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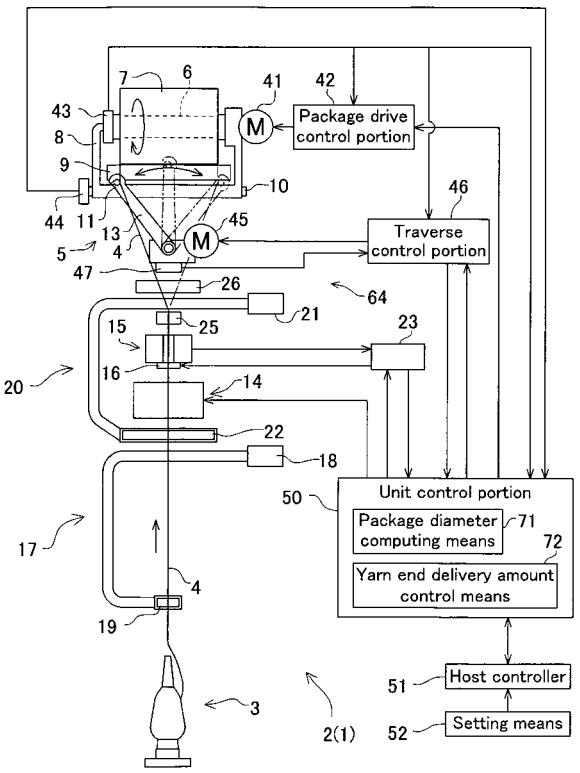
(54) Yarn winding machine

(57) A yarn winding machine (2) includes a diameter sensor (44) that detects a diameter of a yarn layer formed by winding a yarn around a winding tube (6), and a yarn end capturing and guiding means (20) that performs a yarn end extracting operation by approaching a peripheral surface of the yarn layer, sucking a yarn end, and guiding the yarn end to a yarn piecing device (14). A control device that controls respective units during the yarn end extracting operation has a yarn end delivery amount control means (72). The yarn end delivery amount control means (72) controls a package driving motor (41) to perform reverse rotation drive of the winding bobbin (7) and controls to vary a reverse rotation speed or a reverse rotation time of the winding bobbin (7) in n steps (where n is an integer no less than 2) according to the yarn layer diameter detected by the diameter sensor (44).

FIG. 1



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Description

[0001] The present invention relates to a yarn winding machine that forms a package by winding yarn around a winding bobbin.

[0002] A Patent Document 1 (Japanese Published Unexamined Patent Application No. 2002-114445) discloses an automatic winder that winds yarn, supplied from a yarn supplying portion, around a winding bobbin while traversing the yarn. The automatic winder of the Patent Document 1 has a driving device for rotatively driving the winding bobbin, and a drive shaft of this driving device is directly coupled to the winding bobbin.

[0003] The automatic winder of the Patent Document 1 also has a suction nozzle that can pivot upward and downward to suck and capture the yarn of the winding bobbin and thereby to extract the yarn for yarn piecing operation by a yarn piecing device (Patent Document 1 (0029, 0039, FIGS. 1, 2, etc.)).

[0004] Though the Patent Document 1 does not provide a specific description, in an automatic winder with a constitution such as that of the Patent Document 1, the sucking and capturing of the yarn by the suction nozzle may be aided by bringing the suction nozzle close to the winding bobbin and simultaneously delivering the yarn by rotating the winding bobbin in reverse by the driving device.

[0005] However, if the winding bobbin is simply rotated in reverse by the driving device, because the yarn delivery speed differs according to the package diameter, when the package diameter is small, the amount extracted by the suction nozzle becomes excessively small and causes yarn piecing errors to occur at the yarn piecing device, and when the package diameter is large, the amount extracted becomes excessively large and wasting of yarn increases. When the package diameter is large, the excessively extracted yarn may adversely affect the yarn quality by being sucked into a yarn trap, which sucks and removes waste yarn, etc., generated at a yarn breakage, and causing kinked yarn to be mixed in the package.

[0006] The present invention has been made in view of the above circumstances, and an object thereof is to provide a yarn winding machine that can stabilize a leading yarn amount in a yarn end extracting operation regardless of the magnitude of the package diameter and thereby improve production efficiency.

[0007] The theme of the present invention is as described above, and means for achieving this theme and the effects thereof will now be described.

[0008] A first aspect of the present invention provides a yarn winding machine of the following constitution. That is, the yarn winding machine includes: a yarn supplying portion; a winding bobbin rotative driving device that rotates a winding bobbin for winding a yarn from the yarn supplying portion; a diameter sensor that detects a diameter of a yarn layer formed by winding the yarn around the winding bobbin; a yarn piecing device that connects a starting yarn end of the yarn supplying portion with a terminal yarn end of the yarn layer formed by winding the yarn around the winding bobbin; a lower yarn capturing and guiding means that captures and guides the starting yarn end of the yarn supplying portion to the yarn piecing device; an upper yarn capturing and guiding means that captures and guides the terminal yarn end of the yarn layer to the yarn piecing device; a yarn breakage detecting means that detects a breakage of the yarn extending from the yarn supplying portion to the winding bobbin; and a control device that controls the winding bobbin rotative driving device, the yarn piecing device, the lower yarn capturing and guiding means, and the upper yarn capturing and guiding means so that, upon detection of a yarn breakage by the yarn breakage detecting means, the operation of the winding bobbin rotative driving device is stopped and then the yarn piecing device, the lower yarn capturing and guiding means, and the upper yarn capturing and guiding means are actuated while the winding bobbin rotative driving device is operated to rotate the winding bobbin in a reverse direction of a winding direction. The winding bobbin rotative driving device has a drive shaft to perform direct rotative drive of the winding bobbin. The control device has a yarn end delivery amount control means that controls the winding bobbin rotative driving device so as to vary at least one of a reverse rotation speed and a reverse rotation time of the winding bobbin in n steps (where n is an integer no less than 2) according to the diameter of the yarn layer detected by the diameter sensor.

