



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.11.2013 Bulletin 2013/47

(51) Int Cl.:
B65H 63/08 (2006.01)

(21) Application number: **13165639.9**

(22) Date of filing: **26.04.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventor: **Sone, Yoshifuto**
Kyoto, Kyoto 612-8686 (JP)

(74) Representative: **Beck, Alexander**
Hansmann & Vogeser
Patent- und Rechtsanwälte
Maximilianstrasse 4b
82319 Starnberg (DE)

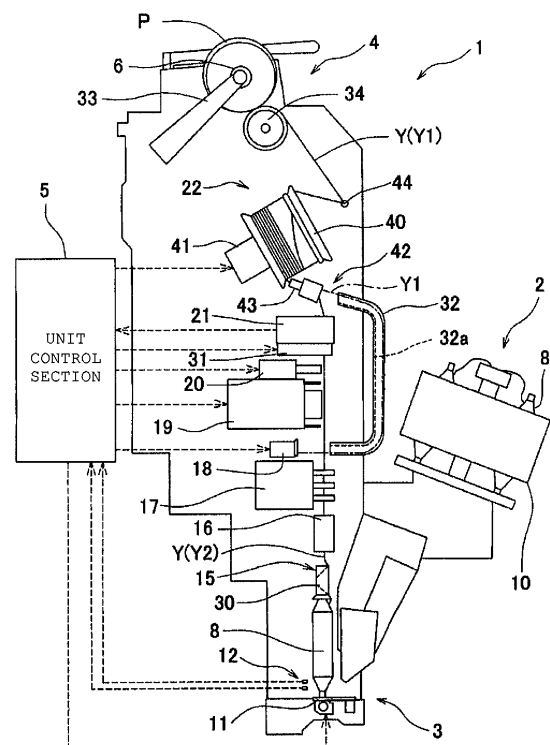
(30) Priority: **18.05.2012 JP 2012114442**

(71) Applicant: **Murata Machinery, Ltd.**
Kyoto-shi, Kyoto 601-8326 (JP)

(54) **Yarn winding device and yarn winding method**

(57) A winding unit (1) of an automatic winder includes a bobbin supporting section (3) adapted to support a yarn supplying bobbin (8) in a replaceable manner; a yarn accumulating device (22) adapted to wind a yarn (y) unwound from the yarn supplying bobbin (8) to accumulate the yarn; a package forming device (4) adapted to wind the yarn (y) unwound from the yarn accumulating device (22) to form a package (P); a yarn amount detecting section (12) adapted to detect an amount of yarn left on the yarn supplying bobbin (8); and a unit control section (5) adapted to predict an end of unwinding of the yarn (y) of the yarn supplying bobbin (8) based on a detection result of the yarn amount detecting section (12) and to decelerate a winding speed of the yarn accumulating device (22) prior to the end of unwinding of the yarn (y).

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding device and a yarn winding method adapted to wind a yarn unwound from a yarn supplying bobbin.

2. Description of the Related Art

[0002] Conventionally, there is known an automatic winder that unwinds a yarn of a yarn supplying bobbin produced by a fine spinning machine and the like, and joins yarns of a plurality of yarn supplying bobbins to form one package while removing a yarn defect such as slub.

[0003] An automatic winder of Japanese Unexamined Patent Publication No. 2009-242036 includes a bobbin supporting section adapted to support a yarn supplying bobbin, a package forming device adapted to wind the yarn unwound from the yarn supplying bobbin around a core tube while traversing the yarn to form a package, and a yarn joining device adapted to join a yarn from the package and a yarn from the yarn supplying bobbin at the time of replacing the yarn supplying bobbin, after carrying out a yarn cutting operation to remove a yarn defect, or after occurrence of an unexpected yarn breakage. A configuration for carrying out the yarn joining operation by the yarn joining device includes two yarn end catching members connected to a negative pressure source and adapted to individually suck and catch a yarn end from the package and a yarn end from the yarn supplying bobbin and transport the yarn ends to the yarn joining device.

[0004] As disclosed in Japanese Unexamined Patent Publication No. 2009-242042, there is known an automatic winder including a yarn accumulating device (accumulator) arranged between the package forming device and the yarn joining device and adapted to wind the yarn unwound from the yarn supplying bobbin to temporarily accumulate the yarn. In the automatic winder of Japanese Unexamined Patent Publication No. 2009-242042, the yarn end from the yarn accumulating device and the yarn end from the yarn supplying bobbin are respectively caught with a yarn end catching member and transported to the yarn joining device at the time of replacing the yarn supplying bobbin, after the cutting of the yarn, or after the yarn breakage, thus performing the yarn joining operation by the yarn joining device. In order that the yarn end from the yarn accumulating device is easily caught by the yarn end catching member, the yarn accumulating device includes a pull-out mechanism adapted to pull out the yarn end pulled into the yarn accumulating device. In the automatic winder of Japanese Unexamined Patent Publication No. 2009-242042, since the yarn accumulated in the yarn accumulating device is unwound and supplied to the package forming device while the yarn joining operation is being carried out, the

winding of the package can be continuously carried out without being interrupted.

[0005] When the yarn of the yarn supplying bobbin is all unwound, a new yarn supplying bobbin is supplied, and then the yarn end unwound from the previous yarn supplying bobbin and the yarn end of the yarn supplying bobbin supplied next are joined by the yarn joining device. In this case, it may be difficult to catch the yarn end (yarn end from the package) unwound from the previous yarn supplying bobbin by the yarn end catching member. For example, in the automatic winder of Japanese Unexamined Patent Publication No. 2009-242036, when the yarn of the yarn supplying bobbin is all unwound, the yarn end may strongly attach to the surface of the package. Alternatively, the yarn may be flipped to a position greatly distant from a predetermined position where the yarn end catching member sucks and catches the yarn end. In such cases, the yarn end becomes difficult to catch.

[0006] Similar problems occur in the automatic winder of Japanese Unexamined Patent Publication No. 2009-242042 including a yarn accumulating device between the yarn supplying bobbin and the package. That is, the yarn end unwound from the yarn supplying bobbin is sometimes pulled into the yarn accumulating device and may bite into the yarn layer. Alternatively, the yarn end unwound from the yarn supplying bobbin may be flipped to a position distant from the predetermined position. In such cases, the yarn end becomes difficult to pull out by the pull-out mechanism, and the yarn end becomes difficult to catch. The operation of the operator thus becomes necessary if the yarn end cannot be automatically caught by the yarn end catching member. Since this requires the winding operation of the package to be stopped, package production efficiency is lowered.

BRIEF SUMMARY OF THE INVENTION

[0007] An object of the present invention is to improve catching probability of a yarn end unwound from a previous yarn supplying bobbin at the time of replacing the yarn supplying bobbin.

[0008] A yarn winding device of the present invention includes a bobbin supporting section adapted to support a yarn supplying bobbin; a winding section adapted to wind a yarn unwound from the yarn supplying bobbin; a yarn amount detecting section adapted to detect an amount of yarn of the yarn supplying bobbin; a control section adapted to control a winding speed of the winding section; and a yarn state detecting section adapted to detect a state of a travelling yarn, wherein the control section predicts end of unwinding of the yarn of the yarn supplying bobbin based on a detection result of the yarn amount detecting section, and decelerates the winding speed of the winding section to stop the winding operation of the winding section before a yarn end reaches the winding section based on the detection result of the yarn state detecting section after the end of unwinding of the yarn from the yarn supplying bobbin.

[0009] According to the present invention, the end of unwinding of the yarn of the yarn supplying bobbin is predicted from the detection result of the yarn amount detecting section, and the winding is decelerated and stopped before the yarn end reaches the winding section when the unwinding of the yarn from the yarn supplying bobbin is finished. Therefore, the yarn end of the yarn unwound from the yarn supplying bobbin becomes easy to catch.

[0010] In the yarn winding device of the present invention, the control section decelerates the winding speed of the winding section when the yarn amount detecting section detects that the amount of yarn of the yarn supplying bobbin is less than a predetermined amount.

[0011] Thus, when the amount of yarn of the yarn supplying bobbin becomes the predetermined amount, the winding speed of the winding section is decelerated assuming the end of unwinding of the yarn is close, whereby the deceleration is carried out prior to the end of unwinding of the yarn.

[0012] In the yarn winding device of the present invention, the yarn amount detecting section includes a plurality of sensors each adapted to detect presence or absence of yarn at a plurality of positions in an axial direction of the yarn supplying bobbin.

[0013] By thus detecting the amount of yarn of the yarn supplying bobbin by the plurality of sensors, a state immediately before the end of unwinding of the yarn in which the yarn amount is small is prevented from being overlooked.

[0014] In the yarn winding device of the present invention, the control section determines that the amount of yarn of the yarn supplying bobbin is less than the predetermined amount when at least one of the plurality sensors detects that the yarn is absent at the detecting position.

[0015] In the state immediately before the end of unwinding, the yarn unwound last may concentrate and may be left as a lump in one area of the yarn supplying bobbin. In such a case, when the remaining yarn is unwound from the state in which the lump of remaining yarn is detected with the sensor, a state in which the yarn of the yarn supplying bobbin becomes completely absent is immediately reached. Hence, it is too late to decelerate the winding section thereafter.

[0016] In the present invention, when at least one of the plurality of sensors detects that the yarn is absent at the detecting position, the control section determines the yarn of the yarn supplying bobbin is less than the predetermined amount. In other words, even when the lump portion of remaining yarn exists and a certain sensor detects the lump of the remaining yarn, determination is made that the yarn of the yarn supplying bobbin is less than the predetermined amount when the yarn is absent at the detecting position of another sensor. Thus, the state before the end of unwinding of the yarn can be detected at an early stage.

[0017] The yarn amount detecting section of the yarn

winding device of the present invention is an unwinding length detection sensor adapted to detect a length of the yarn unwound from the yarn supplying bobbin.

[0018] Thus, the remaining yarn amount of the yarn supplying bobbin is calculated by the unwinding length detection sensor that detects the length of the unwound yarn. The state immediately before the end of the unwinding of the yarn in which the yarn amount is small is thus prevented from being overlooked.

