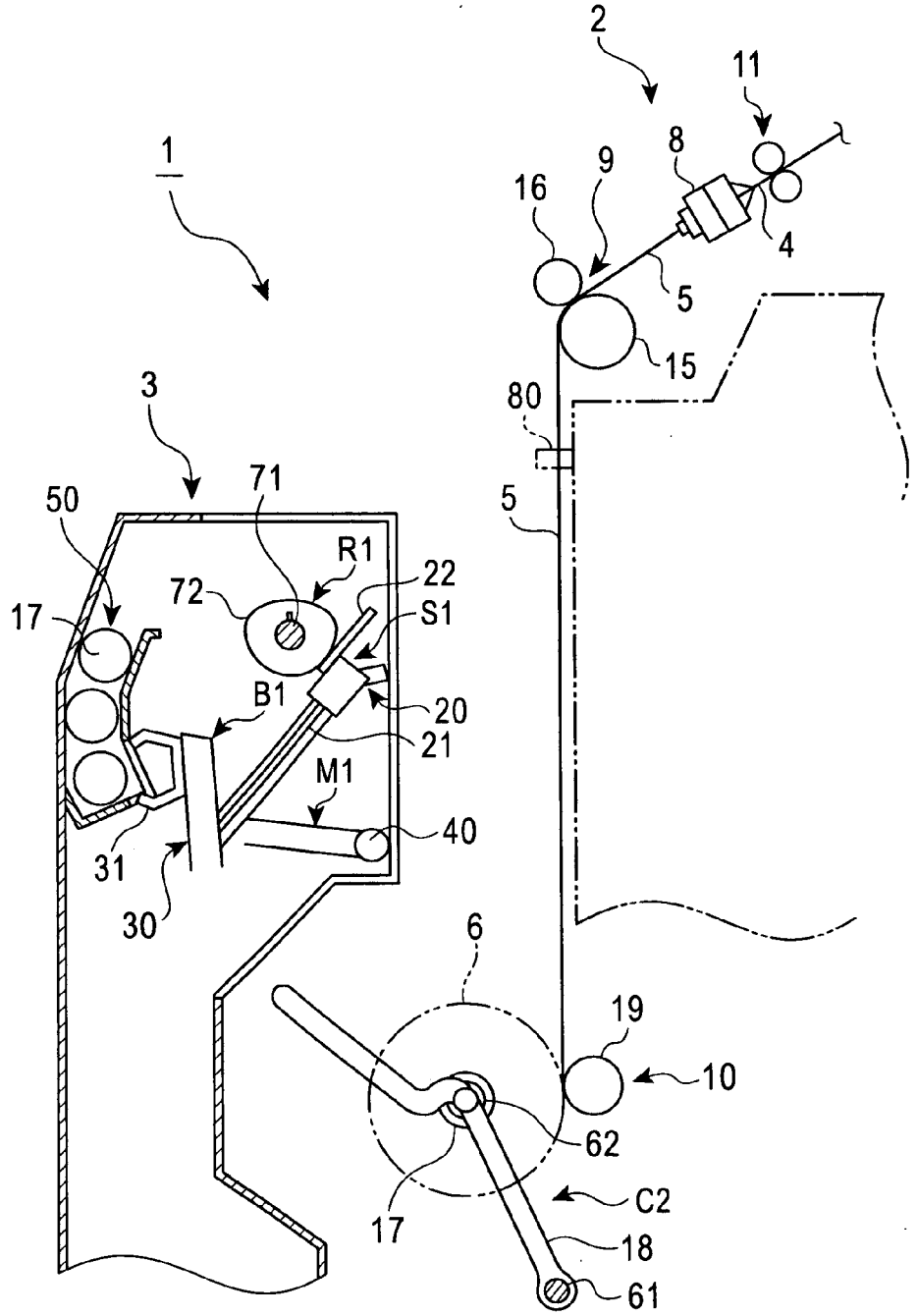

101
DOFFING OPERATION START SIGNAL
(FIGURE 5)
102
START ROTATING MAIN DRIVING SHAFT 71
108
CRADLE OPERATING ARM 40 REACHES OPERATING POSITION M3
110
START YARN DRAWING-OUT PREPARING OPERATION
103
MAIN DRIVING SHAFT 71 HALTS IN ROTATIONAL POSITION R2
104
START DRIVING AIR CYLINDER 75
MAIN DRIVING SHAFT 71 HALTS IN ROTATIONAL POSITION R2
103
107
BOBBIN CHUCKER 30 REACHES TAKING-OUT POSITION B2
SUCTION ARM 20 REACHES YARN CATCHING POSITION S2
105
YARN DRAWING-OUT OPERATION STANDS BY
106
MAIN DRIVING SHAFT 71 HALTS IN ROTATIONAL POSITION R3
(FIGURE 6)
114
START FIRST YARN DRAWING-OUT OPERATION
111
START YARN DRAWING-OUT PREPARING OPERATION (STOP MAIN DRIVING SHAFT 71)
112
YARN SUCCESSFULLY DETECTED?
N
Y
START SECOND YARN DRAWING-OUT OPERATION
116
113
117
(FIGURE 7)
NORMALLY ROTATE MAIN DRIVING SHAFT 71
Y
YARN SUCCESSFULLY DETECTED?
N
118
115
MAIN DRIVING SHAFT 71 RETURNS TO ROTATIONAL POSITION R1
REVERSELY ROTATE MAIN DRIVING SHAFT 71

FIG. 6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50
5
R1
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S1
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B1
20
21
M1
40
31
30
6
19
10
62
C2
17
18
61