[0009] With this constitution, by selection of a reverse rotation speed or a reverse rotation time from the n steps to control the winding bobbin according to the yarn layer diameter, scattering, according to the yarn layer diameter, of the amount of yarn end extracted (amount delivered) from the yarn layer can be reduced. Consequently, the yarn piecing operation can be stably performed by the yarn piecing device, and degradation of the package quality can be avoided.

[0010] With the above-described yarn winding machine, the diameter sensor is preferably constituted as a sensor that can detect the diameter of the yarn layer in a state in which the rotation of the winding bobbin is stopped.

[0011] With this constitution, because the yarn layer diameter can be detected accurately regardless of whether the winding bobbin is in a rotating state or in a stopped state, the reverse rotation speed of the package can be set appropriately and the amount of yarn end led out from the yarn layer can be stabilized more reliably.

[0012] In the above-described yarn winding machine, preferably, a cradle that can support the bobbin is disposed in a swingable manner. The diameter sensor is constituted as an angle sensor that detects a swinging angle of the cradle.

[0013] With this constitution, because the yarn layer diameter can be detected by a simple constitution, manufacturing cost can be reduced.

[0014] FIG. 1 is a schematic front view and block diagram of a winding unit of an automatic winder according to an embodiment of the present invention.

[0015] FIG. 2 is a control flowchart illustrating a control with respect to a package driving motor in a process in which an upper yarn capturing and guiding means extracts an upper yarn at a package side.

[0016] FIG. 3 is schematic front view illustrating a state in which a package is rotated in reverse to extract the upper yarn and guide the upper yarn to a yarn piecing device.

First Embodiment

[0017] An embodiment of the invention will now be described.

[0018] First, based on FIG. 1, a yarn winding unit (yarn winding machine) 2 of an automatic winder 1 will be described. This yarn winding unit 2 winds a yarn 4 from a supplying bobbin (yarn supplying portion) 3 around a winding tube 6 to form a yarn layer while removing yarn defects by a yarn clearer (yarn defect detector) 15 and traversing the yarn by a traverse device 5, and thereby forms a package 7 of predetermined length and predetermined shape. Although just one yarn winding unit 2 is shown in FIG. 1, the automatic winder 1 is constituted by disposing a plurality of such yarn winding units 2 on an unillustrated frame.

[0019] In the present Specification, the winding tube 6 and the package 7 will be referred to collectively as the "winding bobbin." That is, the winding tube 6 is the winding bobbin on which a yarn layer is not formed, and the package 7 is the winding bobbin on which the yarn layer has been formed.

[0020] The yarn winding unit 2 has a cradle (winding bobbin supporting member) 8 that detachably supports the winding tube 6, and a contact roller 9 that makes contact and can followingly rotate along with a peripheral surface of the yarn layer of the package 7. The cradle 8 is constituted to clamp both ends of the winding tube 6 and support the winding tube 6 in a rotatable manner. The cradle 8 is also constituted to be swingable about a swinging shaft 10 so that an increase in the package diameter (thickening) that accompanies the winding of the yarn 4 around the winding bobbin 6 or 7 can be absorbed by the swinging of the cradle 8.

[0021] A package driving motor (winding bobbin rotative driving device) 41, constituted, for example, of a brushless motor, is mounted on the portion of the cradle 8 that clamps the winding tube 6, and the winding tube 6 is driven to rotate by this package driving motor 41 to wind the yarn 4. A motor shaft of the package driving motor 41 is connected to the winding tube 6 in a manner prohibiting relative rotation when the winding tube 6 is clamped by the cradle 8 (so-called direct drive constitution). The actuation of the package driving motor 41 is controlled by a package drive control portion 42, and the package drive control portion 42 is constituted to control operation/stoppage of the package driving motor 41 upon receiving signals from a unit control portion 50. The package driving motor 41 is also constituted capable of rotating in a direction that is reverse from the direction in which the yarn 4 is wound around the winding bobbin 6 or 7 based on a signal from the unit control portion 50.

[0022] A package rotation speed sensor (rotation speed sensor) 43 is mounted on the cradle 8, and the package rotation speed sensor 43 is constituted to detect the rotation speed of the winding bobbin 6 or 7 mounted on the cradle 8. A rotation speed detection signal of the winding bobbin 6 or 7 is transmitted from the package rotation speed sensor 43 to the package drive control portion 42 and the unit control portion 50. The rotation speed detection signal is also input into a traverse control portion 46 to be described later.

[0023] A package diameter sensor (diameter sensor) 44 is also mounted on the cradle 8, and this package diameter sensor 44 detects a diameter of the yarn layer (package 7), formed by winding the yarn 4 around the winding tube 6 held by the cradle 8. Specifically, the package diameter sensor 44 is constituted as a rotary encoder or other angle sensor that detects a swinging angle of the cradle 8 and is constituted to detect the diameter of the yarn layer 7 by detecting the swinging angle at which the cradle 8 swings in accordance with the diameter of the yarn layer 7.

[0024] Because the package diameter sensor 44 is constituted as described above, the diameter of the yarn layer 7 can be detected without any problem even if the winding bobbin 6 or 7 is in a non-rotating, stopped state. The diameter of the yarn layer 7 that is acquired by the package diameter sensor 44 is transmitted to the unit control portion 50.

[0025] The traverse device 5 is disposed near the contact roller 9, and the yarn 4 is wound around the winding bobbin 6 or 7 while being traversed by the traverse device 5. This traverse device 5 has a traverse guide (yarn guide) 11, disposed in a manner capable of moving reciprocatingly in a traverse direction, and a traverse driving motor 45 that reciprocatingly drives the traverse guide 11.