[0019] The yarn winding device of the present invention includes a yarn state detecting section arranged in a yarn travelling path between the bobbin supporting section and the winding section, and adapted to detect a state of a travelling yarn, wherein the control section decelerates the winding speed of the winding section, and then stops the winding operation of the winding section when the yarn state detecting section no longer detects the yarn.

[0020] According to the present invention, whether or not the yarn is travelling is detected by the yarn state detecting section arranged between the bobbin supporting section and the winding section and adapted to detect the state of the yarn. According to such a configuration, the end of unwinding of the yarn of the yarn supplying bobbin can be reliably grasped.

[0021] In the present invention, the yarn state detecting section may be a yarn defect detecting device adapted to detect a yarn defect contained in the yarn. Alternatively, the yarn state detecting section may be a yarn presence/absence detecting device adapted to detect presence or absence of the yarn travelling through the yarn travelling path. Alternatively, the yarn state detecting section may be a yarn speed detecting device adapted to detect a speed of the yarn travelling through the yarn travelling path. Alternatively, the yarn state detecting section may be a yarn length detecting device adapted to detect a length of the yarn travelling through the yarn travelling path. Alternatively, the yarn state detecting section may be a yarn tension detecting device adapted to detect a tension of the yarn travelling through the yarn travelling path.

[0022] According to the present invention, in the yarn winding operation by the normal winding section, the end of unwinding of the yarn of the yarn supplying bobbin is detected using various detecting devices for detecting the state of the yarn. A dedicated detecting section for detecting the end of unwinding of the yarn is not necessary.

[0023] In the yarn winding device of the present invention, the yarn amount detecting section also serves as the yarn state detecting section adapted to detect a state in which the unwinding of the yarn is finished and the yarn is not left on the yarn supplying bobbin in addition to detecting whether or not the yarn of the yarn supplying bobbin is less than the predetermined amount, wherein the control section decelerates the winding speed of the winding section, and then stops the winding operation of the winding section when the state in which the yarn is

not left on the yarn supplying bobbin is detected by the yarn amount detecting section.

[0024] According to the present invention, the yarn amount detecting section detects that the yarn of the yarn supplying bobbin is less than the predetermined amount, and also detects the state of end of the unwinding of the yarn. Therefore, the start of deceleration and the stopping of winding of the winding section can be carried out based on the detection result by one yarn amount detecting section. A special detecting section for detecting the end of unwinding of the yarn is not necessary.

[0025] The yarn winding device of the present invention includes a first yarn end catching section adapted to catch a yarn end from the winding section in replacing the yarn supplying bobbin; a second yarn end catching section adapted to catch a yarn end from the yarn supplying bobbin in replacing the yarn supplying bobbin; and a yarn joining device adapted to join the yarn end from the winding section and the yarn end from the yarn supplying bobbin respectively caught by the first yarn end catching section and the second yarn end catching section.

[0026] As described above, by decelerating the winding speed of the winding section prior to the end of unwinding of the yarn of the yarn supplying bobbin, the yarn end (yarn end from the winding section) is prevented from being entangled with the winding section when the unwinding of the yarn is finished. Alternatively, the yarn end is prevented from biting into the yarn layer of the winding section or from being flipped to an area distant from a predetermined catching position. Therefore, the yarn end of the winding section can be easily caught by the first yarn end catching section, and the success percentage of the yarn joining operation by the yarn joining device increases.

[0027] The yarn winding device of the present invention further includes a package forming device adapted to wind the yarn of the yarn supplying bobbin around a winding tube to form a package, wherein the winding section is a yarn accumulating device arranged between the bobbin supporting section and the package forming device, and adapted to wind the yarn unwound from the yarn supplying bobbin to temporarily accumulate the yarn, and the package forming device winds the yarn unwound from the yarn accumulating device around the winding tube.

[0028] The yarn accumulating device is arranged between the bobbin supporting section and the package forming device to temporarily accumulate the yarn unwound from the yarn supplying bobbin. Even under a state where the yarn is not supplied from the yarn supplying bobbin such as at the time of replacing the yarn supplying bobbin or at the time of occurrence of yarn breakage, the yarn accumulated in the yarn accumulating device can be supplied to the package forming device. Accordingly, the interruption of the winding operation of the package forming device can be suppressed as much as possible, thus improving the package production effi-

ciency. In the yarn winding device equipped with such a yarn accumulating device, by decelerating the winding speed of the yarn accumulating device prior to the end of unwinding of the yarn of the yarn supplying bobbin when the amount of yarn of the yarn supplying bobbin becomes small, the yarn end from the yarn accumulating device can be easily caught after the end of unwinding of the yarn. Furthermore, the yarn winding device can promptly resume the winding (accumulation of yarn) after replacing the yarn supplying bobbin.

[0029] In the yarn winding device of the present invention, the control section decelerates a winding speed of the package forming device when decelerating the winding speed of the winding section prior to the end of unwinding of the yarn of the yarn supplying bobbin.

[0030] In the present invention, the winding speed of the package forming device is decelerated when decelerating the winding speed of the winding section prior to the end of unwinding of the yarn of the yarn supplying bobbin. Thus, it is possible to avoid sudden reduction in the yarn amount accumulated in the yarn accumulating device. According to such a configuration, the yarn accumulated in the yarn accumulating device is prevented from running out.

[0031] The winding section of the yarn winding device of the present invention is a package forming device adapted to wind the yarn of the yarn supplying bobbin around a winding tube to form a package, and the package forming device unwinds the yarn from the yarn supplying bobbin to wind the yarn around the winding tube.

[0032] Accordingly, the yarn end of the package can be easily caught by the first yarn end catching section, and the success percentage of the yarn joining operation by the yarn joining device increases. The package production efficiency is thus improved.

[0033] A yarn winding method of the present invention is a method for winding a yarn unwound from a yarn supplying bobbin, the method including a step of detecting an amount of yarn left on the yarn supplying bobbin, and a step of predicting end of unwinding of the yarn of the yarn supplying bobbin from a detection result of the yarn amount detecting step, and decelerating a winding speed of a winding section adapted to wind the yarn prior to the end of unwinding of the yarn of the yarn supplying bobbin.

[0034] According to the present invention, the remaining amount of the yarn of the yarn supplying bobbin is detected to predict the end of unwinding of the yarn, and the winding speed of the winding section is decelerated prior to the end of unwinding of the yarn to stop the winding before the yarn end reaches the winding section. Even if the yarn end is wound by the winding section, since the tension of the yarn is lowered by the deceleration before the end of unwinding of the yarn, the yarn end is less likely to bite into the yarn layer of the winding section and the yarn end is neither flipped. Therefore, the yarn end of the yarn unwound from the yarn supplying bobbin becomes easy to catch.

[0035] The yarn winding method of the present inven-

tion further includes a step of stopping the winding section before the yarn end of when the yarn of the yarn supplying bobbin is all unwound reaches the winding section after the winding speed of the winding section is decelerated in the decelerating step.

[0036] The yarn end is more easily caught by stopping the winding operation of the winding section before the yarn end of the yarn of the yarn supplying bobbin reaches the winding section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG. 1 is a side view of one winding unit of an automatic winder according to the present invention;

FIG. 2 is a side view of a yarn accumulating device; FIG. 3A is a view describing a yarn amount detecting section shortly before end of unwinding of the yarn; FIG. 3B is a view describing the yarn amount detecting section immediately before the end of unwinding of the yarn;

FIG. 4 is a flowchart describing a series of processing steps performed at the time of replacing a yarn supplying bobbin;

FIG. 5 show graphs illustrating a deceleration profile of a yarn accumulating roller of one embodiment of the present invention and the remaining amount of yarn of the yarn supplying bobbin; and

FIG. 6 is a side view of a winding unit according to an alternative embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0038] An embodiment of the present invention will be described below. The present embodiment is an example in which the present invention is applied to an automatic winder including a plurality of winding units (yarn winding devices), adapted to wind a yarn unwound from a yarn supplying bobbin to form a winding package. The automatic winder has a configuration in which the plurality of winding units, each forming one package, is arranged in a line in one direction. FIG. 1 is a side view of one winding unit 1 of the automatic winder.

[0039] As illustrated in FIG. 1, each winding unit (yarn winding device) 1 includes a bobbin supplying device 2, a bobbin supporting section 3, a package winding device 4, and a unit control section 5 for controlling each section of the winding unit 1. With a yarn supplying bobbin 8 supplied from the bobbin supplying device 2 being held by the bobbin supporting section 3, the winding unit 1 winds a spun yarn Y unwound from the yarn supplying bobbin 8 around a winding tube 6 while traversing the spun yarn Y to form a package P of a predetermined shape.

[0040] The bobbin supplying device 2 includes a rotary magazine 10 capable of holding a plurality of extra yarn supplying bobbins 8. When the magazine 10 is intermit-

tently rotated, one yarn supplying bobbin 8 out of the plurality of yarn supplying bobbins held in the magazine 10 is dropped diagonally so that the yarn supplying bobbin 8 is supplied to the bobbin supporting section 3.

[0041] The bobbin supporting section 3 holds the yarn supplying bobbin 8 in a replaceable manner. Specifically, the yarn supplying bobbin 8 supplied from the bobbin supplying device 2 is held in a substantially upright state by a bobbin holding tool (not illustrated) inserted to a lower end of the yarn supplying bobbin 8. When the yarn of the yarn supplying bobbin 8 is all unwound and the yarn supplying bobbin 8 becomes empty (state in which yarn is not wound), the bobbin supporting section 3 can flip up the yarn supplying bobbin 8 by a springboard 11 to discharge the yarn supplying bobbin 8 outside the bobbin supporting section 3. The bobbin supporting section 3 also includes a yarn amount detecting section 12 (yarn amount detecting section) adapted to detect an amount of yarn of the yarn supplying bobbin 8. The details of the yarn amount detecting section 12 will be described later.

[0042] On a yarn travelling path between the bobbin supporting section 3 and the package forming device 4, an unwinding assisting device 15, a lower yarn blow-up device 16, a tension applying device 17, an upper yarn catching device 18, a yarn joining device 19, a lower yarn catching device 20, a clearer 21 serving as a yarn defect detecting device, and a yarn accumulating device (winding section) 22 are arranged in this order from the bobbin supporting section 3.