FIG. 7

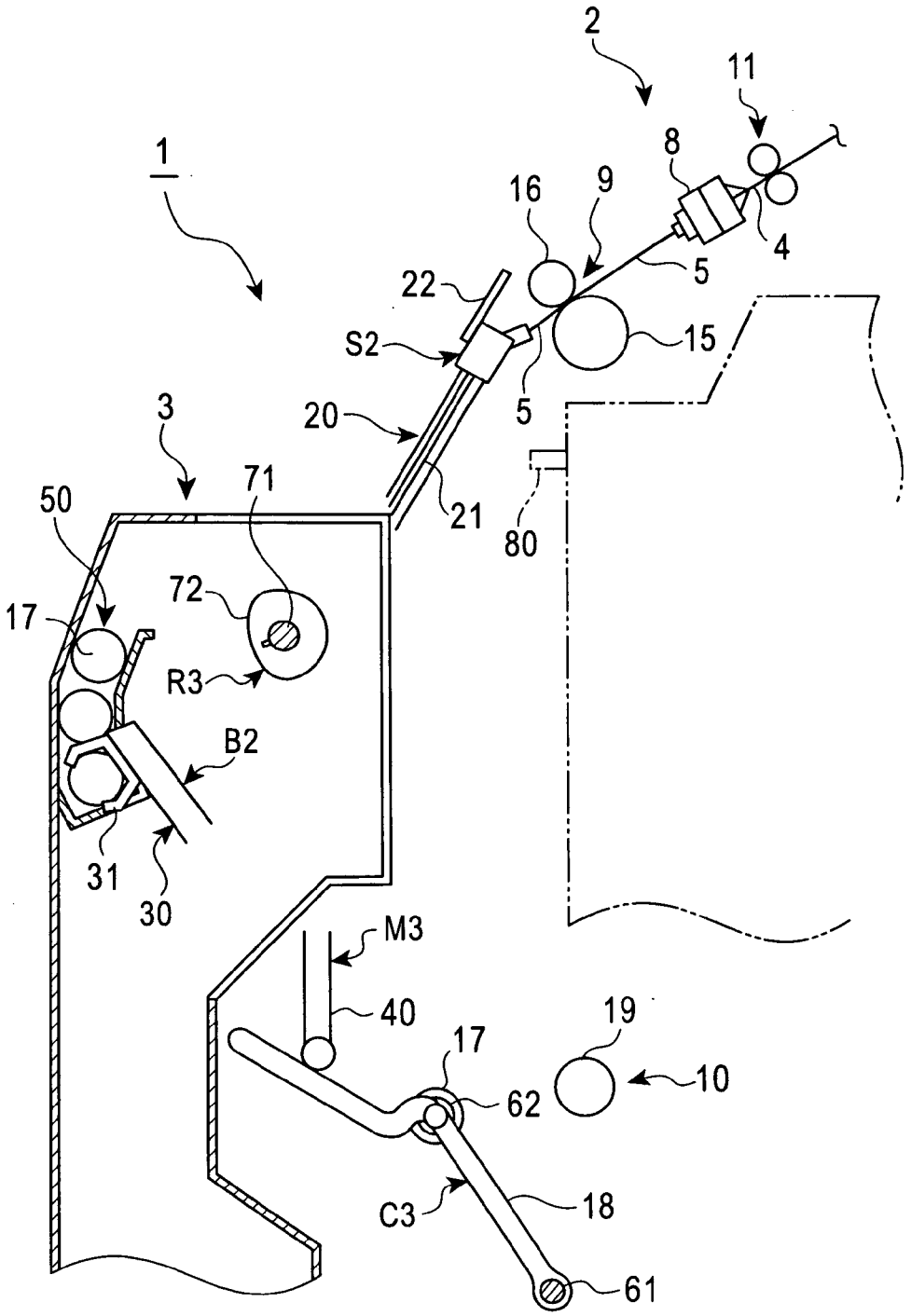