[0026] The traverse device 5 has the hook-shaped traverse guide 11 disposed at a tip of an elongate arm member 13, which pivots about a supporting axis, and reciprocatingly and pivotingly drives the arm member 13 as shown by an arrow in FIG. 1 by the traverse driving motor 45. In the present embodiment, the traverse driving motor 45 that drives the arm member 13 is constituted from a voice coil motor.

[0027] The actuation of the traverse driving motor 45 is controlled by the traverse control portion 46, and the traverse control portion 46 controls the operation/stoppage of the traverse driving motor 45 upon receiving operation signals from the unit control portion 50. The traverse device 5 has a traverse guide position sensor 47 that includes a rotary encoder, etc., and is constituted to detect a pivoting position of the arm member 13 (and

thus the position of the traverse guide 11) and transmit a position signal to the traverse control portion 46.

[0028] As shown in FIG. 1, with the present embodiment, the package driving motor 41 that drives the winding bobbin 6 or 7 and the traverse driving motor 45 that drives the traverse guide 11 are disposed separately, and the winding bobbin 6 or 7 and the traverse guide 11 are driven (controlled) independently of each other. Diverse forms of winding, such as precision winding, step precision winding, random winding, etc., can thereby be realized in the process of winding the yarn 4 around the winding bobbin 6 or 7.

[0029] The unit control portion 50 is provided for each yarn winding unit 2, and each unit control portion 50 is connected to a host controller 51. This host controller 51 performs overall control of the plurality of yarn winding units 2 that are disposed in the automatic winder 1. The host controller 51 includes a setting means 52, such as switches and a numeric keypad, for setting parameters such as preset diameters $\phi 1$ to $\phi 5$ and package reverse rotation speeds V_1 to V_6 to be described below. Detailed description of these parameters will be provided below.

[0030] A yarn piecing device 14, a yarn clearer 15, a waxing device 25, and a yarn trap 26 will be described with reference to FIG. 1. The yarn winding unit 2 has a constitution in which the yarn piecing device 14, the yarn clearer (yarn defect detector) 15, the waxing device 25, and the yarn trap 26 are disposed in that order from the supplying bobbin 3 side in a yarn running path between the supplying bobbin 3 and the contact roller 9.

[0031] The yarn piecing device 14 pieces together a lower yarn at the supplying bobbin 3 side (starting yarn end of the yarn supplying portion 3) and an upper yarn at the package 7 side (terminal yarn end of the yarn layer) when the yarn is cut upon detection of a yarn defect by the yarn clearer 15 or when a yarn breakage occurs during unwinding from the supplying bobbin 3. As the yarn piecing device 14, for example, a splicer or a knotter may be employed.

[0032] The yarn clearer 15 detects thickness defects of the yarn 4 and is constituted to detect the thickness of the yarn 4, passing through a detecting portion of the yarn clearer 15, by an appropriate sensor and detect slubs and other yarn defects by analyzing a signal from the sensor by an analyzer 23 to transmit a yarn defect detection signal to the unit control portion 50. The yarn clearer 15 is provided with a cutter 16 that cuts the yarn 4 immediately when a yarn defect is detected.

[0033] The yarn clearer 15 and the analyzer 23 are constituted to detect, based on the variations in the detected thickness of the yarn 4, whether or not the yarn 4, extending from the supplying bobbin 3 to the winding bobbin 6 or 7, is running, that is, whether or not a yarn breakage of the yarn 4 has occurred, and are constituted to transmit a yarn breakage detection signal to the unit control portion 50 upon detection of a yarn breakage. The yarn clearer 15 and the analyzer 23 thus constitute a yarn defect detecting means for detecting defects of the yarn 4, extending from the yarn supplying portion 3 to the winding bobbin 6 or 7, and a yarn breakage detecting means for detecting whether the yarn 4, extending from the yarn supplying portion 3 to the winding bobbin 6 or 7, has been cut.

[0034] A lower yarn capturing and guiding means 17 that sucks and captures the lower yarn at the supplying bobbin 3 side and guides the yarn to the yarn piecing device 14 is provided at a lower side of the yarn piecing device 14. An upper yarn capturing and guiding means (yarn end capturing and guiding means) 20 that sucks and captures the upper yarn at the package 7 side and guides the yarn to the yarn piecing device 14 is provided at an upper side of the yarn piecing device 14. The upper yarn capturing and guiding means 20 is constituted in a form of a pipe, is disposed in a manner capable of swinging upward and downward about a shaft 21, and has a mouth 22 at its tip. The lower yarn capturing and guiding means 17 is also constituted in a form of a pipe, is disposed in a manner capable of swinging upward and downward about a shaft 18, and has a suction inlet 19 at its tip.

[0035] An appropriate negative pressure source is connected to the upper yarn capturing and guiding means 20 and the lower yarn capturing and guiding means 17 to generate suction act at the mouth 22 and the suction inlet 19. The yarns 4 from the package 7 and the supplying bobbin 3 can thus be sucked and captured, respectively. After yarn piecing by the yarn piecing device 14, the excess yarns 4 that have been extracted from the package 7 and the supplying bobbin 3 and cut by the yarn piecing device 14 are sucked and discarded from the mouth 22 and the suction inlet 19.

[0036] Appropriate actuators, constituted from an electric motor, cylinder, etc., are respectively coupled to the upper yarn capturing and guiding means 20 and the lower yarn capturing and guiding means 17. The upper yarn capturing and guiding means 20 and the lower yarn capturing and guiding means 17 are driven to pivot upward and downward by these actuators.

[0037] The waxing device 25 that applies wax to the running yarn 4 is disposed above (downstream side in the yarn running direction) of the yarn clearer 15. The yarn trap 26 is disposed above the waxing device 25. An appropriate negative pressure source is connected to the yarn trap 26 to suck and remove wax residue resulting from waxing by the waxing device 25 and to suck and remove waste yarn resulting from yarn breakage of the yarn 4.