[0043] The unwinding assisting device 15 lowers a tube body 30, which covers an upper end of the yarn supplying bobbin 8, with advancement in the unwinding of the yarn Y to regulate bulging (balloon) of the yarn Y during the unwinding and stabilize the unwinding tension.

[0044] The lower yarn blow-up device 16 is connected to a compressed air source (not illustrated), and is configured to generate an upward airflow at the time of the yarn joining operation to blow up a lower yarn Y2 from the yarn supplying bobbin 8 towards the yarn joining device 19.

[0045] The tension applying device 17 is adapted to apply a predetermined tension on the travelling yarn Y. The tension applying device 17 may be, for example, a gate-type which includes fixed comb teeth and movable comb teeth movably arranged with respect to the fixed comb teeth.

[0046] The upper yarn catching device 18 (first yarn end catching section) is connected to a negative pressure source (not illustrated). The negative pressure source is adapted to generate a suction airflow during the yarn joining operation to suck and catch an upper yarn Y1 from the yarn accumulating device 22 guided by a guide member 32, to be described later.

[0047] The lower yarn catching device 20 (second yarn end catching section) is connected to the negative pressure source (not illustrated), and catches the lower yarn Y2 blown up by the lower yarn blow-up device 16 at the time of the yarn joining operation.

[0048] The yarn joining device 19 joins the lower yarn Y2 from the yarn supplying bobbin 8 and the upper yarn Y1 from the winding side (yarn accumulating device 22) at the time of replacing the yarn supplying bobbin 8, after yarn cut carried out when the clearer 21, described later, detects a yarn defect, or after yarn breakage during the unwinding of the yarn from the yarn supplying bobbin 8. The yarn joining device 19 may be the yarn joining device 19 (air splicer) including an untwisting nozzle adapted to untwist the yarn end of the upper yarn Y1 and the yarn end of the lower yarn Y2, and a twisting nozzle adapted to apply a whirling airflow on the untwisted yarn ends to twist the yarn ends.

[0049] The clearer 21 (yarn defect detecting device) is arranged on the yarn travelling path between the bobbin supporting section 3 and the yarn accumulating device 22, and detects a yarn defect such as slub of the yarn Y travelling through the yarn travelling path. The clearer 21 is provided with a cutter 31 for cutting the yarn when the yarn defect is detected.

[0050] The substantially tubular guide member 32 is arranged on the side of the yarn joining device 19 between the upper yarn catching device 18 and the yarn accumulating device 22 so as to circumvent a linear yarn travelling path during normal winding. Furthermore, a slit 32a is formed over the entire length of the guide member 32 in a side wall of the guide member 32 on the left side in the figure (yarn travelling path side).

[0051] At the time of the yarn joining operation, the upper yarn Y1 from the yarn accumulating device 22 is pulled out by an upper yarn pull-out device of the yarn accumulating device 22, to be described later, and fed to the guide member 32, and the yarn end of the upper yarn Y1 is passed through the guide member 32 to be caught by the upper yarn catching device 18. Furthermore, when the yarn is pulled by the upper yarn catching device 18, the yarn is pulled out to the outside of the guide member 32 through the slit 32a and guided to the yarn joining device 19. The lower yarn Y2 from the yarn supplying bobbin 8 is blown upward by the lower yarn blow-up device 16. Moreover, the blown-up yarn is caught and pulled by the lower yarn catching device 20 to be guided to the yarn joining device 19. After the upper yarn Y1 and the lower yarn Y2 are set in the yarn joining device 19 in this manner, the yarn joining device 19 joins the upper yarn Y1 and the lower yarn Y2.

[0052] The yarn accumulating device 22 is a winding section adapted to wind the yarn Y unwound from the yarn supplying bobbin 8 to temporarily accumulate the yarn. The details on the structure of the yarn accumulating device 22 will be described later.

[0053] The package forming device 4 includes a cradle 33 which has a pair of cradle arms for rotatably and detachably supporting the winding tube 6, and a traverse drum 34 which can make contact with the surface of the winding tube 6 supported by the cradle 33 or the surface of the package P formed on the winding tube 6. The package forming device 4 is rotated by a drum drive motor

(not illustrated) with the traverse drum 34 making contact with the winding tube 6 (or the surface of the package P). The package forming device 4 is configured such that the winding tube 6 is rotated (accompanying rotation) accompanying the rotation of the traverse drum 34 while traversing the yarn unwound from the yarn accumulating device 22, to form the package P on an outer periphery of the winding tube 6. In place of the traverse drum 34, an arm traverse mechanism including a yarn traverse arm for holding and swinging the yarn to traverse the yarn may be adopted for the package forming device 4. When the arm traverse mechanism is adopted, a configuration in which a package drive motor for directly rotating the package is arranged in the cradle 33 may also be adopted instead of the drum drive motor.

[0054] In the present embodiment, the yarn accumulating device 22 adapted to accumulate the yarn Y is arranged between the bobbin supporting section 3 and the package forming device 4. Even if the unwinding of the yarn from the yarn supplying bobbin 8 is interrupted for some reason (e.g., during the yarn joining operation by the yarn joining device 19), the package forming device 4 can wind the yarn accumulated in the yarn accumulating device 22. Thus, the winding of the package P can be continued even if the unwinding of the yarn from the yarn supplying bobbin 8 is interrupted.

[0055] The unit control section 5 (control section) is configured by a CPU (Central Processing Unit) which is an arithmetic processing unit, a ROM (Read-Only Memory) which stores programs executed by the CPU and data used in the program, a RAM (Random Access Memory) which temporarily stores the data during the execution of the program, an input/output interface for inputting and outputting data from and to outside. The unit control section 5 controls the operation of each device of the above-described winding unit 1 based on a command sent from a machine control device (not illustrated), which performs the overall control of the automatic winder.

[0056] Next, the yarn accumulating device 22 will be described in detail. FIG. 2 is a side view of the yarn accumulating device 22. As illustrated in FIG. 1 and FIG. 2, the yarn accumulating device 22 includes a yarn accumulating roller 40 adapted to wind and accumulate the yarn, a roller driving motor 41 which rotatably drives the yarn accumulating roller 40, and an upper yarn pull-out device 42 which pulls out the yarn end of the yarn wound around the yarn accumulating roller 40 at the time of the yarn joining operation.

[0057] As illustrated in FIG. 2, the yarn accumulating roller 40 is rotatably supported on the machine bed of the winding unit 1 with an axis C1, which is slightly tilted with respect to a horizontal direction, as a center. Tapered portions 40a, 40b, with a diameter, which becomes larger towards the end, are formed at both axial ends of the yarn accumulating roller 40, respectively. The portion between the two tapered portions 40a, 40b is a cylindrical portion 40c having a constant diameter, and the yarn Y is wound around the cylindrical portion 40c. The yarn Y

wound around the cylindrical portion 40c is prevented from falling off by the two tapered portions 40a, 40b at both ends. The outer surface of the cylindrical portion 40c may be formed in a gradually tapered shape.

[0058] The roller driving motor 41 is attached to a basal end (end on the left side in the figure) of the yarn accumulating roller 40. The roller driving motor 41 is a position controllable motor such as a DC brushless motor, a stepping motor, a servo motor, and the like, and can rotatably drive the yarn accumulating roller 40 in both directions.

[0059] A guide tube 43 which constitutes one part of the upper yarn pull-out device 42, to be described later, is arranged in proximity to the tapered portion 40a on the basal end side of the yarn accumulating roller 40. One end of the guide tube 43 is arranged close to the surface of the yarn accumulating roller 40. At the time of the normal winding, the yarn from the yarn supplying bobbin 8 is guided to the tapered portion 40a on the basal end side of the yarn accumulating roller 40 through the guide tube 43.

[0060] When the yarn accumulating roller 40 is rotated in one direction, the yarn Y guided to the tapered portion 40a on the basal end side of the yarn accumulating roller 40 by the guide tube 43 is sequentially wound while pushing up the previous yarn layer from the basal end side (left side in the figure) of the cylindrical portion 40c. As a result, the yarn that is already wound around the yarn accumulating roller 40 is pushed by the newly wound yarn, and is sequentially fed towards the distal end side. The yarn is thus spirally aligned and orderly wound from the basal end side on the outer peripheral surface of the cylindrical portion 40c of the yarn accumulating roller 40.

[0061] Meanwhile, the yarn wound around the yarn accumulating roller 40 is pulled out from the tapered portion 40b on the distal end side (right side in the figure) of the yarn accumulating roller 40, and is fed downstream (towards the package forming device 4). At the tapered portion 40b on the distal end side, the yarn on the yarn accumulating roller 40 is pulled out towards the downstream through a pull-out guide 44, which is positioned on an extended line of the center axis C1 of the yarn accumulating roller 40.

[0062] A rubber annular member 45 such as a rubber band, an O ring, or the like is attached to the distal end of the cylindrical portion 40c of the yarn accumulating roller 40 (boundary portion with the distal end side tapered portion 40b). The yarn wound around the yarn accumulating roller 40 is passed between the yarn accumulating roller 40 and the annular member 45 to be unwound, whereby an appropriate tension is applied on the unwinding yarn. The annular member 45 is prevented from falling off from the yarn accumulating roller 40 by the tapered portion 40b on the distal end side of the yarn accumulating roller 40.

[0063] An upper limit sensor 46 for detecting that the amount of yarn on the yarn accumulating roller 40 is greater than or equal to a predetermined upper limit amount, and a lower limit sensor 47 for detecting that the

amount of yarn is smaller than a predetermined lower limit amount are arranged in proximity of the outer peripheral surface of the cylindrical portion 40c of the yarn accumulating roller 40. The detection results of the upper limit sensor 46 and the lower limit sensor 47 are sent to the unit control section 5. Based on the detection results of the sensors 46, 47, the unit control section 5 controls the roller driving motor 41 such that the yarn accumulating amount (winding amount) of the yarn accumulating roller 40 is within a range between the upper limit amount and the lower limit amount.