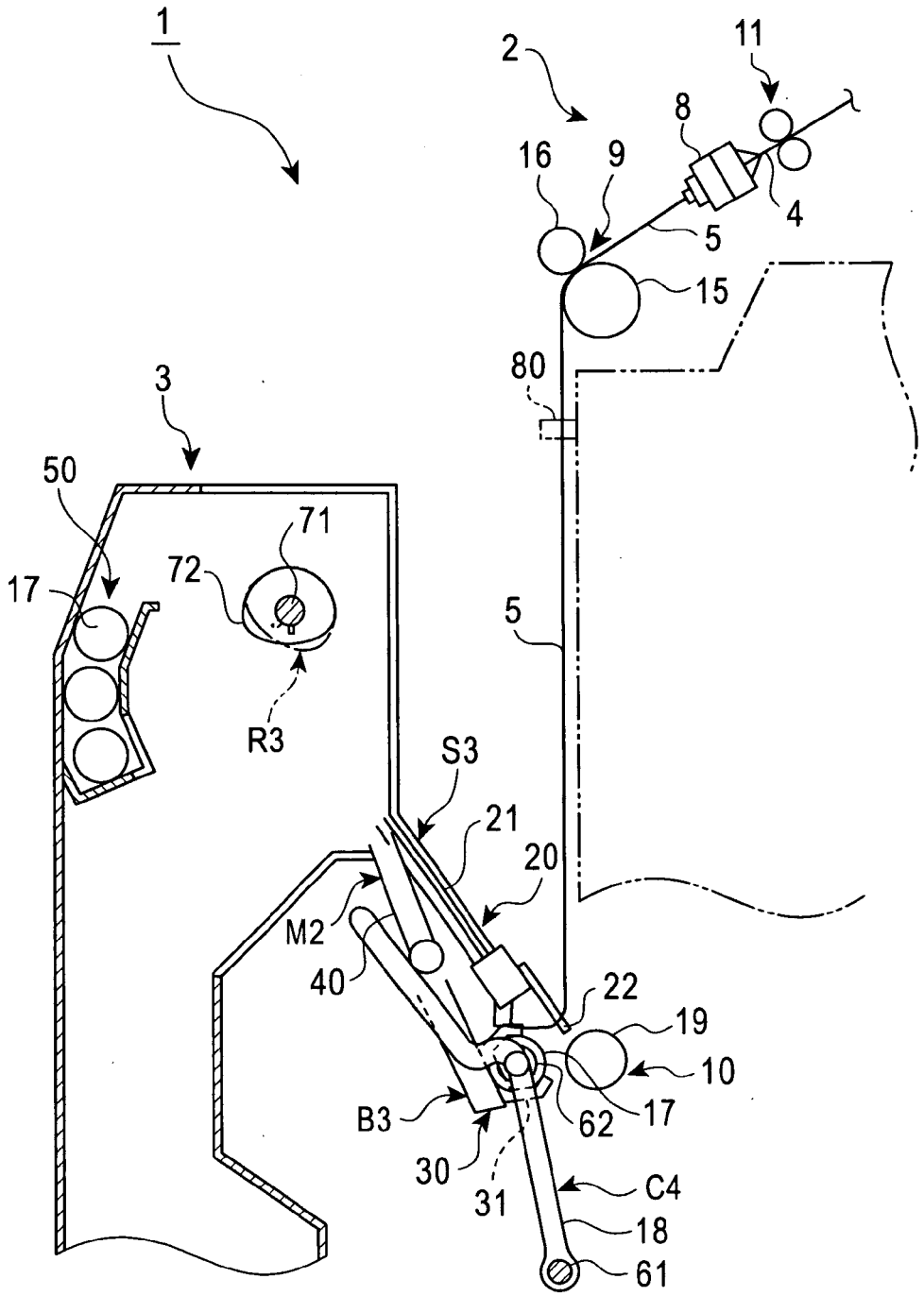