[0038] The automatic winder 1 of the present embodiment is constituted as described above, and in this constitution, a yarn end extracting device 64 includes at least the upper yarn capturing and guiding means 20, the package diameter sensor 44, the package driving motor 41, the package drive control portion 42, and the unit control portion 50.

[0039] Rotation control of the winding bobbin 6 or 7 and traverse control of the traverse guide 11 in the au-

tomatic winder 1 will now be described. The package drive control portion 42 is constituted in the form of a microcomputer, and has a CPU as computing means, and a ROM or RAM, etc., as a storage means (not illustrated). The unit control portion 50 likewise has an unillustrated CPU and a ROM or RAM, etc.

[0040] The package drive control portion 42, the traverse control portion 46, and the unit control portion 50 constitute a control device for the yarn winding unit 2. Though a detailed description will be given below, this control device controls the traverse device 5, the package driving motor 41, the yarn piecing device 14, the lower yarn capturing and guiding means 17, and the upper yarn capturing and guiding means 20 so that when a yarn breakage is detected by the yarn breakage detecting means, the operation of the traverse device 5 is stopped and the yarn piecing device 14, the lower yarn capturing and guiding means 17, and the upper yarn capturing and guiding means 20 are actuated while the package driving motor 41 is operated to rotate the winding bobbin 6 or 7 in a reverse direction of the winding direction.

[0041] Of the control device, the unit control portion 50 has a package diameter computing means 71 and a yarn end delivery amount control means 72. The package diameter computing means 71 acquires the diameter D of the yarn layer 7 based on a signal input from the package diameter sensor 44. The yarn end delivery amount control means 72 is constituted to varyingly control the reverse rotation speed of the package driving motor 41 in six steps based on the package diameter D, acquired by the package diameter computing means 71, in a yarn end extracting operation.

[0042] A process flow at the unit control portion 50 will now be described with reference to FIG. 2. When this flow starts, the unit control portion 50 waits in the process of S101 until a yarn piecing request signal is input. The yarn piecing request signal refers to a yarn defect detection signal that is generated when the yarn clearer 15 detects a yarn defect and cuts the yarn, and a yarn breakage detection signal that is generated when yarn breakage of the yarn that is being unwound from the supplying bobbin 3 is detected by the yarn clearer 15, etc.

[0043] The unit control portion 50 thus repeats the process of S101 while the yarn 4 is being wound around the bobbin 6. When the yarn is cut in accordance with the detection of a yarn defect or when a yarn breakage occurs accompanying the unwinding of the yarn 4 from the supplying bobbin 3, the process proceeds onto a yarn end extracting process (S102 to S114), described below.

[0044] When it is determined at S101 that the yarn defect detection signal or the yarn breakage detection signal has been input into the unit control portion 50, the package driving motor 41 is immediately controlled to stop in order to stop the rotation of the winding bobbin 6 or 7, and in the process of S102, the diameter (package diameter) D of the yarn layer 7, formed by winding the yarn 4 around the winding tube 6, is acquired via the signal from the package diameter sensor 44.

[0045] Then, by the process of S103 to S113, the reverse rotation speed of the winding bobbin 6 or 7 (the speed at which the package driving motor 41 is rotated in reverse) is set to a speed among the six speed steps of V_1 to V_6 according to the acquired value of the package diameter D.

[0046] Specifically, if the package diameter D is less than a first preset diameter ϕ_1, the package reverse rotation speed is set to V_1 (from S103 to S108). If the package diameter D is no less than the first preset diameter ϕ_1 but less than a second preset diameter ϕ_2, the package reverse rotation speed is set to V_2 (from S104 to S109). If the package diameter D is no less than the second preset diameter ϕ_2 but less than a third preset diameter ϕ_3, the package reverse rotation speed is set to V_3 (from S105 to S110). If the package diameter D is no less than the third preset diameter ϕ_3 but less than a fourth preset diameter ϕ_4, the package reverse rotation speed is set to V_4 (from S106 to S111). If the package diameter D is no less than the fourth preset diameter ϕ_4 but less than a fifth preset diameter ϕ_5, the package reverse rotation speed is set to V_5 (from S107 to S112). If none of the above applies, that is, if the package diameter D is no less than the fifth preset diameter ϕ_5, the package reverse rotation speed is set to V_6 (S113).

[0047] The reverse rotation speed of the package driving motor 41 is thus selected from the six steps according to the package diameter D acquired in the process of S102. The speeds V_1 to V_6 are determined appropriately by the setting means 52 so as to decrease successively as the package diameter D increases ($V_1>V_2>V_3>V_4>V_5>V_6$), and signals that are in accordance with the set contents are transmitted from the host controller 51 and stored in advance in the RAM of the unit control portion 50. The package reverse rotation speed that is thus selected is transmitted to the package drive control portion 42.

[0048] The process proceeds onto S114 in which the upper yarn capturing and guiding means 20 is swung upward to bring the mouth 22 close to the surface of the yarn layer 7 and at substantially the same time, a signal is transmitted to the package drive control portion 42 to drive the package driving motor 41 in reverse at the abovementioned selected speed (a speed among V_1 to V_6). As a result, the yarn end of the upper yarn 4 positioned on the surface of the yarn layer 7 is unwound, led out, and captured by suction by the mouth 22 of the upper yarn capturing and guiding means 20 (FIG. 3). In this state, the upper yarn capturing and guiding means 20 is swung downward, the lower yarn capturing and guiding means 17 that has sucked and captured the lower yarn 4 at the supplying bobbin 3 side is swung upward, and the upper yarn 4 and the lower yarn 4 are pieced together by the yarn piecing device 14. The yarn end extracting operation and the yarn piecing operation at S114 are thus completed, the unit control portion 50 restarts winding by driving the package driving motor 41 to rotate forward. The process returns to S101 and the generation of the

yarn piecing request signal is awaited again. In this process, the operation of the upper yarn capturing and guiding means 20 is fixed regardless of the package diameter D, and the time during which the mouth 22 of the upper yarn capturing and guiding means 20 is brought close to the surface of the yarn layer is also fixed regardless of the package diameter D.