[0064] The upper yarn pull-out device 42 is a device for pulling out the yarn end of the yarn from the yarn accumulating device 22 (upper yarn Y1) to perform the yarn joining operation by the yarn joining device 19 at the time of replacement of the yarn supplying bobbin 8, after the cutting of the yarn, or after the yarn breakage when the yarn defect is detected. The upper yarn pull-out device 42 includes the guide tube 43 mentioned above. A yarn passage 50 and a nozzle 51 connected to the yarn passage 50 are formed inside the guide tube 43. One end of the guide tube 43 faces the tapered portion 40a on the basal end side of the yarn accumulating roller 40, and the above-described guide member 32 is arranged at the other end of the guide tube 43 with its opening at the upper end facing the guide tube 43. The nozzle 51 is connected to a compressed air source 52, and an electromagnetic valve 53 that opens and closes by a signal from the unit control section 5 is arranged between the nozzle 51 and the compressed air source 52.

[0065] At the time of the normal winding, the yarn unwound from the yarn supplying bobbin 8 is passed through the yarn passage 50 of the guide tube 43 and guided to the surface of the yarn accumulating roller 40. At the time of the yarn joining operation, the electromagnetic valve 53 is switched from close to open, and the compressed air is supplied from the nozzle 51 into the yarn passage 50, so that the airflow directed from the yarn accumulating roller 40 towards the guide member 32 is generated in the yarn passage 50. Under this state, when the yarn accumulating roller 40 is rotated opposite to the rotation at the time of normal winding, the yarn on the yarn accumulating roller 40 is unwound from the basal end side, and the yarn end thereof is pulled into the guide tube 43 by the airflow and further fed from the guide tube 43 to the guide member 32. The yarn end of the upper yarn Y1 fed to the guide member 32 in this manner is guided to and caught by the above-described upper yarn catching device 18, whereby the upper yarn Y1 is led to the yarn joining device 19.

[0066] The upper yarn Y1 is pulled out from the yarn accumulating device 22 by the upper yarn pull-out device 42 during the yarn joining operation, but the yarn end of the upper yarn Y1 is wound around the yarn accumulating roller 40 when the unwinding of the yarn supplying bobbin 8 is finished. If the tension of the yarn immediately before the end of unwinding is large, the yarn end of the upper yarn Y1 may bite into the yarn layer of the yarn accumu-

lating roller or may be flipped to a position greatly distant from the original position (proximate position of the tapered portion 40a on the basal end side) sucked by the guide tube 43. In such cases, the catching (pulling out) of the yarn end by the upper yarn pull-out device 42 and the upper yarn catching device 18 becomes difficult.

[0067] The winding unit 1 of the present embodiment is thus devised to easily catch the yarn end of the upper yarn Y1 from the yarn accumulating device 22 unwound from the previous yarn supplying bobbin 8 particularly during the yarn joining operation after the yarn supplying bobbin 8 is replaced. Specifically, the amount of yarn of the yarn supplying bobbin 8 is detected to predict that the end on unwinding of the yarn is close, and the rotation speed (winding speed) of the yarn accumulating roller 40 of the yarn accumulating device 22 is decelerated prior to the end of the unwinding of the yarn. Thereafter, when the yarn is all unwound from the yarn supplying bobbin 8, the yarn accumulating roller 40 is stopped from the decelerating state. By once decelerating and then stopping the yarn accumulating roller 40 in this manner, the yarn end of the upper yarn Y1 can be prevented from being wound around the yarn accumulating roller 40. Since this deceleration lowers the tension of the yarn immediately before the end of unwinding of the yarn, the yarn end is prevented from biting into the yarn layer of the yarn accumulating roller 40 or from being flipped to a distant position.

[0068] The control of the yarn accumulating roller 40 at the time of replacing the yarn supplying bobbin 8 will be described below. Before this, the yarn amount detecting section 12 for detecting the yarn amount to predict the end of unwinding of the yarn of the yarn supplying bobbin 8 will be described. In order to perform the deceleration of the yarn accumulating roller 40, the yarn amount detecting section 12 desirably has a configuration of detecting, at an early stage, the state immediately before the end of unwinding of the yarn in which the amount of yarn of the yarn supplying bobbin 8 is less than a predetermined amount, so that the deceleration is performed in time. One example of such a configuration will be described below.

[0069] FIG. 3A and 3B are views describing the yarn amount detecting section 12. As illustrated in FIG. 3A and 3B, the yarn amount detecting section 12 includes reflective photosensors 55a and 55b including a light emitting section for irradiating light toward the yarn supplying bobbin 8 and a light receiving section for receiving the reflected light. The reflectivity of the surface of the yarn supplying bobbin 8 differs between a state in which the yarn layer is present and a state in which the yarn layer is absent at the light irradiating position of the yarn supplying bobbin 8. Therefore, detection is made that the yarn layer is absent at a predetermined detection position from the change in the light receiving amount of the light receiving section of the photosensors 55a and 55b, so that the region where the yarn is wound on the surface of a core tube 54 becomes significantly small, and a state

in which the yarn amount is less than a predetermined amount (i.e., state immediately before the end of unwinding of the yarn) can be detected.

[0070] The yarn amount detecting section 12 includes two photosensors 55a, 55b arranged spaced apart in an axial direction (vertical direction) of the yarn supplying bobbin 8 to respectively detect the yarn at two detecting positions on the surface of the yarn supplying bobbin 8 (core tube 54). Thus, by detecting the presence or absence of the yarn layer at two detecting positions in the vertical direction of the yarn supplying bobbin 8 by the two photosensors 55a, 55b, the state immediately before the end of unwinding of the yarn is less likely to be overlooked.

[0071] In particular, as illustrated in FIG. 3A, the thickness of the yarn layer is not uniformly made thin within a range of the lower end of the core tube 54 immediately before the end of unwinding of the yarn, but as illustrated in FIG. 3B, the state immediately before the end of unwinding of the yarn is less likely to be overlooked if there is more than one photosensor 55a or 55b when the yarn unwound lastly is left as a lump at an unspecified position at the lower end of the core tube 54.

[0072] One of the reasons for the occurrence of the state in which the yarn unwound lastly is left as a lump is that when the yarn supplying bobbin 8 is produced by the fine spinning machine, in particular, when the operator starts winding after manually hooking the yarn on the core tube 54, the yarn at the beginning of the winding tends to be wound in a lump at the first yarn hooking position. Furthermore, when the operator manually hooks the yarn, the yarn hooking position on the core tube 54 may shift in the axial direction, and if the yarn is unwound from such a yarn supplying bobbin 8 by the winding unit 1, the position of the lump of yarn left immediately before the end of unwinding may differ. That is, a lump 56 of yarn is not left at a specific position but can be formed at various positions on the lower end of the core tube 54.

[0073] Therefore, as illustrated in FIG. 3B, there may occur a state where the lump 56 of yarn is left only at the detecting position of the photosensor 55a and the yarn is hardly left at other portions. In this case, if there is only one photosensor 55a or 55b, determination may be wrongly made that sufficient amount of yarn is still left on the yarn supplying bobbin 8 even though only a very small amount of yarn is actually left on the yarn supplying bobbin 8 (only the lump 56 exists). When the lump 56 of yarn that is left last is unwound from such a state, the unwinding of the yarn of the yarn supplying bobbin 8 is immediately terminated and a state in which a small amount of yarn is left cannot be detected in advance before the end of unwinding of the yarn.

[0074] In the present embodiment, two photosensors 55a, 55b are used, and the unit control section 5 determines that the yarn of the yarn supplying bobbin 8 is less than a predetermined amount when at least one of the two photosensors 55a, 55b detects that there is no yarn

at the detecting position. In other words, even if the yarn unwound last exists in a lump form at the detecting position of one of the sensors 55a, 55b, the yarn of the yarn supplying bobbin 8 is determined to be less than the predetermined amount if there is no yarn at the detecting position of the other sensor 55b or 55a. According to such a configuration, a state in which only the lump 56 of yarn is left on the core tube can be detected in advance before the end of unwinding of the yarn.

[0075] The number of photosensors of the yarn amount detecting section 12 is not limited to two, and three or more sensors may be arranged with a spacing in the vertical direction. In this case as well, the yarn of the yarn supplying bobbin 8 is determined to be less than the predetermined amount when at least one of the photosensors detects that there is no yarn.

[0076] A series of processing in replacing the yarn supplying bobbin during package winding will be described. FIG. 4 is a flowchart describing the processing. In FIG. 4, Si (i = 10, 11, 12 ...) indicates a step number.

[0077] During the package winding, the yarn unwound from the yarn supplying bobbin 8 is wound and accumulated by the yarn accumulating device 22, and the yarn unwound from the yarn accumulating device 22 is wound around the winding tube 6 in the package forming device 4. In this case, the package forming device 4 and the yarn accumulating device 22 respectively wind the yarn at a high winding speed (hereinafter referred to as winding speed during normal winding) of greater than or equal to a prescribed winding speed. While the winding of the package P is being carried out in such a manner, the amount of yarn of the yarn supplying bobbin 8 is detected by the yarn amount detecting section 12 of the bobbin supporting section 3 (S10: yarn amount detecting step). When a state in which the amount of yarn of the yarn supplying bobbin 8 is less than the predetermined amount is detected by the yarn amount detecting section 12 (S10: Yes), determination is made that the end of unwinding of the yarn of the yarn supplying bobbin 8 is close, and the unit control section 5 controls the roller driving motor 41 to greatly decelerate the rotation speed (winding speed) of the yarn accumulating roller 40 from the winding speed during the normal winding (S11: decelerating step). This decelerating state is maintained until the yarn left on the yarn supplying bobbin 8 is all unwound.

[0078] In the present embodiment, the clearer 21 (yarn defect detecting device) is used as a yarn state detecting section for detecting the end of unwinding of the yarn of the yarn supplying bobbin 8. That is, the unit control section 5 can reliably grasp whether or not the yarn of the yarn supplying bobbin 8 is all unwound by detecting the presence or absence of the travelling yarn by the clearer 21. In the normal package winding operation of the winding unit 1, the detection signal of the clearer 21 for detecting the yarn defect is used for the detection of the end of unwinding of the yarn of the yarn supplying bobbin 8, and thus a dedicated detecting section for detecting the end of unwinding of the yarn becomes unnecessary.