2
11
1
8
16
9
4
5
22
15
S2
5
3
20
71
21
80
50
72
17
R3
B2
31
30
M3
40
19
17
10
62
C3
18
61

FIG. 8


1
2
11
8
16
9
4
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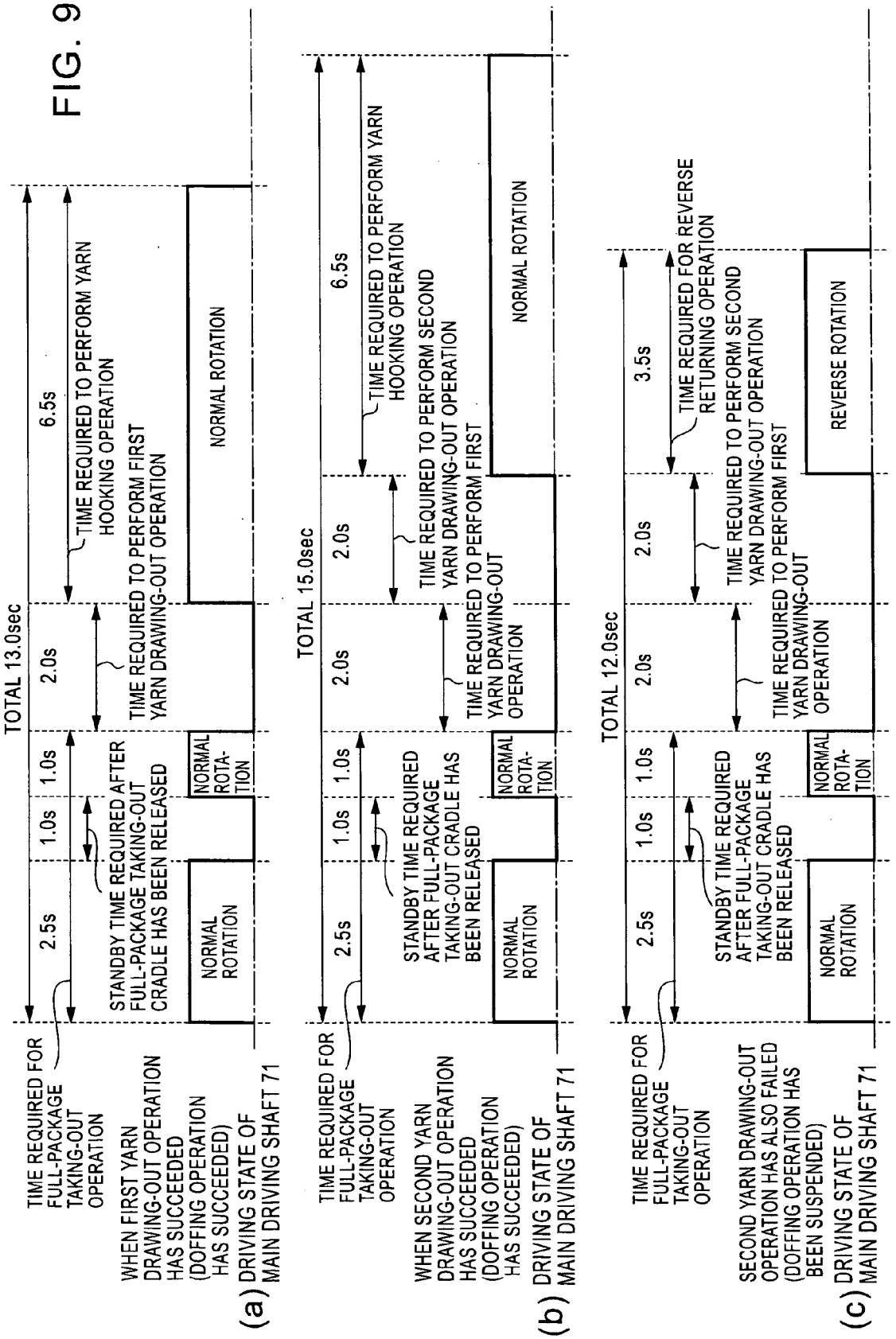
15
80
3
50
71
72
17
5
R3
S3
21
20
M2
40
22
19
10
B3
62
17
30
31
C4
18
61