[0049] With the control of the present embodiment, in the process of delivering the upper yarn 4 from the yarn layer 7 in order to guide the upper yarn 4 to the yarn piecing device 14, one speed among the speeds V_1 to V_6 of six steps is selected as the package reverse rotation speed such that the package reverse rotation speed decreases successively as the package diameter D, obtained from the package diameter sensor 44, increases. Thus, in an initial winding stage in which the package diameter D is small, a high reverse rotation speed (V_1 or V_2, etc.) is selected, and in a stage immediately before a full bobbin is formed, in which the package diameter D is large, a low reverse rotation speed (V_6, etc.) is selected.

[0050] Because the delivered length of yarn end of the upper yarn 4 by reverse rotational drive of the package 7 can thus be stabilized regardless of the magnitude of the package diameter D, lowering of the production efficiency and degradation of the package quality can be prevented. Specifically, it is possible to prevent yarn piecing errors of the yarn piecing device 14 resulting from the extraction amount of the yarn 4 being excessively small when the package diameter D is small. In addition, it is possible to prevent the degradation of the package quality resulting from mixing in of kinked yarn into the yarn 4 due to the extraction amount of the yarn 4 being excessively large when the package diameter D is large and to prevent yarn piecing from being performed with the yarn 4 sucked in the yarn trap 26.

[0051] Since the process is a simple process in which when the diameter D obtained by the package diameter sensor 44 is within a predetermined range (for example, no less than the first preset diameter ϕ_1 but less than the second preset diameter ϕ_2), the speed of the corresponding step (V_1) is selected, the burden on the unit control portion 50 can be lightened and the electrical constitution of the unit control portion 50 can be simplified while acquiring the above-described effects.

[0052] Furthermore, the package diameter sensor 44 can detect the diameter D of the yarn layer 7 in the state in which the rotation of the winding bobbin 6 or 7 is stopped. Specifically, the package diameter sensor 44 is constituted as an angle sensor (rotary encoder) that detects the angle of swing of the cradle 8 that accompanies the increase in the diameter D accompanying the thickening of the yarn layer 7. The diameter D of the yarn layer 7 can thus be detected accurately by a simple control and constitution, and the amount of yarn unwound (leading amount) from the yarn layer 7 by reverse rotation of the package can be stabilized reliably.

[0053] As described above, the yarn winding unit 2 of the automatic winder 1 according to the present embodiment includes: the supplying bobbin (yarn supplying portion) 3; the package driving motor 41 that rotates the winding tube 6 for winding the yarn 4 from the supplying bobbin 3; the package diameter sensor 44 that detects the diameter D of the yarn layer 7 formed by winding the yarn 4 around the winding tube 6; and the yarn piecing device 14 that connects the starting yarn end of the supplying bobbin 3 with the terminal yarn end of the yarn layer 7 formed by winding the yarn 4 around the winding tube 6. The yarn winding unit 2 also includes: the lower yarn capturing and guiding means 17 that captures and guides the starting yarn end of the supplying bobbin 3 to the yarn piecing device 14; the upper yarn capturing and guiding means 20 that captures and guides the terminal yarn end of the yarn layer 7 to the yarn piecing device 14; and the yarn clearer 15 and the analyzer 23 that function as the yarn breakage detecting means that detects breakage of the yarn 4 from the supplying bobbin 3 to the winding bobbin 6 or 7. The yarn winding unit 2 also includes the control device that controls the package driving motor 41, the yarn piecing device 14, the lower yarn capturing and guiding means 17, and the upper yarn capturing and guiding means 20 so that, upon detection of a yarn breakage by the yarn breakage detecting means, the operation of the package driving motor 41 is stopped and then the yarn piecing device 14, the lower yarn capturing and guiding means 17, and the upper yarn capturing and guiding means 20 are actuated while the package driving motor 41 is operated to rotate the winding bobbin 6 or 7 in a reverse direction of the winding direction. The package driving motor 41 has its drive shaft coupled to the winding bobbin 6 or 7 and performs direct rotative drive of the winding bobbin 6 or 7. The control device has the yarn end delivery amount control means 72 that controls the package driving motor 41 so as to vary the reverse rotation speed of the winding bobbin 6 or 7 in six steps according to the diameter D of the yarn layer 7 detected by the package diameter sensor 44.

[0054] Because the reverse rotation speed of the winding bobbin 6 or 7 is controlled by selection of a speed from among six steps (the speeds V_1 to V_6) according to the package diameter D, the leading amount of the upper yarn 4 from the yarn layer 7 can be stabilized regardless of the magnitude of the package diameter D. As a result, yarn piecing errors of the yarn piecing device 4 resulting from inadequate leading amounts can be prevented, and waste loss of the yarn 4 and mixing in of kinked yarn by the yarn 4 being sucked into the yarn trap 26 due to excessive leading amounts can be prevented as well.

[0055] In the yarn winding unit 2 according to the present embodiment, the package diameter sensor 44 is constituted as a sensor that can detect the diameter D of the yarn layer 7 when the rotation of the winding bobbin 6 or 7 is stopped.

[0056] Thus, regardless of the rotation or stoppage of the winding bobbin 6 or 7, the diameter D of the yarn layer 7 can be detected accurately, and the reverse ro-

tation speed of the winding bobbin 6 or 7 can be set appropriately to stabilize the leading amount of the yarn end from the yarn layer 7 more reliably.

[0057] The yarn winding unit 2 according to the present embodiment also has the cradle 8, which can support the winding tube 6 and is disposed in a swingable manner. The package diameter sensor 44 is constituted as the angle sensor that can detect the swinging angle of the cradle 8.