[0079] When the clearer 21 detects that the travelling yarn has run out (S12: Yes), the unit control section 5 stops the rotation of the yarn accumulating roller 40 (S13: stopping step). As described above, since the winding speed of the roller 40 is decelerated before the yarn accumulating roller 40 is stopped, a time required after the end of unwinding of the yarn is detected by the clearer 21 and until the yarn accumulating roller 40 is completely stopped becomes shorter.

[0080] Therefore, the yarn accumulating roller 40 can be stopped before the yarn end unwound last from the yarn supplying bobbin 8 reaches the yarn accumulating roller 40. Even if the yarn end is wound by the yarn accumulating roller 40, the yarn end is less likely to bite into the yarn layer of the yarn accumulating roller 40 since the tension of the yarn is reduced by the deceleration before the end of unwinding of the yarn. Also, the yarn end is not flipped to a position distant from the position (position of the tapered portion 40a of the basal end portion) where the yarn end is pulled out by the upper yarn pull-out device 42. Therefore, the yarn end of the yarn unwound from the yarn supplying bobbin 8 is easily pulled out and caught by the upper yarn pull-out device 42 in the following yarn joining processing (S15). Thus, the success rate of the yarn joining operation with the lower yarn Y2 (yarn of the newly supplied yarn supplying bobbin 8) performed by the yarn joining device 19 increases.

[0081] Furthermore, in the control described above, the deceleration control of the yarn accumulating roller 40 in S11 of FIG. 4 is preferably carried out such that the speed is obtained at which the yarn end is always not wound around the yarn accumulating roller 40 when the unwinding of the yarn of the yarn supplying bobbin 8 is finished. For example, the distance along the yarn travelling path between the clearer 21 and the yarn accumulating roller 40 is known since it can be determined from the position relationship of the clearer 21 and the yarn accumulating roller 40. Therefore, in S11, the speed of the yarn accumulating roller 40 is decelerated to a speed lower than or equal to a speed at which the rotation of the yarn accumulating roller 40 can be stopped before the yarn travels the above distance after passing the clearer 21 and reaches a position near the yarn end pull-out position (tapered portion 40a on the basal end side) of the yarn accumulating roller 40. Thus, by stopping the yarn accumulating roller 40 before the yarn end of the yarn supplying bobbin 8 reaches the yarn accumulating roller 40a, state is obtained in which the yarn end is always outside the yarn accumulating device 22 and the yarn end can be very easily caught.

[0082] When decelerating the winding speed of the yarn accumulating roller 40 in S11, the winding speed of the package forming device 4 (rotation speed of the traverse drum 34) may be decelerated at the same time. Therefore, sudden reduction in the yarn amount accumulated in the yarn accumulating roller 40 can be avoided, and the yarn accumulated in the yarn accumulating device 22 can be prevented from running out.

[0083] After the unwinding of the yarn of the yarn supplying bobbin 8 is finished, the yarn supplying bobbin 8 supported by the bobbin supporting section 3 of FIG. 1 is replaced (S14). Specifically, the bobbin supporting section 3 first flips the empty yarn supplying bobbin 8 by the springboard 11 to discharge this empty bobbin. The bobbin supplying device 2 then drops the yarn supplying bobbin 8 accommodated in the magazine 10 to the bobbin supporting section 3, and the bobbin supporting section 3 receives the dropped yarn supplying bobbin 8 and supports the yarn supplying bobbin 8 in a substantially upright position.

[0084] After the replacement of the yarn supplying bobbin 8 is completed, the yarn joining operation is performed by the yarn joining device 19 (S15). With respect to the lower yarn Y2 from the newly supplied yarn supplying bobbin 8, the yarn end blown up by the lower yarn blow-up device 16 illustrated in FIG. 1 is caught by the lower yarn catching device 20 so that the lower yarn Y2 is guided to the yarn joining device 19. The upper yarn Y1 is pulled out by the upper yarn pull-out device 42 illustrated in FIG. 1 and FIG. 2, and the upper yarn Y1 fed to the guide member 32 is caught by the upper yarn catching device 18 so that the upper yarn Y1 is guided to the yarn joining device 19. The lower yarn Y2 and the upper yarn Y1 are then joined by the yarn joining device 19 to form one yarn. After the yarn joining operation is finished, the unit control section 5 again rotates the yarn accumulating roller 40 to resume the winding of the yarn (accumulation of the yarn) to the roller 40 (S16).

[0085] During the replacing processing of the yarn supplying bobbin 8 and the yarn joining processing described above, the yarn accumulated in the yarn accumulating device 22 is unwound and fed into the package forming device 4, so that the winding of the package P is continuously carried out without being interrupted even during such processing, whereby the production efficiency of the package P is improved. However, if the yarn joining operation by the yarn joining device 19 fails, the time during which the yarn of the yarn accumulating device 22 is continuously wound without the yarn from the yarn supplying bobbin 8 being supplied becomes long by that much. Therefore, if the success rate of the yarn joining operation is low and the yarn joining operation fails in succession, the yarn of the yarn accumulating device 22 eventually runs out and the winding operation of the package P may be inevitably stopped. From this standpoint, the significance of easily catching the yarn end of the upper yarn Y1 and increasing the success rate of the yarn joining operation is great.

[0086] (Embodiment) A specific embodiment of the deceleration and stop control of the yarn accumulating device 22 when replacing the yarn supplying bobbin described above will be described. FIG. 5 shows graphs illustrating a deceleration profile of a yarn accumulating roller of one embodiment of the present invention and transition of remaining amount of yarn of the yarn supplying bobbin.

[0087] In this embodiment, the yarn accumulating roller 40 winds the yarn at the winding speed of 1500 m/min during the normal package winding. From this state, when the amount of yarn of the yarn supplying bobbin 8 becomes less than the predetermined amount (16 m herein as illustrated in the lower graph) according to the yarn amount detecting section 12 (point A in the upper graph), the winding speed of the yarn accumulating roller 40 is promptly decelerated from 1500 m/min to 200 m/min (deceleration: 2600 m/min/sec) in 0.5 seconds (point B). As is apparent from the lower graph, the yarn of about 7 m is unwound from the yarn supplying bobbin 8 during the deceleration. Thereafter, the winding is continued at a low speed of 200 m/min, and when a state is detected in which the yarn of the yarn supplying bobbin 8 has run out (end of unwinding of yarn) (point C) by the clearer 21 serving as the yarn state detecting section, the rotation of the yarn accumulating roller 40 is stopped (point D). Note that from point B to point C, the remaining yarn of about 9 m is unwound from the yarn supplying bobbin 8 by the unwinding at a prescribed speed (200 m/min).

[0088] It takes 0.08 seconds from the detection of the end of unwinding of the yarn by the clearer 21 (point C) until the yarn accumulating roller 40 is completely stopped (point D), and the yarn amount wound by the yarn accumulating roller 40 during this time is about 12 cm. Therefore, if the distance from the clearer 21 to the yarn accumulating roller 40 (distal end of guide tube 43 of upper yarn pull-out device 42) is greater than or equal to 12 cm, the yarn end stops without being pulled into the yarn accumulating roller 40. On the other hand, if the distance is less than 12 cm, the deceleration from point A to point B is to be set to a speed lower than 200 m/min.

[0089] An alternative embodiment in which various modifications are applied on the above embodiment will be described below. Portions having the configuration similar to the embodiment described above are denoted with the same reference numerals, and the description thereof will be appropriately omitted.

[0090] 1) In the above embodiment, after the yarn accumulating roller 40 is decelerated, detection is made that the yarn is all unwound from the yarn supplying bobbin 8 by a yarn absent detection signal of the clearer 21 (yarn defect detecting device). However, the yarn state detecting section for detecting the end of unwinding of the yarn may have a configuration other than the clearer 21.

[0091] The winding unit of the automatic winder may include a yarn state detecting device adapted to detect various states of the travelling yarn other than the clearer 21. For example, the yarn state detecting device may be a yarn presence/absence detecting device for detecting presence or absence of the travelling yarn, a yarn speed detecting device for detecting a speed of the travelling yarn, a yarn length detecting device for detecting the length of the traveling yarn, a yarn tension detecting device for detecting the tension of the travelling yarn, and the like. Such devices may be caused to perform detec-

tion as the yarn state detecting section, and the yarn accumulating roller 40 in the decelerating state may be stopped when detected that there is no longer yarn on the yarn travelling path. In this case as well, similarly to the embodiment using the clearer 21, the end of unwinding of the yarn of the yarn supplying bobbin 8 is detected using various detecting devices for detecting the state of the yarn in the normal winding operation of the winding unit. Thus, a dedicated detecting section for detecting the end of unwinding of the yarn becomes unnecessary.

[0092] Alternatively, the yarn amount detecting section 12 may be configured to not only detect that the amount of yarn of the yarn supplying bobbin 8 is less than the predetermined amount, but also to detect a state in which the unwinding of the yarn is finished and the yarn of the yarn supplying bobbin 8 has completely run out. According to such a configuration, the yarn accumulating roller 40 can be stopped by the detection of the end of unwinding of the yarn by the yarn amount detecting section 12.

[0093] For example, the sensor constituting the yarn amount detecting section 12 may be a so-called area sensor adapted to detect the presence or absence of the yarn existing within a predetermined range in the surface of the yarn supplying bobbin 8. If the area sensor is adopted, detection can be made not only that the amount of yarn of the yarn supplying bobbin 8 is less than the predetermined amount, but also a state in which the yarn of the yarn supplying bobbin 8 has completely run out. According to another example, a state can be detected in which the yarn of the yarn supplying bobbin 8 has all run out when the yarn amount detecting section 12 is configured by a camera for imaging the surface of the yarn supplying bobbin 8 and an image analyzer for analyzing the image captured by the camera. In such configuration examples, since the start of deceleration and stopping of winding of the yarn accumulating roller 40 are carried out based on the detection result of one yarn amount detecting section 12, a special detecting section for detecting the end of unwinding of the yarn is not necessary.