FIG. 9


TOTAL 13.0sec
2.5s
1.0s
1.0s
2.0s
6.5s
TIME REQUIRED FOR FULL-PACKAGE TAKING-OUT OPERATION
STANDBY TIME REQUIRED AFTER FULL-PACKAGE TAKING-OUT CRADLE HAS BEEN RELEASED
TIME REQUIRED TO PERFORM FIRST YARN DRAWING-OUT OPERATION
TIME REQUIRED TO PERFORM YARN HOOKING OPERATION
NORMAL ROTATION
NORMAL ROTA-TION
WHEN FIRST YARN DRAWING-OUT OPERATION HAS SUCCEEDED (DOFFING OPERATION HAS SUCCEEDED)
(a) DRIVING STATE OF MAIN DRIVING SHAFT 71
TOTAL 15.0sec
2.5s
1.0s
1.0s
2.0s
2.0s
6.5s
TIME REQUIRED FOR FULL-PACKAGE TAKING-OUT OPERATION
STANDBY TIME REQUIRED AFTER FULL-PACKAGE TAKING-OUT CRADLE HAS BEEN RELEASED
TIME REQUIRED TO PERFORM FIRST YARN DRAWING-OUT OPERATION
TIME REQUIRED TO PERFORM SECOND YARN DRAWING-OUT OPERATION
TIME REQUIRED TO PERFORM YARN HOOKING OPERATION
NORMAL ROTATION
NORMAL ROTA-TION
WHEN SECOND YARN DRAWING-OUT OPERATION HAS SUCCEEDED (DOFFING OPERATION HAS SUCCEEDED)
(b) DRIVING STATE OF MAIN DRIVING SHAFT 71
TOTAL 12.0sec
2.5s
1.0s
1.0s
2.0s
2.0s
3.5s
TIME REQUIRED FOR FULL-PACKAGE TAKING-OUT OPERATION
STANDBY TIME REQUIRED AFTER FULL-PACKAGE TAKING-OUT CRADLE HAS BEEN RELEASED
TIME REQUIRED TO PERFORM FIRST YARN DRAWING-OUT OPERATION
TIME REQUIRED TO PERFORM SECOND YARN DRAWING-OUT OPERATION
TIME REQUIRED FOR REVERSE RETURNING OPERATION
NORMAL ROTATION
NORMAL ROTA-TION
REVERSE ROTATION
SECOND YARN DRAWING-OUT OPERATION HAS ALSO FAILED (DOFFING OPERATION HAS BEEN SUSPENDED)
(c) DRIVING STATE OF MAIN DRIVING SHAFT 71