[0058] Because the diameter D of the yarn layer 7 can be detected by a simple structure, the manufacturing cost of the yarn end extracting device 64 can be lowered.

[0059] The constitution disclosed above is one example, and following modifications can be made.

[0060] Though in the control example of FIG. 2, the reverse rotation speed of the winding bobbin 6 or 7 is selected from among speeds of six steps (speeds V_1 to V_6), the present invention is not restricted thereto and, the reverse rotation of the package driving motor 41 may be controlled upon selection from among speeds of no less than two steps. A constitution in which the reverse rotation speed of the winding bobbin 6 or 7 is varied in a stepless manner is also possible.

[0061] In the control example of FIG. 2, the reverse rotation time of the winding bobbin 6 or 7 in the yarn end extracting operation is fixed regardless of the package diameter D and just the reverse rotation speed of the winding bobbin 6 or 7 is changed. However, in place of this constitution, a constitution in which just the reverse rotation time of the winding bobbin 6 or 7 is changed in n steps, or a constitution in which both the reverse rotation speed and the reverse rotation time of the winding bobbin 6 or 7 are changed in n steps is also possible. In this case, by shortening the reverse rotation time of the package 7 as the package diameter D increases, the leading amount in the yarn end extracting operation can be stabilized in the same manner as described above. However, the above-described embodiment (FIG. 2) in which just the reverse rotation speed of the winding bobbin 6 or 7 is changed is preferable in that there is no need to change the time for making the upper yarn capturing and guiding means 20 approach the peripheral surface of the package 7 and simple control of the upper yarn capturing and guiding means 20 can thus be realized.

[0062] The package diameter sensor 44 can be constituted, for example, as a potentiometer instead of as a rotary encoder. The package diameter sensor 44 can also be changed, for example, to a non-contact sensor that directly detects the diameter of the yarn layer 7 instead of detecting the swinging angle of the cradle 8.

[0063] Instead of using the setting means 52 connected to the host controller 51 to set the preset diameters ϕ_1 to ϕ_5 and the six speed steps V_1 to V_6 to be selected, for example, the yarn winding unit 2 may be provided with a setting means and the preset diameters and speeds may be set by manual operation of the setting means by an operator.

[0064] Furthermore, the above-described constitution can be applied not only to the automatic winder 1 but also, for example, to a spinning machine that forms a wound package by winding yarn spun by a spinning device while traversing the yarn by a traverse guide and performs yarn piecing of yarn at a spinning side (yarn supplying side) with yarn at the wound package side by a yarn piecing device when a yarn breakage, etc., occurs.

Claims

1. A yarn winding machine comprising:

a yarn supplying portion;
a winding bobbin rotative driving device that rotates a winding bobbin for winding a yarn from the yarn supplying portion;
a diameter sensor that detects a diameter of a yarn layer formed by winding the yarn around said winding bobbin;
a yarn piecing device that connects a starting yarn end of said yarn supplying portion with a terminal yarn end of the yarn layer formed by winding the yarn around said winding bobbin;
a lower yarn capturing and guiding means that captures and guides the starting yarn end of said yarn supplying portion to said yarn piecing device;
an upper yarn capturing and guiding means that captures and guides the terminal yarn end of said yarn layer to said yarn piecing device;
a yarn breakage detecting means that detects breakage of the yarn extending from said yarn supplying portion to said winding bobbin; and
a control device that controls said winding bobbin rotative driving device, said yarn piecing device, said lower yarn capturing and guiding means, and said upper yarn capturing and guiding means so that, upon detection of the yarn breakage by the yarn breakage detecting means, an operation of said winding bobbin rotative driving device is stopped and then said yarn piecing device, said lower yarn capturing and guiding means, and said upper yarn capturing and guiding means are actuated while said winding bobbin rotative driving device is operated to rotate said winding bobbin in a reverse direction of a winding direction,

wherein said winding bobbin rotative driving device has a drive shaft to perform direct rotative drive of said winding bobbin,
said control device has a yarn end delivery amount control means that controls said winding bobbin rotative driving device so as to vary at least one of a reverse rotation speed and a reverse rotation time of said winding bobbin in n steps, provided that n is an integer no less than 2, according to the diameter

of the yarn layer detected by the diameter sensor.

2. The yarn winding machine according to Claim 1, wherein said diameter sensor is a sensor that can detect the yarn layer in a state in which the rotation of said winding bobbin is stopped.

3. The yarn winding machine according to Claim 1 or 2, further comprising:

a cradle that supports said winding bobbin and is disposed in a swingable manner,

wherein said diameter sensor is an angle sensor that detects a swinging angle of said cradle.