[0094] 2) The above embodiment is an example in which the present invention is applied to the winding unit having the yarn accumulating device 22, but application can be made to a winding unit having a configuration in which the yarn accumulating device 22 is not arranged, that is, a configuration in which the yarn unwound from the yarn supplying bobbin 8 is directly wound by the package forming device 4 to form the package P.

[0095] FIG. 6 illustrates a side view of the winding unit described above. As illustrated in FIG. 6, in a winding unit 1A, the unwinding assisting device 15, the tension applying device 17, the yarn joining device 19, and the clearer 21 are arranged in order from the bobbin supporting section 3 on the yarn travelling path between the bobbin supporting section 3 and the package forming device 4. The yarn accumulating device 22 of the above embodiment is not arranged between the clearer 21 and the package forming device 4, and the yarn Y that passed through the clearer 21 is directly wound by the package

forming device 4.

[0096] In the winding unit 1A of FIG. 6, a configuration of guiding the yarn end of the upper yarn Y1 from the package forming device 4 and the yarn end of the lower yarn Y2 from the yarn supplying bobbin 8 respectively to the yarn joining device 19 during the yarn joining operation is slightly different from the above embodiment. An upper yarn catching and guiding pipe 60 (first yarn end catching section) for sucking and catching the upper yarn Y1 from the package P and guiding the upper yarn Y1 to the yarn joining device 19 and a lower yarn catching and guiding pipe 61 (second yarn end catching section) for sucking and catching the lower yarn Y2 from the yarn supplying bobbin 8 and guiding the lower yarn Y2 to the yarn joining device 19 are arranged above and below the yarn joining device 19. The upper yarn catching and guiding pipe 60 is arranged vertically swingable with a shaft 60a as a center, and includes a mouth 60b at the distal end thereof. The lower yarn catching and guiding pipe 61 is also arranged vertically swingable with a shaft 61a as center, and includes a suction port 61b at the distal end thereof. Furthermore, an appropriate negative pressure source is connected to the upper yarn catching and guiding pipe 60 and the lower yarn catching and guiding pipe 61, where air is sucked with the mouth 60b and the suction port 61b at the respective distal end to catch the yarn end.

[0097] The upper yarn catching and guiding pipe 60 is swung to the lower side after catching the yarn end of the upper yarn Y1 wound around the surface of the package P with the mouth 60b to guide the caught upper yarn Y1 to the yarn joining device 19. Similarly, the lower yarn catching and guiding pipe 61 is also swung to the upper side after sucking and catching the yarn end of the lower yarn Y2 of the yarn supplying bobbin 8 with the suction port 61b to guide the caught lower yarn Y2 to the yarn joining device 19.

[0098] Also in the winding unit 1A, when the yarn is all unwound from the yarn supplying bobbin 8, the yarn end may get entangled with the package P or may bite into the yarn layer of the package P. Alternatively, the yarn end may be flipped to a position displaced from the position where the mouth 60b sucks and catches the yarn end. In such cases, the yarn end becomes difficult to be caught by the mouth 60b. Therefore, in such a winding unit 1A as well, it is very effective to apply the present invention and decelerate the winding speed of the package forming device 4 prior to the end of unwinding of the yarn of the yarn supplying bobbin 8 in terms of enabling the yarn end to be easily caught and increasing the success rate of the yarn joining operation. In the present embodiment, the package forming device 4 is the winding section adapted to wind the yarn unwound from the yarn supplying bobbin 8.

[0099] In the above embodiment, two photosensors 55a, 55b are illustrated as the yarn amount detecting section 12 of the winding unit 1, 1A, but the present invention is not limited thereto. An unwinding length de-

tecting sensor for detecting the length of the yarn from the behavior of the yarn unwound from the yarn supplying bobbin 8 may be adopted for the yarn amount detecting section 12.

[0100] Therefore, the remaining yarn amount, which is the amount of yarn left on the yarn supplying bobbin, can be calculated by detecting the length of the yarn unwound from the yarn supplying bobbin by the unwinding length detecting sensor for detecting the length of the yarn. Thus, the state immediately before the end of the unwinding of the yarn in which the yarn amount becomes small is prevented from being overlooked.

Claims

1. A yarn winding device (1) **characterized by** comprising:

a bobbin supporting section (3) adapted to support a yarn supplying bobbin (8);
 a winding section (4, 22) adapted to wind a yarn (y) unwound from the yarn supplying bobbin (8);
 a yarn amount detecting section (12) adapted to detect an amount of yarn of the yarn supplying bobbin (8);
 a control section (5) adapted to control a winding speed of the winding section (4, 22); and
 a yarn state detecting section (21) adapted to detect a state of a travelling yarn, wherein the control section (5) is adapted to predict an end of unwinding of the yarn (y) of the yarn supplying bobbin (8) based on a detection result of the yarn amount detecting section (12), and to decelerate the winding speed of the winding section (4, 22) to stop the winding operation of the winding section before a yarn end reaches the winding section (4, 22) based on the detection result of the yarn state detecting section (21) after the end of unwinding of the yarn (y) from the yarn supplying bobbin (8).

2. The yarn winding device (1) according to claim 1, **characterized in that** the control section (5) is adapted to decelerate the winding speed of the winding section (4, 22) when the yarn amount detecting section (12) detects that the amount of yarn of the yarn supplying bobbin (8) is less than a predetermined amount.
3. The yarn winding device (1) according to claim 2, **characterized in that** the yarn amount detecting section (12) includes a plurality of sensors (55a, 55b) each adapted to detect presence or absence of yarn at a plurality of positions in an axial direction of the yarn supplying bobbin (8).
4. The yarn winding device (1) according to claim 3,

characterized in that the control section (5) is adapted to determine that the amount of yarn of the yarn supplying bobbin (8) is less than the predetermined amount when at least one of the plurality of sensors (55a, 55b) detects that the yarn is absent at its detecting position.

5. The yarn winding device (1) according to claim 2, **characterized in that** the yarn amount detecting section (12) is an unwinding length detecting sensor adapted to detect a length of the yarn unwound from the yarn supplying bobbin (8).
6. The yarn winding device (1) according to any one of claims 1 to 5, **characterized in that** the yarn state detecting section (21) is arranged in a yarn travelling path between the bobbin supporting section (3) and the winding section (4, 22), and the control section (5) is adapted to decelerate the winding speed of the winding section (4, 22) and then to stop the winding operation of the winding section (4, 22) when the yarn state detecting section (21) no longer detects the yarn.
7. The yarn winding device (1) according to claim 6, **characterized in that** the yarn state detecting section (21) is a yarn defect detecting device (21) adapted to detect a yarn defect contained in the yarn.
8. The yarn winding device (1) according to claim 6, **characterized in that** the yarn state detecting section (21) is a yarn presence/absence detecting device adapted to detect presence or absence of the yarn travelling through the yarn travelling path.
9. The yarn winding device (1) according to claim 6, **characterized in that** the yarn state detecting section (21) is a yarn speed detecting device adapted to detect a speed of the yarn travelling through the yarn travelling path.
10. The yarn winding device (1) according to claim 6, **characterized in that** the yarn state detecting section (21) is a yarn length detecting device adapted to detect a length of the yarn travelling through the yarn travelling path.
11. The yarn winding device (1) according to claim 6, **characterized in that** the yarn state detecting section (21) is a yarn tension detecting device adapted to detect a tension of the yarn travelling through the yarn travelling path.
12. The yarn winding device (1) according to any one of claims 1 to 5, **characterized in that** the yarn amount detecting section (12) also serves as the yarn state detecting section (21) adapted to detect a state in which the unwinding of the yarn is

finished and the yarn is not left on the yarn supplying bobbin (8) in addition to detecting whether or not the yarn of the yarn supplying bobbin (8) is less than the predetermined amount, and
the control section (5) is adapted to decelerate the winding speed of the winding section (4, 22), and then to stop the winding operation of the winding section (4, 22) when a state in which no yarn is left on the yarn supplying bobbin (8) is detected by the yarn amount detecting section (12).

13. The yarn winding device (1) according to any one of claims 1 to 12, **characterized by** further comprising:

a first yarn end catching section (60) adapted to catch a yarn end from the winding section (4, 22) after replacing the yarn supplying bobbin (8); a second yarn end catching section (61) adapted to catch a yarn end from the yarn supplying bobbin (8) in replacing the yarn supplying bobbin (8); and
a yarn joining device (19) adapted to join the yarn end from the winding section (4, 22) and the yarn end from the yarn supplying bobbin (8) respectively caught by the first yarn end catching section (60) and the second yarn end catching section (61).

14. The yarn winding device (1) according to any one of claims 1 to 13, **characterized by** further comprising a package forming device (4) adapted to wind the yarn (y) of the yarn supplying bobbin (8) around a winding tube (6) to form a package (P), wherein the winding section is a yarn accumulating device (22) arranged between the bobbin supporting section (3) and the package forming device (4) and adapted to wind the yarn (y) unwound from the yarn supplying bobbin (8) to temporarily accumulate the yarn (y), and
the package forming device (4) winds the yarn (y) unwound from the yarn accumulating device (22) around the winding tube (6).

15. The yarn winding device (1) according to claim 14, **characterized in that** the control section (5) is adapted to decelerate a winding speed of the package forming device (4) when decelerating the winding speed of the winding section (4, 22) prior to the end of unwinding of the yarn (y) of the yarn supplying bobbin (8).

16. The yarn winding device (1) according to any one of claims 1 to 13, **characterized in that** the winding section is a package forming device (4) adapted to wind the yarn of the yarn supplying bobbin (8) around a winding tube (6) to form a package (P), and the package forming device (4) is adapted to unwind the yarn (y) from the yarn supplying bobbin (8) to wind

the yarn (y) around the winding tube (6).

17. A yarn winding method for winding a yarn (y) unwound from a yarn supplying bobbin (8), the method **characterized by** comprising:

a step of detecting a yarn amount left on the yarn supplying bobbin (8); and
a step of predicting end of unwinding of the yarn of the yarn supplying bobbin (8) from a detection result of the yarn amount detecting step, and decelerating a winding speed of a winding section adapted to wind the yarn prior to the end of unwinding of the yarn of the yarn supplying bobbin (8).