FIG. 1

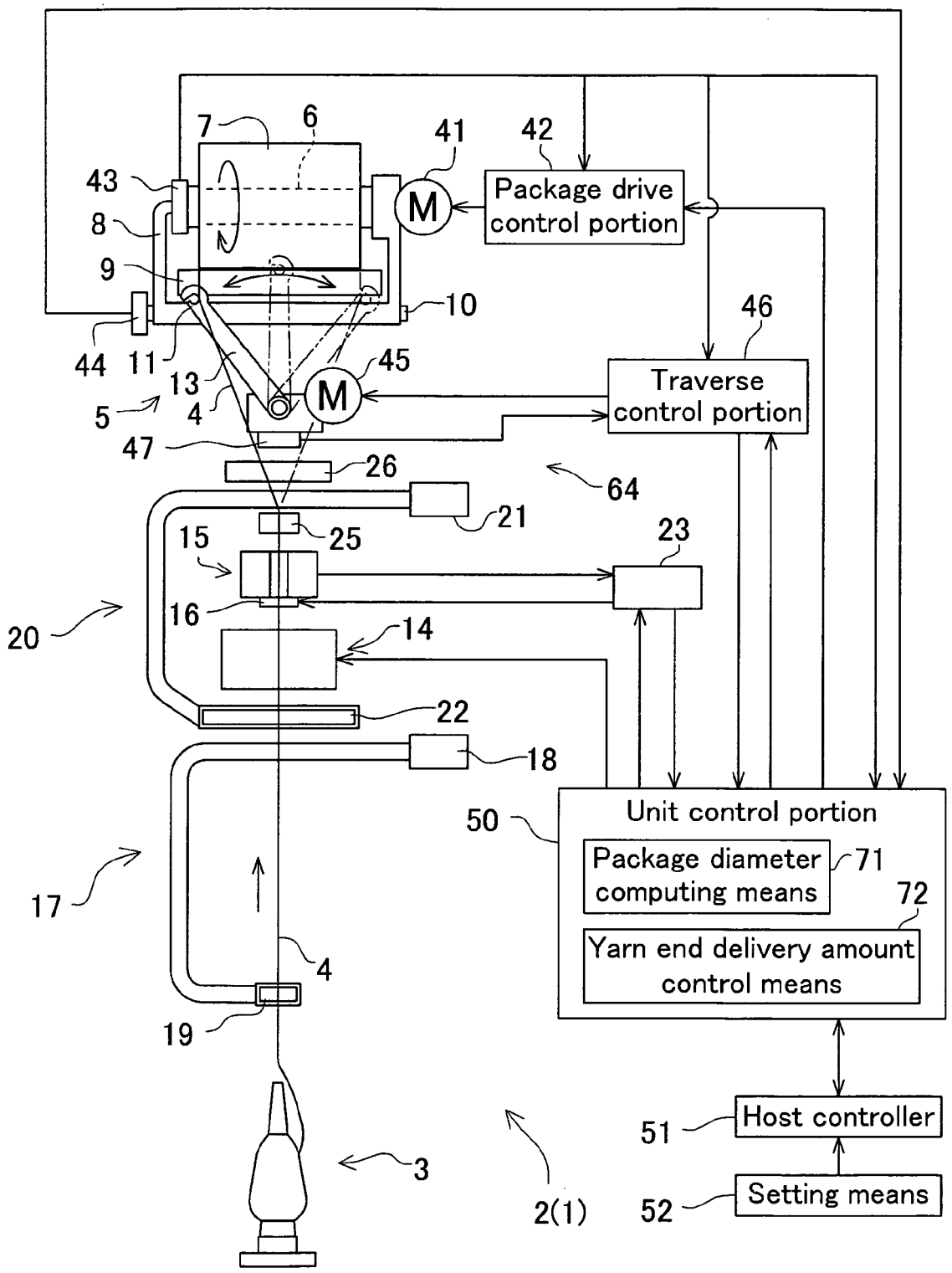

7
6
41
42
43
M
Package drive control portion
8
9
10
46
44
11
13
45
Traverse control portion
5
4
M
47
26
64
21
15
25
23
20
16
14
22
18
Unit control portion
50
Package diameter computing means
71
72
17
Yarn end delivery amount control means
4
19
Host controller
51
3
2(1)
52
Setting means