18. The yarn winding method according to claim 17, **characterized by** further comprising
a step of stopping the winding section before the yarn end when the yarn (y) of the yarn supplying bobbin (8) is all unwound reaches the winding section after the winding speed of the winding section is decelerated in the decelerating step.

FIG. 1

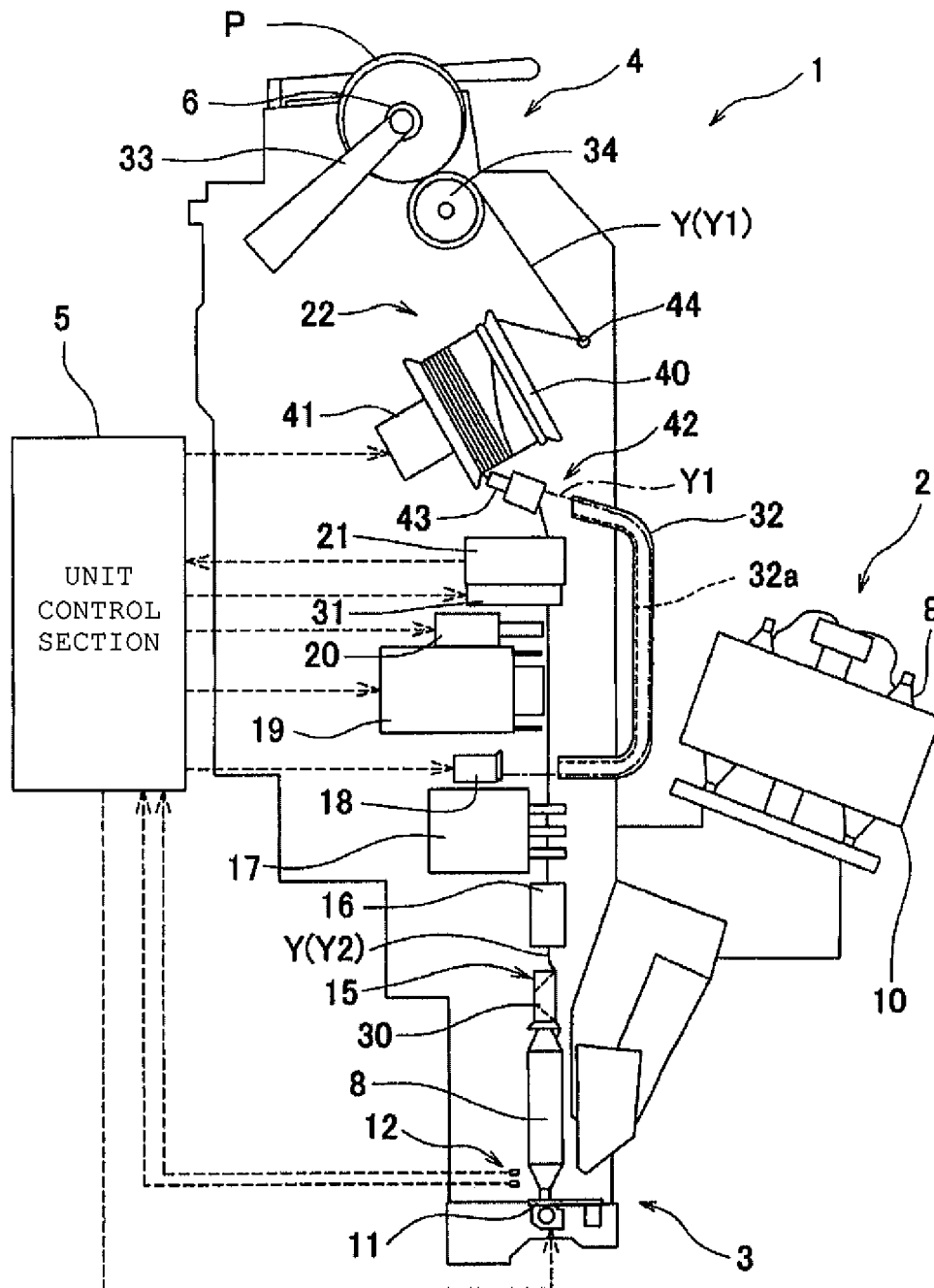


FIG. 2

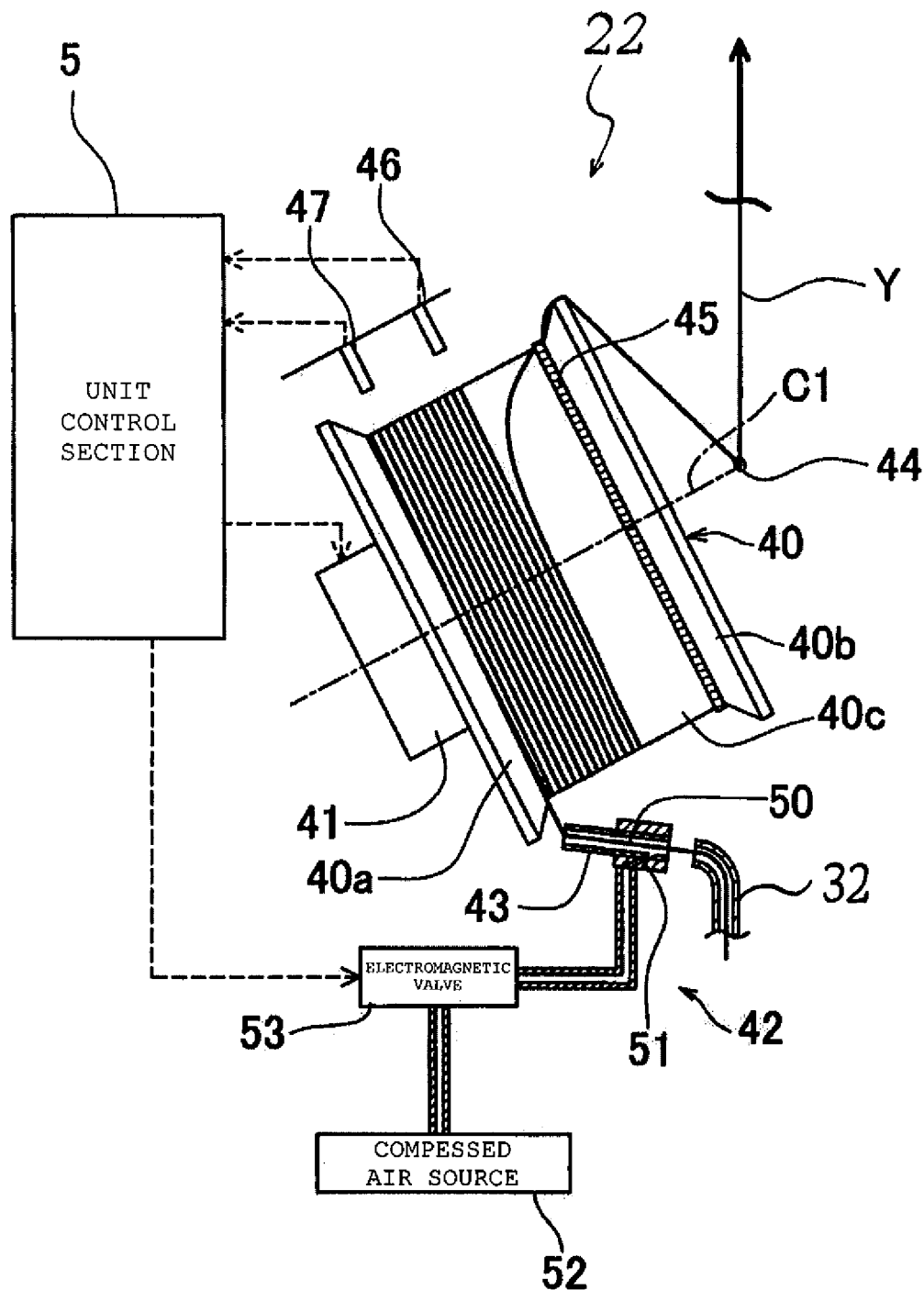


FIG. 3A

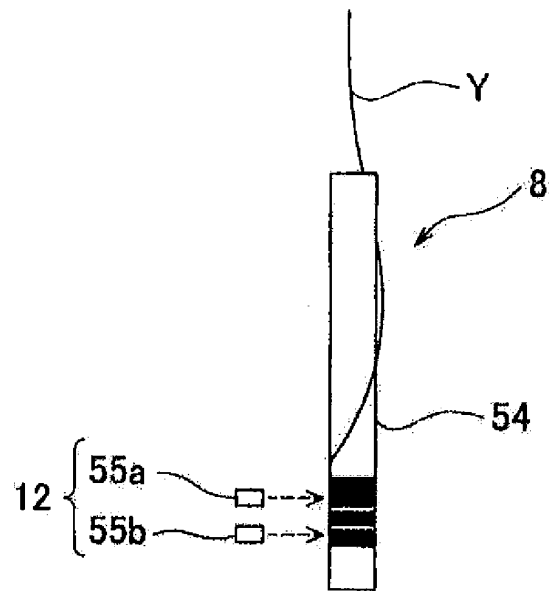


FIG. 3B

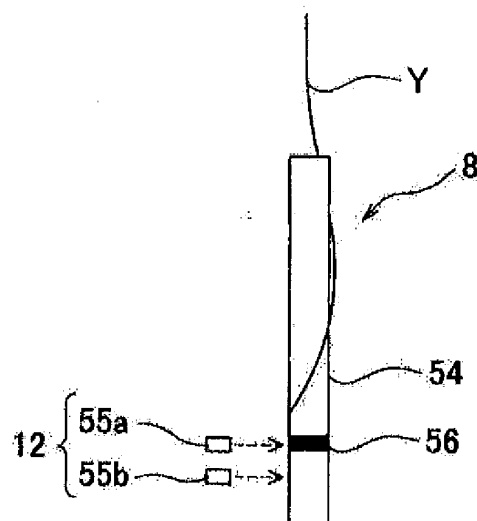


FIG. 4

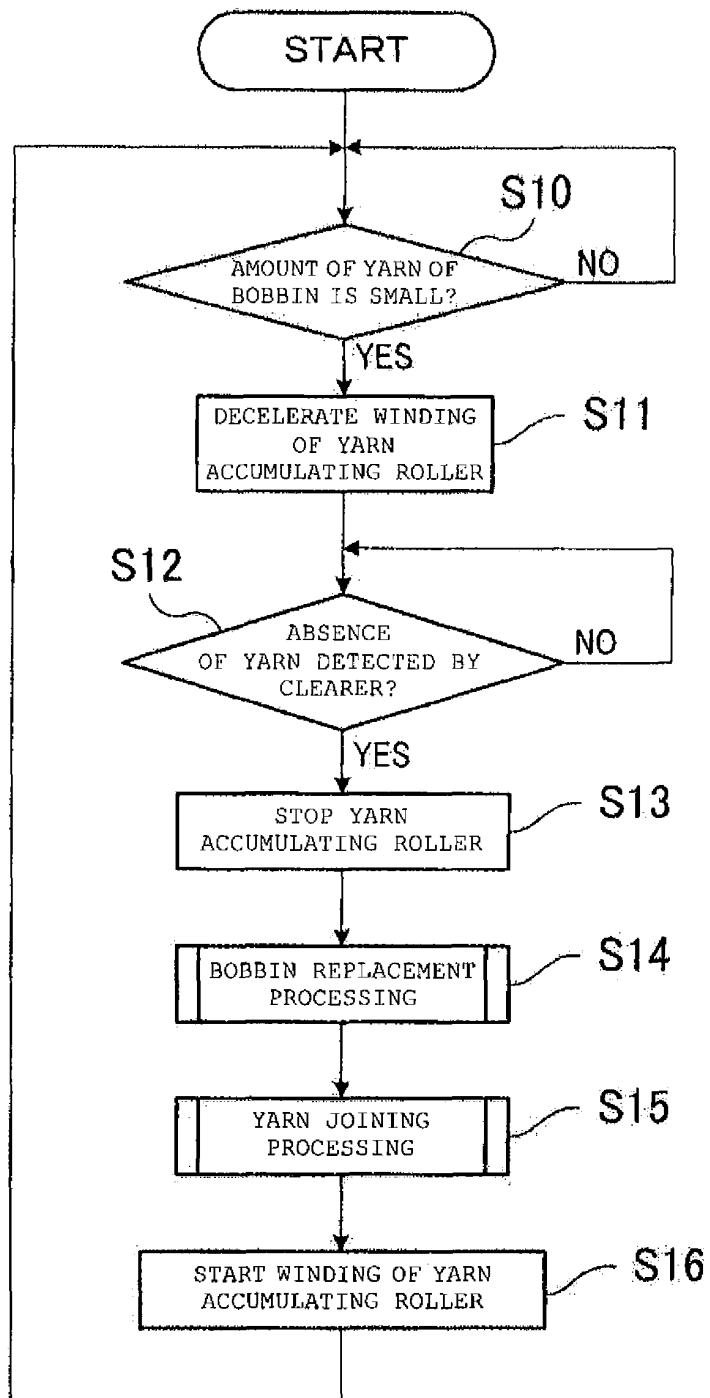


FIG. 5

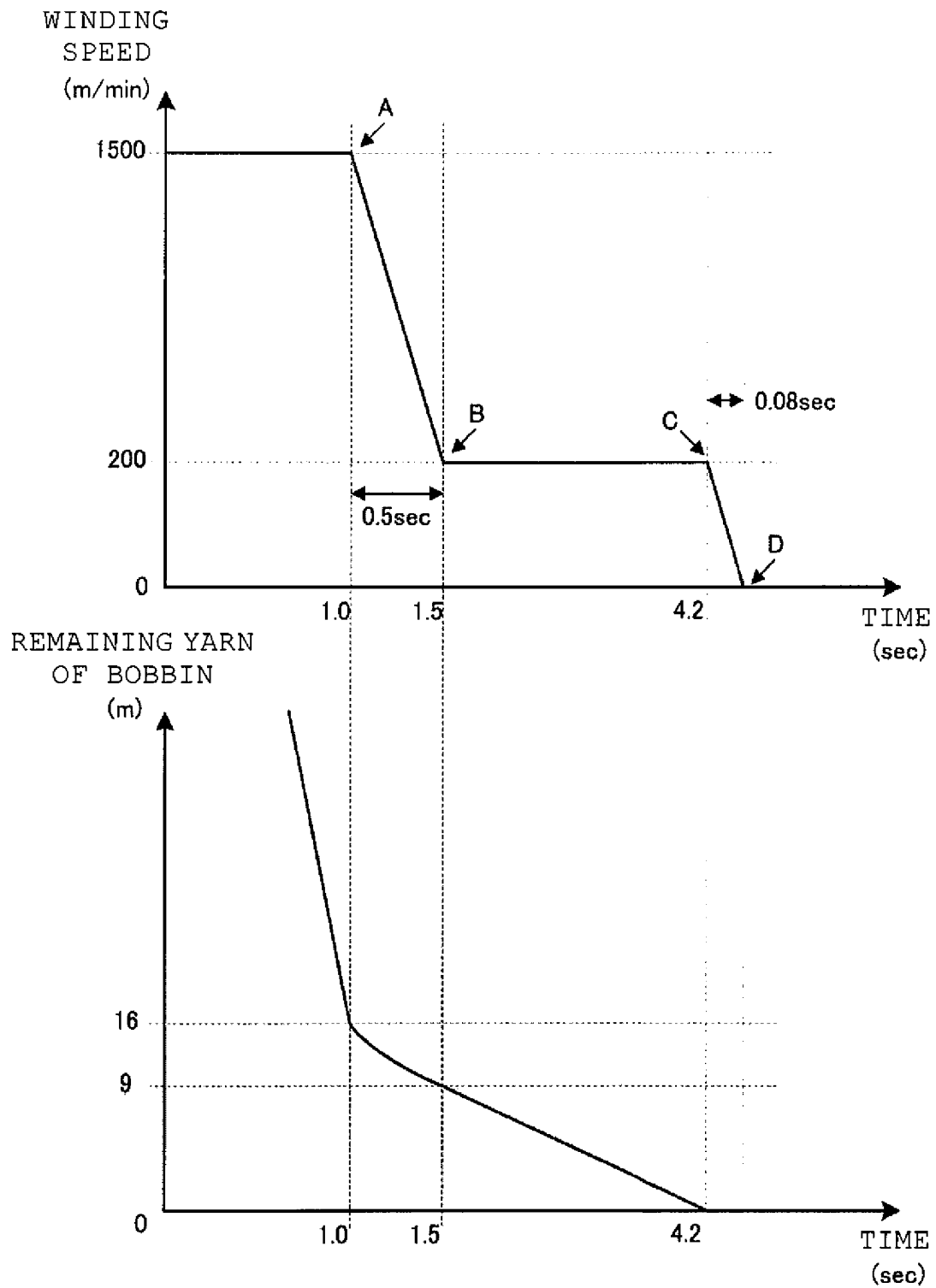
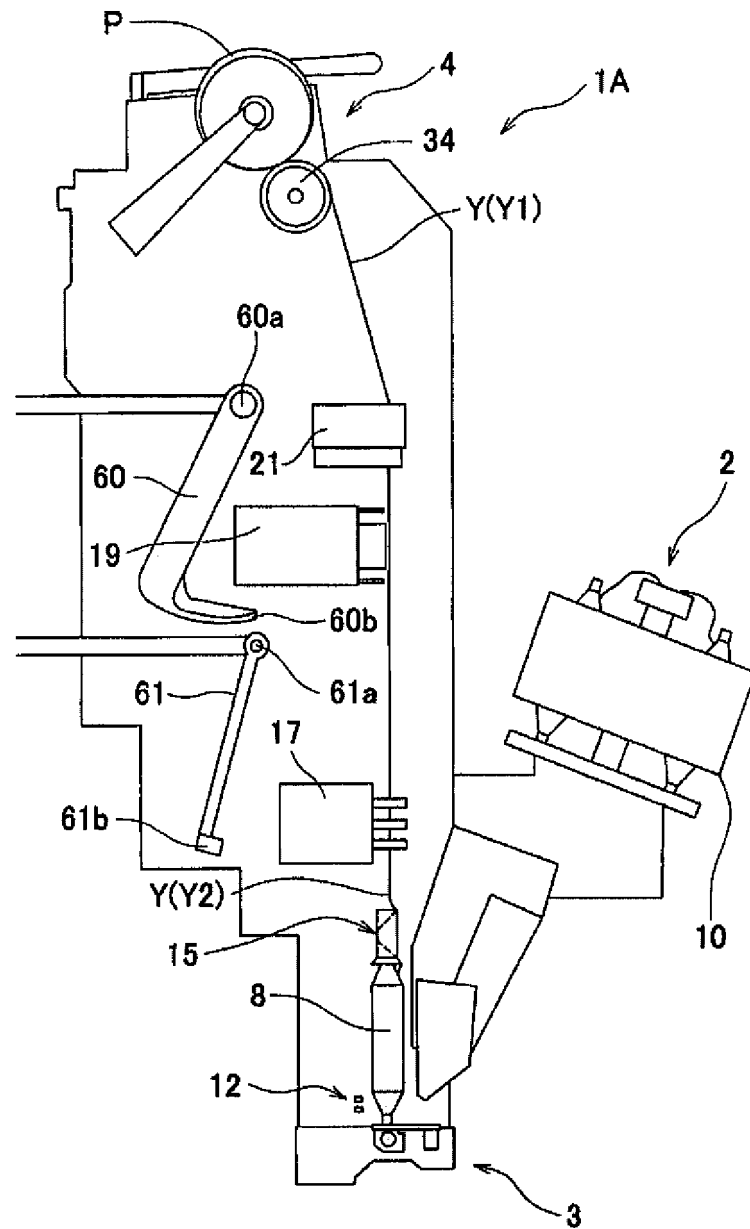


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2009242036 A [0003] [0005]
- JP 2009242042 A [0004] [0006]