FIG. 2

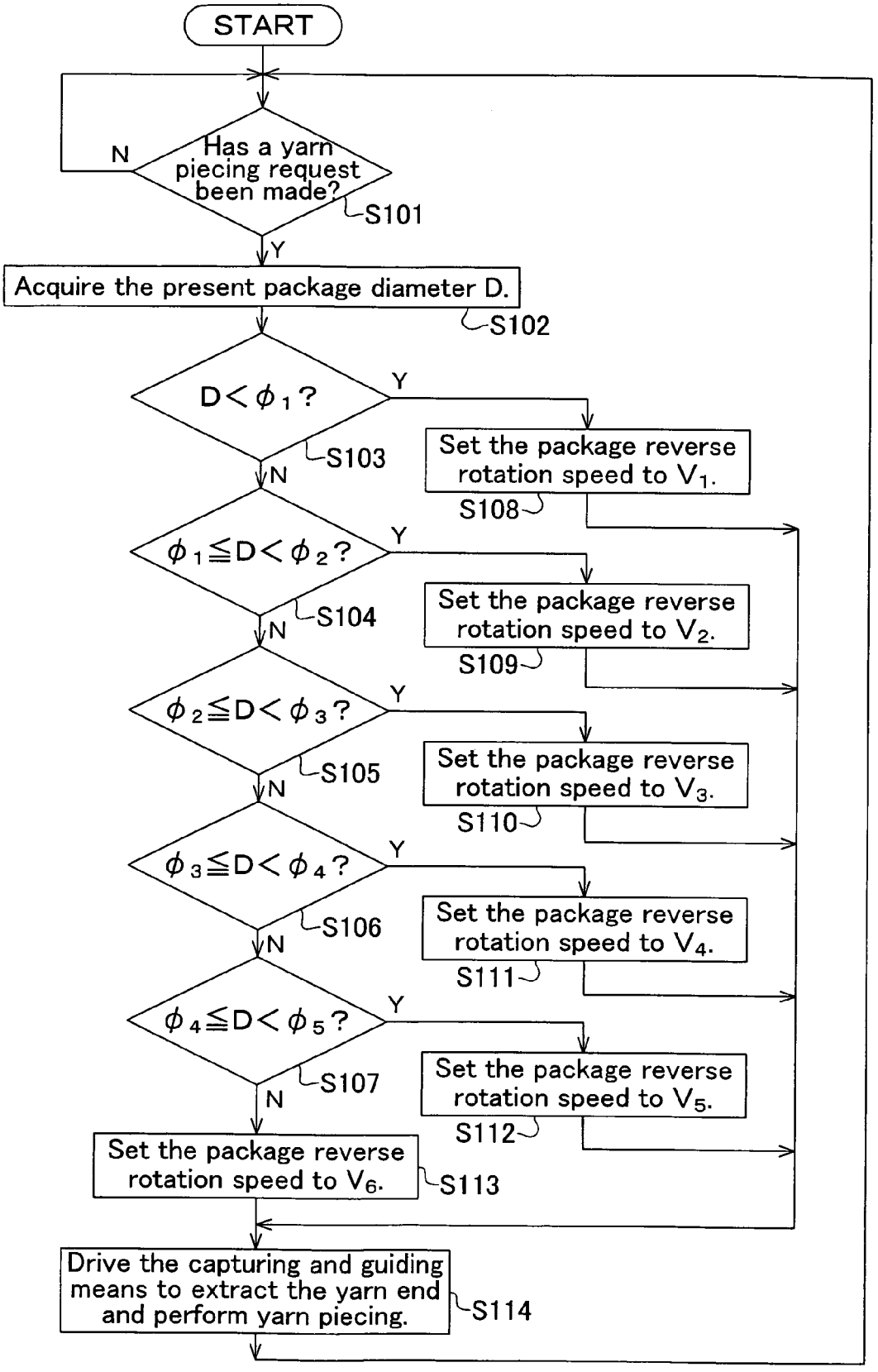
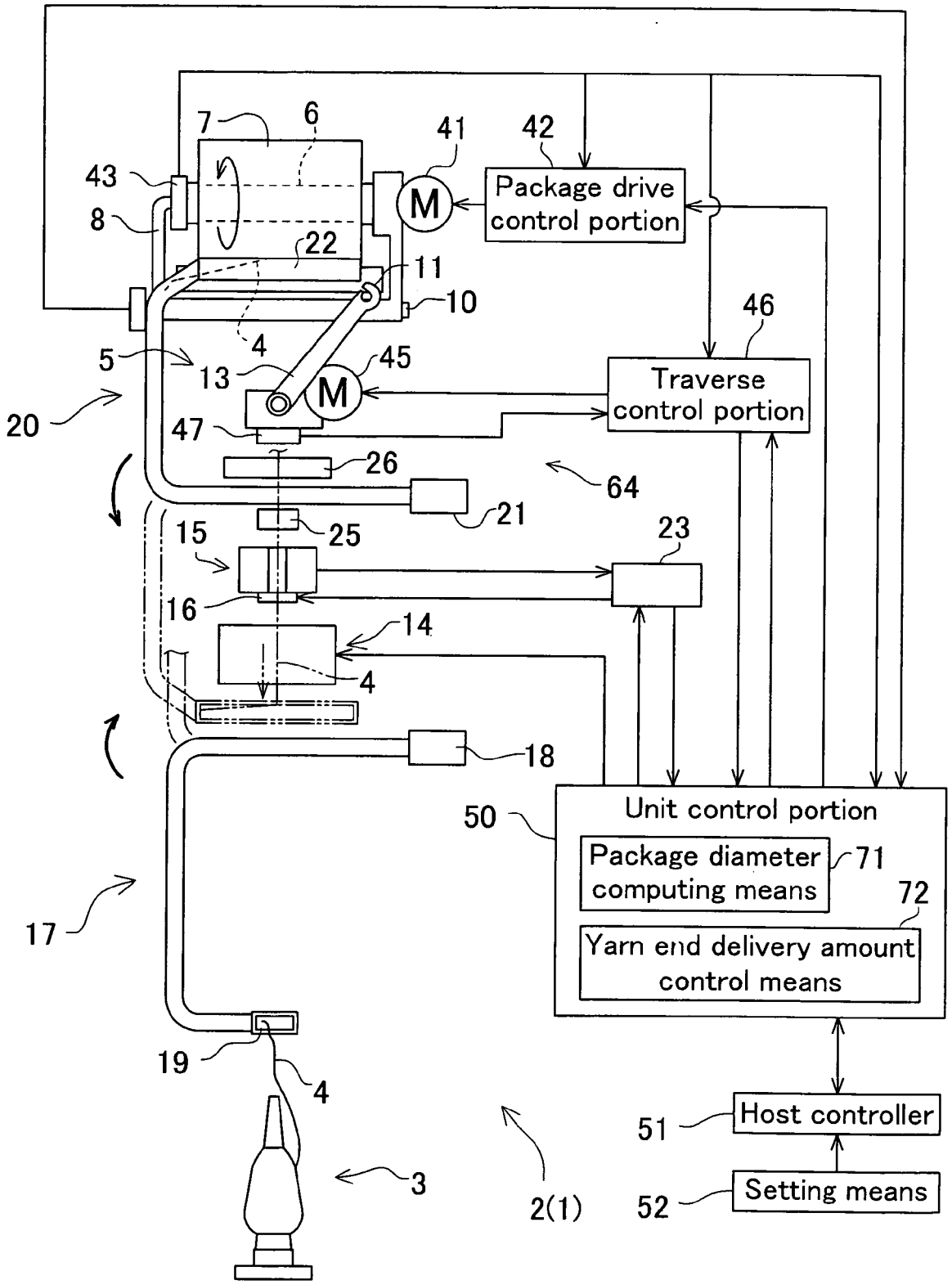

START
Has a yarn piecing request been made?
S101
N
Y
Acquire the present package diameter D.
S102
D<φ1?
S103
Set the package reverse rotation speed to V1.
S108
φ1≦D<φ2?
S104
Set the package reverse rotation speed to V2.
S109
φ2≦D<φ3?
S105
Set the package reverse rotation speed to V3.
S110
φ3≦D<φ4?
S106
Set the package reverse rotation speed to V4.
S111
φ4≦D<φ5?
S107
Set the package reverse rotation speed to V5.
S112
Set the package reverse rotation speed to V6.
S113
Drive the capturing and guiding means to extract the yarn end and perform yarn piecing.
S114

FIG. 3


7
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Package drive control portion
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11
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Traverse control portion
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Unit control portion
Package diameter computing means
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52
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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
Munich	4 April 2007	Kising, Axel

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